



**Foundation Investigation and  
Design Report – Lindsay Drain  
Culvert –Highway 4 widening  
from Clinton Line to New  
Talbotville Bypass and New  
Talbotville Bypass from Highway 4  
to Highway 3 at Ron McNeil Line**

Highway 3 Township of Southwold,  
Elgin County, ON  
West Region

GWP 3042-22-00

Latitude 42.816367  
Longitude -81.248505

Geocres No. 40I14-222

Prepared for:

Ministry of Transportation, Ontario  
(MTO), West Region

Prepared by:

Stantec Consulting Ltd.  
300W – 675 Cochrane Drive  
Markham, ON L3R 0B8

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**FOUNDATION INVESTIGATION AND DESIGN REPORT – LINDSAY DRAIN CULVERT –HIGHWAY 4  
WIDENING FROM CLINTON LINE TO NEW TALBOTVILLE BYPASS AND NEW TALBOTVILLE  
BYPASS FROM HIGHWAY 4 TO HIGHWAY 3 AT RON MCNEIL LINE**

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Introduction  
April 2025

## **FOUNDATION INVESTIGATION REPORT**

For  
G.W.P. 3042-22-00  
Lindsay Drain Culvert

Highway 4 widening from Clinton Line to New Talbotville Bypass and New  
Talbotville Bypass from Highway 4 to Highway 3 at Ron McNeil Line  
West Region, Township of Southwold, Elgin County, Ontario

## **1.0 INTRODUCTION**

Stantec has been retained by the Ministry of Transportation Ontario (MTO) to provide preliminary and detailed design services for the Highway 4 widening from Clinton Line to the new Talbotville Bypass and for the new Talbotville Bypass from Highway 4 to Highway 3 at Ron McNeil Line (GWP 3042-22-00), and for the Highway 3 widening from Ron McNeil Line to Centennial Avenue (GWP 3041-22-00).

As part of the GWP 3042-22-00 new Talbotville Bypass from Highway 4 to Highway 3 at Ron McNeil Line, the following new structures are proposed:

- CNR Talbotville Overhead - Two (2) Single Span Bridges with about 300 m long approach embankment on both sides of bridges,
- Ron McNeil Line Interchange Overpass - Two Span Bridge with approach embankments, and
- Lindsay Drain Culvert (formerly Dodd's Creek Culvert).

As part of the GWP 3041-22-00 Highway 3 Twinning from Ron McNeil Line to Centennial Avenue, the following new structures, including two existing culverts replacement, are proposed:

- Wellington Road Interchange Underpass – New Two-Span Bridge with approach embankments
- Kettle Creek WBL Bridge – New Three-Span Bridge
- 05X-0266/C0 Underhill Drain Culvert – New Culvert Construction Under the proposed Highway Twinning
- 05X-0268/C0 – Existing CSP Culvert replacement & New Culvert Construction Under the proposed Highway Twinning
- Noise Walls (between Stations 13+100 and 11+100, south side of the existing Highway 3, and between Stations 12+400 and 13+600, on both sides of Highway 3)
- Deep Cuts (between Stations 13+650 and 15+050, north of the existing Highway 3)

Eighteen (18) Overhead Signs and three (3) Storm Water Management Ponds (SWMPs) were also planned at the early stage of the project. As per the preliminary design, three (3) Storm Water Management Ponds were eliminated, and four (4) structural culverts were added at the Ron McNeil Line interchange area.



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Site Description  
April 2025

This Foundation Investigation Report has been prepared specifically and solely for the proposed Lindsay Drain Culvert. Other foundations engineering components for this project are reported under separate cover.

The terms of reference for the foundation investigation work scope were provided in the MTO's RFP (Request for Proposal) and addenda. The MTO Guideline for Foundation Engineering Services (V.3.0) is also considered for the borehole termination depth based on the clarifications provided during the bid phase.

## **2.0 SITE DESCRIPTION**

### **2.1 SITE LOCATION**

Lindsay Drain Culvert is planned to cross the Highway 3 Bypass at Station 10+803.222, approximately 850 m east of Highway 4 in Township of Southwold, Elgin County, Ontario. The site location is shown on the Key Plan inset to Drawing No. 1 included in Appendix A.

### **2.2 GENERAL SITE DESCRIPTION**

At the proposed location of the Lindsay Drain culvert, the Highway 3 Bypass is planned to be a twinned freeway, with two lanes (with paved shoulder) in each direction, divided by a grass median. The orientation of the Highway 3 Bypass is approximately east-west and the orientation of the proposed culvert is approximately northwest-southeast. For the purposes of this report, the orientation of the Highway 3 Talbotville Bypass and the Lindsay Drain culvert are taken as east-west and north-south, respectively.

At the culvert site, the eastbound and westbound lanes of the Highway 3 Talbotville Bypass are planned to be constructed on an embankment. The centreline of the eastbound and westbound lanes are planned to be at approximately elevations 240.26 m and 240.37 m, respectively, approximately 4.5 m higher than the deepest portion of the existing watercourse. The embankments are planned to have 2 horizontal : 1 vertical side slope. The top portion of embankment will have a flatter slope - 4 horizontal : 1 vertical (shoulder rounding). The invert of the culvert will be at approximately elevation 235.3 m on the north side and at approximately elevation 235.15 m on the south side. Beyond the culvert and associated drainage features, the overall topography surrounding the culvert site is relatively flat to gently sloping.



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Site Description  
April 2025



**Photo 1 Lindsay Drain Culvert Site (formerly Dodd's Creek) looking south**

Flow in the Lindsay Drain Culvert is from north to south. The surrounding lands generally consist of farm fields.

## 2.3 PROPOSED STRUCTURE

Based on the General arrangement (GA) drawing provided by the structural team, the Lindsay Drain Culvert is planned to consist of two (2) side-by-side precast concrete culverts, with a 60 mm gap, each with a width of 6 m (inner span of 5.4 m), rise of 3.5 m (inner rise of 2.7 m) and an overall length of approximately 109.4 m. The culverts will be at a skew of 51° to the proposed Highway 3 Talbotville Bypass centreline. A concrete header wall is being considered on the north end of the west culvert and precast concrete block retaining walls are planned at the northwest and southeast corners of the culverts.

Both culverts are planned to be filled with up to 800 mm thick layer of waterbody aggregates (substrate), WB-200 with Granular B to fill the voids.

The GA Drawing is included in Appendix A for reference.





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Review of Previous Investigations  
April 2025

## **2.4 GEOLOGICAL INFORMATION**

The project alignment is situated within the physiographic region of Mount Elgin Ridges, as delineated in the Physiography of Southern Ontario (Chapman and Putnam, 1983). According to the Ontario Department of Mines Preliminary Geological Maps 238 (Pleistocene Geology of The St. Thomas Area, West Half) and P.606 (Pleistocene Geology of The St. Thomas Area, East Half), the site subsurface conditions are generally characterized by lacustrine deposits of silt, silty sand and clay, Port Stanley silty clay to clayey silt till and modern alluvium deposits of gravel, sand, and silt along watercourses. As per the Ontario Geological Survey Map 2441 (Geological Highway Map Southern Ontario), the bedrock within the project area is described as grey limestone of the Dundee Formation. Based on the Ontario Department of Mines Preliminary Geological Map P. 482 (St. Thomas Sheet), the bedrock is estimated to be at a depth of approximately 85 m below grade at the location of Lindsay Drain Culvert.

## **2.5 EXISTING UTILITIES**

No existing above-ground or underground utilities have been identified at the proposed Lindsay Drain Culvert site location.

## **3.0 REVIEW OF PREVIOUS INVESTIGATIONS**

A review of MTO GEOCREs database did not identify any reports for the Lindsay Drain Culvert site. However, the following reports included subsurface information for structures in proximity to the planned culvert:

### GEOCREs Reference No. 40114-033

A foundation investigation report dated September 12, 1973, was available for Culverts No. 1, 4, 5, 6 and 7 for the proposed St. Thomas Expressway. The proposed Culvert No. 1 was planned approximately 1 km west of Wonderland Road and approximately 200 m north of the proposed Lindsay Drain Culvert. The report was referenced as follows:

Foundation Investigation Report  
For Proposed St. Thomas Expressway  
Culverts No. 1, 4, 5, 6 and 7  
Twp. Of Southwold and Yarmouth  
County of Elgin  
District No. 2 (London)  
W.O. 73-11019- W.P. 89-69-01

The investigation included two (2) boreholes (C1-1 and C1-2) advanced to a depth of approximately 9.6 m below grade (corresponding to approximate elevation 227 m and 227.3 m) in June 1973.



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Review of Previous Investigations

April 2025

The boreholes encountered a deposit of very stiff to hard clayey silt with some sand and trace gravel. In Borehole C1-1, a 1.8 m thick layer of dense to very dense sand underlain by silt was embedded in the clayey silt deposit.

Groundwater levels were not established in any of the boreholes.

For reference, copies of the Borehole Location Plan, stratigraphy along the culvert, borehole records and laboratory test results are included in Appendix B.

## GEOCRES Reference No. 40114-070

A foundation investigation report dated September 17, 1971, was available for the proposed crossing at CNR spur overhead and St. Thomas Expressway that is located approximately 1 km east of the proposed Lindsay Drain Culvert.

The report was referenced as follows:

Foundation Investigation Report  
For Proposed Crossing at  
CNR Spur Overheads and St. Thomas Expressway  
Twps. Of Southwold; County of Elgin  
W.O. 71-11068 - W.P. 89-69-05 & 06

The investigation included a total of eight (8) sampled boreholes (BH No. 1 to 8), advanced to depths ranging from approximately 10.4 m to 30.2 m below grade (corresponding to approximately elevations 229.8 m to 210.1 m) and eight (8) dynamic cone penetration tests carried out adjacent to each borehole advanced in July 1971.

The boreholes encountered a deep stratum of stiff to hard clayey silt with some sand and trace gravel immediately below the topsoil. Except for the top 2 m, the stratum had a moisture content that was at or below the Plastic Limit. The undrained shear strength of the stratum generally decreased with depth, from greater than 240 kPa at approximate elevation 237.8 m to about 190 kPa at approximate elevation 213.4 m. The deposit appeared to be highly over-consolidated due to desiccation.

Groundwater levels were observed at elevations ranging from approximately 231 m to 218.1 m.

Following shifts in the alignment of the St. Thomas Expressway at the CNR overhead, five (5) additional borings (BH No.11 to 15) were advanced to a depth of approximately 5 m below grade at this site, which reported similar subsoil conditions as those indicated above.

For reference, copies of the Borehole Location Plan, stratigraphy along the culvert, borehole records and laboratory test results are included in Appendix B.



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Investigation Procedures  
April 2025

## **4.0 INVESTIGATION PROCEDURES**

### **4.1 FIELD INVESTIGATION**

The foundation investigation for the detail design of the proposed Lindsay Drain Culvert consisted of a total of three (3) boreholes, designated as Boreholes DCC1, DCC2 and DCC33. All three (3) boreholes were advanced on the east bank of the Lindsay Creek (formerly identified as Dodd's Creek) across the proposed bypass alignment due to the drill rig accessibility issue on the west side of the creek (steep slope and heavy vegetation in the wider floodplain). The locations of these boreholes are shown on the Borehole Locations 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.

The boreholes were advanced using D50 track-mounted drill rigs equipped for soil sampling between the dates of January 10 and February 27, 2024. The boreholes were advanced using continuous flight hollow stem augers.

The subsurface stratigraphy encountered in each borehole was recorded in the field by an experienced Stantec field technician. Standard Penetration Tests (SPT) were carried out in the drilled holes and split spoon samples were collected at regular intervals (0.75 m interval for the shallow depth / critical zone and 1.5 m interval to a depth of 20 m below ground surface to meet the typical MTO subsurface investigation sampling requirements) in accordance with ASTM D1586. All recovered SPT samples were returned to our Markham laboratory for detailed classification and testing. A pocket penetrometer was also used to estimate the strength/consistency of clayey soil samples at the site.

Following completion of drilling, a 50-millimeter (mm) diameter groundwater monitoring well, screened over a depth of 4.6 m to 6.1 m below ground surface, was installed in Borehole DCC2. The borehole annulus surrounding the slotted pipe section was backfilled with sand. The remaining annulus was backfilled with bentonite up to the ground surface.

Groundwater level measurements were taken in borehole DCC2 on March 20, March 27 and May 9, 2024.

Groundwater was also observed in open boreholes during and upon completion of drilling.

After completion of drilling, boreholes were backfilled with a mix of bentonite and drill cuttings.

