



FOUNDATION INVESTIGATION AND DESIGN REPORT

for

NEW CNR OVERHEAD ON HIGHWAY 40

SITE NO.: 14X-0290/B2

G.W.P. 3064-11-00

W.P. 3064-11-02

GEOGRAPHICAL TOWNSHIP OF SARNIA

LAMBTON COUNTY, ONTARIO

LATITUDE AND LONGITUDE: 42.955937, -82.345729

PETO MacCALLUM LTD.
165 CARTWRIGHT AVENUE
TORONTO, ONTARIO
M6A 1V5
Phone: (416) 785-5110
Fax: (416) 785-5120
Email: toronto@petomacallum.com

Distribution:

Electronic Copy: WSP Group Limited for
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PML Ref.: 20TF017
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Geocres No.: 40J16-91
May 4, 2022



PART A - FOUNDATION INVESTIGATION REPORT

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PART A - FOUNDATION INVESTIGATION REPORT

For

New CNR Overhead on Highway 40
Site No.: 14X-0290/B2, GWP 3064-11-00
Geographical Township of Sarnia
Lambton County, Ontario

1. INTRODUCTION

The Ministry of Transportation Ontario (MTO) has retained WSP Canada Ltd. (WSP) as the Prime Consultant, to provide Foundation Engineering Services for the detail foundation investigation and design for the new Canadian National Railway (CNR) Overhead on Highway 40. WSP retained Peto MacCallum Ltd. (PML) on behalf of MTO to provide geotechnical engineering services for the assignment.

The Scope of Work for the Foundations Engineering Services are outlined in the PML proposal, dated April 17, 2020 by PML. This report summarizes the results of the foundation investigation carried out to support the new CNR overhead on Highway 40, located in the Township of Sarnia, Lambton County, Ontario. Foundation investigation and design reports for the replacement of the south culvert, and approach embankments have been completed by PML under separate covers.

The purpose of the investigation was to explore the subsurface conditions to provide foundation recommendations to facilitate and support the new overhead.

The elevations (EL.) in this report are expressed in meters, unless otherwise noted.

2. SITE DESCRIPTION

The site is located approximately 480 m south of the intersection of Confederation Line and Highway 40 in Lambton County, Ontario. The existing CNR overhead accommodates a total of two (2) lanes of vehicular traffic in the northbound and southbound directions (one lane in each direction), and provides access to Highway 402.

The site area is typically flat with the exception of the existing embankments, and is mainly surrounded by industrial and commercial buildings. The residential neighbourhood of Sherwood Village is located in the northwest quadrant of the Confederation Line and Highway 40 intersection.



Geocres Report (40J16-013) reports that the CNR had constructed a small embankment of about 1.5 m (5.0 ft.) above the original ground level using a heterogeneous fill material of clayey silt, sand, gravel, boulders, and cinders prior to construction of the existing Highway 40 and CNR overhead structure.

The existing Highway 40 embankments, north and south of the existing overhead, was placed more than 40 years ago during the construction of the existing overhead structure. Though there were no records of boreholes for this fill, Geocres Report 40J16-61 (1994) indicated that "this approach fill consists of clayey silt to silty clay with varying proportion of sand, boulders and cinders. The thickness of this fill varies from 2.7 m to a maximum of 9.9 m".

3. SITE RECONNAISSANCE

PML staff visited the site with CNR representatives on April 9, 2020 to conduct a site reconnaissance and confirm the accessibility of the proposed borehole locations within the existing CNR track alignment and Right-of-Way (ROW).

4. PREVIOUS FOUNDATION INVESTIGATION AND SUBSURFACE CONDITIONS

The general subsurface conditions presented in this section are based on the Foundation Investigation Reports, GEOCRE 40J16-013, dated March 25, 1963, and GEOCRE 40J16-61, dated October 12, 1994.

The original investigation was carried out for the proposed extension of Highway 40 (Line 'A') crossing the Canadian National Railway tracks by means of an overhead structure.

The Foundation Investigation Report included the Borehole Location and Soil Strata Drawing (Drawing No. 63-F-12A), dated February 1963, which shows the location of Boreholes 1 to 8 and the inferred soil stratigraphy based on the borehole data across the site location. The previous record of borehole sheets and drawings are provided in Appendix A.



The foundation investigation was carried out between January 29 and February 11, 1963 by Canadian Longyear Drilling Company. The field investigation comprised of eight (8) boreholes that were advanced using 125 mm (5 in.) diameter flight augers to depths of 9.3 m to 38.1 m (30.5 ft. to 125.0 ft.), EL. 150.6 to 178.2 (494.0 ft. to 584.5 ft.). A summary of the subsurface soil and groundwater conditions are provided in the following paragraphs.

Very stiff to firm heterogeneous silty clay to clayey silt fill, with sand, gravel, boulders and cinders, was encountered immediately at the ground surface in Boreholes 1, 4 and 5, extending to EL. 186.1 to EL. 185.9. The thickness of the fill ranged from 2.7 m to 3.1 m. Standard Penetration Test (SPT) N values recorded varied between 4 and 24. Moisture content determinations of samples from the fill layer ranged approximately from 9.0% to 23.0%.

Hard to firm clayey silt to silty clay was encountered below the fill in Boreholes 1, 4 and 5, and immediately at the ground surface in the remaining boreholes. Borehole 8 was terminated in this deposit at a depth of 9.3 m, EL. 178.2, below ground surface. In the remaining boreholes, the cohesive deposit extended 36.2 m to 38.2 m, EL. 150.6 to EL. 150.9, below ground surface, overlying probable bedrock. The thickness of the deposit ranged from 35.0 m to 36.9 m, where fully penetrated. Moisture content determinations for the cohesive samples ranged approximately between 8.0% and 23.0%. The undrained shear strength of the till soil was measured in the field by in-situ vane testing and by unconfined compression tests in the laboratory. The field vane shear test results obtained were between approximately 45 and 132 kPa with sensitivity ranging between 1.5 and 3.0. Laboratory shear strengths obtained for clayey silt till ranged from in excess of 239 kPa (5000.0 psf) in the crust to a minimum 26 kPa (540.0 psf) at EL. 181.1 (594.0 ft.).

Groundwater was observed in all boreholes, except for Borehole 8, during the site investigation between elevations 181.3 m (595.0 ft.) and 186.5 m (612.0 ft.), about 1.1 m (3.5 ft.) to 6.1 m (20 ft.) below ground surface. No artesian water was observed at the site location. Natural gas was observed in all boreholes when contact was made with the bedrock.

For further details, refer to GEOCRES 40J16-013, dated March 25, 1963, and GEOCRES 40J16-61, dated October 12, 1994.



5. CURRENT FIELD INVESTIGATION PROCEDURES

The current fieldwork for the foundation investigation was carried out between July 20, 2020 and September 11, 2020. A total of 17 boreholes were investigated for the project. Eight (8) boreholes, relevant to the proposed overhead structure (Boreholes C-2, C-3, CN-4, CN-5, CN-7, CN-8, RW-1, and RW-2), were advanced to depths ranging from 11.3 m to 48.8 m (EL. 177.5 to EL. 146.6) below the existing ground surface (EL. 196.0 to EL.188.5). Boreholes C-2 and C-3 were investigated for the existing south culvert. The borehole Location plan, and the soil stratigraphic profiles and sections are presented on drawings DWGs CN-1 and CN-2 provided in Appendix B. A summary of the depths and locations of the boreholes with respect to the proposed CNR overhead structure is provided in Table 1.

Table 1: Summary of Borehole Location Details

| LOCATION | BOREHOLE ID | GROUND SURFACE ELEVATION (m) | BOREHOLE DEPTH (m) | COORDINATES | | | |
|---------------------------------|-------------|------------------------------|--------------------|-------------|-----------|----------------|-------------|
| | | | | (MTM ON-11) | | DECIMAL DEGREE | |
| | | | | NORTHING | EASTING | LATITUDE | LONGITUDE |
| North Approach | CN-4 | 195.5 | 20.4 | 4 757 383.4 | 317 380.4 | 42.956142 | - 82.345811 |
| North Abutment | CN-5 | 195.4 | 48.8 | 4 757 360.6 | 317 387.1 | 42.955937 | - 82.345729 |
| North Abutment / Retaining Wall | RW-2 | 195.4 | 45.7 | 4 757 366.4 | 317 373.8 | 42.955990 | - 82.345893 |
| Center Pier | CN-6 | Borehole Cancelled | | | | | |
| South Abutment | CN-7 | 195.9 | 48.7 | 4 757 275.2 | 317 383.1 | 42.955168 | - 82.345780 |
| South Abutment/ Retaining Wall | RW-1 | 196.0 | 45.7 | 4 757 272.4 | 317 370.3 | 42.955144 | - 82.345938 |
| South Approach | CN-8 | 195.7 | 20.4 | 4 757 204.6 | 317 374.6 | 42.954533 | - 82.345886 |
| Culvert (mid) | C-2 | 188.8 | 11.3 | 4 757 293.0 | 317 378.9 | 42.955329 | - 82.345831 |
| Culvert Outlet | C-3 | 188.5 | 41.5 | 4 757 291.0 | 317 350.3 | 42.955311 | - 82.346182 |



The borehole locations were selected based on the preliminary Highway 40/CNR Overhead plan and profile drawing, received via email dated November 4, 2019. The locations of these boreholes were reviewed and approved by WSP and MTO prior to commencement of field work.

PML staff used a portable GPS device to establish the borehole locations in the field. Subsequently, PML carried out the survey of the borehole locations as drilled and elevations using a Sokkia SHC5000 Differential GPS system, equipped with a GCX3 (Network RTK rover) GNSS Receiver. The vertical and horizontal accuracy of this equipment are within 0.1 m and 0.5 m, respectively. The survey information provided in this report are referred to in MTM NAD 83 Northing and Easting (MTM Zone – ON11) Geodetic datum and expressed in meters.

PML engineering staff arranged for the clearance of underground services and appropriate permit applications. The respective utility companies cleared the underground services at the borehole locations. Public and private utility authorities were informed, and all of the utility clearance documents were obtained prior to commencement of drilling work.

Due to accessibility issues, Borehole CN-6, located along the centerline of the existing CNR tracks, was cancelled and removed from the borehole programme. Upon discussion and approval by WSP/MTO, Borehole C-3, located at the proposed culvert outlet, was extended to a depth of 41.5 m to supplement the bedrock data in lieu of Borehole CN-6.

The equipment used for drilling was owned and operated by London Soil Test Ltd. (London Soil), of London, Ontario, and Aardvark Drilling (Aardvark) of Guelph, Ontario. London Soil and Aardvark are specialist drilling contractors and worked under the full-time supervision of a PML field supervisor. The boreholes were advanced using a DIEDRICH D50T track-mounted drilling rig, and a CME 75 truck-mounted drilling rig equipped with 200 mm diameter hollow stem augers and rotary drilling capable of coring HQ size bedrock core samples. Water trucks were provided by the respective drillers during bedrock coring. Traffic control was provided by Facca Inc. for the investigation of Boreholes CN-5, CN-7, RW-1 and RW-2. CNR flag personnel was arranged and provided by Facca Inc. for the investigation of Boreholes C-2 and C-3.



Representative soil samples were recovered from the boreholes at 0.75 m intervals to 6.0 m depth, at 1.5 m intervals to 20.0 m depth, and at 3.0 m intervals beyond 20.0 m depth using a conventional 51 mm OD split spoon sampler in accordance with the SPT procedure. SPTs were conducted simultaneously with the sampling operation to assess the strength characteristics of the substrata. In-situ field vane tests were carried with an MTO vane where the recorded SPT N value was less than 8 blows for 300 mm penetration. Undisturbed samples were recovered by utilizing Shelby (thin wall) tubes, where possible. The recovered soil and rock samples were returned to the PML laboratory for detailed visual examination, and testing.

During drilling, natural methane gas was encountered in Borehole CN-5 from EL. 148.6 to EL. 149.6, in Borehole CN-7 from EL. 149.2 to EL. 150.2, in Borehole C-3 at EL. 171.7, in Borehole RW-1 from EL. 149.3 to EL. 150.3, and in Borehole RW-1 from EL. 187.7 to EL. 149.7. The drilling activity was immediately stopped when natural gas was encountered, and the gas level was immediately measured in the borehole using an RKL Eagle 2 unit. Once the natural gas completely dissipated from the borehole, confirmed by gas readings, drilling activity continued to the termination depth of the borehole.

The groundwater conditions at the borehole locations were observed during the drilling by visual examination of the soil samples, sampler, and drill rods as the samples were retrieved. In addition, water level measurements were taken using a Solinst flat tape water level reader in the open boreholes upon completion of drilling. Monitoring wells, consisting of 50 mm diameter PVC pipe, were installed in Boreholes CN-5 and CN-7. The monitoring wells were decommissioned on August 17, 2020. Refer to the Record of Borehole Sheets in Appendix B for details of the monitoring well installation.

Upon completion of drilling and monitoring of groundwater levels in the monitoring wells, the boreholes and the monitoring wells were decommissioned in accordance with the MTO guidelines and R.R.O. 1990, Reg. 903: Wells under Ontario Water Resources Act, as amended.



6. LABORATORY TEST PROCEDURES

6.1 Soil and Rock Testing

Laboratory tests on representative SPT samples recovered during the fieldwork were conducted by the laboratory owned by PML, located in Toronto. The laboratory testing program included the following:

- Natural moisture content determinations (166)
- Grain size distribution analyses (45)
- Hydrometer tests (45)
- Atterberg limits tests (46)
- One dimensional consolidation test (3)
- Unconfined compressive strength tests on rock (6)

All laboratory tests to determine the index properties were performed in accordance with the MTO test procedures, which follow the American Society for Testing Materials (ASTM) standards, with the exception of specific gravity (LS-705) and hydrometer test (LS-702). All the test results are summarized on the attached Record of Borehole Sheets provided with this report. The results of the grain size distribution analyses are presented on Figures GS-1, GS-2A/B, GS-3A/3B, and GS-4. The results of the Atterberg limit tests are presented on Figures PC-1, PC-2A/B, PC-3A/3B, and PC-4. The one-dimensional consolidation (ODC) test was conducted in accordance with ASTM D2435. The unconfined compressive strength (UCS) test on rock core samples was carried out in accordance with ASTM D4543. All test results are summarized on the attached Record of Borehole sheets and provided in Appendix B.

6.2 Chemical Analysis

A total of 14 representative soil samples were sent to SGS Canada Inc. (SGS) in Toronto, Ontario, which is accredited by Canadian Analytical Laboratory Association (CALA) for corrosivity analyses. The corrosivity test results provided by SGS are presented in Appendix C. A summary of the test results is also presented in Section 7.4; Table 4.



7. SITE GEOLOGY AND SUBSURFACE CONDITIONS

7.1 Site Geology

In general, the project area is located within the Lambton Clay Plains of the St. Clair Clay Plains physiographic region, which consists of lacustrine clay over the underlying till, as outlined in The Physiography of Southern Ontario (Chapman and Putnam, 1984).

The Quaternary Geology map published by the Ontario Ministry of Northern Development and Mines (MNDM), indicates that the surface conditions in the area of the CNR overhead structure site consist of St. Joseph Till clays. Based on the Bedrock Geology map (MRD126-REV1, 2011) published by the MNDM, the site lies within Upper Devonian black shale of the Kettle Point formations.

7.2 Subsurface Conditions

The subsurface conditions encountered during the current investigation along with the field and laboratory test results are shown on the attached Record of Borehole Sheets. The borehole locations and stratigraphic profile sections are shown on drawings DWG CN-1 and CN-2. The boundaries between soil strata have been established at the borehole locations only. The boundaries of soil strata between and beyond the boreholes are assumed and may vary from location to location.

In general, the subsoil conditions consist of 1.5 m to 9.2 m of fill, underlain by approximately 38.2 m to 45.8 m, where fully penetrated, of firm to very stiff silty clay/clayey silt deposit, followed by shale bedrock to a maximum termination depth of 48.8 m (EL. 146.6). For classification purposes, the soils encountered at this site can be divided into three (3) distinct zones:

- a) Fill
 - i. Sandy Silt, Some Gravel Fill
 - ii. Gravelly sand/Sand and Gravel, Trace Silt Fill
 - iii. Silty Clay/Clayey Silt, some Sand/Sandy, Trace Gravel Fill
- b) Silty Clay/Clayey Silt, Some/Trace Sand, Trace Gravel
- c) Shale Bedrock



7.2.1 Fill

i. Sandy Silt Fill

This sandy silt layer was encountered immediately below the existing ground surface in Borehole RW-2, and extended to a depth of 0.8 m (EL. 194.6) below the existing ground surface.

The SPT N value recorded in this layer was 11 blows for 30 cm penetration, indicating a compactness condition of compact.

The moisture content of one (1) sample tested from this layer was 15.2%.

ii. Gravelly Sand/Sand and Gravel Fill

This gravelly sand/sand and gravel layer was encountered immediately below the existing ground surface in Boreholes C-2 and C-3, and extended to depths of 1.5 m and 0.8 m (EL. 187.3 and EL. 187.7) below the existing ground surface, respectively.

The SPT N values recorded in this layer were 29 blows and 31 blows for 30 cm penetration, indicating a compactness condition of compact to dense. The moisture content of two (2) sample tested from this layer were 2.2% and 7.4%.

iii. Silty Clay/Clayey Silt Fill

This clayey silt/silty clay fill, with varying proportions of sand and gravel, was encountered immediately below the sandy silt fill in Borehole RW-2, below the gravelly sand/sand and gravel fill in Boreholes C-2 and C-3, and below the existing ground surface in all other investigated boreholes. This deposit ranged from 0.7 m to 9.2 m in thickness, and extended to depths ranging from 1.5 m to 9.2 m (EL. 187.2 to EL. 186.3) below the existing ground surface.

The SPT N values recorded in this layer ranged from as low as 4 blows to 22 blows for 30 cm penetration, indicating firm to very stiff consistency.



In-situ vane shear tests were carried out at depths where low 'N' values were observed. Vane tests were performed at eight (8) locations between EL. 195.0 and EL. 189.0 within this fill layer in Boreholes CN-5, CN-7, CN-8, RW-1 and RW-2. The uncorrected vane shear strengths (C_u) measured exceeded 120 kPa, indicating very stiff consistency.

The moisture content of samples tested from this layer varied from 5.0% to 24.1%, with an average value of 15.7%. The results of the sieve and hydrometer analysis tests performed on 12 representative samples from this layer are provided on Figures GS-1. The test results indicate that this deposit consists of 0% to 6% gravel, 16% to 48% sand, 26% to 47% silt, and 23% to 38% clay sized particles, with the exception of one (1) sample tested in Borehole RW-2; Sample 8, indicating values of 0% gravel, 1% sand, 65% silt and 34% clay sized particles. Atterberg limits tests were performed on the same samples selected for sieve analysis and the results are provided on Figures PC-1. The test results indicate liquid limit values of 26 to 41, plastic limit values ranging from 13 to 19, and the corresponding plasticity index values range from 10 to 24. Based on the test results, this fill may be classified as clayey silt (CL) / silty clay (CI) in the MTO classification system.

A test for unit weight was conducted on one (1) Shelby tube sample obtained from Borehole CN-5 that was considered to be representative of the site conditions. The dry unit weight of the sample was found to be 17.8 kN/m³.

7.2.2 Silty Clay/Clayey Silt

This silty clay/clayey silt deposit, with occasional clayey sand seams, was encountered immediately below the silty clay/clayey silt fill layer in all investigated boreholes. This deposit ranged from 36.5 m to 37.5 m in thickness and extends to depths of 38.2 m to 45.8 m (EL. 150.3 to EL. 149.6) below the existing ground surface, where the layer was fully penetrated. This layer was not fully penetrated in Boreholes C-2, CN-4, and CN-8, which extended to the termination depths of 11.3 m and 20.4 m (EL. 177.5, EL. 175.1, and EL. 175.3, respectively). At elevations ranging from EL. 149.3 to 148.6, near the bedrock surface, natural gas was encountered in Boreholes CN-5, CN-7, RW-1, and RW-2. In Borehole C-3, natural gas was encountered at EL. 171.7. In the previous GEOCRE report, the presence of natural gas was reported in all boreholes when contact was made with bedrock.



The SPT N values in this layer vary from as low as 1 blow to 35 blows for 30 cm penetration, indicating very soft to hard consistency. Between EL. 187.2 and EL. 162.0, a total of 24 in-situ vane shear tests were carried out. In general, the uncorrected vane shear strengths (C_u) measured between 33 kPa and 116 kPa, with a sensitivity ratio value between 1 and 3, indicating firm to very stiff consistency. However, five (5) in-situ vane shear tests exceeded 120 kPa, which occurred in Boreholes CN-4 (EL. 180.9), CN-5 (EL. 176.2), CN-7 (EL. 186.2), RW-1 (EL. 176.5), and RW-2 (EL. 169.5), indicating very stiff consistency compared to the soft to hard consistency based on SPT 'N' values.

SPT N Values over 100 blows for 30 cm penetration were recorded near the bedrock surface in Boreholes C-3, CN-5, CN-7, RW-1, and RW-2, indicating hard consistency.

The moisture content of samples tested from this layer ranged from 2.3% to 41.7%, with an average value of 22.9%. The results of the sieve and hydrometer analysis tests performed on 31 representative samples from this layer are provided on Figures GS-2A/B and GS-3A/B. The test results indicate that this deposit consists of 0% to 16% gravel, 8% to 47% sand, 27% to 64% silt, and 12% to 50% clay sized particles. Atterberg limits tests were performed on 32 representative samples, and the results are provided on Figure PC-2A/B and PC-3A/B. The test results indicate liquid limit values of 22 to 41, plastic limit values of 14 to 22, and the corresponding plasticity index values of 7 to 21. Based on the test results, this layer may be classified as clayey silt (CL) / silty clay (CI) in the MTO classification system.

The results of the sieve and hydrometer analysis tests performed on two (2) representative samples from the clayey sand seams are provided on Figures GS-4. Atterberg limits tests performed the same samples, and the results are provided on Figure PC-4.

One-dimensional consolidation testing was conducted on three (3) Shelby tube samples obtained from Boreholes CN-5, CN-7 and RW-2, and the test results are summarized in Table 2 and provided in Appendix B. As part of the one-dimensional consolidation and particle size analysis of soils (LS 702), specific gravity and unit weight tests were also performed on the selected samples. Specific gravity and unit weight tests were conducted on four (4) additional split spoon soil samples selected from Boreholes CN-4, CN-5, CN-7, and C-3. The specific gravity of the selected



samples ranged from 2.709 to 2.758, with an average value of 2.741. The unit weights of the tested samples ranged from 18.1 kN/m³ to 20.7 kN/m³, with an average value of 19.9 kN/m³.

Table 2: Summary of One-Dimensional Consolidation Test

| LOCATION | BOREHOLE ID | GROUND SURFACE ELEVATION (m) | SAMPLE DEPTH (m) | ESTIMATED σ'_{vo} (kPa) | ESTIMATED σ'_p (kPa) | c_c | c_{cr} |
|----------------|-------------|------------------------------|------------------|--------------------------------|-----------------------------|-------|----------|
| North Abutment | CN-5 | 195.4 | 15.2 – 15.8 | 215 | 430 | 0.33 | 0.05 |
| South Abutment | CN-7 | 195.9 | 15.2 – 15.8 | 216 | 491 | 0.30 | 0.07 |
| North Abutment | RW-2 | 195.4 | 18.3 – 18.9 | 254 | 254 | 0.22 | - |

σ'_{vo} – Effective Overburden Pressure; σ'_p – Preconsolidation Pressure; c_c – Compression Index;
 c_{cr} – Recompression Index

The virgin consolidation curves including σ'_{vo} , σ'_p , c_c and c_{cr} are presented in Appendix B, Figure Nos. CT-1 to CT-3.

7.2.3 Shale Bedrock

Boreholes RW-1 and RW-2 were terminated on probable bedrock at 45.7 m (EL. 150.3) and 45.7 m (EL. 149.7), respectively.

Bedrock was encountered in Boreholes CN-5, CN-7 and C-3, below the existing ground surface at elevations which varied from EL. 150.3 to EL. 149.6. The presence of bedrock was confirmed by obtaining 3.0 m to 3.3 m of rock cores from the boreholes. These boreholes were advanced using an HQ sized core barrel. The rock core recovery ranged from 74% to 100% and the Rock Quality Designation (RQD) of the rock cores ranged from 72% to 100%. With the exception of Run 1 in Borehole C-3 which had an RQD of 0%. Based on the RQD value, the quality of the bedrock at this site may be described as fair to excellent. Unconfined compressive strength (UCS) of rock core tested ranged from 60.8 MPa to 84.1 MPa. Based on the unconfined compression test values, the bedrock may be classified as Type R4 (strong) with respect to strength. The bedrock



was identified as unweathered shale bedrock. For complete description of the bedrock, refer to the Rock Core Photographs and the Rock Core Description logs provided in Appendix B.

7.3 Groundwater Conditions

Groundwater was encountered upon completion of drilling in Boreholes RW-1, RW-2, CN-5, CN-7, and C-2 at depths of 9.1 m (EL. 186.9), 15.2 m (EL. 180.2), 7.1 m (EL. 188.4), 8.2 m (EL. 187.7), and 6.1 m (EL. 182.6), respectively, below the existing ground surface. The groundwater level was not encountered or could not be established during drilling or upon completion of drilling in Boreholes CN-4, CN-8 and C-3. Monitoring wells, consisting of 50 mm diameter PVC pipe, were installed in Boreholes CN-5 and CN-7. Groundwater level readings following the installation of monitoring wells are shown on the Record of Borehole Sheets provided in Appendix B and summarized in Table 3. Groundwater levels may fluctuate due to the influence of precipitation and seasonal changes.



Table 3: Summary of Groundwater Level in Monitoring Wells

| BOREHOLE NO. | GROUND SURFACE EL. (m) | GROUNDWATER LEVEL UPON COMPLETION OF DRILLING | | GROUNDWATER LEVEL MEASURED IN MONITORING WELL | | | | | | | |
|--------------|------------------------|---|---------|---|---------|---------------|---------|-----------------|---------|-----------------|---------|
| | | DEPTH (m) | EL. (m) | DEPTH (m) | EL. (m) | DEPTH (m) | EL. (m) | DEPTH (m) | EL. (m) | DEPTH (m) | EL. (m) |
| | | | | JULY 22, 2020 | | JULY 29, 2020 | | AUGUST 10, 2020 | | AUGUST 17, 2020 | |
| CN-5 | 195.4 | 7.3 | 188.1 | - | - | 7.3 | 188.1 | 7.1 | 188.3 | 6.7 | 188.7 |
| CN-7 | 195.9 | 8.0 | 187.9 | 8.0 | 187.9 | - | - | 7.9 | 188.0 | 8.9 | 187.0 |



7.4 Chemical Analysis

A total of 14 representative soil samples were sent to SGS Canada Inc.'s (SGS) laboratory located in Toronto, Ontario, which is accredited by Canadian Analytical Laboratory Association (CALA). The corrosivity test results provided by SGS are presented in Appendix C. A summary of the test results is presented in the Table 4.

Table 4: Summary of Soil Chemical Analysis Results

| BOREHOLE NO. | SAMPLE | DEPTH (m) | CORROSIVITY INDEX | CONDUCTIVITY (µS/cm) | SULPHATE (µg/g) | CHLORIDE (µg/g) | pH | RESISTIVITY (Ohm-cm) |
|--------------|--------|-------------|-------------------|----------------------|-----------------|-----------------|------|----------------------|
| RW-1 | 10 | 7.6 - 8.2 | 1 | 174 | 49 | 3.6 | 8.50 | 5740 |
| RW-1 | 16 | 16.8 - 17.4 | 8 | 387 | 190 | 10 | 8.50 | 2580 |
| RW-2 | 21 | 30.5 - 31.1 | 6 | 438 | 320 | 19 | 8.40 | 2280 |
| RW-2 | 27 | 42.7 - 43.3 | 12 | 628 | 430 | 34 | 8.40 | 1590 |
| CN-5 | 12 | 12.2 - 12.8 | 8 | 245 | 230 | 6.2 | 8.68 | 4080 |
| CN-5 | 21 | 33.5 - 34.1 | 12 | 624 | 540 | 28 | 8.21 | 1600 |
| CN-7 | 19 | 22.9 - 23.5 | 8 | 308 | 340 | 12 | 8.54 | 3250 |
| CN-7 | 25 | 39.6 - 40.2 | 8 | 387 | 480 | 30 | 8.54 | 2580 |
| C-2 | 5 | 4.6 – 5.2 | 4 | 130 | 240 | 13 | 8.35 | 7700 |
| C-2 | 7 | 6.1 – 6.7 | 4 | 274 | 230 | 9.1 | 8.2 | 3650 |
| C-3 | 5 | 3.7 – 4.3 | 6 | 527 | 3.1 | 37 | 7.75 | 1900 |
| C-3 | 8 | 7.6 – 8.2 | 8 | 169 | 220 | 7.6 | 9.05 | 5910 |
| C-3 | 12 | 13.7 – 14.3 | 6 | 404 | 310 | 12 | 8.37 | 2480 |
| C-3 | 20 | 32.0 -32.6 | 4 | 159 | 420 | 32 | 8.41 | 6290 |



8. CLOSURE

Mr. M. Mohamed carried out the field investigations under the supervision of Mr. N. Rahman, P.Eng. This Report was prepared by Ms. Natasha Leong-Sem, EIT and reviewed by Mr. Nazibur Rahman, P.Eng. Mr. Robert Ng, PhD, P.Eng., MTO Designated Principal Contact conducted an independent review of the report.

Yours very truly,

Peto MacCallum Ltd.

A handwritten signature in blue ink, appearing to read 'Natasha Leong-Sem', is positioned above the printed name.

Natasha Leong-Sem, EIT
Geotechnical Services



Nazibur Rahman, P.Eng.
Senior Engineer, Geotechnical Services



Robert Ng, MBA, PhD, P.Eng.
MTO Designated Principal Contact

NLS/NR/RN:nls-nr-nk



APPENDIX A

Previous Borehole Logs and Drawings (GEOCRES No. 40J16-013)

FOUNDATION SECTION

ORIGINATED BY **T.F.W.**

COMPILED BY T.F.W.

CHECKED BY _____ H.S.

| SOIL PROFILE | | | SAMPLES | DYNAMIC PENETRATION RESISTANCE BLOWS / FOOT | LIQUID LIMIT ——— WL PLASTIC LIMIT ——— WP WATER CONTENT ——— W | BULK DENSITY γ P.C.F. | REMARKS |
|----------------|---|-------------|--------------------------|--|--|--|---------|
| ELEV. DEPTH | DESCRIPTION | STRAT. PLOT | NUMBER TYPE BLOWS / FOOT | ELEV SCALE | SHEAR STRENGTH P.S.F. + Field Vane ○ Unconfined Shear Strength 1000 2000 3000 4000 5000 | WATER CONTENT % WP — W — WL 20 40 60 | |
| 614.0 | Groundlevel | | | 620 | | | |
| 0.0 | | | | | | | |
| | Hard to firm Brown to grey clayey silt with sand and gravel. | | 1 SS 18 | 610 | | | 137.0 |
| | | | 2 TW PH | | | | 133.0 |
| | | | 3 SS 42 | | >4550 | | 133.0 |
| | | | 4 TW PH | | | | 133.0 |
| | | | 5 SS 25 | | | | |
| | | | 6 TW PH | 600 | 1.6 | | 128.0 |
| | | | 7 TW PH | | 2.2 | | 123.0 |
| | | | 8 TW PH | 590 | | | 125.0 |
| | | | 9 TW PH | | | | 125.0 |
| | | | 10 SS P | 580 | | | 125.0 |
| | | | 11 TW PH | | | | |
| 575.0 | | | 12 TW PH | | | | 130.0 |
| 39.0 | | | 13 TW PH | 570 | | | 130.0 |
| | Very stiff to firm, grey, silty clay with sand and gravel. | | 14 TW PH | | | | 129.0 |
| | | | | 560 | | | |
| | | | 15 TW PH | | | | 126.0 |
| | | | 16 TW PH | 550 | | | |
| | | | | 540 | | | |
| | | | 17 TW PH | | | | 129.0 |
| | | | | 530 | | | |
| | | | 18 TW PH | | | | 122.0 |
| | | | | 520 | | | |
| | | | 19 TW PH | | | | 125.0 |
| | | | | 510 | | | |
| | | | 20 TW PH | | | | 123.0 |
| | | | | 500 | | | |
| 495.0 | | | | | | | |
| 119.0 | Shale Bedrock. | | 21 SS 30 for 1" | 490 | | | |
| 490.0 | End of borehole. | | | | | | |
| 124.0 | | | | | | | |

FOUNDATION SECTION

CHECKED BY H.S.

[illegible]

HIGHWAYS - ONTARIO
RESEARCH DIVISION

RECORD OF BOREHOLE NO. 4

FOUNDATION SECTION

12 LOCATION 276/55 33' Rt. ORIGINATED BY T.F.W.
 103 BORING DATE Feb. 6, 1963. COMPILED BY T.F.W.
 Geologic BOREHOLE TYPE 5" Ø Auger. CHECKED BY H.S.

| PROFILE DESCRIPTION | STRAT. PLOT | SAMPLES | | | ELEV SCALE | DYNAMIC PENETRATION RESISTANCE BLOWS / FOOT | | | | | LIQUID LIMIT ——— *L PLASTIC LIMIT ——— *P WATER CONTENT ——— * WP ——— W ——— WL | | | BULK DENSITY P.C.F. | REMARKS |
|--|-------------|---------|------|--------------|------------|---|--|-----|-----|--|---|--|--|---------------------------|---------|
| | | NUMBER | TYPE | BLOWS / FOOT | | SHEAR STRENGTH P.S.F. + Field Vane o Unconfined Shear strength 500 1000 1500 2000 2500 | | | | | WATER CONTENT % 20 40 60 | | | | |
| Groundlevel heterogeneous fill. clayey silt with sand and boulders. | | | | | 620 | | | | | | | | | | |
| | | 1 | SS | 10 | | | | | | | | | | | |
| | | 2 | SS | 8 | | | | | | | | | | | |
| | | 3 | SS | 20 | 610 | | | | | | | | | | |
| | | 4 | SS | 38 | | | | | | | | | | | |
| | | 5 | SS | 10 | 600 | | | | 1.8 | | | | | | |
| | | 6 | TW | PH | 590 | | | 1.7 | | | | | | 130.0 | |
| | | 7 | TW | PH | | | | 1.7 | | | | | | 129.0 | |
| Hard to firm. brown to grey clayey silt with sand and gravel. | | 8 | TW | PH | 580 | | | | | | | | | 130.0 | |
| | | | | | 570 | | | | | | | | | | |
| | | | | | 560 | | | | | | | | | | |
| | | | | | 550 | | | | | | | | | | |
| | | | | | 540 | | | | | | | | | | |
| | | | | | 530 | | | | | | | | | | |
| | | | | | 520 | | | | | | | | | | |
| | | | | | 510 | | | | | | | | | | |
| End of borehole. Probable Bedrock. | | | | | 500 | | | | | | | | | | |
| | | | | | | | | | | | | | | | |

gw1 612.0
 8.0

DEPARTMENT OF HIGHWAYS - ONTARIO
 MATERIALS & RESEARCH DIVISION

RECORD OF BOREHOLE NO. 6

FOUNDATION SECTION

JOB 63-F-12 LOCATION 277/65 38.0' Lt. ORIGINATED BY T.F.W.
 W.P. 53-63 BORING DATE Feb. 8, 1963. COMPILED BY T.F.W.
 DATUM Geodetic BOREHOLE TYPE 5" Ø Auger CHECKED BY H.S.

| SOIL PROFILE | | STRAT. PLOT | SAMPLES | | | ELEV SCALE | DYNAMIC PENETRATION RESISTANCE BLOWS / FOOT | | | | | LIQUID LIMIT — WL PLASTIC LIMIT — WP WATER CONTENT — W | | | BULK DENSITY P.C.F. | REMARKS |
|---------------|---|-------------|---------|------|--------------|------------|---|--|--|--|--|--|--|--|---------------------------|---------|
| ELEV DEPTH | DESCRIPTION | | NUMBER | TYPE | BLOWS / FOOT | | SHEAR STRENGTH P.S.F. + Field Vane o Unconfined Shear Strength 500 1000 1500 2000 2500 | | | | | WATER CONTENT % 20 40 60 | | | | |
| 615.0 | Groundlevel | | | | | 620 | | | | | | | | | | |
| 0.0 | Hard to firm Brown to grey clayey silt with sand and gravel. | | 1 | SS | 14 | 610 | | | | | | | | | 134.0 | |
| | | | 2 | SS | 31 | | | | | | | | | | | 142 |
| | | | 3 | SS | 37 | | | | | | | | | | | 137 |
| | | | 4 | TW | PH | 600 | | | | | | | | | | 131 |
| | | | 5 | TW | PH | | | | | | | | | | | 132 |
| | | | 6 | TW | PH | 590 | | | | | | | | | | 125 |
| | | | 7 | TW | PH | | | | | | | | | | | 128 |
| | | | 8 | TW | PH | 580 | | | | | | | | | | 128 |
| | | | 9 | TW | PH | | | | | | | | | | | 130 |
| | | | | | | 570 | | | | | | | | | | |
| | | | | | | 560 | | | | | | | | | | |
| | | | | | | 550 | | | | | | | | | | |
| | | | | | | 540 | | | | | | | | | | |
| | | | | | | 530 | | | | | | | | | | |
| | | | | | | 520 | | | | | | | | | | |
| | | | | | | 510 | | | | | | | | | | |
| | | | | | | 500 | | | | | | | | | | |
| 494.5 | | | | | | | | | | | | | | | | |
| 120.5 | End of borehole Probable Bedrock | | | | | | | | | | | | | | | |

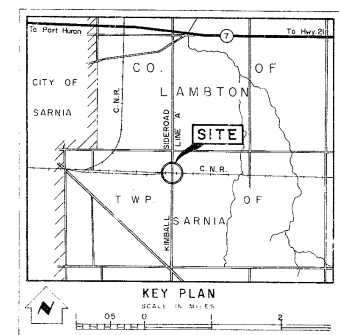
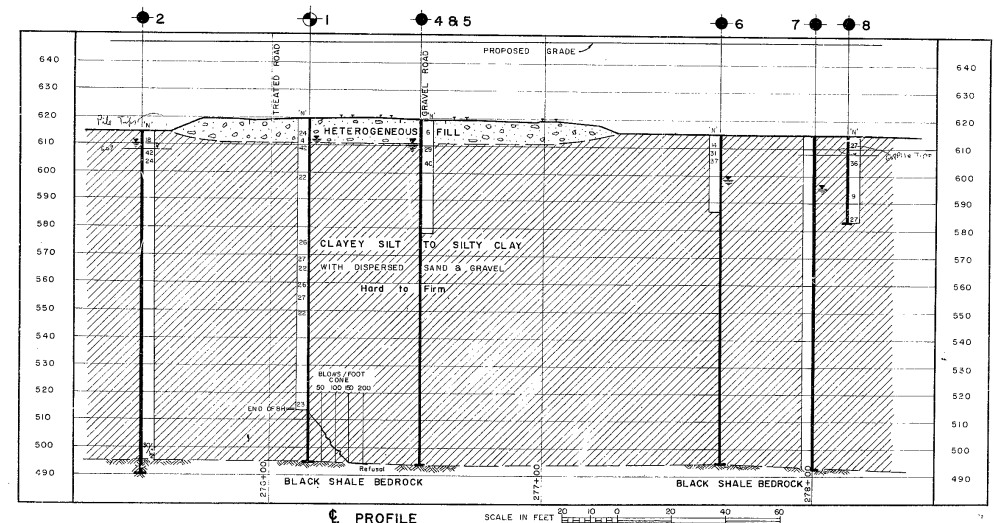
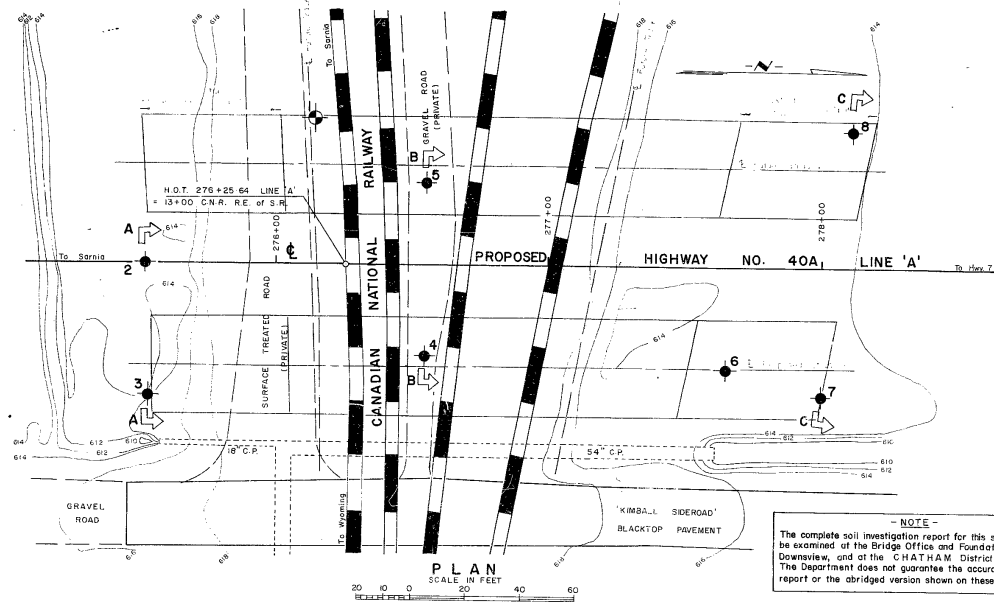
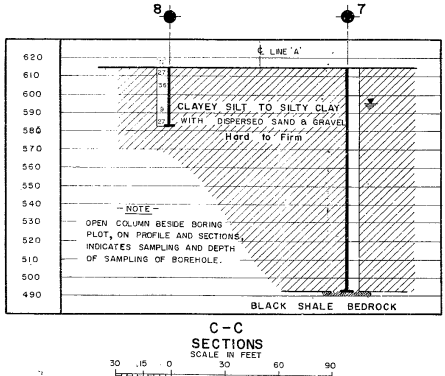
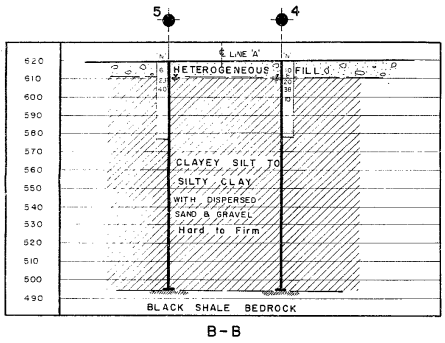
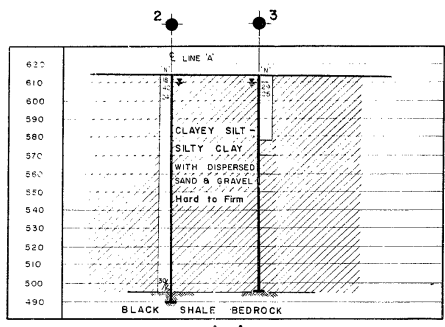
 ∇wl 599
 16.0

FOUNDATION SECTION

CHECKED BY H.S.

| | |
|-------|-----------------|
| 122.0 | End of borehole |
|-------|-----------------|

390210 E
475650 W 40316 W



LEGEND

- Bore Hole
- Cone Penetration Hole
- Bore & Cone Penetration Hole
- Water Levels Station

| NO. | ELEVATION | STATION | OFFSET |
|-----|-----------|---------|--------|
| 1 | 619.5 | 276+14 | 53'LT |
| 2 | 614.0 | 275+52 | € |
| 3 | 314.0 | 275+52 | 48'RT |
| 4 | 620.0 | 276+53 | 35'RT |
| 5 | 619.5 | 276+55 | 29'LT |
| 6 | 615.0 | 277+65 | 38'RT |
| 7 | 615.0 | 278+00 | 49'PT |
| 8 | 615.0 | 278+12 | 50'LT |

NOTE
The boundaries between soil strata have been established only at Bore Hole locations. Between Bore Holes the boundaries are assumed from geological evidence and may be subject to considerable error.

