



Preliminary Foundation Investigation Report

Highway 401 - Proposed Widening of Deep
Cut Adjacent to 164 Skyview Road, Grafton,
Ontario

Highway 401 Planning Study
Cobourg to Colborne, Ontario

Latitude 44.0120
Longitude - 77.9819
GWP 4060-11-00

Geocres No.: 31C-315

Prepared for:

Ministry of Transportation Ontario

Prepared by:

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Project No. 165001231

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PROPOSED WIDENING OF DEEP CUT ADJACENT TO 164 SKYVIEW ROAD, GRAFTON, ONTARIO
HIGHWAY 401 PLANNING STUDY – COBOURG TO COLBORNE, ONTARIO**

PRELIMINARY FOUNDATION INVESTIGATION REPORT

For

G.W.P 4060-11-00

Highway 401 Planning Study from Cobourg to Colborne, Ontario
Proposed Widening of Deep Cut Adjacent to 164 Skyview Road

Grafton, Northumberland County, Ontario

1.0 INTRODUCTION

Stantec Consulting Ltd. (Stantec) has been retained by the Ministry of Transportation of Ontario (MTO) to undertake a planning, preliminary design, and Class Environmental Assessment (Class EA) study for the section of Highway 401 extending from approximately 2 km east of Nagle Road to Percy Street in Northumberland County, Ontario. The study includes the replacement or rehabilitation of structures, interchange modifications and future widening of the highway.

The foundation engineering services for the project include the preparation of foundation desktop studies, and preliminary foundation design reports at a series of bridge (overpass or underpass) and structural culvert sites where replacement or rehabilitation of the existing structure is planned. There are two sites within the study limits where it has been identified there may be insufficient space to develop new cut slopes for the future widened highway without impacting development on the adjacent properties. Foundation investigations are required in order to assess the stability of, and requirements for, deep cuts and/or retaining wall options at these sites.

The property at 164 Skyview Road was identified by the Ministry as one site where options to minimize impacts on the property would be reviewed because the conventional highway widening grading would impact a recently constructed garage structure on the property. The proposed crest of the cut slope encroaches onto the property approximately 23.4 m from the existing ROW. Through discussions with the owners, it was established that property acquisition may be possible in areas away from the garage as long as access in and out of the garage is maintained.

This report presents the results of a foundation investigation related to the widening of the existing highway cut slope on the south side of Highway 401, east of Shelter Valley Creek, and adjacent to the property at 164 Skyview Road where new retaining wall(s) are being considered in order to minimize impacts on the existing buildings/facilities present within that property. A separate Preliminary Foundation Investigation and Design Report has been prepared for the other property.

The purpose of the foundation investigation was to assess the subsurface conditions at the site by drilling two boreholes and carrying out associated in-situ and laboratory tests, and to provide preliminary foundation engineering input to the assessment of strategies/options for the proposed widening of the deep cut slope.

This Preliminary Foundation Investigation and Design Report (FIDR) has been prepared specifically and solely for the proposed widening of the cut slope adjacent to the property at 164 Skyview Road as described above.



2.0 SITE DESCRIPTION

2.1 SITE LOCATION

The subject property (164 Skyview Road) is located on the south side of Highway 401, approximately 350 km east of Shelter Valley Road, in Northumberland County. The site location is shown on the Key Plan portion of Drawing No. 1 provided in Appendix A. Widening of the existing highway cut slope will be required on the south side of the highway from approximately Station 19+600 to Station 19+900.

2.2 SITE DESCRIPTION

At the location of the site, Highway 401 is a four-lane divided freeway with two lanes in each direction that is aligned in an approximate east-west orientation. The chainage on Highway 401 increases from west to east.

The Highway 401 profile slopes up towards the east, from Elevation 147 m at Station 19+600 to 153 m at Station 19+900. The ground surface at the northern perimeter of the private property, above the highway cut slope, varies from approximately 154 m to 159 m. The existing ground surface profile along the MTO Right of Way (ROW) boundary and the Highway 401 profile in the area of the highest portion of the cut slope are shown on Drawing No. 1 provided in Appendix A.

The cut slope adjacent to the Skyview Drive property ranges from about 5 to 8 m in height and has slope inclinations varying from about 2.25 horizontal to 1 vertical (2.25H:1V) to 2.5H:1V. The current crest of the highway cut slope is typically 7 m to 10 m north of the southern extent of the MTO Right of Way (ROW) in the area of the property at 164 Skyview Drive. The existing slope is covered by vegetation including trees, brush, and grasses.

A building has recently been constructed within the property at 164 Skyview Road. The building is located near Station 19+780 and is offset approximately 20 m south of the current ROW boundary.

2.2.1 Site Drainage

A rock/rip-rap lined drainage ditch is present at the bottom of the slope.

Locally within the MTO ROW, surface water drains to the west towards the Shelter Valley Creek. Regionally, surface drainage typically flows from north to south towards Lake Ontario.

2.2.2 Geological Information

As described in The Physiography of Southern Ontario (Chapman and Putnam, 1984), the site lies within the Iroquois Plain physiographic area. The Ontario Geological Survey (OGS) Quaternary geology map also suggests the site is located within a sandy silt to silty sand till overlain to the south by coarse-grained glaciolacustrine deposits consisting of sand or gravel with minor silt and clay.



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Review of available Ontario Government well records indicates that the overburden soils are quite deep in the vicinity of the site extending to depths in excess of 50 m below ground surface. Based on the geological mapping information, bedrock is expected to consist of limestone.

2.2.3 Available Subsurface Information

No site-specific foundation investigation reports were available for this site in the MTO GEOCRES database/library.

A 1957 GEOCRES report titled “Foundation Report on New Bridge at Highway 401 Crossing Shelter Valley Creek, about 2 miles North East of Grafton” provides some information on the subsurface conditions in the area of the Highway 401 crossing of the Shelter Valley Creek valley. Several boreholes and penetration tests were advanced as part of the investigation for the creek crossing, including Borehole No. 3, Borehole No. 4, and Borehole No. 10, advanced on the east side of the creek, about 300 m to 400 m west of the current study area. The subsurface conditions are described as gravel and sand to dense fine sand in Borehole No. 3, which was advanced to about 12.5 m below ground surface. Penetration resistances ranged from 38 to greater than 100 blows per 300 mm, indicating the site soils were in a dense to very dense state. Borehole No. 4 and Borehole No. 10 were unsampled, with penetration testing only, and encountered refusal on inferred boulders at about 1.2 m below ground surface.

Relevant borehole records and a site plan displaying the 1957 borehole locations are included in Appendix B for reference.

3.0 INVESTIGATION PROCEDURES

3.1 SITE RECONNAISSANCE

A site reconnaissance of the existing cut slope and adjacent private property was carried out by a Stantec geotechnical engineer on October 4, 2021. The following provides a summary of observations made during the site reconnaissance:

- No visible indications of deep-seated slope instability (e.g. headscarps/displaced blocks, tension cracks, bulging at the toe of the slope etc.) were noted. Similarly, no signs of shallow instability or slope creep (e.g. surficial sloughing, curved tree trunks etc.) were observed
- The roadside drainage ditch was lined with rip rap in most areas (see Photograph 1 below). Rip-rap, or rockfill drainage ditches are present at the base of the cut slopes on both sides of Highway 401, east and west of the Shelter Valley crossing.
- The slope was generally covered by a variety of vegetation including trees, brush and grasses. In localized areas, generally just above the drainage ditch, the vegetative and surficial topsoil coverage was sparse (for example, see Photograph 2 below) and the mineral overburden soils were visible on the slope face. No signs of significant erosion were noted in these areas.
- No signs of seepage erosion on the slope face, normally associated with high groundwater gradients, were observed.

Overall, the existing cut slope adjacent to the golf course property is considered to be performing satisfactorily.



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Public utility locates for the property at 164 Skyview Road did not identify any public or MTO underground utilities within the area of the boreholes. A private utility locate company, Onsite Locates Inc., confirmed that there were no identifiable private utilities at the borehole locations. Additionally, no private underground utilities were anticipated in the vicinity of the borehole locations based on conversations with the owner of the private property. The locate process did identify the presence of a telecommunications line located parallel to, and approximately 3 m to 4 m north of, the ROW boundary in the vicinity of the boreholes.



Photo No. 1: Existing slope looking west from toe of slope.

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Photo No. 2: Existing slope looking east from toe of slope.



Photo No. 3: Existing slope looking northwest from crest of slope.



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Photograph 4 below displays the existing, single-storey garage building present near to the MTO ROW on the property at 164 Skyview Road. The north face of the building is located approximately 22 m south of the current MTO ROW boundary and has a vehicle entrance/exit door facing the highway.



Photo No. 4: Existing building at 164 Skyview Road viewed from the north.

3.2 FIELD INVESTIGATION

The foundation investigation program consisted of advancing two boreholes, designated as MW21-1 and BH21-2, between October 18 and 21, 2021. The two boreholes were advanced within the property at 164 Skyview Road directly south of the MTO ROW boundary. Borehole BH21-2 was located immediately north of the building recently constructed at the site. The borehole locations are displayed 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 and retained a private utility locating subcontractor to clear the borehole locations for drilling. Drilling was carried out with a track-mounted drill rig equipped for soil sampling. The boreholes were advanced using continuous flight hollow stem augers.

The subsurface stratigraphy encountered in the boreholes was recorded in the field by experienced Stantec field personnel. Standard Penetration Tests (SPT) (ASTM D1586) were carried out in the boreholes at regular intervals; typically, every 760 mm to approximately 6 m to 7 m depth and 1520 mm below this depth. A relatively undisturbed Shelby Tube sample was attempted to be collected at a depth of approximately 12.5 m in Borehole BH21-2; however, the tube sheared off in the borehole when trying to remove it. The borehole was abandoned, and a new borehole was advanced approximately 1.8 m east of the original borehole location to facilitate sampling and testing at greater depths.