### **4.2 LOCATION AND ELEVATION SURVEY**

The borehole locations and respective ground surface elevations were surveyed by Stantec Geomatics personnel using Trimble R12i GPS with an elevation and spatial accuracy of  $\pm 0.02$  m vertically and  $\pm 0.01$  m horizontally to meet the survey accuracy requirements (vertical accuracy of 0.1 m and horizontal accuracy of 0.5 m) of the Guideline for MTO Foundation Engineering Services.



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Subsurface Conditions  
April 2025

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.

**Table 4.1: Borehole Information Summary**

Investigation Borehole	MTM Zone 11 Coordinates		Ground surface elevation (m)	Total depth drilled or advanced (m)	End of borehole elevation (m)	Number of soil samples
	Northing	Easting				
DCC1	4742624.0	407117.6	237.3	15.9	221.4	15
DCC2	4742609.0	407154.4	237.4	15.9	221.5	15
DCC3	4742591.0	407191.9	237.3	15.9	221.4	14

## 4.3 LABORATORY TESTING

All samples were taken to Stantec's Markham laboratories where they were subjected to a detailed visual and tactile examination. The geotechnical laboratory testing program completed on the borehole samples is summarized in Table 4.2. One soil sample was forwarded to AGAT Laboratories. The sample was tested for pH, soluble sulphate content, chloride content, electrical conductivity, resistivity, and redox potential.

**Table 4.2: Laboratory Testing Program**

Laboratory Test Type	Number of Tests
Moisture Content	47
Gradation Analysis	10
Atterberg Limits	10
Chemical Analysis	1

Samples remaining after testing will be placed in storage for a period of one year after issuance 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 C. An explanation of the symbols and terms used to describe the Borehole Records is also provided in Appendix C. The results of the geotechnical laboratory testing are presented on Figures D1 to D4 contained in Appendix D.

A borehole location plan and a stratigraphic section of the soils encountered in the boreholes along the culvert alignment are provided on Drawing No.1 in Appendix A.



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Subsurface Conditions  
April 2025

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 consisted of:

- Ground surface cover (grass and topsoil); underlain by,
- Fill comprising clayey silt to the depths of approximately 0.9 m and 1.0 m below grade in boreholes DCC1 and DCC2 respectively; underlain by,
- Firm silty clay and clay to a depth of approximately 1.4 m below grade in boreholes DCC1 and DCC3, respectively; underlain by,
- Very stiff to hard clayey silt till.

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

## 5.2 OVERBURDEN

### 5.2.1 Ground Surface Cover

Grass underlain by topsoil was encountered at all three (3) borehole locations. The topsoil was approximately 180 mm, 200 mm and 150 mm thick in Borehole DCC1, DCC2 and DCC3, respectively.

### 5.2.2 Fill (Clayey Silt)

Fill materials comprising brown to black clayey silt were encountered below the topsoil in Boreholes DCC1 and DCC2. Samples obtained from the fill materials typically contained trace to some sand. Trace rootlets and a silty sand layer were noted in the samples obtained from the fill in Borehole DCC2. These materials were described as fill based on the soil texture as examined in the field (previously disturbed, possibly tilled soil due to farming) and presence of rootlets and topsoil inclusions.

The fill materials were 0.7 m and 0.8 m thick and extended to the depths of approximately 0.9 m and 1.0 m, corresponding to approximately elevations 236.5 m and 236.4 m in Boreholes DCC1 and DCC2, respectively.

N-values of 7, 8 and 9 blows per 0.3 m penetration were obtained from the SPTs advanced in the fill materials, indicating firm to stiff consistency.

Samples obtained from the fill materials were described as moist based on manual examination of the samples in the field. Laboratory tests conducted on samples of the fill yielded natural moisture contents ranging from approximately 16% to 26%, averaging 23%.



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Subsurface Conditions  
April 2025

## 5.2.3 Silty Clay and Clay

Layers of brown silty clay and clay were encountered below the fill materials in Boreholes DCC1 and DCC3, respectively. Samples obtained from the silty clay and clay layers typically contained trace sand and gravel.

The silty clay and clay layers were approximately 0.5 m to 1.3 m thick and extended to a depth of approximately 1.4 m below grade, corresponding to approximate elevation 235.9 m.

N-values of 4 to 7 blows per 0.3 m penetration were obtained from the SPTs advanced in the silty clay and clay soils. Undrained shear strengths of approximately 63 kPa and 125 kPa were estimated for the silty clay and clay, respectively based on the results of pocket penetrometer tests. Based on the results of SPT and pocket penetrometer tests, the silty clay and clay soils are described as firm to stiff.

Laboratory tests conducted on samples of the silty clay and clay soils yielded natural moisture contents of approximately 22%, 22% and 28%.

Gradation analyses were carried out on a single sample of the clay soils obtained from Borehole DCC3. The test results are illustrated on the borehole record in Appendix C and on the gradation curve on Figure No. D1 in Appendix D. The tests yielded the following results:

- Gravel: 0%
- Sand: 15%
- Silt: 43%
- Clay: 42%

Atterberg Limits tests were conducted on the sample referenced above. The tests yielded a Liquid Limit of 54% and a Plastic Limit of 32%, corresponding to a Plasticity Index of 22%. The test results are illustrated on the borehole records in Appendix C and on the gradation curve on Figure No. D2 in Appendix D.

Based on the results of the laboratory tests, the sample tested can be classified as clay with a group symbol of CH based on the Unified Soil Classification System (USCS).

## 5.2.4 Clayey Silt Till

A deposit of clayey silt till was encountered below the soils described in the preceding sections in all three (3) boreholes. Samples obtained from the clayey silt till deposit typically contained some sand and trace gravel. Presence of cobbles and/or boulder was inferred in this deposit based on rock fragments in the samples. A sand seam was noted in a sample of the clayey silt deposit obtained from Borehole DCC3.

All three (3) boreholes were terminated in the clayey silt till deposit after penetrating approximately 14.5 m, 14.9 m and 14.5 m into the deposit.

N-values ranging from 13 to 84 blows per 0.3 m penetration were obtained from the SPTs advanced in the clayey silt layer. If the single N-value of 84 is disregarded, the remaining N-values ranged from 13 to



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Subsurface Conditions  
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45. Undrained shear strengths ranging from approximately 163 kPa to more than 220 kPa were estimated for the clayey silt till based on the results of pocket penetrometer tests. In this respect, the clayey silt till layer can be described as very stiff to hard.

Laboratory tests conducted on samples of the clayey silt layer yielded natural moisture contents ranging from approximately 6% to 18%, averaging 13%.

Gradation analyses were carried out on nine (9) representative samples of the clayey silt till soils. The test results are illustrated on the borehole records in Appendix C and on the gradation curve on Figure No. D3 in Appendix D. The tests yielded the following results:

- Gravel: 0% to 8%
- Sand: 8% to 15%
- Silt: 44% to 71%
- Clay: 19% to 44%

Atterberg Limits tests were also conducted on the samples referenced above. The tests yielded Liquid Limits ranging from approximately 20% to 34%, Plastic Limits ranging from approximately 13% to 19%, and corresponding Plasticity Indices ranging from approximately 7% to 19%. The test results are illustrated on the borehole records in Appendix C and on the gradation curve on Figure No. D4 in Appendix D.

Based on the results of the laboratory tests, the samples tested can be classified as clayey silt with a group symbol of CL-ML and CL based on the Unified Soil Classification System (USCS).

## 5.3 BEDROCK

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

## 5.4 GROUNDWATER CONDITIONS

A monitoring well was installed in Borehole DCC2 to observe the long-term groundwater levels. In other boreholes, groundwater level observations were made during drilling operations, and in the open boreholes upon completion of drilling. Cave-in depths were also recorded. The groundwater level recorded in DCC2 and inferred in the other boreholes are summarized in Table 5.1 below.

**Table 5.1: Measured and Inferred Groundwater Levels**

Borehole No	Date	Groundwater Level (m)		Remark
		Depth	Elevation	
DCC1	Upon completion	Dry	Dry	Borehole Open
DCC2	March 20, 2024	5.5	231.9	-
	March 27, 2024	5.0	232.4	-
	May 9, 2024	2.1	235.3	-
DCC3	Upon completion	Dry	Dry	Cave-in at 14.9 m



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

## 5.5 CHEMICAL ANALYSIS

A single soil sample was forwarded to AGAT Laboratories to be tested for pH, soluble sulphate content, chloride content, electrical conductivity, resistivity, and redox potential. The results of the tests are summarized in the table below and included in Appendix D for reference.

**Table 5.2: Results of Chemical Analysis**

Borehole No	Sample No.	Depth (m)	pH	Chloride (µg/g)	Sulphate (µg/g)	Resistivity (Ohm-cm)
DCC2	SS3	1.5 – 2.1	8.40	17	24	5430





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## **6.0 MISCELLANEOUS**

The field work was carried out under the supervision of Mr. Kirby Lales, EIT and Mr. Akshat Shukla, EIT under the direction of Gwangha Roh, P. Eng., Ph.D.

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

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

The borehole locations and elevations were surveyed by Stantec's Geomatics division based in London.

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

This report was prepared by Roshan Rashed, M.Sc., P.Eng., and reviewed by Gwangha Roh, P. Eng., Ph.D., and Raymond Haché, M.Sc., P.Eng., Designated Principal MTO Foundation 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.**



Roshan Rashed, M.Sc., P.Eng.  
Geotechnical Engineer



Gwangha Roh, P. Eng., Ph.D.  
Senior Geotechnical Engineer



Raymond Haché, M.Sc., P. Eng.  
MTO Designated Principal Foundation Contact



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# **FOUNDATION INVESTIGATION AND DESIGN REPORT – LINDSAY DRAIN CULVERT –HIGHWAY 4 WIDENING FROM CLINTON LINE TO NEW TALBOTVILLE BYPASS AND NEW TALBOTVILLE BYPASS FROM HIGHWAY 4 TO HIGHWAY 3 AT RON MCNEIL LINE**

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## **FOUNDATION DESIGN REPORT**

For

G.W.P. 3042-22-00

Lindsay Drain Culvert

Highway 4 widening from Clinton Line to New Talbotville Bypass and New  
Talbotville Bypass from Highway 4 to Highway 3 at Ron McNeil Line  
West Region, Township of Southwold, Elgin County, Ontario

## **8.0 DISCUSSIONS AND ENGINEERING RECOMMENDATIONS**

### **8.1 PROJECT DESCRIPTION AND BACKGROUND**

#### **8.1.1 Project Purpose and Description**

This project involves preliminary and detailed design of the Highway 4 widening from Clinton Line to the new Talbotville Bypass and new Talbotville Bypass from Highway 4 to Highway 3 at Ron McNeil Line (GWP 3042-22-00), and the Highway 3 widening from Ron McNeil Line to Centennial Avenue (GWP 3041-22-00). As part of the project, a new twin-cell precast concrete culvert is proposed at approximate Station 10+803.222, approximately 850 m east of Highway 4.

This foundation investigation and design report has been prepared specifically for the proposed Lindsay Drain Culvert and other project foundations engineering components are reported under separate covers.

#### **8.1.2 Proposed Structure**

Based on the General arrangement (GA) drawing provided by the structural team, the Lindsay Drain Culvert is planned to consist of two (2) side-by-side precast concrete culverts, with a 60 mm gap, each with a width of 6 m (inner span of 5.4 m), height of 3.5 m (inner rise of 2.7 m) and an overall length of approximately 109.4 m. The culverts will be at a skew of 51° to the proposed Highway 3 Talbotville Bypass centreline. A concrete header wall is being considered on the north end of the west culvert and precast concrete block retaining walls are planned at the northwest and southeast corners of the culverts.

The Highway 3 Bypass eastbound and westbound lanes are planned to be constructed on an embankments with about 22.5 m wide median. The centreline of the eastbound and westbound lanes are planned to be at approximate elevations of 240.26 m and 240.37 m, respectively, approximately 4.5 m higher than the deepest point of the existing watercourse. The embankments are planned to have 2 horizontal : 1 vertical side slopes. The top portion of embankment will have a flatter slope - 4 horizontal : 1 vertical (shoulder rounding).

The base of the culvert will be at approximate elevation 234.9 m on the north side and at approximate elevation 234.7 m on the south side.



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It is expected that the culverts will be placed during the highway embankment construction and in this respect, no staging/closure is anticipated to be required.

The GA Drawing is included in Appendix A for reference.

## 8.1.3 Degree of Site and Prediction Model Understanding

The Canadian Highway Bridge Design Code (CHBDC S6-19) 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 include 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.