DEPARTMENT OF HIGHWAYS - ONTARIO
MATERIALS & RESEARCH DIVISION - FOUNDATION SECTION

CANADIAN NATIONAL RAILWAY

KING'S HIGHWAY NO. 40A LINE 'A' REVISION DIST NO. 1
CO. LAMBTON
TWP. SARNIA LOT 15 & 16 CON. IV

BORE HOLE LOCATIONS & SOIL STRATA

DRAWN T.W. CHECKED J.C. S.F. NO. 53-63
DRAWN F.C. CHECKED J.C. JOB NO. 63-F-12
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APPROVED [Signature] CONT NO.

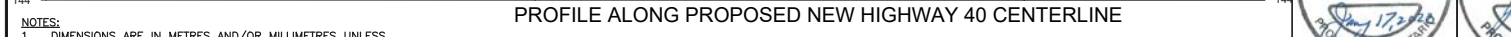
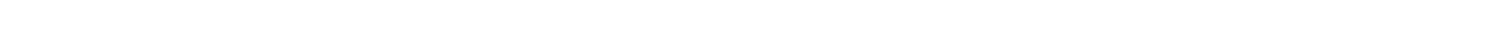
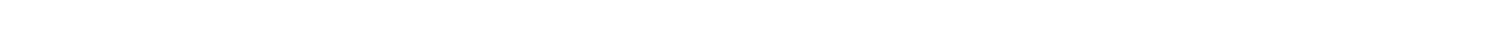
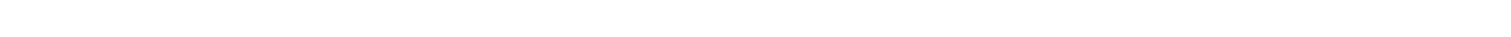
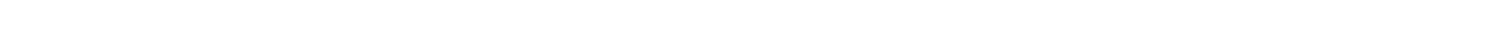
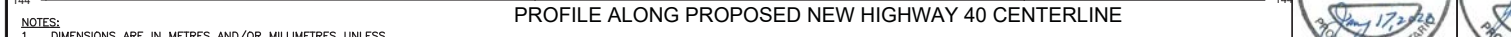
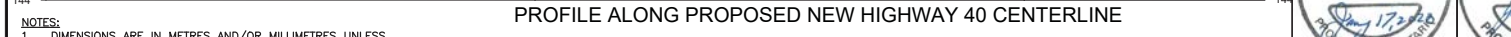
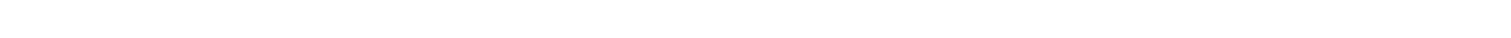
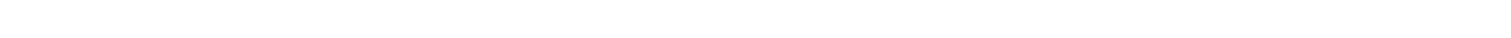
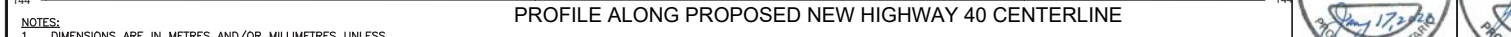
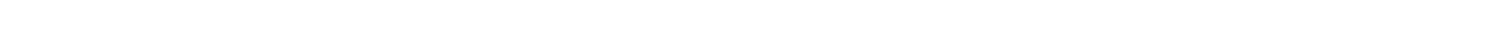
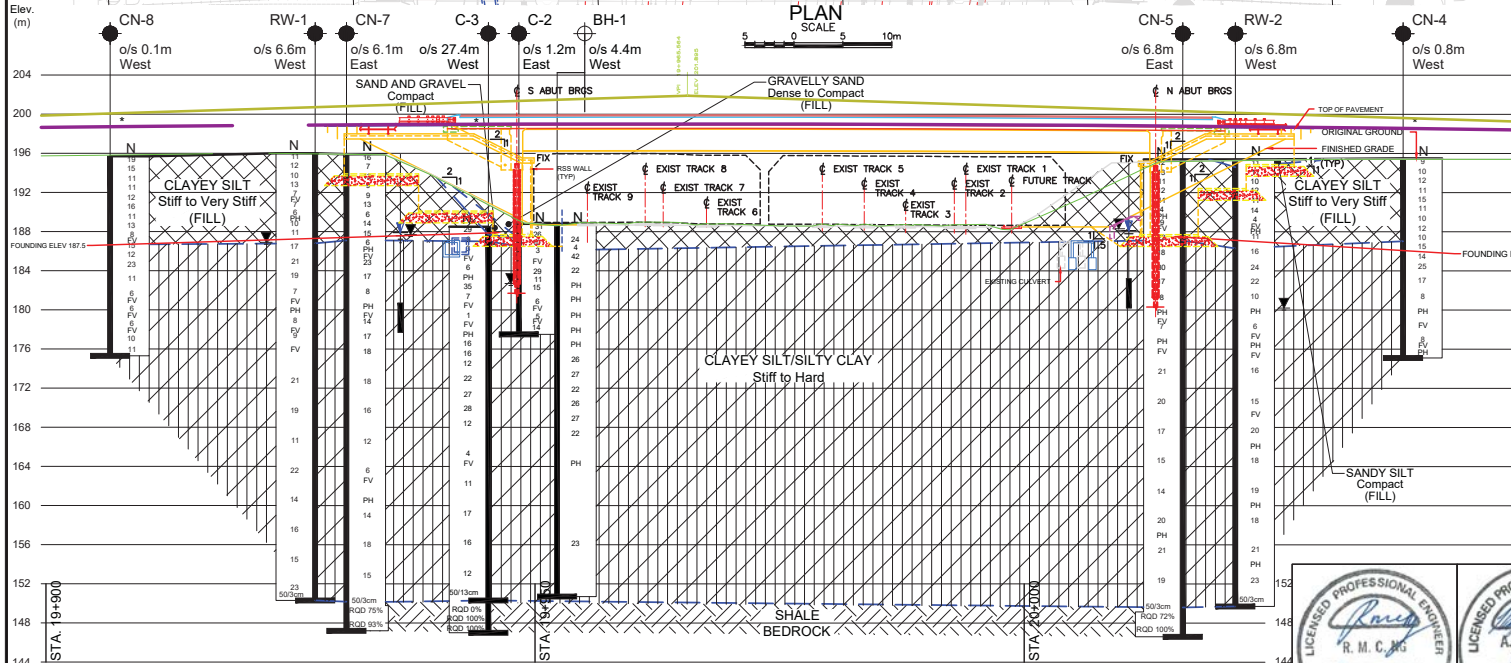
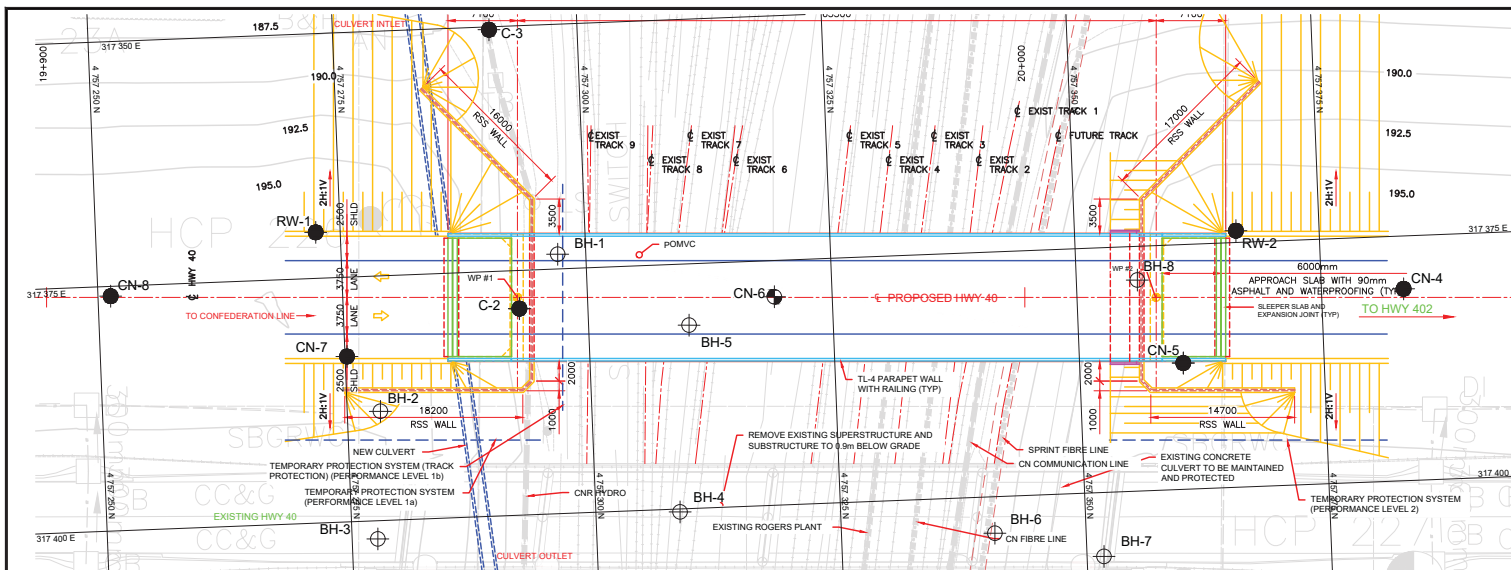
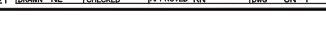
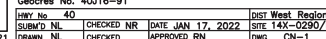
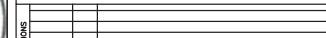
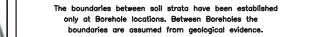
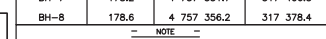
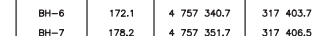
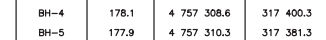
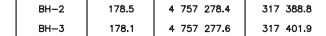
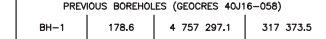
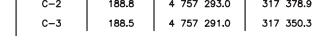
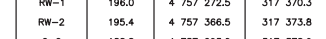
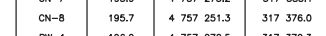
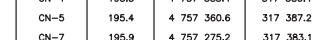
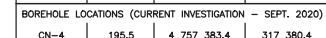
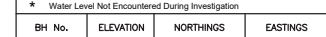
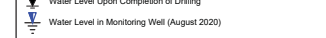
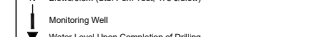
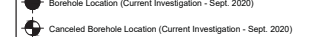
63-F-12A

SOME DEFECTS IN NEGATIVE DUE
TO CONDITION OF ORIGINAL DOCUMENTS



APPENDIX B

Borehole Locations Plan & Profile Drawing DWG CN-1
Sections Drawing DWG CN-2
Explanation of Terms Used in Report
Record of Borehole Sheets C-2, C-3, CN-4, CN-5, CN-7, CN-8, RW-1, and RW-2
Results of Grain Size Distribution Analyses – Figures GS-1, GS-2A/B, GS-3A/B, and GS-4
Results of Atterberg Limit Tests (Plasticity Charts) – Figures PC-1, PC-2A/B, PC-3A/B, and PC-4
Results of One-Dimensional Consolidation Tests – Figure Nos. CT-1 to CT-3
Results of Unconfined Compressive Strength Tests on Rock
Rock Core Description Logs
Rock Core Photographs





LEGEND

- Borehole Location (Current Investigation - Sept. 2020)
- ⊕ Previous Borehole Location (GEOCRE 40J16-058)
- N Blows/0.3m (Std. Pen. Test, 475 Jblow)
- Monitoring Well
- Water Level Upon Completion of Drilling
- Water Level in Monitoring Well (August 2020)
- * Water Level Not Encountered During Investigation

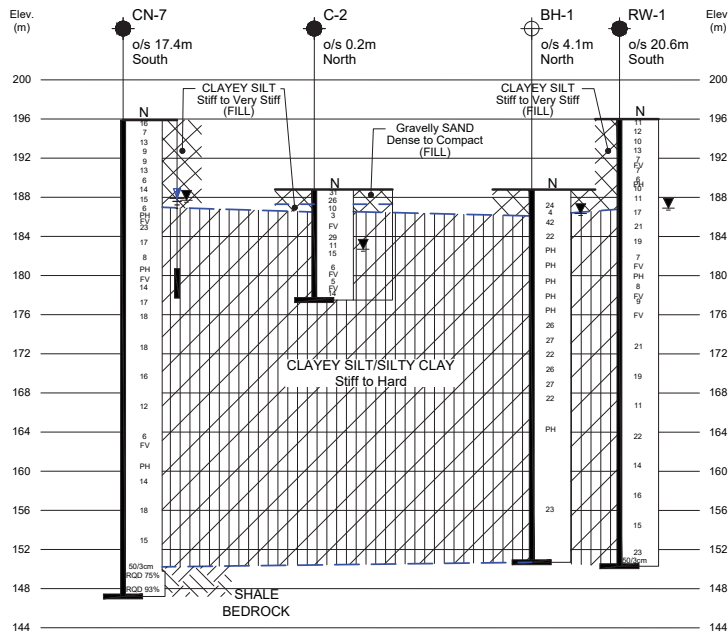
| BH No. | ELEVATION | NORTHINGS | EASTINGS |
|--|-----------|-------------|-----------|
| BOREHOLE LOCATIONS (CURRENT INVESTIGATION - SEPT. 2020) | | | |
| CN-4 | 195.5 | 4 757 383.4 | 317 380.4 |
| CN-5 | 195.4 | 4 757 360.6 | 317 387.2 |
| CN-7 | 195.9 | 4 757 275.2 | 317 383.1 |
| CN-8 | 195.7 | 4 757 251.3 | 317 376.0 |
| RW-1 | 196.0 | 4 757 272.5 | 317 370.3 |
| RW-2 | 195.4 | 4 757 366.5 | 317 373.8 |
| C-2 | 188.8 | 4 757 293.0 | 317 378.9 |
| C-3 | 188.5 | 4 757 291.0 | 317 350.3 |
| PREVIOUS BOREHOLES (GEOCRE 40J16-058) | | | |
| BH-1 | 178.6 | 4 757 297.1 | 317 373.5 |
| BH-2 | 178.5 | 4 757 278.4 | 317 388.8 |
| BH-3 | 178.1 | 4 757 277.6 | 317 401.9 |
| BH-4 | 178.1 | 4 757 308.6 | 317 400.3 |
| BH-5 | 177.9 | 4 757 310.3 | 317 381.3 |
| BH-6 | 172.1 | 4 757 340.7 | 317 403.7 |
| BH-7 | 178.2 | 4 757 351.7 | 317 406.5 |
| BH-8 | 178.6 | 4 757 356.2 | 317 378.4 |

NOTE
The boundaries between soil strata have been established only at Borehole locations. Between Boreholes the boundaries are assumed from geological evidence.

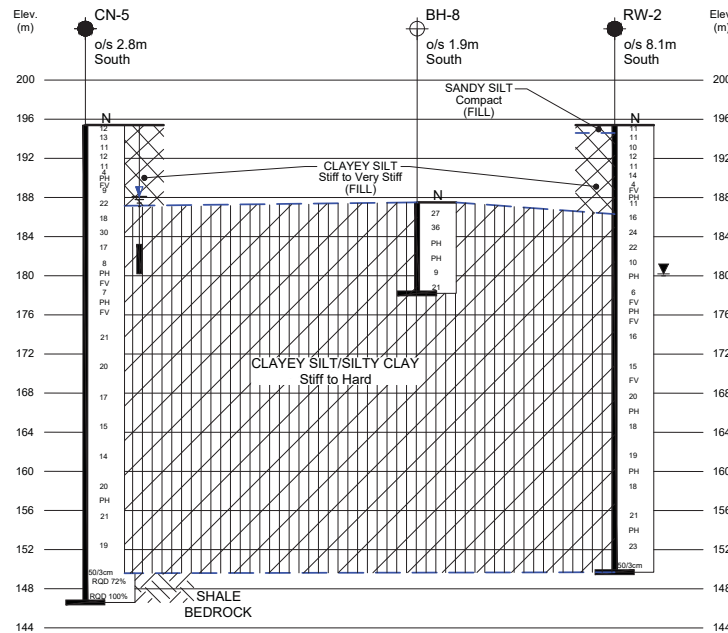
| DATE | BY | DESCRIPTION |
|----------------------|------------|------------------------------------|
| Geocres No. 40J16-91 | | |
| RW No. 40 | | Dist West Region |
| SUBM'D NL | CHECKED NR | DATE JAN 17, 2022 SITE 14X-0290/B2 |
| DRAWN NL | CHECKED | APPROVED RN DWG CN-2 |



REF WSP Drawing: GWP S3813001-330-001GA.dwg, Dated Dec., 2021



SECTION ALONG SOUTH ABUTMENT CENTERLINE



SECTION ALONG NORTH ABUTMENT CENTERLINE

- NOTES:**
- DIMENSIONS ARE IN METRES AND/OR MILLIMETRES UNLESS OTHERWISE SHOWN. STATIONS ARE IN KILOMETRES AND METRES.
 - THIS DRAWING SHOULD BE READ IN CONJUNCTION WITH THE TEXT OF THE REPORT AND RECORD OF BOREHOLE SHEETS.

EXPLANATION OF TERMS USED IN REPORT

SPT N VALUE: THE STANDARD PENETRATOIN TEST (SPT) N VALUE IS THE NUMBER OF BLOWS REQUIRED TO CAUSE A STANDARD 51mm O.D. SPLIT-BARREL SAMPLER TO PENETRATE 0.3 m, AFTER AN INITIAL PENETRATIO OF 150 mm, INTO UNDISTURBED GROUND IN A BOREHOLE WHEN DRIVEN BY A HAMMER WITH A MASS OF 63.5 kg, FALLING FREELY A DISTANCE OF 0.76 m FOR PENETRATIONS. A SPT N VALUE IS INDICATED AS THE NUMBER OF BLOWS REQUIRED TO DRIVE THE SPLIT-BARREL SAMPLER A DISTANCE OF 300 MM. AN AVERAGE SPT N VALUE IS DENOTED as \bar{N} .

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

SOILS ARE DESCRIBED BY THEIR COMPOSITION, CONSISTENCY OR COMPACTNESS.

COMPOSITION: SECONDARY SOIL COMPONENTS ARE DESCRIBED ON THE BASIS OF PERCENTAGE BY MASS OF THE WHOLE SAMPLE AS FOLLOWS:

| PERCENTAGE BY MASS | 0 - 10 | 10 - 20 | 20 -35 | >35 | >35 and main fraction |
|--------------------|---------|---------|---------------------------------------|-------|---------------------------------|
| | 'trace' | 'some' | Adjective (silty, sandy, clayey etc.) | 'and' | Noun (gravel, sand, silt, clay) |

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 |

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

| N (BLOWS/0.3 m PENETRATION) | 0 - 4 | 4 - 10 | 10 -30 | 30 - 50 | >50 |
|-----------------------------|------------|--------|---------|---------|------------|
| | VERY LOOSE | LOOSE | COMPACT | DENSE | VERY DENSE |

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

TOTAL CORE RECOVERY (REC): CORE RECOVERED AS A PERCENTAGE OF TOTAL CORE RUN LENGTH.

ROCK QUALITY DESIGNATION (RQD): TOTAL LENGTH OF SOUND ROCK RECEIVED IN PIECES 10 cm OR LARGER AS A PERCENTAGE OF TOTAL CORE RUN LENGTH. CLASSIFICATION OF ROCK WITH RESPECT TO RQD VALUE AS FOLLOWS:

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

UNIAXIAL COMPRESSIVE STRENGTH (UCS): MAXIMUM AXIAL COMPRESSIVE STRESS THAT A ROCK CORE SPECIMEN CAN WITHSTAND BEFORE FAILING.

POINT LOAD STRENGTH INDEX: AN INDEX TEST TO DETERMINE POINT LOAD STRENGTH INDEX OF ROCK.

CLASSIFICATION OF ROCK WITH RESPECT TO STRENGTH IS AS FOLLOWS:

| GRADE* | R0 | R1 | R2 | R3 | R4 | R5 | R6 |
|------------------------|----------------|-----------|--------|---------------|----------|-------------|------------------|
| UCS (MPa) | 0.25 - 1 | 1 - 5 | 5 - 25 | 25 - 50 | 50 - 100 | 100 - 250 | >250 |
| POINT LOAD INDEX (MPa) | ** | ** | ** | 1 - 2 | 2 - 4 | 4 - 10 | >10 |
| TERM | EXTREMELY WEAK | VERY WEAK | WEAK | MEDIUM STRONG | STRONG | VERY STRONG | EXTREMELY STRONG |

* - GRADE ACCORDING TO THE INTERNATIONAL SOCIETY OF ROCK MECHANICS (ISRM), 1981.

** - ROCKS WITH UNIAXIAL COMPRESSIVE STRENGTH BELOW 25 MPa ARE LIKELY TO YIELD HIGHLY AMBIGUOUS RESULTS UNDER POINT LOAD TESTING.

DISCONTINUITY SPACING: DISTANCE BETWEEN A PAIR OF DISCONTINUITIES MEASURED ALONG A LINE OF SPECIFIED LOCATION AND ORIENTATION. CLASSIFICATION OF ROCK WITH RESPECT TO DISCONTINUITY SPACING IS AS FOLLOWS (ISRM, 1981):

| SPACING WIDTH (m) | <0.02 | 0.02 - 0.06 | 0.06 - 0.20 | 0.20 - 0.6 | 0.6 - 2.0 | 2.0 - 6.0 | >6.0 |
|------------------------|-----------------|-------------|-------------|------------------|-----------|-----------|----------------|
| SPACING CLASSIFICATION | EXTREMELY CLOSE | VERY CLOSE | CLOSE | MODERATELY CLOSE | WIDE | VERY WIDE | EXTREMELY WIDE |

ABBREVIATIONS AND SYMBOLS

FIELD SAMPLING

SS - SPLIT SPOON
WS - WASH SAMPLE
AS - AUGER SAMPLE
FV - FIELD VANE
CS - CHUNK SAMPLE
TW - THINWALL SHELBY TUBE SAMPLE
PH - TW ADVANCED HYDRULICALLY
PM - TW ADVANCED MANUALLY

TP - THINWALL PISTON SAMPLE
OS - OSTERBERG SAMPLE
RC - ROCK CORE
BS - BLOCK SAMPLE
FS - FOIL SAMPLE

STRESS AND STRAIN

| | |
|--------------------------------------|-------------------------------------|
| u_w | PORE WATER PRESSURE (kPa) |
| r_u | PORE PRESSURE RATIO |
| σ | TOTAL NORMAL STRESS (kPa) |
| σ' | EFFECTIVE NORMAL STRESS (kPa) |
| τ | SHEAR STRESS (kPa) |
| $\sigma_1, \sigma_2, \sigma_3$ | PRINCIPAL STRESSES (kPa) |
| ϵ | LINEAR STRAIN (%) |
| $\epsilon_1, \epsilon_2, \epsilon_3$ | PRINCIPAL STRAINS (%) |
| E | MODULUS OF LINEAR DEFORMATION (MPa) |
| G | MODULUS OF SHEAR DEFORMATION (MPa) |
| μ | COEFFICIENT OF FRICTION |

MECHANICAL PROPERTIES OF SOIL

| | |
|----------------|--|
| C_c | COMPRESSION INDEX |
| C_{cr} | RECOMPRESSION INDEX |
| C_s | SWELL INDEX |
| c_v | COEFFICIENT OF CONSOLIDATION - VERTICAL (cm ² /s) |
| c_h | COEFFICIENT OF CONSOLIDATION - HORIZONTAL (cm ² /s) |
| C_α | COEFFICIENT OF SECONDARY CONSOLIDATION |
| m_v | COEFFICIENT OF VOLUME CHANGE (kPa ⁻¹) |
| σ'_p | PRECONSOLIDATION PRESSURE (kPa) |
| σ'_{vo} | EFFECTIVE OVERBURDEN PRESSURE (kPa) |
| H | DRAINAGE PATH (m) |
| U | DEGREE OF CONSOLIDATION |
| T_v | TIME FACTOR; VERTICAL DRAINAGE |
| T_h | TIME FACTOR; HORIZONTAL DRAINAGE |
| S_{at}, c_u | UNDRAINED SHEAR STRENGTH (kPa) |
| S_R | RESIDUAL SHEAR STRENGTH (kPa) |
| S_r | REMOULDED SHEAR STRENGTH (kPa) |
| σ_c | UNIAXIAL COMPRESSIVE STRENGTH (kPa) |
| c' | EFFECTIVE COHESION INTERCEPT (kPa) |
| c | APPARENT COHESION INTERCEPT (kPa) |
| Φ' | EFFECTIVE ANGLE OF INTERNAL FRICTION (Degrees) |
| S_t | SENSITIVITY (= c_u'/S_c) |
| I_p | POINT LOAD STRENGTH INDEX |

PHYSICAL PROPERTIES


| | | |
|---|---|---|
| W _p - PLASTIC LIMIT (%) | W _L - LIQUID LIMIT (%) | W - MOISTURE CONTENT (%) |
| W _s - SHRINKAGE LIMIT (%) | I _p - PLASTICITY INDEX (%) | γ_w - UNIT WEIGHT OF WATER (kg/m ³) |
| γ - UNIT WEIGHT OF SOIL (kg/m ³) | γ_{sat} - UNIT WEIGHT OF SATURATED SOIL (kg/m ³) | γ_d - UNIT WEIGHT OF DRY SOIL (kg/m ³) |
| ρ_w - DENSITY OF WATER (kN/m ³) | ρ - DENSITY OF SOIL (kN/m ³) | ρ_{sat} - DENSITY OF SATURATED SOIL (kN/m ³) |
| ρ_d - DENSITY OF DRY SOIL (kN/m ³) | S_r - DEGREE OF SATURATION (%) | D_r, SG - RELATIVE DENSITY (FORMERLY SPECIFIC GRAVITY) |
| C_u - UNIFORMITY COEFFICIENT | C_c - CURVATURE COEFFICIENT | |

RECORD OF BOREHOLE No C-2

1 OF 1

METRIC

G.W.P. 3064-11-00-06 LOCATION Coords: 4 757 293.0 N; 317 378.9 E ORIGINATED BY M.M.
 DIST West Region HWY 40 BOREHOLE TYPE Continuous Flight Hollow Stem Augers COMPILED BY N.L.
 DATUM Geodetic DATE 2020.09.10 LATITUDE 42.955329 LONGITUDE -82.345831 CHECKED BY N.R.

| SOIL PROFILE | | | SAMPLES | | | GROUND WATER CONDITIONS | ELEVATION SCALE | DYNAMIC CONE PENETRATION RESISTANCE PLOT | | | | PLASTIC LIMIT W _p | NATURAL MOISTURE CONTENT W | LIQUID LIMIT W _L | UNIT WEIGHT γ kN/m ³ | REMARKS & GRAIN SIZE DISTRIBUTION (%) | |
|---------------|--|------------|---------|------|------------|----------------------------|-----------------|---|----|----|----|------------------------------------|-------------------------------------|-----------------------------------|--|---|------------|
| ELEV DEPTH | DESCRIPTION | STRAT PLOT | NUMBER | TYPE | "N" VALUES | | | SHEAR STRENGTH kPa | | | | | | | | | |
| 188.8 | Ground Surface | | | | | | | 20 | 40 | 60 | 80 | 100 | | | | | |
| 0.0 | Gravelly SAND, trace silt | | 1 | SS | 31 | | 188 | | | | | | | | | | |
| | Dense to compact, Brown, Moist | | 2 | SS | 26 | | | | | | | | | | | | |
| | CLAYEY SILT | | 3 | SS | 10 | | 187 | | | | | | | | | | |
| | Stiff, Brown, Moist (FILL) | | | | | | | | | | | | | | | | |
| 186.5 | SILTY CLAY TO CLAYEY SILT, sandy to some sand, trace gravel | | 4 | SS | 3 | | 186 | | | | | | | | | 4 | 27 39 30 |
| 2.3 | Firm to very stiff, Brown, Moist | | | | | | | | | | | | | | | | |
| | | | | VANE | FV | | 185 | | | | | | | | | | |
| | | | 5 | SS | 29 | | 184 | | | | | | | | | | |
| | | | 6 | SS | 11 | | 183 | | | | | | | | | | |
| | | | 7 | SS | 15 | | 182 | | | | | | | | | 2 | 17 44 37 |
| | | | 8 | SS | 6 | | 181 | | | | | | | | | | |
| | | | | VANE | FV | | 180 | | | | | | | | | | 2 16 46 36 |
| | | | 9 | SS | 5 | | 179 | | | | | | | | | | |
| | | | | VANE | FV | | 178 | | | | | | | | | | |
| | | | 10 | SS | 14 | | | | | | | | | | | | |
| 177.5 | End of borehole | | | | | | | | | | | | | | | | |
| 11.3 | | | | | | | | | | | | | | | | | |
| |  Groundwater level measured upon completion of drilling | | | | | | | | | | | | | | | | |
| | NOTE: No cave-in was noted inside the borehole upon extraction of hollow stem augers. | | | | | | | | | | | | | | | | |

Groundwater level measured upon completion of drilling
 NOTE: No cave-in was noted inside the borehole upon extraction of hollow stem augers.

>>: Greater than

+³, ×³: Numbers refer to Sensitivity

○ 3% STRAIN AT FAILURE

RECORD OF BOREHOLE No C-3

1 OF 3

METRIC

G.W.P. 3064-11-00-06 LOCATION Coords: 4 757 291.0 N; 317 350.3 E ORIGINATED BY M.M.
 DIST West Region HWY 40 BOREHOLE TYPE CFHS Augers + Mud Rotary at 3.7 m + HQ Rock Coring COMPILED BY N.L.
 DATUM Geodetic DATE 2020.09.03 - 2020.09.10 LATITUDE 42.955311 LONGITUDE -82.346182 CHECKED BY N.R.

| SOIL PROFILE | | | SAMPLES | | | GROUND WATER CONDITIONS | ELEVATION SCALE | DYNAMIC CONE PENETRATION RESISTANCE PLOT | | PLASTIC LIMIT | | NATURAL MOISTURE CONTENT | | LIQUID LIMIT | | UNIT WEIGHT γ kN/m³ | REMARKS & GRAIN SIZE DISTRIBUTION (%) | | | | |
|---------------|---|------------|---------|------|------------|----------------------------|-----------------|---|--|----------------|---|--------------------------------|-------------------|-----------------|----|--------------------------------------|---|----|----|--|--|
| ELEV DEPTH | DESCRIPTION | STRAT PLOT | NUMBER | TYPE | "N" VALUES | | | SHEAR STRENGTH kPa | | W _p | W | W _L | WATER CONTENT (%) | | GR | | SA | SI | CL | | |
| 188.5 | Ground Surface | | | | | | | | | | | | | | | | | | | | |
| 0.0 | SAND AND GRAVEL, trace silt | | 1 | SS | 29 | | | | | | | | | | | | | | | | |
| | Compact, Brown, Dry | | | | | | | | | | | | | | | | | | | | |
| | CLAYEY SILT, some sand, trace gravel | | 2 | SS | 9 | | | | | | | | | | | | | | | | |
| | Soft to stiff, Brown, Moist (FILL) | | | | | | | | | | | | | | | | | | | | |
| 187.0 | SILTY CLAY/CLAYEY SILT, some sand/ sandy, trace gravel | | 3 | SS | 3 | | | | | | | | | | | | | | | | |
| 1.5 | Stiff to hard, Brown, Moist | | | | | | | | | | | | | | | | | | | | |
| | | | | VANE | FV | | | | | | | | | | | | | | | | |
| | | | 4 | SS | 6 | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | | | |
| | | | 5 | TW | PH | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | | | |
| | | | 6 | SS | 35 | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | | | |
| | | | 7 | SS | 7 | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | | | |
| | | | | VANE | FV | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | | | |
| | | | 8 | SS | 1 | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | | | |
| | | | | VANE | FV | | | | | | | | | | | | | | | | |
| | | | 9 | TW | PH | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | | | |
| | | | 10 | SS | 16 | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | | | |
| | | | 11 | SS | 16 | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | | | |
| | | | 12 | SS | 12 | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | | | |
| 173.5 | | | | | | | | | | | | | | | | | | | | | |

Continued Next Page

>>: Greater than

+³, X³: Numbers refer to Sensitivity

○ 3% STRAIN AT FAILURE

RECORD OF BOREHOLE No C-3

2 OF 3

METRIC

G.W.P. 3064-11-00-06 LOCATION Coords: 4 757 291.0 N; 317 350.3 E ORIGINATED BY M.M.
 DIST West Region HWY 40 BOREHOLE TYPE CFHS Augers + Mud Rotary at 3.7 m + HQ Rock Coring COMPILED BY N.L.
 DATUM Geodetic DATE 2020.09.03 - 2020.09.10 LATITUDE 42.955311 LONGITUDE -82.346182 CHECKED BY N.R.

| SOIL PROFILE | | | SAMPLES | | | GROUND WATER CONDITIONS | ELEVATION SCALE | DYNAMIC CONE PENETRATION RESISTANCE PLOT | | PLASTIC LIMIT W _p | NATURAL MOISTURE CONTENT W | LIQUID LIMIT W _L | UNIT WEIGHT γ kN/m ³ | REMARKS & GRAIN SIZE DISTRIBUTION (%) | |
|---------------|--|------------|---------|------|------------|----------------------------|-----------------|---|----------------------------|------------------------------------|-------------------------------------|-----------------------------------|--|---|-------------------|
| ELEV DEPTH | DESCRIPTION | STRAT PLOT | NUMBER | TYPE | "N" VALUES | | | SHEAR STRENGTH kPa | | | | | | | WATER CONTENT (%) |
| | | | | | | | | ○ UNCONFINED ● QUICK TRIAXIAL | + FIELD VANE × LAB VANE | | | | | | |
| 173.5 15.0 | CLAYEY SILT/SILTY CLAY, trace/some sand, trace gravel Stiff to very stiff, Grey, Moist | | | | | | | | | | | | | | |
| | | | 13 | SS | 22 | | 173 | | | | | | | 1 12 45 42 | |
| | | | | | | | 172 | | | | | | | | |
| | | | 14 | SS | 27 | | 171 | | | | | | | | |
| | | | | | | | 170 | | | | | | | | |
| | | | 15 | SS | 28 | | 169 | | | | | | | | |
| | | | | | | | 168 | | | | | | | | |
| | | | | | | | 167 | | | | | | | | |
| | | | | | | | 166 | | | | | | | | |
| | | | 16 | SS | 12 | | 165 | | | | | | | | |
| | | | | | | | 164 | | | | | | | | |
| | | | | | | | 163 | | | | | | | | |
| | | | | | | | 162 | | | | | | | | |
| | | | | | | | 161 | | | | | | | | |
| | | | | | | | 160 | | | | | | | | |
| | | | | | | | 159 | | | | | | | | |
| | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | |
| 158.5 | | | | | | | | | | | | | | | |

Continued Next Page

>>: Greater than

+³, ×³: Numbers refer to Sensitivity

○ 3% STRAIN AT FAILURE

METRIC

ONTARIO MTO 20TF016.GPJ ONTARIO MTO.GDT 21-9-21

○ 3% STRAIN AT FAILURE

RECORD OF BOREHOLE No CN-4

1 OF 2

METRIC

G.W.P. 3064-11-00-06 LOCATION Coords: 4 757 383.4 N; 317 380.4 E ORIGINATED BY M.M.
 DIST West Region HWY 40 BOREHOLE TYPE Continuous Flight Hollow Stem Augers COMPILED BY N.L.
 DATUM Geodetic DATE 2020.08.04 LATITUDE 42.956142 LONGITUDE -82.345811 CHECKED BY N.R.

| SOIL PROFILE | | | SAMPLES | | | GROUND WATER CONDITIONS | ELEVATION SCALE | DYNAMIC CONE PENETRATION RESISTANCE PLOT | | | | | UNIT WEIGHT γ kN/m ³ | REMARKS & GRAIN SIZE DISTRIBUTION (%) |
|---------------|--|------------|---------|------|------------|----------------------------|-----------------|---|----|----|----|-----|---|---|
| ELEV DEPTH | DESCRIPTION | STRAT PLOT | NUMBER | TYPE | "N" VALUES | | | 20 | 40 | 60 | 80 | 100 | | |
| 195.5 | Ground Surface | | | | | | | | | | | | | |
| 0.0 | CLAYEY SILT/SILTY CLAY, some sand, trace gravel | | 1 | SS | 9 | | 195 | | | | | | ○ | |
| | Stiff to very stiff, Grey, Moist (FILL) | | 2 | SS | 10 | | | | | | | | ○ | |
| | | | 3 | SS | 12 | | 194 | | | | | | ○ | |
| | | | 4 | SS | 11 | | 193 | | | | | | ○ | |
| | | | 5 | SS | 15 | | 192 | | | | | | ○ | |
| | | | 6 | SS | 11 | | 191 | | | | | | ○ | |
| | | | 7 | SS | 10 | | | | | | | | ○ | |
| | | | 8 | SS | 12 | | 190 | | | | | | ○ | |
| | | | 9 | SS | 10 | | 189 | | | | | | ○ | |
| | | | | | | | 188 | | | | | | ○ | |
| | | | 10 | SS | 15 | | | | | | | | ○ | |
| 187.2 | CLAYEY SILT, some sand, trace gravel | | | | | | 187 | | | | | | | |
| 8.3 | Very stiff to stiff, Grey, Moist | | 11 | SS | 14 | | 186 | | | | | | ○ | |
| | | | 12 | SS | 25 | | 185 | | | | | | ○ | |
| | | | 13 | SS | 17 | | 183 | | | | | | ○ | |
| | | | 14 | SS | 8 | | 182 | | | | | | ○ | |
| | | | | | | | 181 | | | | | | ○ | |
| 180.5 | | | | | | | | | | | | | ○ | |

Continued Next Page

>>: Greater than

+³, X³: Numbers refer to
Sensitivity

○ 3% STRAIN AT FAILURE

RECORD OF BOREHOLE No CN-4

2 OF 2

METRIC

G.W.P. 3064-11-00-06 LOCATION Coords: 4 757 383.4 N; 317 380.4 E ORIGINATED BY M.M.
DIST West Region HWY 40 BOREHOLE TYPE Continuous Flight Hollow Stem Augers COMPILED BY N.L.
DATUM Geodetic DATE 2020.08.04 LATITUDE 42.956142 LONGITUDE -82.345811 CHECKED BY N.R.

| SOIL PROFILE | | | SAMPLES | | | GROUND WATER CONDITIONS | ELEVATION SCALE | DYNAMIC CONE PENETRATION RESISTANCE PLOT | | | | | UNIT WEIGHT γ kN/m ³ | REMARKS & GRAIN SIZE DISTRIBUTION (%) |
|---------------|--|------------|---------|------|------------|----------------------------|-----------------|---|----|----|----|-----|---|---|
| ELEV DEPTH | DESCRIPTION | STRAT PLOT | NUMBER | TYPE | "N" VALUES | | | 20 | 40 | 60 | 80 | 100 | | |
| 180.5 | | | | | | | | | | | | | | |
| 15.0 | CLAYEY SILT, some sand, trace gravel Stiff, Grey, Moist | | 15 | TW | PH | | 180 | | | | | | 16.8 | 3 14 44 39 SG = 2,740 |
| | | | | | | | 179 | | | | | | | |
| | | | | VANE | FV | | 178 | | | | | | | |
| | | | 16 | SS | 8 | | 177 | | | | | | | 1 13 47 39 |
| | | | | VANE | FV | | 176 | | | | | | | |
| | | | 17 | TW | PH | | | | | | | | | |
| 175.1 | End of borehole | | | | | | | | | | | | | |
| 20.4 | NOTES: 1. Groundwater level was not encountered during or upon completion of drilling. 2. No cave-in was noted upon extraction of hollow stem augers. 3. The shear vane test conducted at depth 14.6 m (EL. 180.9) below the existing ground surface, was carried out in a second borehole drilled adjacent to Borehole CN-4. | | | | | | | | | | | | | |

>>: Greater than

+³, X³: Numbers refer to Sensitivity

○ 3% STRAIN AT FAILURE

RECORD OF BOREHOLE No CN-5

1 OF 4

METRIC

G.W.P. 3064-11-00-06 LOCATION Coords: 4 757 360.6 N; 317 387.2 E ORIGINATED BY M.M.
 DIST West Region HWY 40 BOREHOLE TYPE Continuous Flight Hollow Stem Augers + HQ Rock Coring COMPILED BY N.L.
 DATUM Geodetic DATE 2020.07.27 LATITUDE 42.955937 LONGITUDE -82.345729 CHECKED BY N.R.

| SOIL PROFILE | | | SAMPLES | | | GROUND WATER CONDITIONS | ELEVATION SCALE | DYNAMIC CONE PENETRATION RESISTANCE PLOT | | | PLASTIC LIMIT w _p | NATURAL MOISTURE CONTENT w | LIQUID LIMIT w _L | UNIT WEIGHT γ kN/m ³ | REMARKS & GRAIN SIZE DISTRIBUTION (%) |
|---------------|---|------------|---------|------|------------|----------------------------|-----------------|---|--|--|------------------------------------|-------------------------------------|-----------------------------------|--|---|
| ELEV DEPTH | DESCRIPTION | STRAT PLOT | NUMBER | TYPE | "N" VALUES | | | SHEAR STRENGTH kPa | | | | | | | |
| 195.4 | Ground Surface | | | | | | | 20 40 60 80 100 | | | | | | | |
| 0.0 | CLAYEY SILT, some sand, trace gravel | | 1 | SS | 12 | | 195 | | | | | | | | |
| | Stiff to very stiff, Brown, Moist | | 2 | SS | 13 | | 194 | | | | | | | | |
| | (FILL) | | 3 | SS | 11 | | | | | | | | | | |
| | | | 4 | SS | 12 | | 193 | | | | | | | | |
| | | | 5 | SS | 11 | | 192 | | | | | | | | |
| | | | 6 | SS | 4 | | 191 | | | | | | | | |
| | | | 7 | TW | PH | | 190 | | | | | | | | |
| | | | | VANE | FV | | | | | | | | | | |
| | | | 8 | SS | 9 | | 189 | | | | | | | | |
| | | | | | | | 188 | | | | | | | | |
| | | | 9 | SS | 22 | | 187 | | | | | | | | |
| 187.1 | CLAYEY SILT/SILTY CLAY, some sand, trace gravel | | 10 | SS | 18 | | 186 | | | | | | | | |
| 8.3 | Very stiff to stiff, Brown, Moist | | 11 | SS | 30 | | 185 | | | | | | | | |
| | | | 12 | SS | 17 | | 184 | | | | | | | | |
| | | | | | | | 183 | | | | | | | | |
| | | | 13 | SS | 8 | | 182 | | | | | | | | |
| | | | | | | | 181 | | | | | | | | |
| 180.4 | | | | | | | | | | | | | | | |