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Shear vane testing, using N-sized vane testing equipment, was carried out at various depths in BH21-2 and in a borehole located approximately 0.5 m east of MW21-1. Vane testing was carried out in accordance with ASTM D2573.

The split spoon samples recovered from the SPTs were returned to our Markham laboratory for detailed classification and testing.

A monitoring well was installed in Borehole MW21-1 with a 3 m well screen located from approximately 6 m to 9 m below ground surface; the screened section of the well was provided with a sand filter and bentonite was placed above and below the sand pack. The water level was measured in the MW21-1 well between October 19 and 21, 2021. The monitoring well was decommissioned in accordance with Ontario Regulation 903 on October 21, 2021.

Observations of the groundwater conditions in Borehole BH21-2 were made in the open borehole at the time of drilling. Bentonite was used in the backfilling of the boreholes in conjunction with the intent of Environment Regulation 903.

3.3 LOCATION AND ELEVATION SURVEY

The borehole locations and respective ground surface elevations were determined by Stantec surveying personnel.

Summary information pertaining to the Stantec boreholes included in this report is given in Table 3.1 below.

Table 3.1: Borehole Information Summary

	Borehole Number	
	MW21-1	BH21-2
MTM Zone 10 Coordinates		
Northing	4875785.2	4875798.5
Easting	426494.7	426562.0
Ground Surface Elevation, m	155.4	158.6
Total Depth Drilled, m	15.9	18.9
End of Borehole Elevation, m	139.5	139.7
Number of soil samples	16	17

3.4 LABORATORY TESTING

All samples were transported to our Markham laboratory for visual examination and laboratory testing. The geotechnical laboratory testing program completed on the borehole samples is summarized below in Table 3.2.

Table 3.2: Laboratory Testing Program

Laboratory Test Type	Number of Tests
Moisture Content	34
Gradation Analysis	9
Atterberg Limits	6

Two soil samples were also submitted to AGAT Laboratories of Mississauga for analysis of pH, soluble sulphate content, chloride content, and resistivity.



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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.

4.0 SUBSURFACE CONDITIONS

4.1 OVERVIEW

The subsurface conditions observed in the boreholes are presented in detail on the Borehole Records provided in Appendix B. Also, an explanation of the symbols and terms used to describe the Borehole Records is also provided in Appendix B. A borehole location plan and a stratigraphic profile of the soils encountered within the boreholes is provided on Drawing No. 1 in Appendix A.

The stratigraphic boundaries on the borehole records and the stratigraphic profile are inferred from non-continuous sampling and, therefore, represent transitions between soil types rather than exact boundaries between geological units. The subsoil conditions will vary beyond the borehole location.

In general, the subsurface stratigraphy encountered in the boreholes advanced at the site consisted of a surficial layer of topsoil, overlying fill consisting of silty sand, overlying predominantly cohesionless soils comprised of sand to silt. The sand/silt deposits are underlain by a clayey silt stratum that contains occasional sandy silt to silt seams. A deeper sand/silty sand deposit was encountered below the clayey silt at the location of Borehole MW21-1. Detailed descriptions of the subsurface conditions encountered are provided in the following subsections.

4.2 OVERBURDEN

4.2.1 Topsoil

An approximately 150 mm to 200 mm thick topsoil layer was encountered at ground surface in Boreholes MW21-1 and BH21-2.

4.2.2 Fill

Fill materials comprised of silty sand containing trace to some gravel, trace clay rootlets, and occasional cobbles were encountered below the topsoil in both boreholes. The fill materials extended to depths of about 1.5 m (~Elevation 153.9 m) and 1.7 m (~Elevation 156.9 m) below ground surface in Boreholes MW21-1 and BH21-2, respectively.

Standard Penetration Test (SPT) 'N' resistance values measured within the silty sand fill ranged between 3 and 16 blows per 0.3 m of penetration indicating the fill materials are in a very loose to compact state.

Index tests carried out on representative samples of the fill yielded the following results:

Moisture Contents:

- 7 to 16%



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Grain Size Distribution Results:

- Gravel: 0%
- Sand: 65%
- Silt: 30%
- Clay: 5%

Grain size analysis results for one sample of the fill are presented on Figure C1 in Appendix C. The Unified Soil Classification System (USCS) group symbol for the fill material is SM (Silty Sand).

4.2.3 Sand

A native sand deposit containing some silt and gravel was encountered beneath the fill in Borehole BH21-2. Occasional cobbles and boulders are inferred to present within the sand deposit based on grinding of the augers during drilling. The sand deposit was approximately 1.4 m thick and was encountered to a depth of approximately 3.1 m below ground surface corresponding to an elevation of 155.6 m.

SPT N-values measured within the sand deposit ranged from 10 to 35 blows per 0.3 m indicating these materials are in a compact to dense state.

The natural moisture content of the sand was measured to be approximately 3 percent expressed as a dry weight of the soil.

4.2.4 Silt/Sandy Silt

A silt/sandy silt deposit containing variable but generally minor amounts of gravel and clay was encountered below the fill and/or sand deposits in both boreholes. Sandy silt materials were encountered to a depth of 3.8 m below ground surface (~Elevation 151.6 m) at Borehole MW21-1. An approximately 1.5 m thick deposit of silt containing some sand that extended to a depth of 4.6 m (~Elevation 154.0 m) was encountered beneath the sand in Borehole BH21-2.

SPT N-values measured within the silt/sandy silt deposits ranged from 19 to 57 blows per 0.3 m indicating these materials are in a compact to very dense state.

Index tests carried out on representative samples from the silt/sandy silt deposit yielded the following results:

Moisture Contents:

- 16 to 20%

Grain Size Distribution Results:

- Gravel: 0%
- Sand: 14 and 33%
- Silt: 61 and 72%
- Clay: 6 and 14%

An Atterberg Limit test was completed on one sample of the silt collected from BH21-2. The test results indicate that the material tested was non-plastic.



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The results of grain size analyses and the Atterberg Limit test conducted on samples of the silt/sandy silt deposits are presented on Figures C2 and C3 in Appendix C. The USCS group symbol for these materials is ML.

4.2.5 Clayey Silt

A deposit of clayey silt containing trace sand was encountered below the silt/sandy silt deposits. The clayey silt extended to a depth of 13.7 m (~Elevation 141.7 m) at Borehole MW21-1 and to the termination depth of 18.9 m (~Elevation 139.7 m) at Borehole BH21-2. Occasional to frequent sandy silt to silt seams were encountered within the clayey silt deposit. An approximately 0.7 m thick layer/zone of silt was encountered at a depth of 8.4 m (~Elevation 147.0 m) in Borehole MW21-1 and an approximately 0.3 m thick sandy silt layer/zone was encountered at a depth of 13.0 m (~Elevation 145.6 m) in Borehole BH21-1.

SPT N-values measured within the clayey silt deposit ranged from 10 to 43 blows per 0.3 m. In-situ shear vane testing using N-vane equipment, attempted at approximate depths of 6.1 m, 7.3 m, and 9.1 m in MW21-1 and approximate depths of 9.0 m, 9.9 m, 11.7 m and 14.6 m in BH21-2, encountered refusal (i.e., inability to turn vane). Based on the field and laboratory testing, and examination of samples obtained, the deposit is considered to generally have a very stiff to hard consistency with zones of stiff soils present.

SPT N-values of 33 and 68 blows per 0.3 m were measured within the sandy silt to silt zones described above indicating those materials are in a dense to very dense state.

Index tests carried out on representative samples from the clayey silt deposit yielded the following results:

Moisture Contents:

- 13 to 23%

Grain Size Distribution Results:

- Gravel: 0%
- Sand: 0 to 3%
- Silt: 64 to 78%
- Clay: 19 to 36%

Grain Size Distribution on silt layer within clayey silt deposit:

- Gravel: 0%
- Sand: 2%
- Silt: 81%
- Clay: 17%

Atterberg Limit Testing:

- Liquid limit: 19 to 21%
- Plastic limit: 13 to 14%
- Plasticity index: 5 to 8

An Atterberg Limit test conducted on the silt layer encountered within the clayey silt deposit at a depth of approximately 8.5 m in Borehole MW21-1 indicated that the material tested was non-plastic.



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The results of grain size analyses and Atterberg limit testing conducted on samples of the clayey silt are presented on Figures C4 and C5 in Appendix C. The USCS group symbols for this deposit are considered to range from CL-ML to CL (Clayey Silt).

The grain size analysis and Atterberg limits results for testing completed on a sample of the silt interlayer (Sample 11 from Borehole MW21-1) are presented on Figures C2 and C3 in Appendix C. The USCS group symbol for this material is ML (Silt).

4.2.6 Lower Sand/Silty Sand

A lower sand/silty sand deposit containing some gravel and trace clay was encountered below the clayey silt in Borehole MW21-1. The borehole was terminated within the lower sand deposit at a depth of 15.9 m below ground surface (~Elevation 139.5).

SPT N-values measured within the sand/silty sand deposit varied from 18 to 73 blows per 0.3 m indicating this material is in a compact to very dense state.

Index tests carried out on representative samples from the lower sand deposit yielded the following results:

Moisture Contents:

- 12 and 18%

Grain Size Distribution:

- Gravel: 18%
- Sand: 61%
- Silt: 15%
- Clay: 6%

The results of the grain size analysis test conducted on a sample of the lower sand deposit are presented on Figure C6 in Appendix C. The USCS group symbol for this deposit is SM (Silty Sand).

4.3 BEDROCK

Bedrock was not encountered within the termination depths of the boreholes advanced during the current investigation.

4.4 GROUNDWATER

The water level was recorded in the monitoring well at Borehole MW21-1 at 5.8 m (~Elev. 149.6 m) below ground surface on October 19, 2021; at 3.2 m (~Elev. 152.2 m) on October 20, 2021 and at 3.4 m (~Elev. 152.0 m) on October 21, 2021.