## 8.2 GEOTECHNICAL DESIGN PARAMETERS

The soil conditions encountered in the boreholes advanced at the site generally consist of topsoil underlain by clayey silt fill materials; underlain by firm to stiff silty clay to clay underlain by a deposit of very stiff to hard clayey silt till.

Table 8.1 below outlines 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.

**Table 8.1: Geotechnical Model – Lindsay Drain Culvert**

Elevation (m)		Soil Type	Design Parameters			
From	To		Total Unit Weight $\gamma$ (kN/m <sup>3</sup> )	Drained Friction Angle <sup>1</sup> $\phi'$ (°)	Undrained Shear Strength $S_u$ <sup>2</sup> (kPa)	Soil Modulus E (MPa)
Ground Surface	236.4	FILL: firm to stiff CLAYEY SILT (in DCC1 and DCC2)	20	28	50	10
236.4	235.8	Firm to stiff SILTY CLAY (CI) to CLAY (CH) (in DCC1 and DCC3)	20	30	40	10
Below 235.8		Very stiff to hard CLAYEY SILT TILL	21.5	32	150	75

Notes:

<sup>1</sup> The friction angle is applicable to drained conditions only

<sup>2</sup> The shear strength is applicable to undrained conditions only, Shear strengths are estimated based on the SPT N values and pocket penetrometer readings



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The shallowest groundwater level in the monitoring well installed in Borehole DCC2 was recorded at a depth of 2.1 m below existing grade, corresponding to an elevation of 235.3 m. A static groundwater level at an elevation of 235 m is recommended for design purposes.

## 8.3 FROST PENETRATION

In accordance with OPSD 3090.101, the design frost penetration depth for foundations,  $f$ , can be taken as 1.2 m.

Footings for structures including the retaining wall foundation would typically therefore be provided with a minimum of 1.2 m of soil cover or equivalent insulation for protection against frost heaving. However, frost protection is not required for a box culvert, as this type of culvert can typically tolerate a small magnitude of movement associated with freeze-thaw cycles.

The depth of frost penetration stated should, however, be considered in the design of frost tapers for the culvert backfill.

## 8.4 SEISMIC DESIGN CONSIDERATIONS

### 8.4.1 Site Class

The seismic site class determination is based on the soil conditions in the upper 30 m of the stratigraphy as encountered in the boreholes for the Geotechnical Investigation. Based on a comparison of the foundations investigation findings and the geophysical survey (Multi Channel Analysis of Surface Wave) test results done for the proposed CNR overhead about 1 km away from the site, this site is assessed to be Seismic Site Class D as per CHBDC S6-19 Commentary Table 4.1.

### 8.4.2 Peak Ground Acceleration (PGA)

Seismic hazard values for the Lindsay Drain Culvert site were obtained from Natural Resources Canada (2020 National Building Code Canada). Table 8.2 below summarizes the parameters obtained and recommended for use in the design based on a 2475-year return period.

**Table 8.2: Peak Ground Acceleration Data**

$PGA^*$	$S_a(0.2)^*$	$S_a(1.0)^*$
0.142	0.242g	0.133g

\* For a site class D

The 2020 NBCC Seismic Hazard calculation sheet is provided in Appendix E.

### 8.4.3 Liquefaction Potential

Seismic liquefaction is the sudden loss in stiffness and strength of soil due to cyclic loading effects of an earthquake. Liquefaction occurs due to increased pore water pressures that can arise from earthquake



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shaking (or other rapid loading). Under these conditions, the soil flows in a manner resembling a liquid until the shear stresses acting on the mass are as low as the reduced shear resistance.

The CHBDC describes saturated low-plastic silts exhibiting sand-like behavior (e.g.,  $PI < 7$ ), sands, sand-silt mixtures, gravels confined by low permeability soil layers, and gravel-sand mixtures, as having a potential for liquefaction. The CHBDC references the use of the Bray et al (2004) criteria for evaluation of liquefaction susceptibility in fine-grained soils. The Bray criteria include consideration for a Plasticity Index  $< 12$  and a ratio of the Natural Moisture Content to Liquid Limit  $> 0.85$  as an indication of possible liquefaction.

Based on our local experience and site clayey soils' properties (plasticity, shear strength, sensitivity, OCR, natural moisture content close to or lower than plastic limit, etc.), shear strength degradation potential under anticipated earthquake condition is considered minimal (Idriss and Boulanger, 2008) and cyclic mobility may not be a significant issue for this project.

## **8.5 FOUNDATION RECOMMENDATIONS FOR BOX CULVERT AND RETAINING WALL**

### **8.5.1.1 Overview**

According to the GA drawing, twin precast concrete box culverts are being considered for this site. A concrete header wall (on top of the culvert) is planned at the north end of the west culvert. Precast concrete block retaining walls are also planned at the northwest and southeast corners of the culverts.

The design recommendations presented in the following sections have been developed in accordance with the requirements and methods described in the Canadian Highway Bridge Design Code (CHBDC, 2019).

### **8.5.1.2 Foundation Subgrade Preparation**

The base of the proposed box culverts is planned to be at approximately elevations 234.9 m to 234.7 m. The excavation required for the installation of granular bedding layer and concrete mud mat/working slab will extend to an elevation slightly above 234 m.

Based on the conditions encountered in the boreholes, the subgrade exposed at the design founding level of the new culverts is anticipated to consist of the native very stiff clayey silt till. These materials are considered suitable to support the culverts provided that groundwater and surface water are properly controlled, as described below, and are protected from disturbance.

Fill materials were terminated above the proposed culvert founding levels at the locations of the boreholes. However, presence of these materials cannot be ruled out at other locations within the footprint of the culverts. Any existing fill (if encountered), organic soils, creek bed sediments or other softened/loosened soils encountered at the subgrade level during construction should be removed and



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replaced with engineered/structural fill materials consisting of compacted OPSS Granular A material placed and compacted in maximum 300 mm thick lifts.

The foundation investigation identified that the groundwater level is at approximate elevation 235 m, approximately 1 m above the anticipated base of the excavation required for construction of the culverts. Although creek water flow is expected to be intermittent, a temporary creek water diversion and/or cofferdam installation may be required for the proposed culvert construction (depending on the water level at the time of construction). Groundwater seepage from the native clayey silt till deposits should be expected in the excavations for construction of the culverts; however, the volume of seepage is expected to be limited based on the inherent low hydraulic conductivity of the native fine grain soils. Pumping from filtered sumps established in the floor of the excavations should be satisfactory to handle the seepage. Given the very stiff nature of these soils, basal instability is not anticipated to be a concern for this site.

Following completion of the preparation of the founding surface, a milestone inspection should be conducted by foundation/geotechnical personnel arranged for by the Contract Administrator in accordance with OPSS 902. Moving construction equipment over the saturated clayey silt subgrade should be minimized since it could cause extensive disturbance to the foundation subgrade. In this respect, it is suggested that a minimum 100 mm thick concrete working slab be placed immediately following inspection and approval of the founding surface to protect the subgrade for culverts and possibly retaining walls. The working slab should have a minimum 28-day strength of 5 MPa. A Non-Standard Special Provision (NSSP) has been included in Appendix F in this respect. A 300 mm thick OPSS Granular A bedding should be placed on top of the work slab or inspection & approved subgrade. A levelling course/pad consisting of a 75 mm thick layer of uncompacted OPSS Granular A materials should be placed over the bedding in accordance with the requirements of OPSS.803.010.

The dewatering and unwatering operations should continue during the excavation, placement of any required structural fill, placement of the mud mat/working slab, placement of the levelling course/pad and throughout construction and backfilling of the culvert.

## **8.5.1.3 Geotechnical Resistances and Reactions for Precast Concrete Box Culvert**

The geotechnical resistance and reactions (for vertical concentric loads) provided in Table 8.3 below may be used in the design of the precast box culverts. The values developed are based on the construction of the box culvert on the concrete working slab overlying the undisturbed native soils plus bedding and levelling course as described in Section 8.5.1.2 . The resistance and reaction provided will also apply where structural fill is required to backfill any localized sub-excavated zones of soft/loose materials, organics, or previously existing fill materials.



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**Table 8.3: Geotechnical Vertical Resistance & Reaction – Box Culvert**

Founding Element	Founding Elevation (m)	Culvert Width (m)	Factored Geotechnical Resistance at ULS <sub>r</sub> (kPa) $\phi_{gu} = 0.5$	Factored Geotechnical Reaction at SLS* (kPa) $\phi_{gs} = 0.8$
Box Culvert	± 234.9 to 234.7	2 x 6.0	350	120

Note \* overall culvert settlement will be controlled by subgrade settlement under the proposed embankment - expected maximum grade raise is about 3.0 m (geotechnical resistance factor of 1.0 for embankment settlement can be considered as per the MERO 2020-1)-see Section 8.7.3.\*\* vertical and horizontal arching factors for installation type B1 (embankment) as per CHBDC S6-19 were considered.

The SLS reaction value considers up to 12 mm of settlement induced by embankment load and up to 13 mm by the culvert bearing pressures. Greater SLS reaction values could be considered, should larger settlements be accepted by the designer.

In accordance with Table 6.1 in the CHBDC, the ULS Resistance and SLS Reaction were determined based on a consequence level of “Typical” with a consequence factor equal to 1.

In accordance with Table 6.2 of Section 6.9.1 in the CHBDC and the consequence and site understanding classification of “Typical”, a resistance factor of 0.5 has been applied in calculating the factored geotechnical resistance at Ultimate Limit State (ULS<sub>r</sub>).

In accordance with Table 6.2 of Section 6.9.1 in the CHBDC and the consequence and site understanding classification of “Typical”, a resistance factor of 0.8 has been applied in calculating the geotechnical reaction at Serviceability Limit State (SLS) which corresponds to a maximum total and differential settlements of 25 mm and 20 mm, respectively.

## 8.5.1.4 Geotechnical Resistances and Reactions for Retaining Walls

Relatively short section of precast concrete block retaining walls (about 2 to 6 m long) with variable height are planned at the northwest and southeast corners of the proposed culverts to accommodate the Highway embankments. These retaining walls are planned to be less than 3 m high. The GA drawing indicates that the retaining walls are planned to be founded within the newly built embankment.

The geotechnical resistance and reactions (for vertical concentric loads) provided in Table 8.4 below may be used in the design of the precast concrete block retaining walls. As mentioned above, the proposed precast concrete block walls will be founded on the newly built embankment and/or culvert backfill and it is assumed that granular material (such as OPSS Granular B Type I or II) is utilized and compacted to its 100% SPMDD (standard proctor maximum dry density) to support the walls. The resistance and reaction provided will also apply where structural fill is required to backfill any localized sub-excavated zones of soft/loose materials, organics, or previously existing fill materials. A minimum 1.2 m of earth cover has been considered in design and should be provided.





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**Table 8.4: Geotechnical Vertical Resistance & Reaction – Retaining Walls**

Foundation Width (m)	Founding Elevation (m)	Factored Geotechnical Resistance at ULS <sub>r</sub> (kPa) $\phi_{gu} = 0.5$	Factored Geotechnical Reaction at SLS (kPa) $\phi_{gs} = 0.8$
1.0-2.5	± 235.9 to 235.7	350	150

The resistance and reaction factors referenced in the preceding section have been considered in the ULS/SLS values.

The ULS/SLS values provided are for concentric loads and should be adjusted for eccentric loads according to CHBDC S6-19 Section 6.10.1.2.

## 8.5.1.5 Geotechnical Horizontal Resistance (Sliding)

The unfactored horizontal resistance to sliding of the precast box culvert and retaining wall foundation may be calculated using the following unfactored coefficient of friction:

- 0.40 between clayey silt and cast in place concrete (mud mat)
- 0.40 between OPSS Granular A and precast concrete
- 0.30 between OPSS SSM and precast concrete
- 0.25 between clayey silt and precast concrete

In accordance with Table 6.2 of the CHBDC and the consequence and site understanding classification of “Typical”, a resistance factor against sliding of 0.8 (frictional) should be applied to obtain the resistance at ULS<sub>r</sub>.

## 8.5.2 Culvert Bedding, Backfill and Erosion/Scour Protection

The bedding, levelling course, backfill, cover materials and frost taper (backfill transition) for the culvert should be as outlined in OPSS 422 (Construction Specification for Precast Reinforced Concrete Box Culverts in Open Cut), OPSD 803.010 (Backfill and Cover for Concrete Culverts). As previously discussed in this report, OPSD 3090.101 indicates that the frost penetration depth is at 1.2 m. This frost penetration depth should be used for the design of the culvert frost tapers.