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>>: Greater than

+³, X³: Numbers refer to
Sensitivity

○ 3% STRAIN AT FAILURE

RECORD OF BOREHOLE No CN-5

2 OF 4

METRIC

G.W.P. 3064-11-00-06 LOCATION Coords: 4 757 360.6 N; 317 387.2 E ORIGINATED BY M.M.
DIST West Region HWY 40 BOREHOLE TYPE Continuous Flight Hollow Stem Augers + HQ Rock Coring COMPILED BY N.L.
DATUM Geodetic DATE 2020.07.27 LATITUDE 42.955937 LONGITUDE -82.345729 CHECKED BY N.R.

| SOIL PROFILE | | | SAMPLES | | | GROUND WATER CONDITIONS | ELEVATION SCALE | DYNAMIC CONE PENETRATION RESISTANCE PLOT | | PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT | | | UNIT WEIGHT γ kN/m ³ | REMARKS & GRAIN SIZE DISTRIBUTION (%) | | | | | | |
|---------------|--|------------|---------|------|------------|----------------------------|-----------------|---|----|---|-----|----|---|---|--|----|----|----|----|----|
| ELEV DEPTH | DESCRIPTION | STRAT PLOT | NUMBER | TYPE | "N" VALUES | | | SHEAR STRENGTH kPa | | | | | | WATER CONTENT (%) | | | GR | SA | SI | CL |
| | | | | | | | | ○ UNCONFINED + FIELD VANE | | | | | | w _p w w _L | | | | | | |
| | | | | | | | | ● QUICK TRIAXIAL × LAB VANE | | | | | | | | | | | | |
| 180.4 | | | | | | | 20 | 40 | 60 | 80 | 100 | 20 | 40 | 60 | | | | | | |
| 15.0 | CLAYEY SILT/SILTY CLAY, some to trace sand, trace gravel Stiff to very stiff, Brown, Moist | | | | | | | | | | | | | | | | | | | |
| | | | 14 | TW | PH | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | | |
| | | | | VANE | FV | | | | | | | | | | | | | | | |
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| | | | 15 | SS | 7 | | | | | | | | | | | | | | | |
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| | | | | | | | | | | | | | | | | | | | | |
| | | | 16 | TW | PH | | | | | | | | | | | | | | | |
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| | | | | VANE | FV | | | | | | | | | | | | | | | |
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Continued Next Page

>>: Greater than

+³, X³: Numbers refer to
Sensitivity

○ 3% STRAIN AT FAILURE

RECORD OF BOREHOLE No CN-5

3 OF 4

METRIC

G.W.P. 3064-11-00-06 LOCATION Coords: 4 757 360.6 N; 317 387.2 E ORIGINATED BY M.M.
 DIST West Region HWY 40 BOREHOLE TYPE Continuous Flight Hollow Stem Augers + HQ Rock Coring COMPILED BY N.L.
 DATUM Geodetic DATE 2020.07.27 LATITUDE 42.955937 LONGITUDE -82.345729 CHECKED BY N.R.

| SOIL PROFILE | | | SAMPLES | | | GROUND WATER CONDITIONS | ELEVATION SCALE | DYNAMIC CONE PENETRATION RESISTANCE PLOT | | | | | UNIT WEIGHT γ kN/m ³ | REMARKS & GRAIN SIZE DISTRIBUTION (%) |
|---------------|---|------------|---------|------|------------|----------------------------|-----------------|---|----|----|----|-----|---|---|
| ELEV DEPTH | DESCRIPTION | STRAT PLOT | NUMBER | TYPE | "N" VALUES | | | 20 | 40 | 60 | 80 | 100 | | |
| 165.4 | | | | | | | | | | | | | | |
| 30.0 | CLAYEY SILT/SILTY CLAY, trace to some sand, trace gravel Very stiff, Brown, Moist | | | | | | 165 | | | | | | | |
| | | | 20 | SS | 15 | | 164 | | | | | | | |
| | | | | | | | 163 | | | | | | | |
| | | | | | | | 162 | | | | | | | |
| | | | 21 | SS | 14 | | 161 | | | | | | | |
| | | | | | | | 160 | | | | | | | |
| | | | | | | | 159 | | | | | | | |
| | | | 22 | SS | 20 | | 158 | | | | | | | |
| | | | | | | | 157 | | | | | | | |
| | | | 23 | TW | PH | | 156 | | | | | | | |
| | | | | | | | 155 | | | | | | | |
| | | | 24 | SS | 21 | | 154 | | | | | | | |
| | | | | | | | 153 | | | | | | | |
| | | | 25 | SS | 19 | | 152 | | | | | | | |
| | | | | | | | 151 | | | | | | | |
| 150.4 | | | | | | | | | | | | | | |

Continued Next Page

>>: Greater than

+³, X³: Numbers refer to
Sensitivity

○ 3% STRAIN AT FAILURE

RECORD OF BOREHOLE No CN-5

4 OF 4

METRIC

G.W.P. 3064-11-00-06 LOCATION Coords: 4 757 360.6 N; 317 387.2 E ORIGINATED BY M.M.
 DIST West Region HWY 40 BOREHOLE TYPE Continuous Flight Hollow Stem Augers + HQ Rock Coring COMPILED BY N.L.
 DATUM Geodetic DATE 2020.07.27 LATITUDE 42.955937 LONGITUDE -82.345729 CHECKED BY N.R.

| SOIL PROFILE | | | SAMPLES | | | GROUND WATER CONDITIONS | ELEVATION SCALE | DYNAMIC CONE PENETRATION RESISTANCE PLOT | | | PLASTIC LIMIT w _p | NATURAL MOISTURE CONTENT w | LIQUID LIMIT w _L | UNIT WEIGHT γ kN/m ³ | REMARKS & GRAIN SIZE DISTRIBUTION (%) | | | | | | | | | | |
|---------------|--|------------|-----------|-------|------------|----------------------------|-----------------|---|-----|-------|------------------------------------|-------------------------------------|-----------------------------------|--|---|----|------------------------------|----|----|----|----|----|----|----|--|
| ELEV DEPTH | DESCRIPTION | STRAT PLOT | NUMBER | TYPE | "N" VALUES | | | 20 | 40 | 60 | | | | | | 80 | 100 | 20 | 40 | 60 | GR | SA | SI | CL | |
| 150.4 | | | | | | | | | | | | | | | | | | | | | | | | | |
| 45.0 | CLAYEY SILT, some sand, trace gravel | | | | | | | | | | | | | | | | | | | | | | | | |
| | Hard, Brown, Moist | | | | | | | | | | | | | | | | | | | | | | | | |
| 149.6 | | | 26 | SS | 50/3cm | | | | | | | | | | | | | | | | | | | | |
| 45.8 | SHALE BEDROCK | | | | | | | | | | | | | | | | | | | | | | | | |
| | Unweathered | | RUN 1 | RC HQ | RQD 72% | | | | | | | | | | | | REC = 74% UCS = 71.7 MPa | | | | | | | | |
| | | | RUN 2 | RC HQ | RQD 100% | | | | | | | | | | | | REC = 100% UCS = 84.0 MPa | | | | | | | | |
| 146.6 | End of borehole | | | | | | | | | | | | | | | | | | | | | | | | |
| 48.8 | | | | | | | | | | | | | | | | | | | | | | | | | |
| | <div><div></div>Groundwater level measured upon completion of drilling</div> <div><div></div>Groundwater level measured in monitoring well</div> <div>NOTES: 1. No cave-in was noted upon extraction of hollow stem augers. 2. Gas pocket encountered from EL. 148.6 to EL. 149.6. LEL = 100%. 45 minutes taken to dissipate before rock coring. 3. Gas reading on Aug. 17 2020: LEL = 0%. 4. Gas reading on Aug. 27 2020: LEL = 0%. Monitoring well decommissioned.</div> <div>Monitoring Well Readings: <table><tr><th>Date</th><th>Depth (m)</th><th>Elev.</th></tr><tr><td>Jul. 29/20</td><td>7.3</td><td>188.1</td></tr><tr><td>Aug.10/20</td><td>7.1</td><td>188.3</td></tr><tr><td>Aug.17/20</td><td>6.7</td><td>188.7</td></tr></table></div> <div>Monitoring Well Legend: <div> Concrete</div><div> Bentonite seal</div><div> Filter sand</div><div> Screen</div></div> | Date | Depth (m) | Elev. | Jul. 29/20 | 7.3 | 188.1 | Aug.10/20 | 7.1 | 188.3 | Aug.17/20 | 6.7 | 188.7 | | | | | | | | | | | | |
| Date | Depth (m) | Elev. | | | | | | | | | | | | | | | | | | | | | | | |
| Jul. 29/20 | 7.3 | 188.1 | | | | | | | | | | | | | | | | | | | | | | | |
| Aug.10/20 | 7.1 | 188.3 | | | | | | | | | | | | | | | | | | | | | | | |
| Aug.17/20 | 6.7 | 188.7 | | | | | | | | | | | | | | | | | | | | | | | |

ONTARIO MTO 20TF016.GPJ ONTARIO MTO.GDT 21-9-21

>>: Greater than

+ ³, X ³: Numbers refer to Sensitivity

○ 3% STRAIN AT FAILURE

RECORD OF BOREHOLE No CN-7

1 OF 4

METRIC

G.W.P. 3064-11-00-06 LOCATION Coords: 4 757 275.2 N; 317 383.1 E ORIGINATED BY M.M.
 DIST West Region HWY 40 BOREHOLE TYPE Continuous Flight Hollow Stem Augers + HQ Rock Coring COMPILED BY N.L.
 DATUM Geodetic DATE 2020.07.20 - 2020.07.21 LATITUDE 42.955168 LONGITUDE -82.34578 CHECKED BY N.R.

| SOIL PROFILE | | | SAMPLES | | | GROUND WATER | CONDITIONS | ELEVATION SCALE | DYNAMIC CONE PENETRATION RESISTANCE PLOT | | PLASTIC LIMIT W _p | NATURAL MOISTURE CONTENT W | LIQUID LIMIT W _L | UNIT WEIGHT γ | REMARKS & GRAIN SIZE DISTRIBUTION (%) |
|---------------|---|------------|---------|------|------------|--------------|------------|-----------------|--|--|---------------------------------|-------------------------------|--------------------------------|------------------|---------------------------------------|
| ELEV DEPTH | DESCRIPTION | STRAT PLOT | NUMBER | TYPE | "N" VALUES | | | | SHEAR STRENGTH kPa | | | | | | |
| 195.9 | Ground Surface | | | | | | | | | | | | | | |
| 0.0 | CLAYEY SILT, some sand/sandy, trace/some gravel | | 1 | NR | 16 | | | | | | | | | | |
| | Stiff to very stiff, Brown, Moist (FILL) | | 2 | SS | 7 | | | | | | | | | | |
| | | | 3 | SS | 13 | | | | | | | | | | |
| | | | 4 | SS | 9 | | | | | | | | | | |
| | | | 5 | SS | 9 | | | | | | | | | | |
| | | | 6 | SS | 13 | | | | | | | | | | |
| | | | 7 | SS | 6 | | | | | | | | | | |
| | | | 8 | SS | 14 | | | | | | | | | | |
| | | | 9 | SS | 15 | | | | | | | | | | |
| | | | 10 | SS | 6 | | | | | | | | | | |
| 186.9 | CLAYEY SILT/SILTY CLAY, sandy, trace gravel | | 11 | TW | PH | | | | | | | | | | |
| 9.0 | Very stiff to stiff, Grey, Moist | | | VANE | FV | | | | | | | | | | |
| | | | 12 | SS | 23 | | | | | | | | | | |
| | | | 13 | SS | 17 | | | | | | | | | | |
| | | | 14 | SS | 8 | | | | | | | | | | |
| 180.9 | | | | | | | | | | | | | | | |

Continued Next Page

>>: Greater than

+³, ×³: Numbers refer to
Sensitivity

○ 3% STRAIN AT FAILURE

RECORD OF BOREHOLE No CN-7

2 OF 4

METRIC

G.W.P. 3064-11-00-06 LOCATION Coords: 4 757 275.2 N; 317 383.1 E ORIGINATED BY M.M.
DIST West Region HWY 40 BOREHOLE TYPE Continuous Flight Hollow Stem Augers + HQ Rock Coring COMPILED BY N.L.
DATUM Geodetic DATE 2020.07.20 - 2020.07.21 LATITUDE 42.955168 LONGITUDE -82.34578 CHECKED BY N.R.

| SOIL PROFILE | | | SAMPLES | | | GROUND WATER CONDITIONS | DYNAMIC CONE PENETRATION RESISTANCE PLOT | | PLASTIC LIMIT W _p | NATURAL MOISTURE CONTENT W | LIQUID LIMIT W _L | UNIT WEIGHT γ kN/m ³ | REMARKS & GRAIN SIZE DISTRIBUTION (%) |
|---------------|---|------------|---------|------|------------|----------------------------|---|-----------------|------------------------------------|-------------------------------------|-----------------------------------|---|---|
| ELEV DEPTH | DESCRIPTION | STRAT PLOT | NUMBER | TYPE | "N" VALUES | | 20 40 60 80 100 | 20 40 60 80 100 | | | | | |
| 180.9 | | | | | | | | | | | | | |
| 15.0 | CLAYEY SILT/SILTY CLAY, some to trace sand, trace gravel Very stiff to stiff, Grey, Moist | | 15 | TW | PH | | | | | | | 20.4 | 4 14 46 36 SG = 2.744 e ₀ = 0.624 p ₀ = 491 kPa C _c = 0.301 C _{cr} = 0.065 |
| | | | | VANE | FV | | | | | | | | |
| | | | 16 | SS | 14 | | | | | | | | 3 9 48 40 |
| | | | 17 | SS | 17 | | | | | | | | |
| | | | 18 | SS | 18 | | | | | | | | |
| | | | 19 | SS | 18 | | | | | | | | |
| | | | 20 | SS | 16 | | | | | | | | 2 8 44 46 |
| | | | 21 | SS | 12 | | | | | | | | |
| 165.9 | | | | | | | | | | | | | |

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>>: Greater than

+³, X³: Numbers refer to
Sensitivity

○ 3% STRAIN AT FAILURE

METRIC

○ 3% STRAIN AT FAILURE

RECORD OF BOREHOLE No CN-7

4 OF 4

METRIC

G.W.P. 3064-11-00-06 LOCATION Coords: 4 757 275.2 N; 317 383.1 E ORIGINATED BY M.M.
 DIST West Region HWY 40 BOREHOLE TYPE Continuous Flight Hollow Stem Augers + HQ Rock Coring COMPILED BY N.L.
 DATUM Geodetic DATE 2020.07.20 - 2020.07.21 LATITUDE 42.955168 LONGITUDE -82.34578 CHECKED BY N.R.

| SOIL PROFILE | | | | SAMPLES | | | GROUND WATER CONDITIONS | ELEVATION SCALE | DYNAMIC CONE PENETRATION RESISTANCE PLOT | | | PLASTIC LIMIT w _p | NATURAL MOISTURE CONTENT w | LIQUID LIMIT w _L | UNIT WEIGHT γ kN/m ³ | REMARKS & GRAIN SIZE DISTRIBUTION (%) | | | | | | | | | | | | | | | | | | | | |
|---|---|------------|--------|----------|------------|--|----------------------------|-----------------|---|----|-----|--|---|---------------------------------------|--|---|--------------------------------|-----------|-------|------------|-----|-------|------------|-----|-------|------------|-----|-------|--|----------|--|----------------|--|-------------|--|--------|
| ELEV DEPTH | DESCRIPTION | STRAT PLOT | NUMBER | TYPE | "N" VALUES | SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE | | | WATER CONTENT (%) | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 150.9 45.0 | SILTY CLAY, trace sand, trace gravel Hard, Grey, Moist | | | | | | 20 | 40 | 60 | 80 | 100 | 20 | 40 | 60 | GR SA SI CL | | | | | | | | | | | | | | | | | | | | | |
| 150.2 45.7 | SHALE BEDROCK Unweathered | | 27 | SS | 50/3cm | | 150 | | | | | | | | | | REC = 78% UCS = 84.1 MPa | | | | | | | | | | | | | | | | | | | |
| | | | Run 1 | RC HQ | RQD 75% | | 149 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | | | Run 2 | RC HQ | RQD 93% | 148 | | | | | | | | | | REC = 93% UCS = 60.8 MPa | | | | | | | | | | | | | | | | | | | | |
| 147.2 48.7 | End of borehole | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| <div> Groundwater level measured upon completion of drilling</div> <div> Groundwater level measured in monitoring well</div> <div>NOTES: 1. No cave-in was noted upon extraction of hollow stem augers. 2. The shear vane tests conducted at depths 0.8 m (EL. 195.1) and 4.6 m (EL. 191.3) below the existing ground surface, were carried out in a second borehole drilled adjacent to Borehole CN-7. 3. Gas pocket encountered from EL. 149.2 to EL. 150.2. LEL = 100%. 45 minutes taken to dissipate before rock coring. 4. Gas reading on Aug. 17 2020: LEL = 5% to LEL = 0% in 30 seconds. 5. Gas reading on Aug. 27 2020: LEL = 1% to LEL = 0% in 15 seconds. Monitoring well decommissioned.</div> <div>Monitoring Well Readings: <table><tr><th>Date</th><th>Depth (m)</th><th>Elev.</th></tr><tr><td>Jul. 22/20</td><td>8.0</td><td>187.9</td></tr><tr><td>Aug. 10/20</td><td>7.9</td><td>188.0</td></tr><tr><td>Aug. 17/20</td><td>8.9</td><td>187.0</td></tr></table></div> <div>Monitoring Well Legend: <table><tr><td></td><td>Concrete</td></tr><tr><td></td><td>Bentonite seal</td></tr><tr><td></td><td>Filter sand</td></tr><tr><td></td><td>Screen</td></tr></table></div> | | | | | | | | | | | | | | | | | Date | Depth (m) | Elev. | Jul. 22/20 | 8.0 | 187.9 | Aug. 10/20 | 7.9 | 188.0 | Aug. 17/20 | 8.9 | 187.0 | | Concrete | | Bentonite seal | | Filter sand | | Screen |
| Date | Depth (m) | Elev. | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Jul. 22/20 | 8.0 | 187.9 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Aug. 10/20 | 7.9 | 188.0 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Aug. 17/20 | 8.9 | 187.0 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | Concrete | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | Bentonite seal | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | Filter sand | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | Screen | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |

ONTARIO MTO 20TF016.GPJ ONTARIO MTO.GDT 21-9-21

>>: Greater than

+ 3, X 3: Numbers refer to Sensitivity

○ 3% STRAIN AT FAILURE

RECORD OF BOREHOLE No CN-8

1 OF 2

METRIC

G.W.P. 3064-11-00-06 LOCATION Coords: 4 757 251.3 N; 317 376.0 E ORIGINATED BY M.M.
 DIST West Region HWY 40 BOREHOLE TYPE Continuous Flight Hollow Stem Augers COMPILED BY N.L.
 DATUM Geodetic DATE 2020.08.06 LATITUDE 42.954533 LONGITUDE -82.345886 CHECKED BY N.R.

| SOIL PROFILE | | | SAMPLES | | | GROUND WATER CONDITIONS | ELEVATION SCALE | DYNAMIC CONE PENETRATION RESISTANCE PLOT | | | | | UNIT WEIGHT γ kN/m ³ | REMARKS & GRAIN SIZE DISTRIBUTION (%) |
|---------------|--|------------|---------|------|------------|----------------------------|-----------------|---|----|----|----|-----|---|---|
| ELEV DEPTH | DESCRIPTION | STRAT PLOT | NUMBER | TYPE | "N" VALUES | | | 20 | 40 | 60 | 80 | 100 | | |
| 195.7 | Ground Surface | | | | | | | | | | | | | |
| 0.0 | CLAYEY SILT/SILTY CLAY, sandy, trace gravel | | 1 | SS | 19 | | 195 | | | | | | | |
| | Stiff to very stiff, Grey, Moist (FILL) | | 2 | SS | 15 | | 194 | | | | | | | |
| | | | 3 | SS | 11 | | 193 | | | | | | | 1 28 35 36 |
| | | | 4 | SS | 11 | | 192 | | | | | | | 1 25 38 36 |
| | | | 5 | SS | 12 | | 191 | | | | | | | |
| | | | 6 | SS | 16 | | 190 | | | | | | | |
| | | | 7 | SS | 11 | | 189 | | | | | | | 1 21 40 38 |
| | | | 8 | SS | 13 | | 188 | | | | | | | |
| | | | 9 | SS | 8 | | 187 | | | | | | | |
| | | | VANE | FV | | | 186 | | | | | | | |
| | | | 10 | SS | 15 | | 185 | | | | | | | 1 19 44 36 |
| 186.7 | CLAYEY SILT/SILTY CLAY, some sand, trace gravel | | 11 | SS | 12 | | 184 | | | | | | | |
| 9.0 | Stiff to very stiff, Grey, Moist | | 12 | SS | 23 | | 183 | | | | | | | |
| | | | 13 | SS | 11 | | 182 | | | | | | | |
| | | | 14 | SS | 6 | | 181 | | | | | | | |
| | | | VANE | FV | | | | | | | | | | |

Continued Next Page

>>: Greater than

+³, X³: Numbers refer to
Sensitivity

○ 3% STRAIN AT FAILURE

RECORD OF BOREHOLE No CN-8

2 OF 2

METRIC

G.W.P. 3064-11-00-06 LOCATION Coords: 4 757 251.3 N; 317 376.0 E ORIGINATED BY M.M.
DIST West Region HWY 40 BOREHOLE TYPE Continuous Flight Hollow Stem Augers COMPILED BY N.L.
DATUM Geodetic DATE 2020.08.06 LATITUDE 42.954533 LONGITUDE -82.345886 CHECKED BY N.R.

| SOIL PROFILE | | | SAMPLES | | | GROUND WATER CONDITIONS | ELEVATION SCALE | DYNAMIC CONE PENETRATION RESISTANCE PLOT | | | PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT | | | UNIT WEIGHT γ kN/m ³ | REMARKS & GRAIN SIZE DISTRIBUTION (%) | | | | | | | | | | | | | | | | | | | | | |
|---------------|--|------------|---------|------|------------|----------------------------|-----------------|---|----|----|---|----|----------------|---|---|--|--|--|----|----|----|----|--|--|--|--|--|--|--|--|--|--|--|--|--|--|
| ELEV DEPTH | DESCRIPTION | STRAT PLOT | NUMBER | TYPE | "N" VALUES | | | SHEAR STRENGTH kPa | | | W _p | W | W _L | | WATER CONTENT (%) | | | | GR | SA | SI | CL | | | | | | | | | | | | | | |
| 180.7 | CLAYEY SILT/SILTY CLAY, some sand, trace gravel Stiff to very stiff, Grey, Moist (<i>Cont'd</i>) | | | | | | 20 | 40 | 60 | 80 | 100 | 20 | 40 | 60 | | | | | | | | | | | | | | | | | | | | | | |
| | | | 15 | SS | 6 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | | | | VANE | FV | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | | | 16 | SS | 6 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | | | | VANE | FV | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | | | 17 | SS | 10 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
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>>: Greater than

+³, X³: Numbers refer to Sensitivity

○ 3% STRAIN AT FAILURE

RECORD OF BOREHOLE No RW-1

1 OF 4

METRIC

G.W.P. 3064-11-00-06 LOCATION Coords: 4 757 272.5 N; 317 370.3 E ORIGINATED BY M.M.
DIST West Region HWY 40 BOREHOLE TYPE Continuous Flight Hollow Stem Augers COMPILED BY N.L.
DATUM Geodetic DATE 2020.07.24 LATITUDE 42.955144 LONGITUDE -82.345938 CHECKED BY N.R.

| SOIL PROFILE | | | SAMPLES | | | GROUND WATER CONDITIONS | ELEVATION SCALE | DYNAMIC CONE PENETRATION RESISTANCE PLOT | | | | PLASTIC LIMIT W _P | NATURAL MOISTURE CONTENT W | LIQUID LIMIT W _L | UNIT WEIGHT γ kN/m ³ | REMARKS & GRAIN SIZE DISTRIBUTION (%) | |
|---------------|---|------------|---------|---------|------------|----------------------------|-----------------|---|----|----|----|------------------------------------|-------------------------------------|-----------------------------------|--|---|-------------------|
| ELEV DEPTH | DESCRIPTION | STRAT PLOT | NUMBER | TYPE | "N" VALUES | | | SHEAR STRENGTH kPa | | | | | | | | | WATER CONTENT (%) |
| | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | |
| 196.0 | Ground Surface | | | | | | | 20 | 40 | 60 | 80 | 100 | | | | | |
| 0.0 | CLAYEY SILT, trace/some sand, trace gravel | | 1 | SS | 11 | | | | | | | | | | | | |
| | Stiff to very stiff, Brown, Moist (FILL) | | 2 | SS | 12 | | | | | | | | | | | | |
| | | | 3 | SS | 10 | | | | | | | | | | | | |
| | | | 4 | SS | 13 | | | | | | | | | | | | |
| | | | 5 | SS | 7 | | | | | | | | | | | | |
| | | | 6 | VANE SS | FV 7 | | | | | | | | | | | | |
| | | | 7 | SS | 6 | | | | | | | | | | | | |
| | | | 8 | TW | PH | | | | | | | | | | | | |
| | | | 9 | SS | 10 | | | | | | | | | | | | |
| | | | 10 | SS | 11 | | | | | | | | | | | | |
| 186.8 | CLAYEY SILT/SILTY CLAY, some sand, trace gravel | | 11 | SS | 17 | | | | | | | | | | | | |
| 9.2 | Very stiff to stiff, Grey, Moist | | 12 | SS | 21 | | | | | | | | | | | | |
| | | | 13 | SS | 19 | | | | | | | | | | | | |
| | | | 14 | SS | 7 | | | | | | | | | | | | |
| | | | VANE | FV | | | | | | | | | | | | | |
| 181.0 | | | | | | | | | | | | | | | | | |

Continued Next Page

>>: Greater than

+³, ×³: Numbers refer to Sensitivity

○ 3% STRAIN AT FAILURE

RECORD OF BOREHOLE No RW-1

2 OF 4

METRIC

G.W.P. 3064-11-00-06 LOCATION Coords: 4 757 272.5 N; 317 370.3 E ORIGINATED BY M.M.
 DIST West Region HWY 40 BOREHOLE TYPE Continuous Flight Hollow Stem Augers COMPILED BY N.L.
 DATUM Geodetic DATE 2020.07.24 LATITUDE 42.955144 LONGITUDE -82.345938 CHECKED BY N.R.

| SOIL PROFILE | | | SAMPLES | | | GROUND WATER CONDITIONS | ELEVATION SCALE | DYNAMIC CONE PENETRATION RESISTANCE PLOT | | | | | UNIT WEIGHT γ kN/m ³ | REMARKS & GRAIN SIZE DISTRIBUTION (%) |
|---------------|--|------------|---------|------|------------|----------------------------|-----------------|---|----|----|----|-----|---|---|
| ELEV DEPTH | DESCRIPTION | STRAT PLOT | NUMBER | TYPE | "N" VALUES | | | 20 | 40 | 60 | 80 | 100 | | |
| 181.0 | | | | | | | | | | | | | | |
| 15.0 | CLAYEY SILT/SILTY CLAY, some sand, trace gravel Stiff to very stiff, Grey, Moist | | 15 | TW | PH | | 180 | | | | | | | |
| | | | 16 | SS | 8 | | 179 | | | | | | | |
| | | | | VANE | FV | | 178 | | | | | | | |
| | | | 17 | SS | 9 | | 177 | | | | | | | |
| | | | | VANE | FV | | 176 | | | | | | | |
| | | | | | | | 175 | | | | | | | |
| | | | | | | | 174 | | | | | | | |
| | | | 18 | SS | 21 | | 173 | | | | | | | |
| | | | | | | | 172 | | | | | | | |
| | | | | | | | 171 | | | | | | | |
| | | | 19 | SS | 19 | | 170 | | | | | | | |
| | | | | | | | 169 | | | | | | | |
| | | | | | | | 168 | | | | | | | |
| | | | 20 | SS | 11 | | 167 | | | | | | | |
| 166.0 | | | | | | | | | | | | | | |

Continued Next Page

>>: Greater than

+³, X³: Numbers refer to
Sensitivity

○ 3% STRAIN AT FAILURE

METRIC

Continued Next Page



○ 3% STRAIN AT FAILURE

RECORD OF BOREHOLE No RW-1

4 OF 4

METRIC

G.W.P. 3064-11-00-06 LOCATION Coords: 4 757 272.5 N; 317 370.3 E ORIGINATED BY M.M.
 DIST West Region HWY 40 BOREHOLE TYPE Continuous Flight Hollow Stem Augers COMPILED BY N.L.
 DATUM Geodetic DATE 2020.07.24 LATITUDE 42.955144 LONGITUDE -82.345938 CHECKED BY N.R.

| SOIL PROFILE | | | SAMPLES | | | GROUND WATER CONDITIONS | ELEVATION SCALE | DYNAMIC CONE PENETRATION RESISTANCE PLOT | | | | | PLASTIC LIMIT w _p | NATURAL MOISTURE CONTENT w | LIQUID LIMIT w _L | UNIT WEIGHT γ | REMARKS & GRAIN SIZE DISTRIBUTION (%) | | | |
|---------------|---|---|---------|------|------------|----------------------------|-----------------|---|----|----|----|--------------|--|---|---------------------------------------|-------------------------|---|-------------------|------------------|------------|
| ELEV DEPTH | DESCRIPTION | STRAT PLOT | NUMBER | TYPE | "N" VALUES | | | SHEAR STRENGTH kPa | | | | | | | | | | WATER CONTENT (%) | | |
| | | | | | | | | | | | | ○ UNCONFINED | | | | | | + FIELD VANE | ● QUICK TRIAXIAL | × LAB VANE |
| 151.0 | | | | | | | | 20 | 40 | 60 | 80 | 100 | | | | | | | | |
| 45.0 | CLAYEY SILT, some sand, trace gravel |  | | | | | | | | | | | | | | | | | | |
| | Hard, Grey, Moist | | | | | | | | | | | | | | | | | | | |
| 150.3 | | | 26 | SS | 50/3cm | | | | | | | | | | | | | | | |
| 45.7 | End of borehole Auger refusal on probable bedrock | | | | | | | | | | | | | | | | | | | |
| |  Groundwater level measured upon completion of drilling | | | | | | | | | | | | | | | | | | | |
| | NOTES: 1. No cave-in was noted upon extraction of hollow stem augers. 2. Gas pocket encountered from EL. 149.3 to EL. 150.3. LEL = 100%. 3. The shear vane tests conducted at depths 3.1 m (EL. 192.9), 4.0 m (EL. 192.0), and 4.6 m (EL. 191.4) below the existing ground surface, were carried out in a second borehole drilled adjacent to Borehole RW-1. | | | | | | | | | | | | | | | | | | | |

>>: Greater than

+ 3, X 3: Numbers refer to Sensitivity

○ 3% STRAIN AT FAILURE

RECORD OF BOREHOLE No RW-2

1 OF 4

METRIC

G.W.P. 3064-11-00-06 LOCATION Coords: 4 757 366.5 N; 317 373.8 E ORIGINATED BY M.M.
 DIST West Region HWY 40 BOREHOLE TYPE Continuous Flight Hollow Stem Augers COMPILED BY N.L.
 DATUM Geodetic DATE 2020.07.22 - 2020.07.23 LATITUDE 42.95599 LONGITUDE -82.345893 CHECKED BY N.R.

| SOIL PROFILE | | | SAMPLES | | | GROUND WATER CONDITIONS | ELEVATION SCALE | DYNAMIC CONE PENETRATION RESISTANCE PLOT | | | | | UNIT WEIGHT γ kN/m ³ | REMARKS & GRAIN SIZE DISTRIBUTION (%) |
|---------------|--|------------|---------|------|------------|----------------------------|-----------------|---|----|----|----|-----|---|---|
| ELEV DEPTH | DESCRIPTION | STRAT PLOT | NUMBER | TYPE | "N" VALUES | | | 20 | 40 | 60 | 80 | 100 | | |
| 195.4 | Ground Surface | | | | | | | | | | | | | |
| 0.0 | SANDY SILT, some gravel, organics Compact, Brown, Moist | | 1 | SS | 11 | | 195 | | | | | | | |
| | CLAYEY SILT/SILTY CLAY, sandy to trace sand, trace gravel | | 2 | SS | 11 | | 194 | | | | | | | |
| | Stiff to very stiff, Brown, Moist (FILL) | | 3 | SS | 10 | | 193 | | | | | | | |
| | | | 4 | SS | 12 | | 192 | | | | | | | |
| | | | 5 | SS | 11 | | 191 | | | | | | | |
| | | | 6 | SS | 14 | | 190 | | | | | | | |
| | | | 7 | SS | 4 | | 189 | | | | | | | |
| | | | | VANE | FV | | 188 | | | | | | | |
| | | | 8 | TW | PH | | 187 | | | | | | | |
| | | | | | | | 186 | | | | | | | |
| | | | 9 | SS | 11 | | 185 | | | | | | | |
| | | | | | | | 184 | | | | | | | |
| | | | | | | | 183 | | | | | | | |
| | | | | | | | 182 | | | | | | | |
| | | | | | | | 181 | | | | | | | |
| 186.3 | CLAYEY SILT/SILTY CLAY, some sand, trace gravel | | 10 | SS | 16 | | 186 | | | | | | | |
| 9.1 | Very stiff to stiff, Brown, Moist | | | | | | 185 | | | | | | | |
| | | | 11 | SS | 24 | | 184 | | | | | | | |
| | | | | | | | 183 | | | | | | | |
| | | | 12 | SS | 22 | | 182 | | | | | | | |
| | | | | | | | 181 | | | | | | | |
| | | | 13 | SS | 10 | | 180 | | | | | | | |
| 180.4 | | | | | | | | | | | | | | |

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>>: Greater than

+³, X³: Numbers refer to
Sensitivity

○ 3% STRAIN AT FAILURE

RECORD OF BOREHOLE No RW-2

2 OF 4

METRIC

G.W.P. 3064-11-00-06 LOCATION Coords: 4 757 366.5 N; 317 373.8 E ORIGINATED BY M.M.
DIST West Region HWY 40 BOREHOLE TYPE Continuous Flight Hollow Stem Augers COMPILED BY N.L.
DATUM Geodetic DATE 2020.07.22 - 2020.07.23 LATITUDE 42.95599 LONGITUDE -82.345893 CHECKED BY N.R.

| SOIL PROFILE | | | SAMPLES | | | GROUND WATER CONDITIONS | ELEVATION SCALE | DYNAMIC CONE PENETRATION RESISTANCE PLOT | | PLASTIC LIMIT W _p | NATURAL MOISTURE CONTENT W | LIQUID LIMIT W _L | UNIT WEIGHT γ kN/m ³ | REMARKS & GRAIN SIZE DISTRIBUTION (%) |
|---------------|--|------------|---------|------|------------|----------------------------|-----------------|---|-----------------|------------------------------------|-------------------------------------|-----------------------------------|--|--|
| ELEV DEPTH | DESCRIPTION | STRAT PLOT | NUMBER | TYPE | "N" VALUES | | | 20 40 60 80 100 | 20 40 60 80 100 | | | | | |
| 180.4 | | | | | | | | | | | | | | |
| 15.0 | CLAYEY SILT/SILTY CLAY, some to trace sand, trace gravel Stiff to very stiff, Brown, Moist | | 14 | TW | PH | | 180 | | | | ○ | | 20.7 | e _s = 0.556 P _c = 250 kPa C _c = 0.223 |
| | | | | | | | 179 | | | | | | | |
| | | | 15 | SS | 6 | | 178 | | | | | | | |
| | | | | VANE | FV | | | | | >> | | | | |
| | | | 16 | TW | PH | | 177 | | | | ○ | | | |
| | | | | VANE | FV | | 176 | | | | | | | |
| | | | | | | | 175 | | | | | | | |
| | | | | | | | 174 | | | | | | | |
| | | | 17 | SS | 16 | | 173 | | | | | | | |
| | | | | | | | 172 | | | | | | | |
| | | | 18 | SS | 15 | | 171 | | | | ○ | | 2 | 9 44 45 |
| | | | | VANE | FV | | 170 | | | | | | | |
| | | | | | | | 169 | | | | | | | |
| | | | 19 | SS | 20 | | 168 | | | | | | | |
| | | | | | | | 167 | | | | | | | |
| | | | 20 | TW | PH | | 166 | | | | ○ | | | |
| | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | |
| 165.4 | | | | | | | | | | | | | | |

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>>: Greater than

+³, ×³: Numbers refer to
Sensitivity

○ 3% STRAIN AT FAILURE

RECORD OF BOREHOLE No RW-2

3 OF 4

METRIC

G.W.P. 3064-11-00-06 LOCATION Coords: 4 757 366.5 N; 317 373.8 E ORIGINATED BY M.M.
 DIST West Region HWY 40 BOREHOLE TYPE Continuous Flight Hollow Stem Augers COMPILED BY N.L.
 DATUM Geodetic DATE 2020.07.22 - 2020.07.23 LATITUDE 42.95599 LONGITUDE -82.345893 CHECKED BY N.R.

| SOIL PROFILE | | | SAMPLES | | | GROUND WATER CONDITIONS | ELEVATION SCALE | DYNAMIC CONE PENETRATION RESISTANCE PLOT | | | | | UNIT WEIGHT γ kN/m ³ | REMARKS & GRAIN SIZE DISTRIBUTION (%) |
|---------------|--|------------|---------|------|------------|----------------------------|-----------------|---|----|----|----|-----|---|---|
| ELEV DEPTH | DESCRIPTION | STRAT PLOT | NUMBER | TYPE | "N" VALUES | | | 20 | 40 | 60 | 80 | 100 | | |
| 165.4 | | | | | | | | | | | | | | |
| 30.0 | CLAYEY SILT/SILTY CLAY, trace sand, trace gravel Very stiff, Grey, Moist | | 21 | SS | 18 | | 165 | | | | | | | |
| | | | | | | | 164 | | | | | | | |
| | | | | | | | 163 | | | | | | | |
| | | | | | | | 162 | | | | | | | |
| | | | 22 | SS | 19 | | 161 | | | | | | | |
| | | | | | | | 160 | | | | | | | |
| | | | 23 | TW | PH | | 159 | | | | | | | |
| | | | | | | | 158 | | | | | | | |
| | | | 24 | SS | 18 | | 157 | | | | | | | |
| | | | | | | | 156 | | | | | | | |
| | | | 25 | SS | 21 | | 155 | | | | | | | |
| | | | | | | | 154 | | | | | | | |
| | | | 26 | TW | PH | | 153 | | | | | | | |
| | | | | | | | 152 | | | | | | | |
| | | | 27 | SS | 23 | | 151 | | | | | | | |
| 150.4 | | | | | | | | | | | | | | |

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+³, X³: Numbers refer to Sensitivity





○ 3% STRAIN AT FAILURE

RECORD OF BOREHOLE No RW-2

4 OF 4

METRIC

G.W.P. 3064-11-00-06 LOCATION Coords: 4 757 366.5 N; 317 373.8 E ORIGINATED BY M.M.
 DIST West Region HWY 40 BOREHOLE TYPE Continuous Flight Hollow Stem Augers COMPILED BY N.L.
 DATUM Geodetic DATE 2020.07.22 - 2020.07.23 LATITUDE 42.95599 LONGITUDE -82.345893 CHECKED BY N.R.