The water level was observed below a depth of 9.1 m (~Elev. 149.5 m) in Borehole BH21-2 during drilling. It should be noted that this observed groundwater level is not a stabilized measurement and hence is deemed to be an “inferred” water level.



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

4.5 CHEMICAL TESTING

Two representative samples of the native soils were submitted to AGAT Laboratories in Mississauga, Ontario, for analysis of pH, water soluble sulphates & chloride concentrations, and resistivity. The analysis results are provided in Table 4.1. The chemical testing results provided by AGAT Laboratories are also provided in Appendix C for reference.

Table 4.1: Results of Chemical Analysis

Borehole #	Sample #	Depth (m)	pH	Chloride (µg/g)	Sulphate (µg/g)	Resistivity (Ohm.cm)
MW21-1	SS10	6.9 to 7.5	8.42	5	6	8330
BH21-2	SS6	3.8 to 4.4	8.63	12	5	8700

5.0 MISCELLANEOUS

The field work was carried out under the supervision of Kirby Lales, EIT, under the direction of Mr. Kevin Nelson, P.Eng.

The public utility locates for this borehole investigation were arranged by Stantec personnel and private utility locates were completed by Onsite Locates Inc.

The track-mounted drill rig was supplied and operated by Downing Drilling of Hawkesbury, Ontario.

The location and elevation survey of the boreholes was completed by Tulloch Geomatics Inc. personnel.

Geotechnical laboratory testing was carried out in Stantec's Markham laboratory. Chemical testing for pH, soluble sulphate, chloride and organic contents, and resistivity was carried out by AGAT Laboratories of Mississauga.

This report was prepared by Zach Popper, P.Eng. and reviewed by Kevin Nelson, P.Eng. and Raymond Haché, P.Eng., Designated Principal MTO Foundation Contact.



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6.0 CLOSURE

A subsurface investigation is a limited sampling of a site. The subsurface conditions 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 location, we request that we be notified immediately in order to assess the additional information.

Respectfully Submitted,

STANTEC CONSULTING LTD.



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Geotechnical Engineer



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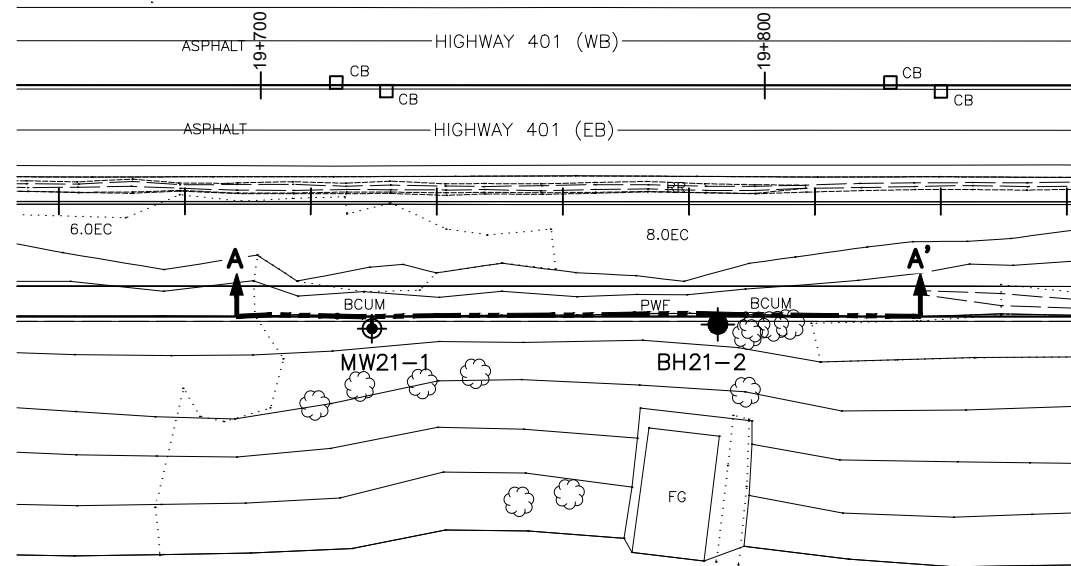
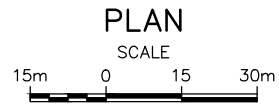
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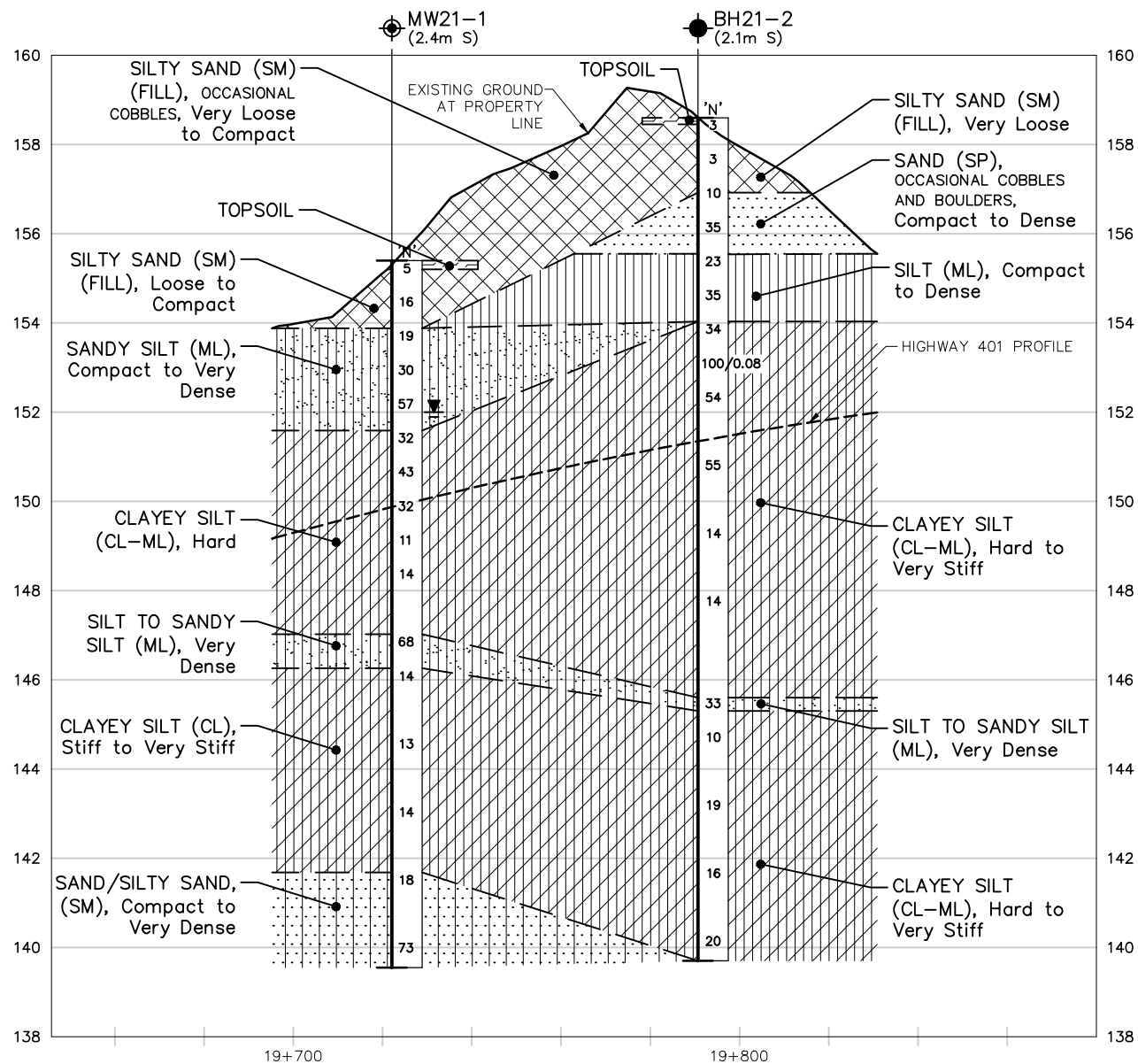
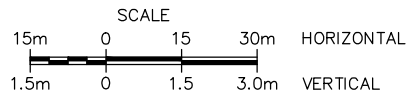
APPENDIX A

A.1 DRAWING NO. 1 – BOREHOLE LOCATIONS AND SOIL STRATA DRAWING



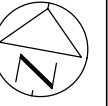


CROSS SECTION A-A'



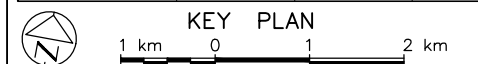
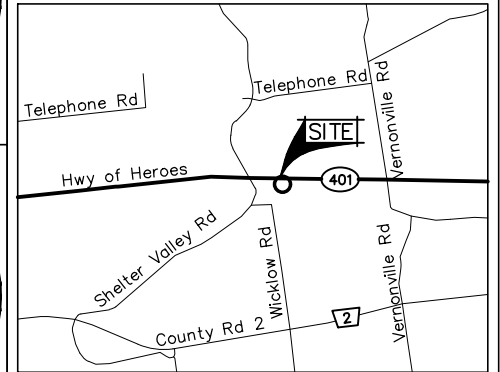
METRIC
DIMENSIONS ARE IN METRES
AND/OR MILLIMETRES
UNLESS OTHERWISE SHOWN

PLATE No
CONT
GWP 4060-11-00



HWY 401 WIDENING
164 SKYVIEW RD., COBOURG, ON
BOREHOLE LOCATIONS & SOIL STRATA

SHEET
—



LEGEND

- Borehole
- Monitoring Well
- (x.x m) Offset from Cross Section Line in meters
- N Blows/0.3m (Std Pen Test, 475 J/blow)
- WL Measured on October 2021

No	ELEVATION	MTM ZONE 10 COORDINATES NORTH	COORDINATES EAST
MW21-1	155.4	4 875 785.2	426 494.7
BH21-2	158.6	4 875 798.5	426 562.0

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.

