



Foundation Investigation and Design Report

Rehabilitation of Highway 40 (Modeland
Road) Overpasses at London Line

(Site Nos. 14X-0279/B1 and B2)
Highway 40, City of Sarnia, ON

Latitude 42.984961
Longitude -82.344100
G.W.P. 3001-20-00

Geocres No. 40J16-93

March 18, 2022

Prepared for:

Ministry of Transportation Ontario

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Project No. 165001228 (340)



**FOUNDATION INVESTIGATION AND DESIGN REPORT
REHABILITATION OF HIGHWAY 40 OVERPASS STRUCTURES AT LONDON LINE
SITE NOS. 14X-0279/B1 AND B2**

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Introduction
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FOUNDATION INVESTIGATION REPORT

For

G.W.P. 3001-20-00

Rehabilitation of Highway 40 Overpass Structures at London Line
Site Nos. 14X-0279/B1 and B2

City of Sarnia, Lambton County, Ontario

1.0 INTRODUCTION

Stantec Consulting Ltd. (Stantec) was retained by the Ministry of Transportation, Ontario (MTO) under Retainer Agreement 3019-E-0009 to provide foundation engineering services for the rehabilitation of the Highway 40 (Modeland Road) overpass structures (Site Nos. 14X-0279/B1 and B2) at Lambton Road 22 (London Line) in Sarnia, Lambton County (G.W.P. 3001-20-00). The site is located at approximately Latitude 42.984961° and Longitude - 81.344100°.

The rehabilitation project is proposed to include the removal of existing expansion joints and conversion to semi-integral abutments, repair and/or replacement of other bridge superstructure components, and replacement of existing bridge-mounted signs with new ground mounted signs at two locations on London Line.

This report presents the results of a foundation investigation conducted for the rehabilitation of the overpass structures and the installation of the new overhead signs. The purpose of the investigation was to supplement existing information on the subsurface soil and groundwater conditions at the site by drilling seven (7) boreholes, carrying out in-situ testing, installing a groundwater monitoring well, and completing a laboratory testing program on selected soil samples obtained from the boreholes.

This foundation investigation report has been prepared specifically and solely for the proposed rehabilitation of the overpass structures at Site Nos. 14X-0279/B1 and B2.

2.0 SITE DESCRIPTION AND GEOLOGY

Site Location

The subject site is located at the Highway 40 (Modeland Road) and Highway 22 (London Line) interchange, which is situated about 600 m south of Highway 402, in the City of Sarnia. The site location is shown on the Key Plan inset to Drawing No. 1 provided in Appendix A.



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General Site Description

Within the project study area, Highway 40 is aligned approximately north-south and is a four-lane highway with two lanes in each direction. The overpass structures carry the northbound and southbound lanes of Highway 40 over London Line. There are three lanes on each structure; two through lanes and one acceleration lane associated with the London Line on-ramps to Highway 40. Beneath the overpasses, London Line is oriented almost orthogonal to Highway 40 and is 8 lanes wide (2 through lanes and 2 turning/on-ramp lanes in each direction). The bridges, viewed from the west, are shown in Photo 1 below.

Highway 40 and the associated on-ramps and off-ramps from/to London Line have been constructed on embankments. To the north and south of the overpasses, an approximately 14 m wide grass-covered median, that contains a centerline storm sewer, separates the northbound and southbound lanes of the highway.

The abutment fore-slopes are surfaced with concrete, slope protection panels. The embankment side-slopes are surfaced with vegetative cover consisting of grass, brush, and trees. A small tree was observed in the center median between the north abutments.

The surfaces of the overpasses are approximately 6 m higher than the travelled lanes of London Line. The pavement surface elevations vary between 187.2 m and 187.4 m on the west (SBL) bridge, 186.9 m and 187.1 m on the east (NBL) bridge and about 181.2 m and 181.4 m on London Line.

Beyond the highway embankments, the overall topography is relatively flat to gently sloping with ground surface elevations varying between approximately 179 m and 183 m. Surface drainage in the vicinity of the site is typically from west to east towards Perch Creek which is located about 300 m east of Highway 40.

Site Reconnaissance

The following observations were made during a general site reconnaissance:

- There were signs of localized concrete spalling/delamination on the superstructures of both bridges.
- No indications of poor foundation performance were observed. Some differential settlement was noted between the approach slabs and the abutments/parapet walls on both bridges (see example of settlement in Photo 2 below).
- No indications of embankment instability were noted. The concrete protection present on the slopes below the abutments is typically in fair condition (see Photos 3 and 4 below).



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Photo 1: View of East Bridge (Looking West)



Photo 2: Settlement Between Approach Slab and Parapet Wall (East Bridge)

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Photo 3: West bridge north abutment fore-slope (looking northeast)



Photo 4: East bridge north abutment fore-slope (looking north)



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Available Subsurface Information

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Physiographic Description

The site is located within a physiographic region known as the Huron Fringe. According to the Physiography of Southern Ontario, by Chapman and Putnam (1984), this region is generally comprised of “wave-cut terraces of glacial Lake Algonquin and Lake Nipissing with their boulders, gravel bars, and sand dunes” along with “sandy beaches along the shore protecting a marshy lagoon”.

Available Surficial Geology Mapping of Southern Ontario indicates that the surficial materials in the vicinity of the overpass structures consist of coarse-textured lacustrine deposits flanked by areas of organic deposits to the north and clay to silt textured glacial till to the south. The coarse-textured lacustrine deposits are generally comprised of sand and/or gravel, with minor silt and clay.

A review of well records in the Ontario Ministry of Environment, Conservation, and Parks (MECP) database for wells within an approximate 1 km radius of the site indicated bedrock was encountered at depths of between about 32 m and 34 m below ground surface.

3.0 AVAILABLE SUBSURFACE INFORMATION

Subsurface information was reviewed from the following document obtained from the MTO GEOCRE library:

- A report titled “Foundation Investigation Report For Modeland Road Interchange Overpass S.B.L., W.P. 122-65-06, Site 14-279, District 1, Chatham” prepared by the Ministry of Transportation and Communications and dated 1979 (GEOCRE Reference No. 40J16-008).

The GEOCRE report contains the results of a foundation investigation completed by Geocon Ltd. (Geocon) for the overpass structures that was originally presented in Geocon Report No. S-7389 titled “Soil Conditions and Foundations – Proposed Modeland Road Underpass – Highway No. 402 – W.P. 29-62 – Sarnia, Ontario’ dated July 18, 1962 and an addendum to that report dated July 25, 1962. The investigation carried out by Geocon consisted of advancing a total of eight boreholes (designated as Boreholes 1 to 8) to depths of between 9.3 m and 35.8 m below original grade at the approximate locations shown on Figure 1, Borehole Location Plan included in Appendix A. Groundwater monitoring wells/pipes were installed in three of the boreholes.

The subsurface conditions encountered in the boreholes consisted of approximately 1.5 m to 2.1 m of sandy silt fill overlying an extensive deposit of clayey silt/silty clay containing varying amounts of sand and trace gravel that extended to depths of about 28 m to 29 m below ground surface. The Geocon report identifies that the gradation of this deposit is typical of many glacial tills in the region and that others have referred to this deposit as a clay till. The upper 4.5 m of the deposit was described as a desiccated, brown to grey-brown crust with a stiff to hard consistency. In-situ vane testing conducted below the crust yielded undrained shear strengths in the range of 800 psf to 3000 psf (~38 kPa to 144 kPa) indicating that soil has a firm to very stiff consistency.



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Investigation Procedures
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Laboratory testing conducted on selected samples of the native clayey silt/silty clay till indicated the following:

- Moisture contents varying from approximately 17 to 28 percent;
- Plastic Limits of between 13 and 22 percent and Liquid Limits of between 25 and 41 percent;
- Grain size distributions ranging between 30 to 32% sand, 30 to 35% silt, and 35 to 38% clay;
- Undrained compressive strengths (determined by triaxial testing) in excess of 4.5 tons/sq.ft (~430 kPa) near ground surface, decreasing to about 0.7 tons/sq.ft (~67 kPa) at 20 ft (6.1 m) depth and then increasing to about 1.8 tons/sq.ft (~172 kPa) at 60 ft (18.3 m);
- Unit weights of 131 to 137 pcf (20.6 to 21.5 kN/m³); and
- Samples were normally consolidated to slightly pre-consolidated with measured compression indices (Cc) varying from 0.12 to 0.17.

The clayey silt/silty clay till was underlain by approximately 5.2 m to 5.7 m thick layer of dense sand, which was in turn underlain by shale bedrock encountered at a depth of 34 m below existing grade (corresponding to elevations of approximately 146.7 m and 147.0 m).

Free groundwater was measured in the monitoring wells in Boreholes 1 and 8, which were installed within the clayey silt/silty clay till, at depths of 5.4 m and 5.2 m below ground surface (~Elevations 175.8 m and 175.7 m), respectively. The monitoring well in borehole 3 was reported as dry. The report also identified a perched groundwater level within the sandy silt fill at a depth of about 1 m below ground surface.

4.0 INVESTIGATION PROCEDURES

4.1 FIELD INVESTIGATION

The subsurface investigation for the rehabilitation of Highway 40 overpass structures consisted of advancing seven boreholes, designated as Boreholes 21-1 to 21-7.

Boreholes 21-1 to 21-5 were drilled from the Highway 40 level to provide information on the composition of the existing embankments for use in assessing temporary protection system requirements for excavations associated with the semi-integral abutment conversion. Boreholes 21-6 and 21-7 were drilled on London Line to provide subsurface information near the locations of the proposed overhead sign foundations. The locations of the boreholes are shown on the Borehole Location and Soil Strata Plan, Drawing No. 1, in Appendix A.

Prior to carrying out the investigation, Stantec contacted public utility authorities to mark and clear the borehole locations of public and MTO-owned utilities.

Drilling was carried out with rubber track-mounted and truck-mounted Diedrich D-50T drill rigs equipped for soil sampling. Boreholes 21-1 to 21-5 were drilled using the track-mounted rig on July 28th and 29th, 2021, and Boreholes 21-6 and 21-7 were drilled using the truck-mounted rig on September 17th, 2021. The boreholes were advanced using continuous flight hollow-stem augers.



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The subsurface stratigraphy encountered in the boreholes was recorded in the field by a member of Stantec's geotechnical staff. Standard Penetration Tests (SPT) (ASTM D1586) were carried out in the boreholes at regular intervals (typically every 760 mm to approximately 6 m depth and 1500 mm thereafter). The split spoon samples recovered from the SPTs were returned to Stantec's Markham laboratory for detailed classification and testing. In situ shear vane testing using a N-size vane was attempted at several depths in the boreholes.

Following completion of drilling, a 50-millimeter (mm) diameter groundwater monitoring well, screened over a depth of 1.5 m to 4.6 m below ground surface, was installed in Borehole 21-5. The borehole annulus surrounding the slotted pipe section was backfilled with sand. The remainder of the borehole annulus was backfilled with bentonite up to the ground surface. Groundwater level measurements were obtained on July 29th and on September 17th, 2021.

The remaining boreholes were backfilled with bentonite chips and sealed with cold patch at surface on completion of drilling.

4.2 LOCATION AND ELEVATION SURVEY

The borehole locations and respective ground surface elevations were surveyed by Stantec Geomatics personnel for Boreholes 21-1 to 21-5. The locations and elevations of Boreholes 21-6 and 21-7 were determined based on measurements from existing site features of known elevation.

Table 4.1 below summarizes the borehole survey information and includes the drilling depth, end of borehole elevation and number of samples recovered for each borehole. The borehole survey data is considered accurate to 0.5 m for coordinates and 0.1 m for elevations.

Table 4.1: Borehole Information Summary

	Borehole Number						
	21-1	21-2	21-3	21-4	21-5	21-6	21-7
MTM Zone 11 Coordinates Northing Easting	4760621.1 317508.0	4760617.3 317522.7	4760550.5 317506.0	4760546.9 317520.6	4760548.4 317511.6	4760576.9 317485.7	4760592.3 317544.2
Elevation, m	187.2	186.9	187.4	187.1	186.8	181.2	181.4
Total Depth Drilled, m	11.3	11.3	11.3	11.3	5.5	8.2	8.5
Base of Borehole Elevation, m	175.9	175.7	176.1	175.8	181.3	173.0	172.9
Number of soil samples	12	12	12	13	7	10	10

4.3 LABORATORY TESTING

All samples were visually examined by a Geotechnical Engineer. Select soil samples were submitted for gradation analysis, Atterberg Limits testing and moisture content testing. The geotechnical laboratory testing program completed on the borehole samples is summarized below in Table 4.2.



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Table 4.2: Laboratory Testing Program

Laboratory Test Type	Number of Tests
Moisture Content	76
Gradation Analysis	20
Atterberg Limits	14

In addition to the geotechnical laboratory testing, chemical analysis consisting of pH, sulphate content, chloride content and resistivity was completed by AGAT Laboratories in Mississauga on a total of two samples collected from Boreholes 21-6 and 21-7.

Samples remaining after testing will be placed in storage for a period of one year after issue of the final report. After the storage period, the samples will be discarded unless we are directed otherwise by MTO.

5.0 SUBSURFACE CONDITIONS

5.1 FRAMEWORK & OVERVIEW

The detailed soil and groundwater conditions encountered in the boreholes and the results of the in-situ and laboratory testing are shown on the Borehole Records included in Appendix B. An explanation of the symbols and terms used to describe the Borehole Records is also provided in Appendix B. The results of the geotechnical laboratory testing are presented on Figures C1 to C7 contained in Appendix C.

A borehole location plan and stratigraphic section of the soils encountered in the boreholes are provided on Drawing No. 1 in Appendix A. The stratigraphic boundaries on the borehole records and the strata plot are inferred from non-continuous sampling and therefore represent transitions between soil types rather than exact boundaries between geological units. The subsurface conditions will vary between and beyond the borehole locations.

In general, the subsurface stratigraphy encountered in the boreholes consists of surficial topsoil or asphalt that is underlain by heterogeneous fill materials varying in composition from sand and gravel to gravelly sand to clayey silt/silty clay. In general, the fill materials are underlain by clayey silt till containing trace sand and gravel. Thin layers of buried topsoil and sandy silt was encountered between the fill and clayey silt till in Borehole 21-6. All boreholes, except Borehole 21-5 which was terminated within the embankment fill, were terminated in the clayey silt till at depths ranging between about 8.2 m to 11.3 m below ground surface (corresponding to Elevations of about 172.9 m to 176.1 m).

More detailed descriptions of the subsurface conditions encountered in the boreholes are provided in the following sections.



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5.2 OVERBURDEN

5.2.1 Topsoil

An approximately 100 mm thick layer of topsoil was encountered at the ground surface in Borehole 21-5.

A layer of topsoil was also encountered at a depth of approximately 1.5 m below existing ground surface in Borehole 21-6. The buried topsoil layer was about 150 mm thick, extending to a depth of 1.7 m, corresponding to an elevation of about 179.5 m.

5.2.2 Asphaltic Concrete

Asphaltic concrete was encountered at the ground surface in all the other boreholes. The thickness of the asphalt ranged between approximately 125 mm and 250 mm.

5.2.3 FILL

Fill materials were encountered below the topsoil or asphalt in all boreholes and extended to depths ranging between 1.5 m and 9.0 m below existing grades, corresponding to elevations ranging between approximately 178.2 m and 179.7 m.

The fill was heterogeneous in nature and was often comprised of layered sequences of cohesionless fill and cohesive fill. The cohesionless fill varied in composition from sand/silty sand to sand and gravel. The cohesive fill consisted of clayey silt to silty clay containing some sand and trace gravel. Occasional thin layers of buried topsoil and/or pulverized asphalt were encountered within the fill in Boreholes 21-2, 21-3, 21-4, and 21-5. Cobbles and/or boulders were inferred to have been encountered at various depths within the fill materials in numerous boreholes.

Borehole 21-5 was terminated in the fill at a depth of 5.5 m below existing grade.

5.2.3.1 Cohesionless Fill

Standard Penetration Test (SPT) 'N' values recorded in the cohesionless fill generally ranged from 7 to 60 blows per 300 mm advancement of the split spoon sampler indicating the fill is in a loose to very dense state.

Laboratory tests conducted on samples of the cohesionless fill yielded moisture contents ranging from 5% to 30% expressed as a percentage of the dry weight of the soil.

Eight (8) samples of the cohesionless fill materials were selected for gradation analysis. The laboratory test results are shown on the borehole records in Appendix B and on the gradation curves on Figure No. C1 in Appendix C.

Atterberg Limits tests were carried out on three of the cohesionless fill samples referenced above. All three samples were determined to be non-plastic. The results of the Atterberg Limits test are shown on the borehole records and are illustrated on Figure C2 in Appendix C.



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Based on the test results, the cohesionless fill materials tested vary in composition from sand (SP) to sand and gravel (SM) to gravelly sand (SP/SM) to silty sand with gravel (SM) in accordance with the Unified Soil Classification System (USCS).

5.2.3.2 Cohesive Fill

Standard Penetration Test (SPT) 'N' values recorded in the cohesive fill generally ranged from 3 to 23. In-situ shear vane tests were attempted at various depths within the cohesive fill in boreholes 21-2 to 21-5, but the vane could not be turned. Based on the in-situ testing and manual examination of the samples collected, the clayey silt/silty clay fill is considered to have a stiff to hard consistency.

Laboratory tests conducted on samples of the cohesive fill yielded moisture contents ranging from 9% to 22% expressed as a percentage of the dry weight of the soil.

Six (6) samples of the cohesive fill materials were selected for gradation analysis. The laboratory test results are shown on the borehole records in Appendix B and on the gradation curves on Figure No. C3 in Appendix C.

Atterberg Limits tests were carried out on the six cohesive samples referenced above. The tests yielded Liquid Limits ranging from 23% to 37%, Plastic Limit ranging from 12% to 16%, and Plasticity Index ranging from 11% to 21%. The results of the Atterberg Limits tests are shown on the borehole records and are illustrated on Figure C4 in Appendix C. The laboratory results indicate that the cohesive fill is comprised of clayey silt of low plasticity (CL) to silty clay of intermediate plasticity (CI).

Based on the test results, the cohesive fill materials tested vary in composition from clayey silt of low plasticity (CL) to silty clay of intermediate plasticity (CI).

5.2.4 SANDY SILT

A deposit of sandy silt was encountered beneath the buried topsoil layer in Borehole 21-6. The sandy silt deposit contained trace shell fragments and extended to a depth of 2.3 m below ground surface (corresponding to Elevation 178.9 m).

A SPT 'N' value of 17 was recorded in the sandy silt indicating this soil is in a compact state.

Laboratory testing of a sample of the sandy silt yielded a moisture content of 26% expressed as a percentage of the dry weight of the soil.

One (1) sample of the sandy silt was selected for gradation analysis. The laboratory test results are shown on the borehole record in Appendix B and on the gradation curve on Figure No. C5 in Appendix C.

Based on the test results, the material is classified as sandy silt (ML) in accordance with the USCS.



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Subsurface Conditions

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5.2.5 CLAYEY SILT (TILL)

A deposit of glacial till consisting of clayey silt to silty clay was encountered beneath the fill or sandy silt in all the boreholes except Boreholes 21-5 which was terminated within the fill. The till deposit contained varying amounts of sand and gravel as well as occasional cobbles and/or boulders; low/poor sample recovery in Borehole 21-7 at a depth of 4.6 m (Sample SS7) was inferred to have been caused by the presence of cobbles or boulders. The till deposits of southern Ontario are known to contain cobbles and boulders and these materials should be anticipated to be present throughout the till deposit at this site.

SPT 'N' values recorded in the glacial till ranged from 4 to 22. In-situ shear vane tests were attempted at various depths within the glacial till but the vane could not be turned with the exception of one location in Borehole 21-7 at a depth of 7.0 m below existing grade. At that location, the undrained shear strength (S_u) of the glacial till was measured to be 89 kPa (with a corresponding remoulded shear strength of 47 kPa). Based on the field testing and manual examination of the samples collected, the glacial till is considered to have a very stiff to hard consistency with localized stiff zones.

Laboratory testing of samples of the glacial till yielded moisture contents ranging from 13% to 22%.