The backfill material should consist of granular fill meeting the requirements of OPSS.PROV 1010 Granular A or Granular B Type II materials. The backfill should be placed on each side of the structure simultaneously and compacted in accordance with OPSS 501.

Erosion protection should be provided at the culvert inlet and outlet. In order to minimize the potential for seepage through the bedding and granular backfill materials and avoid consequent erosion of these materials and subgrade, a concrete cut-off wall and clay seal should be installed to sufficient depth and extent at the culvert inlet and outlet. Erosion protection should be extended for the proposed retaining walls as well.



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The clay seal should have a minimum thickness of 0.5 m, completely surround the culvert, extend laterally the width of the granular backfill material, extend above the high-water level and the material used should conform to the requirements of OPSS 1205.

Slope protection and drainage measures will be required to provide for the long-term surficial stability of the embankment slopes at the locations of culvert inlet/outlet. All slopes within 3 m of the culvert inlet and outlet should be surfaced with rip-rap at least 300 mm thick placed on a Class II non-woven filter fabric; the rip-rap should extend up the slope to 0.3 m above the design high water level. The requirements for, and design of, erosion protection measures within the channel at the culvert inlet and outlet should be assessed by the hydraulic design engineer.

Where embankment construction includes earth fill, vegetation on the slopes should be established as soon as possible after completion of the embankment construction to minimize the potential for surficial erosion.

## 8.6 EARTH PRESSURES

Calculation of loads and earth pressures acting on the precast concrete culvert and retaining walls should be in accordance with Section 7.8.6.3 of the CHBDC (2019).

The effects of compaction should be accounted for by applying a compaction surcharge as outlined in Section 6.12.3 and as shown in Figure 6.8 of the CHBDC (2019).

### 8.6.1 Earth Pressures Under Static Conditions

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

$$\begin{aligned}P_A &= \frac{1}{2} K_a \gamma H^2 \\P_O &= \frac{1}{2} K_o \gamma H^2 \\P_P &= \frac{1}{2} K_p \gamma H^2\end{aligned}$$

where  $H$  is the height of the wall and  $\gamma$  is the unit weight of the backfill soil. Values for  $K_a$ ,  $K_p$ ,  $K_o$  and  $\gamma$  are provided in Table 8.5 for horizontal backfill conditions. These values should be adjusted if sloped backfill is considered. The thrust acts at a point one third up the height of the wall.

**Table 8.5: Recommended Static Earth Pressure Parameters (Horizontal Backfill)**

Parameter	OPSS Gran B Type I	OPSS Gran A and Gran B Type II	Regular Earth Fill
Bulk Unit Weight, $\gamma$ (kN/m <sup>3</sup> )	22	22	20
Effective Friction Angle, $\Phi$ (°)	32	35	28
Coefficient of Earth Pressure at Rest, $K_o$	0.47	0.43	0.53
Coefficient of Active Earth Pressure, $K_a$	0.31	0.27	0.36
Coefficient of Passive Earth Pressure, $K_p$	3.25	3.69	2.77



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## 8.6.2 Earth Pressures Under Seismic Conditions

The total active and passive thrusts under seismic loading conditions can be calculated using the following equations:

$$P_{AE} = \frac{1}{2} K_{AE} \gamma H^2 (1 - k_v)$$

$$P_{PE} = \frac{1}{2} K_{PE} \gamma H^2 (1 - k_v)$$

where:

$K_{AE}$  = active earth pressure coefficient (combined static and seismic)

$K_{PE}$  = passive earth pressure coefficient (combined static and seismic)

$H$  = height of wall

$k_h$  = horizontal acceleration coefficient

$k_v$  = vertical acceleration coefficient

$\gamma$  = total unit weight

For this site, the following design parameters were used to develop the recommended  $K_{AE}$  and  $K_{PE}$  values as per CHBDC 2019.

**Table 8.6: Seismic Design Parameters to Estimate Lateral Earth Pressures**

<b><i>PGA</i></b>	Horizontal Acceleration Coefficient, $k_{ho}$	Horizontal Acceleration Coefficient, $k_h$
	Non-Yielding	Yielding ( <i>wall movements of 25 mm to 50 mm</i> )
0.142g	0.142	0.071
Note: $k_{ho}$ is the seismic horizontal acceleration coefficient that corresponds to zero wall movement and is equal to the <b><i>PGA</i></b> estimated at ground surface. The vertical acceleration coefficient ( $k_v$ ) should be ignored in the calculations as per CHBDC 2019, section C4.14.7.2.		

The angle of friction between the soil and the wall has been set at 0° to provide a conservative estimate.

The seismic earth pressures may be calculated using the parameters detailed in Table 8.7 for horizontal backfill configuration. These values should be adjusted if sloped backfill is considered.

**Table 8.7: Recommended Seismic Earth Pressure Parameters (Horizontal Backfill)**

Parameter	OPSS Gran B Type I	OPSS Gran A and Gran B Type II	Regular Earth Fill
Bulk Unit Weight, $\gamma$ (kN/m <sup>3</sup> )	22	22	20
Effective Friction Angle	32	35	28
Passive Earth Pressure, ( $K_{PE}$ )	3.12	3.55	2.65
Height of Application of $P_{PE}$ from the base as a ratio of the wall height, ( $H$ )	0.322	0.323	0.321
<b>Yielding Wall</b>			
Active Earth Pressure ( $K_{AE}$ ) for Yielding Wall	0.35	0.31	0.41



# FOUNDATION INVESTIGATION AND DESIGN REPORT – LINDSAY DRAIN CULVERT –HIGHWAY 4 WIDENING FROM CLINTON LINE TO NEW TALBOTVILLE BYPASS AND NEW TALBOTVILLE BYPASS FROM HIGHWAY 4 TO HIGHWAY 3 AT RON MCNEIL LINE

Discussions and Engineering Recommendations  
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Parameter	OPSS Gran B Type I	OPSS Gran A and Gran B Type II	Regular Earth Fill
Height of Application of $P_{AE}$ from base as a ratio of wall height, (H) for Yielding Wall	0.365	0.367	0.363
<b>Non-Yielding Wall</b>			
Active Earth Pressure ( $K_{AE}$ ) for Non-Yielding Wall	0.40	0.35	0.46
Height of Application of $P_{AE}$ from base as a ratio of wall height, (H) for Non-Yielding Wall	0.393	0.396	0.390

## 8.7 HIGHWAY EMBANKMENTS

### 8.7.1 Embankment Construction

Based on the General Arrangement Drawing, the eastbound and westbound lanes for the Highway 3 are going to be constructed on an embankment up to approximately 2.5 m above the existing site grade. Typical 2H:1V or flatter embankment side slopes are recommended for the low height embankments.

In preparation for the construction of the embankments, all topsoil, organic matter or softened/loosened soils including disturbed portions of the native soils should be stripped from areas where widening or regrading is required.

The embankment fill should be placed and compacted in accordance with OPSS 206 and OPSS 501.

All embankment slopes should be constructed at inclinations no steeper than 2H:1V. The fill required for construction of the embankments should consist of earth fill that is free of organics, debris and/or other deleterious materials.

All retaining walls and header walls should be backfilled with proper granular materials.

### 8.7.2 Stability of Slopes and Retaining Wall

The highway embankments are planned to be up to 2.5 m high (above o.g.) and will be constructed using typical 2H:1V and/or milder side slopes. In this respect, no slope stability concerns are anticipated for the embankments at the site location. Appropriate erosion protection measures should be implemented to prevent shallow surficial sloughing and potential toe instability.

The precast concrete block retaining walls are planned to be lower than 3 m high and no significant stability issues are anticipated for those walls. It is typical to place the precast concrete blocks with a slight back-batter to enhance the wall long-term performance. Walls should be backfilled with free-draining granular material with drainage as per OPSD 3101.150. If the wall type and geometry changes, additional stability analyses may be required.



# FOUNDATION INVESTIGATION AND DESIGN REPORT – LINDSAY DRAIN CULVERT –HIGHWAY 4 WIDENING FROM CLINTON LINE TO NEW TALBOTVILLE BYPASS AND NEW TALBOTVILLE BYPASS FROM HIGHWAY 4 TO HIGHWAY 3 AT RON MCNEIL LINE

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## 8.7.3 Embankment Settlement

Analyses were carried out to evaluate the magnitude of settlement of the soils underlying the proposed highway embankments in the area of Lindsay Drain Culvert. The evaluation of settlement was carried out using the commercial program Settle3D (Rocscience 2021). The geotechnical design parameters provided in Table 8.1 were used in the analysis. The analysis results indicated settlements of up to 25 mm below the maximum height of the embankments.

Self-weight settlement due to compression of the maximum 2.5 m of additional embankment material over the existing grade and culvert is expected to be less than 12 mm (approximating 0.5 % of the new embankment material height). The bulk of the settlement will take place rapidly and be completed during the construction of the embankments.

Given that the settlements will mostly occur during the construction of the embankments, the embankment settlements meet the Post-Construction Settlement Criteria for New Embankments provided in the MTO document titled 'Embankment Settlement Criteria for Design (2010)'.

The culverts will be constructed in relatively short precast concrete segments and in this respect, the differential settlements are not anticipated to adversely affect the performance of the culverts. If required, consideration should be given to the typical culvert cambering to mitigate the possible differential settlement issue.

## 8.8 CEMENT TYPE AND CORROSION PROTECTION

The results of the analytical tests on the sample of the native soils are presented in Section 5.5 and Appendix D.

As per the MTO Structural Manual (2021) section 2.8.5, concrete is considered subject to sulphate attack when

- Water-soluble sulphate ( $\text{SO}_4$ ) content of the adjacent soil is equal to or greater than 0.10%; or,
- Sulphate ( $\text{SO}_4$ ) in groundwater is equal to or greater than 150 mg/L.

When concrete is identified as subject to sulphate attack, the concrete shall be resistant to sulphate attack. Based on the test results, concrete will not be subject to sulphate attack for this culvert replacement site (water-soluble sulphate in soil samples <0.10% which is equivalent to 1000 $\mu\text{g/g}$ ).

The analytical test results were also compared to Table 7.2 of the U.S. Federal Highway Administration Publication No. FHWA-NHI-14-007 (2015) Criteria for Assessing Ground Corrosion Potential for the potential attack on buried steel. The results are provided below in Table 8.8.

**Table 8.8: Results of Corrosion Potential Assessment**

Borehole No	Sample No.	Depth (m)	Corrosion Potential
DCC2	SS3	1.5 – 2.1	Non-aggressive



# FOUNDATION INVESTIGATION AND DESIGN REPORT – LINDSAY DRAIN CULVERT –HIGHWAY 4 WIDENING FROM CLINTON LINE TO NEW TALBOTVILLE BYPASS AND NEW TALBOTVILLE BYPASS FROM HIGHWAY 4 TO HIGHWAY 3 AT RON MCNEIL LINE

Construction Considerations

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It should be noted that the final selection of corrosion mitigation measures should be a decision of the structural design engineer.

## 9.0 CONSTRUCTION CONSIDERATIONS

### 9.1 CONSTRUCTION STAGING

It is anticipated that the new culverts will be constructed during the proposed bypass construction and no staging will be required.

### 9.2 TEMPORARY ROADWAY PROTECTION

As referenced in a preceding section, the highway embankments will be constructed following completion of the culvert construction and in this respect, no excavations/temporary roadway protection systems will be required.

### 9.3 SURFACE WATER AND GROUNDWATER CONTROL

The design of surface water control and temporary flow passage systems associated with the culvert construction is the responsibility of the contractor. Temporary flow passage systems should follow the requirements of OPSS 517 as amended by SSP 517F01. The following inputs should be included in the Dewatering Systems section of Table A in SP517F01:

- “N/A” should be entered for the preconstruction survey distance.
- Given that dewatering is not anticipated to be required in advance of the construction, the Design Engineer Requirements box should be input as “No”.

Control of surface water, including drainage/creek flows, will be necessary to allow excavation and bedding placement to be carried out in dry conditions. Temporary cofferdams may be needed to divert drain channel flows away from the work area for culvert construction and into/through the temporary flow passage system.

Table 9.1 provides a summary of alternative cofferdam options, with advantages, disadvantages, risks and relative costs, that could be implemented if cofferdams are installed on either end of the culverts to facilitate the proposed replacement works.