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

GEOGRES No 31C-315

HWY No 401			DIST
SUBM'D KN	CHECKED	DATE 2023-01-16	SITE
DRAWN GBB	CHECKED	APPROVED RH	DWG 1

APPENDIX B

B.1 SYMBOLS AND TERMS USED ON STANTEC BOREHOLE RECORDS

B.2 BOREHOLE RECORDS

B.3 AVAILABLE GEOCRES INFORMATION



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	Very Poor Quality
25-50	Poor Quality
50-75	Fair Quality
75-90	Good Quality
90-100	Excellent Quality

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

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	Extremely Wide	-
2000-6000	Very Wide	Very Thick
600-2000	Wide	Thick
200-600	Moderate	Medium
60-200	Close	Thin
20-60	Very Close	Very Thin
<20	Extremely Close	Laminated
<6	-	Thinly Laminated

Terminology describing rock strength:

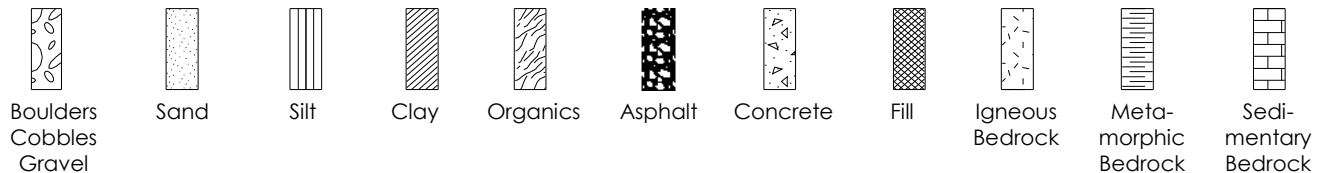
Strength Classification	Grade	Unconfined Compressive Strength (MPa)
Extremely Weak	R0	<1
Very Weak	R1	1 – 5
Weak	R2	5 – 25
Medium Strong	R3	25 – 50
Strong	R4	50 – 100
Very Strong	R5	100 – 250
Extremely Strong	R6	>250

Terminology describing rock weathering:

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

STRATA PLOT

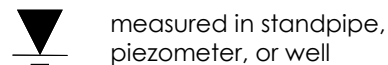
Strata plots symbolize the soil or bedrock description. They are combinations of the following basic symbols. The dimensions within the strata symbols are not indicative of the particle size, layer thickness, etc.



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
y	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 MW21-1

1 OF 2

METRIC

W.P. GWP 4060-11-00 LOCATION Highway 401 East of Shelter Valley Road N:4875785.2 E:426494.7 ORIGINATED BY KL
 DIST East HWY 401 BOREHOLE TYPE Hollow Stem Auger - Split Spoon COMPILED BY RR
 DATUM Geodetic DATE 2021.10.18 - 2021.10.18 LATITUDE 44.011973 LONGITUDE -77.982276 CHECKED BY KN

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%)		
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa							w _p w w _L	
								○ UNCONFINED + FIELD VANE								WATER CONTENT (%)
								● QUICK TRIAXIAL × LAB VANE								
						20 40 60 80 100				20 40 60						
155.4																
150.0	200 mm TOPSOIL															
0.2	Silty SAND (SM), trace to some gravel and rootlets (FILL). Occasional cobbles. Loose to compact Brown Moist Auger grinding at 0.76 m		1	SS	5		155									
			2	SS	16											
153.9							154									
1.5	Sandy SILT (ML), trace clay Compact to very dense Grey Moist to wet		3	SS	19											
			4	SS	30											
			5	SS	57		152									
151.6																
3.8	CLAYEY SILT (CL-ML) Hard Grey Moist 50 mm wet sandy silt seam at 5.8 m Becomes very stiff below 6 m		6	SS	32		151									
			7	SS	43											
			8	SS	32		150									
			9	SS	11		149									
			10	SS	14		148									
147.0																
8.4	SILT (ML), some clay, trace sand. Contains silty clay seams/layers. Very dense Grey Wet		11	SS	68		147									
146.3																
9.1	CLAYEY SILT (CL) Stiff to very stiff Grey Moist		12	SS	14		146									
							145									
			13	SS	13		144									
			14	SS	14		143									
							142									
141.7																
13.7	SAND (SM), some silt to silty, some gravel, trace clay		15	SS	18											

Continued Next Page

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

ONTARIO MTO 165001231_HWY_401_COBOURG.GPJ ONTARIO MTO.GDT 7/18/22

RECORD OF BOREHOLE No MW21-1

2 OF 2

METRIC

W.P. GWP 4060-11-00 LOCATION Highway 401 East of Shelter Valley Road N:4875785.2 E:426494.7 ORIGINATED BY KL
 DIST East HWY 401 BOREHOLE TYPE Hollow Stem Auger - Split Spoon COMPILED BY RR
 DATUM Geodetic DATE 2021.10.18 - 2021.10.18 LATITUDE 44.011973 LONGITUDE -77.982276 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																
							20	40	60	80	100					
							20	40	60	80	100					

RECORD OF BOREHOLE No BH21-2

1 OF 2

METRIC

W.P. GWP 4060-11-00 LOCATION Highway 401 East of Shelter Valley Road N:4875798.5 E:426562.0 ORIGINATED BY KL
DIST East HWY 401 BOREHOLE TYPE Hollow Stem Auger - Split Spoon COMPILED BY RR
DATUM Geodetic DATE 2021.10.20 - 2021.10.21 LATITUDE 44.012081 LONGITUDE -77.981434 CHECKED BY KN

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20	40	60	80	100		
158.6	150 mm TOPSOIL		1	SS	3		158							
158.6 0.2	Silty SAND (SM), trace clay and rootlets (FILL). Occasional cobbles. Very loose Brown Moist Auger grinding at 0.46 m		2	SS	3									
156.9			3	SS	10		157							
1.7	SAND (SP), some silt and gravel/rock fragments. Occasional cobbles and/or boulders. Compact to dense Brown Moist Grinding of augers noted at 2 m and 2.6 m depths. No recovery in SS4		4	SS	35		156							
155.6			5	SS	23		155							
3.1	SILT (ML), some sand and clay Compact to dense Brown to grey Moist to wet		6	SS	35									
154.0			7	SS	34		154							
4.6	CLAYEY SILT (CL-ML), trace sand Hard Brown to grey Moist SS8 dry to moist		8	SS	100/0.08		153							
	Occasional moist to wet sandy silt/silt seams below 6.1 m		9	SS	54		152							
			10	SS	55		151							
			11	SS	14		149							
	Becomes very stiff below 9 m		12	SS	14		148							
							147							
	Attempted taking a Shelby tube sample from 12.2 m to 12.8 m. Tube unable to be retrieved.						146							
145.6			13	SS	33		145							
13.0	Sandy SILT (ML) zone encountered at 13.0 m depth													
145.3														
13.3	CLAYEY SILT (CL-ML), trace sand Very stiff Brown to grey Moist		14	SS	10									
144.3														