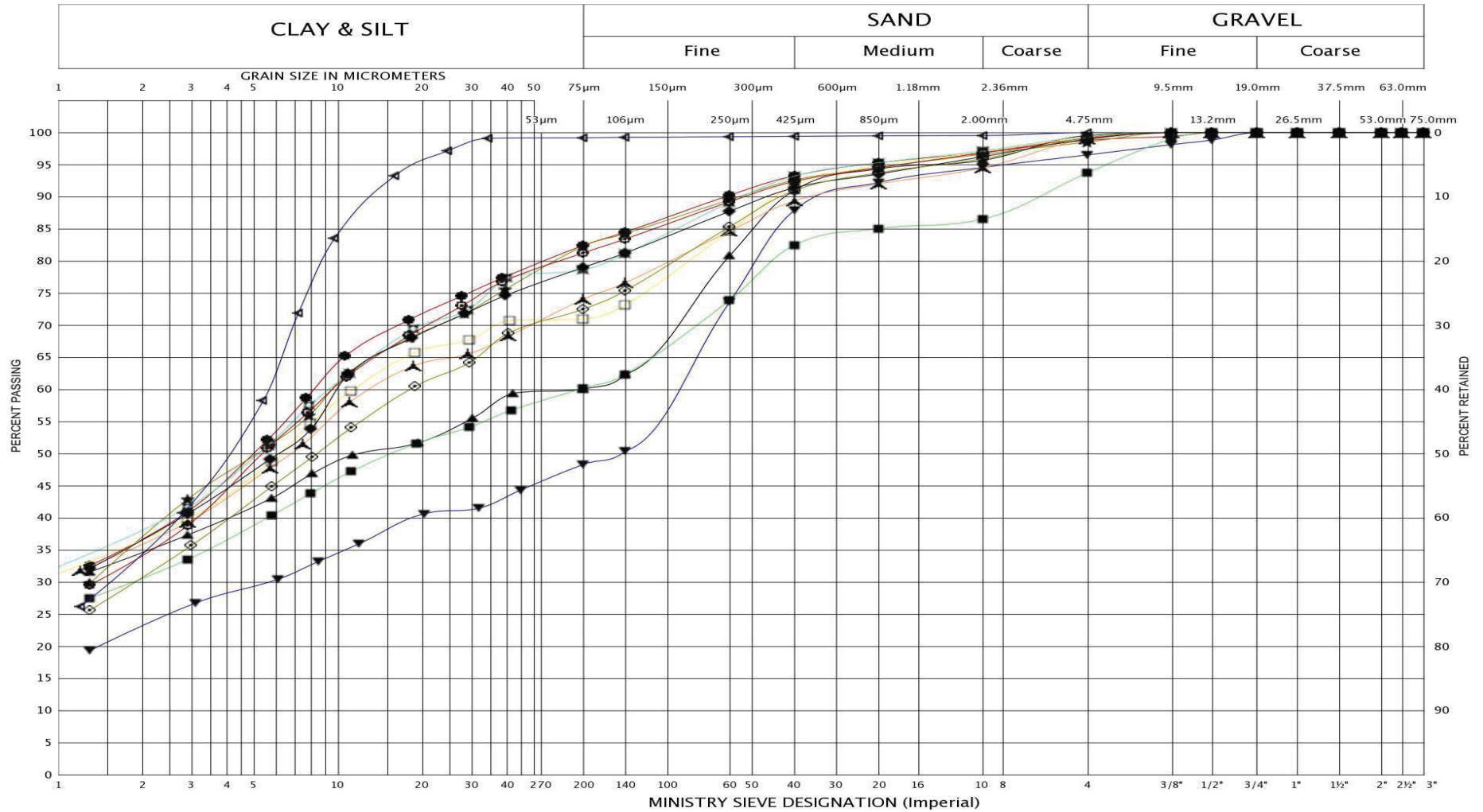
| SOIL PROFILE | | | SAMPLES | | | GROUND WATER CONDITIONS | ELEVATION SCALE | DYNAMIC CONE PENETRATION RESISTANCE PLOT | | | PLASTIC LIMIT w _p | NATURAL MOISTURE CONTENT w | LIQUID LIMIT w _L | UNIT WEIGHT γ kN/m ³ | REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL | | |
|---------------|--|---|---------|------|------------|----------------------------|-----------------|--|----|----|------------------------------------|-------------------------------------|-----------------------------------|--|--|-------------------|--|
| ELEV DEPTH | DESCRIPTION | STRAT PLOT | NUMBER | TYPE | "N" VALUES | | | SHEAR STRENGTH kPa | | | | | | | | WATER CONTENT (%) | |
| | | | | | | | | ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE | | | | | | | | | |
| 150.4 | | | | | | | | 20 | 40 | 60 | 80 | 100 | | | | | |
| 45.0 | SILTY CLAY, trace sand, trace gravel Hard, Grey, Moist |  | | | | | 150 | | | | | | | | | | |
| 149.7 | |  | 28 | SS | 50/3cm | | | | | | | | | | | | |
| 45.7 | End of borehole Auger refusal on probable bedrock |  | | | | | | | | | | | | | | | |
| | <div> Groundwater level measured upon completion of drilling</div> <div>NOTES: 1. No cave-in was noted upon extraction of hollow stem augers. 2. Gas pocket encountered from EL. 148.7 to EL. 149.7. LEL = 100%. 45 minutes taken to dissipate before rock coring.</div> | | | | | | | | | | | | | | | | |

>>: Greater than

+³, X³: Numbers refer to
Sensitivity

○ 3% STRAIN AT FAILURE

UNIFIED SOIL CLASSIFICATION SYSTEM



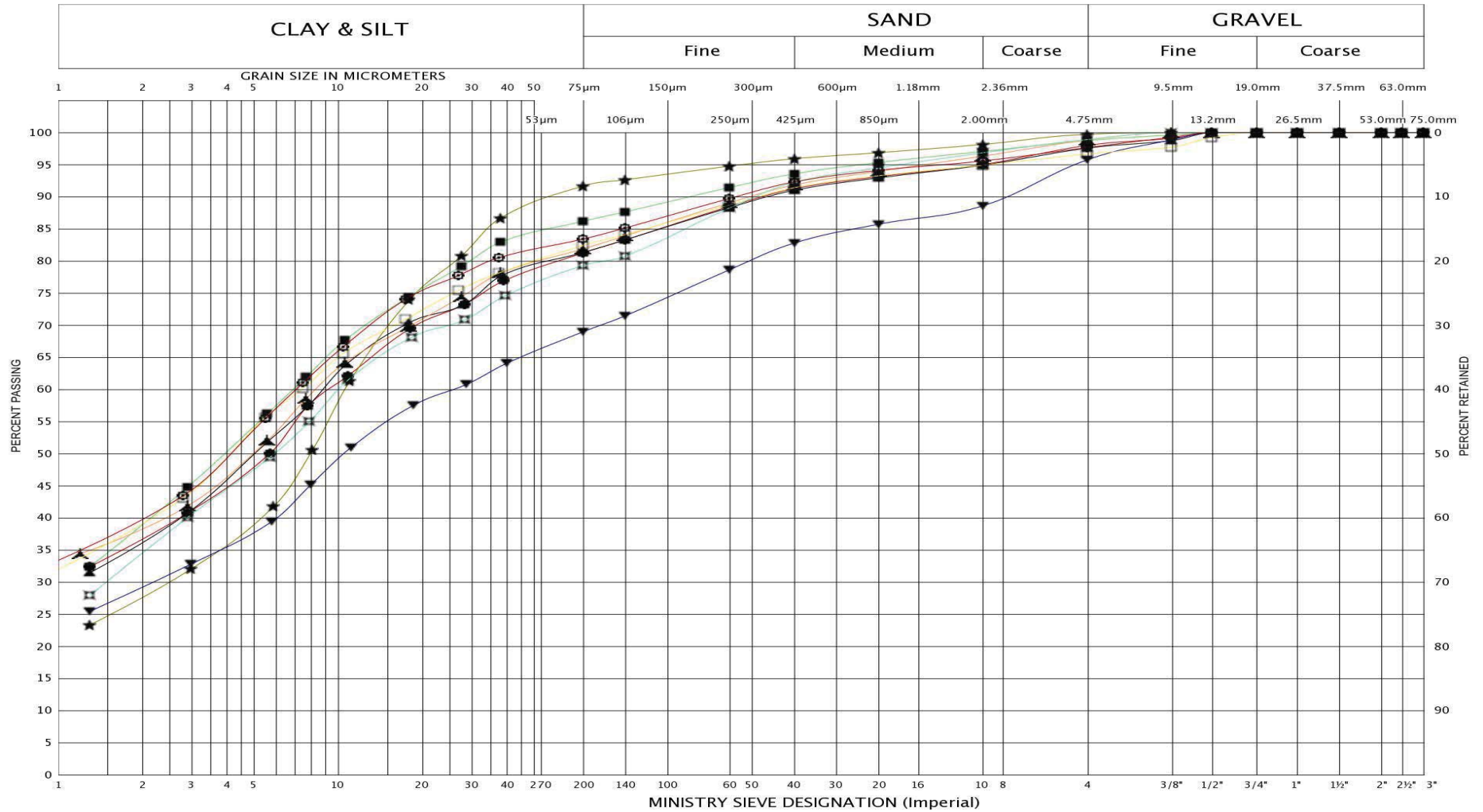
| LEGEND | BH | CN-4 | CN-4 | CN-5 | CN-5 | CN-7 | CN-8 | CN-8 | CN-8 | RW-1 | RW-1 | RW-2 | RW-2 |
|--------|--------|------|------|------|------|------|------|------|------|------|------|------|------|
| | SAMPLE | 7 | 10 | 4 | 9 | 5 | 6 | 4 | 9 | 5 | 9 | 4 | 8 |
| | SYMBOL | ● | ▲ | ★ | ▼ | ■ | ▲ | □ | ■ | ⊕ | ◆ | ◇ | ◀ |



GRAIN SIZE DISTRIBUTION
CLAYEY SILT/ SILTY CLAY, Some Sand/Sandy, Trace
Gravel (FILL)

FIG No.: GS-1
HWY : 40
GWP 3064-11-00

UNIFIED SOIL CLASSIFICATION SYSTEM



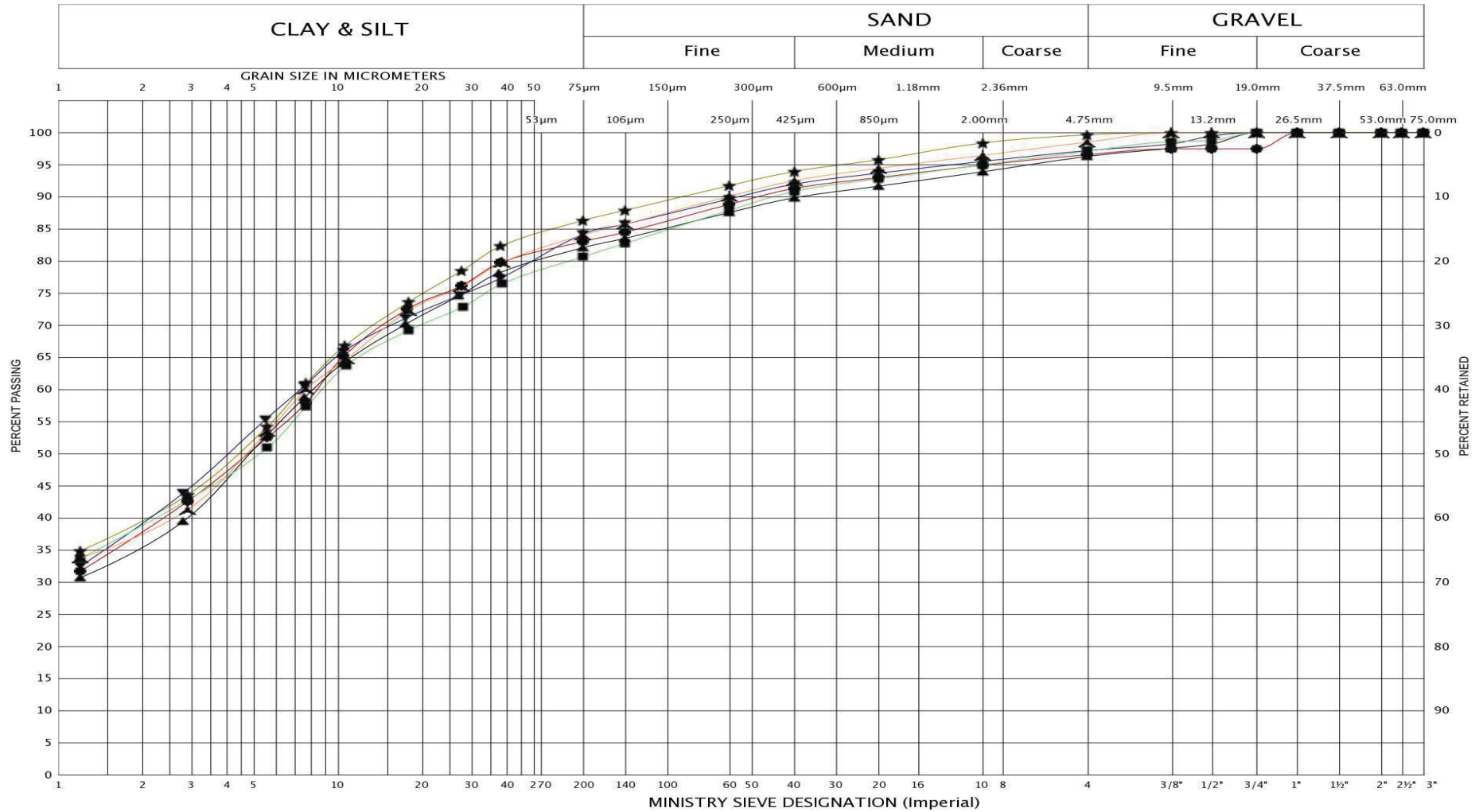
| | | | | | | | | | | |
|--------|--------|-----|-----|-----|-----|------|------|------|------|------|
| LEGEND | BH | C-2 | C-2 | C-3 | C-3 | CN-4 | CN-4 | CN-4 | CN-5 | CN-5 |
| | SAMPLE | 7 | 9 | 10 | 6 | 16 | 13 | 15 | 11 | 14 |
| | SYMBOL | ● | ▲ | ★ | ▼ | ■ | ▲ | □ | ■ | ⊕ |



GRAIN SIZE DISTRIBUTION
CLAYEY SILT, Some Sand, Trace Gravel

FIG No.: GS-2A
HWY : 40
GWP 3064-11-00

UNIFIED SOIL CLASSIFICATION SYSTEM



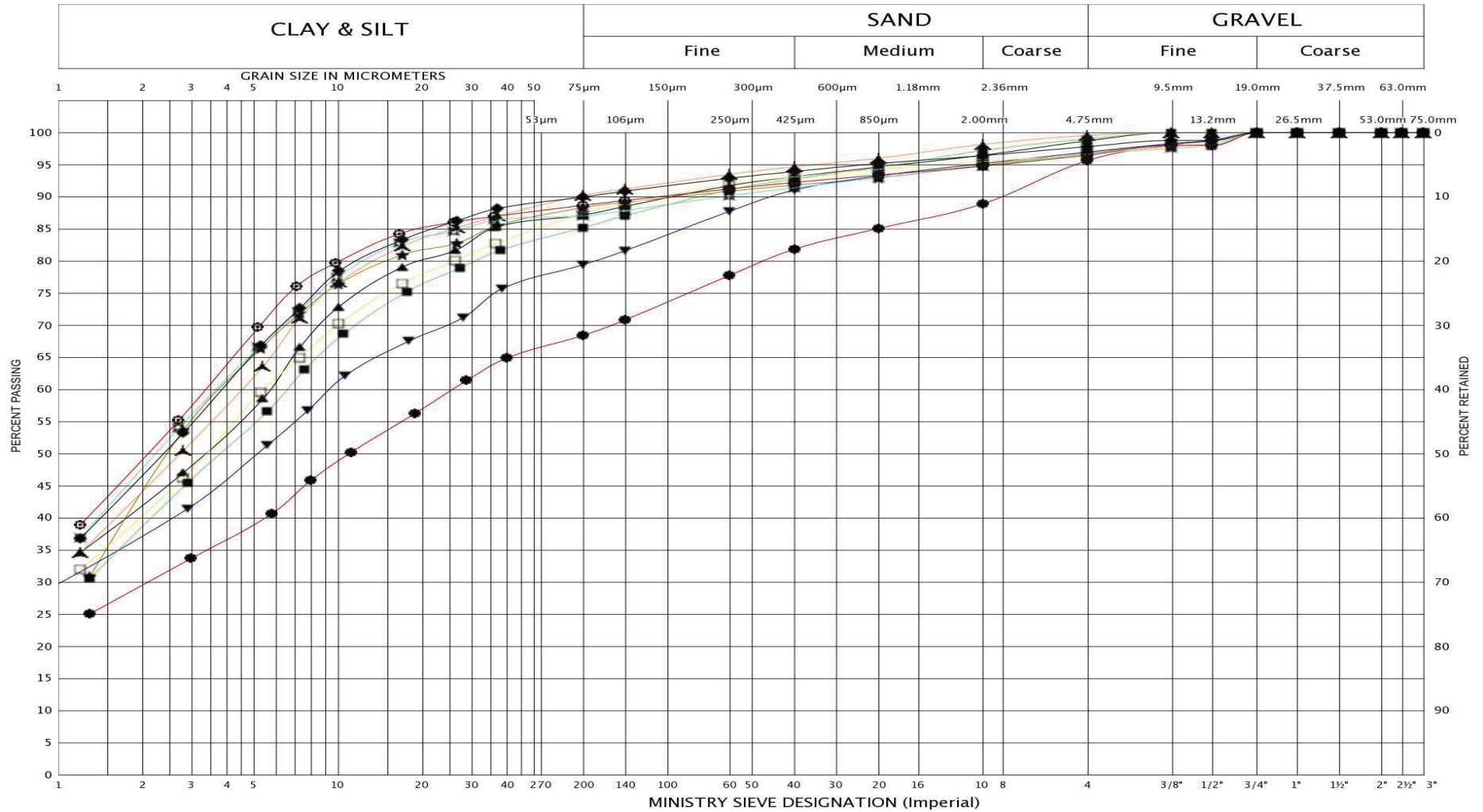
| LEGEND | BH | CN-5 | CN-7 | CN-8 | RW-1 | RW-1 | RW-2 |
|--------|--------|------|------|------|------|------|------|
| | SAMPLE | 15 | 15 | 16 | 17 | 14 | 15 |
| | SYMBOL | ● | ▲ | ★ | ▼ | ■ | ▲ |



GRAIN SIZE DISTRIBUTION
CLAYEY SILT, Some Sand, Trace Gravel

FIG No.: GS-2B
HWY : 40
GWP 3064-11-00

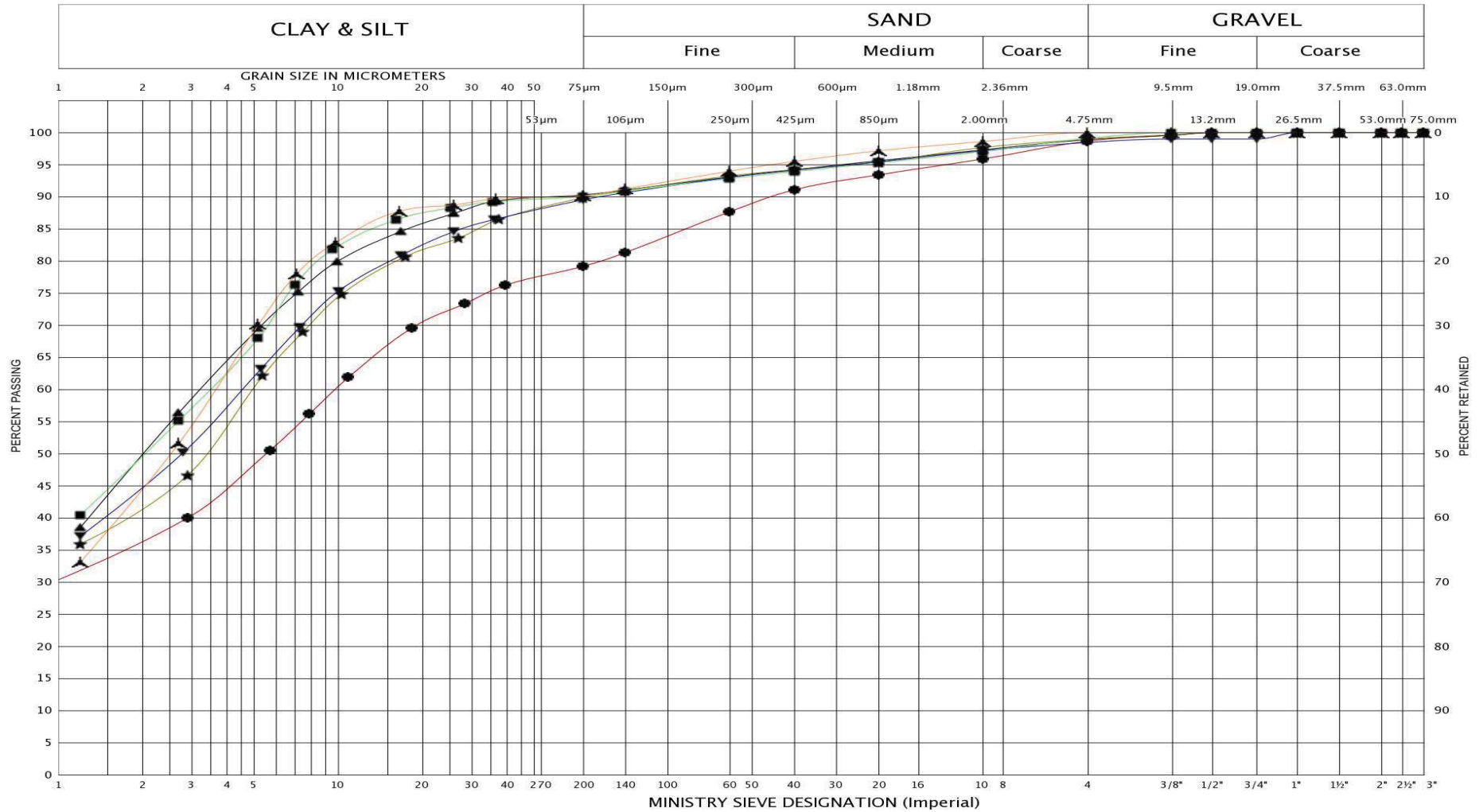
UNIFIED SOIL CLASSIFICATION SYSTEM



GRAIN SIZE DISTRIBUTION
SILTY CLAY, Trace to Some Sand, Trace Gravel

FIG No.: GS-3A
HWY : 40
GWP 3064-11-00

UNIFIED SOIL CLASSIFICATION SYSTEM



| | | | | | | | |
|--------|--------|------|------|------|------|------|------|
| LEGEND | BH | CN-8 | RW-1 | RW-2 | RW-2 | RW-2 | RW-2 |
| | SAMPLE | 12 | 21 | 17 | 19 | 24 | 26 |
| | SYMBOL | ● | ▲ | ★ | ▼ | ■ | ▲ |



GRAIN SIZE DISTRIBUTION
SILTY CLAY, Trace to Some Sand, Trace Gravel

FIG No.: GS-3B
HWY : 40
GWP 3064-11-00

CLAY & SILT

SAND

GRAVEL

Grain size distribution plot showing Percent Retained (Y-axis, 0 to 100) versus Grain Size in Micrometers (X-axis, 1 to 75.0 μm) and Ministry Sieve Designation (Imperial) (X-axis, 1 to 3").

The plot is divided into three regions: CLAY & SILT (left), SAND (middle), and GRAVEL (right).

The X-axis is labeled with Grain Size in Micrometers (1 to 75.0 μm) and Ministry Sieve Designation (Imperial) (1 to 3").



The Y-axis is labeled with Percent Retained (0 to 100).

Two curves are plotted, representing different samples or conditions:

- Curve 1 (Circular markers): Shows a higher percentage of material retained at smaller grain sizes compared to Curve 2.
- Curve 2 (Triangular markers): Shows a lower percentage of material retained at smaller grain sizes compared to Curve 1.

Key data points for Curve 1 (Circular markers):

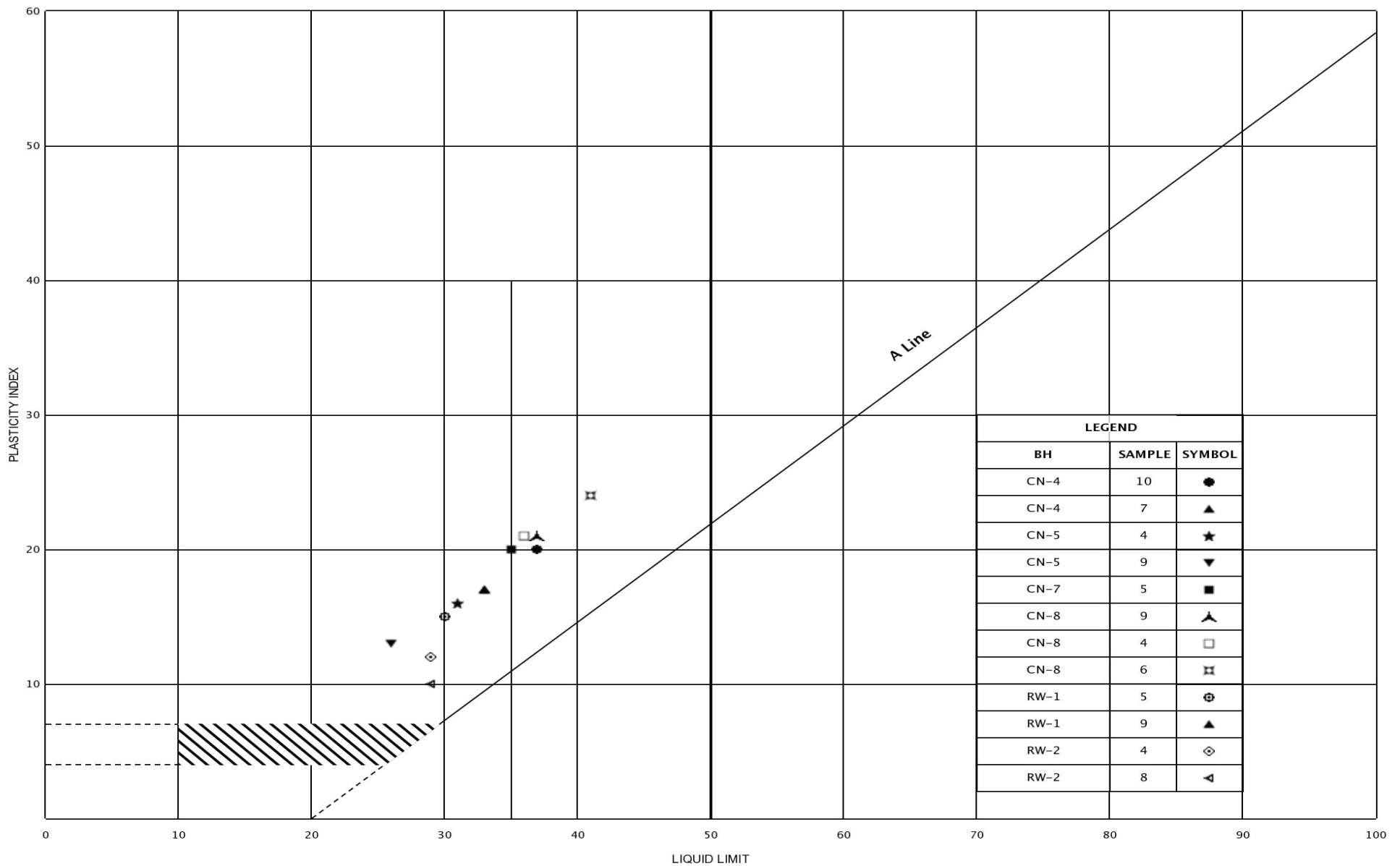
| Grain Size (μm) | Percent Retained (%) |
|----------------------------|-----------------------------|
| 1.18 | 80 |
| 2.36 | 75 |
| 4.75 | 65 |
| 9.5 | 55 |
| 19.0 | 45 |
| 37.5 | 35 |
| 75.0 | 25 |
| 150 | 15 |
| 300 | 10 |
| 600 | 5 |
| 1200 | 2 |
| 2500 | 1 |
| 5000 | 0.5 |
| 10000 | 0.2 |
| 20000 | 0.1 |
| 40000 | 0.05 |
| 80000 | 0.02 |
| 160000 | 0.01 |
| 320000 | 0.005 |
| 640000 | 0.002 |
| 1280000 | 0.001 |
| 2560000 | 0.0005 |
| 5120000 | 0.0002 |
| 10240000 | 0.0001 |
| 20480000 | 0.00005 |
| 40960000 | 0.00002 |
| 81920000 | 0.00001 |
| 163840000 | 0.000005 |
| 327680000 | 0.000002 |
| 655360000 | 0.000001 |
| 1310720000 | 0.0000005 |
| 2621440000 | 0.0000002 |
| 5242880000 | 0.0000001 |
| 10485760000 | 0.00000005 |
| 20971520000 | 0.00000002 |
| 41943040000 | 0.00000001 |
| 83886080000 | 0.000000005 |
| 167772160000 | 0.000000002 |
| 335544320000 | 0.000000001 |
| 671088640000 | 0.0000000005 |
| 1342177280000 | 0.0000000002 |
| 2684354560000 | 0.0000000001 |
| 5368709120000 | 0.00000000005 |
| 10737418240000 | 0.00000000002 |
| 21474836480000 | 0.00000000001 |
| 42949672960000 | 0.000000000005 |
| 85899345920000 | 0.000000000002 |
| 171798691840000 | 0.000000000001 |
| 343597383680000 | 0.0000000000005 |
| 687194767360000 | 0.0000000000002 |
| 1374389534720000 | 0.0000000000001 |
| 2748779069440000 | 0.00000000000005 |
| 5497558138880000 | 0.00000000000002 |
| 10995116277760000 | 0.00000000000001 |
| 21990232555520000 | 0.000000000000005 |
| 43980465111040000 | 0.000000000000002 |
| 87960930222080000 | 0.000000000000001 |
| 175921860444160000 | 0.0000000000000005 |
| 351843720888320000 | 0.0000000000000002 |
| 703687441776640000 | 0.0000000000000001 |
| 1407374883553280000 | 0.00000000000000005 |
| 2814749767106560000 | 0.00000000000000002 |
| 5629499534213120000 | 0.00000000000000001 |
| 11258999068426240000 | 0.000000000000000005 |
| 22517998136852480000 | 0.000000000000000002 |
| 45035996273704960000 | 0.000000000000000001 |
| 90071992547409920000 | 0.0000000000000000005 |
| 180143985094819840000 | 0.0000000000000000002 |
| 360287970189639680000 | 0.0000000000000000001 |
| 720575940379279360000 | 0.00000000000000000005 |
| 1441151880758558720000 | 0.00000000000000000002 |
| 2882303761517117440000 | 0.00000000000000000001 |
| 5764607523034234880000 | 0.000000000000000000005 |
| 11529215046068469760000 | 0.000000000000000000002 |
| 23058430092136939520000 | 0.000000000000000000001 |
| 46116860184273879040000 | 0.0000000000000000000005 |
| 92233720368547758080000 | 0.0000000000000000000002 |
| 184467440737095516160000 | 0.0000000000000000000001 |
| 368934881474191032320000 | 0.00000000000000000000005 |
| 737869762948382064640000 | 0.00000000000000000000002 |
| 1475739525896764129280000 | 0.00000000000000000000001 |
| 2951479051793528258560000 | 0.000000000000000000000005 |
| 5902958103587056517120000 | 0.000000000000000000000002 |
| 11805916207174113034240000 | 0.000000000000000000000001 |
| 23611832414348226068480000 | 0.0000000000000000000000005 |
| 47223664828696452136960000 | 0.0000000000000000000000002 |
| 94447329657392904273920000 | 0.0000000000000000000000001 |
| 1888946593 | |

| | | | |
|---------------|---------------|---|---|
| LEGEND | BH | CN-7 | RW-1 |
| | SAMPLE | 11 | 25 |
| | SYMBOL |  |  |



CLAYEY SAND, With Silt, Some Gravel

| | |
|-----|------------|
| GWP | 3064-11-00 |
|-----|------------|



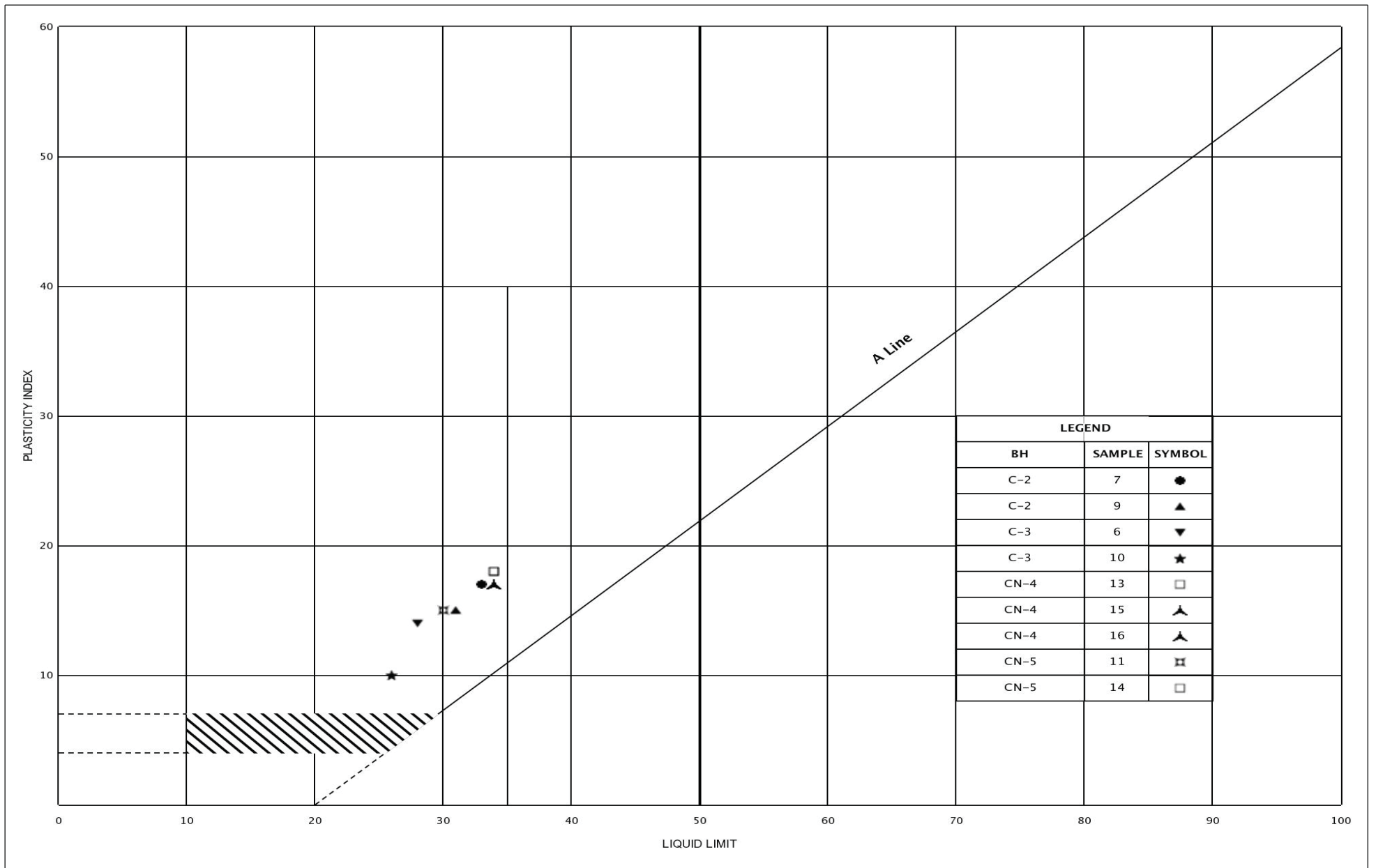
PLASTICITY CHART

CLAYEY SILT/SILTY CLAY, Some Sand/Sandy, Trace Gravel (FILL)

FIG No.: PC-1

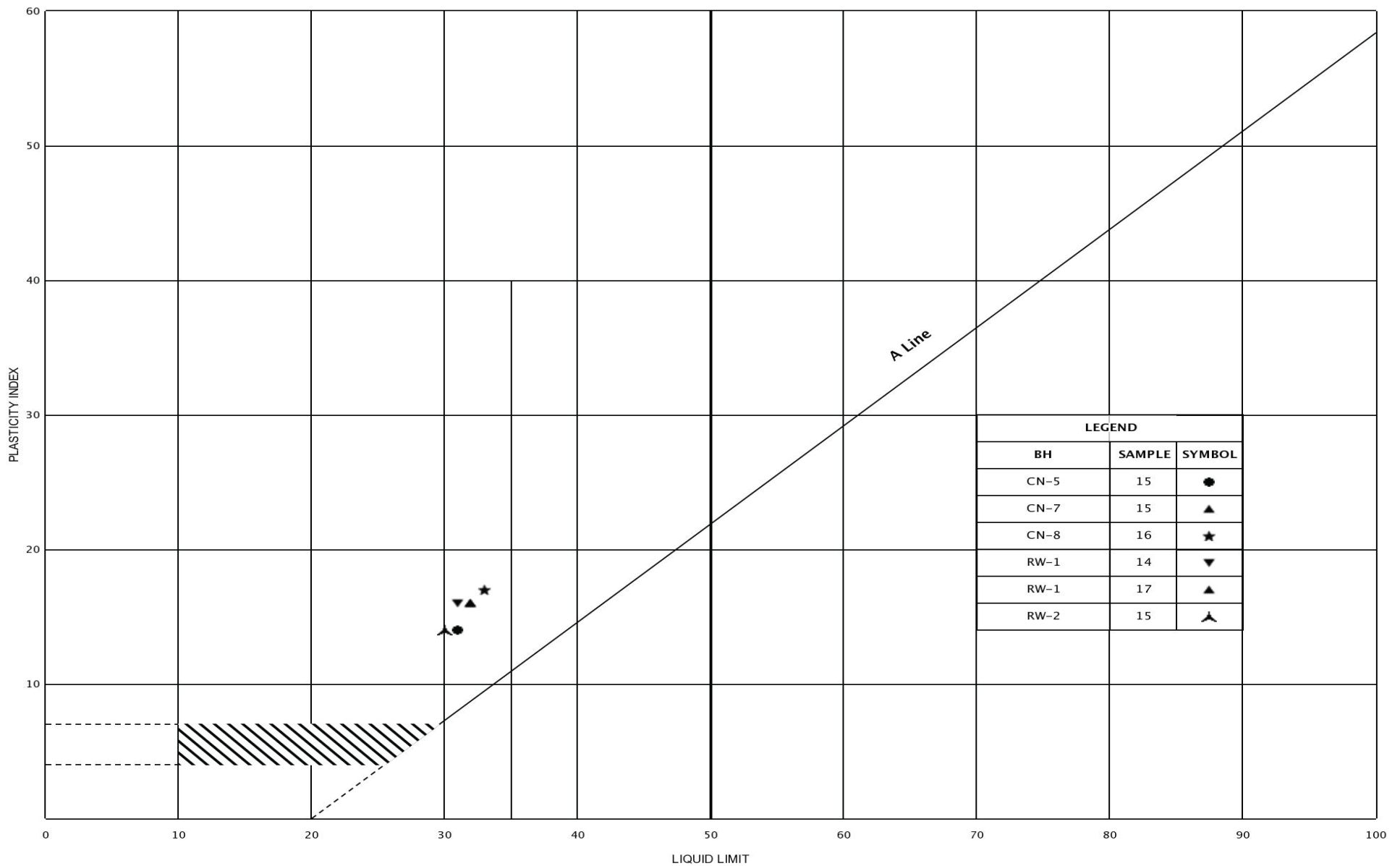
HWY.: 40

GWP 3064-11-00



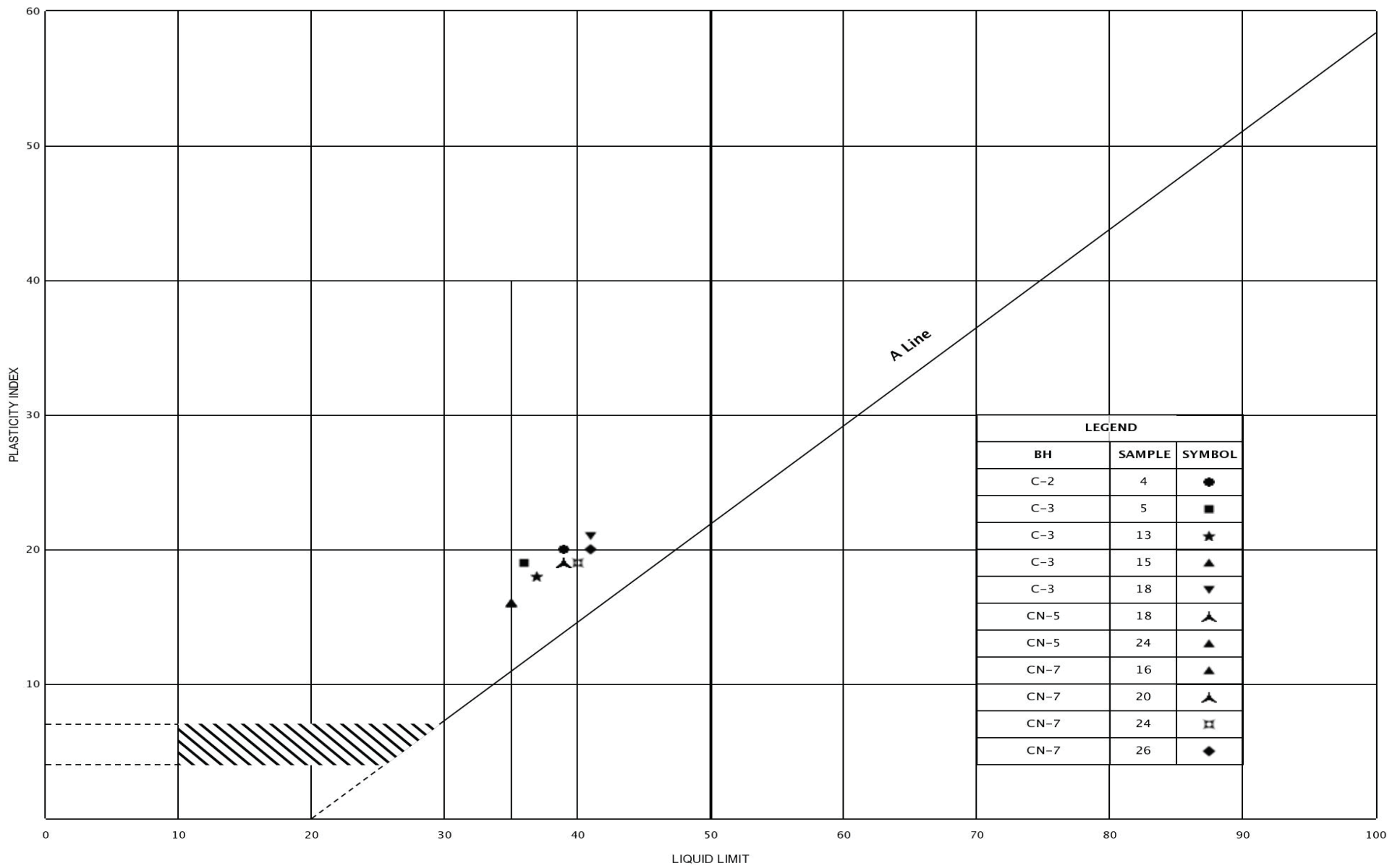
PLASTICITY CHART
CLAYEY SILT, Some Sand, Trace Gravel