**Table 9.1: Comparison of Cofferdam Options for Surface Water Control**

Option	Advantages	Disadvantages	Relative Cost	Risk/Consequences
Sandbag Dam	<ul style="list-style-type: none"><li>• Able to be installed in limited work areas</li><li>• Decreased sedimentation compared to earth dams.</li></ul>	<ul style="list-style-type: none"><li>• Slower installation compared to other cofferdam systems.</li><li>• Allows groundwater flow beneath cofferdam</li></ul>	Low to Medium	<ul style="list-style-type: none"><li>• Low risk option</li></ul>
Aqua Dams	<ul style="list-style-type: none"><li>• Decreased sedimentation compared to earth dams.</li><li>• Fast installation</li></ul>	<ul style="list-style-type: none"><li>• Allows groundwater flow beneath cofferdam</li></ul>	Low to Medium	<ul style="list-style-type: none"><li>• Low risk option</li></ul>



# FOUNDATION INVESTIGATION AND DESIGN REPORT – LINDSAY DRAIN CULVERT –HIGHWAY 4 WIDENING FROM CLINTON LINE TO NEW TALBOTVILLE BYPASS AND NEW TALBOTVILLE BYPASS FROM HIGHWAY 4 TO HIGHWAY 3 AT RON MCNEIL LINE

## Construction Considerations

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Option	Advantages	Disadvantages	Relative Cost	Risk/Consequences
Granular Fill Dams	<ul style="list-style-type: none"> <li>• Fast installation.</li> <li>• Low cost.</li> </ul>	<ul style="list-style-type: none"> <li>• Increased environmental impact (i.e. sediment deposition in watercourse)</li> <li>• Increased streambed disturbance during dam removal</li> <li>• Allows groundwater flow beneath cofferdam</li> </ul>	Low	<ul style="list-style-type: none"> <li>• Increased potential for washout and sediment transport and deposition during storm events</li> </ul>
Steel sheet piles (SSP)	<ul style="list-style-type: none"> <li>• Simple installation process</li> <li>• Provides cut-off to groundwater seepage.</li> </ul>	<ul style="list-style-type: none"> <li>• Requires larger construction equipment</li> <li>• Difficult to drive/install where cobbles/boulders are present</li> </ul>	Medium to high	<ul style="list-style-type: none"> <li>• Possible misalignment of, or damage to, sheet piles during installation due to obstructions</li> </ul>

The design of dewatering/unwatering systems is the responsibility of the contractor. Depending on the water taking/dewatering volumes and source(s) of water, the dewatering activities may require a Permit to Take Water (PTTW) from the Ministry of Environment, Conservation and Parks (MECP) or registration of the water taking activity in the Environmental Activity and Sector Registry (EASR). The permit/registration requirements are outlined in Table 1.0 of CDED B517.

As referenced in a previous section, based on the conditions encountered in the investigation, a groundwater elevation of 235 m is recommended for design purposes. Excavations for the installation of the culverts will be required to extend to depths of about 1 m below this groundwater level.

Based on the subsurface and groundwater conditions encountered in the boreholes advanced for the foundation investigation, it is anticipated that the excavations for the culverts will encounter a combination of existing fill materials and native cohesive silty clay to clay and clayey silt till soils. Sand seams were present in the soil samples obtained from the boreholes. Higher seepage rates may be anticipated from these seams, if encountered in the excavations. Given the conditions outlined, groundwater seepage from the native soils should be expected in the excavations for construction of the culverts; however, the volume of seepage is expected to be limited based on the inherent low hydraulic conductivity of the native fine grain soils. Given that the very stiff clayey silt soils are expected to be present at the excavation base, basal instability is not anticipated to be a concern.

Typical construction dewatering measures such as pumping from filtered sumps established in the floor of the excavations are anticipated to be sufficient to handle the accumulated seepage. The unwatering operations should continue during the excavation, placement of any required structural fill, placement of the mud mat/working slab, placement of the bedding and levelling course, and backfilling of the culverts. All groundwater control systems required for the culvert rehabilitation works should be designed and implemented in accordance with OPSS 902.

Temporary erosion and sediment control measures, including controlling the discharge of water, shall be according to OPSS.PROV 805.



# **FOUNDATION INVESTIGATION AND DESIGN REPORT – LINDSAY DRAIN CULVERT –HIGHWAY 4 WIDENING FROM CLINTON LINE TO NEW TALBOTVILLE BYPASS AND NEW TALBOTVILLE BYPASS FROM HIGHWAY 4 TO HIGHWAY 3 AT RON MCNEIL LINE**

Construction Considerations  
April 2025

## **9.4 EXCAVATION AND BACKFILLING**

Excavation and backfill for the new culvert should be carried out in accordance with OPSS 902 Construction Specification for Excavation and Backfilling – Structures. The contractor should provide sediment control fences and erosion control blankets, as required, throughout the duration of the construction to prevent silt/sediment from running off the site.

Any vegetation, fill, organic soils, and other unsuitable soft or loose materials must be removed from beneath the proposed culverts. Where deleterious materials are encountered, the materials should be excavated, removed and replaced with compacted granular fill materials. The lateral extent of the zone of sub-excavation (and replacement) should include all deleterious material within the influence zone of the culvert box.

All side slopes for open cut excavations should conform to the Occupational Health & Safety Act & Regulations for Construction Projects (OH&S Act). The excavations required for the culverts will extend to depths in the order of 2 m below the existing ground surface. The excavations will encounter cohesive fill materials, silty clay to clay and clayey silt till soils. These excavations should be undertaken via open cut methods provided suitable unwatering and dewatering are carried out prior to excavation.

Moving construction equipment over the wet clayey silt material may not be favourable and could cause extensive disturbance to the foundation subgrade. It is therefore recommended that construction equipment not be permitted on the foundation subgrade.

The cohesive fill and native clayey soils would be classified as Type 3 soils provided they are above the groundwater table and the water level in the watercourse, or are unwatered prior to excavation. The OH&S Act indicates that temporary excavations in these materials when above the water table or dewatered should be developed with side slopes no steeper than 1H:1V.

Evaluation of the stability of temporary excavations is the responsibility of the Contractor who must assess the stability of the side slopes taking into consideration their construction means and methods including the location(s) of heavy construction equipment.

Backfilling of the culverts shall be conducted in accordance with OPSSs 206, 501 and 902.

Grading work should be carried out in accordance with OPSS206 Construction Specification for Grading.

## **9.5 OBSTRUCTIONS**

Cobbles and/or boulders are expected to be present in the native till deposits and may be present within fill materials that underlie the site. These materials could impede excavations.





**FOUNDATION INVESTIGATION AND DESIGN REPORT – LINDSAY DRAIN CULVERT –HIGHWAY 4  
WIDENING FROM CLINTON LINE TO NEW TALBOTVILLE BYPASS AND NEW TALBOTVILLE  
BYPASS FROM HIGHWAY 4 TO HIGHWAY 3 AT RON MCNEIL LINE**

Specifications  
April 2025

## 10.0 SPECIFICATIONS

The following specifications are referenced in this report:

**Table 10.1: Specifications Referenced in Report**

Document	Title
OPSD 803.010	Backfill and Cover for Concrete Culverts
OPSD 3090.101	Foundation Frost Depths for Southern Ontario
OPSD 3101.150	Walls, Abutment, Backfill, Minimum Granular Requirement
OPSS.PROV 206	Construction Specification for Grading
OPSS 422	Construction Specification for Precast Reinforced Concrete Box Culverts and Box Sewers in Open Cut
OPSS.PROV 501	Construction Specification for Compacting
OPSS.PROV 517	Construction Specification for Dewatering of Pipeline, Utility, and Associated Structure Excavation
OPSS.MUNI 804	Construction Specification for Seed and Cover
OPSS.PROV 804	Construction Specification for Temporary Erosion Control
OPSS.MUNI 805	Construction Specification for Temporary Erosion and Sediment Control Measures
OPSS.PROV 805	Construction Specification for Temporary Sediment Control
OPSS.PROV 902	Construction Specification for Excavation and Backfilling – Structures
OPSS.PROV 1004	Material Specification for Aggregates - Miscellaneous
OPSS.PROV 1010	Material Specification for Aggregates
OPSS.PROV 1205	Material Specification for Clay Seal
SP517F01	Amendment to OPSS 517



# FOUNDATION INVESTIGATION AND DESIGN REPORT – LINDSAY DRAIN CULVERT –HIGHWAY 4 WIDENING FROM CLINTON LINE TO NEW TALBOTVILLE BYPASS AND NEW TALBOTVILLE BYPASS FROM HIGHWAY 4 TO HIGHWAY 3 AT RON MCNEIL LINE

References  
April 2025

## 11.0 REFERENCES

- ASTM. 1999. Standard Test Method for Penetration Test and Split-Barrel Sampling of Soils (ASTM D1586). ASTM International, West Conshohocken, PA.
- ASTM. 2000. Standard Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System) (ASTM D2487). ASTM International, West Conshohocken, PA.
- CHBDC. 2019. Canadian Highway Bridge Design Code. Canadian Standards Association, Mississauga, Ontario.
- Ministry of Transportation Ontario, 2003, Concrete Culvert Design and Detailing Manual
- Ministry of Transportation Ontario, 2010. Embankment Settlement Criteria for Design.
- Ministry of Transportation Ontario. 1973. Foundation Investigation Report for Proposed St. Thomas Expressway Culverts No. 1, 4, 5, 6 and 7 Twps. of Southwold and Yarmouth, County of Elgin, District No. 2 (London). W.O 73-11019- W.P. 89-69-01
- Ministry of Transportation Ontario. 1971. Foundation Investigation Report for Proposed Crossing at CNR Spur Overheads and St. Thomas Expressway, Twp. of Southwold, County of Elgin. W.O 71-11068 - W.P. 89-69-05 & 6.
- Ministry of Transportation Ontario. 2020. Guidelines for MTO Foundation Engineering Services V.2
- OHSA. 2021. Occupational Health and Safety Act Regulations for Construction Projects. Carswell, Toronto Ontario.



# FOUNDATION INVESTIGATION AND DESIGN REPORT – LINDSAY DRAIN CULVERT –HIGHWAY 4 WIDENING FROM CLINTON LINE TO NEW TALBOTVILLE BYPASS AND NEW TALBOTVILLE BYPASS FROM HIGHWAY 4 TO HIGHWAY 3 AT RON MCNEIL LINE

Closure  
April 2025

## 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 Roshan Rashed, M.Sc., P.Eng., and reviewed by Gwangha Roh, P. Eng., Ph.D., and Raymond Haché, M.Sc., P.Eng., Designated Principal MTO Foundation Contact.

Respectfully submitted,

**STANTEC CONSULTING LTD.**



Roshan Rashed, M.Sc., P.Eng.  
Geotechnical Engineer



Gwangha Roh, P. Eng., Ph.D.  
Senior Geotechnical Engineer



Raymond Haché, M.Sc., P. Eng.  
MTO Designated Principal Foundation Contact



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3022e0014\project\geotechnical\_investigation\_reports\lindsay\_creek\165001308\_dft\_talbotville\_fidr\_lindsay\_creek\_culvert\_20250402.docx



**FOUNDATION INVESTIGATION AND DESIGN REPORT – LINDSAY DRAIN CULVERT –HIGHWAY 4  
WIDENING FROM CLINTON LINE TO NEW TALBOTVILLE BYPASS AND NEW TALBOTVILLE  
BYPASS FROM HIGHWAY 4 TO HIGHWAY 3 AT RON MCNEIL LINE**

April 2025

## **APPENDIX A**

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

### **A.2 GENERAL ARRANGEMENT DRAWING**



BB-05  
PR-D-707  
MINISTRY OF TRANSPORTATION, ONTARIO  
165001308\_Lindsay Drain\_PP\_250401.dwg  
G.B.B.  
C:\Users\gbriones\AppData\Local\temp\AcPublish\_24204\165001308\_Lindsay Drain\_PP\_250401.dwg  
DRAFTING NAME: 165001308\_Lindsay Drain\_PP\_250401.dwg  
CREATED BY: G.B.B.  
MODIFIED: C:\Users\gbriones\AppData\Local\temp\AcPublish\_24204\165001308\_Lindsay Drain\_PP\_250401.dwg  
Printed: Apr 01, 2025