Continued Next Page

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

ONTARIO MTO 165001231_Hwy_401_COBOURG.GPJ ONTARIO MTO.GDT 7/18/22

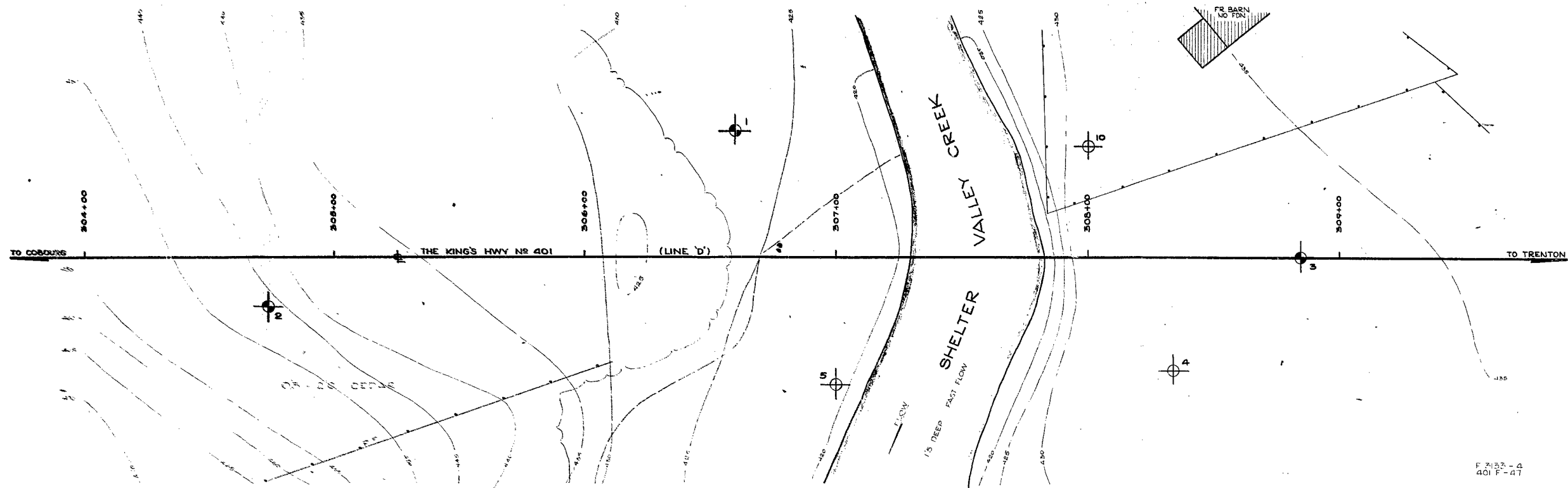
RECORD OF BOREHOLE No BH21-2

2 OF 2

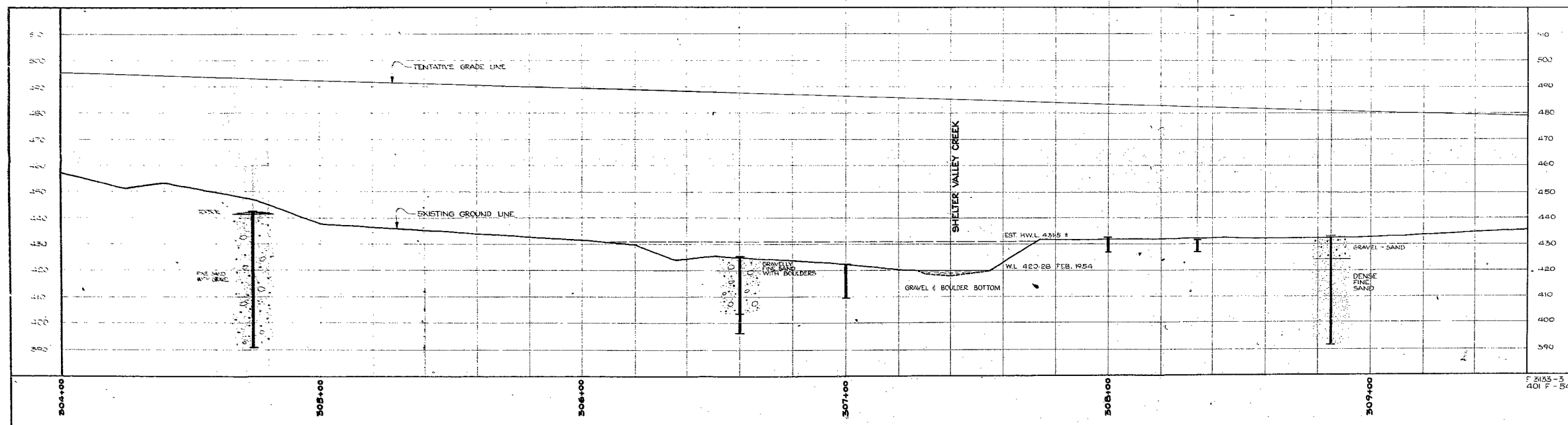
METRIC

W.P. GWP 4060-11-00 LOCATION Highway 401 East of Shelter Valley Road N:4875798.5 E:426562.0 ORIGINATED BY KL
 DIST East HWY 401 BOREHOLE TYPE Hollow Stem Auger - Split Spoon COMPILED BY RR
 DATUM Geodetic DATE 2021.10.20 - 2021.10.21 LATITUDE 44.012081 LONGITUDE -77.981434 CHECKED BY KN

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20	40	60	80	100		
14.3	CLAYEY SILT (CL), trace sand, occasional to frequent wet silt seams Very stiff Grey Wet						144							Su > 118 kPa (N-vane refusal)
			15	SS	19		143							
							142							
			16	SS	16		141							
							140							
139.7 18.9	End of Borehole Groundwater observed at ~9.1 m depth (~Elev. 149.5 m) during drilling. New borehole drilled approximately 1.8 m east of BH21-2. Sampling and testing below 12.2 m was conducted in adjacent borehole.		17	SS	20									



PLAN SCALE 1 IN = 20 FT



PROFILE SCALE HOR VER 1 IN = 20 FT

LEGEND			
BORE HOLES			
PENETRATION HOLE			
BORE & PENETRATION HOLE			
HOLE NO.	ELEVATION	STATION	DISTANCE FROM #
1	425.65	306+60'	50' LT
2	442.5	304+74'	20' RT
3	437.25	308+65'	4
4	431.4	308+34'	45 RT
5	422.5	307+00'	51' RT
10	432.6	308+00'	44' LT

NOTE

THE BOUNDARIES BETWEEN SOIL STRATA HAVE BEEN ESTABLISHED ONLY AT BORE HOLE LOCATIONS. BETWEEN BORE HOLES THE BOUNDARIES ARE ASSUMED FROM GEOLOGICAL EVIDENCE AND MAY BE SUBJECT TO CONSIDERABLE ERROR.

DEPARTMENT OF HIGHWAYS - ONTARIO		
MATERIALS & RESEARCH SECTION - DOWNSVIEW		
SHELTER VALLEY CREEK PROPOSED CROSSING 2 MILES N.E. OF GRAFTON SHOWING POSITION & ELEVATION OF HOLES		
HWY. NO. 401 (LINE 'D')	W.P. 55-57	DIV. NO. 7
CO. NORTHUMBERLAND		
TWP. HALDIMAND	LOT. 14	CON. 1
SCALE AS SHOWN	SUBMITTED BY	DATE 30 SEPT. 57
DRAWN BY R.E.F.	APPROVED BY	DRAWING NO. F-57-27A

DRILL RIG 541 OPERATION BORE & PENETIN JOB F 57-27 W.P. 55 57 BORING 3 STA. 308 +85 ON 4
CASING BA (standard samplers to fit unless noted) DATUM GEODINIC DATE REPORT SEPT. 1957
SAMPLER HAMMER WT. 350 LBS. DROP 40 INCHES COMPILED BY H.S. CHECKED BY AL DATE BORING 31 JULY 1957

SAMPLE TYPES

SAMPLE CONDITION

V - INSITU VANE SHEAR TEST	Q - TRIAXIAL QUICK	K - PERMIABILITY
M - MECHANICAL ANALYSIS	S - TRIAXIAL SLOW	C - CONSOLIDATION
U - UNCONFINED COMPRESSION	WL - WATER LEVEL IN CASING	CA - CASING
Q _c - TRIAXIAL CONSOLIDATED QUICK	WT - WATER TABLE IN SOIL	γ - UNIT WEIGHT

C.S. - CHUNK	S.S. - SLEEVE SAMPLE
D.O. - DRIVE OPEN	P.S. - PISTON SAMPLE
D.F. - DRIVE FOOT VALVE	W.S. - WASHED SAMPLE
T.O. - THIN WALLED OPEN	R.C. - ROCK CORE



- DISTURBED
- FAIR
- GOOD
- LOST

SAMPLES

ELEVATION DEPTH	WATER CONDITIONS	DESCRIPTION	STRAT PLOT	ELEVATION SCALE	WATER CONTENT W %			O - NAT			□ - P.W.			△ - L.W.			CASING BLOW (ACTUAL)	OTHER TESTS	CONDITION	TYPE	NO.	PENETRATION RESISTANCE	ELEV. RECOV. %
					PENETRATION TEST RESISTANCE BLOWS PER FOOT AT STANDARD ENERGY (4200 IN. LBS. PER BLOW) D. CONE PEN. X-----X-----X STAND. PEN. •-----•-----•																		
433.25 433.25		GROUND LEVEL																			433.25 433.25		
3.5		GRAVEL - SAND																			428.25 430.25		
5.5	424.25 431.25 9.3'																				423.25 433.25		
13.5																					418.25 420.25		
18.5																					413.25 423.25		
23.5		DENSE FINE SAND																			408.25 410.25		
28.5																					403.25 413.25		
33.5																					398.25 408.25		
38.5	391.75 401.75 41.5'	END OF BOREHOLE																			393.25 403.25		
43.5																					43.5		

DEPARTMENT OF HIGHWAYS - ONTARIO
MATERIALS & RESEARCH BRANCH - FOUNDATIONS SECTION - DOWNSVIEW
OFFICE REPORT ON SOIL EXPLORATION

DRILL RIG 5- OPERATION PENETRATION JOB F-37-27 W.P. 55-57 BORING 4 STA. 308+34.45 (RT.)
CASING 3" (standard samplers to fit unless noted) DATUM GIODITIC DATE REPORT SEPT 1957
SAMPLER HAMMER WT. 25 LBS. DROP 19 INCHES COMPILED BY U.S. CHECKED BY A.L. DATE BORING 30 JULY 1957

ABBREVIATIONS

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

SAMPLE TYPES

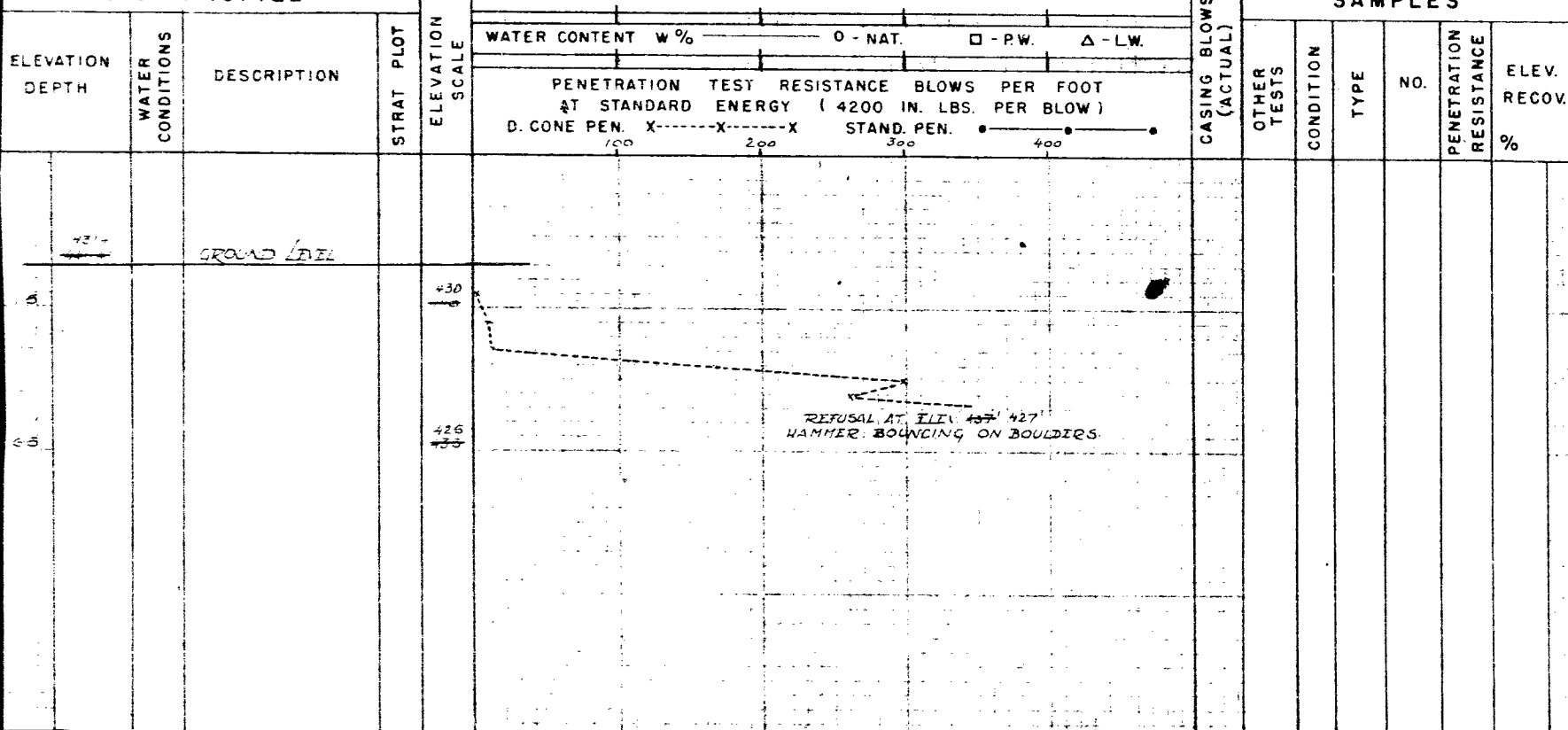
C.S. - CHUNK S.S. - SLEEVE SAMPLE
D.O. - DRIVE OPEN P.S. - PISTON SAMPLE
D.F. - DRIVE FOOT VALVE W.S. - WASHED SAMPLE
T.O. - THIN WALLED OPEN R.C. - ROCK CORE