FIG No.: PC-2A
HWY.: 40
GWP 3064-11-00



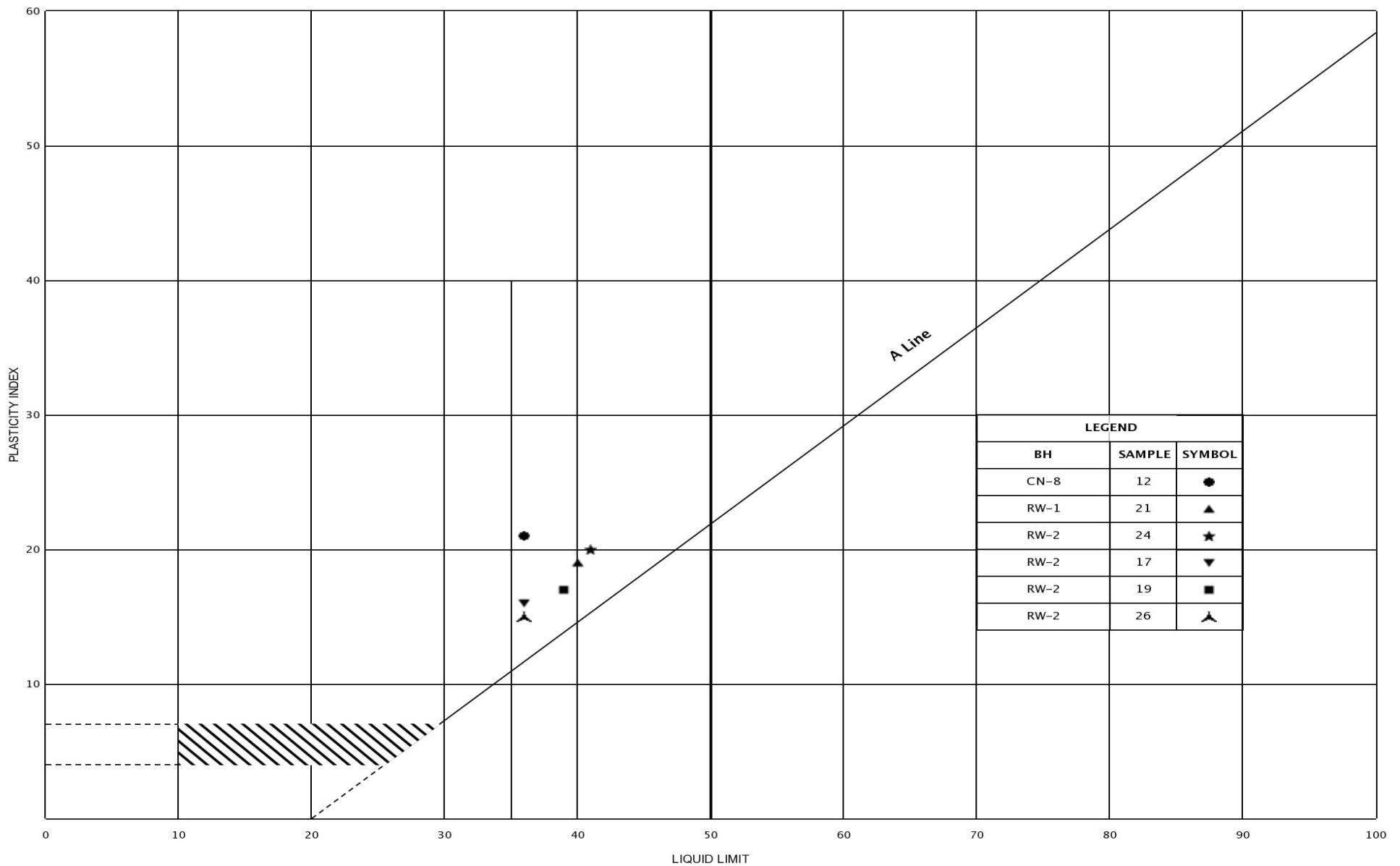
PLASTICITY CHART
CLAYEY SILT, Some Sand, Trace Gravel

FIG No.: PC-2B
HWY.: 40
GWP 3064-11-00



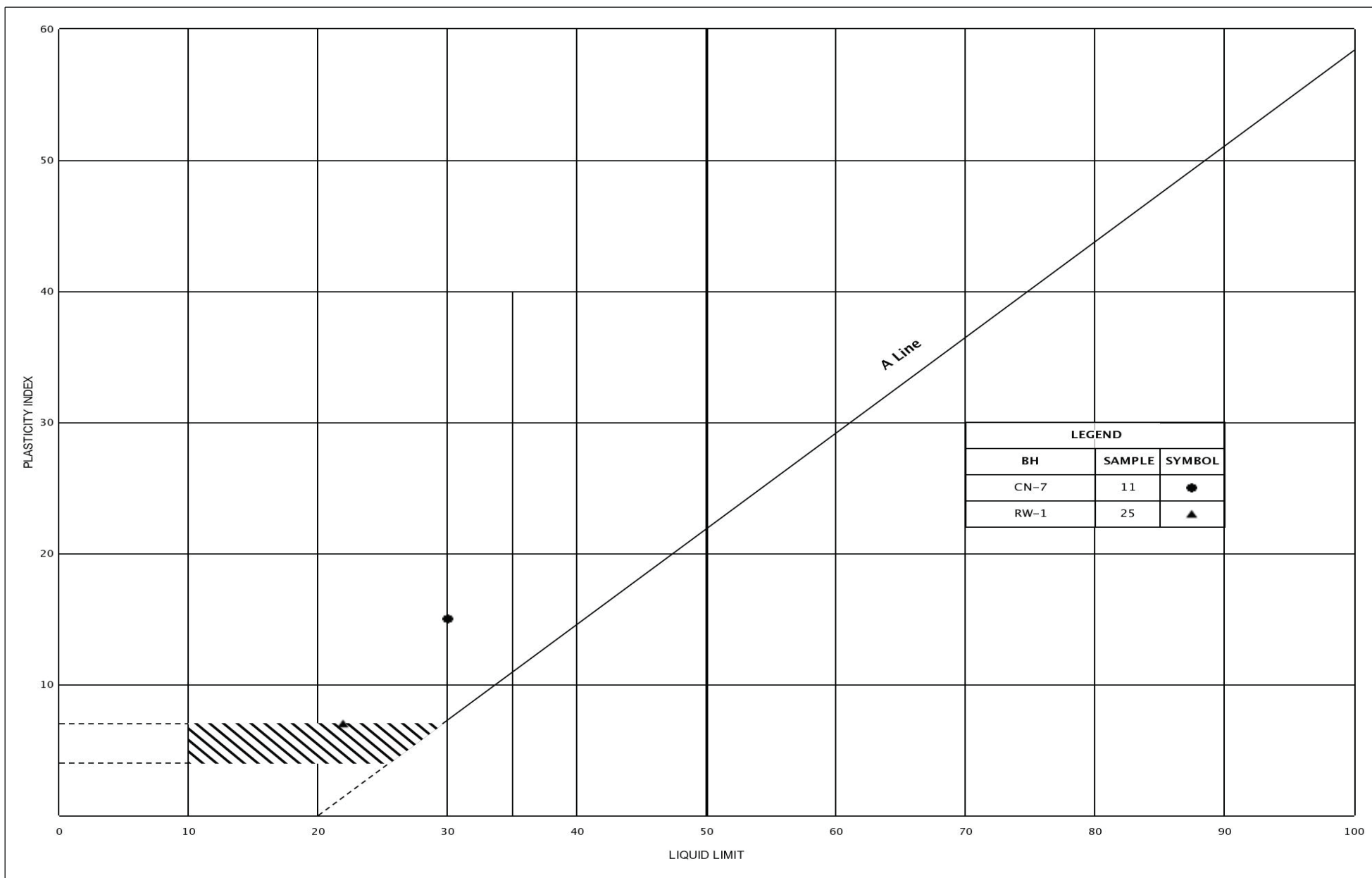
PLASTICITY CHART
 SILTY CLAY, Trace to Some Sand, Trace Gravel

FIG No.: PC-3A
 HWY.: 40
 GWP 3064-11-00



PLASTICITY CHART
SILTY CLAY, Trace to Some Sand, Trace Gravel

FIG No.: PC-3B
HWY.: 40
GWP 3064-11-00



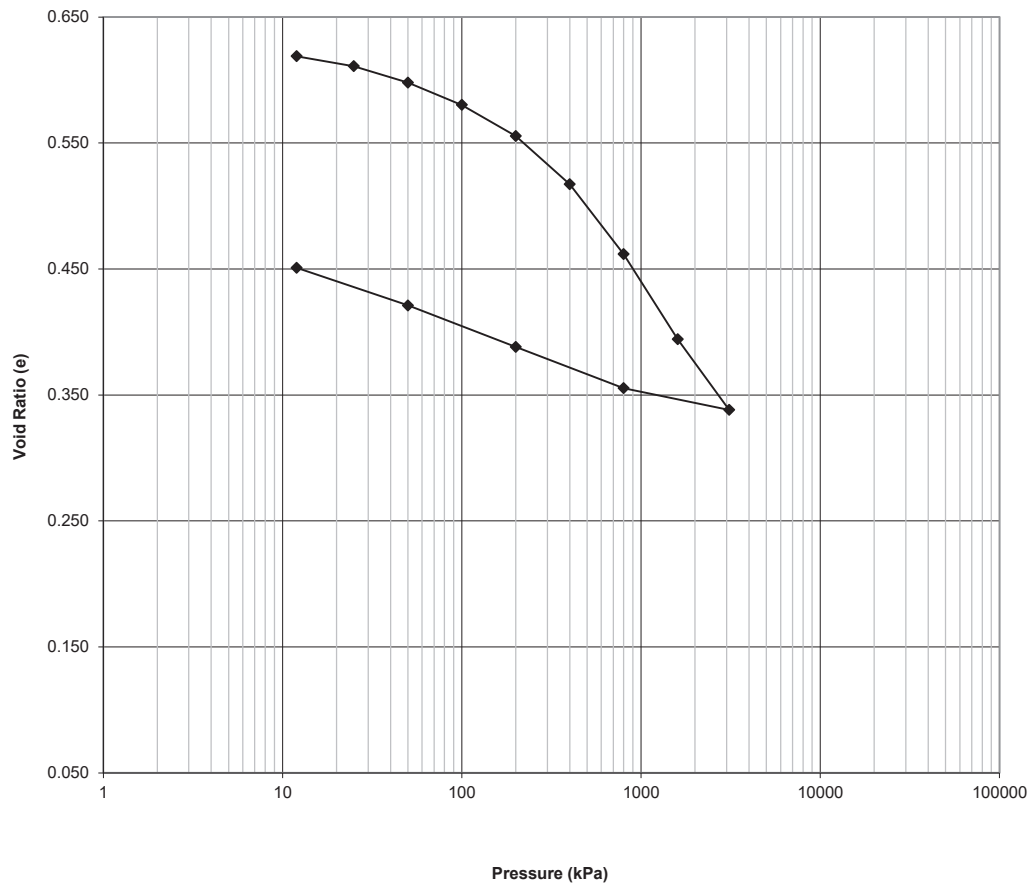
PLASTICITY CHART
CLAYEY SAND, With Silt, Some Gravel

| | |
|----------|------------|
| FIG No.: | PC-4 |
| HWY.: | 40 |
| GWP | 3064-11-00 |

Consolidation Test Results
(ASTM D2435)
Highway 40/CNR Overhead (WP 3064-11-02)

Borehole CN-5, Sample 14, Depth 15.2 - 15.8 m

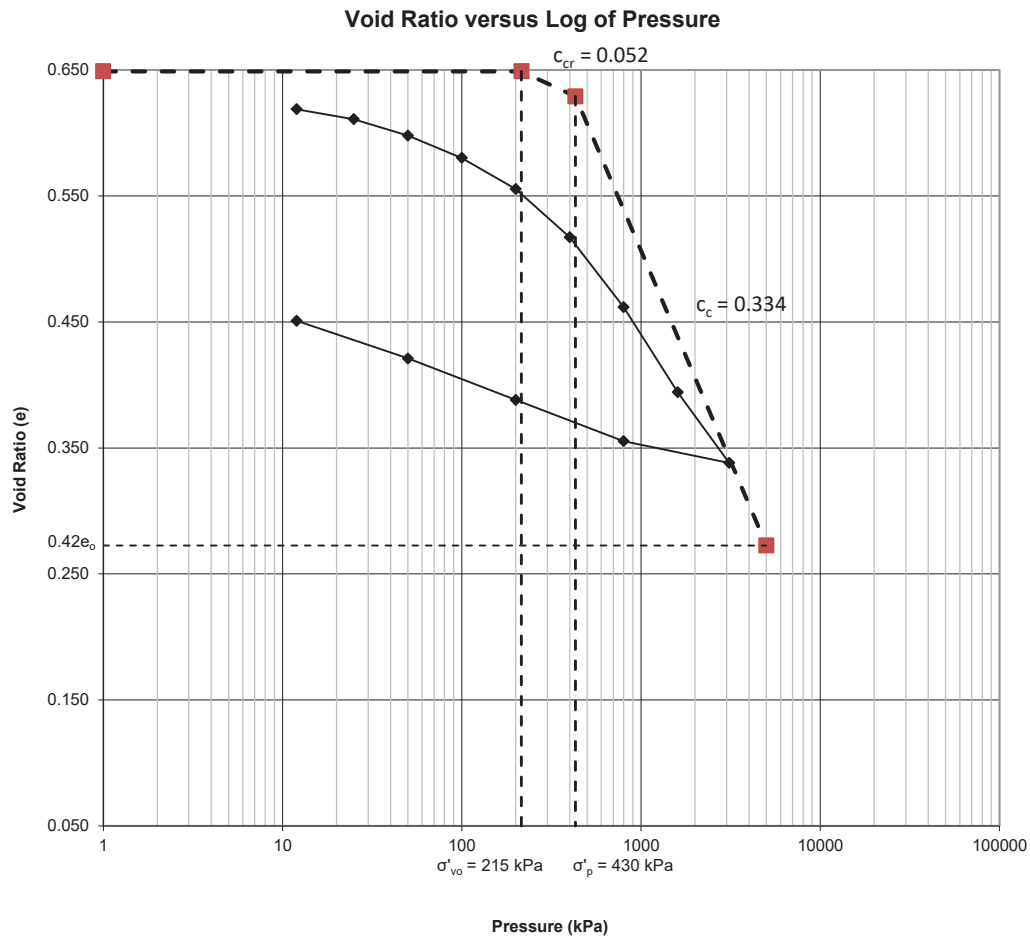
Void Ratio versus Log of Pressure



| | | | |
|---|--------------------------|-------|------|
| SOIL TYPE: Silty Clay | | | |
| e_0 | = 0.649 | W_L | = 34 |
| W_0 | = 23.8 % | W_P | = 16 |
| γ | = 20.3 kN/m ³ | PI | = 18 |
| FIGURE No: CT-1 | | | |
| Highway 40/CNR Overhead (WP 3064-11-02) | | | |
| PML Ref: 20TF017 | | | |

Consolidation Test Results
(ASTM D2435)
Highway 40/CNR Overhead (WP 3064-11-02)

Borehole CN-5, Sample 14, Depth 15.2 - 15.8 m

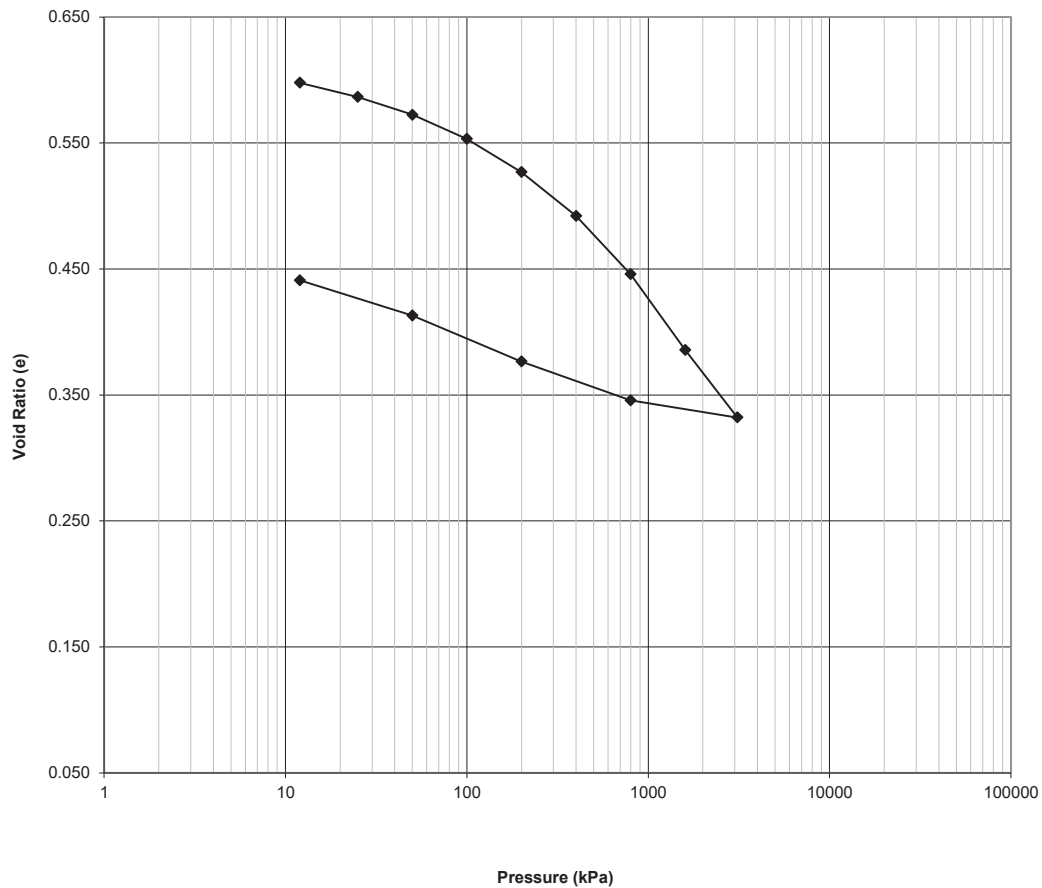


| | | | |
|-----------------------|--------------------------|---|------|
| SOIL TYPE: Silty Clay | | | |
| e_0 | = 0.649 | W_L | = 34 |
| W_0 | = 23.8 % | W_P | = 16 |
| γ | = 20.3 kN/m ³ | PI | = 18 |
| | | FIGURE No: CT-1 | |
| | | Highway 40/CNR Overhead (WP 3064-11-02) | |
| | | PML Ref: 20TF017 | |

Consolidation Test Results
(ASTM D2435)
Highway 40/CNR Overhead (WP3064-11-02)

Borehole CN-7, Sample 15, Depth 15.2 - 15.8 m

Void Ratio versus Log of Pressure

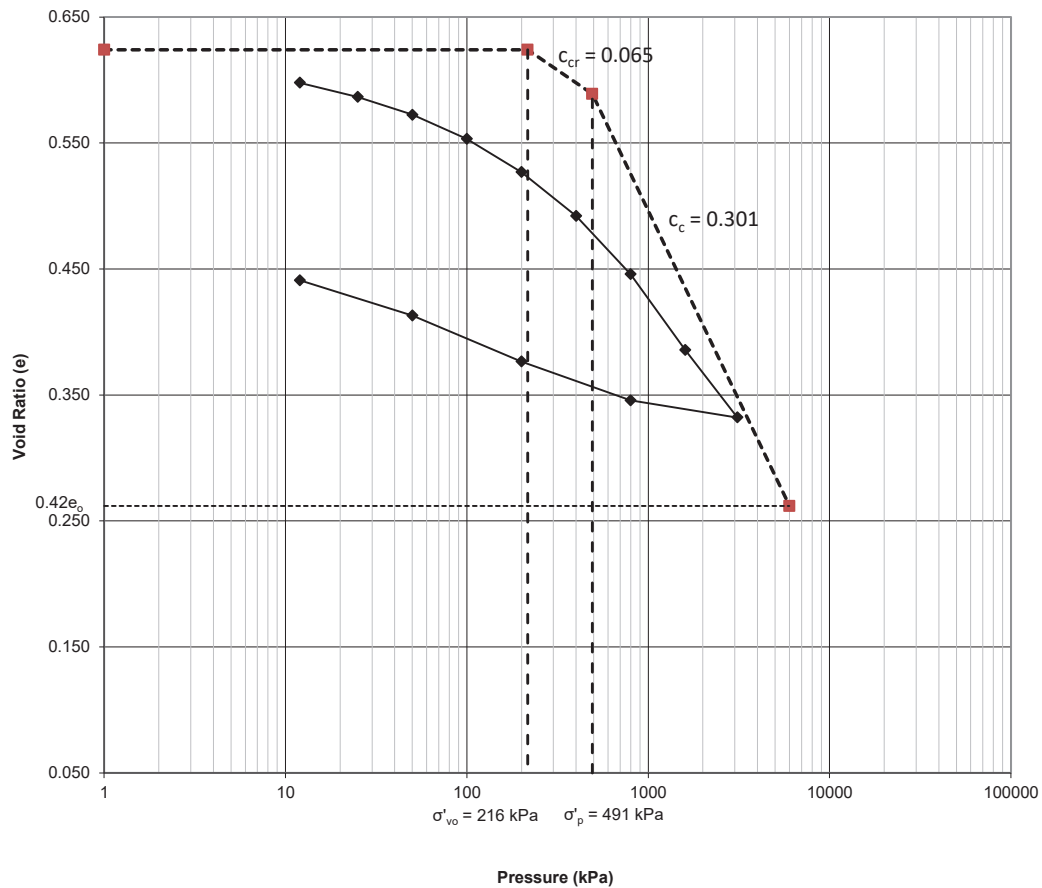


| | | | |
|--|--------------------------|-------|------|
| SOIL TYPE: Silty Clay | | | |
| e_0 | = 0.624 | W_L | = 32 |
| W_0 | = 23.1 % | W_P | = 16 |
| γ | = 20.4 kN/m ³ | PI | = 16 |
| FIGURE No: CT-2 | | | |
| Highway 40/CNR Overhead (WP3064-11-02) | | | |
| PML Ref: 20TF017 | | | |

Consolidation Test Results
(ASTM D2435)
Highway 40/CNR Overhead (WP3064-11-02)

Borehole CN-7, Sample 15, Depth 15.2 - 15.8 m

Void Ratio versus Log of Pressure

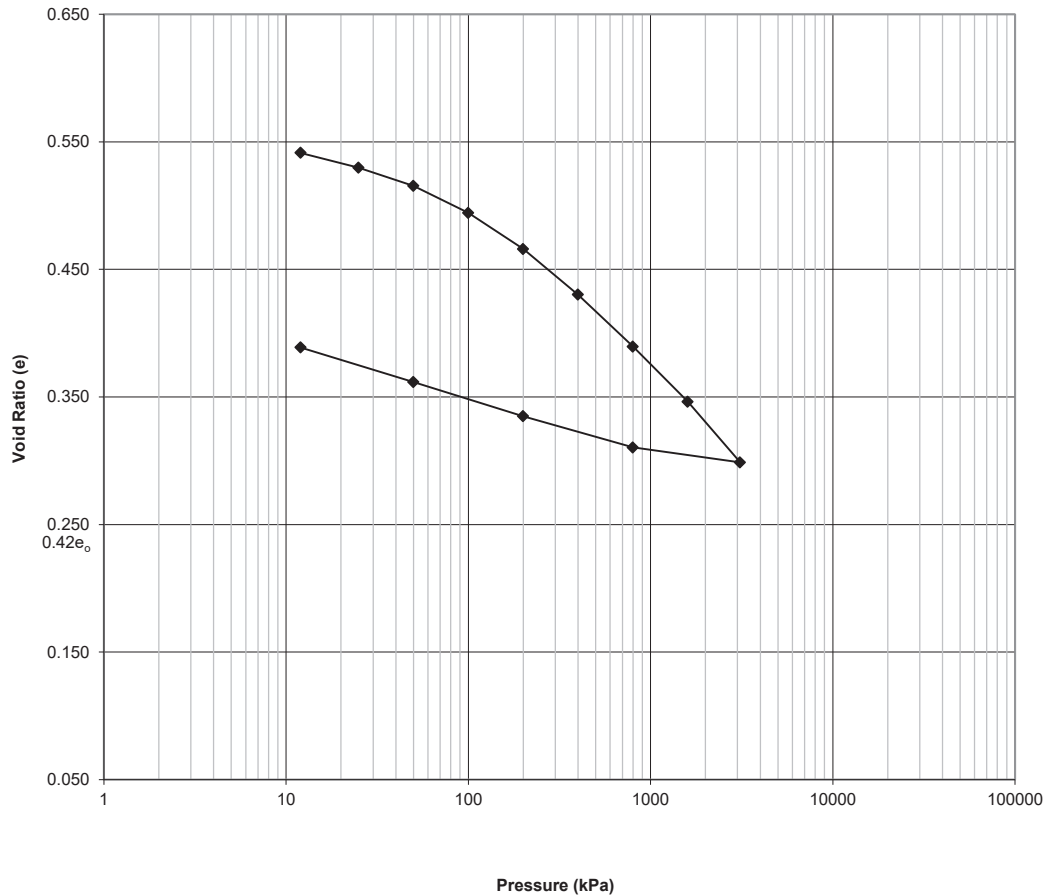


| | | | |
|--|--------------------------|-------|------|
| SOIL TYPE: Silty Clay | | | |
| e_0 | = 0.624 | W_L | = 32 |
| W_0 | = 23.1 % | W_P | = 16 |
| γ | = 20.4 kN/m ³ | PI | = 16 |
| FIGURE No: CT-2 | | | |
| Highway 40/CNR Overhead (WP3064-11-02) | | | |
| PML Ref: 20TF017 | | | |

Consolidation Test Results
(ASTM D2435)
Highway 40/CNR Overhead (WP 3064-11-02)

Borehole RW2, Sample 16, Depth 18.3 - 18.9 m

Void Ratio versus Log of Pressure

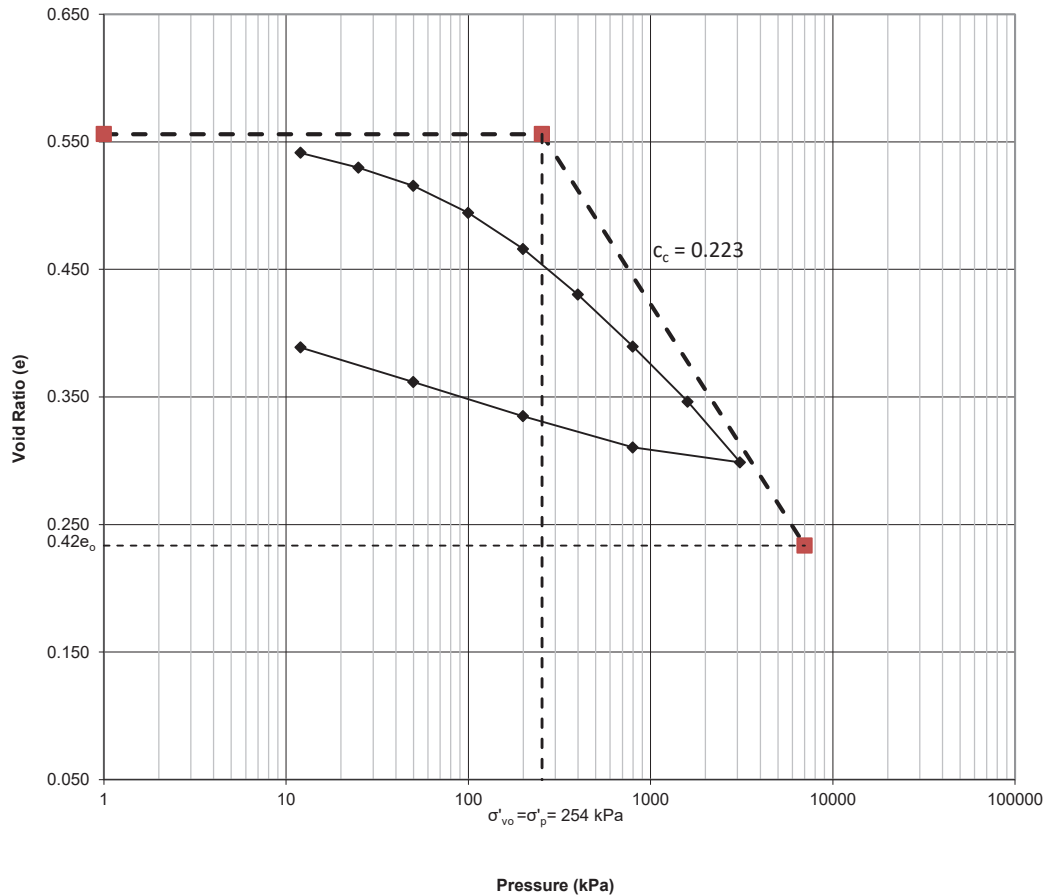


| | | | |
|-----------------------|---|------------------------|---|
| SOIL TYPE: Silty Clay | | | |
| e_0 | = | 0.556 | W_L = - |
| W_0 | = | 21.9 % | W_P = - |
| γ | = | 20.7 kN/m ³ | PI = - |
| | | | FIGURE No: CT-3 |
| | | | Highway 40/CNR Overhead (WP 3064-11-02) |
| | | | PML Ref: 20TF017 |

Consolidation Test Results
(ASTM D2435)
Highway 40/CNR Overhead (WP 3064-11-02)

Borehole RW2, Sample 16, Depth 18.3 - 18.9 m

Void Ratio versus Log of Pressure



| | | | |
|-----------------------|---|------------------------|---|
| SOIL TYPE: Silty Clay | | | |
| e_0 | = | 0.556 | W_L = - |
| W_0 | = | 21.9 % | W_P = - |
| γ | = | 20.7 kN/m ³ | PI = - |
| | | | FIGURE No: CT-3 |
| | | | Highway 40/CNR Overhead (WP 3064-11-02) |
| | | | PML Ref: 20TF017 |

Peto MacCallum Ltd.

CONSULTING ENGINEERS

UNIAXIAL COMPRESSIVE STRENGTH OF ROCK CORE

ASTM D7012

CLIENT WSP
PROJECT HWY 40/CNR OVERPASS
SAMPLE IDENTIFICATION CN-5 RUN1 46.55 m - 46.81 m

PML REF 20TF017
LAB NO. 2008570A
DATE SAMPLED 2020/12/17
DATE TESTED
TESTED BY

| CORE DIMENSIONS | | COMPRESSIVE STRENGTH | |
|------------------------------|---------|---------------------------------------|--------|
| SPECIMEN DIAMETER (mm.) | 62.705 | TEST TIME (min) (spec. 2 to 15) | 19:12 |
| SPECIMEN LENGTH (mm.) | 131.648 | MAXIMUM LOAD APPLIED (kN) | 221.50 |
| | 131.953 | | |
| | 131.597 | COMPRESSIVE STRENGTH (MPa) | 71.7 |
| AVE. | 131.724 | TYPE OF FAILURE | 2 |
| CROSS SECTIONAL AREA (sq mm) | 3088 | LENGTH TO DIAMETER RATIO (spec 2-2.5) | 2.1 |

MOISTURE CONTENT

UNIT WEIGHT

| | | | |
|---------------------------------|---------|---------------------------------|----------|
| WEIGHT OF WET SAMPLE + TARE (g) | 1080.31 | WEIGHT OF DRY SAMPLE IN AIR (g) | 957.17 |
| WEIGHT OF DRY SAMPLE + TARE (g) | 1065.50 | VOLUME OF SAMPLE (cu m) | 0.000407 |
| WEIGHT OF WATER (g) | 14.81 | UNIT WEIGHT (kg/cu m) | 2353 |
| WEIGHT OF TARE (g) | 128.09 | | |
| WEIGHT OF DRY SAMPLE (g) | 937.41 | | |
| MOISTURE CONTENT (%) | 1.6 | | |
| REMARKS | | | |



REVIEWED BY

J.Noor

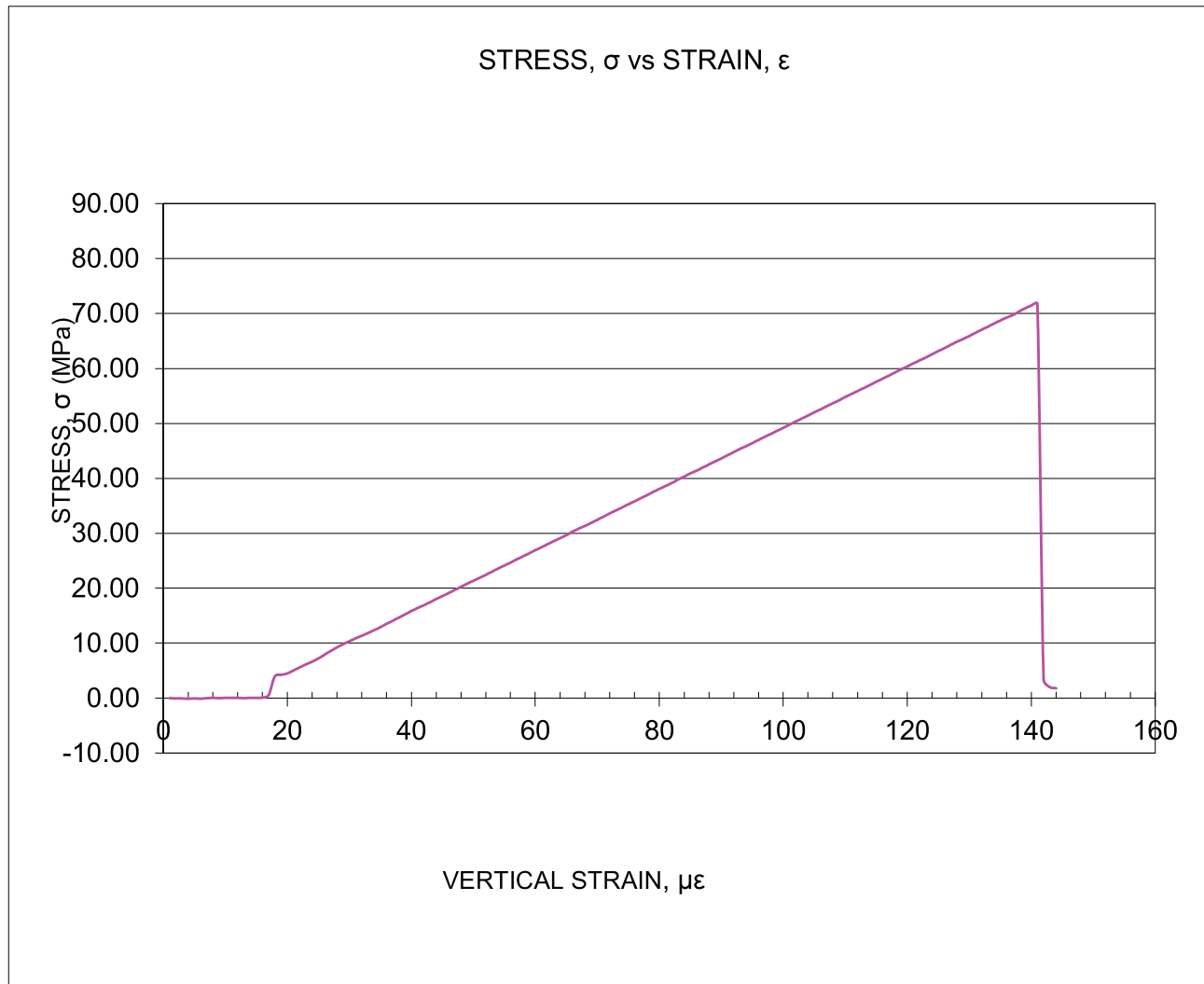
DATE

2021/01/08

ELASTIC MODULI OF ROCK CORE IN UNIAXIAL COMPRESSION

ASTM D7012

| | | | |
|--|-----------------------------|-----------------|------------|
| CLIENT | WSP | PML REF | 20TF017 |
| PROJECT | HWY 40/CNR OVERPASS | LAB NO. | 2008570A |
| SAMPLE IDENTIFICATION | CN-5 RUN1 46.55 m - 46.81 m | DATE SAMPLED | 2020/12/17 |
| YOUNG'S MODULUS, E_{tan} (at 50% σ) | GPa | DATE TESTED | |
| YOUNG'S MODULUS, E_{sec} (at 50% σ) | GPa | TESTED BY | |
| YOUNG'S MODULUS, $E_{ave.}$ (at 50% σ) | GPa | POISSON'S RATIO | |



REVIEWED BY

J.Noor

DATE 2021/01/08

Peto MacCallum Ltd.

CONSULTING ENGINEERS

UNIAXIAL COMPRESSIVE STRENGTH OF ROCK CORE

ASTM D7012

CLIENT WSP
PROJECT HWY 40/CNR OVERPASS
SAMPLE IDENTIFICATION CN-5 RUN2 48.36 m - 48.58 m

PML REF 2005221A
LAB NO. 20TF017
DATE SAMPLED 2020/08/18
DATE TESTED 8/31/2020
TESTED BY A.Saidajan

| CORE DIMENSIONS | | COMPRESSIVE STRENGTH | |
|------------------------------|---------|---------------------------------------|--------|
| SPECIMEN DIAMETER (mm.) | 62.669 | TEST TIME (min) (spec. 2 to 15) | 9:36 |
| SPECIMEN LENGTH (mm.) | 153.492 | MAXIMUM LOAD APPLIED (kN) | 259.20 |
| | 152.730 | | |
| | 152.806 | COMPRESSIVE STRENGTH (MPa) | 84.0 |
| AVE. | 153.010 | TYPE OF FAILURE | 2 |
| CROSS SECTIONAL AREA (sq mm) | 3085 | LENGTH TO DIAMETER RATIO (spec 2-2.5) | 2.44 |

MOISTURE CONTENT

UNIT WEIGHT

| | | | |
|---------------------------------|---------|---------------------------------|----------|
| WEIGHT OF WET SAMPLE + TARE (g) | 1252.52 | WEIGHT OF DRY SAMPLE IN AIR (g) | 1103.79 |
| WEIGHT OF DRY SAMPLE + TARE (g) | 1229.23 | VOLUME OF SAMPLE (cu m) | 0.000472 |
| WEIGHT OF WATER (g) | 23.29 | UNIT WEIGHT (kg/cu m) | 2339 |
| WEIGHT OF TARE (g) | 187.01 | | |
| WEIGHT OF DRY SAMPLE (g) | 1042.22 | | |
| MOISTURE CONTENT (%) | 2.2 | | |
| REMARKS | | | |



REVIEWED BY

J.Noor

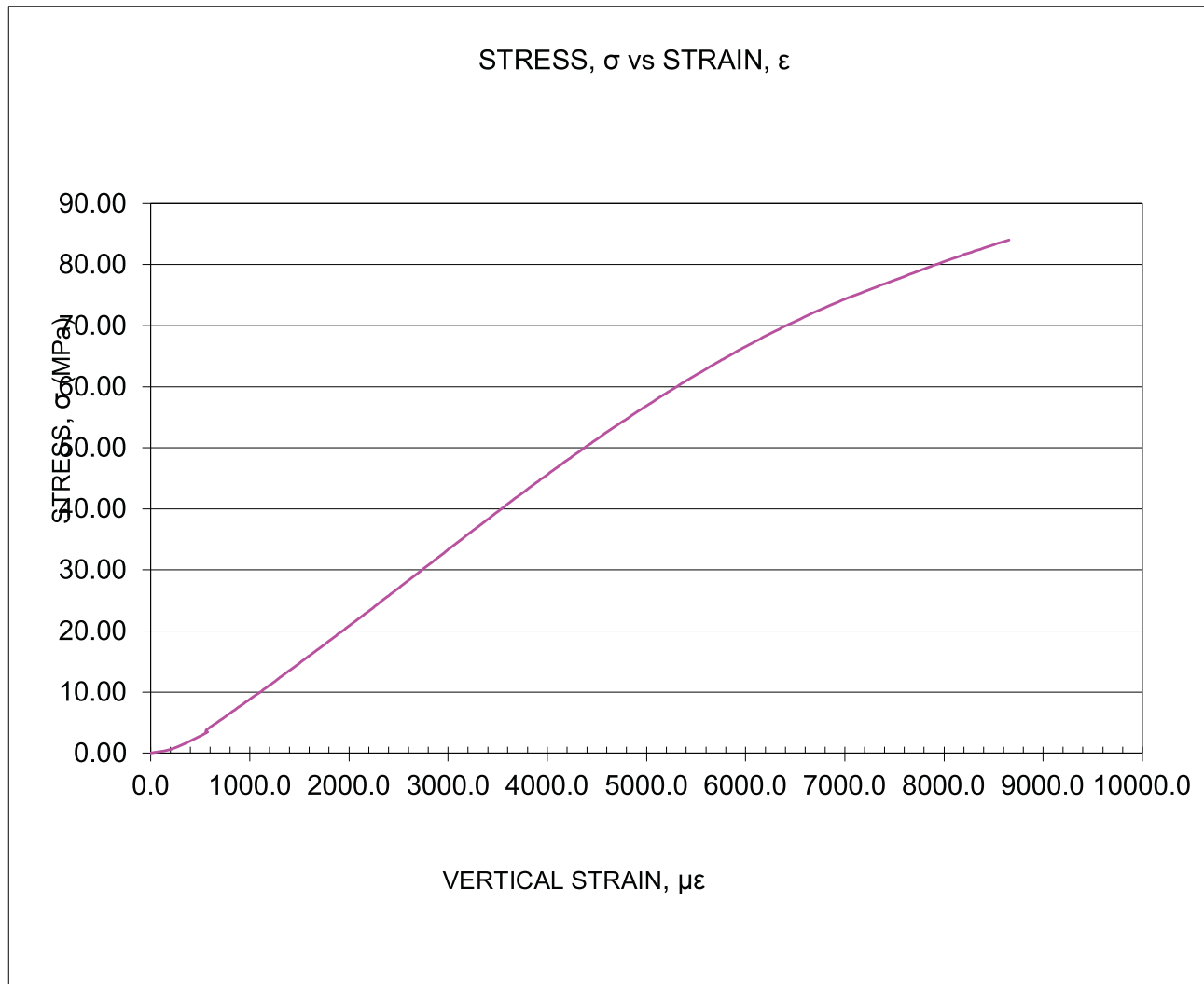
DATE

2020/09/03

ELASTIC MODULI OF ROCK CORE IN UNIAXIAL COMPRESSION

ASTM D7012

| | | | |
|--|-----------------------------|-----------------|------------|
| CLIENT | WSP | PML REF | 2005221A |
| PROJECT | HWY 40/CNR OVERPASS | LAB NO. | 20TF017 |
| SAMPLE IDENTIFICATION | CN-5 RUN2 48.36 m - 48.58 m | DATE SAMPLED | 2020/08/18 |
| YOUNG'S MODULUS, E_{tan} (at 50% σ) | 12.92 GPa | DATE TESTED | 8/31/2020 |
| YOUNG'S MODULUS, E_{sec} (at 50% σ) | 11.35 GPa | TESTED BY | A.Saidajan |
| YOUNG'S MODULUS, $E_{ave.}$ (at 50% σ) | 12.13 GPa | POISSON'S RATIO | 0.192 |



REVIEWED BY

J.Noor

DATE 2020/09/03

Peto MacCallum Ltd.