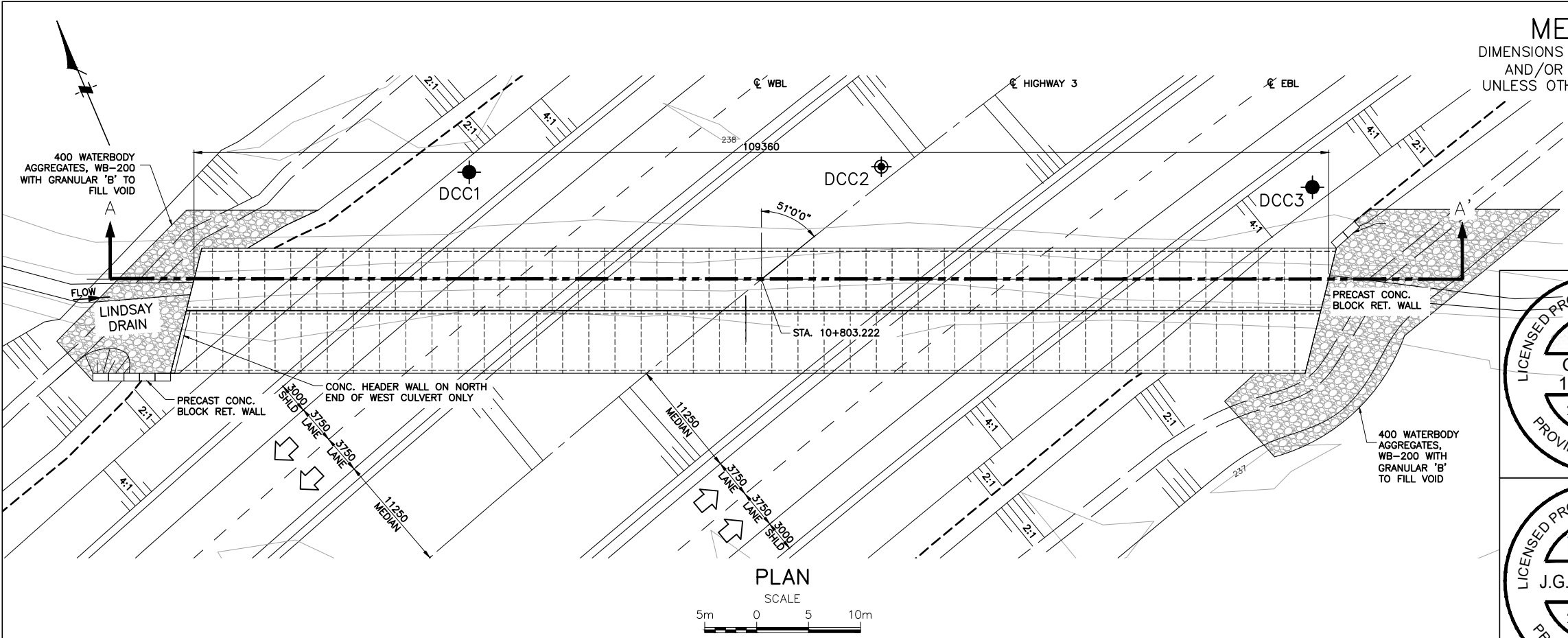
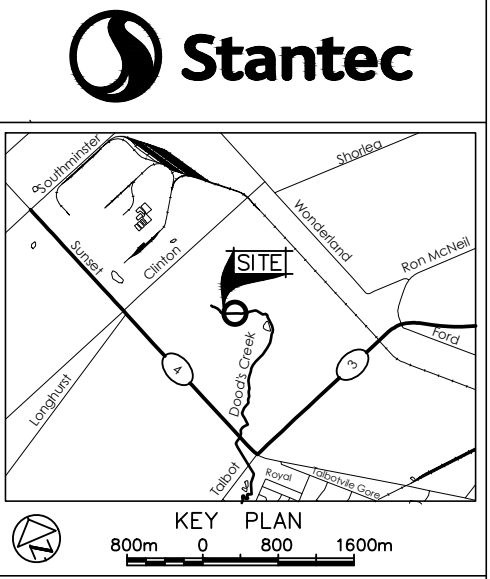


PLATE No  
**CONT WP 3041-22-00**

LINDSAY DRAIN CULVERTS  
ST. THOMAS, ONTARIO  
BOREHOLE LOCATIONS & SOIL STRATA

**SHEET**  
—



- LEGEND**
- Borehole (Stantec, 2024)
  - Monitoring Well (Stantec, 2024)
  - (x.x m) Offset from Hwy 3 Centreline
  - N Blows/0.3m (Std Pen Test, 475 J/blow)
  - WL Measured on May 2024
  - Piezometer

No	ELEV	MTM ZONE 11 NORTH	COORDINATES EAST
DCC1	237.3	4 742 624.0	407 117.6
DCC2	237.4	4 742 609.0	407 154.4
DCC3	237.3	4 742 591.0	407 191.9

**NOTES**

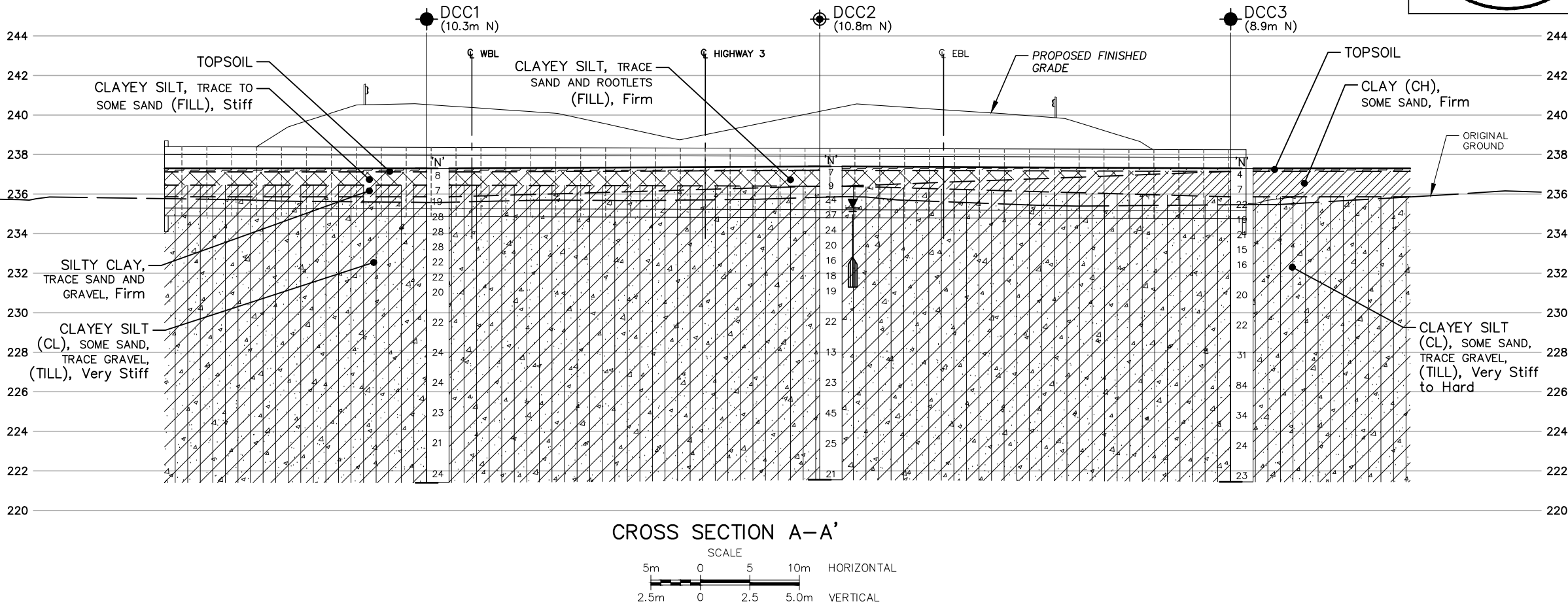
The boundaries between soil strata have been established only at borehole locations. Between boreholes the boundaries are assumed from geological evidence.

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

GEOCREs No 40114-222	
HWY No 3	DIST
SUBM'D RR	CHECKED
DRAWN GBB	CHECKED
DATE 2025-04-01	APPROVED
SITE 05X-0374/CO	DWG 1





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

HWY 3  
CONT  
GWP 3042-22-00



LINDSAY DRAIN CULVERTS

SHEET

PRELIMINARY  
GENERAL ARRANGEMENT



### GENERAL NOTES

#### 1. SPECIFIED 28-DAY CONCRETE COMPRESSIVE STRENGTH:

PRE-CAST CONCRETE 45 MPa  
MASS CONCRETE 20 MPa  
REMAINDER 30 MPa

#### 2. CLEAR COVER TO REINFORCING STEEL:

ALL 50±10

#### 3. REINFORCING STEEL:

REINFORCING STEEL SHALL BE GRADE 500W UNLESS OTHERWISE SPECIFIED.

TENSION LAP LENGTHS NOT INDICATED ON THE CONTRACT DRAWINGS SHALL BE CLASS B.

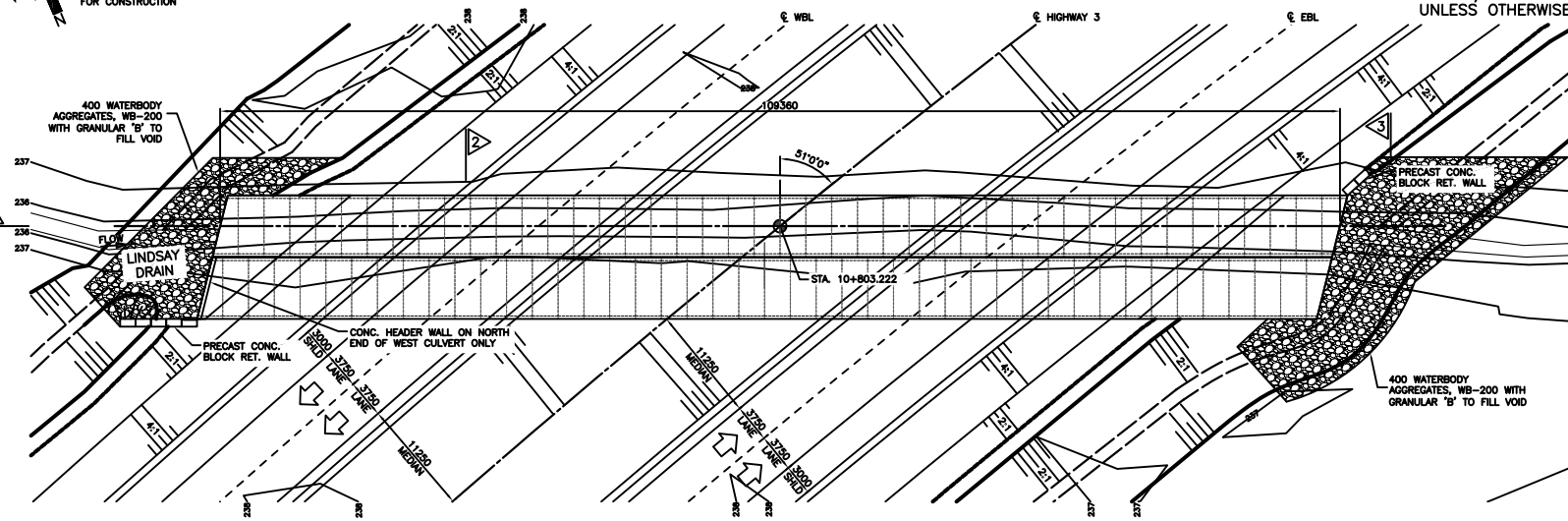
BAR HOOKS SHALL HAVE STANDARD HOOK DIMENSIONS USING MINIMUM BEND DIAMETERS. WHILE STIRRUPS AND TIES SHALL HAVE MINIMUM HOOK DIMENSIONS. ALL HOOKS SHALL BE IN ACCORDANCE WITH THE STRUCTURAL STANDARD DRAWING SS112-1, UNLESS INDICATED OTHERWISE.