Five (5) samples of the glacial till were selected for gradation analysis. The laboratory test results are shown on the borehole records in Appendix B and on Figure No. C6 in Appendix C.

Atterberg Limits tests were carried out on the five glacial till samples referenced above. The tests yielded Liquid Limits ranging from 29% to 33%, Plastic Limit ranging at 14%, and Plasticity Index ranging from 15% to 19%. The results of the Atterberg Limits tests are shown on the borehole records and are illustrated on Figure C7 in Appendix C. The laboratory results indicate that the glacial till is classified as clayey silt of low plasticity (CL) in accordance with the USCS.

Boreholes 21-1 to 21-4, 21-6 and 21-7 were terminated within the glacial till stratum at depths of between 8.2 m and 11.3 m below ground surface corresponding to elevations of approximately 172.9 m to 176.1 m.

5.3 BEDROCK

Bedrock was not encountered to the termination depth of the boreholes.

5.4 GROUNDWATER CONDITIONS

Groundwater seepage was observed during drilling in all boreholes, except Borehole 21-5, at depths ranging from approximately 1.3 m to 7.5 m below ground surface, corresponding to elevations ranging from 179.1 m to 179.9 m. Free groundwater was observed in the open boreholes on completion of drilling in Boreholes 21-3 and 21-7 at depths ranging from approximately 6.0 m to 8.5 m below ground surface (corresponding to elevations of about 175.4 m to 178.7 m).

A monitoring well was installed in Borehole 21-5 which was drilled within the grassed median of Highway 40 between the south abutments of the bridges. The monitoring well was dry the day after installation



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Miscellaneous

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and the water level in the well was 3.5 m below existing grade (corresponding to an elevation of 183.3 m) on September 17th, 2021.

Groundwater levels at the site will be subject to fluctuations due to seasonal changes and precipitation events. The water levels should be expected to be higher during the spring season or during and following periods of heavy precipitation or snow melt.

5.5 CHEMICAL ANALYSIS

Chemical analyses related to parameters associated with the potential for corrosion or sulphate attack (i.e. pH, resistivity, and chloride and sulphate content) were completed by AGAT Laboratories Inc. on two (2) samples (one of the cohesionless fill and one of the native clayey silt till soil). These analyses results are summarized in Table 5.1.

Table 5.1: Results of Chemical Analysis

Borehole No	Sample No.	Depth (m)	pH	Chloride (µg/g)	Sulphate (µg/g)	Resistivity (Ohm-m)
21-6	SS2	0.8 – 1.4	8.91	145	52	25.1
21-7	SS8	5.3 – 5.9	8.12	32	125	33.7

6.0 MISCELLANEOUS

The field work was carried out under the supervision of David Lee, P.Eng., under the direction of Kevin Nelson, P. Eng.

Utility locates were arranged by Stantec staff prior to initiation of drilling.

The drilling equipment was supplied and operated by London Soil Test Ltd. based in London, Ontario.

The borehole locations and elevations for Boreholes 21-1 to 21-5 were surveyed by Stantec's Geomatics division. The locations and elevations of Boreholes 21-6 and 21-7 were determined based on measurements from existing site features of known elevation.

Geotechnical laboratory testing was carried out at Stantec's laboratory in Markham, Ontario.

Corrosivity laboratory testing was carried out by AGAT Laboratories Inc., a subcontracted laboratory.

This report was prepared by David Lee, P.Eng., and reviewed by Kevin Nelson, P. Eng., and John J. Brisbois, MScE., P. Eng., MTO Designated Principal Contact.



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7.0 CLOSURE

A subsurface investigation is a limited sampling of a site. The subsurface conditions described herein are based on information obtained at the specific borehole locations. Should any conditions at the site be encountered which differ from those at the borehole locations, we request that we be notified immediately to assess the additional information.

Respectfully Submitted;

STANTEC CONSULTING LTD.



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For
G.W.P. 3001-20-00**

Rehabilitation of Highway 40 Overpass Structures at London Line
Site No. 14X-0279/B1 and B2

City of Sarnia, Lambton County, Ontario

8.0 DISCUSSIONS AND ENGINEERING RECOMMENDATIONS

8.1 OVERVIEW

This section provides foundation design recommendations for the proposed rehabilitation of the existing bridge structures and construction of new ground-mounted signs at the Highway 40 overpass (Site Nos. 14X-0279/B1 and B2) at London Line (Lambton Road 22) in Sarnia (G.W.P. 3001-20-00). The recommendations are based on interpretation of the factual data obtained from the subsurface investigation and the results of the laboratory testing program completed on samples obtained from the subsurface investigation. The discussion and input presented herein is intended to provide the designers with sufficient information to complete the design of the overpass rehabilitation and the new signs.

Comments provided with respect to construction are intended to highlight those aspects that could affect the design of the project and for which special provisions may be required in the Contract Documents. Contractors bidding the work should make their own interpretation of the factual information provided as such interpretation may affect their design, equipment selection, proposed construction methods, scheduling and other aspects of execution of construction.

8.2 PROJECT DESCRIPTION AND BACKGROUND INFORMATION

8.2.1 Project Description

Based on the preliminary design information available at the time of preparation of this report, the structure rehabilitation is to include the removal of existing expansion joints and conversion to semi-integral abutments for the SBL bridge, replacement of joints on the NBL, the repair and/or replacement of other bridge superstructure components and the replacement of existing bridge-mounted signs with new ground-mounted (tri-chord or cantilever) signs at two locations on London Line. No significant changes to the bridge geometries and/or approach embankment grades are planned.

Excavations extending to depths of about 2.0 m below the existing highway surface are anticipated to be required for the conversion to semi-integral abutments.



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8.2.2 Existing Bridge Structures

The existing east (NBL) bridge is a four-span structure constructed in the 1960's (WP No. 29-62) that has an overall length of approximately 57 m. The piers are supported by shallow spreading footings and the abutments are supported by pad foundations with counterfort abutment walls. All bridge footings are founded on native soil at about Elevation 179 m.

The existing west (SBL) bridge is a four-span structure constructed in the late 1970's (WP No. 122-65-05) that has an overall length of approximately 57 m. The piers are supported by shallow spread footings founded on native soil at about Elevation 179 m. The abutments are supported by spread footings perched within the approach embankments on a compacted Granular 'A' core. The abutment foundations are founded at about Elevation 183 m.

The travelled surface of Highway 40 is approximately 6 m higher than the travelled surface of London Line. The paved surface on Highway 40 is at approximately elevation 187.2 m to 187.4 m at the southbound bridge and between about 186.9 m and 187.1 m at the northbound bridge. The paved surface on London Line is at approximately elevation 181.2 m to 181.4 m beneath the bridges.

8.3 DEGREE OF SITE AND PREDICTION MODEL UNDERSTANDING

The Canadian Highway Bridge Design Code (CHBDC) [2019] requires an assessment of the "degree of site and prediction model understanding" as a component of the geotechnical engineering investigation and/or services. The site and prediction model understanding includes the geotechnical properties on the site and the accuracy and degree of confidence regarding the numerical performance prediction models to be used to estimate the geotechnical serviceability limit states reactions and ultimate limit states resistances.

Based on the scope and extent of the geotechnical investigation completed for this project, a "Typical Understanding" and a "Typical Consequence" Classification have been adopted for design purposes.

8.4 GEOTECHNICAL DESIGN PARAMETERS

The soil conditions encountered in the boreholes advanced for the planned overpass rehabilitation work consist of embankment fill materials underlain by native clayey silt till.

Table 8.1 provides the geotechnical properties for the stratigraphy encountered in the boreholes.

The elevations provided in Table 8.1 reflect a synthesis of the borehole data and are not based on any specific location; reference should be made to the Record of Boreholes for conditions at specific locations.



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Table 8.1: Geotechnical Model for Site Nos. 14X-0279/B1 and B2

Elevation (m)		Soil Type	Design Parameters		
From	To		Total Unit Weight γ (kN/m ³)	² Drained Friction Angle ϕ' (°)	³ Undrained Shear Strength S_u (kPa)
Ground Surface	186.0	Pavement Structure Granular FILL: Compact to dense, SAND to SAND and GRAVEL (SP to SM)	23	33	N/A
186.0	178.5	¹ Variable FILL: Loose to dense, Silty SAND to Gravelly SAND (SP to SM) to stiff to hard, CLAYEY SILT / SILTY CLAY (CL to CI)	21	30	50
178.5	<176.1	¹ TILL: Very stiff to hard, CLAYEY SILT (CL)	21	32	150

- Notes: 1 Cobbles and/or boulders are present within the fill materials and till deposit.
2 The friction angle is applicable to drained conditions only
3 The shear strength is applicable to the clayey silt/silty clay soils under undrained conditions only

Groundwater seepage was observed during the drilling of the Boreholes 21-1 to 21-4 (advanced through the Highway 40 embankments) and 21-6 to 21-7 (drilled on London Line) at elevations of between about 179.1 m and 180.1 m during drilling. For the overhead signs, a static groundwater level at an elevation of 180.1 m is recommended for design purposes.

The monitoring well installed in Borehole 21-5 was initially dry (July 29th) with the water level in the well measured to be at an elevation of approximately 183.3 m on September 17th, 2021 suggesting transient, perched groundwater conditions may also develop within the embankment fill materials.

8.5 FROST PENETRATION

In accordance with OPSD 3090.101, the design frost penetration depth for foundations, f , within the study area is 1.2 m. This depth of frost penetration should be considered in the design of the overhead sign foundation supports and the frost tapers adjacent to the bridge abutment walls.

8.6 BACKFILL AND LATERAL EARTH PRESSURES

Excavation and backfill for the rehabilitated bridge structure should be carried out in accordance with OPSS 902 Construction Specification for Excavation and Backfilling – Structures.

The materials used as backfill behind/adjacent to the rehabilitated bridge abutments should consist of free-draining granular fill placed and compacted using methods and equipment appropriate to the type of structure. For the purpose of developing the lateral earth pressure coefficients discussed below, it is assumed that backfill materials meeting the requirements of OPSS Granular B (Type I or Type II) or Granular A materials will be used. Backfill materials should meet the requirements of OPSS.PROV 1010 and be placed and compacted in accordance with the requirements of OPSS.PROV 206 and OPSS.PROV 501, respectively.



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8.6.1 Static Lateral Earth Pressures

Static lateral earth pressures will need to be considered in the design of the rehabilitation works. Computation of earth pressures on the bridge structures should be in accordance with Section 6.13.3 of the CHBDC (2019). For walls that are designed to allow rotation, active earth pressure may be used for design. For rigidly tied and unyielding structures, the at-rest earth pressure should be used for design. The effects of compaction should be accounted for by applying a compaction surcharge as shown in Figure 6.8 of the CHBDC. Where applicable (i.e. where unbalanced water pressures may develop), the structures should also be designed to account for hydrostatic pressures.

The total at rest, (P_O) active (P_A) and passive (P_P) thrusts can be calculated using the following equations:

$$P_O = \frac{1}{2} K_o \gamma H^2$$

$$P_A = \frac{1}{2} K_a \gamma H^2$$

$$P_P = \frac{1}{2} K_p \gamma H^2$$

where H is the height of the wall and γ is the unit weight of the backfill soil. Values of γ and K_a , K_p , and K_o for horizontal backfill conditions are provided in Table 8.2. The thrust acts at a point one third up the height of the wall.

Table 8.2: Recommended Static Earth Pressure Parameters (Horizontal Backfill)

Parameter	OPSS Granular B Type I	OPSS Granular A and Granular B Type II
Bulk Unit Weight, γ (kN/m ³)	21	22
Effective Friction Angle	32°	35°
Coefficient of Earth Pressure at Rest (K_o)	0.47	0.43
Coefficient of Active Earth Pressure (K_a)	0.31	0.27
Coefficient of Passive Earth Pressure (K_p)	3.25	3.7

8.7 SIGN FOUNDATION DESIGN

8.7.1 General

Table 10.1 below summarizes the sign location, sign description, and planned support type for each of the proposed new signs. The Borehole ID at each of the sign locations is provided in the last column.



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Table 8.3: Proposed Sign Support Details

Location, Station and Offset		Sign Description	Sign Support Type	Borehole ID
London Line	9+965 RT	Highway 40 Northbound	Ground Mounted Breakaway	21-6
London Line	10+030 LT	Highway 40 Southbound	Ground Mounted Breakaway	21-7

8.7.2 Foundations for Steel Column Sign Supports

The proposed signs are understood to be ground-mounted breakaway signs supported on Steel Column Sign Supports. The most recent version of MTO's Sign Support Manual (SSM) (MTO, 2019) does not include information related to the design of these type of signs but Division 5 (Steel Column Sign Supports) in previous versions of the SSM (e.g. 2011 version) contained the following input related to foundations for these types of signs:

- Section 5.1.5 of the SSM indicated that footings for the signs would be constructed by placing the steel columns in concrete filled holes.
- Details on standard footing dimensions were provided in Section 5.4.2 and in Figure 5.4.3 which indicated that the Steel Column sign supports would consist of 0.45 m diameter, concrete pier (caisson) footings with required footing embedment depths varying from 1.6 m to 2.4 m depending on the size of the sign.
- The footing depths in Section 5.4.3 were identified as the minimum required for each support and were based on an assumed passive resistance associated with the foundations being embedded in cohesive soil with a shear strength of at least 50 kPa and that if "the soil parameters for a particular site are less than those noted above, a site-specific footing design must be carried out". The SSM also indicates that the recommended footing depths assume that lateral soil resistance is based on the full depth of the footing "without reduction for frost depth of soil" and that this is considered "reasonable given the size of the footing for this type of sign".

The soils present within approximately 2 m to 2.5 m of ground surface at the sign locations consist of compact silt sandy to gravelly sand fill materials or native soils comprised of compact sandy silt. As these soils are predominantly cohesionless in nature, they do not meet the cohesive soil criteria (outlined above) required for use of the standard footings and, as such, a site-specific footing design is required.

8.7.2.1 Design Parameters and Passive Lateral Earth Pressure

The following table provides recommended foundation design parameters for use in the site-specific foundation design for the planned ground mounted sign structures.



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Table 8.4: Design Parameters for Sign Support Foundations

Sign Location	BH	Top/Bottom Elevation of soil layer (m)	Soil type	Ground-water Elevation (m)	γ Total unit weight (kN/m ³)	γ' Effective unit weight (kN/m ³)	ϕ^1 Effective soil friction angle ² (°)	S_u Shear strength ³ (kPa)	K_a Coefficient of active earth pressure	K_p Coefficient of passive earth pressure
London Line 9+965 RT	21-6	181.1 / 179.7	Compact Silty SAND (FILL)	180.1	21.0	11.2	32	n/a	0.31	3.2
		179.7 / 179.5	Sandy Silt (TOPSOIL)		19.0	9.2	30	n/a	0.33	3.0
		179.5 / 178.9	Compact Sandy SILT		20.0	10.2	30	n/a	0.33	3.0
		178.9 / 174	Very Stiff to hard CLAYEY SILT (TILL)		21.0	11.2	32	125	0.31	3.2
London Line 10+030 LT	21-7	181.2 / 179.0	Compact Gravelly SAND (FILL)	180.1	22.0	11.2	32	n/a	0.31	3.2
		179.0 / 178.4	Very stiff CLAYEY SILT (FILL)		19.0	9.2	30	100	-	-
		178.4 / 175	Very Stiff to hard CLAYEY SILT (TILL)		21.0	11.2	32	125	-	-

- Notes: 1 Cobbles and/or boulders are present within the fill materials and till deposit.
2 The friction angle is applicable to drained conditions only
3 The shear strength is applicable to the clayey silt/silty clay soils under undrained conditions only

The unfactored passive lateral earth pressure, P_p (kPa), may be calculated using the following equations:

$$P_p = K_p \gamma z \quad \text{Above the groundwater table}$$

$$P_p = K_p (\gamma z_w + \gamma' (z - z_w)) \quad \text{Below the groundwater table}$$

Where: K_p is the passive earth pressure coefficient;

γ is the total unit weight (kN/m³);

γ' is the effective unit weight below the groundwater level (kN/m³);

z is the depth below the ground surface (m); and

z_w is the depth to the groundwater level (m).

For cohesionless soils, the passive resistance can be developed over a width equal to three times the pile/caisson diameter.



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In cohesive soils, the unfactored lateral resistance (acting over a bearing width equal to the pile/caisson diameter) should be limited to 2 times the undrained shear strength (S_u) at ground surface increasing to a maximum of 9 times S_u at a depth equivalent to three caisson diameters.

A resistance factor of 0.5 should be applied to the calculated lateral resistance to obtain the factored lateral geotechnical resistance at Ultimate Limit States (ULS).

8.8 CEMENT TYPE AND CORROSION POTENTIAL

One soil sample from each sign location was submitted to AGAT Laboratories Inc. for analysis of pH, water soluble sulphate and chloride concentrations, and resistivity. The testing was completed to determine the potential for degradation of the concrete in the presence of soluble sulphates and the potential for corrosion of exposed steel used in foundations and buried infrastructure. The results of the analysis are summarized in Table 5.1 in a preceding section of this report.

The concentration of soluble sulphate provides an indication of the degree of sulphate attack that is expected for concrete in contact with soil and groundwater. The soluble sulphate concentrations for the samples tested varied from 52 to 125 $\mu\text{g/g}$. Soluble sulphate concentrations less than 1000 $\mu\text{g/g}$ generally indicate that a low degree of sulphate attack is expected for concrete in contact with soil and groundwater. Therefore, based on the soil testing results, Type GU (General Use) Portland Cement should therefore be suitable for use in buried concrete.

The pH, resistivity and chloride concentration provide an indication of the degree of corrosiveness of the sub-surface environment. The soil pH values varied from 8.91 to 8.12, which are within what is considered the normal range for soil pH of 5.5 to 9.0. The measured resistivity values suggest a moderately corrosive to corrosive environment. The additional test results provided in Table 5.1 may be used to aid in the selection of coatings and corrosion protection systems for buried infrastructure incorporating steel components.

8.9 DECOMMISSIONING OF MONITORING WELL

Ontario Regulation 903 under the *Ontario Water Resources Act, R.S.O. 1990 (Regulation 903)* requires that monitoring wells be decommissioned when there is no further requirement for use or where they cannot be maintained in a usable condition. As of the time of this report the monitoring well installed in BH21-5 has not been decommissioned. In this respect it is noted that confirmation of the groundwater level prior to and during construction is often of benefit to the project. It is therefore recommended that decommissioning of the monitoring well installed in BH21-5 be undertaken as part of the construction contract.

The wells must be decommissioned by a licensed water well contractor in accordance with requirements set out in Regulation 903. The Contractor should provide a copy of the record of the well abandonment to the Contract Administrator.



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9.0 CONSTRUCTION CONSIDERATIONS

9.1 CONSTRUCTION STAGING & DETOURS

Rehabilitation of the overpass structures at Site Nos. 14X-0279/B1 and B2 is anticipated to be completed with Temporary Protection Systems (TPS) installed between the slow and fast lanes to facilitate maintaining a single-lane of traffic during excavations for the abutment rehabilitation and conversions. No detours are currently planned for this work.

9.2 TEMPORARY PROTECTION SYSTEMS

The proposed overpass rehabilitation activities are planned to be carried out using staged construction measures to allow one lane of traffic to be maintained on each bridge during the rehabilitation activities.

Temporary roadway protection measures would be required adjacent to the active roadway lane to permit exposure of the existing abutment foundations and conversion to semi-integral abutments as intended. Excavations extending to depths of about 2 m below existing road grades are understood to be required for this purpose.

Table 9.1 below compares the available roadway protection options available for this purpose.