CONSULTING ENGINEERS

UNIAXIAL COMPRESSIVE STRENGTH OF ROCK CORE

ASTM D7012

CLIENT WSP
PROJECT HWY 40/CNR OVERPASS
SAMPLE IDENTIFICATION C-3 RUN2 38.86 m - 39.13 m

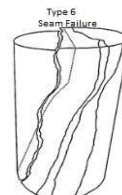
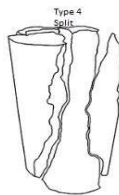
PML REF 20TF017
LAB NO. 2008570D
DATE SAMPLED 2020/12/17
DATE TESTED 1/5/2021
TESTED BY Azar Saidajar

| CORE DIMENSIONS | | COMPRESSIVE STRENGTH | |
|------------------------------|---------|---------------------------------------|--------|
| SPECIMEN DIAMETER (mm.) | 30.544 | TEST TIME (min) (spec. 2 to 15) | 4:00 |
| SPECIMEN LENGTH (mm.) | 121.971 | MAXIMUM LOAD APPLIED (kN) | 229.00 |
| | 121.641 | | |
| | 121.869 | COMPRESSIVE STRENGTH (MPa) | 78.1 |
| AVE. | 121.818 | TYPE OF FAILURE | 1 |
| CROSS SECTIONAL AREA (sq mm) | 2931 | LENGTH TO DIAMETER RATIO (spec 2-2.5) | 1.99 |

MOISTURE CONTENT

UNIT WEIGHT

| | | | |
|---------------------------------|--------|---------------------------------|----------|
| WEIGHT OF WET SAMPLE + TARE (g) | 943.73 | WEIGHT OF DRY SAMPLE IN AIR (g) | 838.30 |
| WEIGHT OF DRY SAMPLE + TARE (g) | 934.57 | VOLUME OF SAMPLE (cu m) | 0.000357 |
| WEIGHT OF WATER (g) | 9.16 | UNIT WEIGHT (kg/cu m) | 2348 |
| WEIGHT OF TARE (g) | 105.96 | | |
| WEIGHT OF DRY SAMPLE (g) | 828.61 | | |
| MOISTURE CONTENT (%) | 1.1 | | |
| REMARKS | | | |



REVIEWED BY

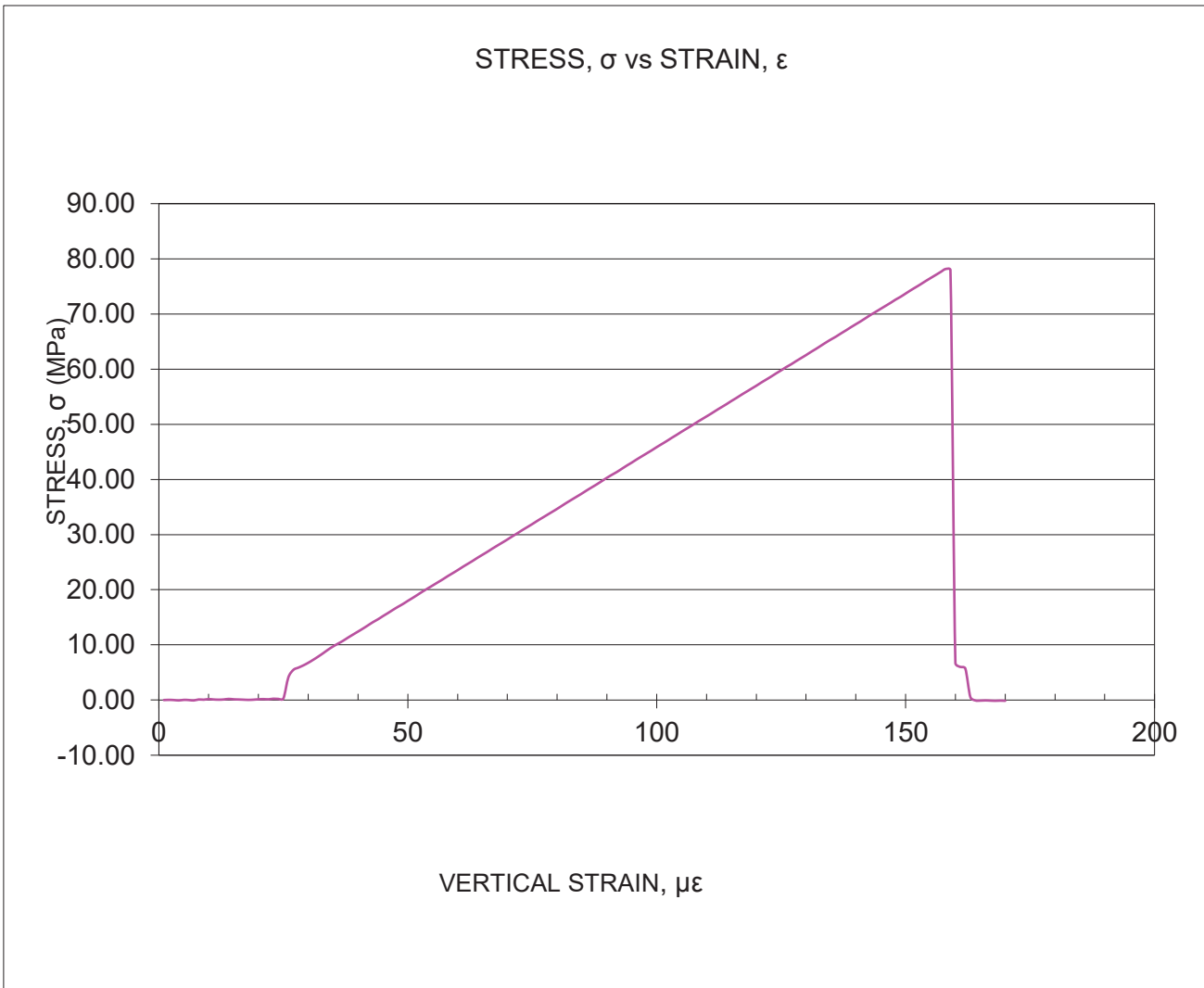
J.Noor

DATE

2021/01/08

ELASTIC MODULI OF ROCK CORE IN UNIAXIAL COMPRESSION
ASTM D7012

| | | | |
|--|---------------------------|-----------------|---------------|
| CLIENT | WSP | PML REF | 20TF017 |
| PROJECT | HWY 401/CNR OVERPASS | LAB NO. | 2008570D |
| SAMPLE IDENTIFICATION | C-3 RUN2 38.86 m- 39.13 m | DATE SAMPLED | 2020/12/17 |
| YOUNG'S MODULUS, E_{tan} (at 50% σ) | GPa | DATE TESTED | 1/5/2021 |
| YOUNG'S MODULUS, E_{sec} (at 50% σ) | GPa | TESTED BY | Azar Saidajan |
| YOUNG'S MODULUS, $E_{ave.}$ (at 50% σ) | GPa | POISSON'S RATIO | |



REVIEWED BY

J.Noor

DATE 2021/01/08

Peto MacCallum Ltd.

CONSULTING ENGINEERS

UNIAXIAL COMPRESSIVE STRENGTH OF ROCK CORE

ASTM D7012

CLIENT WSP
PROJECT HWY 401/CNR OVERPASS
SAMPLE IDENTIFICATION C-3 RUN3 40.4 m - 40.59 m

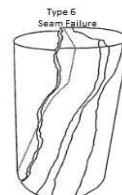
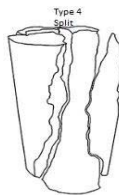
PML REF 20TF017
LAB NO. 2008570C
DATE SAMPLED 2020/12/17
DATE TESTED 1/5/2021
TESTED BY Azar Saidajar

| CORE DIMENSIONS | | COMPRESSIVE STRENGTH | |
|------------------------------|---------|---------------------------------------|--------|
| SPECIMEN DIAMETER (mm.) | 30.298 | TEST TIME (min) (spec. 2 to 15) | 1:36 |
| SPECIMEN LENGTH (mm.) | 122.809 | MAXIMUM LOAD APPLIED (kN) | 213.80 |
| | 122.377 | | |
| | 122.301 | COMPRESSIVE STRENGTH (MPa) | 74.1 |
| AVE. | 122.504 | TYPE OF FAILURE | 2 |
| CROSS SECTIONAL AREA (sq mm) | 2884 | LENGTH TO DIAMETER RATIO (spec 2-2.5) | 2.02 |

MOISTURE CONTENT

UNIT WEIGHT

| | | | |
|---------------------------------|--------|---------------------------------|----------|
| WEIGHT OF WET SAMPLE + TARE (g) | 943.94 | WEIGHT OF DRY SAMPLE IN AIR (g) | 853.68 |
| WEIGHT OF DRY SAMPLE + TARE (g) | 932.26 | VOLUME OF SAMPLE (cu m) | 0.000353 |
| WEIGHT OF WATER (g) | 11.68 | UNIT WEIGHT (kg/cu m) | 2416 |
| WEIGHT OF TARE (g) | 128.08 | | |
| WEIGHT OF DRY SAMPLE (g) | 804.18 | | |
| MOISTURE CONTENT (%) | 1.5 | | |
| REMARKS | | | |



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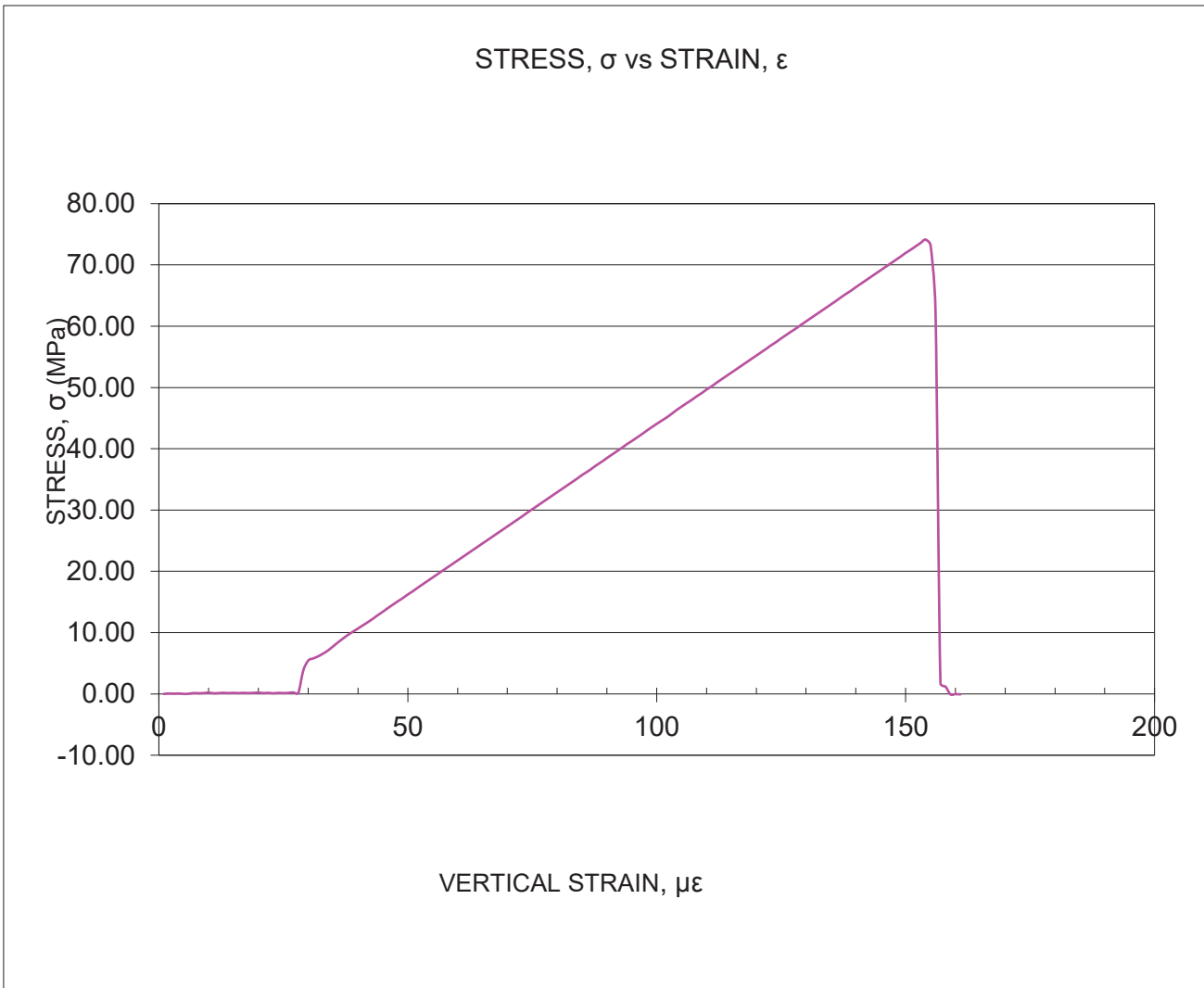
J.Noor

DATE

2021/01/08

ELASTIC MODULI OF ROCK CORE IN UNIAXIAL COMPRESSION
ASTM D7012

| | | | |
|--|---------------------------|-----------------|---------------|
| CLIENT | WSP | PML REF | 20TF017 |
| PROJECT | HWY 401/CNR OVERPASS | LAB NO. | 2008570C |
| SAMPLE IDENTIFICATION | C-3 RUN3 40.4 m - 40.59 m | DATE SAMPLED | 2020/12/17 |
| YOUNG'S MODULUS, E_{tan} (at 50% σ) | GPa | DATE TESTED | 1/5/2021 |
| YOUNG'S MODULUS, E_{sec} (at 50% σ) | GPa | TESTED BY | Azar Saidajan |
| YOUNG'S MODULUS, $E_{ave.}$ (at 50% σ) | GPa | POISSON'S RATIO | |



REVIEWED BY

J.Noor

DATE 2021/01/08

Peto MacCallum Ltd.

CONSULTING ENGINEERS

UNIAXIAL COMPRESSIVE STRENGTH OF ROCK CORE

ASTM D7012

CLIENT WSP
PROJECT HWY40/CNR
SAMPLE IDENTIFICATION CN-7 RUN1 46.65 m - 46.81 m

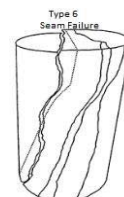
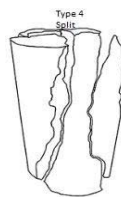
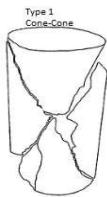
PML REF 2005221B
LAB NO. 20TF017
DATE SAMPLED 2020/08/18
DATE TESTED 8/31/2020
TESTED BY A.Saidajan

| CORE DIMENSIONS | | COMPRESSIVE STRENGTH | |
|------------------------------|---------|---------------------------------------|--------|
| SPECIMEN DIAMETER (mm.) | 31.559 | TEST TIME (min) (spec. 2 to 15) | 9:36 |
| SPECIMEN LENGTH (mm.) | 150.089 | MAXIMUM LOAD APPLIED (kN) | 263.30 |
| | 149.962 | | |
| | 149.936 | COMPRESSIVE STRENGTH (MPa) | 84.1 |
| AVE. | 149.987 | TYPE OF FAILURE | 1 |
| CROSS SECTIONAL AREA (sq mm) | 3129 | LENGTH TO DIAMETER RATIO (spec 2-2.5) | 2.38 |

MOISTURE CONTENT

UNIT WEIGHT

| | | | |
|---------------------------------|---------|---------------------------------|----------|
| WEIGHT OF WET SAMPLE + TARE (g) | 1270.59 | WEIGHT OF DRY SAMPLE IN AIR (g) | 1110.00 |
| WEIGHT OF DRY SAMPLE + TARE (g) | 1254.09 | VOLUME OF SAMPLE (cu m) | 0.000469 |
| WEIGHT OF WATER (g) | 16.50 | UNIT WEIGHT (kg/cu m) | 2365 |
| WEIGHT OF TARE (g) | 173.58 | | |
| WEIGHT OF DRY SAMPLE (g) | 1080.51 | | |
| MOISTURE CONTENT (%) | 1.5 | | |
| REMARKS | | 173.58 | |



REVIEWED BY

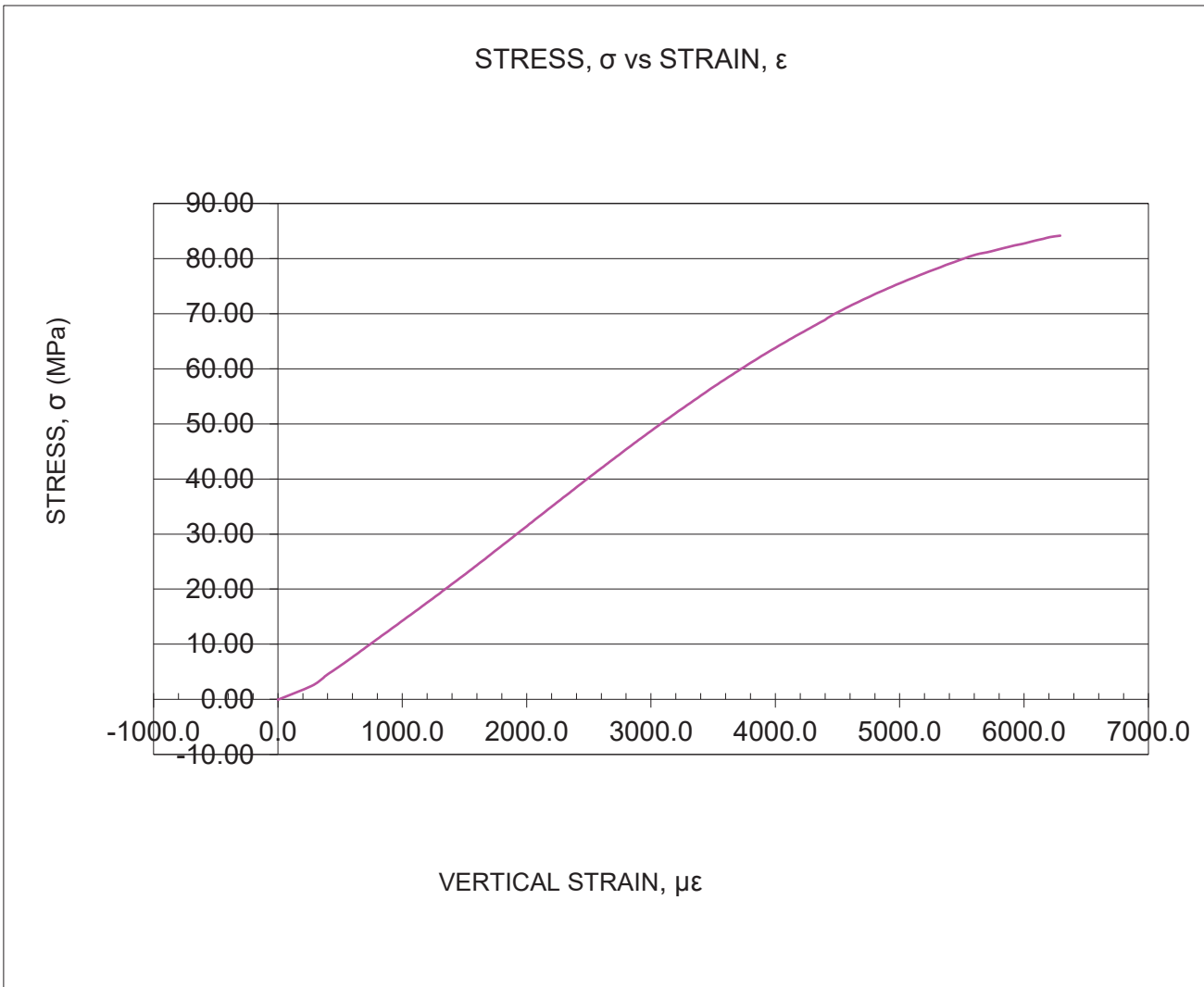
J.Noor

DATE

2020/09/03

ELASTIC MODULI OF ROCK CORE IN UNIAXIAL COMPRESSION
ASTM D7012

| | | | |
|--|---------------------------|-----------------|------------|
| CLIENT | WSP | PML REF | 2005221B |
| PROJECT | HWY40/CNR | LAB NO. | 20TF017 |
| SAMPLE IDENTIFICATION | CN-7 RUN1 46.65 m-46.81 m | DATE SAMPLED | 2020/08/18 |
| YOUNG'S MODULUS, E_{tan} (at 50% σ) | 17.33 GPa | DATE TESTED | 8/31/2020 |
| YOUNG'S MODULUS, E_{sec} (at 50% σ) | 16.13 GPa | TESTED BY | A.Saidajan |
| YOUNG'S MODULUS, $E_{ave.}$ (at 50% σ) | 16.73 GPa | POISSON'S RATIO | 0.453 |



REVIEWED BY

J.Noor

DATE 2020/09/03

Peto MacCallum Ltd.

CONSULTING ENGINEERS

UNIAXIAL COMPRESSIVE STRENGTH OF ROCK CORE

ASTM D7012

CLIENT WSP
PROJECT HWY 401/CNR OVERPASS
SAMPLE IDENTIFICATION CN-7 RUN2 48.13 m - 48.31 m

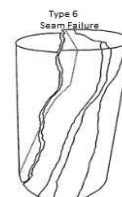
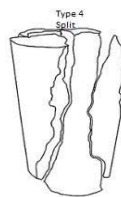
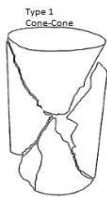
PML REF 20TF017
LAB NO. 2008570B
DATE SAMPLED 2020/12/17
DATE TESTED 12/23/2020
TESTED BY Azar Saidajar

| CORE DIMENSIONS | | COMPRESSIVE STRENGTH | |
|------------------------------|---------|---------------------------------------|--------|
| SPECIMEN DIAMETER (mm.) | 63.010 | TEST TIME (min) (spec. 2 to 15) | 16:00 |
| SPECIMEN LENGTH (mm.) | 133.096 | MAXIMUM LOAD APPLIED (kN) | 189.60 |
| | 133.045 | | |
| | 133.147 | COMPRESSIVE STRENGTH (MPa) | 60.8 |
| AVE. | 133.096 | TYPE OF FAILURE | 1 |
| CROSS SECTIONAL AREA (sq mm) | 3118 | LENGTH TO DIAMETER RATIO (spec 2-2.5) | 2.11 |

MOISTURE CONTENT

UNIT WEIGHT

| | | | |
|---------------------------------|---------|---------------------------------|----------|
| WEIGHT OF WET SAMPLE + TARE (g) | 1074.14 | WEIGHT OF DRY SAMPLE IN AIR (g) | 960.58 |
| WEIGHT OF DRY SAMPLE + TARE (g) | 1069.00 | VOLUME OF SAMPLE (cu m) | 0.000415 |
| WEIGHT OF WATER (g) | 5.14 | UNIT WEIGHT (kg/cu m) | 2315 |
| WEIGHT OF TARE (g) | 112.65 | | |
| WEIGHT OF DRY SAMPLE (g) | 956.35 | | |
| MOISTURE CONTENT (%) | 0.5 | | |
| REMARKS | | | |



REVIEWED BY

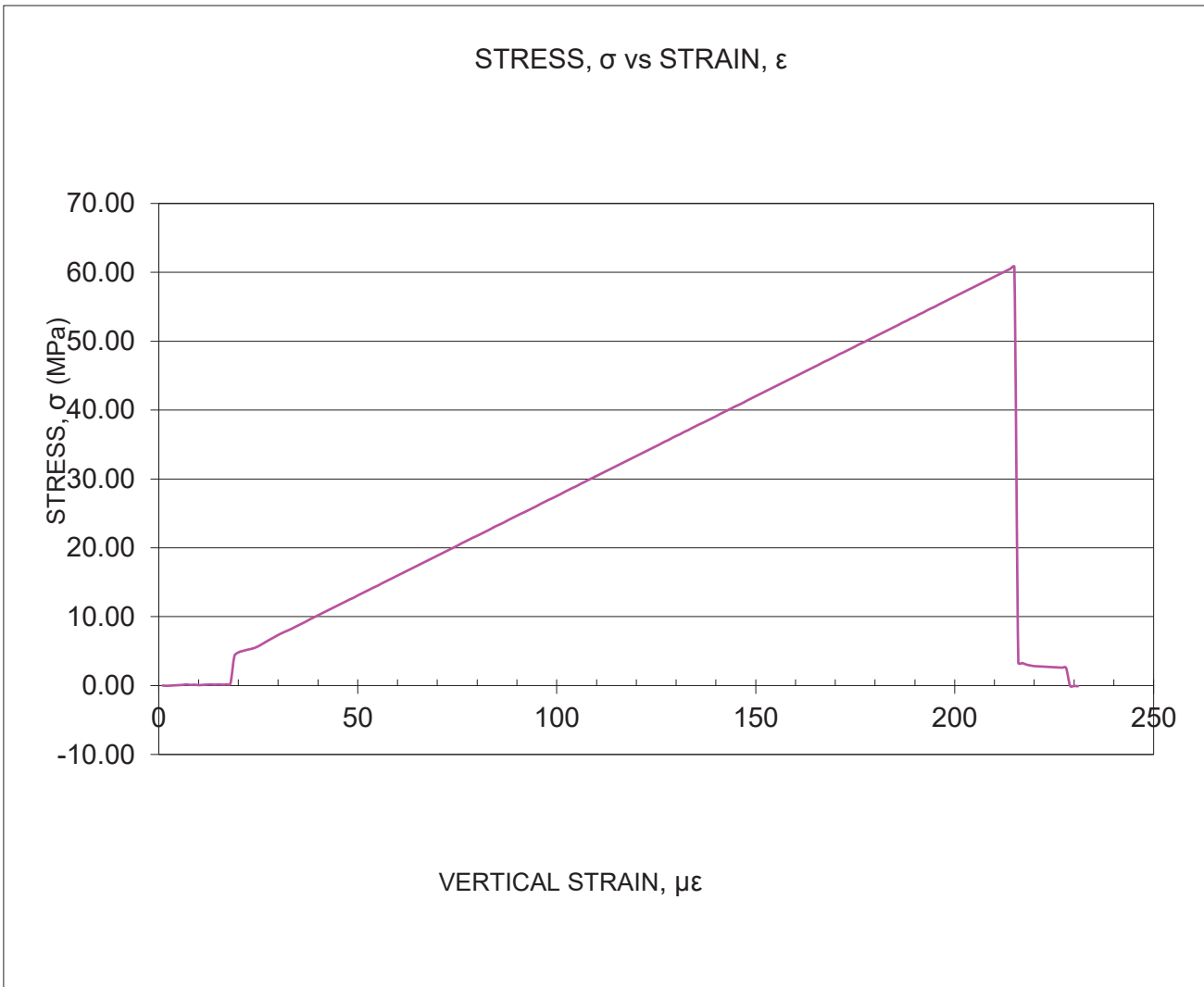
J.Noor

DATE

2021/01/08

ELASTIC MODULI OF ROCK CORE IN UNIAXIAL COMPRESSION
ASTM D7012

| | | | |
|--|---------------------------|-----------------|---------------|
| CLIENT | WSP | PML REF | 20TF017 |
| PROJECT | HWY 401/CNR OVERPASS | LAB NO. | 2008570B |
| SAMPLE IDENTIFICATION | CN-7 RUN2 48.13 m-48.31 m | DATE SAMPLED | 2020/12/17 |
| YOUNG'S MODULUS, E_{tan} (at 50% σ) | GPa | DATE TESTED | 12/23/2020 |
| YOUNG'S MODULUS, E_{sec} (at 50% σ) | GPa | TESTED BY | Azar Saidajan |
| YOUNG'S MODULUS, $E_{ave.}$ (at 50% σ) | GPa | POISSON'S RATIO | |



REVIEWED BY

J.Noor

DATE 2021/01/08

STRENGTH

VH = Very High = >200 MPa
H = High = 50-200 MPa
M = Medium = 15-50 MPa
L = Low = 4-15 MPa
VL = Very Low = 1-4 MPa

WEATHERING

U = Unweathered = No signs
S = Slightly = Oxidized
M = Moderately = Discoloured
H = Highly = Friable
C = Completely = Soil-Like

DISCONTINUITY TYPE

B = Bedding Joint
J = Cross Joint
F = Fault
S = Shear Plane
BR = Broken Rock

ORIENTATION

F = Flat = 0-20°
D = Dipping = 20-50°
V = Vertical >50°

SPACING

VW = Very Wide = >3 m
W = Wide = 1-3 m
M = Moderate = 0.3-1 m
C = Close = 5-30 cm
VC = Very Close = <5 cm

ROUGHNESS

RU = Rough Undulating
RP = Rough Planar
SU = Smooth Undulating
SP = Smooth Planar
LU = Slickensided Undulating
LP = Slickensided Planar

FILLING

T = Tight, Hard
O = Oxidized
SA = Slightly Altered, Clay Free
S = Sandy, Clay Free
Si = Sandy, Silty, Minor Clay
NC = Non-softening Clay
SC = Swelling, Soft Clay

CORE LOG IDENTIFICATION

BOREHOLE #: CN-5
PML REF.: 20TF017
PROJECT: Highway 40/CNR 2019-3076 Overhead
LOCATION: Highway 40 CNR Sarnia, Ontario
DATE: August 7, 2020
LOGGED BY: H. Racher, P.Geo.

Provincial Highways: A Guide to the
Description of Rock for Engineering
Purposes
MI-47

| RUN # | DEPTH TO (m) | CORE RECOVERY (%) | RQD (%) | DEPTH TO (m) | GENERAL DESCRIPTION | STRENGTH | WEATHERING | DISCONTINUITIES | | | | | | | OCCASIONAL FEATURES | DRILLING OBSERVATIONS |
|-------|--------------|-------------------|------------------|--------------|---|----------|------------|-----------------|------|-------------|---------|-----------|----------|---------|--|-----------------------|
| | | | | | | | | # OF SETS | TYPE | ORIENTATION | SPACING | ROUGHNESS | APERTURE | FILLING | | |
| 1 | 45.72 | 74% (1.12 m) | 72% (1.09 m) | 47.24 | KETTLE POINT FORMATION Unweathered, fissile, thinly laminated, black, soft SHALE . | L | U | 2 | J | F | C | SP | - | - | Occasional presence of sulphide lenses. | |
| | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | |
| 2 | 47.24 | 100% (1.52 m) | 100% (1.52 m) | 48.76 | KETTLE POINT FORMATION Unweathered, fissile, thinly laminated, black, soft SHALE . | L | U | - | - | - | - | - | - | - | Occasional presence of sulphide lenses/nodules; sample taken at 48.36-48.58 m. | |
| | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | |

STRENGTH

VH = Very High = >200 MPa
H = High = 50-200 MPa
M = Medium = 15-50 MPa
L = Low = 4-15 MPa
VL = Very Low = 1-4 MPa

WEATHERING

U = Unweathered = No signs
S = Slightly = Oxidized
M = Moderately = Discoloured
H = Highly = Friable
C = Completely = Soil-Like

DISCONTINUITY TYPE

B = Bedding Joint
J = Cross Joint
F = Fault
S = Shear Plane
BR = Broken Rock

ORIENTATION

F = Flat = 0-20°
D = Dipping = 20-50°
V = Vertical >50°

SPACING

VW = Very Wide = >3 m
W = Wide = 1-3 m
M = Moderate = 0.3-1 m
C = Close = 5-30 cm
VC = Very Close = <5 cm

ROUGHNESS

RU = Rough Undulating
RP = Rough Planar
SU = Smooth Undulating
SP = Smooth Planar
LU = Slickensided Undulating
LP = Slickensided Planar

FILLING

T = Tight, Hard
O = Oxidized
SA = Slightly Altered, Clay Free
S = Sandy, Clay Free
Si = Sandy, Silty, Minor Clay
NC = Non-softening Clay
SC = Swelling, Soft Clay

CORE LOG IDENTIFICATION

BOREHOLE #: CN-7
PML REF.: 20TF017
PROJECT: Highway 40/CNR 2019-3076 Overhead
LOCATION: Highway 40 CNR Sarnia, Ontario
DATE: August 7, 2020
LOGGED BY: H. Racher, P.Geo.

Provincial Highways: A Guide to the
Description of Rock for Engineering
Purposes
MI-47

| RUN # | DEPTH TO (m) | CORE RECOVERY (%) | RQD (%) | DEPTH TO (m) | GENERAL DESCRIPTION | STRENGTH | WEATHERING | DISCONTINUITIES | | | | | | | OCCASIONAL FEATURES | DRILLING OBSERVATIONS |
|-------|--------------|-------------------|-----------------|--------------|---|----------|------------|-----------------|------|-------------|---------|-----------|----------|---------|--|-----------------------|
| | | | | | | | | # OF SETS | TYPE | ORIENTATION | SPACING | ROUGHNESS | APERTURE | FILLING | | |
| 1 | 45.72 | 78% (1.19 m) | 75% (1.14 m) | 47.24 | KETTLE POINT FORMATION Unweathered, fissile, thinly laminated, black, soft SHALE . | L | U | 1 | J | F | - | SP | - | - | Broken rock at 45.72-45.74 m; sample taken at 46.65-46.81 m. | |
| | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | |
| 2 | 47.24 | 93% (1.42 m) | 93% (1.42 m) | 48.76 | KETTLE POINT FORMATION Unweathered, fissile, thinly laminated, black, soft SHALE . | L | U | 2 | J | F | M | SP | - | - | Occasional presence of sulphide stringers/nodules; white quartz vein <15.0 mm thick. | |
| | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | |

STRENGTH

VH = Very High = >200 MPa
H = High = 50-200 MPa
M = Medium = 15-50 MPa

L = Low = 4-15 MPa
VL = Very Low = 1-4 MPa

WEATHERING

U = Unweathered = No signs
S = Slightly = Oxidized
M = Moderately = Discoloured
H = Highly = Friable
C = Completely = Soil-Like

DISCONTINUITY TYPE

B = Bedding Joint
J = Cross Joint

F = Fault

S = Shear Plane
BR = Broken Rock

ORIENTATION

F = Flat = 0-20°
D = Dipping = 20-50°
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VC = Very Close = <5 cm

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RP = Rough Planar
SU = Smooth Undulating
SP = Smooth Planar
LU = Slickensided Undulating
LP = Slickensided Planar

FILLING

T = Tight, Hard
O = Oxidized

SA = Slightly Altered, Clay Free

S = Sandy, Clay Free
Si = Sandy, Silty, Minor Clay
NC = Non-softening Clay
SC = Swelling, Soft Clay

CORE LOG IDENTIFICATION

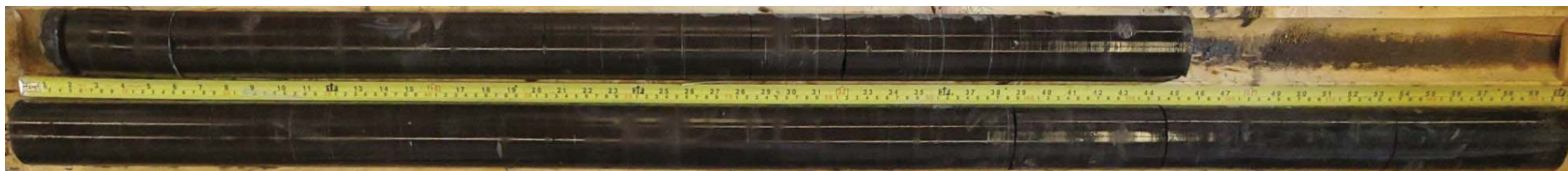
BOREHOLE #: C-3
PML REF.: 20TF017
PROJECT: Highway 40/CNR 2019-3076 Overhead
LOCATION: Highway 40 CNR Sarnia, Ontario
DATE: October 2, 2020
LOGGED BY: H. Racher, P.Geo.

Provincial Highways: A Guide to the
Description of Rock for Engineering
Purposes
MI-47

| RUN # | DEPTH TO (m) | CORE RECOVERY (%) | ROD (%) | DEPTH TO (m) | GENERAL DESCRIPTION | STRENGTH | WEATHERING | DISCONTINUITIES | | | | | | | OCCASIONAL FEATURES | DRILLING OBSERVATIONS |
|-------|--------------|-------------------|------------------|--------------|---|----------|------------|-----------------|------|-------------|---------|-----------|----------|---------|--|-----------------------|
| | | | | | | | | # OF SETS | TYPE | ORIENTATION | SPACING | ROUGHNESS | APERTURE | FILLING | | |
| 1 | 38.25 | 74% (0.13 m) | 0% (0.00 m) | 38.41 | KETTLE POINT FORMATION Unweathered, fissile, thinly laminated, black, soft SHALE . | L | U | 1 | BR | - | - | - | - | - | Entire run broken rock. | |
| | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | |
| 2 | 38.41 | +100% (1.65 m) | 100% (1.55 m) | 39.93 | KETTLE POINT FORMATION Unweathered, fissile, thinly laminated, black, soft SHALE . | L | U | 1 | J | F | - | SP | - | - | Occasional presence of sulphide lenses/nodules; broken rock at 39.45-39.51 m; sample taken at 38.86-39.13 m. | |
| | | | | | | | | 1 | BR | - | - | - | - | - | | |
| | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | |
| 3 | 39.93 | +100% (1.63 m) | 100% (1.63 m) | 41.45 | KETTLE POINT FORMATION Unweathered, fissile, thinly laminated, black, soft SHALE . | L | U | 1 | J | F | - | SP | - | - | Occasional presence of sulphide lenses/nodules; calcite vein <3.0 mm wide; vertical fracture at 41.40-41.56 m. | |
| | | | | | | | | 1 | J | V | - | SP | - | - | | |
| | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | |

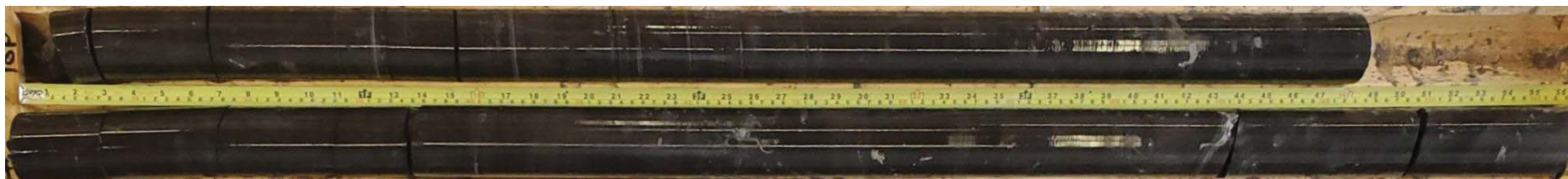
ROCK CORE PHOTOGRAPHS

Borehole CN-5



Borehole CN5 – RUN1 and RUN2– 45.72-48.76 m

Borehole CN-7



Borehole CN7 – RUN1 and RUN2– 45.72-48.76 m

Borehole C-3



Borehole C-3 – RC1 and RC2– 38.25 -39.93 m

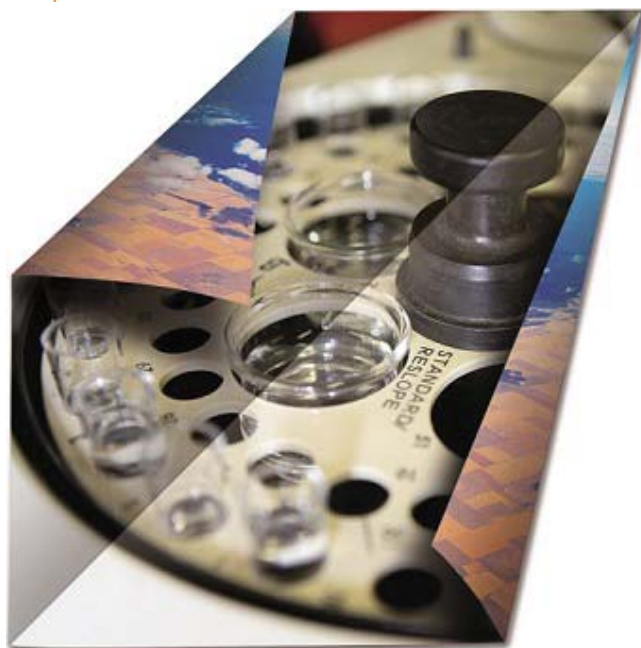


Borehole C-3 – RC3 – 39.93-41.45 m



APPENDIX C

Results of Chemical Tests Provided by SGS Canada Inc.