SAMPLE CONDITION



- DISTURBED
- FAIR
- GOOD
- LOST

SOIL PROFILE



DEPARTMENT OF HIGHWAYS - ONTARIO
MATERIALS & RESEARCH BRANCH - FOUNDATIONS SECTION - DOWNSVIEW
OFFICE REPORT ON SOIL EXPLORATION

DRILL NO. 54-1 OPERATION PENETRATION
CASING BK (standard samplers to fit unless noted)
SAMPLER HAMMER WT. 350 LBS. DROP 19 INCHES

JOB F-57-27 W.P. 55-57
 DATUM GEODETIC
 COMPILED BY H.S. CHECKED BY A.L.

BORING 10 STA. 308+00 (44' LT.)
DATE REPORT SEPT. 1957
DATE BORING 14 AUG. 1957

ABBREVIATIONS

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

SAMPLE TYPES

C.S. - CHUNK	S.S. - SLEEVE SAMPLE
D.O. - DRIVE OPEN	P.S. - PISTON SAMPLE
D.F. - DRIVE FOOT VALVE	W.S. - WASHED SAMPLE
T.O. - THIN WALLED OPEN	R.C. - ROCK CORE

SAMPLE CONDITION



- DISTURBED
- FAIR
- GOOD
- LOST

SOIL PROFILE

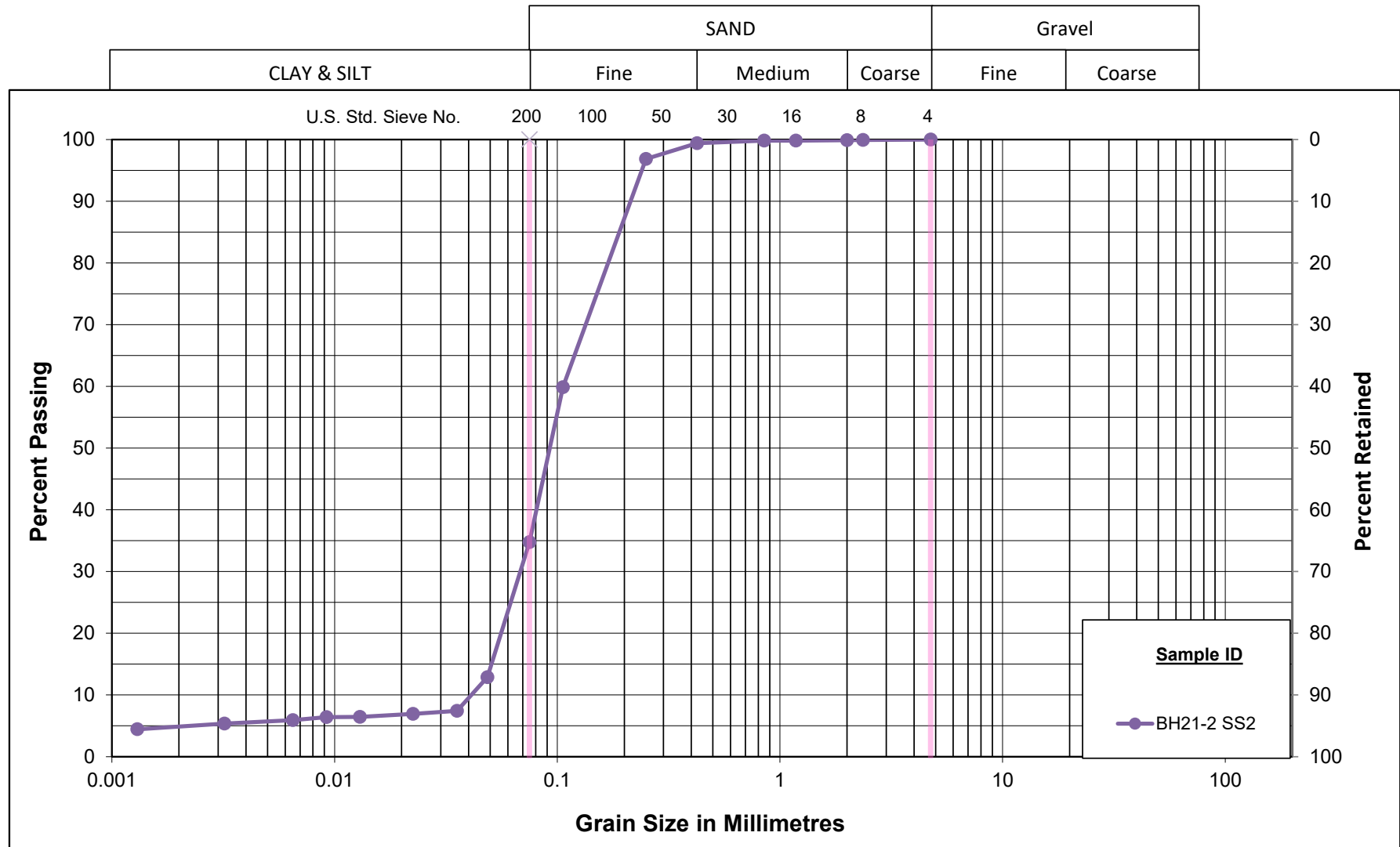
SOIL PROFILE						SAMPLES						
ELEVATION DEPTH	WATER CONDITIONS	DESCRIPTION	STRAT PLOT	ELEVATION SCALE	WATER CONTENT W% PENETRATION TEST RESISTANCE BLOWS PER FOOT AT STANDARD ENERGY (4200 IN. LBS. PER BLOW) D. CONE PEN. X-----X-----X STAND. PEN. ●-----●-----●	CASING BLOWS (ACTUAL)	OTHER TESTS	CONDITION	TYPE	NO.	PENETRATION RESISTANCE	ELEV. RECOV. %
		GROUND LEVEL		432.6								
25				430								
75				426	REFUSAL AT ELEV. 437.1 HAMMER BOUNCING ON BOULDERS							