Table 9.1: Comparison of Roadway Protection Systems

Option	Advantages	Disadvantages	Relative Cost	Risk & Consequences
Soldier piles with timber lagging; (struts/rakers as required)	<ul style="list-style-type: none"> Simple installation process 	<ul style="list-style-type: none"> Additional labour required Groundwater seepage into the excavation can occur from perched groundwater within the embankment fill Removal of soldier piles can be difficult 	Low	<ul style="list-style-type: none"> Potential for groundwater seepage and loss of ground unless groundwater control measures are implemented Potential for minor loss of ground at rear of lagging
Steel sheet piles (SSP)	<ul style="list-style-type: none"> Simple installation process Provides cut-off to groundwater seepage from sides of excavation 	<ul style="list-style-type: none"> Difficult to drive/install in dense sand and gravel; may encounter refusal on cobbles or boulders May require large sections where cantilever design is adopted 	Medium	<ul style="list-style-type: none"> Possible damage to sheet piles during driving
Slide rail	<ul style="list-style-type: none"> Simple installation and removal processes Modular system 	<ul style="list-style-type: none"> Difficult to drive/install in dense sand and gravel; may encounter refusal on cobbles or boulders 	Medium	<ul style="list-style-type: none"> Possible damage to components during driving

All of the retaining systems provided in the table are considered feasible at this site. However, the use of a soldier pile and lagging wall system is considered preferable from a foundation engineering perspective



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as the installation of this type of system is less likely to be influenced/hindered by the presence of cobbles within the embankment fill.

The protection systems must be designed to resist loads applied from construction equipment and surcharge loads. Lateral support could be provided by walers and struts across the excavation width, rakers or temporary ground anchors.

Roadway protection design should meet the requirements of Performance Level 2 in accordance with OPSS.PROV 539 and should consider traffic loading. Performance Level 2 specifies a Maximum Angular Distortion of 1:200 and a Maximum Horizontal Displacement of 25 mm. Horizontal movement should be monitored throughout the culvert replacement process as described in OPSS.PROV 539. The monitoring requirements are outlined in OPSS.PROV 539 and SP105S09, including the milestone inspections to be completed by the Contractor's Engineer.

From a geotechnical perspective, the temporary protection system can either be removed or left in place. If the system is to be removed, the removal operations shall be in accordance with OPSS.PROV 539. If components are left in place, all portions of the systems should be removed to a level at least 1.2 m below final grades.

9.3 EXCAVATION AND BACKFILLING

Excavation and backfill activities should be carried out in accordance with OPSS.PROV 902 Construction Specification for Excavation and Backfilling – Structures.

The excavations required for the construction of the semi-integral abutment conversions will extend to depths in the order of 2 m to 2.5 m below the existing road grades at the overpasses. The excavations will encounter the embankment fill materials including granular backfill materials adjacent to the existing bridge and retaining walls structures.

All side slopes for open cut excavations should conform to the Occupational Health & Safety Act & Regulations for Construction Projects (OH&S Act). The fill materials would be classified as Type 3 soil provided they are above the groundwater table or are dewatered prior to excavation. The OH&S Act indicates that temporary excavations in Type 3 soils above the water table should have side slopes no steeper than 1H:1V.

Excavations carried out at/beyond the toes of the embankments (i.e. at the London Line level) may encounter cohesionless soils that are below the water level (i.e. granular fill materials and/or the sandy silt deposit encountered in Borehole 21-6) which would be classified as Type 4 soils unless dewatered prior to excavation. Excavations in Type 4 soils should be sloped no steeper than 3H:1V based on OH&S Act requirements.

Grading work should be carried out in accordance with OPSS.PROV 206 Construction Specification for Grading and SP 206S03.



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The contractor should provide sediment control fences and erosion control blankets, as required, throughout the duration of the construction.

9.4 TEMPORARY SURFACE WATER AND GROUNDWATER CONTROL

Control of surface water will also be necessary to allow excavation for the abutment conversions to be carried out in dry conditions. Surface water should be directed away from the area of the planned excavations.

The results of the investigation indicate that the excavations required for the semi-integral abutment conversion will be above the static groundwater level at the site.

Measurements taken in the monitoring well installed in Borehole 21-5 suggest that perched groundwater levels may be encountered in/above fine-grained portions of the fill materials in the approach embankments. As such, minor groundwater seepage may be encountered in excavations in the embankment fill. Seepage and infiltration from the clayey silt fill layers are anticipated to be very low given the inherent low hydraulic-conductivity of these materials. Increased flows may occur when excavations encounter perched water within the existing granular fill materials but the extent and volume of this water is expected to be limited and will reduce rapidly with time.

Based on the subsurface conditions at the site, temporary unwatering, using conventional sump and pump techniques, is considered appropriate for handling localized groundwater seepage into the excavations provided that all overland flows are directed away from the excavation areas. Dewatering activities should be carried out in accordance with OPSS.PROV 517.

Groundwater control measures will also need to be implemented during construction of the foundations for the overhead signs. Additional discussion regarding this item is provided in the following section of this report.

9.5 SIGN FOUNDATION CONSTRUCTION CONSIDERATIONS

Construction of the sign foundations should be in accordance with OPSS.PROV 915 (Construction Specification for Sign Support Structures) and OPSS.PROV 903 (Construction Specification for Deep Foundations).

The surficial soils at the sign support locations generally consist of fill ranging in composition from silty sand with gravel to gravelly sand to clayey silt. A stratum of saturated, sandy silt was encountered beneath the fill Borehole 21-6. These materials are underlain by a deposit of clayey silt till.

The shallow groundwater levels observed in the boreholes at the time of drilling were within the anticipated installation depths of the foundations at the sign locations. Where wet, cohesionless soil materials such as the granular fill and/or the sandy silt deposit are encountered, these materials should be expected to run or flow into the holes drilled for the sign support foundations. Therefore, provision should be included for the use of temporary liners and/or drilling fluids to reduce the potential for sidewall



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instability and ground loss during drilling/concrete placement and for the use of tremie methods for placement of concrete where the foundations extend below the water level.

Cobbles or boulders were encountered in the fill, and glacial till soils in all boreholes during the investigation. In this regard, cobbles and boulders should be anticipated within the fill materials and most of the native glacial till deposits. Therefore, the construction equipment and procedures used must be suitable for penetrating and/or removing cobbles and boulders (if encountered) during the drilling of the holes for the foundations of the overhead sign supports. A Non-Standard Special Provisions (NSSP) should be included in the contract to address this item; a draft version of a sample NSSP is provided in Appendix D.

10.0 SPECIFICATIONS

The following specifications are referenced in this report:

Table 10.1: Specifications Referenced in Report

Document	Title
OPSD 3090.101	Foundation Frost Depths for Southern Ontario
OPSD 3101.150	Walls – Abutment, Backfill – Minimum Granular Requirement
OPSS. PROV 517	Construction Specification for Dewatering
OPSS.PROV 902	Construction Specification for Excavation and Backfilling – Structures
OPSS.PROV 206	Construction Specification for Grading
OPSS.PROV 501	Construction Specification for Compacting
OPSS. PROV 539	Construction Specification for Temporary Protection System
OPSS.PROV 1010	Material Specification for Aggregates
SP517F01	Dewatering System – Item No. Temporary Flow Passage System – Item No.
SP105S09	Amendment to OPSS539
SP105S10	Construction Specification for Compaction
SP105S21	MTO's Special Provision (Amendment to OPSS 501).
SP 206S03	Earth Excavation, Grading



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11.0 REFERENCES

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**FOUNDATION INVESTIGATION AND DESIGN REPORT
REHABILITATION OF HIGHWAY 40 OVERPASS STRUCTURES AT LONDON LINE
SITE NOS. 14X-0279/B1 AND B2**

Closure
March 18, 2022

12.0 CLOSURE

A soil investigation is a limited sampling of a site. The conclusions given herein are based on information gathered at the specific borehole locations. Should any conditions at the site be encountered which differ from those at the borehole locations, we request that we be notified immediately in order to assess the additional information and its effects on the above recommendations.

We trust the information presented herein meets your present requirements. Should you have any questions or require additional information, please do not hesitate to contact us.

This report was prepared by David Lee, P.Eng., and reviewed by Kevin Nelson, P. Eng., and John J. Brisbois, MScE., P. Eng., MTO Designated Principal Contact.

Respectfully submitted,

STANTEC CONSULTING LTD.



David Lee, P.Eng.
Geotechnical Engineer



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Principal, Senior Geotechnical Engineer



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Designated Principal MTO Foundation Contact



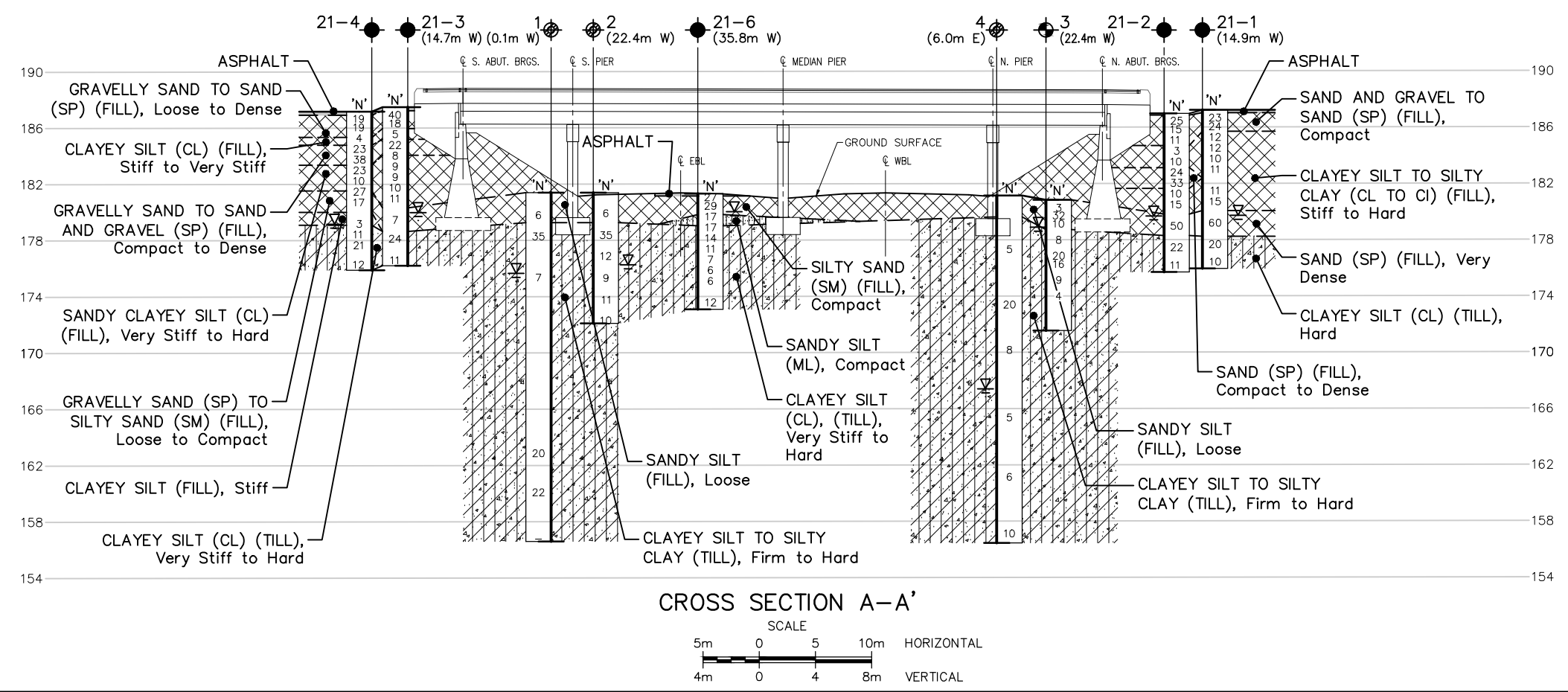
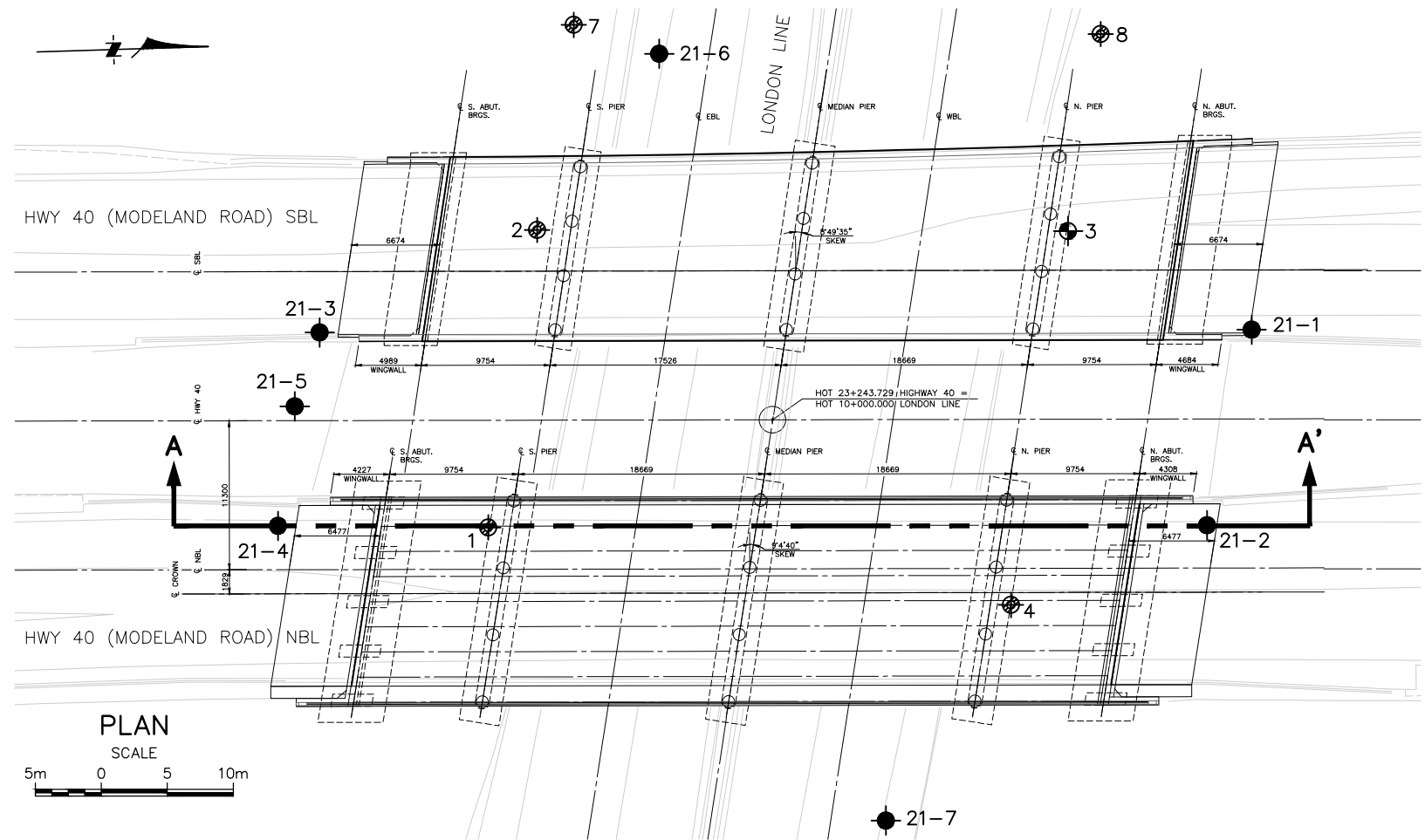
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APPENDIX A

A.1 DRAWING NO. 1 – BOREHOLE LOCATION PLAN AND SOIL STRATA PLOT





METRIC
DIMENSIONS ARE IN METRES
AND/OR MILLIMETRES
UNLESS OTHERWISE SHOWN



PLATE No
**CONT
GWP 3001-20-00**

HIGHWAY 40 (MODELAND RD)
AT LONDON LINE, SARNIA, ON
BOREHOLE LOCATIONS & SOIL STRATA

SHEET
—

KEY PLAN
500m 0 500 1000m

LEGEND				
	Borehole (Stantec, 2021)			
	Borehole (MTO, 1962)			
	Borehole & Cone (MTO, 1962)			
(x.x m)	Offset from Cross Section Line in meters			
N	Blows/0.3m (Std Pen Test, 475 J/blow)			
WL	WL at time of Investigation			
No	ELEVATION	MTM, ZONE 11 NORTH	COORDINATES EAST	
21-1	187.2	4 760 621.1	317	508.0
21-2	186.9	4 760 617.3	317	522.7
21-3	187.4	4 760 550.5	317	506.0
21-4	187.1	4 760 546.9	317	520.6
21-5	186.8	4 760 548.4	317	511.6
21-6	181.2	4 760 576.9	317	485.7
21-7	181.4	4 760 592.2	317	544.3
1	181.3	4 760 562.8	317	521.2
2	181.3	4 760 567.2	317	498.8
3	181.1	4 760 607.4	317	500.1
4	180.8	4 760 602.2	317	528.3
7	181.1	4 760 570.4	317	483.3
8	180.9	4 760 610.3	317	482.2

NOTES

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

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

Not all boreholes shown on cross section for clarity purposes.

NOTE: The complete foundation investigation and design report for this project and other related documents may be examined at the Engineering Materials Office, Downsview. Information contained in this report and related documents is specifically excluded in accordance with the conditions of Section 102-2 of Form 100.

REVISIONS		DATE		BY		DESCRIPTION	

GEOCREs No 40J16-93

HWY No		DIST	
SUBM'D KN	CHECKED	DATE 2022-02-24	SITE 14X-279/B0
DRAWN GBB	CHECKED	APPROVED	DWG 1

APPENDIX B

B.1 SYMBOLS AND TERMS USED ON BOREHOLE RECORDS

B.2 BOREHOLE RECORDS

B.3 SUBSURFACE INFORMATION FROM GEOCRES REPORT 40J16-008



SYMBOLS AND TERMS USED ON BOREHOLE AND TEST PIT RECORDS

SOIL DESCRIPTION

Terminology describing common soil genesis:

<i>Rootmat</i>	- vegetation, roots and moss with organic matter and topsoil typically forming a mattress at the ground surface
<i>Topsoil</i>	- mixture of soil and humus capable of supporting vegetative growth
<i>Peat</i>	- mixture of visible and invisible fragments of decayed organic matter
<i>Till</i>	- unstratified glacial deposit which may range from clay to boulders
<i>Fill</i>	- material below the surface identified as placed by humans (excluding buried services)

Terminology describing soil structure:

<i>Desiccated</i>	- having visible signs of weathering by oxidization of clay minerals, shrinkage cracks, etc.
<i>Fissured</i>	- having cracks, and hence a blocky structure
<i>Varved</i>	- composed of regular alternating layers of silt and clay
<i>Stratified</i>	- composed of alternating successions of different soil types, e.g. silt and sand
<i>Layer</i>	- > 75 mm in thickness
<i>Seam</i>	- 2 mm to 75 mm in thickness
<i>Parting</i>	- < 2 mm in thickness

Terminology describing soil types:

The classification of soil types are made on the basis of grain size and plasticity in accordance with the Unified Soil Classification System (USCS) (ASTM D 2487 or D 2488) which excludes particles larger than 75 mm. For particles larger than 75 mm, and for defining percent clay fraction in hydrometer results, definitions proposed by Canadian Foundation Engineering Manual, 4th Edition are used. The USCS provides a group symbol (e.g. SM) and group name (e.g. silty sand) for identification.

Terminology describing cobbles, boulders, and non-matrix materials (organic matter or debris):

Terminology describing materials outside the USCS, (e.g. particles larger than 75 mm, visible organic matter, and construction debris) is based upon the proportion of these materials present:

<i>Trace, or occasional</i>	Less than 10%
<i>Some</i>	10-20%
<i>Frequent</i>	> 20%

Terminology describing compactness of cohesionless soils:

The standard terminology to describe cohesionless soils includes compactness (formerly "relative density"), as determined by the Standard Penetration Test (SPT) N-Value - also known as N-Index. The SPT N-Value is described further on page 3. A relationship between compactness condition and N-Value is shown in the following table.

Compactness Condition	SPT N-Value
<i>Very Loose</i>	<4
<i>Loose</i>	4-10
<i>Compact</i>	10-30
<i>Dense</i>	30-50
<i>Very Dense</i>	>50

Terminology describing consistency of cohesive soils:

The standard terminology to describe cohesive soils includes the consistency, which is based on undrained shear strength as measured by *in situ* vane tests, penetrometer tests, or unconfined compression tests. Consistency may be crudely estimated from SPT N-Value based on the correlation shown in the following table (Terzaghi and Peck, 1967). The correlation to SPT N-Value is used with caution as it is only very approximate.