### CONSTRUCTION NOTES

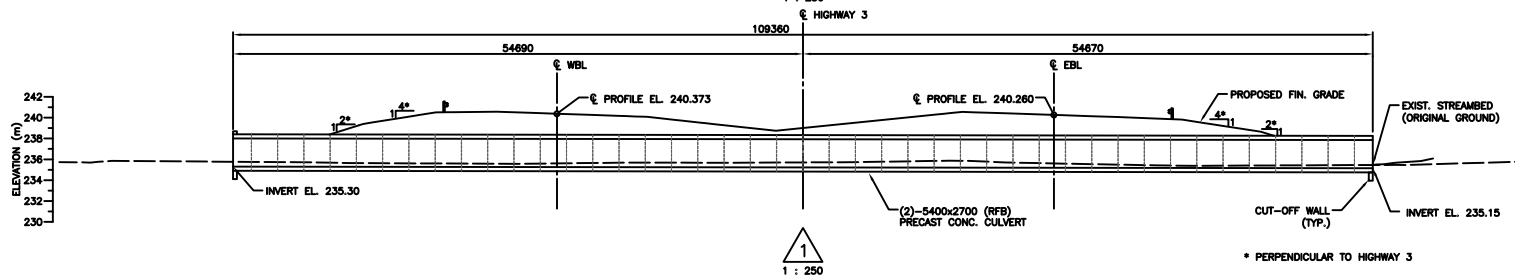
- BACKFILL SHALL BE PLACED SIMULTANEOUSLY BEHIND BOTH CONCRETE WALLS KEEPING THE HEIGHT OF THE BACKFILL APPROXIMATELY THE SAME. AT NO TIME SHALL THE DIFFERENCE IN ELEVATION BE GREATER THAN 500mm.
- THE CONTRACTOR SHALL ISOLATE WORK AREAS FROM THE WATERCOURSE FLOW FOR CULVERT INSTALLATION AS REQUIRED TO COMPLETE ALL WORK IN THE DRY.

### LIST OF DRAWINGS:

- GENERAL ARRANGEMENT
- BOREHOLE LOCATION AND SOIL STRATA
- CULVERT DETAILS I
- CULVERT DETAILS II
- EXCAVATION AND BACKFILL
- MISCELLANEOUS DETAILS

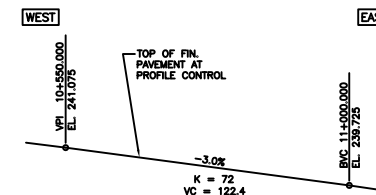


PLAN  
1 : 250

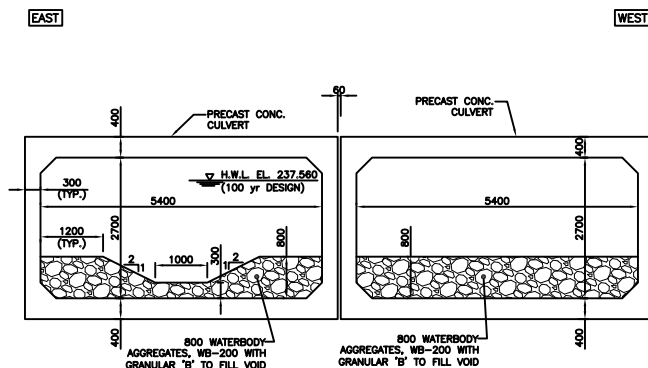


1 : 250

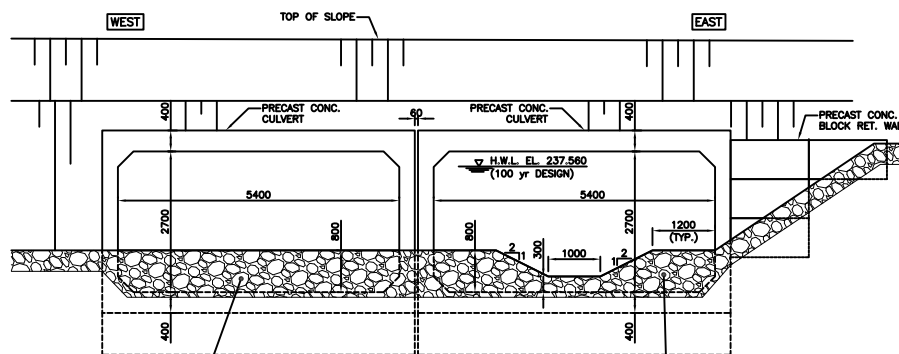
\* PERPENDICULAR TO HIGHWAY 3



PROFILE OF HIGHWAY 3 (BYPASS)  
N.T.S.



2  
1 : 50



3  
1 : 50

DRAWING NOT TO BE SCALED  
100 mm ON ORIGINAL DRAWING

REVISIONS		DATE		BY	DESCRIPTION		DATE	BY
DESIGN	CHK	CODE	CSA 58:19	LOAD	CL-425-0NT	DATE	AUG 2024	
DRAWN	H.L.	CHK	M.D.	SITE	05X-0374/03	STRUCT	SCHEME	DWG. P1

**FOUNDATION INVESTIGATION AND DESIGN REPORT – LINDSAY DRAIN CULVERT –HIGHWAY 4  
WIDENING FROM CLINTON LINE TO NEW TALBOTVILLE BYPASS AND NEW TALBOTVILLE  
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April 2025

## **APPENDIX B**

### **B.1 AVAILABLE GEOCRETS INFORMATION**



61-20 SEP 1976

GEOCRES No. 40J14-33  
DIST. 2 REGION Southwestern  
W.P. No. 89-69-01

CONT. No. 78-96

W. O. No. \_\_\_\_\_

STR. SITE No. \_\_\_\_\_

HWY. No. \_\_\_\_\_

LOCATION Proposed St. Thomas  
Expressway

OVERSIZE DRAWINGS TO BE INCLUDED WITH THIS REPORT. 2

REMARKS: documents to be unfolded  
before microfilming



FOUNDATIONS OFFICE

JOB 73-11019

LOCATION Co-ords. 15,558,786 N; 1,336,588 E.

ORIGINAL ED BY LJH

W.P. 89-69-01

BORING DATE June 4, 1973

COMPILED BY LJH

DATUM Geodetic

BOREHOLE TYPE Auger & Cone Test

CHECKED BY C.

20  
15  $\phi$  5 % STRAIN AT FAILURE  
10

DESIGN SERVICES BRANCH

FOUNDATIONS OFFICE

## RECORD OF BOREHOLE NO C1-2

JOB 73-11019

LOCATION Co-ord's N. 15,558,532; E. 1,336,884

ORIGINATED BY L.J.E.

W.P. 89-69-01

BORING DATE June 4, 1973

COMPILED BY L.J.E.

DATUM Geodetic

BOREHOLE TYPE Auger &amp; Core Test

CHECKED BY

SOIL PROFILE			SAMPLES			ELEV. SCALE	DYNAMIC PENETRATION RESISTANCE BLOWS / FOOT					LIQUID LIMIT — W <sub>L</sub> PLASTIC LIMIT — W <sub>P</sub> WATER CONTENT — W			BULK DENSITY	REMARKS
ELEV. DEPTH	DESCRIPTION	STRAT. PLT	NUMBER	TYPE	BLOWS/FOOT		20	40	60	80	100	W <sub>P</sub>	W	W <sub>L</sub>		
777.0	Ground Level															
0.0			1	SS	21	770										1 15 58 2
	Brown Grey		2	SS	26											
	Clayey silt, some sand, trace of gravel. Very stiff		3	SS	26	760										
			4	SS	26											
			5	SS	29	750										4 11 49 36
745.5			6	SS	26											
31.5	End of Borehole					740										
	NOTE: Groundwater level not established															

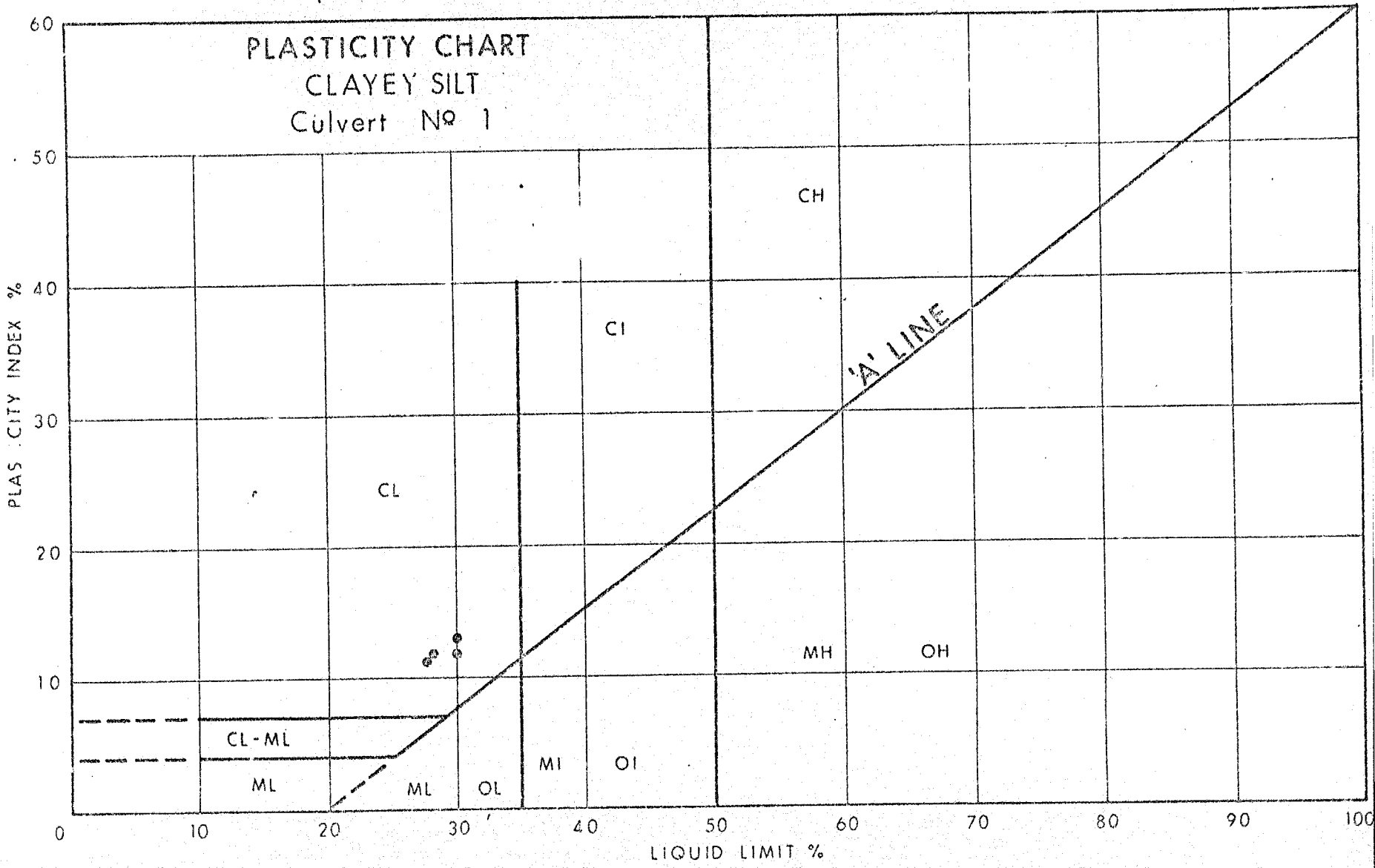
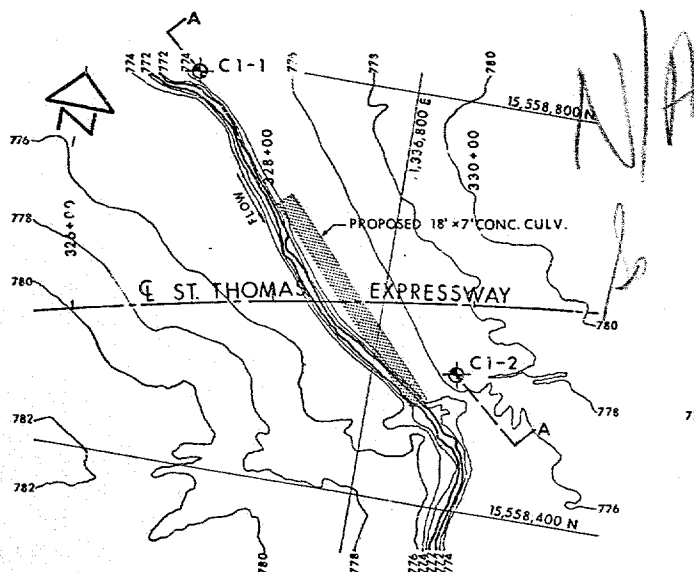
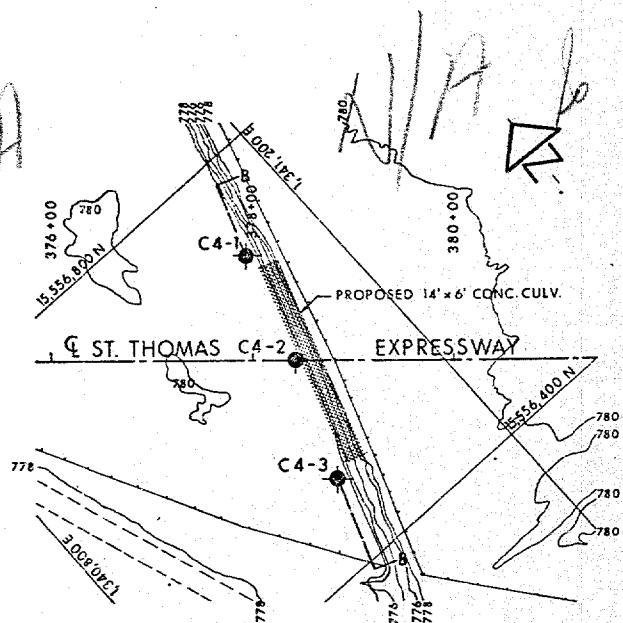