APPENDIX C

C.1 LABORATORY TEST RESULTS



Unified Soil Classification System



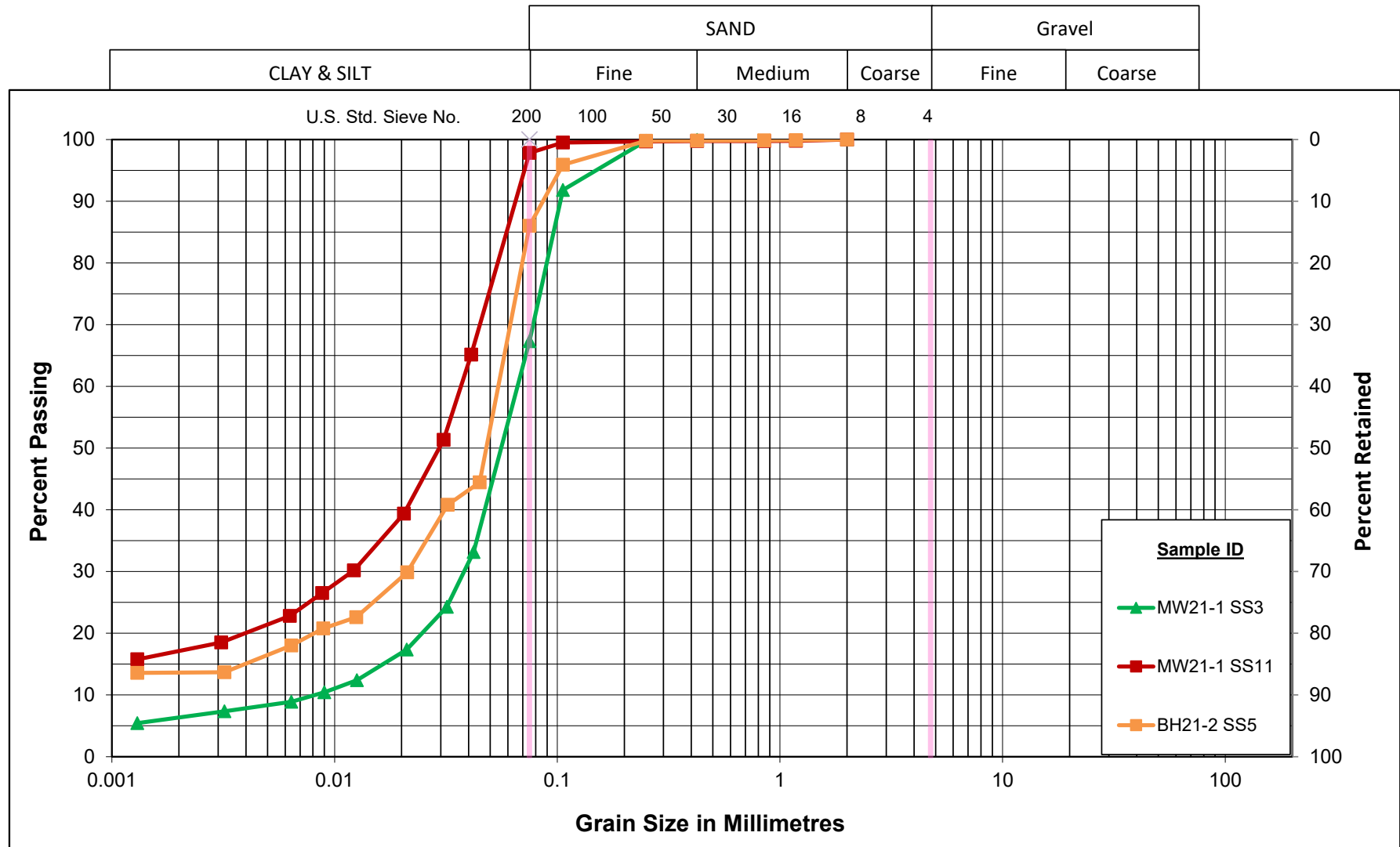
GRAIN SIZE DISTRIBUTION

FILL: Silty SAND (SM), trace clay
Highway 401 Cobourg to Colborne

Figure No. C1

Project No. 165001231

Unified Soil Classification System

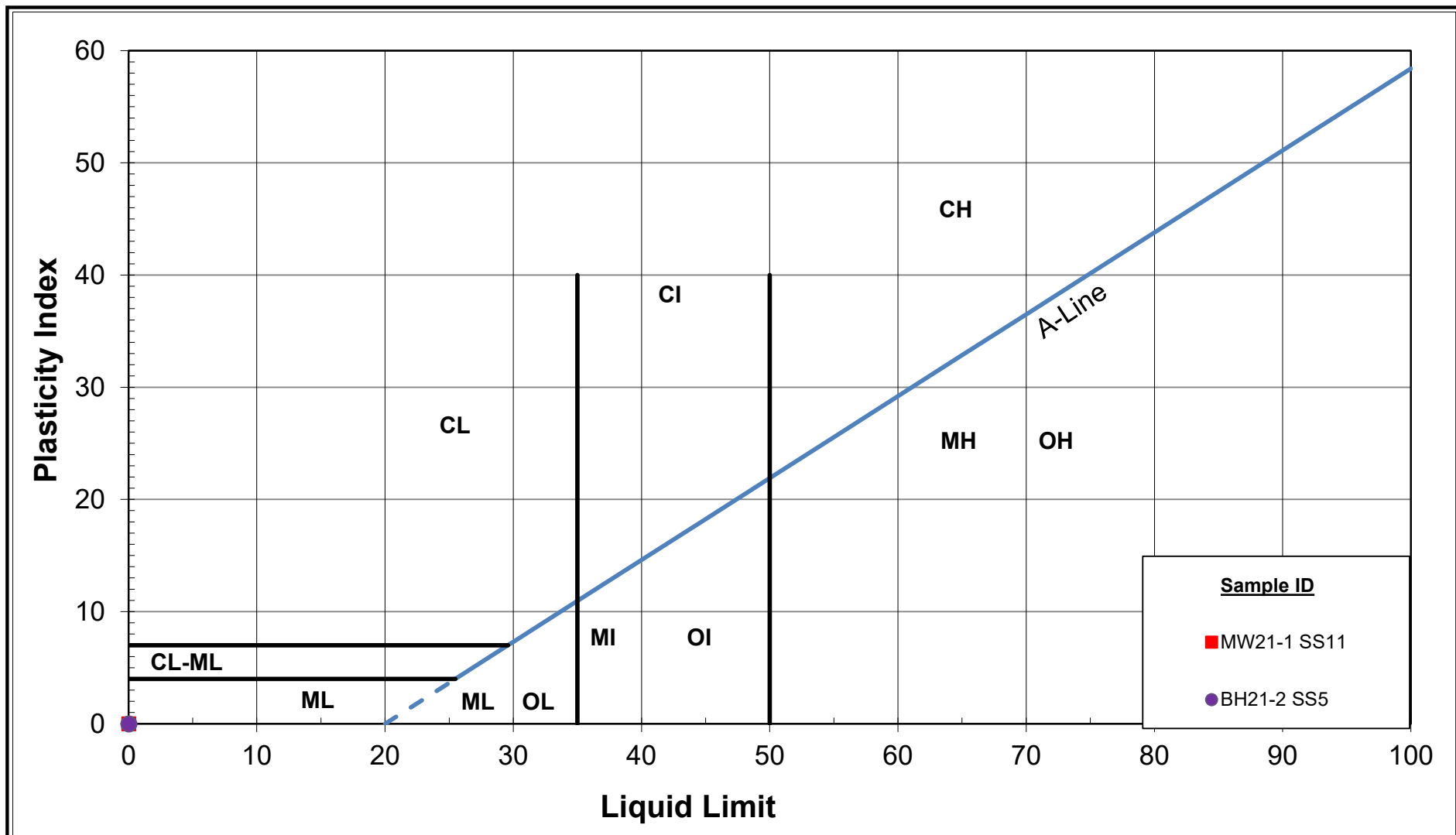


GRAIN SIZE DISTRIBUTION

SILT (ML), trace sand to sandy
Highway 401 Cobourg to Colborne

Figure No. C2

Project No. 165001231



SILT (ML), trace to some sand, some clay

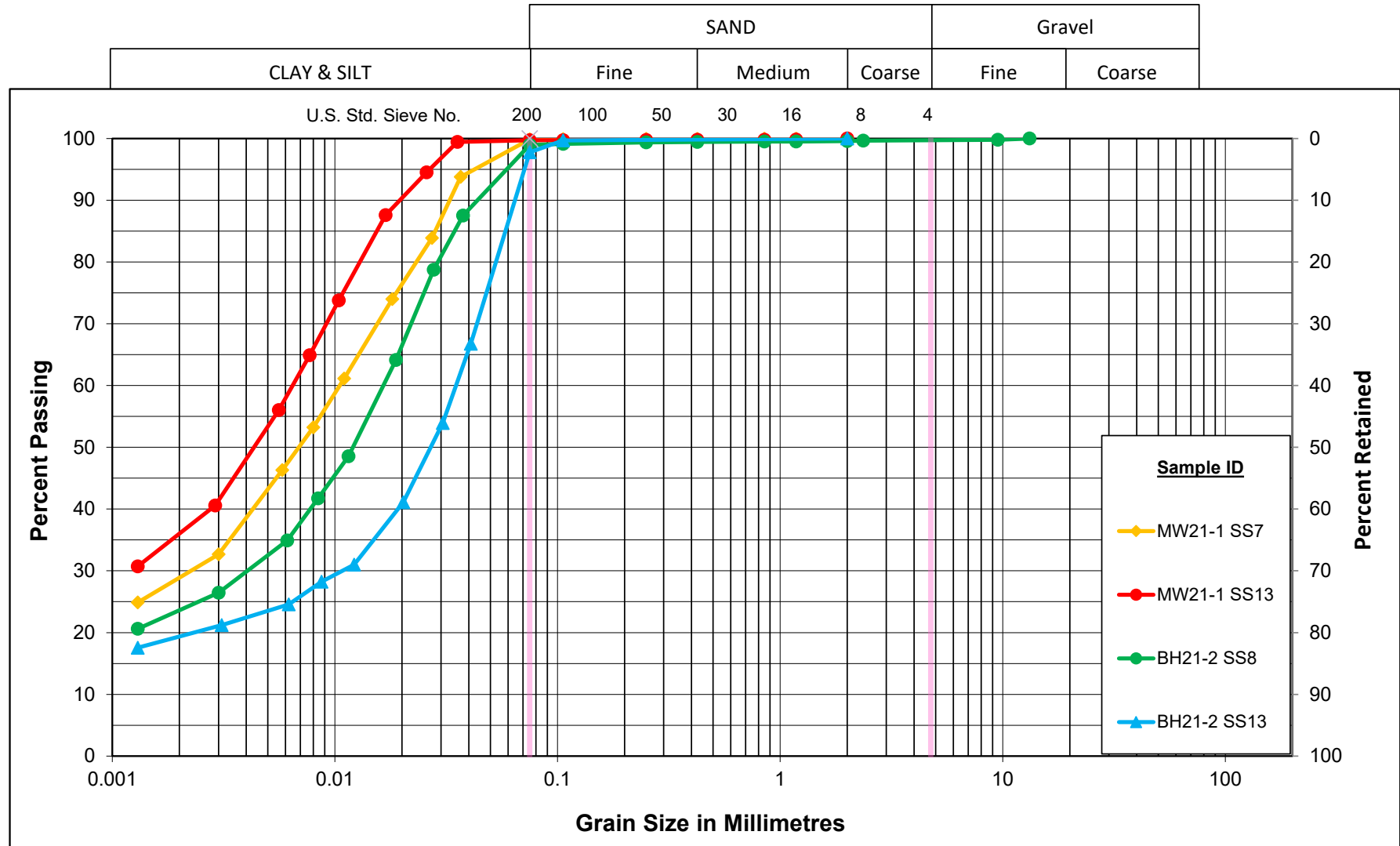
Highway 401 Cobourg to Colborne

PLASTICITY CHART

Figure No. C3

Project No. 165001231

Unified Soil Classification System

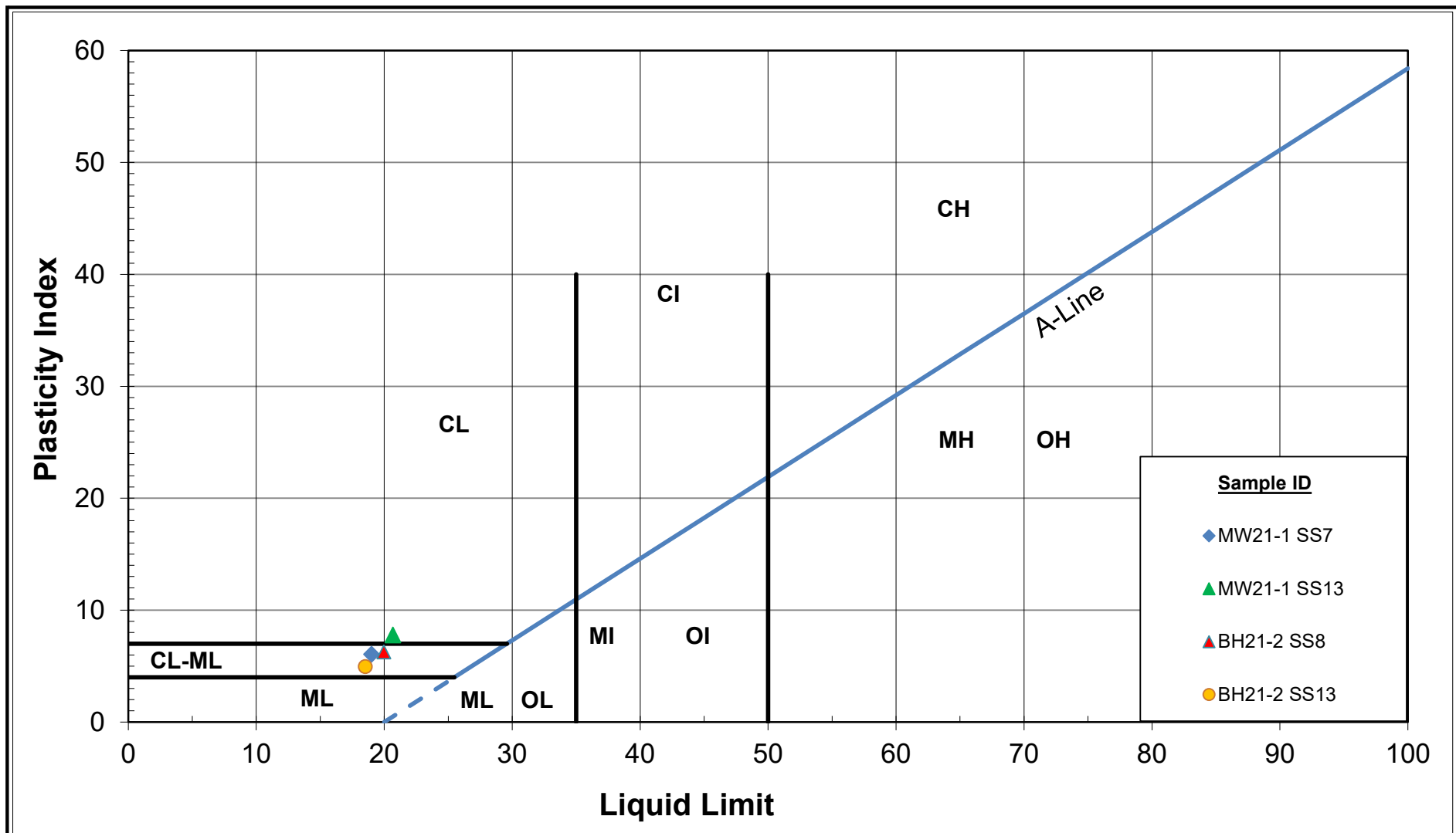


GRAIN SIZE DISTRIBUTION

CLAYEY SILT (CL to CL-ML)
Highway 401 Cobourg to Colborne

Figure No. C4

Project No. 165001231

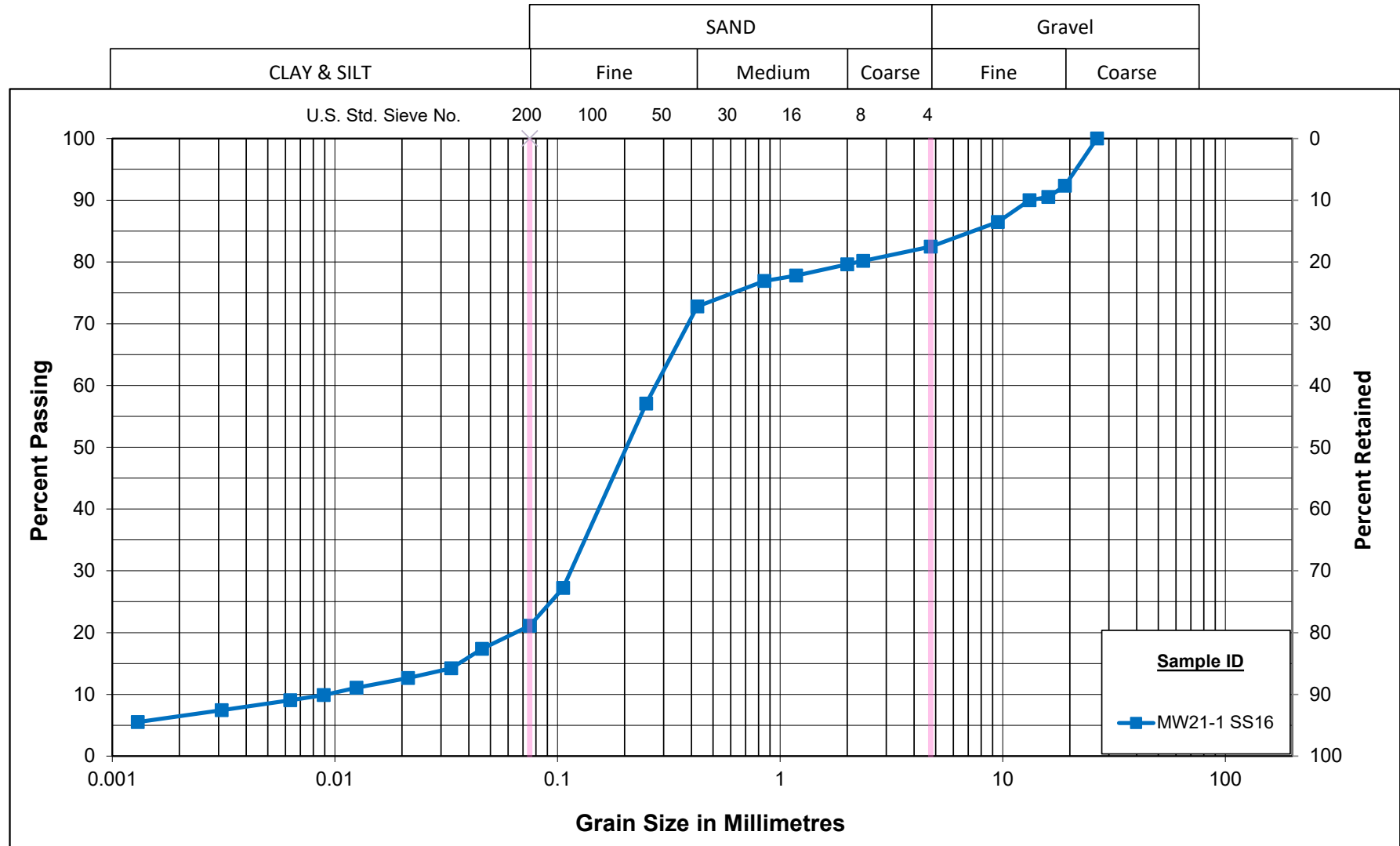


CLAYEY SILT (CL to CL-ML)
 Highway 401 Cobourg to Colborne
PLASTICITY CHART

Figure No. C5

Project No. 165001231

Unified Soil Classification System



GRAIN SIZE DISTRIBUTION

SAND (SM), some silt, some gravel, trace clay
Highway 401 Cobourg to Colborne

Figure No. C6

Project No. 165001231



AGAT Laboratories

Certificate of Analysis