Consistency	Undrained Shear Strength		Approximate SPT N-Value
	kips/sq.ft.	kPa	
<i>Very Soft</i>	<0.25	<12.5	<2
<i>Soft</i>	0.25 - 0.5	12.5 - 25	2-4
<i>Firm</i>	0.5 - 1.0	25 - 50	4-8
<i>Stiff</i>	1.0 - 2.0	50 - 100	8-15
<i>Very Stiff</i>	2.0 - 4.0	100 - 200	15-30
<i>Hard</i>	>4.0	>200	>30

ROCK DESCRIPTION

Except where specified below, terminology for describing rock is as defined by the International Society for Rock Mechanics (ISRM) 2007 publication "The Complete ISRM Suggested Methods for Rock Characterization, Testing and Monitoring: 1974-2006"

Terminology describing rock quality:

RQD	Rock Mass Quality
0-25	<i>Very Poor Quality</i>
25-50	<i>Poor Quality</i>
50-75	<i>Fair Quality</i>
75-90	<i>Good Quality</i>
90-100	<i>Excellent Quality</i>

Alternate (Colloquial) Rock Mass Quality	
<i>Very Severely Fractured</i>	<i>Crushed</i>
<i>Severely Fractured</i>	<i>Shattered or Very Blocky</i>
<i>Fractured</i>	<i>Blocky</i>
<i>Moderately Jointed</i>	<i>Sound</i>
<i>Intact</i>	<i>Very Sound</i>

RQD (Rock Quality Designation) denotes the percentage of intact and sound rock retrieved from a borehole of any orientation. All pieces of intact and sound rock core equal to or greater than 100 mm (4 in.) long are summed and divided by the total length of the core run. RQD is determined in accordance with ASTM D6032.

SCR (Solid Core Recovery) denotes the percentage of solid core (cylindrical) retrieved from a borehole of any orientation. All pieces of solid (cylindrical) core are summed and divided by the total length of the core run (It excludes all portions of core pieces that are not fully cylindrical as well as crushed or rubble zones).

Fracture Index (FI) is defined as the number of naturally occurring fractures within a given length of core. The Fracture Index is reported as a simple count of natural occurring fractures.

Terminology describing rock with respect to discontinuity and bedding spacing:

Spacing (mm)	Discontinuities	Bedding
>6000	<i>Extremely Wide</i>	-
2000-6000	<i>Very Wide</i>	<i>Very Thick</i>
600-2000	<i>Wide</i>	<i>Thick</i>
200-600	<i>Moderate</i>	<i>Medium</i>
60-200	<i>Close</i>	<i>Thin</i>
20-60	<i>Very Close</i>	<i>Very Thin</i>
<20	<i>Extremely Close</i>	<i>Laminated</i>
<6	-	<i>Thinly Laminated</i>

Terminology describing rock strength:

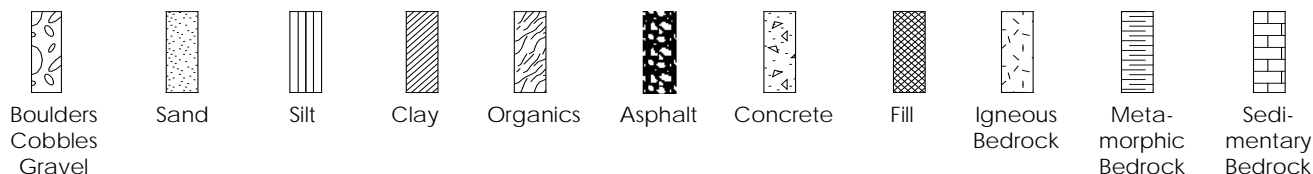
Strength Classification	Grade	Unconfined Compressive Strength (MPa)
<i>Extremely Weak</i>	R0	<1
<i>Very Weak</i>	R1	1 – 5
<i>Weak</i>	R2	5 – 25
<i>Medium Strong</i>	R3	25 – 50
<i>Strong</i>	R4	50 – 100
<i>Very Strong</i>	R5	100 – 250
<i>Extremely Strong</i>	R6	>250

Terminology describing rock weathering:

Term	Symbol	Description
<i>Fresh</i>	W1	No visible signs of rock weathering. Slight discoloration along major discontinuities
<i>Slightly</i>	W2	Discoloration indicates weathering of rock on discontinuity surfaces. All the rock material may be discolored.
<i>Moderately</i>	W3	Less than half the rock is decomposed and/or disintegrated into soil.
<i>Highly</i>	W4	More than half the rock is decomposed and/or disintegrated into soil.
<i>Completely</i>	W5	All the rock material is decomposed and/or disintegrated into soil. The original mass structure is still largely intact.
<i>Residual Soil</i>	W6	All the rock converted to soil. Structure and fabric destroyed.

STRATA PLOT

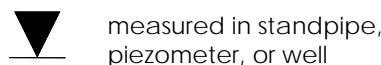
Strata plots symbolize the soil or bedrock description. They are combinations of the following basic symbols. The dimensions within the strata symbols are not indicative of the particle size, layer thickness, etc.



SAMPLE TYPE

SS	Split spoon sample (obtained by performing the Standard Penetration Test)
ST	Shelby tube or thin wall tube
DP	Direct-Push sample (small diameter tube sampler hydraulically advanced)
PS	Piston sample
BS	Bulk sample
HQ, NQ, BQ, etc.	Rock core samples obtained with the use of standard size diamond coring bits.

WATER LEVEL MEASUREMENT



measured in standpipe, piezometer, or well



inferred

RECOVERY

For soil samples, the recovery is recorded as the length of the soil sample recovered. For rock core, recovery is defined as the total cumulative length of all core recovered in the core barrel divided by the length drilled and is recorded as a percentage on a per run basis.

N-VALUE

Numbers in this column are the field results of the Standard Penetration Test: the number of blows of a 140 pound (63.5 kg) hammer falling 30 inches (760 mm), required to drive a 2 inch (50.8 mm) O.D. split spoon sampler one foot (300 mm) into the soil. In accordance with ASTM D1586, the N-Value equals the sum of the number of blows (N) required to drive the sampler over the interval of 6 to 18 in. (150 to 450 mm). However, when a 24 in. (610 mm) sampler is used, the number of blows (N) required to drive the sampler over the interval of 12 to 24 in. (300 to 610 mm) may be reported if this value is lower. For split spoon samples where insufficient penetration was achieved and N-Values cannot be presented, the number of blows are reported over sampler penetration in millimetres (e.g. 50/75). Some design methods make use of N-values corrected for various factors such as overburden pressure, energy ratio, borehole diameter, etc. No corrections have been applied to the N-values presented on the log.

DYNAMIC CONE PENETRATION TEST (DCPT)

Dynamic cone penetration tests are performed using a standard 60 degree apex cone connected to 'A' size drill rods with the same standard fall height and weight as the Standard Penetration Test. The DCPT value is the number of blows of the hammer required to drive the cone one foot (300 mm) into the soil. The DCPT is used as a probe to assess soil variability.

OTHER TESTS

S	Sieve analysis
H	Hydrometer analysis
k	Laboratory permeability
γ	Unit weight
G_s	Specific gravity of soil particles
CD	Consolidated drained triaxial
CU	Consolidated undrained triaxial with pore pressure measurements
UU	Unconsolidated undrained triaxial
DS	Direct Shear
C	Consolidation
Q_u	Unconfined compression
I_p	Point Load Index (I_p on Borehole Record equals $I_p(50)$ in which the index is corrected to a reference diameter of 50 mm)

	Single packer permeability test; test interval from depth shown to bottom of borehole
	Double packer permeability test; test interval as indicated
	Falling head permeability test using casing
	Falling head permeability test using well point or piezometer

RECORD OF BOREHOLE No 21-1

1 OF 1

METRIC

W.P. 3001-20-00 LOCATION Highway 40 - London Line Overpass, Samia ORIGINATED BY DL
 DIST West HWY 40 BOREHOLE TYPE 83 mm ID Hollow Stem Auger - Split Spoon COMPILED BY DL
 DATUM Geodetic DATE 2021.07.29 LATITUDE 42.985287 LONGITUDE -82.344173 CHECKED BY KN

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 (%)					GR	SA	SI	CL
								20	40	60	80	100					20	40	60						
187.2	Paved Shoulder																								
187.0	200 mm ASPHALTIC CONCRETE																								
0.2	SAND and GRAVEL to Gravelly SAND (SM), some silt (FILL) Compact Brown Dry		1	SS	23								○					37	47	12	5				
			2	SS	24								○												
185.7																									
1.5	CLAYEY SILT to SILTY CLAY (CL to CI), some sand, trace gravel (FILL) Occasional cobbles Very stiff to hard Mottled brown and grey Moist		3	SS	12								○												
			4	SS	12								●	—				1	15	30	54				
			5	SS	10								○												
			6	SS	11								○												
			7	SS	9								●	—				2	19	31	48				
	0.1 m thick, wet gravelly sand layer encountered at 5.9 m		8	SS	11								○												
			9	SS	15								○												
180.0																									
7.2	SAND (SP), trace silt (FILL) Occasional cobbles and/or boulders Dense Brown Wet		10	SS	60								○												
178.2																									
9.0	CLAYEY SILT (CL), some sand, trace gravel (TILL) Hard Brown Moist to wet		11	SS	20								●	—											
	Stiff																								
			12	SS	10								○												
175.9																									
11.3	End of Borehole																								
	Groundwater observed below 7.5 m depth (~Elev. 179.7 m) during drilling.																								

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

RECORD OF BOREHOLE No 21-2

1 OF 1

METRIC

W.P. 3001-20-00 LOCATION Highway 40 - London Line Overpass, Samia ORIGINATED BY DL
 DIST West HWY 40 BOREHOLE TYPE 83 mm ID Hollow Stem Auger - Split Spoon COMPILED BY DL
 DATUM Geodetic DATE 2021.07.28 LATITUDE 42.985252 LONGITUDE -82.343993 CHECKED BY KN

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT NATURAL LIQUID LIMIT MOISTURE CONTENT			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 (%)																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																							
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+³, ×³: Numbers refer to Sensitivity ○ 3% STRAIN AT FAILURE

RECORD OF BOREHOLE No 21-3

1 OF 1

METRIC

W.P. 3001-20-00 LOCATION Highway 40 - London Line Overpass, Samia ORIGINATED BY DL
 DIST West HWY 40 BOREHOLE TYPE 83 mm ID Hollow Stem Auger - Split Spoon COMPILED BY DL
 DATUM Geodetic DATE 2021.07.29 LATITUDE 42.984651 LONGITUDE -82.344199 CHECKED BY KN

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 (%)		
								20	40	60	80	100						20	40	60
187.4	Paved Shoulder																			
0.0	250 mm ASPHALTIC CONCRETE																			
187.1																				
0.3	Gravelly SAND (SM), some silt (FILL) Compact to dense Brown Dry to moist		1	SS	40		187										35 48 13 5			
			2	SS	18		186													
185.9																				
1.5	CLAYEY SILT (CL), some sand, trace gravel (FILL) Stiff to very stiff Brown Moist		3	SS	5		185													
185.1																				
2.3	Gravelly SAND (SP), trace silt (FILL) Compact Dark grey Moist		4	SS	22		184													
	Increasing fines content below 3 m depth.		5	SS	8		183										2 18 34 46 Su>118 kPa (N-vane refusal)			
184.0																				
3.4	CLAYEY SILT (CL), some sand, trace gravel (FILL) Very stiff to hard Brownish grey Moist SPT 'N' value for SS6 influenced by attempted vane testing		6	SS	9		182													
	125 mm thick layer of silty sand containing topsoil encountered at 4.8 m depth in SS7		7	SS	9		181										7 18 32 44			
	100 mm thick wet sand and gravel layer with wood piece		8	SS	10		180													
			9	SS	11		179													
180.2																				
7.2	SILTY SAND (SM) (FILL) Loose Grey with black streaks Wet		10	SS	7		178													
178.5																				
8.8	CLAYEY SILT (CL), some sand, trace gravel (TILL) Hard becomes very stiff below 10 m Brown to brownish grey Moist		11	SS	24		177										2 15 34 49			
			12	SS	11															
176.1																				
11.3	End of Borehole																			
	Groundwater observed below 7.5 m depth (~Elev. 179.9 m) during drilling. Groundwater level in open borehole at 8.5 m depth (~Elev. 178.7 m) on completion of drilling.																			

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

RECORD OF BOREHOLE No 21-4

1 OF 1

METRIC

W.P. 3001-20-00 LOCATION Highway 40 - London Line Overpass, Samia ORIGINATED BY DL
DIST West HWY 40 BOREHOLE TYPE 83 mm ID Hollow Stem Auger - Split Spoon COMPILED BY DL
DATUM Geodetic DATE 2021.07.28 LATITUDE 42.984619 LONGITUDE -82.344021 CHECKED BY KN

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 (%)			GR	SA	SI	CL
								○ UNCONFINED ● QUICK TRIAXIAL	+ FIELD VANE × LAB VANE	20	40	60					80	100	20				
187.1	Paved Shoulder																						
0.0	250 mm ASPHALTIC CONCRETE																						
186.8																							
186.8	Gravelly SAND (SP), trace silt (FILL)		1	SS	19								○										
0.5	SAND (SP), trace silt and gravel (FILL) Loose to Compact Brown Moist		2	SS	19								○										
185.2																							
1.8	CLAYEY SILT (CL), some sand, trace gravel (FILL) Contains sandy zones/inclusions Stiff to very stiff Brown Moist		3	SS	4								○										
184.7																							
2.4	Gravelly SAND to SAND and GRAVEL (SP), trace silt (FILL) Contains asphalt layers/pieces up to 75 mm in thickness. Compact to dense Brown Moist		4	SS	23								○										
			5	SS	38								○					38	51	8	4		
183.2																							
3.8	Sandy CLAYEY SILT (CL), trace gravel and topsoil (FILL) Occasional cobbles Very stiff to hard Brown Moist ~0.2 m thick layer of gravelly sand encountered at 4.1 m depth		6	SS	23								○										
			7	SS	10								○										
181.4																							
5.6	Gravelly SAND (SP), trace silt and topsoil (FILL) Compact Brown to dark brown Moist		8	SS	27								○					9	39	21	31		
													○										
179.9																							
7.2	CLAYEY SILT (CL), some sand, trace gravel (FILL) Stiff Brown Moist																						
179.0	Very loose silty sand layer encountered at 8.0 m depth.		10	SS	3								○										
8.1	CLAYEY SILT (CL), some sand, trace gravel (TILL) Occasional cobbles and/or boulders Very stiff to hard Brown to brownish grey Moist to wet SPT 'N' value for SS11 influenced by attempted vane testing.																						
			11	SS	11								○								Su>118 kPa (N-vane refusal)		
			12	SS	21								○										

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

RECORD OF BOREHOLE No 21-5

1 OF 1

METRIC

W.P. 3001-20-00 LOCATION Highway 40 - London Line Overpass, Samia ORIGINATED BY DL
 DIST West HWY 40 BOREHOLE TYPE 83 mm ID Hollow Stem Auger - Split Spoon COMPILED BY DL
 DATUM Geodetic DATE 2021.07.28 LATITUDE 42.984633 LONGITUDE -82.344131 CHECKED BY KN

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									
								○ UNCONFINED + FIELD VANE									
								● QUICK TRIAXIAL × LAB VANE									
							WATER CONTENT (%)										
186.8	Grassed							20	40	60	80	100					
186.0	100 mm TOPSOIL (FILL)																
188.3	SANDY SILT (ML), trace gravel (FILL)																
0.3	CLAYEY SILT (CL), some sand, trace gravel (FILL) Stiff to very stiff Brown Moist		1	SS	12									○			
			2	SS	10									○			
185.3																	
1.5	SAND (SM), some gravel, trace to some silt (FILL) Compact Brown to grey Moist		3	SS	24									○			
	0.2 m thick layer of clayey silt encountered at 2.3 m depth																
	75 mm thick asphalt encountered at 2.7 m depth		4	SS	32									○			
183.5																	
3.3	CLAYEY SILT (CL), some sand, trace gravel, trace topsoil (FILL) Stiff to very stiff Brown Moist		5	SS	19									○			
	75 mm thick topsoil encountered at 3.4 m depth																
	50 mm thick pulverized asphalt layers encountered at 3.5 m and 4.3 m depths		6	SS	9									○			
			7	SS	8									○			
181.3																	
5.5	End of Borehole																
	Monitoring well dry on July 28th and 29th, 2021. Water level in monitoring well measured at 3.5 m depth (~Elev. 183.3 m) on Sept. 17th, 2021.																

17 68 8 7
Non-plastic

Su>118 kPa
(N-vane refusal)

RECORD OF BOREHOLE No 21-6

1 OF 1

METRIC

W.P. 3001-20-00 LOCATION Highway 40 - London Line Overpass, Samia ORIGINATED BY DL
 DIST West HWY London Line BOREHOLE TYPE 83 mm ID Hollow Stem Auger - Split Spoon COMPILED BY DL
 DATUM Geodetic DATE 2021.09.17 LATITUDE 42.984891 LONGITUDE -82.344467 CHECKED BY KN

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 (%)			GR	SA	SI	CL
								○ UNCONFINED + FIELD VANE															
								● QUICK TRIAXIAL × LAB VANE															
181.2	Paved Shoulder						20	40	60	80	100												
180.9	175 mm ASPHALTIC CONCRETE																						
0.2	Silty SAND (SM), some gravel (FILL) Occasional cobbles in the upper portion Compact Brown Dry to moist		1	SS	27	▽	181							○					19 66 9 6				
			2	SS	29		180							○									
179.7							179																
179.5	BURIED TOPSOIL - Sandy SILT (ML) Loose Black Moist		3	SS	17		178								○				1 41 49 10				
1.7							177																
178.9	Sandy SILT (ML), trace shell fragments Compact Grey, occasional dark streaks Wet		4	SS	17		176								○								
2.3	CLAYEY SILT (CL), trace to some sand, trace gravel (TILL) Occasional cobbles and/or boulders Very stiff to Hard Brown to grey Moist to wet		5	SS	14		175								○								
			6	SS	11		174																
			7	SS	7										○								
			8	SS	6										+								
	SPT 'N' value for SS8 influenced by attempted vane testing		9	SS	6									+				2 13 34 51 Su>118 kPa (N-vane refusal)					
	Stiff																						