FINAL REPORT

CA14944-AUG20 R1

20TF017

Prepared for

Peto MacCallum Ltd

First Page

| CLIENT DETAILS | | LABORATORY DETAILS | |
|----------------|--|--------------------|---|
| Client | Peto MacCallum Ltd | Project Specialist | Brad Moore Hon. B.Sc |
| Address | 165 Cartwright Ave Toronto, ON M6A 1V5, Canada | Laboratory | SGS Canada Inc. |
| Contact | Nazibur Rahman | Address | 185 Concession St., Lakefield ON, K0L 2H0 |
| Telephone | 416-785-5110 | Telephone | 705-652-2143 |
| Facsimile | 416-785-5120 | Facsimile | 705-652-6365 |
| Email | nrahman@petomacallum.com | Email | brad.moore@sgs.com |
| Project | 20TF017 | SGS Reference | CA14944-AUG20 |
| Order Number | | Received | 08/31/2020 |
| Samples | Soil (8) | Approved | 09/03/2020 |
| | | Report Number | CA14944-AUG20 R1 |
| | | Date Reported | 09/03/2020 |

| COMMENTS |
|--|
| <p>Temperature of Sample upon Receipt: 9 degrees C</p> <p>Cooling Agent Present: YES</p> <p>Custody Seal Present: YES</p> <p>Chain of Custody Number: 013261</p> <p>Corrosivity Index is based on the American Water Works Corrosivity Scale according to AWWA C-105. An index greater than 10 indicates the soil matrix may be corrosive to cast iron alloys.</p> |


| SIGNATORIES |
|---|
| <p>Brad Moore Hon. B.Sc</p>  |

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| QC Summary..... | 5-6 |
| Legend..... | 7 |
| Annexes..... | 8 |



FINAL REPORT

CA14944-AUG20 R1

Client: Peto MacCallum Ltd

Project: 20TF017

Project Manager: Nazibur Rahman

Samplers: Omar Noor

PACKAGE: - Corrosivity Index (SOIL)

| Sample Number | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 |
|---------------|---------------------------|-----------------------------|---------------------------|-----------------------------|---------------------------|---------------------------|-----------------------------|-----------------------------|
| Sample Name | CN-7 Sample 19 75'-77' | CN-7 Sample 25 130'-132' | CN-5 Sample 12 40'-42' | CN-5 Sample 21 110'-112' | RW-1 Sample 10 25'-27' | RW-1 Sample 16 55'-57' | RW-2 Sample 21 100'-102' | RW-2 Sample 27 140'-140' |
| Sample Matrix | Soil | Soil | Soil | Soil | Soil | Soil | Soil | Soil |
| Sample Date | 31/08/2020 | 31/08/2020 | 31/08/2020 | 31/08/2020 | 31/08/2020 | 31/08/2020 | 31/08/2020 | 31/08/2020 |

| Parameter | Units | RL | Result | Result | Result | Result | Result | Result | Result |
|--------------------------|----------|-------|--------|--------|--------|--------|--------|--------|--------|
| Corrosivity Index | | | | | | | | | |
| Corrosivity Index | none | 1 | 8 | 8 | 8 | 12 | 1 | 8 | 6 |
| Soil Redox Potential | mV | - | 164 | 218 | 241 | 157 | 239 | 84 | 148 |
| Sulphide | % | 0.04 | 0.44 | 0.40 | 0.13 | 0.43 | < 0.04 | 0.15 | 0.46 |
| pH | pH Units | 0.05 | 8.54 | 8.54 | 8.68 | 8.21 | 8.50 | 8.50 | 8.40 |
| Resistivity (calculated) | ohms.cm | -9999 | 3250 | 2580 | 4080 | 1600 | 5740 | 2580 | 2280 |

PACKAGE: - General Chemistry (SOIL)

| Sample Number | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 |
|---------------|---------------------------|-----------------------------|---------------------------|-----------------------------|---------------------------|---------------------------|-----------------------------|-----------------------------|
| Sample Name | CN-7 Sample 19 75'-77' | CN-7 Sample 25 130'-132' | CN-5 Sample 12 40'-42' | CN-5 Sample 21 110'-112' | RW-1 Sample 10 25'-27' | RW-1 Sample 16 55'-57' | RW-2 Sample 21 100'-102' | RW-2 Sample 27 140'-140' |
| Sample Matrix | Soil | Soil | Soil | Soil | Soil | Soil | Soil | Soil |
| Sample Date | 31/08/2020 | 31/08/2020 | 31/08/2020 | 31/08/2020 | 31/08/2020 | 31/08/2020 | 31/08/2020 | 31/08/2020 |

| Parameter | Units | RL | Result | Result | Result | Result | Result | Result | Result |
|--------------------------|-------|----|--------|--------|--------|--------|--------|--------|--------|
| General Chemistry | | | | | | | | | |
| Conductivity | uS/cm | 2 | 308 | 387 | 245 | 624 | 174 | 387 | 438 |

PACKAGE: - Metals and Inorganics (SOIL)

| Sample Number | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 |
|---------------|---------------------------|-----------------------------|---------------------------|-----------------------------|---------------------------|---------------------------|-----------------------------|-----------------------------|
| Sample Name | CN-7 Sample 19 75'-77' | CN-7 Sample 25 130'-132' | CN-5 Sample 12 40'-42' | CN-5 Sample 21 110'-112' | RW-1 Sample 10 25'-27' | RW-1 Sample 16 55'-57' | RW-2 Sample 21 100'-102' | RW-2 Sample 27 140'-140' |
| Sample Matrix | Soil | Soil | Soil | Soil | Soil | Soil | Soil | Soil |
| Sample Date | 31/08/2020 | 31/08/2020 | 31/08/2020 | 31/08/2020 | 31/08/2020 | 31/08/2020 | 31/08/2020 | 31/08/2020 |

| Parameter | Units | RL | Result | Result | Result | Result | Result | Result | Result |
|------------------------------|-------|-----|--------|--------|--------|--------|--------|--------|--------|
| Metals and Inorganics | | | | | | | | | |
| Moisture Content | % | 0.1 | 18.5 | 19.8 | 15.6 | 21.9 | 13.3 | 18.0 | 19.6 |



FINAL REPORT

CA14944-AUG20 R1

Client: Peto MacCallum Ltd

Project: 20TF017

Project Manager: Nazibur Rahman

Samplers: Omar Noor

PACKAGE: - Metals and Inorganics (SOIL)

| Sample Number | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 |
|---------------|---------------------------|-----------------------------|---------------------------|-----------------------------|---------------------------|---------------------------|-----------------------------|-----------------------------|
| Sample Name | CN-7 Sample 19 75'-77' | CN-7 Sample 25 130'-132' | CN-5 Sample 12 40'-42' | CN-5 Sample 21 110'-112' | RW-1 Sample 10 25'-27' | RW-1 Sample 16 55'-57' | RW-2 Sample 21 100'-102' | RW-2 Sample 27 140'-140' |
| Sample Matrix | Soil | Soil | Soil | Soil | Soil | Soil | Soil | Soil |
| Sample Date | 31/08/2020 | 31/08/2020 | 31/08/2020 | 31/08/2020 | 31/08/2020 | 31/08/2020 | 31/08/2020 | 31/08/2020 |

| Parameter | Units | RL | Result | Result | Result | Result | Result | Result | Result |
|-----------|-------|----|--------|--------|--------|--------|--------|--------|--------|
|-----------|-------|----|--------|--------|--------|--------|--------|--------|--------|

Metals and Inorganics (continued)

| | | | | | | | | | | | |
|----------|------|-----|--|-----|-----|-----|-----|----|-----|-----|-----|
| Sulphate | µg/g | 0.4 | | 340 | 480 | 230 | 540 | 49 | 190 | 320 | 430 |
|----------|------|-----|--|-----|-----|-----|-----|----|-----|-----|-----|

PACKAGE: - Other (ORP) (SOIL)

| Sample Number | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 |
|---------------|---------------------------|-----------------------------|---------------------------|-----------------------------|---------------------------|---------------------------|-----------------------------|-----------------------------|
| Sample Name | CN-7 Sample 19 75'-77' | CN-7 Sample 25 130'-132' | CN-5 Sample 12 40'-42' | CN-5 Sample 21 110'-112' | RW-1 Sample 10 25'-27' | RW-1 Sample 16 55'-57' | RW-2 Sample 21 100'-102' | RW-2 Sample 27 140'-140' |
| Sample Matrix | Soil | Soil | Soil | Soil | Soil | Soil | Soil | Soil |
| Sample Date | 31/08/2020 | 31/08/2020 | 31/08/2020 | 31/08/2020 | 31/08/2020 | 31/08/2020 | 31/08/2020 | 31/08/2020 |

| Parameter | Units | RL | Result | Result | Result | Result | Result | Result | Result |
|-----------|-------|----|--------|--------|--------|--------|--------|--------|--------|
|-----------|-------|----|--------|--------|--------|--------|--------|--------|--------|

Other (ORP)

| | | | | | | | | | | | |
|----------|------|-----|--|----|----|-----|----|-----|----|----|----|
| Chloride | µg/g | 0.4 | | 12 | 30 | 6.2 | 28 | 3.6 | 10 | 19 | 34 |
|----------|------|-----|--|----|----|-----|----|-----|----|----|----|



FINAL REPORT

CA14944-AUG20 R1

QC SUMMARY

Anions by IC
Method: EPA300/MA300-Ions1.3 | Internal ref.: ME-CA-IENVIC-LAK-AN-001

| Parameter | QC batch Reference | Units | RL | Method Blank | Duplicate | | LCS/Spike Blank | | | Matrix Spike / Ref. | | |
|-----------|--------------------|-------|-----|--------------|-----------|--------|--------------------|---------------------|------|---------------------|---------------------|------|
| | | | | | RPD | AC (%) | Spike Recovery (%) | Recovery Limits (%) | | Spike Recovery (%) | Recovery Limits (%) | |
| | | | | | | | | Low | High | | Low | High |
| Chloride | DIO0019-SEP20 | µg/g | 0.4 | <0.4 | 0 | 20 | 94 | 80 | 120 | 107 | 75 | 125 |
| Sulphate | DIO0019-SEP20 | µg/g | 0.4 | <0.4 | 0 | 20 | 96 | 80 | 120 | 94 | 75 | 125 |

Carbon/Sulphur
Method: ASTM E1915-07A | Internal ref.: ME-CA-IENVIARD-LAK-AN-020

| Parameter | QC batch Reference | Units | RL | Method Blank | Duplicate | | LCS/Spike Blank | | | Matrix Spike / Ref. | | |
|-----------|--------------------|-------|------|--------------|-----------|--------|--------------------|---------------------|------|---------------------|---------------------|------|
| | | | | | RPD | AC (%) | Spike Recovery (%) | Recovery Limits (%) | | Spike Recovery (%) | Recovery Limits (%) | |
| | | | | | | | | Low | High | | Low | High |
| Sulphide | ECS0004-SEP20 | % | 0.04 | < 0.04 | 1 | 20 | 104 | 80 | 120 | | | |

Conductivity
Method: SM 2510 | Internal ref.: ME-CA-IENVIEWL-LAK-AN-006

| Parameter | QC batch Reference | Units | RL | Method Blank | Duplicate | | LCS/Spike Blank | | | Matrix Spike / Ref. | | |
|--------------|--------------------|-------|----|--------------|-----------|--------|--------------------|---------------------|------|---------------------|---------------------|------|
| | | | | | RPD | AC (%) | Spike Recovery (%) | Recovery Limits (%) | | Spike Recovery (%) | Recovery Limits (%) | |
| | | | | | | | | Low | High | | Low | High |
| Conductivity | EWL0012-SEP20 | uS/cm | 2 | < 2 | 2 | 20 | 100 | 90 | 110 | NA | | |



FINAL REPORT

CA14944-AUG20 R1

QC SUMMARY

pH
Method: SM 4500 | Internal ref.: ME-CA-IENVIEWL-LAK-AN-001

| Parameter | QC batch Reference | Units | RL | Method Blank | Duplicate | | LCS/Spike Blank | | | Matrix Spike / Ref. | | |
|-----------|-----------------------|----------|------|-----------------|-----------|-----------|--------------------------|------------------------|------|--------------------------|------------------------|------|
| | | | | | RPD | AC (%) | Spike Recovery (%) | Recovery Limits (%) | | Spike Recovery (%) | Recovery Limits (%) | |
| | | | | | | | | Low | High | | Low | High |
| pH | EWL0012-SEP20 | pH Units | 0.05 | NA | 0 | | 100 | | | NA | | |

Method Blank: a blank matrix that is carried through the entire analytical procedure. Used to assess laboratory contamination.

Duplicate: Paired analysis of a separate portion of the same sample that is carried through the entire analytical procedure. Used to evaluate measurement precision.

LCS/Spike Blank: Laboratory control sample or spike blank refer to a blank matrix to which a known amount of analyte has been added. Used to evaluate analyte recovery and laboratory accuracy without sample matrix effects.

Matrix Spike: A sample to which a known amount of the analyte of interest has been added. Used to evaluate laboratory accuracy with sample matrix effects.

Reference Material: a material or substance matrix matched to the samples that contains a known amount of the analyte of interest. A reference material may be used in place of a matrix spike.

RL: Reporting limit

RPD: Relative percent difference

AC: Acceptance criteria

Multielement Scan Qualifier: as the number of analytes in a scan increases, so does the chance of a limit exceedance by random chance as opposed to a real method problem. Thus, in multielement scans, for the LCS and matrix spike, up to 10% of the analytes may exceed the quoted limits by up to 10% absolute and the spike is considered acceptable.

Duplicate Qualifier: for duplicates as the measured result approaches the RL, the uncertainty associated with the value increases dramatically, thus duplicate acceptance limits apply only where the average of the two duplicates is greater than five times the RL.

Matrix Spike Qualifier: for matrix spikes, as the concentration of the native analyte increases, the uncertainty of the matrix spike recovery increases. Thus, the matrix spike acceptance limits apply only when the concentration of the matrix spike is greater than or equal to the concentration of the native analyte.

LEGEND

FOOTNOTES

NSS Insufficient sample for analysis.

RL Reporting Limit.

↑ Reporting limit raised.

↓ Reporting limit lowered.

NA The sample was not analysed for this analyte

ND Non Detect

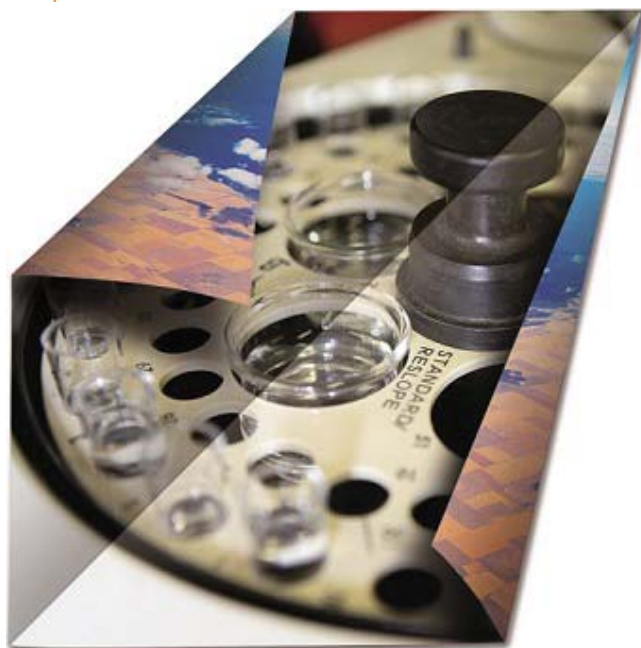
Samples analysed as received. Solid samples expressed on a dry weight basis. "Temperature Upon Receipt" is representative of the whole shipment and may not reflect the temperature of individual samples.

Analysis conducted on samples submitted pursuant to or as part of Reg. 153/04, are in accordance to the Protocol for Analytical Methods Used in the Assessment of Properties under Part XV.1 of the Environmental Protection Act" published by the Ministry and dated March 9, 2004 as amended.

SGS provides criteria information (such as regulatory or guideline limits and summary of limit exceedances) as a service. Every attempt is made to ensure the criteria information in this report is accurate and current, however, it is not guaranteed. Comparison to the most current criteria is the responsibility of the client and SGS assumes no responsibility for the accuracy of the criteria levels indicated. This document is issued, on the Client's behalf, by the Company under its General Conditions of Service available on request and accessible at http://www.sgs.com/terms_and_conditions.htm. The Client's attention is drawn to the limitation of liability, indemnification and jurisdiction issues defined therein. Any other holder of this document is advised that information contained hereon reflects the Company's findings at the time of its intervention only and within the limits of Client's instructions, if any. The Company's sole responsibility is to its Client and this document does not exonerate parties to a transaction from exercising all their rights and obligations under the transaction documents.

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-- End of Analytical Report --



FINAL REPORT

CA14840-OCT20 R1

20TF017

Prepared for

Peto MacCallum Ltd

First Page

| CLIENT DETAILS | | LABORATORY DETAILS | |
|----------------|--|--------------------|---|
| Client | Peto MacCallum Ltd | Project Specialist | Jill Campbell, B.Sc.,GISAS |
| Address | 165 Cartwright Ave Toronto, ON M6A 1V5, Canada | Laboratory | SGS Canada Inc. |
| Contact | Nazibur Rahman | Address | 185 Concession St., Lakefield ON, K0L 2H0 |
| Telephone | 416-785-5110 | Telephone | 2165 |
| Facsimile | 416-785-5120 | Facsimile | 705-652-6365 |
| Email | nrahman@petomacallum.com | Email | jill.campbell@sgs.com |
| Project | 20TF017 | SGS Reference | CA14840-OCT20 |
| Order Number | | Received | 10/21/2020 |
| Samples | Soil (8) | Approved | 10/27/2020 |
| | | Report Number | CA14840-OCT20 R1 |
| | | Date Reported | 10/27/2020 |

COMMENTS

Temperature of Sample upon Receipt: 7 degrees C

Cooling Agent Present:Yes

Custody Seal Present:Yes

Chain of Custody Number:004117

Corrosivity Index is based on the American Water Works Corrosivity Scale according to AWWA C-105. An index greater than 10 indicates the soil matrix may be corrosive to cast iron alloys.

SIGNATORIES

Jill Campbell, B.Sc.,GISAS



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FINAL REPORT

CA14840-OCT20 R1

Client: Peto MacCallum Ltd

Project: 20TF017

Project Manager: Nazibur Rahman

Samplers: Omar Noor

PACKAGE: - Corrosivity Index (SOIL)

| Sample Number | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 |
|---------------|--------------------------|---------------------------|-----------------------------|--------------------------|--------------------------|--------------------------|------------------------------|--------------------------|
| Sample Name | C-3 Sample 8, 25'-27" | C-3 Sample 12, 45'-47" | C-3 Sample 20, 105'-107" | C-3 Sample 5, 12'-14' | C-2 Sample 5, 15'-17' | C-2 Sample 7, 20'-22' | C-1 Sample 5, 12.5'-14.5' | C-1 Sample 8, 25'-27" |
| Sample Matrix | Soil | Soil | Soil | Soil | Soil | Soil | Soil | Soil |
| Sample Date | 16/10/2020 | 16/10/2020 | 16/10/2020 | 20/10/2020 | 20/10/2020 | 21/10/2020 | 21/10/2020 | 21/10/2020 |

| Parameter | Units | RL | Result | Result | Result | Result | Result | Result | Result |
|-----------|-------|----|--------|--------|--------|--------|--------|--------|--------|
|-----------|-------|----|--------|--------|--------|--------|--------|--------|--------|

Corrosivity Index

| | | | | | | | | | | | |
|--------------------------|----------|-------|--|------|------|------|--------|------|------|------|------|
| Corrosivity Index | none | 1 | | 8 | 6 | 4 | 6 | 4 | 4 | 10 | 8 |
| Soil Redox Potential | mV | - | | 149 | 169 | 151 | 142 | 161 | 163 | 152 | 128 |
| Sulphide (Na2CO3) | % | 0.04 | | 0.13 | 0.41 | 0.41 | < 0.04 | 0.10 | 0.13 | 0.10 | 0.12 |
| pH | pH Units | 0.05 | | 9.05 | 8.37 | 8.41 | 7.75 | 8.35 | 8.20 | 8.55 | 8.51 |
| Resistivity (calculated) | ohms.cm | -9999 | | 5910 | 2480 | 6290 | 1900 | 7700 | 3650 | 2410 | 4220 |

PACKAGE: - General Chemistry (SOIL)

| Sample Number | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 |
|---------------|--------------------------|---------------------------|-----------------------------|--------------------------|--------------------------|--------------------------|------------------------------|--------------------------|
| Sample Name | C-3 Sample 8, 25'-27" | C-3 Sample 12, 45'-47" | C-3 Sample 20, 105'-107" | C-3 Sample 5, 12'-14' | C-2 Sample 5, 15'-17' | C-2 Sample 7, 20'-22' | C-1 Sample 5, 12.5'-14.5' | C-1 Sample 8, 25'-27" |
| Sample Matrix | Soil | Soil | Soil | Soil | Soil | Soil | Soil | Soil |
| Sample Date | 16/10/2020 | 16/10/2020 | 16/10/2020 | 20/10/2020 | 20/10/2020 | 21/10/2020 | 21/10/2020 | 21/10/2020 |

| Parameter | Units | RL | Result | Result | Result | Result | Result | Result | Result |
|-----------|-------|----|--------|--------|--------|--------|--------|--------|--------|
|-----------|-------|----|--------|--------|--------|--------|--------|--------|--------|

General Chemistry

| | | | | | | | | | | | |
|--------------|-------|---|--|-----|-----|-----|-----|-----|-----|-----|-----|
| Conductivity | uS/cm | 2 | | 169 | 404 | 159 | 527 | 130 | 274 | 415 | 237 |
|--------------|-------|---|--|-----|-----|-----|-----|-----|-----|-----|-----|

PACKAGE: - Metals and Inorganics (SOIL)

| Sample Number | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 |
|---------------|--------------------------|---------------------------|-----------------------------|--------------------------|--------------------------|--------------------------|------------------------------|--------------------------|
| Sample Name | C-3 Sample 8, 25'-27" | C-3 Sample 12, 45'-47" | C-3 Sample 20, 105'-107" | C-3 Sample 5, 12'-14' | C-2 Sample 5, 15'-17' | C-2 Sample 7, 20'-22' | C-1 Sample 5, 12.5'-14.5' | C-1 Sample 8, 25'-27" |
| Sample Matrix | Soil | Soil | Soil | Soil | Soil | Soil | Soil | Soil |
| Sample Date | 16/10/2020 | 16/10/2020 | 16/10/2020 | 20/10/2020 | 20/10/2020 | 21/10/2020 | 21/10/2020 | 21/10/2020 |

| Parameter | Units | RL | Result | Result | Result | Result | Result | Result | Result |
|-----------|-------|----|--------|--------|--------|--------|--------|--------|--------|
|-----------|-------|----|--------|--------|--------|--------|--------|--------|--------|

Metals and Inorganics

| | | | | | | | | | | | |
|------------------|---|-----|--|------|------|------|------|------|------|------|------|
| Moisture Content | % | 0.1 | | 18.7 | 18.2 | 22.3 | 18.8 | 14.8 | 17.3 | 14.2 | 18.5 |
|------------------|---|-----|--|------|------|------|------|------|------|------|------|



FINAL REPORT

CA14840-OCT20 R1

Client: Peto MacCallum Ltd

Project: 20TF017

Project Manager: Nazibur Rahman

Samplers: Omar Noor

PACKAGE: - Metals and Inorganics (SOIL)

| Sample Number | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 |
|---------------|--------------------------|---------------------------|-----------------------------|--------------------------|--------------------------|--------------------------|------------------------------|--------------------------|
| Sample Name | C-3 Sample 8, 25'-27" | C-3 Sample 12, 45'-47" | C-3 Sample 20, 105'-107" | C-3 Sample 5, 12'-14' | C-2 Sample 5, 15'-17' | C-2 Sample 7, 20'-22' | C-1 Sample 5, 12.5'-14.5' | C-1 Sample 8, 25'-27" |
| Sample Matrix | Soil | Soil | Soil | Soil | Soil | Soil | Soil | Soil |
| Sample Date | 16/10/2020 | 16/10/2020 | 16/10/2020 | 20/10/2020 | 20/10/2020 | 21/10/2020 | 21/10/2020 | 21/10/2020 |

| Parameter | Units | RL | Result | Result | Result | Result | Result | Result | Result | Result |
|-----------|-------|----|--------|--------|--------|--------|--------|--------|--------|--------|
|-----------|-------|----|--------|--------|--------|--------|--------|--------|--------|--------|

Metals and Inorganics (continued)

| | | | | | | | | | | | |
|----------|------|-----|--|-----|-----|-----|-----|-----|-----|-----|-----|
| Sulphate | µg/g | 0.4 | | 220 | 310 | 420 | 3.1 | 240 | 230 | 190 | 200 |
|----------|------|-----|--|-----|-----|-----|-----|-----|-----|-----|-----|

PACKAGE: - Other (ORP) (SOIL)

| Sample Number | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 |
|---------------|--------------------------|---------------------------|-----------------------------|--------------------------|--------------------------|--------------------------|------------------------------|--------------------------|
| Sample Name | C-3 Sample 8, 25'-27" | C-3 Sample 12, 45'-47" | C-3 Sample 20, 105'-107" | C-3 Sample 5, 12'-14' | C-2 Sample 5, 15'-17' | C-2 Sample 7, 20'-22' | C-1 Sample 5, 12.5'-14.5' | C-1 Sample 8, 25'-27" |
| Sample Matrix | Soil | Soil | Soil | Soil | Soil | Soil | Soil | Soil |
| Sample Date | 16/10/2020 | 16/10/2020 | 16/10/2020 | 20/10/2020 | 20/10/2020 | 21/10/2020 | 21/10/2020 | 21/10/2020 |

| Parameter | Units | RL | Result | Result | Result | Result | Result | Result | Result | Result |
|-----------|-------|----|--------|--------|--------|--------|--------|--------|--------|--------|
|-----------|-------|----|--------|--------|--------|--------|--------|--------|--------|--------|

Other (ORP)

| | | | | | | | | | | | |
|----------|------|-----|--|-----|----|----|----|----|-----|----|-----|
| Chloride | µg/g | 0.4 | | 7.6 | 12 | 32 | 37 | 13 | 9.1 | 91 | 9.4 |
|----------|------|-----|--|-----|----|----|----|----|-----|----|-----|



FINAL REPORT

CA14840-OCT20 R1

QC SUMMARY

Anions by IC
Method: EPA300/MA300-Ions1.3 | Internal ref.: ME-CA-IENVIC-LAK-AN-001

| Parameter | QC batch Reference | Units | RL | Method Blank | Duplicate | | LCS/Spike Blank | | | Matrix Spike / Ref. | | |
|-----------|--------------------|-------|-----|--------------|-----------|--------|--------------------|---------------------|------|---------------------|---------------------|------|
| | | | | | RPD | AC (%) | Spike Recovery (%) | Recovery Limits (%) | | Spike Recovery (%) | Recovery Limits (%) | |
| | | | | | | | | Low | High | | Low | High |
| Chloride | DIO0467-OCT20 | µg/g | 0.4 | <0.4 | 12 | 20 | 94 | 80 | 120 | 98 | 75 | 125 |
| Sulphate | DIO0467-OCT20 | µg/g | 0.4 | <0.4 | 7 | 20 | 94 | 80 | 120 | 110 | 75 | 125 |

Carbon/Sulphur
Method: ASTM E1915-07A | Internal ref.: ME-CA-IENVIARD-LAK-AN-020

| Parameter | QC batch Reference | Units | RL | Method Blank | Duplicate | | LCS/Spike Blank | | | Matrix Spike / Ref. | | |
|-------------------|--------------------|-------|------|--------------|-----------|--------|--------------------|---------------------|------|---------------------|---------------------|------|
| | | | | | RPD | AC (%) | Spike Recovery (%) | Recovery Limits (%) | | Spike Recovery (%) | Recovery Limits (%) | |
| | | | | | | | | Low | High | | Low | High |
| Sulphide (Na2CO3) | ECS0029-OCT20 | % | 0.04 | < 0.04 | 18 | 20 | 109 | 80 | 120 | | | |

Conductivity
Method: SM 2510 | Internal ref.: ME-CA-IENVIEWL-LAK-AN-006

| Parameter | QC batch Reference | Units | RL | Method Blank | Duplicate | | LCS/Spike Blank | | | Matrix Spike / Ref. | | |
|--------------|--------------------|-------|----|--------------|-----------|--------|--------------------|---------------------|------|---------------------|---------------------|------|
| | | | | | RPD | AC (%) | Spike Recovery (%) | Recovery Limits (%) | | Spike Recovery (%) | Recovery Limits (%) | |
| | | | | | | | | Low | High | | Low | High |
| Conductivity | EWL0421-OCT20 | uS/cm | 2 | < 2 | 0 | 20 | 100 | 90 | 110 | NA | | |



FINAL REPORT

CA14840-OCT20 R1

QC SUMMARY

pH
Method: SM 4500 | Internal ref.: ME-CA-IENVIEWL-LAK-AN-001

| Parameter | QC batch Reference | Units | RL | Method Blank | Duplicate | | LCS/Spike Blank | | | Matrix Spike / Ref. | | |
|-----------|-----------------------|----------|------|-----------------|-----------|-----------|--------------------------|------------------------|------|--------------------------|------------------------|------|
| | | | | | RPD | AC (%) | Spike Recovery (%) | Recovery Limits (%) | | Spike Recovery (%) | Recovery Limits (%) | |
| | | | | | | | | Low | High | | Low | High |
| pH | EWL0421-OCT20 | pH Units | 0.05 | NA | 0 | | 100 | | | NA | | |

Method Blank: a blank matrix that is carried through the entire analytical procedure. Used to assess laboratory contamination.

Duplicate: Paired analysis of a separate portion of the same sample that is carried through the entire analytical procedure. Used to evaluate measurement precision.

LCS/Spike Blank: Laboratory control sample or spike blank refer to a blank matrix to which a known amount of analyte has been added. Used to evaluate analyte recovery and laboratory accuracy without sample matrix effects.

Matrix Spike: A sample to which a known amount of the analyte of interest has been added. Used to evaluate laboratory accuracy with sample matrix effects.

Reference Material: a material or substance matrix matched to the samples that contains a known amount of the analyte of interest. A reference material may be used in place of a matrix spike.

RL: Reporting limit

RPD: Relative percent difference

AC: Acceptance criteria

Multielement Scan Qualifier: as the number of analytes in a scan increases, so does the chance of a limit exceedance by random chance as opposed to a real method problem. Thus, in multielement scans, for the LCS and matrix spike, up to 10% of the analytes may exceed the quoted limits by up to 10% absolute and the spike is considered acceptable.

Duplicate Qualifier: for duplicates as the measured result approaches the RL, the uncertainty associated with the value increases dramatically, thus duplicate acceptance limits apply only where the average of the two duplicates is greater than five times the RL.

Matrix Spike Qualifier: for matrix spikes, as the concentration of the native analyte increases, the uncertainty of the matrix spike recovery increases. Thus, the matrix spike acceptance limits apply only when the concentration of the matrix spike is greater than or equal to the concentration of the native analyte.

LEGEND

FOOTNOTES

NSS Insufficient sample for analysis.

RL Reporting Limit.

↑ Reporting limit raised.

↓ Reporting limit lowered.

NA The sample was not analysed for this analyte

ND Non Detect

Samples analysed as received. Solid samples expressed on a dry weight basis. "Temperature Upon Receipt" is representative of the whole shipment and may not reflect the temperature of individual samples.

Analysis conducted on samples submitted pursuant to or as part of Reg. 153/04, are in accordance to the Protocol for Analytical Methods Used in the Assessment of Properties under Part XV.1 of the Environmental Protection Act" published by the Ministry and dated March 9, 2004 as amended.

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-- End of Analytical Report --



PART B – FOUNDATION DESIGN REPORT

for

NEW CNR OVERHEAD ON HIGHWAY 40

SITE NO.: 14X-0290/B2

G.W.P. 3064-11-00

W.P. 3064-11-02

GEOGRAPHICAL TOWNSHIP OF SARNIA

LAMBTON COUNTY, ONTARIO

LATITUDE AND LONGITUDE: 42.955937, -82.345729

PETO MacCALLUM LTD.
165 CARTWRIGHT AVENUE
TORONTO, ONTARIO
M6A 1V5
Phone: (416) 785-5110
Fax: (416) 785-5120
Email: toronto@petomaccallum.com

Distribution:

Electronic Copy: WSP Group Limited for
Distribution to MTO

Electronic Copy: WSP Group Limited
Electronic Copy: PML Toronto

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ATTACHMENTS

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Appendix E – List of Standard Specifications, NSSPs, SSP 109F57M and Operations Constraint
 Relevant to the Report

PART B - FOUNDATION DESIGN REPORT

For

New CNR Overhead on Highway 40
Site No.: 14X-0290/B2, GWP 3064-11-00
Geographical Township of Sarnia
Lambton County, Ontario

9. INTRODUCTION

This foundation investigation and design report including the interpretations and recommendations are intended for the use of WSP on behalf of the MTO, for this project, and shall not be used or relied upon for any other purposes or by any other parties. Where comments related to construction are made in this report, they are provided only to highlight those aspects that could affect the design of the project. Contractors must make their own interpretation of the factual information provided in Part A of the report for construction purposes, as it may affect equipment selection, proposed construction methods and scheduling.

10. PROJECT DESCRIPTION

10.1 General

This report provides detail design level foundation design recommendations for the new Highway 40 CNR Overhead, located in the Town of Sarnia, Ontario. The recommendations are based on interpretation of the geotechnical data presented in the factual report (Part A).

10.2 Existing Embankment for New Overhead Structure

The new overhead structure will be constructed approximately 22.0 m west of the existing Highway 40 alignment. The north and south embankments along the proposed CNR overhead structure alignment were built more than 40 years ago. The existing south and north embankments are as high as 8.9 m and 8.0 m, respectively. Based on the cross section drawings provided by WSP via email dated May 4, 2021, the south embankment will be raised approximately 2.8 m to 6.4 m from Station 19+730 to Station 19+941.18, and the north embankment will be raised approximately 3.0 m to 4.3 m from Station 20+020.28 to Station 20+350 above the existing embankment grades to the proposed grades.



10.3 Proposed New Overhead

Based on the Preliminary General Arrangement (GA) drawing, provided by WSP via email dated May 12, 2021, the proposed length of the single-span overhead structure is 65.3 m and the width is 13.1 m. The proposed abutments are proposed to be supported on integral abutments. The design grade of the approaches at the north and south abutments will be approximately EL. ± 198.6 and EL. ± 198.8 , respectively.

10.3.1 Foundation Alternatives

The following alternatives are considered for the proposed structure outlining the advantages, disadvantages and risk/consequences.

| FOUNDATION TYPE | ADVANTAGES | DISADVANTAGES | RISKS / CONSEQUENCES |
|---|---|--|--|
| Driven piles | <ul style="list-style-type: none"> • High geotechnical resistance available • Ability to drive through cobbles or dense gravel • Does not require deep excavation • Straight forward conventional construction techniques • Suited for integral abutment design | <ul style="list-style-type: none"> • Vibration induced during driving • May require pile tip reinforcement • May need to design for corrosion protection | <ul style="list-style-type: none"> • Steel piles may require corrosion protection, which needs to be designed by specialists |
| H-Piles in Pre-augered Holes into Bedrock | <ul style="list-style-type: none"> • High geotechnical resistance available • Ability to install through cobbles or dense gravel • No vibration during installation • Corrosion protection provided by concrete encasement • Suited for integral abutment design | <ul style="list-style-type: none"> • Mud drilling will be required to install the piles in pre-augered holes to maintain the stability of the walls and base of the holes • Higher cost relative to driven piles | <ul style="list-style-type: none"> • Potential construction considerations when encountering natural gas when augering through overburden/coring into bedrock |



| FOUNDATION TYPE | ADVANTAGES | DISADVANTAGES | RISKS / CONSEQUENCES |
|-----------------|---|---|---|
| Caissons | <ul style="list-style-type: none"> Higher bearing resistance available for caissons founded in bedrock | <ul style="list-style-type: none"> High cost relative to driven piles May require permanent lining within the fill Construction procedures may influence the integrity and performance of the caisson Concrete in shaft liable to squeezing or necking where liners are not used May need to design concrete to provide protection against sulphate attack | <ul style="list-style-type: none"> Potential for necking of concrete while withdrawing temporary liners Requires caisson integrity testing for potential necking of concrete, if mud drilling is used Potential construction considerations when encountering natural gas when augering through overburden/coring into bedrock |
| Spread Footing | <ul style="list-style-type: none"> Lower cost relative to driven piles | <ul style="list-style-type: none"> Lower bearing resistance compared to driven piles Deep excavation required through existing embankments to construct the spread footings Require temporary roadway protection/shoring system to construct the footings | <ul style="list-style-type: none"> Potential higher settlements and differential settlement to be considered |

10.3.1.1 Driven Piles for Integral Abutment

The proposed structure north and south abutments may be supported on steel 310 x 110 H-piles, driven vertically to bedrock elevations provided in Table 5, in accordance with Ontario Provincial Standard Specifications (OPSS.PROV) 903. The requirement should be addressed with a note on the structural drawing for foundation to drive the piles to bedrock. The steel H-piles driven to bedrock may be designed assuming a factored axial geotechnical resistance at Ultimate Limit State (ULS) of 1800 KN. Axial resistances at Serviceability Limit States (SLS) will not govern because the loads required to produce detrimental deformation are anticipated to be larger than the factored resistance at ULS recommended. For the steel pile lengths considered, the axial deformation (structural shortening) of the steel pile under the applied load should be checked to assure it is within serviceability limits of 25 mm, and may limit the factored axial resistance at SLS. Reduction in the axial geotechnical resistance to allow for negative skin friction is not required.



Table 5: Pile Tip Elevations

| LOCATION | PILE CUT-OFF ELEVATION (m) | APPROXIMATE PILE TIP ELEVATION (m) | APPROXIMATE PILE LENGTH (m) | REFERENCE BOREHOLES |
|----------------|----------------------------|------------------------------------|-----------------------------|---------------------|
| North Abutment | 192.8 | 149.6 ± 0.5 | 43.2 ± 0.5 | CN-5 and RW-2 |
| South Abutment | 192.7 | 150.2 ± 0.5 | 42.5 ± 0.5 | CN-7 and RW-1 |

As shown in the preliminary GA drawing, the piles may be lowered into a 600 mm diameter pre-augered hole supported by CSP to a depth of 3.0 m from the pile cut-off elevations with the underside of the CSP at EL. 189.8 at north abutment and EL. 189.7 at the south abutment. Consideration should be given to MTO report SO-96-01 (Integral Abutment Bridges) for design guidelines.

The preliminary GA drawing shows that the north and south culverts are skewed approximately at 9.9 degrees and 7.9 degrees, respectively, from the proposed north and south abutments. The north culvert is approximately 4.9 m to 7.0 m south from the proposed north abutment, and the south culvert is approximately 6.2 m to 8.8 m south from the proposed south abutment. The invert levels of the north and south culverts are approximately at EL. 184.3 and EL. 185.7, respectively. It is understood that the proposed abutments will be supported by steel H-piles driven vertically; therefore, no conflict is anticipated. The impact of vibration on existing culverts may be minimized by lowering the piles in pre-augured holes to a depth of 3.0 m below the base of the existing culverts (EL. 181.3 at the north abutment and EL. 182.7 at the south abutment) and driven to tip elevations as shown in Table 5. The pre-augering process would reduce soil disturbance and avoid inducing settlement of the existing culvert. A temporary steel liner may be required in the installation procedure.

Once the piles are driven to the tip elevations specified, the annular space of pre-augured holes should be filled with granular material containing nominal particle size not exceeding 16.0 mm from EL. 181.3 to EL. 189.8 at the north abutment and from EL. 182.7 to EL. 189.7. The augered hole with CSP from approximate EL. 189.8 to the top at the north abutment and from approximate EL. 189.7 to the top at the south abutment should be filled with loose sand as required by the



design of integral abutments. The lateral resistance of the piles may be computed using the equation provided below for cohesive soils, and the soil parameters recommended in Table 6.

a) Cohesionless Soils (Terzaghi, 1955)

$$k_s = n_h z/b$$

where n_h = coefficient related to soil density
 z = depth, m
 b = pile width, m (pile width for driven piles; pre-augered hole width for H-pile placed in pre-augered hole)

b) Cohesive Soils (Davison, 1970)

$$k_s = 67 S_u/d$$

where S_u = Undrained shear strength
 d = Pile diameter or width, m

Table 6: Parameters for Calculation of Coefficient of Lateral Subgrade Reaction

| LOCATION | SOIL BOUNDARY ELEVATION | | SOIL TYPE | UNDRAINED SHEAR STRENGTH (kPa) | n_h (kN/m ³) |
|----------------|-------------------------|-------|--|--------------------------------|----------------------------|
| | FROM | TO | | | |
| North Abutment | 192.8 | 189.8 | Loose Sand | - | 1000 |
| | 189.8 | 188.7 | Granular Material (above groundwater) | - | 6500 |
| | 188.7 | 181.3 | Granular Material (below groundwater) | - | 4500 |
| | 181.3 | 177.0 | Stiff Clayey Silt/Silty Clay | 70 | - |
| | 177.0 | 149.6 | Very Stiff Clayey Silt/Silty Clay | 120 | - |
| South Abutment | 192.7 | 189.7 | Loose Sand | - | 1000 |
| | 189.7 | 187.0 | Granular Material (above groundwater) | - | 6500 |
| | 187.0 | 182.7 | Granular Material (below groundwater) | - | 4500 |
| | 182.7 | 166.0 | Stiff to Very Stiff Clayey Silt/Silty Clay | 50 | - |
| | 166 | 160.0 | Stiff Clayey Silt/Silty Clay | 90 | - |
| | 160.0 | 150.2 | Stiff to Very Stiff Clayey Silt/Silty Clay | 120 | - |



For steel H-piles, battered piles may be considered to resist lateral loads on the abutments.

Boulders and cobbles were not encountered during the current investigation. Borehole Nos. 1, 2, and 8 (GEOCRES No. 40J16-013) did not encounter boulders and cobbles in the previous investigation. However, the project area is located within the Lambton clay plains of the St. Clair Clay Plains physiographic region, which consists of lacustrine clay over the underlying till. Given the nature of glacial deposits, cobbles and boulders may exist within the site area. A non-standard special provision (NSSP) is included to advise the Contractor of the potential presence of cobbles and boulders, may be present within the ground, and abandoned ground infrastructure, construction debris, concrete, cinders, and the like materials may be encountered during the excavation/foundation works.

The construction of the pile foundation should be in accordance with OPSS.PROV 903. Piles driven to bedrock shall be in accordance to OPSS.PROV 903.07.02.07.03.03, and the pile capacity shall be verified by high-strain dynamic testing (Pile Driving Analyzer or equivalent) on at least one pile from each abutment location. Modified Special Provisions (SSP) 109F57 for high-strain dynamic testing is included in this report.

For piles driven to end bearing on shale bedrock, through moderate driving conditions or obstructions such as cobbles and boulders, bearing points such as Titus 'H' bearing pile point standard model shall be specified. APF hard bite is not recommended based on previous project experience. Though PML did not encounter boulders and cobbles in the boreholes, there is a possibility that such obstructions may be encountered during pile driving where field investigation was not carried out.

It is assumed that CNR may not have concern about pile driving in the vicinity of the tracks. A vibration monitoring program may be implemented if deemed necessary by CNR policy. A NSSP for a CNR vibration monitoring program could be prepared if this is required based on CNR requirements.

10.3.1.2 H-Piles in Pre-augered Holes Extending below Bedrock Surface

Alternatively, the H-piles may be lowered into pre-augered holes. The pre-augered holes should extend below the bedrock elevation to a depth of at least one diameter of the augered hole. It is



recommended that the annular space from the tip of the H-piles to the point of contraflexure be backfilled with concrete and the space above the point of contraflexure be backfilled with fine to medium grained uniformly graded loose sand. Splice should not be allowed within 6.0 m below the pile cut-off. The construction of pile foundation should be in accordance with OPSS.PROV 903.

For design purposes, the piles (HP 310 x 110) lowered into the bedrock may be designed assuming a factored axial geotechnical resistance at Ultimate Limit State (ULS) of 1600 kN. Geotechnical resistance at Serviceability Limit State (SLS) will not govern because the loads required to produce detrimental deformation is anticipated to be larger than the factored resistance at ULS recommended. Reduction in the axial geotechnical resistance to allow for negative skin friction is not required. The pile tip elevations recommended are presented in Table 7.

Table 7 – Pile Tip Elevations

| STRUCTURE | PILE TIP ELEVATION (m) |
|------------------|-------------------------------|
| North Abutment | 148.6 ± 0.5 |
| South Abutment | 149.2 ± 0.5 |

The coefficient of horizontal subgrade reaction values presented in Table 6 may be used to determine the point of contraflexure for HP 310 x 110 steel H-piles. For the length of the pile below the contraflexure point, the pre-augered width should be considered as the pile width and for the pile length above the contraflexure point, the width of the pile should be considered as the pile width. Pile lowered into the pre-augered holes should be tapped to ensure that the pile tips are seated in bedrock at the design elevations.

Natural gas was encountered at depth near the bedrock surface. Mitigation to control and store the natural gas release during augering at depth should be assessed, and proper technique and equipment should be engaged to control the gas release in a safe manner. The Contractor should select the installation methods based on the groundwater conditions, presence of gas at depth and rock type encountered at site.



10.3.1.3 Caisson Foundations

For preliminary purposes, 1.0 m diameter caissons socketed at least two (2) diameters into the sound Shale bedrock may be designed assuming a factored axial geotechnical resistance at ULS of 4,500 kN. Axial resistances at SLS will not govern because the loads required to produce detrimental deformation would be larger than the factored resistance at ULS. For the nominal 1.0 m diameter caissons, the base of the caissons should be at least two (2) times the diameter below the bedrock surface elevations, as indicated in Table 8.

Table 8: Minimum Caisson Base Levels

| FOUNDATION ELEMENT | BEDROCK SURFACE ELEVATION | BASE ELEVATION |
|--------------------|---------------------------|----------------|
| North Abutment | 149.6 ± 0.5 | 147.6 ± 0.5 |
| South Abutment | 150.2 ± 0.5 | 148.2 ± 0.5 |

The construction of the caisson foundations should conform to OPSS.PROV 903. Temporary steel liners and groundwater control would be required to install the caissons. Natural gas was encountered at depth near the bedrock surface. Mitigation to control and store the natural gas release during augering at depth should be assessed and proper technique and equipment should be engaged to control the gas release in a safe manner. The Contractor should follow the OH&S Act, and select the installation methods based on the groundwater conditions, presence of gas at depth and rock type encountered at site.

10.3.1.4 Spread Footing

Spread footing at the abutment locations were considered for the proposed overhead. Based on the subsoil and groundwater conditions encountered, it is anticipated that the north and south abutments will be founded at approximately EL. 186.3 and EL. 184.5, respectively, and the footings are anticipated to be founded on stiff to very stiff clayey silt/silty clay. Construction for the footings for the proposed abutments may require deep excavation of about 4.3 m to 6.5 m at the south abutment and 8.9 m to 9.1 m at the north abutment from the existing ground profile, and will require related roadway protection/shoring. Table 9 summarizes the approximate footing



elevations, factored geotechnical resistances at ULS and SLS, and anticipated depth of excavations. A 3.0 m wide footing was assumed at the abutment locations.