AGAT WORK ORDER: 22T861910

PROJECT: 165001231.309

5835 COOPERS AVENUE
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<http://www.agatlabs.com>

CLIENT NAME: STANTEC CONSULTING LTD

SAMPLING SITE:

ATTENTION TO: Nabeel Basheer

SAMPLED BY:

Corrosivity Package

DATE RECEIVED: 2022-02-09

DATE REPORTED: 2022-02-15

				MW21-1, SS-10	BH21-2, SS-6	BH21-6, SS-10	BH21-7, SS-10
SAMPLE DESCRIPTION:				22'6"-24'6"	12'6"-14'6"	25'-27'	25'-27'
SAMPLE TYPE:				Soil	Soil	Soil	Soil
DATE SAMPLED:				2021-10-18	2021-10-20	2022-02-02	2022-02-03
Parameter	Unit	G / S	RDL	3496115	3496117	3496118	3496119
Chloride (2:1)	µg/g		2	5	12	7	4
Sulphate (2:1)	µg/g		2	6	5	3	136
pH (2:1)	pH Units		NA	8.42	8.63	8.39	8.20
Electrical Conductivity (2:1)	mS/cm		0.005	0.120	0.115	0.130	0.268
Resistivity (2:1) (Calculated)	ohm.cm		1	8330	8700	7690	3730
Redox Potential 1	mV		NA	405	406	382	373
Redox Potential 2	mV		NA	406	407	384	374
Redox Potential 3	mV		NA	408	408	385	375

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

3496115-3496117 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. Samples were received and analyzed beyond recommended hold time.

3496118-3496119 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:

Anamjot Bhela