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

RECORD OF BOREHOLE No 21-7

1 OF 1

METRIC

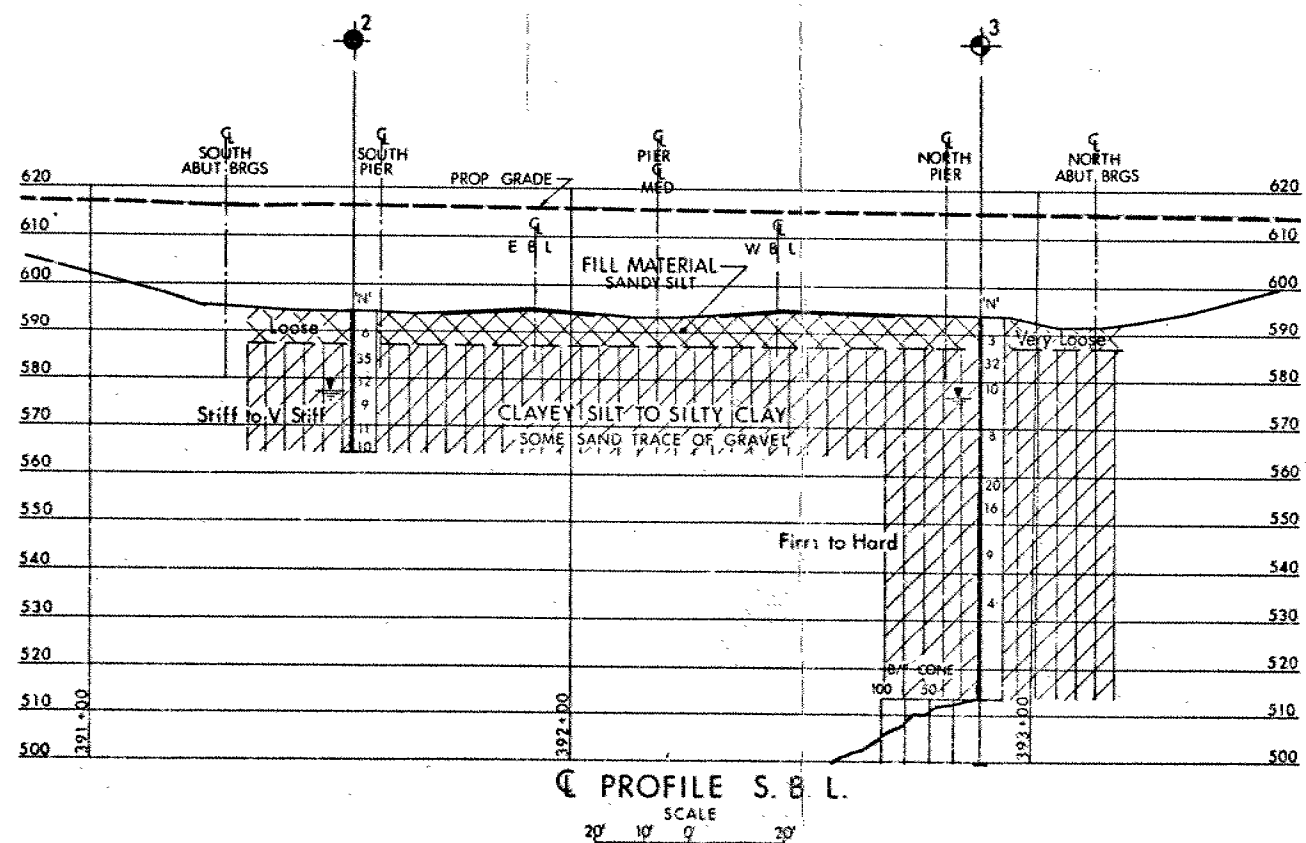
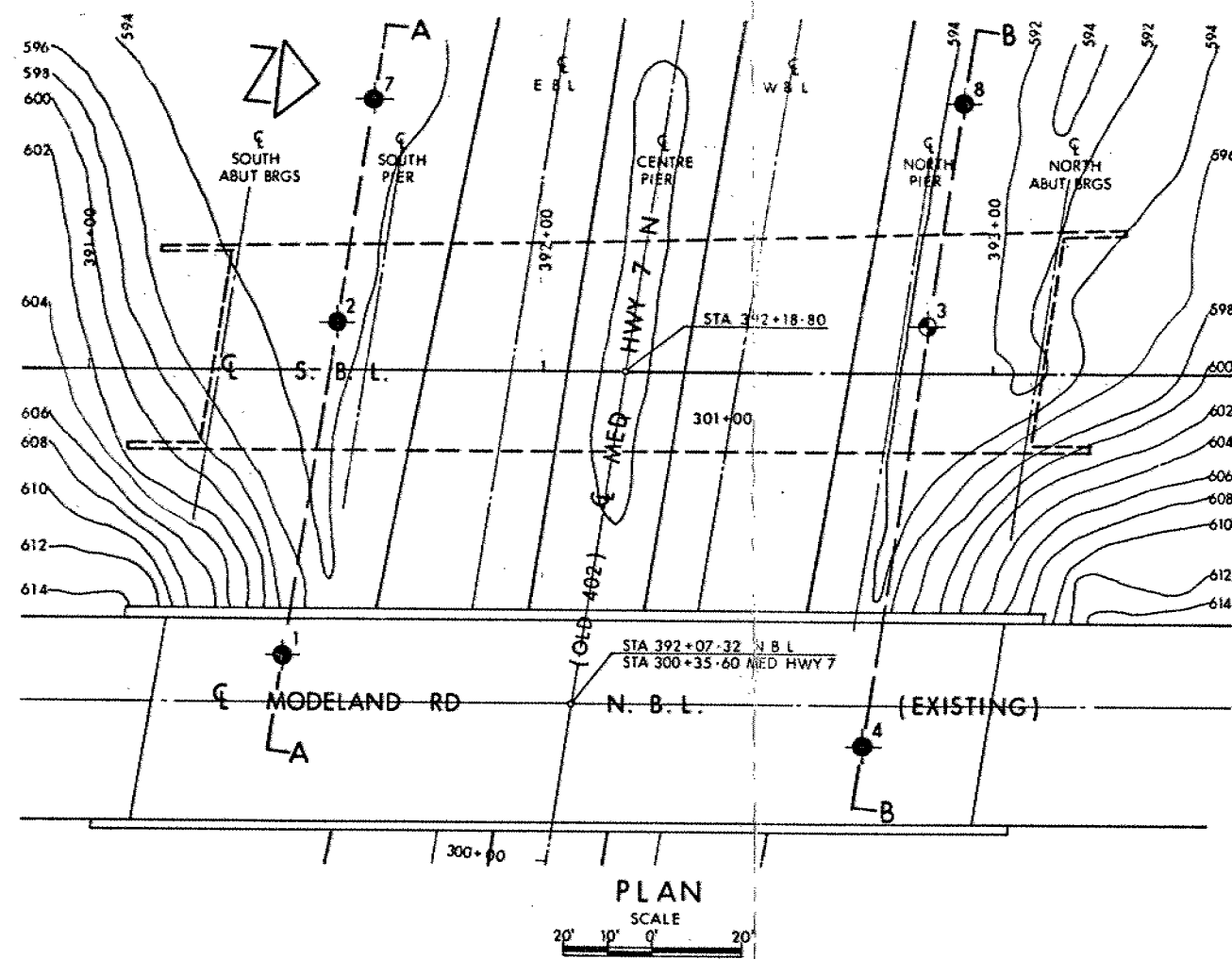
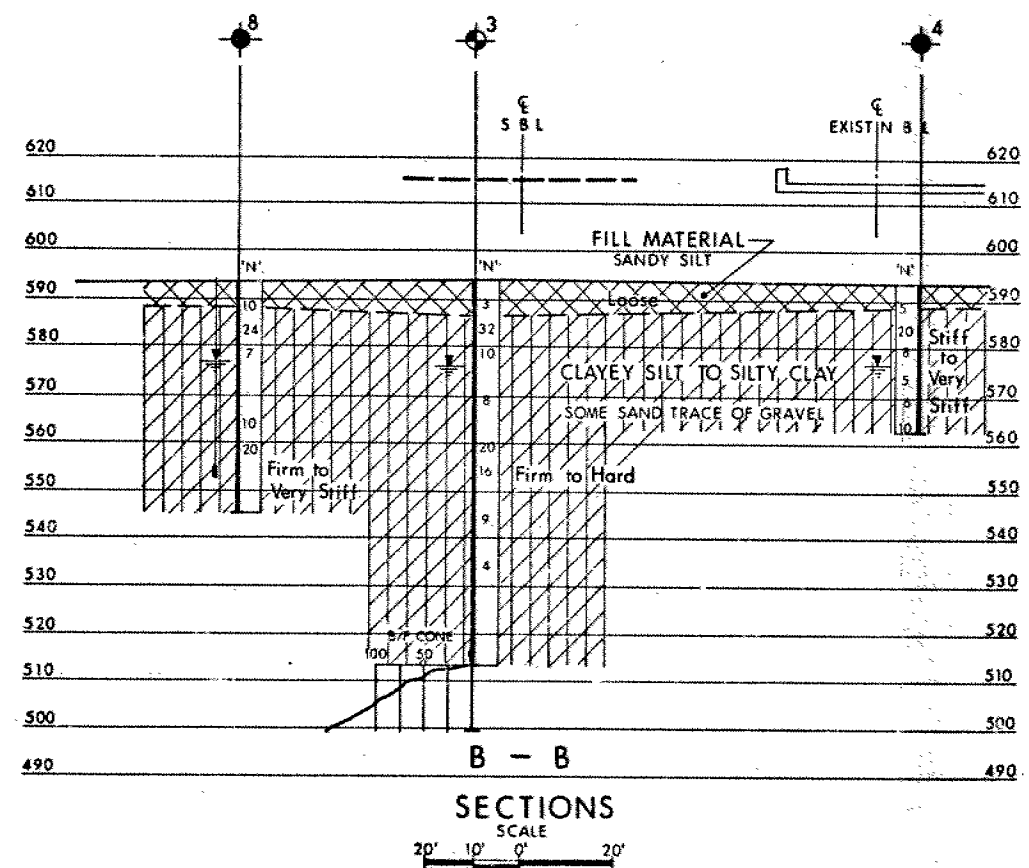
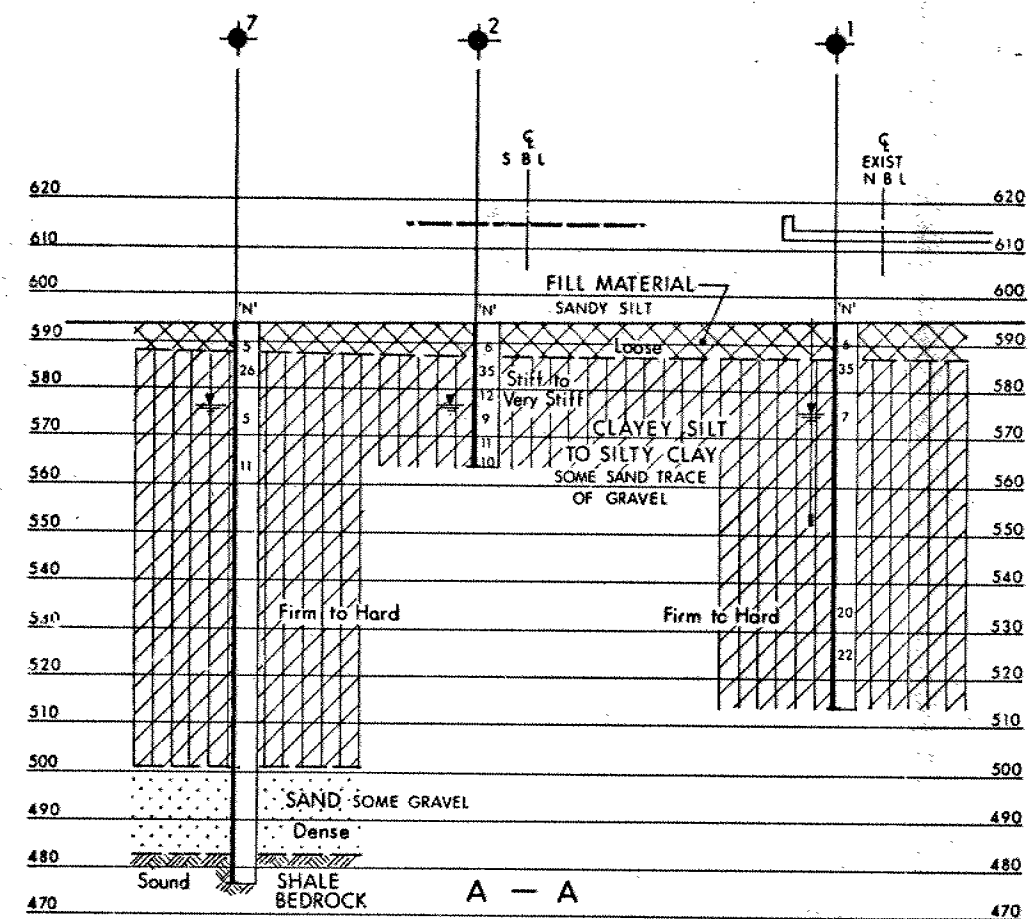
W.P. 3001-20-00 LOCATION Highway 40 - London Line Overpass, Samia ORIGINATED BY DL
 DIST West HWY London Line BOREHOLE TYPE 83 mm ID Hollow Stem Auger - Split Spoon COMPILED BY DL
 DATUM Geodetic DATE 2021.09.17 LATITUDE 42.985034 LONGITUDE -82.343727 CHECKED BY KN

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										
181.4	Paved Shoulder						20	40	60	80	100							
181.2	200 mm ASPHALTIC CONCRETE						20	40	60	80	100							
0.2	Gravelly SAND (SM), some silt to silty (FILL) Occasional cobbles in the upper portion Compact Brown to grey Moist to wet		1	SS	30	▽								○				
			2	SS	24										○			30 49 14 7
			3	SS	14										○			
179.0																		
2.4	CLAYEY SILT (CL), some sand, trace gravel (FILL) Very stiff Grey, dark streaks Wet		4	SS	9										○			
178.4															○			
3.0	CLAYEY SILT (CL), some sand, trace gravel (TILL) Occasional cobbles and/or boulders Hard Brown/grey mottled to grey Wet		5	SS	14										○			
			6	SS	10										He			3 15 31 51
			7	SS	10										○			
			8	SS	4										○			
	SPT 'N' value for SS9 influenced by attempted vane testing		9	SS	5							+		○			Su>118 kPa (N-vane refusal)	
			10	SS	8											He	2 16 32 51	
172.9																	Su>118 kPa (N-vane refusal)	
8.5	End of Borehole																	
	Groundwater observed below 1.3 m depth during drilling. Water level in open borehole at 6 m depth on completion of drilling.																	

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

SUBSURFACE INFORMATION FROM GEOCREST REPORT 40J16-008





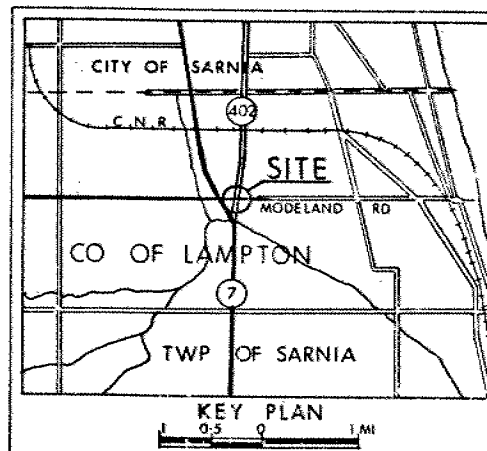
CONT No
WP No 122-65-06

MODELAND RD INTERCHANGE
OVERPASS S.B.L.

BORE HOLE LOCATIONS & SOIL STRATA



SHEET



LEGEND

- Bore Hole
- ⊕ Dynamic Cone Penetration Test (Cone)
- ⊙ Bore Hole & Cone
- 'N' Blows/ft (Std Pen Test 350 ft lbs energy)
- CONE Blows/ft (60° Cone, 350 ft lbs energy)
- W.L. at time of investigation JULY 1962
- PIEZOMETER

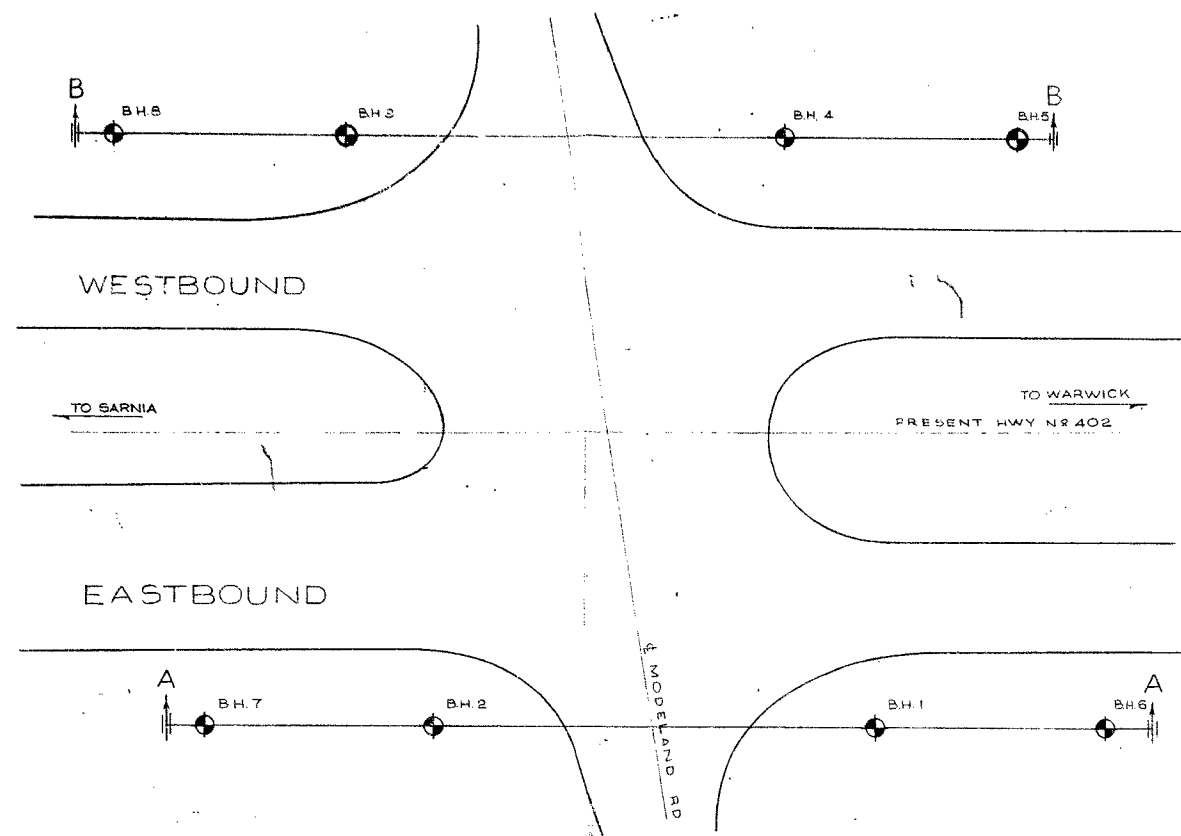
No.	ELEVATION	STATION	OFFSET S.B.L.
1	594.6	391+42	64' RT
2	594.7	391+54	10' LT
3	594.1	392+86	10' LT
4	593.0	392+72	83' LT
7	594.1	391+63	61' LT
8	593.5	392+94	59' LT

NOTE

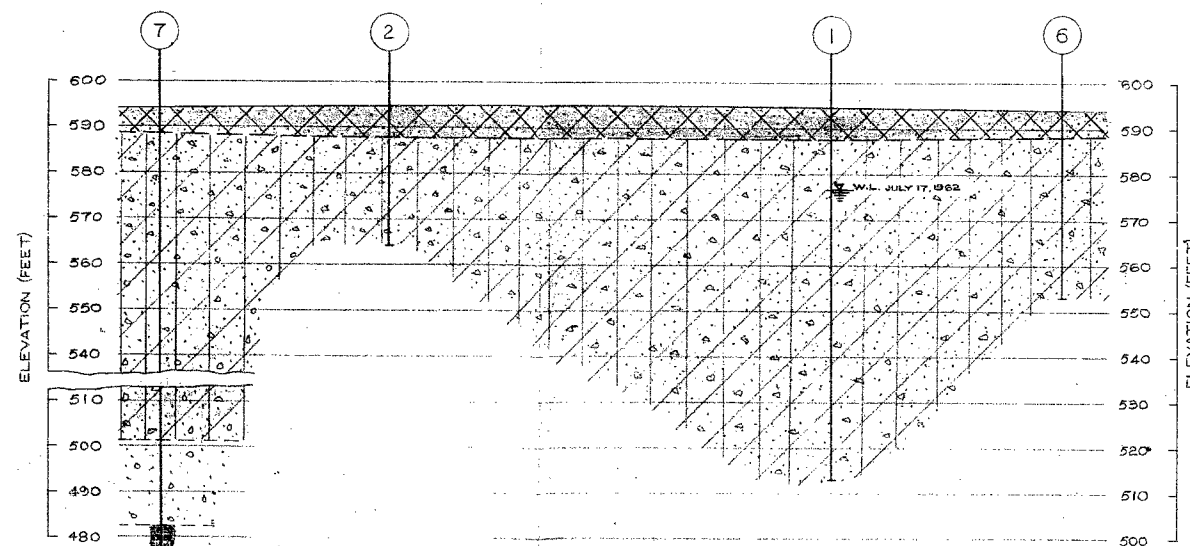
The boundaries between soil strata have been established only at Bore Hole locations. Between Bore Holes the boundaries are assumed from geological evidence.