Table 9: Geotechnical Factored ULS and SLS Resistances

| LOCATION | APPROXIMATE FOOTING ELEVATION | FACTORED ULS (kPa) | FACTORED SLS (kPa) | APPROXIMATE EXCAVATION DEPTH FROM EXISTING GRADES TO FOOTING ELEVATION (m) |
|----------------|-------------------------------|--------------------|--------------------|--|
| North Abutment | 186.5 | 380 | 200 | 8.9 to 9.1 |
| South Abutment | 184.5 | 270 | 150 | 4.3 to 6.5 |

It should be noted that at the proposed south abutment the soil consistency changes from stiff to firm at approximate EL. 181.0.

The total settlement corresponds to the factored geotechnical resistance at SLS and is expected to be 25 mm (north abutment) to 50 mm (south abutment).

The bearing resistance for inclined loads should be reduced in accordance with the requirements of clause 6.10.2 of the CHBDC (2019).

A modulus of subgrade reaction of 18,000 kN/m³ for the soil at the founding levels of footings may be assumed for the design purposes.

The sliding resistance of footings against lateral loads between the concrete footing and subgrade should be calculated in accordance with Section 6.10.5 of the CHBDC (2019). For cast-in-place concrete footings constructed on concrete working slabs and on top of very stiff clayey silt, the following friction factors ($\tan \delta$) are suggested:

- Cast-In-Place footing on concrete working slab: = 0.6
- Cast-In-Place concrete working slab on very stiff clayey silt: = 0.4

Based on the anticipated deep excavation depths at the abutment locations to construct the spread footings, and the geotechnical factored resistances at the proposed abutment locations, the spread footing option is not considered a preferred option.



10.3.1.5 Foundation Recommendation

Based on the above discussion on foundation alternatives, driven piles to bedrock for integral abutment is the preferred alternative from foundation and technical perspectives for the proposed overhead structure.

10.3.2 Approach Embankments

Slope stability and settlement analyses were carried out for the north embankment from Station 20+020.38 to Station 20+350 and for the south embankment from Station 19+941.18 to Station 19+730. Refer to "Foundation Investigation and Design Report for New Embankments on Highway 40 at CNR Overhead", GEOCRE No. 40J16-92, prepared by PML, for details of the analyses and discussions.

In summary, the slope configuration from Station 20+150 to Station 20+020.38, using a mid-slope berm will meet the minimum FOS of 1.4. The slope configurations, from Station 19+941.18 to Station 19+730 for the south embankment, and from Station 20+180 to 20+350 for the north embankment, with a 1.0 to 1.4 m thick layer of rip rap protection will meet the minimum FOS of 1.4. For steepened 1.75H:1.0V side slopes, only the south approach from Station 19+941.18 to Station 19+930 meet the minimum FOS of 1.4. The proposed slope configurations and the assessed FOS suggested that it is feasible to construct the embankment within the MTO ROW.

From the settlement analyses, in summary, it is estimated that the maximum total settlements will range from 40 mm to 55 mm, and is within the acceptable settlement limit. The estimated maximum differential settlements are also expected to be within the acceptable limits also.

For the north embankment, it is anticipated that the settlement will be within the acceptable post construction settlement following 4 months after embankment construction to the full height. The pavement could be constructed over the new north embankment after this period. For the south embankment, it is anticipated that the settlement will be within the acceptable post construction settlement following 8 months after embankment construction to full height. The pavement could be



constructed over the new south embankment after this period. The differential settlement is anticipated to be within 65.5 mm.

It is recommended to monitor the settlements within the 20 m of north and south approaches prior to pavement construction following construction of the embankments to their full heights. If the rate of settlements have attenuated prior to the predicted dates, then the paving could commence at an earlier date at the approval of the CA.

10.4 RSS Walls

The RSS walls required at this site should be “High Performance” and “High Appearance” and to be selected from MTO RSS DSM list for False Abutment or Wall/Slope. The design of RSS walls will be the responsibility of the proprietary RSS supplier and the design should meet the MTO RSS Design Guideline, and SSP 599S22 and SSP 599S23.

The preliminary GA drawing indicates that the reinforced soil mass and front panel with levelling pad is expected to be founded at EL. 186.5 at the north abutment and at EL. 186.9 at the south abutment. Construction of a minimum 1.0 m thick Granular ‘A’ pad will be required to found the RSS wall at the elevations proposed for the step levelling pads. The Granular A material should be in accordance with OPSS.PROV 1010, amended by SSP 110S06, and compacted to 100% Standard Proctor Maximum Dry Density. The RSS walls founded on a minimum 1.0 m thick granular pad may be designed using a factored geotechnical resistance at Ultimate Limit State (ULS) of 375 kPa and a factored geotechnical resistance at Serviceability Limit State (SLS) of 200 kPa.

The unfactored friction factor between the compacted granular fill of the RSS wall and the properly prepared subgrade may be taken as 0.45. The value may be reviewed and adjusted if necessary, by the proprietary RSS wall designer during the detail design.

It is anticipated that excavation of the existing south embankment fill approximately up to 9.0 m from Station 19+950 to Station 19+925 will be required for construction purposes. At the north embankment, the existing embankment fill will be excavated approximately up to 9.0 m from



Station 19+998 to Station 20+032 for construction purposes. A part of the existing north embankment, approximately from Station 19+998 to Station 20+013, will be removed permanently during the construction of the new CNR overhead structure.

The internal stability and sliding resistance of the RSS wall will be assessed by the designer of proprietary product and will remain the sole responsibility of the supplier.

Global stability analyses were carried out for the north and south RSS face wall locations, and are presented in Appendix D. The slope stability analyses were carried out utilizing the commercially available software Slide (Version 6.0) developed by Rocscience Inc., employing Morgenstern-Price method of slices for the limit equilibrium analysis. The configurations of the RSS walls were based on the preliminary GA drawing provided by WSP. A FOS value of 1.5 is considered satisfactory for earth retaining structures. The soil parameters assumed for the slope stability analyses are presented in the figures appended in Appendix D. The FOS values obtained ranged from 1.6 to 1.9 for the global stability. Based on the results, slope surface sloughing is anticipated as shown in the results. Vegetative cover (OPSS.PROV 803) should be provided on the side slopes soon after the embankment construction to mitigate surface sloughing/erosion, where required.

In the absence of the RSS wall details, the default values from the software were utilized for the reinforcing strips, which are presented in the figures appended in Appendix D.

It is anticipated that the new embankment fill will be placed and compacted to 100% of Standard Proctor Maximum Dry Density (SPMDD). Hence, no settlement of the new fill is anticipated after placement. Compaction shall be carried out in accordance with OPSS.PROV 501, amended by SSP 105S22. Because the existing embankment fills at the RSS walls are anticipated to be excavated to full depth, no immediate settlement is expected following new fill placement. The secondary compression (also known as creep) of subgrade soil consisting of the low plastic clayey silt (CL) at this site is not expected to exceed about 10 mm over a long period of time and is not included in the estimation of total settlement.

A total of three (3) consolidation tests were conducted on undisturbed samples obtained from the cohesive subgrade. Based on the laboratory results, samples tested from Boreholes CN-5 and



CN-7 are considered overconsolidated (OCR ranging from 2.0 to 2.2). The graphical procedure developed by Schmertmann (1955) was used to estimate the field virgin compression index (c_c) of the clayey silt and resulted in an average c_c value of 0.318, and an average recompression index (c_{cr}) value of 0.059. The sample tested from Borehole RW-2 is considered normally consolidated (OCR=1) based on the consolidation test result. The c_c of the sample is estimated to be 0.223.

Table 10 summarizes the calculated primary consolidation of the cohesive soils below the existing fill embankment and the duration it will take to reach acceptable post construction settlement level at the RSS wall locations following construction.

Table 10: Results of Settlement Analyses

| LOCATION | APPROXIMATE STATION | MAXIMUM FILL HEIGHT TO BE PLACED AFTER EXCAVATION (m) | PRIMARY CONSOLIDATION OF CLAYEY SILT BELOW EXISTING FILL EMBANKMENT (mm) | MAXIMUM TOTAL SETTLEMENT (mm) | DURATION TO REACH ACCEPTABLE POST CONSTRUCTION SETTLEMENT OF 25 MM AFTER EMBANKMENT CONSTRUCTION (months) |
|----------------|---------------------|---|--|-------------------------------|---|
| North RSS Wall | 20+013 | 9.0 | 25 | 25 | 4 |
| South RSS Wall | 19+950 | 9.0 | 50 | 50 | 8 |

Based on the results of the analysis, following construction of the RSS walls, a period of 4 to 8 months should be allowed for the post construction settlement to reach the acceptable post construction limit of 25 mm. Because the south abutment will be constructed approximately 5.7 m away from the closest CNR track, a geotechnical instrumentation and monitoring plan (GIMP) shall be implemented for the CNR track adjacent to the south abutment to monitor the settlements at the track location. The GIMP shall be prepared with input and review from both CNR and MTO.

10.5 Lateral Earth Pressure

Earth retaining walls or abutments should be designed to resist the horizontal earth pressure imposed by the backfill and any surcharge load. The earth pressure for concrete structures should

be computed as per Clause 6.12.2 of Canadian Highway Bridge Design Code (CHBDC, 2019). The lateral earth pressure, p (kPa), may be computed the following equation, assuming a triangular pressure distribution:

$$P = K (\gamma h_1 + \gamma' h_2 + q) + \gamma_w h_2 + C_p + C_s$$

where K = Coefficient of lateral earth pressure (dimensionless)

γ = Unit weight of backfill material above assumed water level (kN/m³)

γ' = Unit weight of submerged backfill ($\gamma_{\text{sat}} - \gamma_w$) material below assumed water level (kN/m³)

γ_w = Unit weight of water (9.8 kN/m³)

h_1 = Depth below final grade above design water level (m)

h_2 = Depth below design water level (m)

q = Surcharge load (kPa)

C_p = Compaction pressure (kPa) (Clause 6.12.3 of CHBDC, 2019)

C_s = Earth pressure from seismic events, (kPa) (Clause 4.6.5 of CHBDC, 2019)

Granular 'A' or 'B Type II' in accordance with OPSS.PROV 1010, amended by SP110S59906, should be used as backfill material behind the wall and compacted in accordance with the requirements specified in the OPSS.PROV 902. The backfill material should be placed in layers not exceeding 200 mm (8 in.) in thickness before compaction.

Heavy vibratory compaction equipment adjacent to retaining structures should be restricted to limit the compaction pressure described in Clause 6.12.3 of the CHBDC, 2019. Restrictions on compaction near the retaining wall shall be as specified in OPSS.PROV 902. The type of compaction equipment and the compaction procedure that can be used for this purpose should be in accordance with OPSS.PROV 501. Table 11 provides the recommended earth pressure coefficients.



Table 11: Earth Pressure Coefficients

| PARAMETERS | OPSS GRANULAR 'A' | OPSS GRANULAR 'B' TYPE II or Type III | FILL | CLAYEY SILT TO SILT CLAY |
|--|----------------------|---|----------------------------------|---|
| Internal Friction Angle, (degrees) | 35° | 30° | Effective Stress Value 20° | Effective Stress Value 28° ⁽¹⁾ |
| Unit weight, γ (kN/m ³) | 22.5 ± 0.3 | 21.5 ± 0.3 | 18.0 ± 0.5 | 20.0 ± 0.5 |
| Coefficient of Active Earth Pressure, K_a ² | 0.27 | 0.33 | 0.49 | 0.36 |
| Coefficient of Earth Pressure at Rest, K_o | 0.43 | 0.50 | 0.65 | 0.53 |
| Coefficient of Passive Earth Pressure, K_p ^{2,3} | 3.69 | 3.00 | 2.04 | 2.77 |

Note(s): (1) – Based on GEOCRE No. 40J16-013.

(2) The lateral earth pressure coefficients assume an adjacent horizontal surface. For a sloped surface adjacent to the excavation, the values should be corrected.

(3) The passive pressure coefficient should be reduced by an appropriate factor to account for the fact that a large strain is needed to mobilize the full K_p (Ref. Section 6 of CHBDC (2019)).

The coefficient of earth pressure “at rest” should be used for design of rigid and unyielding walls where sufficient movement of the structure wall is not permitted. For unrestrained structures, the active earth pressure coefficient should be employed.

For concrete retaining wall, a weeping tile system (OPSS.PROV 405 and OPSD 3190.100) and/or weep holes should be installed to minimize the build-up of hydrostatic pressure behind the wall. The weeping tiles should be surrounded by a properly designed granular filter or geotextile (Filter opening size (FOS) 125 μ m to 250 μ m) to prevent migration of fines into the system. The drainage pipe should be installed on a positive grade and lead to a frost-free outlet. The geotextile should conform to OPSS.PROV 1860.



Backfilling adjacent to retaining structures should be carried out in conformance with OPSS.PROV 902. The minimum requirement of backfill material should be in accordance with OPSD 3101.150 for abutment and for retaining walls, it should be in accordance with OPSD 3121.150.

11. CONSTRUCTION CONSIDERATIONS

11.1 Excavation

Groundwater levels recorded in the monitoring wells installed in Boreholes CN-5 and CN-7 at the north and south abutment locations were at EL. 188.7 and EL. 187.0, respectively, as of August 17, 2020. Excavation should be in accordance with OPSS.PROV 902.

Provided adequate groundwater control is achieved, the onsite soils may be classified as Type 3 as defined in the Occupational Health and Safety Act (OHSA). Excavations within Type 3 soil that may not be steeper than one horizontal to one vertical (1H:1V) from the base. Soils below the groundwater level will take on the characteristics of Type 4 soil and will be classified as Type 4 soils, unless adequate groundwater control is provided as discussed later in this report. A Type 4 soil requires excavation at three horizontal to one vertical (3H:1V) from the base in accordance with OHSA. Workers should not enter an unprotected excavation if there is evidence of ongoing ground water seepage in the pits. The slope of excavation walls should conform to as described in Ont. Reg. 213/92, S. 234. Temporary shoring systems may be required if slopes as described in Ont. Reg. 213/92, S. 234 cannot be provided.

Any spongy or soft area observed within the base of the proposed approach embankments should be removed and replaced with suitable fill material and compacted in accordance with OPSS.PROV 401.



Excavated material shall not be stockpiled in the areas immediately adjacent to the top of the excavation slopes. An operations constraint with regards to stockpiling of excavated material is included with this report. All excavated surfaces should be kept free of frost and water during the period of construction. Runoff shall be directed away from open excavations and should not be allowed to flow into the excavation. A NSSP is included to advise the Contractor of the potential presence of cobbles and boulders may be present within the ground, and abandoned ground infrastructure, construction debris, concrete, cinder and the like materials may be encountered during the excavation works.

If excavations steeper than approximately 1H:1V are required, protection systems should be designed as specified in OPSS.PROV 539 and SP 105S09 (See Section 11.2).

To construct the RSS walls, deep excavation would be required. Where slope cuts in accordance to OHSA cannot be achieved, temporary protection system will be required to construct the RSS walls.

11.2 Temporary Roadway Protection

For the construction of the proposed structure, it may require a properly designed temporary roadway protection system. The earth pressure values presented in Table 11 may be used for design of the TPS. Temporary roadway protection shall be designed to meet at least a Performance Level of 2 and constructed in accordance with OPSS.PROV 539, amended by SP 105S09. The Contractor shall be responsible for the selection, detailed design and performance of the roadway protection system. OPSS.PROV 539, amended by SP 105S09, also calls for monitoring of the roadway protection system by the Contractor to check the horizontal and vertical displacements of the roadway.

Multiple-level anchor system including all anchors below level of base of excavation and existing fill into the native cohesive clayey silt/silty clay layer may be required in the median. Parameters provided in Table 12 may be used to determine the capacity of anchor. The length of anchor and penetration of the temporary retaining structure and each level of anchoring system shall be



checked for stability. It is recommended that the shoring design to be carried out by qualified professional with minimum of 5 years of experience in the design of similar tie back wall systems.

Table 12: Soil Parameters

| ELEVATION | | SOIL TYPE | SOIL PARAMETERS | | |
|--|-------|----------------------------|---------------------------|-------------------------------|-----------|
| FROM | TO | | FRICTION ANGLE, (degrees) | UNIT WEIGHT, γ (kN/m3) | Cu, kN/m3 |
| For TPS Along the Median of the South Embankment | | | | | |
| 195.9 | 186.3 | Clayey Silt Fill | 0 | 18 | 75 |
| 186.3 | 170.0 | Clayey Silt/ Silty Clay | 0 | 20 | 100 |
| 170.0 | 160.0 | | 0 | | 90 |
| 160.0 | 150.2 | | 0 | | 100 |
| For TPS Along the Median of the North Embankment | | | | | |
| 195.4 | 185.9 | Clayey Silt Fill | 0 | 18 | 75 |
| 185.9 | 181.5 | Clayey Silt/ Silty Clay | 0 | 20 | 100 |
| 181.5 | 176.0 | | 0 | | 70 |
| 176.0 | 149.6 | | 0 | | 100 |

A reduction factor of 0.45 for adhesion may be considered for the design.

Design tests (sacrificial anchor pull-out test) shall be carried out by the contractor before the installations of working (production) anchors. Anchor pull-out tests shall be carried out to verify the resistance during construction phase. Contractors shall review available information and carry out as necessary survey for underground utilities and potential obstructions to avoid conflicts with tie back installations.

Non-destructive proof load test shall be carried out on working servicing anchors, and should be taken to the maximum test load of 1.33 times the working service load.



11.3 Groundwater Control

Surface water flow or seepage from perched water should be directed away from the excavation areas to mitigate disturbance and weakening of the native clayey silt/silty clay soil.

Conventional sump pumping techniques are considered to be adequate to mitigate any surface runoff and seepage from localized soil fissures at the excavation depths. The RSS levelling pads are expected to be founded at EL. 186.5 at the north abutment and at EL. 186.9 at the south abutment. Because the cohesive layer at the levelling pad elevations is considered to have low permeability, conventional sump pumping techniques are considered to be adequate to mitigate any surface runoff and seepage from localized soil fissures at the excavation depth to construct the RSS walls.

The contractor shall be responsible for the selection, performance and detailed design of the unwatering/dewatering system. The dewatering scheme is required to lower the groundwater level to a minimum of 0.5 m below the lowest level of excavation. The unwatering/dewatering system should be designed to conform to the requirements of OPSS.PROV 517 and SP 517F01.

11.4 Foundation Frost Depth

In accordance with OPSD 3090.101, a minimum of 1.1 m earth cover is required to protect against the frost penetration in the area where the site is located.

Frost tapers within the granular backfill should be constructed in accordance with OPSD 3101.150. The frost penetration depth, f , is measured from the top of the grade to the bottom of the footing.

11.5 Seismic Considerations

The Spectral ($S_a(T)$, where T is in seconds) and Peak Ground Acceleration (PGA) for the project site is 0.086 ($S_a(0.2)$) and 0.050 (2%/50 years), respectively, based on the longitude and latitude coordinates of the proposed structure (National Building Code of Canada, 2015). The soil below the founding level



at this site for seismic design purposes is classified as Site Class D in accordance with Table 4.1, CHBDC 2019.

11.6 Soil Corrosivity

A total of 14 samples from the fill and clayey silt to silty clay deposit were tested for soil corrosivity and potential exposure of concrete to sulphate attack. A summary of the results of chemical analyses are provided in Section 7.4 of Part A of this report. The corrosivity index ranged from 1 to 12. The sulphate concentration varied from 3.1 µg/g to 540 µg/g (0.0003% to 0.054%). Compared to the values suggested in Canadian Standard A23.1-14, the effect on buried concrete is considered negligible. The chloride contents of the samples ranged from as low as 3.6 µg/g to 37 µg/g (0.0004% to 0.0037%). Generally, the concentration value in excess of 250 ppm (0.025%) leads to corrosive environment for buried metals or reinforcing steel. The potential for corrosive environment of this fill is assessed to be low to moderate.

Electrical resistivity less than 2000 ohm-cm generally leads to highly corrosive environment for steel elements in contact with soil. The resistivity values of samples ranged from 1590 ohm-cm to 7700 ohm-cm. The test results suggest that a corrosive environment exists at this site for steel elements in contact with soils where the resistivity was less than 2000 ohm-cm. The pH values of the samples ranged from 8.21 to 8.68.

A limited number of soil corrosivity tests was carried out and may not be representative of the corrosiveness of the full depth of the overburden soils encountered in the boreholes. Additional tests may be required during the construction period.

Generally, it is advisable to use imported backfill granular material selected to provide a benign chemical environment. Otherwise, measures to mitigate the impact of the chemical environment would need to be considered.



12. CLOSURE

This report was prepared by Mr. Nazibur Rahman, P.Eng., Senior Engineer with the assistance of Ms. Natasha Leong-Sem, EIT. Mr. Robert Ng, P.Eng., MTO Designated Principal Contact, conducted an independent review of the report.

Yours very truly,

Peto MacCallum Ltd.

A handwritten signature in blue ink, appearing to read "Natasha Leong-Sem", is positioned above the name and title of the signatory.

Natasha Leong-Sem, EIT
Geotechnical Services



Nazibur Rahman, P.Eng.
Senior Engineer, Geotechnical Services



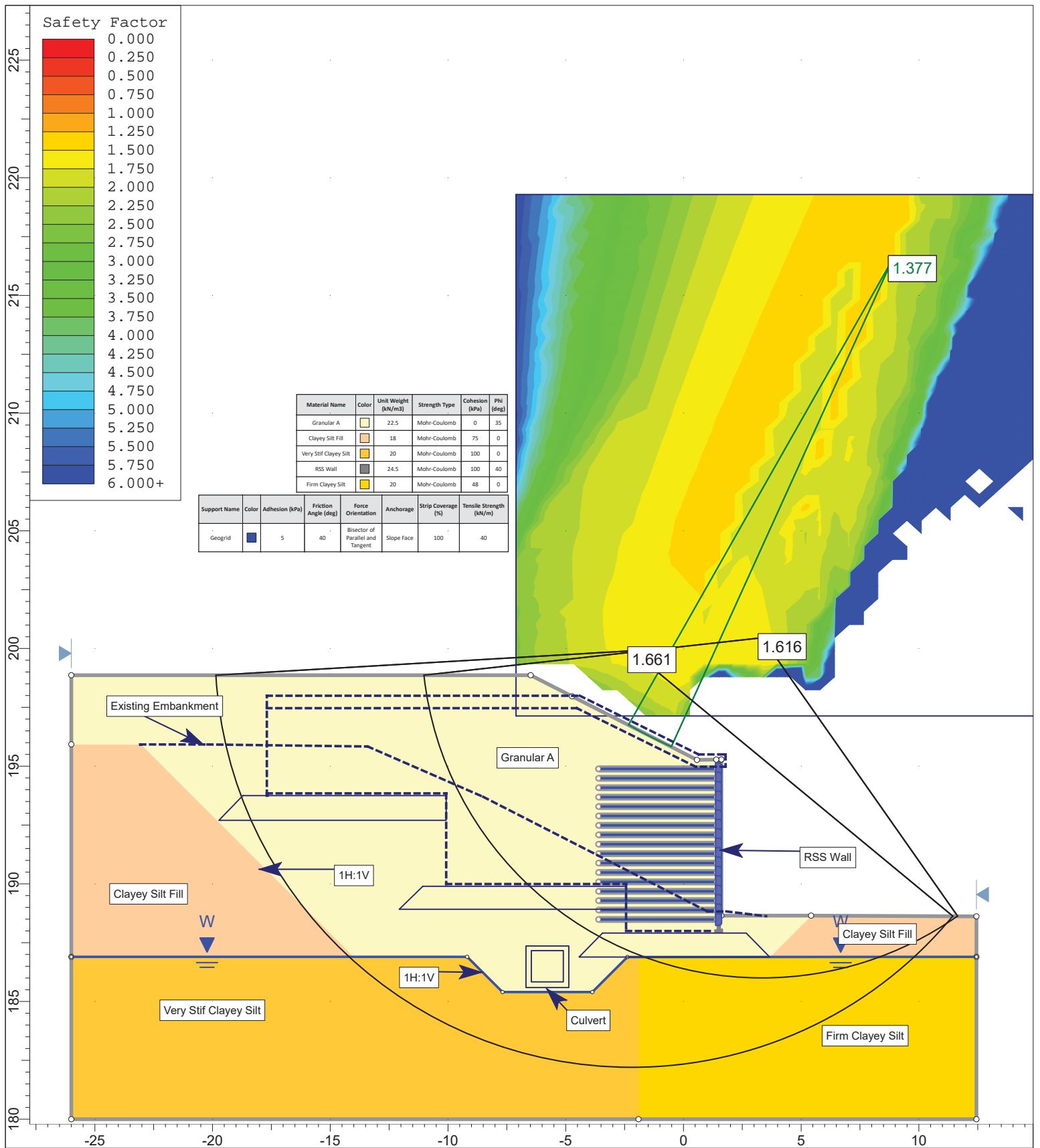
Robert Ng, MBA, PhD, P.Eng.
MTO Designated Principal Contact


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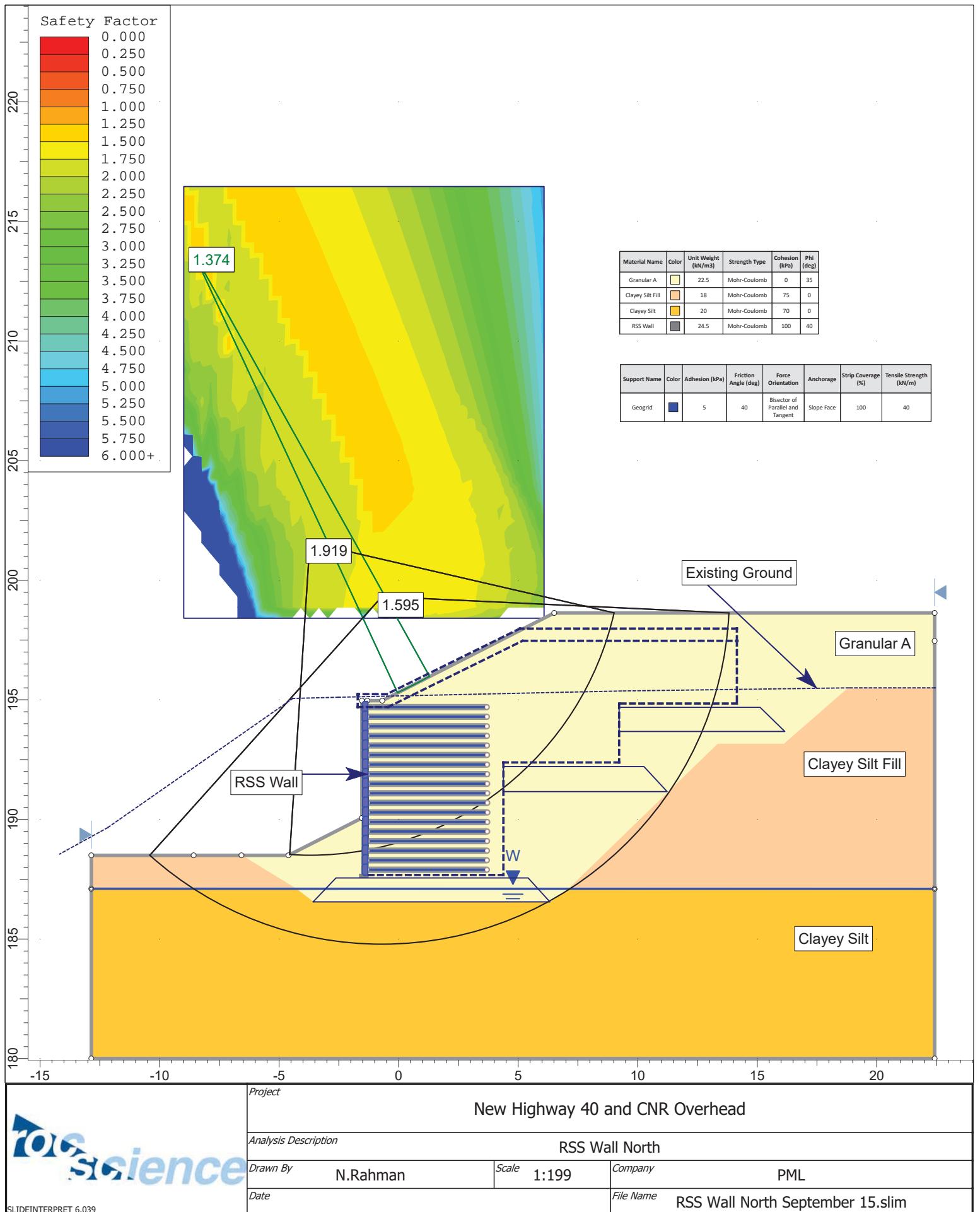


APPENDIX D

Slope Stability Analyses Results



| | | | | |
|---|--|----------------|--|--|
|  <small>SLIDEINTERPRET 6.039</small> | Project New Highway 40 and CNR Overhead | | | |
| | Analysis Description RSS Wall South | | | |
| | Drawn By N.Rahman | Scale 1:215 | Company PML | |
| | Date | | File Name RSS Wall South Sept 15.slim | |





APPENDIX E

List of Standard Specifications, NSSPs, SSP 109F57M and Operations Constraint
Relevant to the Report



LIST OF STANDARD SPECIFICATIONS

| DOCUMENT | TITLE |
|----------------|--|
| OPSS.PROV 401 | Construction Specification for Trenching, Backfilling, and Compacting |
| OPSS.PROV 405 | Construction Specification for Pile Subdrains |
| OPSS.PROV 501 | Construction Specification for Compacting |
| OPSS.PROV 517 | Construction Specification for Dewatering |
| OPSS.PROV 539 | Construction Specification for Temporary Protection System |
| OPSS.PROV 803 | Construction Specification for Vegetative Cover |
| OPSS.PROV 902 | Construction Specification for Excavation and Backfilling - Structures |
| OPSS.PROV 903 | Construction Specification for Deep Foundations |
| OPSS.PROV 1010 | Material Specification for Aggregates – Base, Subbase, Select Subgrade and Backfill Material |
| OPSS.PROV 1860 | Material Specification for Geotextiles |
| OPSD 3090.101 | Foundation, Frost Penetration depths for Southern Ontario |
| OPSD 3101.150 | Walls, Abutment, Backfill, Minimum Granular Requirement |
| OPSD 3121.150 | Walls, Retaining, Backfill, Minimum Granular Requirement |
| OPSD 3190.100 | Walls, Retaining and Abutment, Wall Drain |
| SSP 105S09 | Amendment to OPSS 539 |
| SSP 105S22 | Amendment to OPSS 501 |
| SSP 110S06 | Amendment to OPSS 1010 |
| SSP 517F01 | Amendment to OPSS 517 |
| SSP 599S22 | Requirements for Design and Construction of RSS Walls and Steep Slopes |
| SSP 599S23 | Requirements for Retained Soil Systems (RSS) |
| SSP 109F57M | Amendment to OPSS 903 |



NSSP – Presence of Cobbles and Boulders (Addition to OPSS.PROV 903 and OPSS.PROV 539)

The Contractor shall be advised that cobbles and boulders may be present within the ground, and abandon ground infrastructure, construction debris, concrete, cinders, and the like materials may be encountered during the excavation/foundation works within the fill, and that the Contractor shall use appropriate methods of installation of H-piles and/or sheet piles to address this ground conditions.

NSSP – Excavation (Addition to OPSS.PROV 902)

The Contractor shall be advised that cobbles and boulders may be present within the ground, and abandon ground infrastructure, construction debris, concrete, cinders, and the like materials may be encountered within the fill, and that the Contractor shall use appropriate equipment and methods for the excavations.

Operations Constraint

Stockpiling of excavated soils and/or construction materials including granular material shall not be permitted anywhere on the top or the sides of the north and south approach embankments, or near the crest of any temporary excavations to minimize the potential for embankment/excavation instability.



AMENDMENT TO OPSS 903, APRIL 2016

Special Provision No. 109F57M

August 2021

903.02 REFERENCES

Section 903.02 of OPSS 903 is amended by the addition of the following:

ASTM International

- | | |
|-------------------|---|
| A500 / A500M - 21 | Standard Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes |
| A572 / A572M - 18 | Standard Specification for High-Strength Low-Alloy Columbium-Vanadium Structural Steel |
| A913 / A913M - 19 | Standard Specification for High-Strength Low-Alloy Steel Shapes of Structural Quality, Produced by Quenching and Self-Tempering Process (QST) |

903.03 DEFINITIONS

Section 903.03 of OPSS 903 is amended by the deletion of the definitions for Certificate of Conformance and Quality Verification Engineer.

903.04 DESIGN AND SUBMISSION REQUIREMENTS

903.04.02.04.02.01 Milestone Inspections

Clause 903.04.02.04.02.01 of OPSS 903 is deleted in its entirety.

903.04.02.05 Qualifications

Clause 903.04.02.05 of OPSS 903 is deleted in its entirety.

903.04.02.06 Review of Splice Test Results and Permission to Proceed

Clause 903.04.02.06 of OPSS 903 is deleted in its entirety.

903.05 MATERIALS

903.05.02.01 H-Piles

Clause 903.05.02.01 of OPSS 903 is deleted in its entirety and replaced with the following:

Steel H-Piles shall be of the grade specified in the Contract Documents and shall be according to CSA G40.20/G40.21.



When CSA G40.20/G40.21, Grade 350W has been specified, the following steel grades may be substituted:

- a) ASTM A572, Grade 345; or
- b) ASTM A913, Grade 345.

When CSA G40.20/G40.21, Grade 450W has been specified, the following steel grades may be substituted:

- a) ASTM A572, Grade 450; or
- b) ASTM A913, Grade 450.

903.05.02.02 Tube Piles

Clause 903.05.02.02 of OPSS 903 is deleted in its entirety and replaced with the following:

Steel tube piles shall be as specified in the Contract Documents. When ASTM A252, Grade 3 has been specified, the following steel grades may be substituted:

- a) ASTM A500, Grade C; or
- b) CSA G40.20/G40.21, Grade 350W.

903.07 CONSTRUCTION

903.07.02.03.03 H-Piles, Tube Piles, and Sheet Piles

Clause 903.07.02.03.03 of OPSS 903 is deleted in its entirety and replacing it with the following:

Welding shall be according to CSA W59 and shall be done by a qualified welder employed by a firm certified according to CSA W47.1, Division 1 or Division 2.

Steel H-piles and steel tube piles may be spliced providing the pieces being spliced are not less than 3 m long, except for integral abutments' piles, where the pieces being spliced shall not be less than 7.0 m long.

Where piles are located in a waterbody, splices shall be located below the low water level, unless otherwise encased in concrete.

Sheet piles shall not be spliced without approval by the Contract Administrator.

903.07.02.07.01 General

Clause 903.07.02.07.01 of OPSS 903 is amended by deleting the first paragraph in its entirety and replacing it with the following:



The driving of piles shall be carefully monitored and controlled. Pile driving records shall be produced for each pile and shall be submitted to the Contract Administrator.

903.07.02.07.03 Driving to a Specified Ultimate Resistance

Clause 903.07.02.07.03 of OPSS 903 is deleted in its entirety and replaced with the following:

903.07.02.07.03.01 General

Piles are to be driven to a specified ultimate resistance that shall be determined using the High-Strain Dynamic Testing at end of initial driving. If the specified ultimate resistance is not achieved, retap/restrike shall be conducted after initial driving as specified in the Contract Documents.

The Contractor shall supply all equipment, material, and personnel necessary to facilitate a Foundation Specialist (FES) to conduct high-strain dynamic testing for a selected number of piles. High-strain dynamic testing shall be carried out on a minimum of 10% of the piles in each pile group, rounded up but not fewer than two piles per pile group, or as specified in the Contract Documents.

High-strain dynamic testing shall be performed by the FES using the Pile Driving Analyzer (PDA), or approved equivalent, for the determination of pile ultimate resistance, establishment of pile installation criteria, assessment of pile integrity, monitoring of hammer/drive system performance and driving stresses, as specified in the Contract Documents. The method and equipment for testing and its reporting shall be according to ASTM D 4945.

The location, sequencing and scheduling of the individual pile analysis/testing shall be proposed by the Contractor based on the purpose of the analysis/testing and shall be submitted to the Contract Administrator for review. The final selection of the piles to be analyzed/tested will be determined by the Contract Administrator.

The Contractor shall coordinate with the Foundation Specialist (FES) to be retained by the Contractor Administrator for dynamic formula and high-strain dynamic testing.

A Request to Proceed shall be submitted to the Contract Administrator after the design ultimate resistance is achieved.

The next operation shall not proceed until a Notice to Proceed has been received from the Contract Administrator.

903.07.02.07.03.02 Driving to a Set

The founding elevation shall be established by driving to a set determined in accordance with the dynamic formula specified in the Contract Documents or by the application of the wave equation analysis procedure that verifies the pile resistance. This set shall be established on the first pile of every ten piles driven in a pile group.

The other piles shall be controlled by the pile penetration rate in blows per millimetre that correlates to the set.



When new conditions, such as change in hammer size, change in pile size, or change in soil material occur, new sets shall be determined.

903.07.02.07.03.03 Driving to Bedrock

When driving piles to bedrock, the pile shall be adequately seated on bedrock without damaging the pile.

Where rock points are used, the rock points shall penetrate into the rock. Piles driven using rock points shall be driven to ensure adequate seating on the bedrock without damaging the pile.

Driving of piles on sloping bedrock shall be stopped when initial contact is made with the bedrock. The bedrock elevation shall be recorded. Driving shall then continue, commencing with energy of 10% of the maximum energy of the hammer. The pile shall be driven in sets of 20 blows at this energy until no penetration is observed. Twenty additional blows shall be applied, and, if no penetration is observed, the energy shall be increased by an additional 10% and the above procedure repeated.

Driving shall continue with these stepped increases in energy and with the same series of blows as described above, until the pile has been seated on the bedrock.

If unrealistic excessive penetration per blow is observed, driving shall be stopped, and this excessive penetration immediately reported to the Contract Administrator.

903.07.02.07.04 Wave Equation Analysis

Clause 903.07.02.07.04 of OPSS 903 is deleted in its entirety and replaced with the following:

When requested by the Contract Administrator, all equipment, material, and personnel shall be supplied to conduct the wave equation analysis procedure.

903.07.03.07 Concrete

903.07.03.07.01 General

Clause 903.07.03.07.01 of OPSS 903 is deleted in its entirety and replaced with the following:

A Request to Proceed shall be submitted to the Contract Administrator before the concrete placement.

The reinforcement shall not be displaced or distorted during the construction of the caisson.

The placement of concrete shall not proceed until the Contract Administrator has inspected the caisson hole and issued a Notice to Proceed.

Concrete shall be placed immediately after the Notice to Proceed has been received and shall be placed in the caisson according to OPSS 904 and as specified herein.



Arching of concrete during casing withdrawal shall be prevented.

903.07.03.07.05 Founding Elevation

Clause 903.07.03.07.05 of OPSS 903 is amended by deleting the last paragraph in its entirety and replacing it with the following:

Complete access to inspect the bearing area of the caisson pile prior to the placement of concrete shall be given to the Contract Administrator.

903.07.04 Displacement Caisson Piles

Subsection 903.07.04 of OPSS 903 is amended by deleting the fourth paragraph in its entirety and replacing it with the following:

A Request to Proceed shall be submitted to the Contract Administrator before the installation of displacement caisson piles.

The next operation shall not proceed until a Notice to Proceed has been received from the Contract Administrator.

903.07.06 Load Test

Subsection 903.07.06 of OPSS 903 is amended by deleting the first paragraph in its entirety and replacing it with the following:

When a load test is specified in the Contract Documents, the testing shall be according to ASTM D1143 for piles under vertical static load, ASTM D3689 for piles under tensile load, and ASTM D3966 for piles under lateral loads. The Contract Administrator shall witness the pile load test. All records and results of the pile load test shall be submitted to the Contract Administrator.

903.07.08 Quality Control

903.07.08.01.01 Qualifications of Companies and Individuals

Clause 903.07.08.01.01 of OPSS 903 is deleted in its entirety.

903.07.08.01.02 Visual Inspection of Welds

Clause 903.07.08.01.02 of OPSS 903 is deleted in its entirety and replaced with the following:

Complete access to visually inspect the welds shall be given to the Contract Administrator.

All welds shall conform with the requirements of CSA W59 and the Contract Documents. A representative sample of splice welds, not less than 30%, shall be selected by the Contract Administrator for visual inspection. The sample of splice welds shall be taken from different piles.



If the sample of splice welds do not pass the visual inspection and need to be repaired, the visual inspection by the Contract Administrator may be increased up to 100% of the welds.

903.07.08.01.03 Non-Destructive Testing of Welds

Clause 903.07.08.01.03 of OPSS 903 is deleted in its entirety and replaced with the following:

The Contract Administrator shall be notified in writing, 48 hours in advance of installing piles, which will require weld splicing. The Contract Administrator shall be immediately notified in writing if there are any schedule changes for each pile requiring weld splicing.

A Request to Proceed shall be submitted to the Contract Administrator after the completion of splice welds for each construction stage of work.

The next operation shall not proceed until a Notice to Proceed has been received from the Contract Administrator.

Radiographic or ultrasonic testing shall be carried out by the Contract Administrator using procedures according to CSA W59.

Ultrasonic or radiographic testing shall be carried out on the entire length of selected splice welds chosen at random by the Contract Administrator.

The welds selected for the random ultrasonic or radiographic testing shall be taken from different piles and shall include 10% of the splice welds, rounded to the next highest number, but no fewer than two.

If any welds do not pass the ultrasonic or radiographic-testing and need to be repaired, these non-destructive testing requirements may be increased up to 100% of the welds.

903.07.08.01.04 Repaired Welds

Clause 903.07.08.01.04 of OPSS 903 is deleted in its entirety and replaced with the following:

All welds that have been repaired shall be visually inspected and shall undergo non-destructive testing performed by the Contract Administrator

903.07.08.02 Non-Destructive Test Reports and Visual Inspection Reports

Clause 903.07.08.02 of OPSS 903 is deleted in its entirety and replaced with the following:

Results from completed Visual Inspection Reports and Non-Destructive Test Reports will be provided upon request.

903.07.08.03 Certificate of Conformance

Clause 903.07.08.03 of OPSS 903 is deleted in its entirety.



903.10 BASIS FOR PAYMENT

903.10.01 Supply Equipment for Installing Driven Piles - Item

Subsection 903.10.01 of OPSS 903 is amended by deleting the second paragraph in its entirety and replacing it with the following:

For payment purposes, 50% of the work under this item shall be paid when the satisfactory performance of the equipment has been demonstrated to the Contract Administrator by the installation of 1% of piles.

Another 40% shall be paid by progress payments proportional to the work completed. The remaining 10% shall be paid on the satisfactory completion of the installation of piles.

903.10.04 Failed Visual Inspection or Non-Destructive Testing of Welds

Section 903.10 of OPSS 903 is amended by the addition of the following:

Costs associated with any required removals and replacement or repairs of defective welds, following the visual inspection or non-destructive testing, shall be the Contractor's responsibility at no additional cost to the Owner. No additional payment will be made for labour and equipment provided by the Contractor, and the Contractor will pay the Owner \$500 for each weld requiring additional re-testing.