REVISIONS	DATE	BY	DESCRIPTION

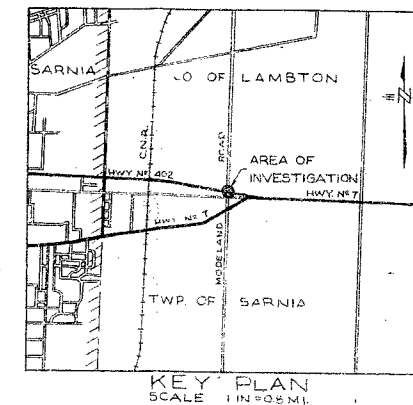
HWY No 7 (OLD 402) DIST 1
SUBWD P. CHECKED DATE 79 02 02 SITE 14-279
DRAWN J. CHECKED DATE 79 02 02 14-279-2



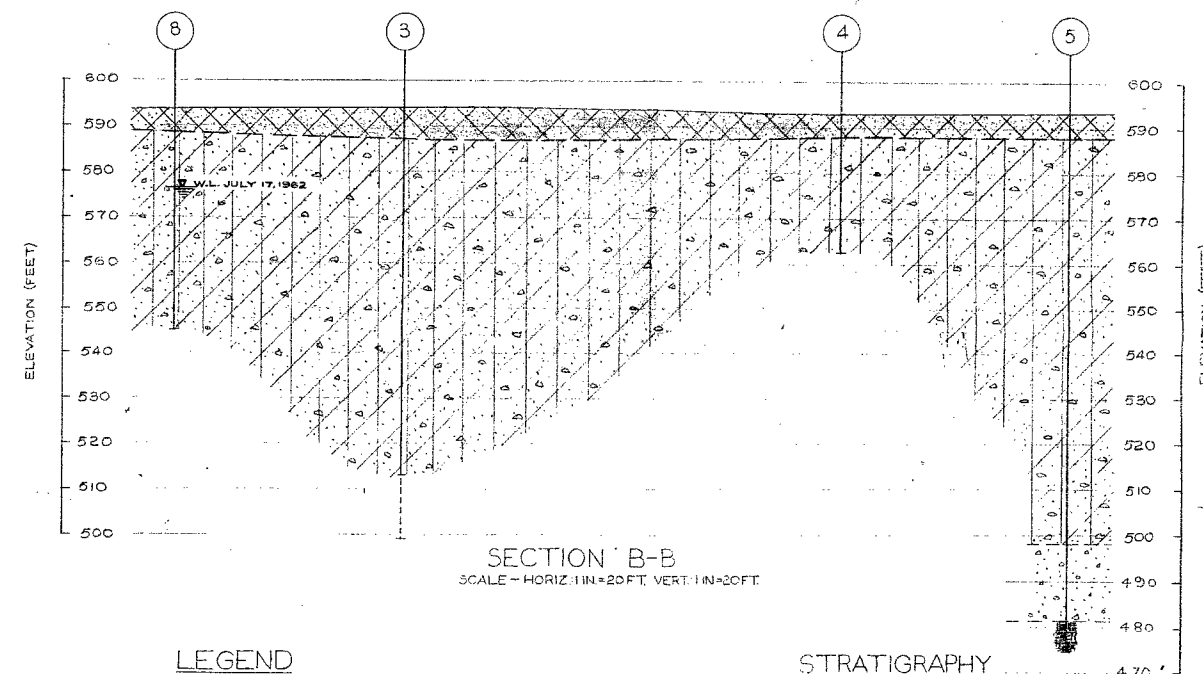
PLAN
SCALE: 1 IN. = 20 FT.



SECTION A-A
SCALE - HORIZ. 1 IN. = 20 FT. VERT. 1 IN. = 20 FT.



KEY PLAN
SCALE: 1 IN. = 0.5 MI.



SECTION B-B
SCALE - HORIZ. 1 IN. = 20 FT. VERT. 1 IN. = 20 FT.

LEGEND

- BOREHOLE IN PLAN
- BOREHOLE WITH PENETRATION TEST IN PLAN
- BOREHOLE IN ELEVATION
- PENETRATION TEST IN ELEVATION

- LOOSE BROWN TO DARK BROWN SAND FILL
- HARD TO STIFF BROWN TO GREY SILTY CLAY WITH SAND AND GRAVEL
- GREY MEDIUM AND FINE SAND WITH SOME GRAVEL
- BLACK SHALE BEDROCK

SPECIAL NOTE: DATA CONCERNING THE VARIOUS STRATA HAVE BEEN OBTAINED AT BOREHOLE LOCATIONS ONLY. THE SOIL STRATIGRAPHY BETWEEN BOREHOLES HAS BEEN INFERRED FROM GEOLOGICAL EVIDENCE AND SO MAY VARY FROM THAT SHOWN.

REVISIONS			REFERENCE			REFERENCE		
MARK	DATE	DESCRIPTION	DWG. NO.	DESCRIPTION	DWG. NO.	DESCRIPTION	DESCRIPTION	DESCRIPTION
A	20/7/62	ADDITIONAL INFORMATION AT DEPTH AT BOREHOLE 5 AND 7			E-4114-1	DEPARTMENT OF HIGHWAYS, ONTARIO PROPOSED CROSSING AT MODELAND ROAD AND THE KING'S HIGHWAY NO 402	DEPARTMENT OF HIGHWAYS, ONTARIO TORONTO PROPOSED MODELAND ROAD UNDERPASS SARNIA BORING PLAN AND SOIL STRATIGRAPHY	GEOCON LTD DATE JULY 17, 1962 SCALE HORIZ. 1 IN. = 20 FT. VERT. 1 IN. = 20 FT. MADE BY: A.I.B. CHKD. BY: J.W. APPD. BY: F.J.H. NO. S7389-1-A



RECORD OF BOREHOLE No 1

W P 122-65-06 LOCATION Sta. 391+42, 64' Rt. of S.B.L. ORIGINATED BY Geocon
DIST 1 HWY 7 BOREHOLE TYPE Continuous Flight Auger COMPILED BY S.O.
DATUM Geodetic DATE July 6, 1962 CHECKED BY

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			20	40	60	80	100					
594.6	Ground Level																
0.0	Sandy Silt																
	Loose																
	Fill Material		1	SS	6		590										
587.6																	
7.0	Clayey Silt to		2	SS	35												
	Silty Clay																
	Some Sand																
	Trace of Gravel																
	Firm to Hard		3	SS	7		580										
			4A	TW	PH												
			4B	TW	PH												
			5	TW	PH		550										
			6	SS	20		530										
			7	SS	22												
513.1			8	TW	PH												
81.5	End of Borehole																

+3, x5: Numbers refer to
Sensitivity

20
15 \diamond 5 (%) STRAIN AT FAILURE
10



RECORD OF BOREHOLE No 2

W P 122-65-06 LOCATION Sta. 391+54, 10' Lt. of S.B.L. ORIGINATED BY Geocon
DIST 1 HWY 7 BOREHOLE TYPE Continuous Flight Auger COMPILED BY S.O.
DATUM Geodetic DATE July 9, 1962 CHECKED BY *oif*

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 (%) GR SA SI CL						
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100						WATER CONTENT (%)					
								SHEAR STRENGTH															
								○ UNCONFINED + FIELD VANE															
								● QUICK TRIAXIAL x LAB VANE															
594.7	Ground Level																						
0.0	Sandy Silt							590															
587.7	Loose Fill Material		1	SS	6																		
7.0	Clayey Silt to Silty Clay		2	SS	35																		
			3	SS	12																		
			4	SS	9																		
			5	SS	11																		
564.2			6	SS	10		570																
30.5	End of Borehole																						

+3, x5: Numbers refer to
Sensitivity

20
15 \div 5 (%) STRAIN AT FAILURE
10



RECORD OF BOREHOLE No 3

W P 122-65-06 LOCATION STA. 392+86, 10' Lt. of S.B.L. ORIGINATED BY Geocon
DIST 1 HWY 7 BOREHOLE TYPE Continuous Flight Auger COMPILED BY S.O.
DATUM Geodetic DATE July 9, 1962 CHECKED BY *[Signature]*

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 (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20 40 60 80 100									
								SHEAR STRENGTH									
								○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB VANE 400 800 1200 1600 2000									
594.1	Ground Level																
0.0	Sandy Silt Very Loose Fill Material		1	SS	3		590										
587.1			2	SS	32												
7.0	Clayey Silt to Silty Clay		3	SS	10		580										
	Some Sand		4	TW	PH												
	Trace of Gravel		5	SS	8		570										
	Firm to Hard		6	TW	PH												
			7	SS	20		560										
			8	SS	16												
			9	SS	9		550										
			10	SS	4		540										
			11	TW	PH		530										
513.1							520										
81.0	End of Borehole						510										
499.1							500										
95.0	End of Cone Test																

+3, x5: Numbers refer to
Sensitivity

20
15 5 (%) STRAIN AT FAILURE
10



RECORD OF BOREHOLE No 4

W P 122-65-06 LOCATION Sta. 392+72, 83' Lt. of S.B.L. ORIGINATED BY Geocon
DIST 1 HWY 7 BOREHOLE TYPE Continuous Flight Auger COMPILED BY S.O.
DATUM Geodetic DATE July 9, 1962 CHECKED BY _____

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 Y	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100					
593.0	Ground Level																
0.0	Sandy Silt						590										
588.0	Loose		1	SS	5												
	Fill Material		2	SS	20												
5.0	Clayey Silt to Silty Clay		3	SS	8		580										
	Some Sand		4	SS	5												
	Traces of Gravel		5	SS	6												
	Stiff to Very Stiff		6	SS	10		570										
562.5	End of Borehole																
30.5																	

+3, x5: Numbers refer to
Sensitivity

20
15 \diamond 5 (%) STRAIN AT FAILURE
10

GEOCON

OFFICE REPORT ON SOIL EXPLORATION

CONTRACT 57389 BORING # 5 DATUM GEODETIC CASING
 BORING DATE JULY 5, 1962 REPORT DATE JULY 12, 1962 COMPILED BY A.I.B. CHECKED BY J.I.V.
 SAMPLER HAMMER WT. 140 LBS. DROP 30 INCHES (PENETRATION RESISTANCES CONVERTED TO BLOWS OF 4200 IN - LBS. ENERGY)

SAMPLE CONDITION



A.S. - AUGER SAMPLE
 S.T. - SLOTTED TUBE
 W.S. - WASHED SAMPLE
 D.O. - DRIVE-OPEN
 D.F. - DRIVE-FOOT VALVE
 C.S. - CHUNK SAMPLE

SAMPLE TYPES

F.S. - FOIL SAMPLE
 S.O. - SLEEVE-OPEN
 S.F. - SLEEVE-FOOT VALVE
 T.O. - THIN WALLED OPEN
 R.C. - ROCK CORE

ABBREVIATIONS

V - IN-SITU VANE TEST
 M - MECHANICAL ANALYSIS
 U - UNCONFINED COMPRESSION
 QC - TRIAXIAL CONSOLIDATED QUICK
 Q - TRIAXIAL QUICK
 S - TRIAXIAL SLOW

γ - WET UNIT WEIGHT
 K - PERMEABILITY
 C - CONSOLIDATION

WL - WATER LEVEL IN CASING
 WT - WATER TABLE IN SOIL

SOIL PROFILE

ELEV. DEPTH	WATER CONDITIONS	DESCRIPTION	STRAT. PLOT	ELEVATION SCALE
593.2 0.0		GROUND LEVEL		600
587.7 5.5		LOOSE BROWN TO DARK BROWN SAND FILL		590
575.0 18.2		HARD TO STIFF BROWN TO GREY SILTY CLAY WITH SAND AND GRAVEL		580
		STIFF TO VERY STIFF GREY SILTY CLAY WITH SAND AND GRAVEL		570
				560
				550
				540
				530
				520
513.7 79.5		END OF BOREHOLE PROBABLY VERY STIFF GREY SILTY CLAY WITH SAND AND GRAVEL		510
502.2 91.0		END OF PEN TEST		500

COMPRESSIVE STRENGTH TONS/SQ. FT.
 VANE TEST + (NAT) ⊕ (REM) ◆ UNDRAINED TRIAXIAL

WATER CONTENT W% 0 NAT. □ LW Δ PW

DYNAMIC PENETRATION TEST BLOWS PER FOOT

20 40 60 80 100

OTHER TESTS

SAMPLES

CONDITION	TYPE	NUMBER	PENETRATION RESISTANCE BLOWS/FT.
2" S.O.	1	4	
S.O.	2	13	
S.O.	3	21	
S.O.	4	8	
3" T.O.	5A	HYD. PUSH	
T.O.	5	HYD. PUSH	
2" S.O.	6	11	
S.O.	7	8	
2" T.O.	8	HYD. PUSH	
T.O.	9	HYD. PUSH	
2" S.O.	10	20	

GEOCON

OFFICE REPORT ON SOIL EXPLORATION

CONTRACT 57383 BORING # 6 DATUM GEODETIC CASING
 BORING DATE JULY 8, 1962 REPORT DATE JULY 13, 1962 COMPILED BY A.I.B. CHECKED BY J.W.
 SAMPLER HAMMER WT. 140 LBS. DROP 30 INCHES (PENETRATION RESISTANCES CONVERTED TO BLOWS OF 4200 IN - LBS. ENERGY)

SAMPLE CONDITION



A.S. - AUGER SAMPLE
 S.T. - SLOTTED TUBE
 W.S. - WASHED SAMPLE
 D.O. - DRIVE-OPEN
 D.F. - DRIVE-FOOT VALVE
 C.S. - CHUNK SAMPLE

SAMPLE TYPES

F.S. - FOIL SAMPLE
 S.O. - SLEEVE-OPEN
 S.F. - SLEEVE-FOOT VALVE
 T.O. - THIN WALLED OPEN
 R.C. - ROCK CORE

ABBREVIATIONS

V - IN-SITU VANE TEST
 M - MECHANICAL ANALYSIS
 U - UNCONFINED COMPRESSION
 QC - TRIAXIAL CONSOLIDATED QUICK
 Q - TRIAXIAL QUICK
 S - TRIAXIAL SLOW
 γ - WET UNIT WEIGHT
 K - PERMEABILITY
 C - CONSOLIDATION
 WL - WATER LEVEL IN CASING
 WT - WATER TABLE IN SOIL

SOIL PROFILE

SOIL PROFILE								OTHER TESTS	SAMPLES			
ELEVN. DEPTH	WATER CONDITIONS	DESCRIPTION	STRAT. PLOT	ELEVATION SCALE	WATER CONTENT W% O NAT. □ LW ▲ Pw				CONDITION	TYPE	NUMBER	PENETRATION RESISTANCE BLOWS/F.T.
					DYNAMIC PENETRATION TEST BLOWS PER FOOT							
				600								
594.1 0.0		GROUND LEVEL										
		LOOSE BROWN TO DARK BROWN SAND FILL		590								
588.1 6.0												
		HARD TO STIFF BROWN TO GREY SILTY CLAY WITH SAND AND GRAVEL		580								
575.0 19.1												
		STIFF GREY SILTY CLAY WITH SAND AND GRAVEL		570								
				560								
553.1 41.0		END OF HOLE		550								



RECORD OF BOREHOLE No 7

W P 122-65-06 LOCATION Sta. 391+63, 61' Lt. of S.B.L. ORIGINATED BY Geocon
DIST 1 HWY 7 BOREHOLE TYPE Continuous Flight Auger COMPILED BY S.O.
DATUM Geodetic DATE July 13 & 19, 1962 CHECKED BY e.f.

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 PCF	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100					
594.1	Ground Level																
0.0	Sandy Silt Loose																
588.6	Fill Material		1	SS	5		590										
5.5	Clayey Silt to Silty Clay		2	SS	26												
	Some Sand																
	Trace of Gravel						580			3+							
	Firm to Hard		3	SS	5												
							570			1+							
			4	SS	11												
							560										
							550										
							540										
							530										
							520										
							510										
501.1							500										
93.0	Sand Some Gravel Dense						490										
482.3																	
111.8	Shale Bedrock Black						480										
476.6	Sound																
117.5	End of Borehole																

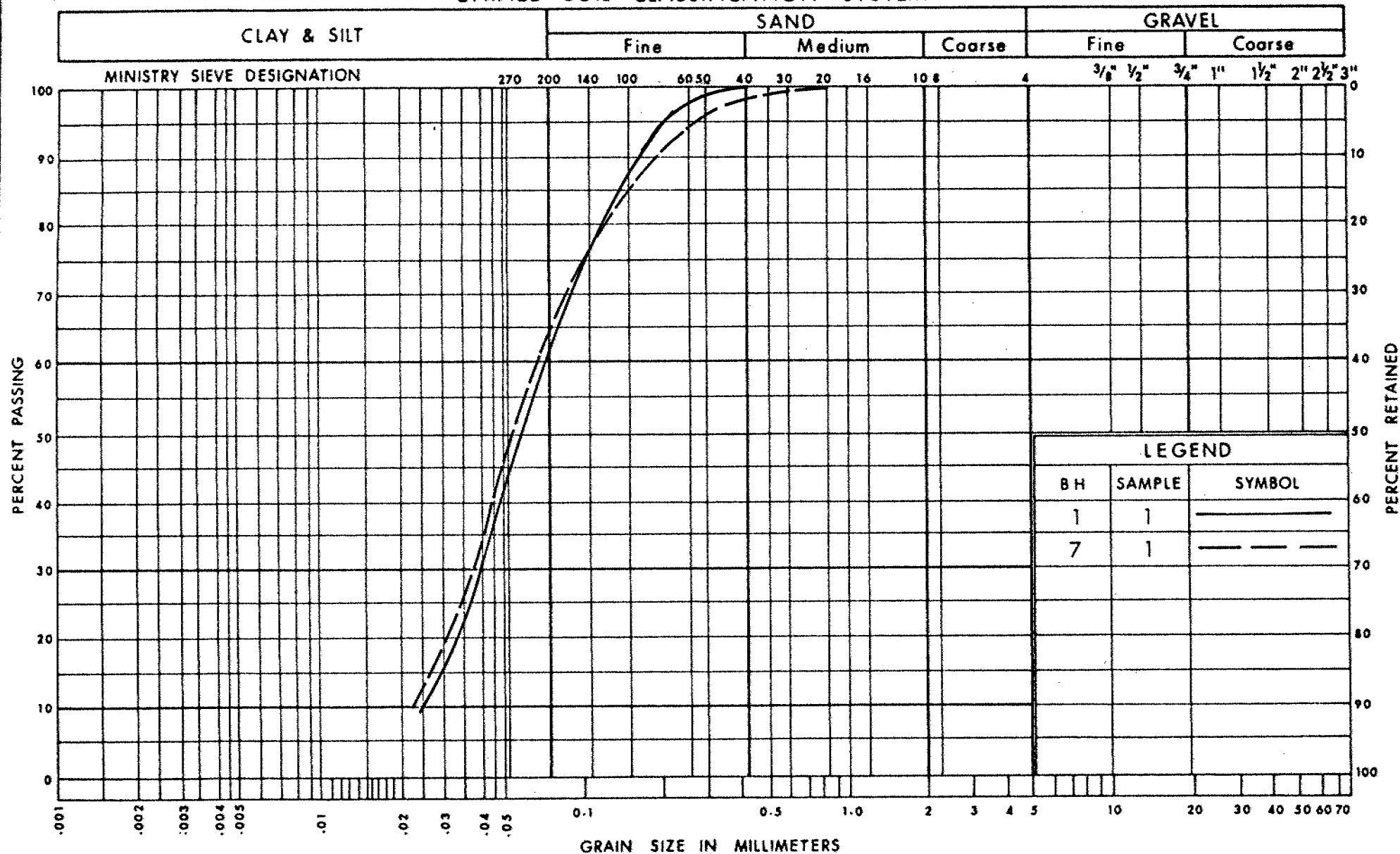
+3, x5: Numbers refer to
Sensitivity

20
15 \div 5 (%) STRAIN AT FAILURE
10

W P 122-65-06 LOCATION Sta. 392+94, 59' Lt. of S.B.L. ORIGINATED BY Geonon
DIST 1 HWY 7 BOREHOLE TYPE Continuous Flight Auger COMPILED BY S.O.
DATUM Geodetic DATE July 13, 1962 CHECKED BY W.F.

+3, x5: Numbers refer to Sensitivity

UNIFIED SOIL CLASSIFICATION SYSTEM



Ontario

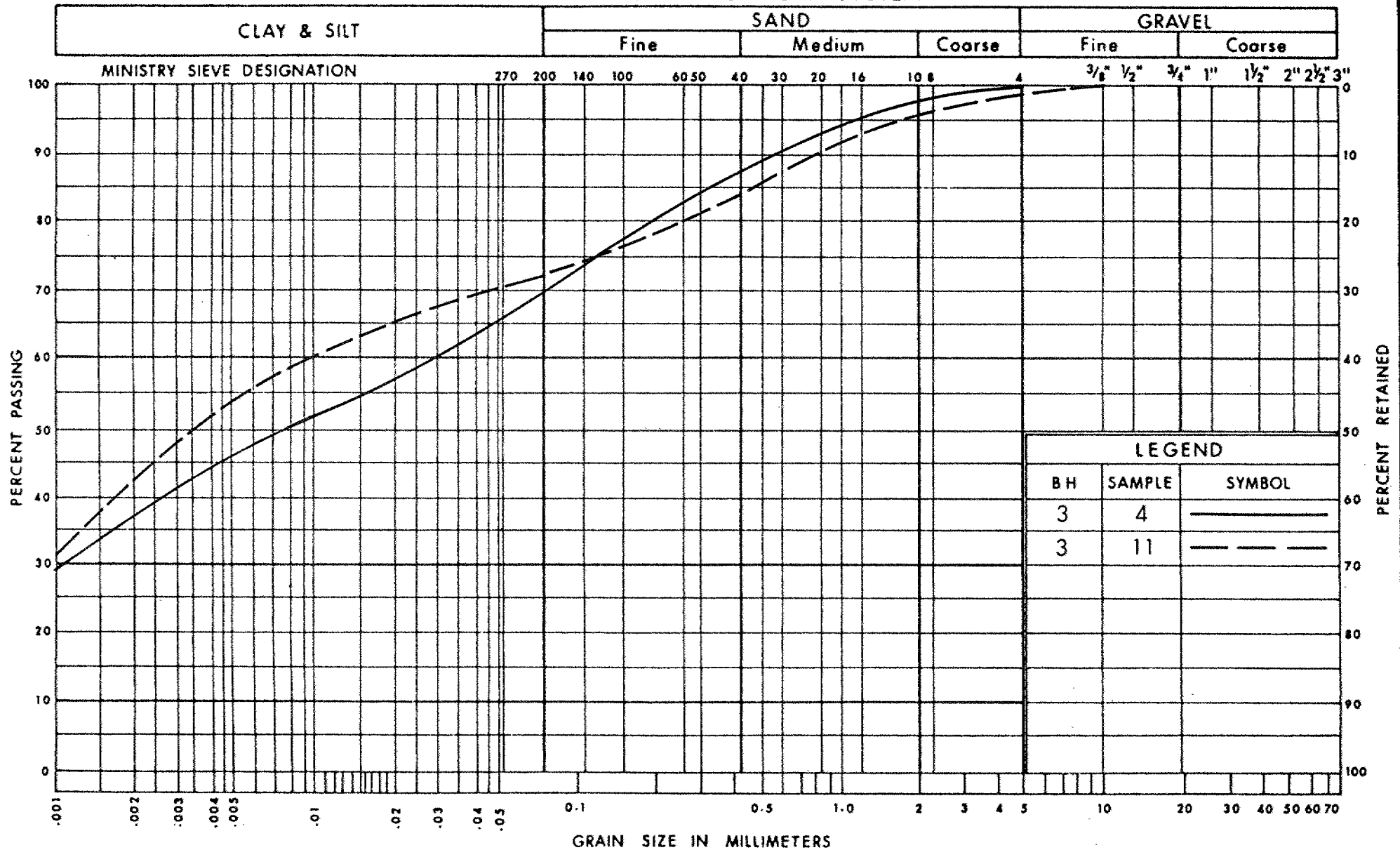
 Ministry of
Transportation and
Communications

GRAIN SIZE DISTRIBUTION FILL MATERIAL

FIG No 1

W P 122-65-06

UNIFIED SOIL CLASSIFICATION SYSTEM



Ontario

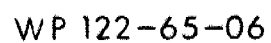
 Ministry of
Transportation and
Communications

GRAIN SIZE DISTRIBUTION

CLAYEY SILT TO SILTY CLAY

FIG No 2

W P 122-65-06

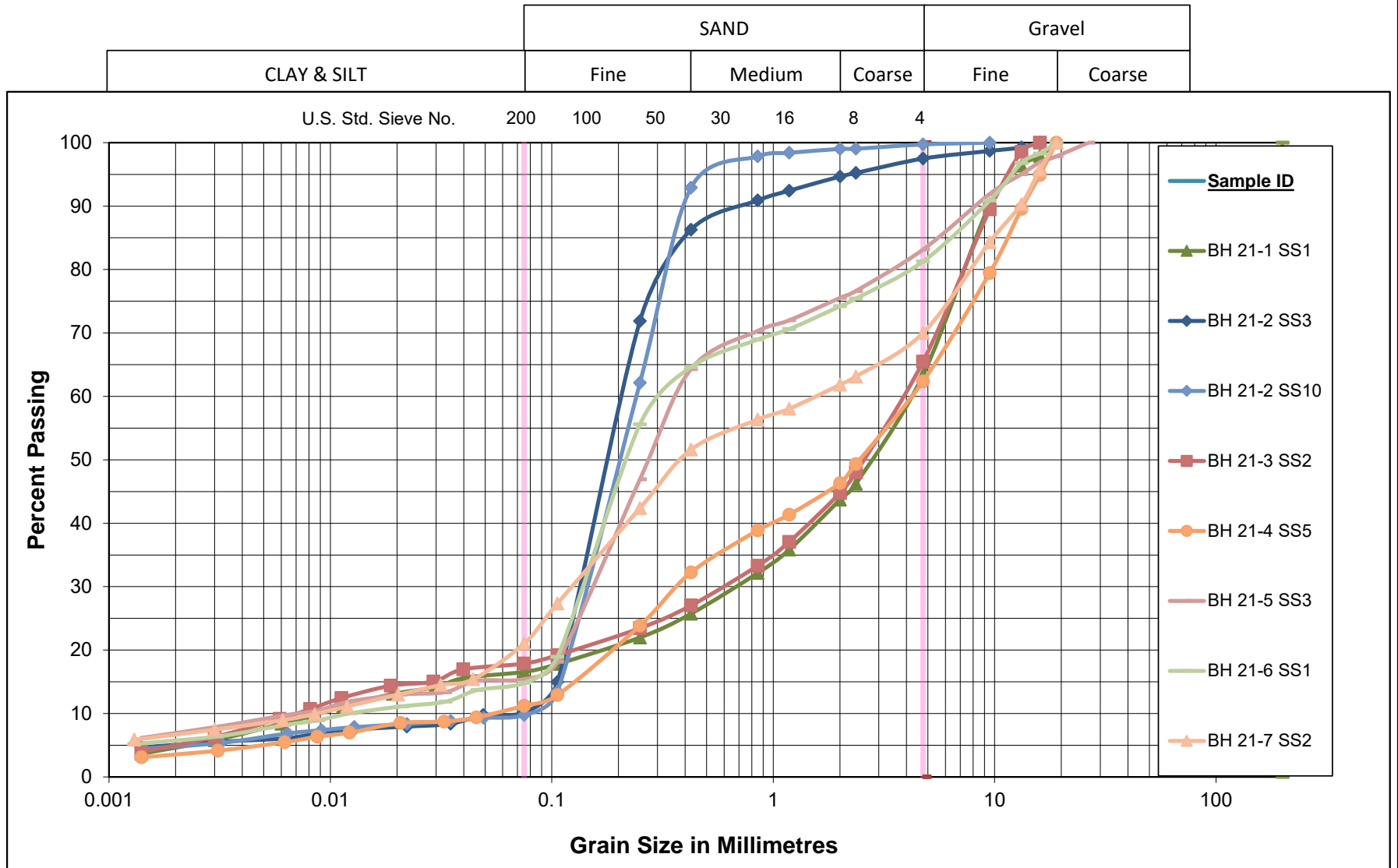


APPENDIX C

C.1 LABORATORY TEST RESULTS



Unified Soil Classification System



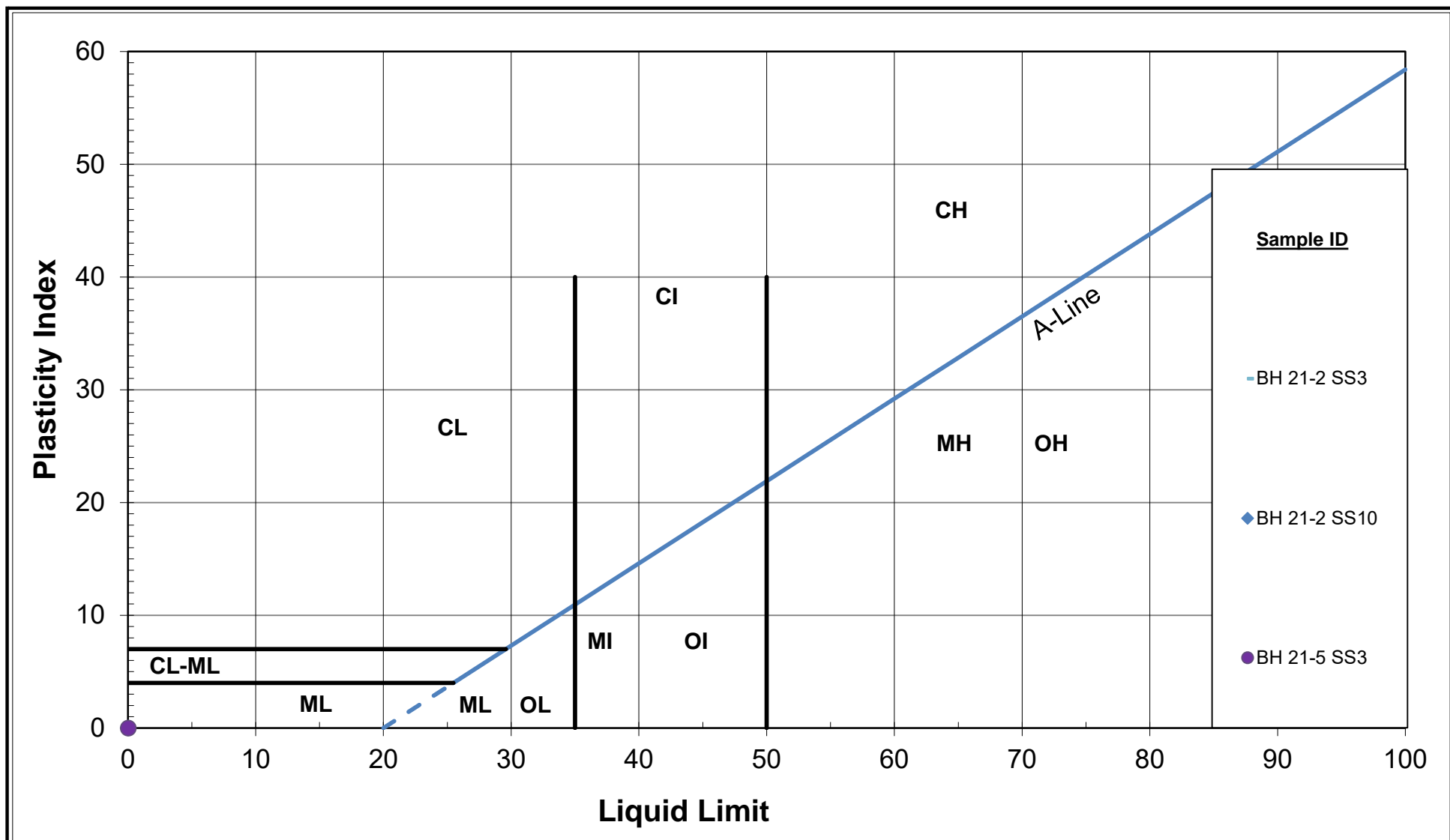
GRAIN SIZE DISTRIBUTION

FILL: SAND (SP) to SAND and GRAVEL/Gravelly SAND (SM)

Hwy 40 Rehabilitation - Site Nos. 14X-0279/B1 and B2

Figure No. C1

Project No. 165001228 (340)



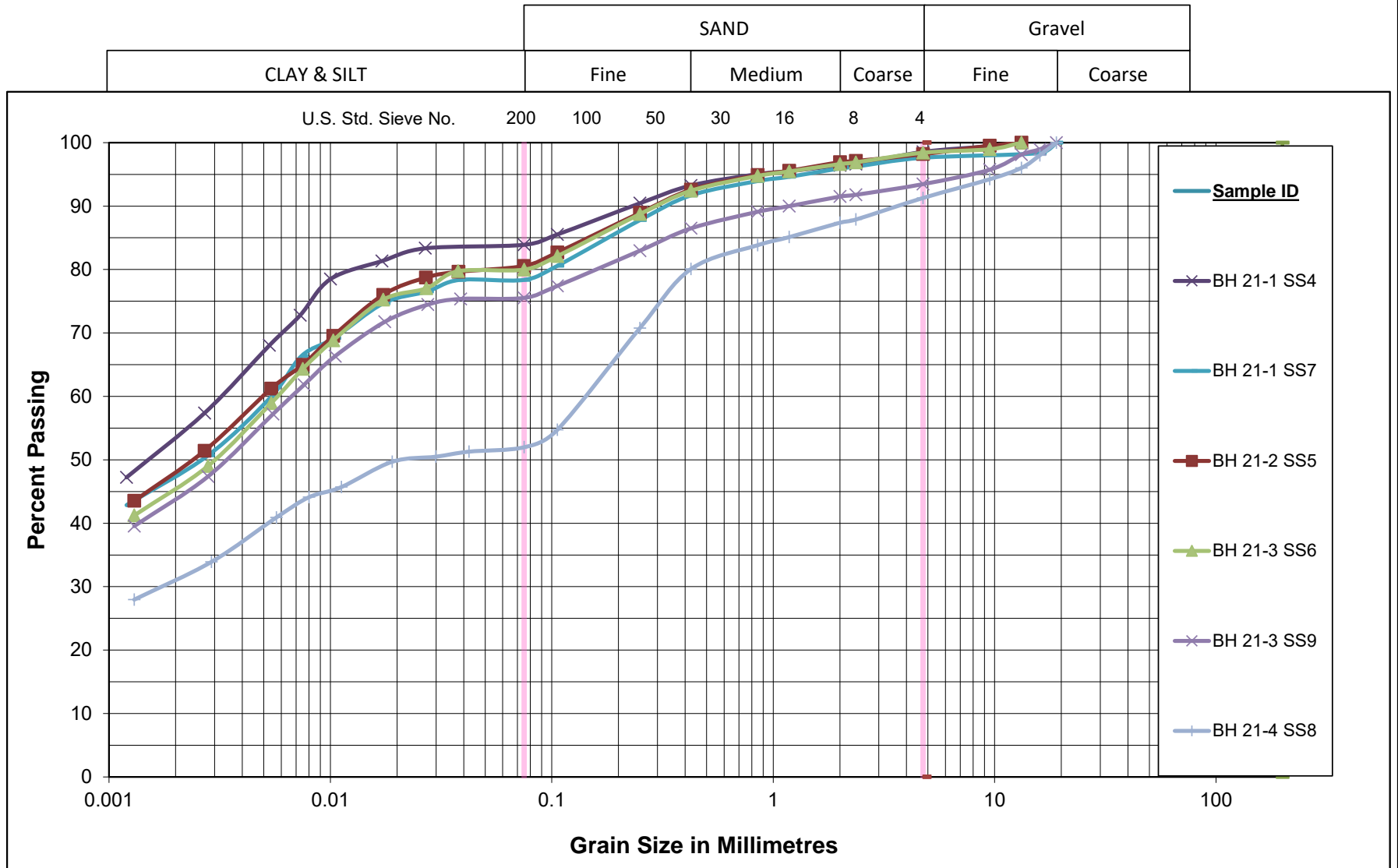
FILL: SAND (SP) to SAND and GRAVEL/Gravelly SAND (SM)
Hwy 40 Rehabilitation - Site Nos. 14X-0279/B1 and B2

PLASTICITY CHART

Figure No. C2

Project No. 165001228 (340)

Unified Soil Classification System



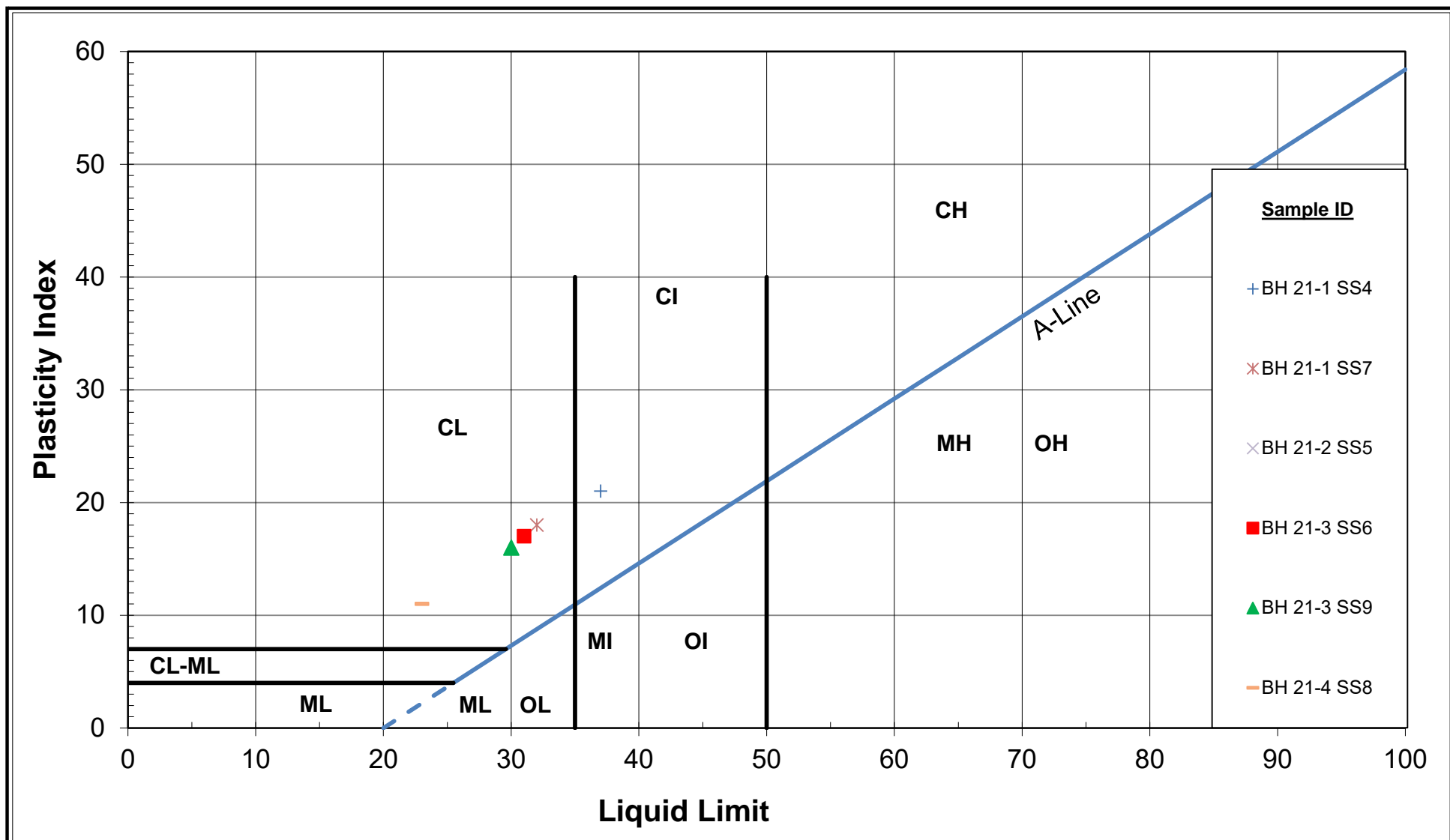
GRAIN SIZE DISTRIBUTION

FILL: Sandy CLAYEY SILT (CL) to SILTY CLAY (CI)

Hwy 40 Rehabilitation - Site Nos. 14X-0279/B1 and B2

Figure No. C3

Project No. 165001228 (340)



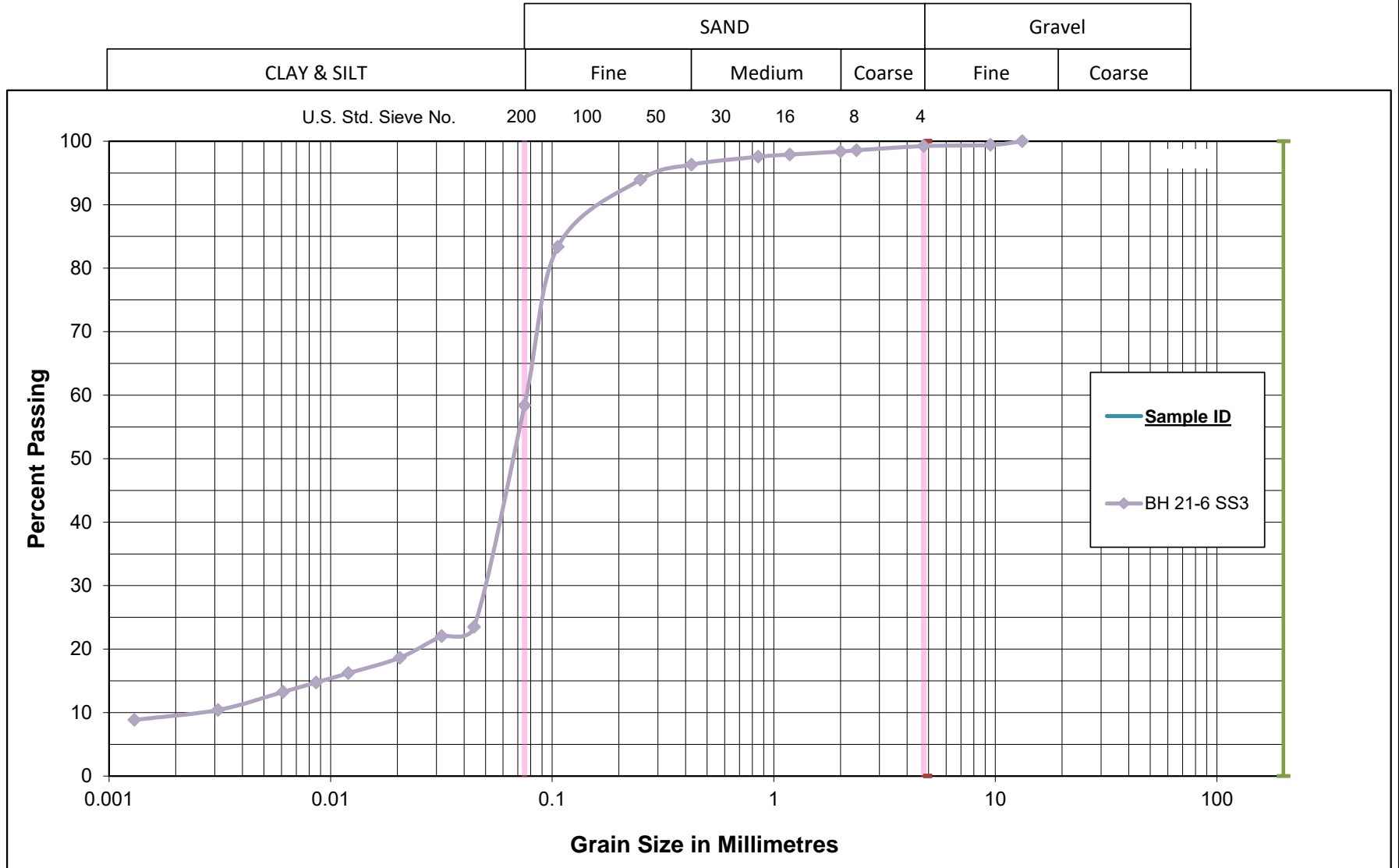
FILL: Sandy CLAYEY SILT (CL) to SILTY CLAY (CI)
Hwy 40 Rehabilitation - Site Nos. 14X-0279/B1 and B2

PLASTICITY CHART

Figure No. C4

Project No. 165001228 (340)

Unified Soil Classification System



GRAIN SIZE DISTRIBUTION

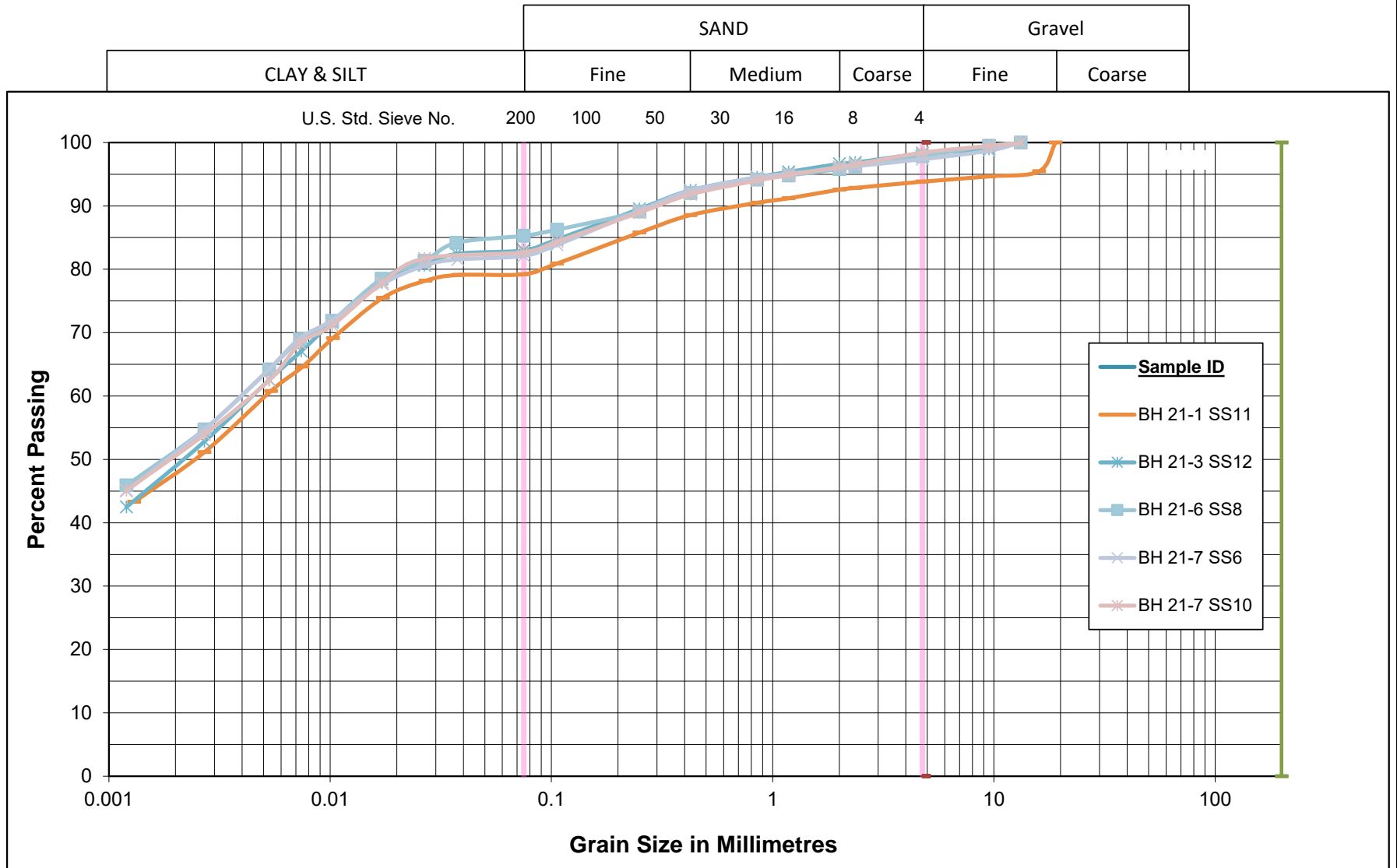
Sandy SILT (ML)

Hwy 40 Rehabilitation - Site Nos. 14X-0279/B1 and B2

Figure No. C5

Project No. 165001228 (340)

Unified Soil Classification System



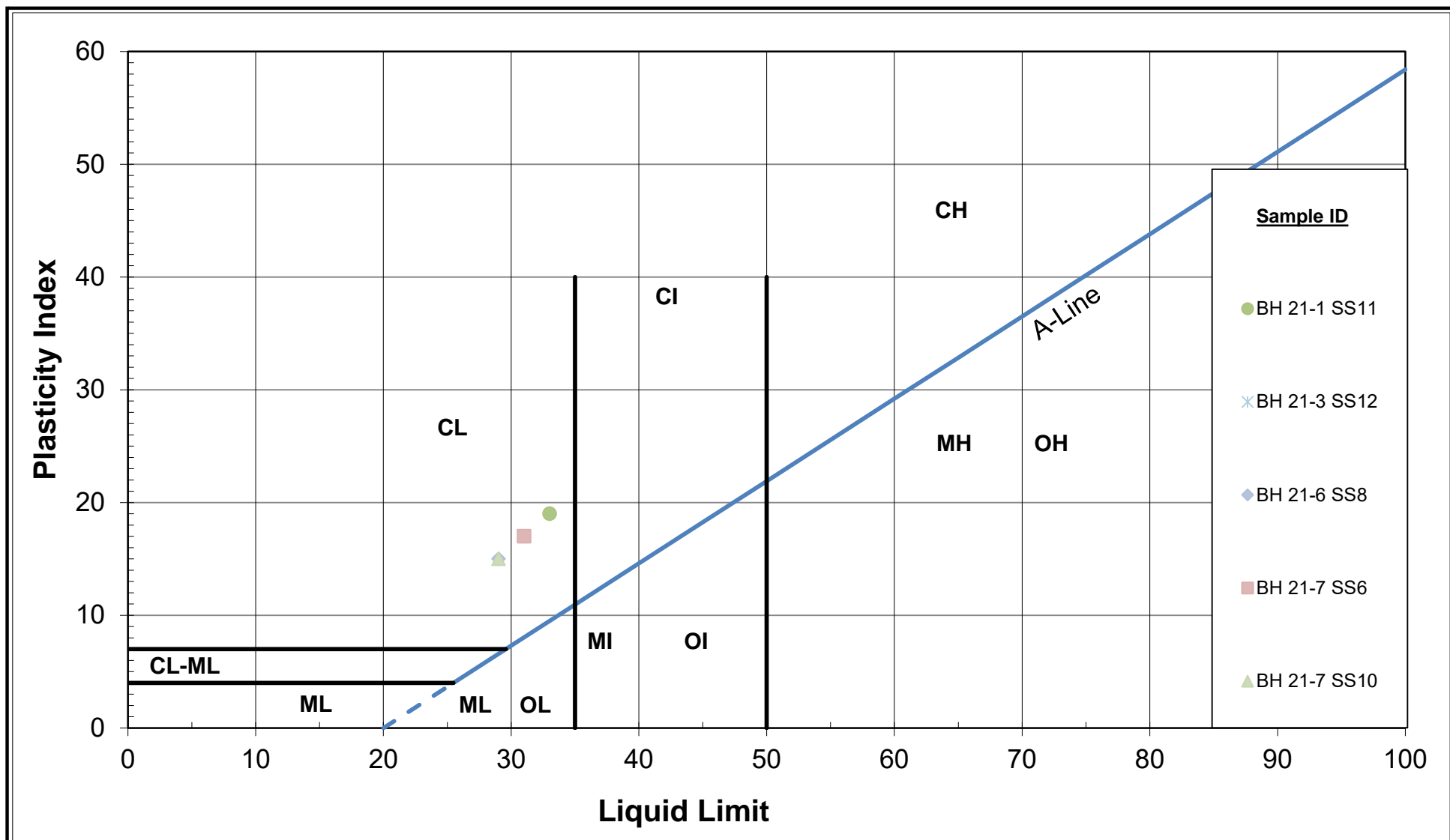
GRAIN SIZE DISTRIBUTION

CLAYEY SILT (CL) TILL

Hwy 40 Rehabilitation - Site Nos. 14X-0279/B1 and B2

Figure No. C6

Project No. 165001228 (340)



CLAYEY SILT (CL) TILL
Hwy 40 Rehabilitation - Site Nos. 14X-0279/B1 and B2
PLASTICITY CHART

Figure No. C7

Project No. 165001228 (340)

CLIENT NAME: STANTEC CONSULTING LTD
300-675 Cochrane Drive
MARKHAM, ON L3R0B8
(905) 444-7777

ATTENTION TO: Nabeel Basheer

PROJECT: 165001228.340

AGAT WORK ORDER: 21T809942

SOIL ANALYSIS REVIEWED BY: Nivine Basily, Inorganics Report Writer

DATE REPORTED: Oct 12, 2021

PAGES (INCLUDING COVER): 5

VERSION*: 1

Should you require any information regarding this analysis please contact your client services representative at (905) 712-5100

*Notes

Disclaimer:

- All work conducted herein has been done using accepted standard protocols, and generally accepted practices and methods. AGAT test methods may incorporate modifications from the specified reference methods to improve performance.
- All samples will be disposed of within 30 days after receipt unless a Long Term Storage Agreement is signed and returned. Some specialty analysis may be exempt, please contact your Client Project Manager for details.
- AGAT's liability in connection with any delay, performance or non-performance of these services is only to the Client and does not extend to any other third party. Unless expressly agreed otherwise in writing, AGAT's liability is limited to the actual cost of the specific analysis or analyses included in the services.
- This Certificate shall not be reproduced except in full, without the written approval of the laboratory.
- The test results reported herewith relate only to the samples as received by the laboratory.
- Application of guidelines is provided "as is" without warranty of any kind, either expressed or implied, including, but not limited to, warranties of merchantability, fitness for a particular purpose, or non-infringement. AGAT assumes no responsibility for any errors or omissions in the guidelines contained in this document.
- All reportable information as specified by ISO/IEC 17025:2017 is available from AGAT Laboratories upon request.

Certificate of Analysis

AGAT WORK ORDER: 21T809942

PROJECT: 165001228.340

5835 COOPERS AVENUE
MISSISSAUGA, ONTARIO
CANADA L4Z 1Y2
TEL (905)712-5100
FAX (905)712-5122
<http://www.agatlabs.com>

CLIENT NAME: STANTEC CONSULTING LTD

ATTENTION TO: Nabeel Basheer

SAMPLING SITE:

SAMPLED BY:

Corrosivity Package

DATE RECEIVED: 2021-10-01

DATE REPORTED: 2021-10-12

		SAMPLE DESCRIPTION: BH21-06, SS-2		BH21-07, SS-8	
		SAMPLE TYPE: Soil		Soil	
		DATE SAMPLED: 2021-09-08		2021-09-08	
Parameter	Unit	G / S	RDL	3041699	3041701
Chloride (2:1)	µg/g		2	145	32
Sulphate (2:1)	µg/g		2	52	125
pH (2:1)	pH Units		NA	8.91	8.12
Electrical Conductivity (2:1)	mS/cm		0.005	0.398	0.297
Resistivity (2:1) (Calculated)	ohm.cm		1	2510	3370
Redox Potential 1	mV		NA	207	24
Redox Potential 2	mV		NA	208	28
Redox Potential 3	mV		NA	209	31

Comments: RDL - Reported Detection Limit; G / S - Guideline / Standard

3041699-3041701 EC, pH, Chloride and Sulphate were determined on the extract obtained from the 2:1 leaching procedure (2 parts DI water: 1 part soil). Resistivity is a calculated parameter. Redox potential measured on as received sample. Due to the potential for rapid change in sample equilibrium chemistry with exposure to oxidative/reduction conditions laboratory results may differ from field measured results. Redox potential measurement in soil is quite variable and non reproducible due in part, to the general heterogeneity of a given soil. It is also related to the introduction of increased oxygen into the sample after extraction. The interpretation of soil redox potential should be considered in terms of its general range rather than as an absolute measurement.

Analysis performed at AGAT Toronto (unless marked by *)

Certified By:




Quality Assurance

CLIENT NAME: STANTEC CONSULTING LTD

PROJECT: 165001228.340

SAMPLING SITE:

AGAT WORK ORDER: 21T809942

ATTENTION TO: Nabeel Basheer

SAMPLED BY:

Soil Analysis

RPT Date: Oct 12, 2021			DUPLICATE			Method Blank	REFERENCE MATERIAL		METHOD BLANK SPIKE		MATRIX SPIKE	
PARAMETER	Batch	Sample Id	Dup #1	Dup #2	RPD		Measured Value	Acceptable Limits		Recovery	Acceptable Limits	
								Lower	Upper		Lower	Upper

Corrosivity Package

Chloride (2:1)	3037474		42	43	2.4%	< 2	94%	70%	130%	95%	80%	120%	106%	70%	130%
Sulphate (2:1)	3037474		51	50	2.0%	< 2	106%	70%	130%	91%	80%	120%	109%	70%	130%
pH (2:1)	3041699	3041699	8.91	8.92	0.1%	NA	100%	80%	120%						
Electrical Conductivity (2:1)	3041699	3041699	0.398	0.402	1.0%	< 0.005	100%	80%	120%						

Comments: NA signifies Not Applicable.

pH duplicates QA acceptance criteria was met relative as stated in Table 5-15 of Analytical Protocol document.

Certified By:


Nabeel Basheer

Method Summary

CLIENT NAME: STANTEC CONSULTING LTD

PROJECT: 165001228.340

SAMPLING SITE:

AGAT WORK ORDER: 21T809942

ATTENTION TO: Nabeel Basheer

SAMPLED BY:

PARAMETER	AGAT S.O.P	LITERATURE REFERENCE	ANALYTICAL TECHNIQUE
Soil Analysis			
Chloride (2:1)	INOR-93-6004	modified from SM 4110 B	ION CHROMATOGRAPH
Sulphate (2:1)	INOR-93-6004	modified from SM 4110 B	ION CHROMATOGRAPH
pH (2:1)	INOR 93-6031	modified from EPA 9045D and MCKEAGUE 3.11	PH METER
Electrical Conductivity (2:1)	INOR-93-6036	modified from MSA PART 3, CH 14 and SM 2510 B	EC METER
Resistivity (2:1) (Calculated)	INOR-93-6036	McKeague 4.12, SM 2510 B, SSA #5 Part 3	CALCULATION
Redox Potential 1	INOR-93-6066	G200-20, SM 2580 B	REDOX POTENTIAL ELECTRODE
Redox Potential 2	INOR-93-6066	G200-20, SM 2580 B	REDOX POTENTIAL ELECTRODE
Redox Potential 3	INOR-93-6066	G200-20, SM 2580 B	REDOX POTENTIAL ELECTRODE

APPENDIX D

D.1 SAMPLE NSSP



Notice to Contractor - Obstructions

Special Provision

Cobbles and boulders were identified in the fill materials and native soil deposits at the site. These materials may obstruct excavation activities and the installation of caisson foundations including temporary liners.

The Contractor is advised that appropriate equipment and construction procedures will be required to penetrate through or remove obstructions, such as cobbles and boulders, to permit excavations and installation of drilled pier foundation and temporary protection system elements.

The removal of cobbles and boulders from excavations may lead to undermining of materials in the sidewalls of excavations. The contractor shall implement appropriate measures to prevent instability, sloughing, caving etc. of any undermined materials.

v:\01216\active\other_pc_projects\165001228\05_report_deliv\deliverables\report\appendix d - nssp\165001228 noticetocontractor-obstructions_20220225_(finalrpt).docx