FIG. 1

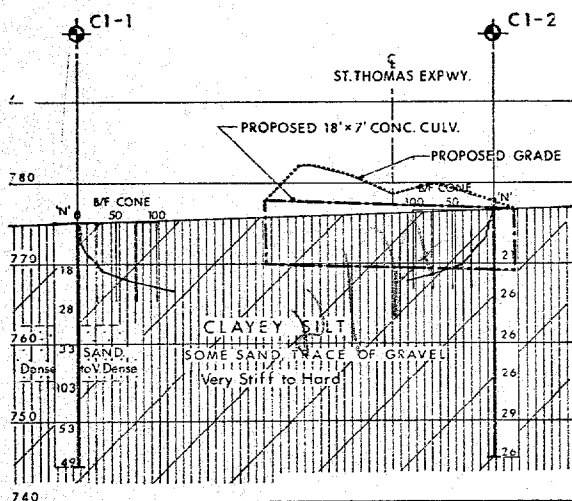


CULVERT NO.1

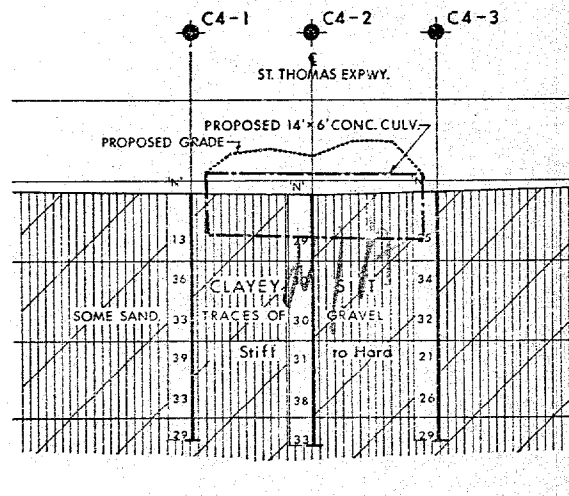


CULVERT NO.4

PLANS

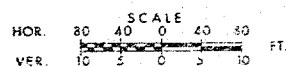


CULVERT NO.1  
A-A



CULVERT NO.4  
B-B

SECTIONS



DOCUMENT MICROFILMING IDENTIFICATION

G.I.-30 SEPT. 1976

GEOCRES No. 40I14-70

DIST. 2 REGION

W.P. No. 89-69-05

CONT. No.

W. O. No.

STR. SITE No. 5-212

HWY. No. 3N

LOCATION PROPOSED CROSSING

AT CNR

No. of PAGES -

=====

OVERSIZE DRAWINGS TO BE INCLUDED WITH THIS REPORT.

REMARKS:

DEPARTMENT OF HIGHWAYS- ONTARIO

MATERIALS &amp; TESTING OFFICE

## RECORD OF BOREHOLE No. 1

FOUNDATION SECTION

JOB 71-11068

LOCATION Co-Ord's 557,826 N. 339,591 E.

ORIGINATED BY P.P.

W.P. 89-69-05 &amp; 06

BORING DATE July 22, 1971

COMPILED BY P.P.

DATUM Geodetic

BOREHOLE TYPE Continuous Flight Auger

CHECKED BY

SOIL PROFILE		SAMPLES			ELEV SCALE	DYNAMIC PENETRATION RESISTANCE BLOWS / FOOT					LIQUID LIMIT ——— $w_L$ PLASTIC LIMIT ——— $w_P$ WATER CONTENT ——— $w$			BULK DENSITY $\gamma$	REMARKS
ELEV DEPTH	DESCRIPTION	NUMBER	TYPE	BLOWS / FOOT		20	40	60	80	100	$w_o$	$w$	$w_L$		
788.1	Ground level.														
0.0	Clayey silt, some sand, trace of gravel.	1	SS	29											
		2	TW	PH	780									134	1 13 49 37
	Very stiff to hard.	3	SS	27											
		4	SS	70/6"	770										
		5	SS	34											
		6	TW	PH	760									140	
		7	SS	34											
		8	TW	PH	750									142	
		9	SS	40											
		10	TW	PH	740									136.5	
		11	SS	22											
					730										
		12	TW	PH										133	3 9 43 45
					720										
		13	SS	29											
					710										
		14	TW	PH										131	
					700										
		14A	SS	33											
689.1		15	TW	PH	690										
99.0	End of borehole.														

DEPARTMENT OF HIGHWAYS- ONTARIO  
MATERIALS & TESTING OFFICE

## RECORD OF BOREHOLE No. 2

FOUNDATION SECTION

JOB 71-11068

LOCATION Co-Ord's 557,929 N. 339,505 E.

ORIGINATED BY P.P.

W.P. 89-69-05 &amp; 06

BORING DATE July 23, 1971

COMPILED BY H.S.

DATUM Geodetic

BOREHOLE TYPE Continuous Flight Auger

CHECKED BY

SOIL PROFILE		SAMPLES			ELEV. SCALE	DYNAMIC PENETRATION RESISTANCE BLOWS / FOOT					LIQUID LIMIT ——— $w_L$ PLASTIC LIMIT ——— $w_p$ WATER CONTENT ——— $w$			BULK DENSITY $\gamma$ P.C.F. GR. SA. SI. CL.	REMARKS
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE		20	40	60	80	100	WATER CONTENT % $w_p$ ——— $w$ ——— $w_L$				
787.0	Ground level.														
	Clayey silt, some sand, trace of gravel.		1	SS	25										
			2	TW	PH										
	Very stiff to hard.		3	SS	20										
			4	TW	PH										
			5	SS	41										
			6	SS	65/6										
			7	TW	PH										
748.0			8	SS	53										
39.0	End of borehole.														

DEPARTMENT OF HIGHWAYS- ONTARIO

MATERIALS & TESTING OFFICE

RECORD OF BOREHOLE No. 3

FOUNDATION SECTION

JOB 71-11068

LOCATION Co-Ord's 557,920 N. 339,456 E.

ORIGINATED BY P.P.

W.P. 89-69-05 & 06

BORING DATE July 26, 1971

COMPILED BY H.S.

DATUM Geodetic

BOREHOLE TYPE Continuous Flight Auger.

CHECKED BY

SOIL PROFILE		SAMPLES			ELEV. SCALE	DYNAMIC PENETRATION RESISTANCE					LIQUID LIMIT			BULK DENSITY	REMARKS
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE		BLOWS / FOOT	BLOWS / FOOT					PLASTIC LIMIT			
						20	40	60	80	100	WATER CONTENT				
						SHEAR STRENGTH P.S.F.					Wp				
						○ UNCONFINED + FIELD VANE					10 20 30				
						● QUICK TRIAXIAL x LAB VANE					Wp				
						2000 4000					10 20 30				
787.0	Ground level.														
	Clayey silt, some sand, trace of gravel.  Hard.		1	SS	34										
			2	TW	PH										
			3	SS	32										
			4	TW	PH										
			5	SS	93/6"										
			6	SS	67										
			7	TW	PH										
			8	SS	65										
740.5	End of borehole.		9	SS	67										
46.5															



DEPARTMENT OF HIGHWAYS- ONTARIO  
MATERIALS & TESTING OFFICE

RECORD OF BOREHOLE No. 4

FOUNDATION SECTION

JOB 71-11068 LOCATION Co-Ord's 558,019 N. 339,370 E. ORIGINATED BY P.P.  
W.P. 89-69-05 & 06 BORING DATE July 27, 1971 COMPILED BY H.S.  
DATUM Geodetic BOREHOLE TYPE Continuous Flight Auger. CHECKED BY

SOIL PROFILE			SAMPLES			DYNAMIC PENETRATION RESISTANCE					LIQUID LIMIT ——— w <sub>L</sub> PLASTIC LIMIT ——— w <sub>p</sub> WATER CONTENT ——— w			BULK DENSITY γ	REMARKS	
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	BLOWS / FOOT	ELEV. SCALE	20	40	60	80	100	w <sub>p</sub> ——— w ——— w <sub>L</sub> WATER CONTENT % 10 20 30				
787.9	Ground level.						SHEAR STRENGTH P.S.F. ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB VANE 2000 4000								P.C.F. GR. SA. SI. CL.	
	Clayey silt, some sand, trace of gravel.  Very stiff to hard.		1	SS	17											
			2	SS	27											
			3	SS	35	780										
			4	SS	27											
			5	SS	25											
			6	SS	25											
			7	SS	27	770										
			8	SS	33											
			9	SS	24	760										
753.9			10	SS	40											
34.0	End of borehole.					750										

DEPARTMENT OF HIGHWAYS- ONTARIO  
MATERIALS & TESTING OFFICE

RECORD OF BOREHOLE No. 5

FOUNDATION SECTION

JOB 71-11068 LOCATION Co-Ord's 558,163 N. 339,320 E. ORIGINATED BY P.P.  
W.P. 89-69-05 & 06 BORING DATE July 27, 1971 COMPILED BY H.S.  
DATUM Geodetic BOREHOLE TYPE Continuous Flight Auger CHECKED BY

SOIL PROFILE		SAMPLES			ELEV SCALE	DYNAMIC PENETRATION RESISTANCE BLOWS / FOOT					LIQUID LIMIT --- w <sub>L</sub> PLASTIC LIMIT --- w <sub>p</sub> WATER CONTENT --- w			BULK DENSITY γ	REMARKS
ELEV DEPTH	DESCRIPTION	NUMBER	TYPE	BLOWS / FOOT		20	40	60	80	100	w <sub>p</sub>	w	w <sub>L</sub>		
788.3	Ground level.														
0.0															
	Clayey silt, some	1	SS	16											
	sand, trace of	2	TW	PH	780									136	
	gravel.	3	SS	17											
		4	TW	PH										135	
	Very stiff to	5	SS	55											
	hard.	6	TW	PH	770									139	
		7	SS	55											
		8	TW	PH	760										
		9	SS	40	750									140	2 13 51 34
		10	TW	PH	740										
		11	SS	69	730										
		12	TW	PH	720									133	
		13	SS	34	710										
706.8		14	SS	50	700										
81.5	End of borehole.														0 9 41 50

DEPARTMENT OF HIGHWAYS- ONTARIO  
MATERIALS & TESTING OFFICE

## RECORD OF BOREHOLE No.6

FOUNDATION SECTION

JOB 71-11068

LOCATION Co-Ord's 558,074 N. 339,402 E.

ORIGINATED BY P.P.

W.P. 89-69-05 &amp; 06

BORING DATE July 26, 1971

COMPILED BY H.S.

DATUM Geodetic

BOREHOLE TYPE Continuous Flight Auger.

CHECKED BY

SOIL PROFILE			SAMPLES			DYNAMIC PENETRATION RESISTANCE BLOWS / FOOT					LIQUID LIMIT - $w_L$ PLASTIC LIMIT - $w_p$ WATER CONTENT - $w$			BULK DENSITY $\gamma$	REMARKS
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	BLOWS / FOOT	20	40	60	80	100	$w_p$	$w$	$w_L$		
788.4	Ground level.														
0.0	Clayey silt, some sand, trace of gravel.		1	SS	26										
			2	SS	48										
			3	SS	51										
			4	TW	PH										
	Very stiff to hard.		5	SS	65									136	1 12 49 38
			6	TW	PH									141	
			7	SS	55										
			8	TW	PH									140	
			9	SS	56										
746.9															
41.5	End of borehole.														

DEPARTMENT OF HIGHWAYS- ONTARIO  
MATERIALS & TESTING OFFICE

## RECORD OF BOREHOLE No. 7

FOUNDATION SECTION

JOB 71-11068 LOCATION Co-Ord's 558,080 N, 339,453 E. ORIGINATED BY P.P.  
 W.P. 89-69-05 & 06 BORING DATE July 26, 1971 COMPILED BY H.S.  
 DATUM Geodetic BOREHOLE TYPE Continuous Flight Auger. CHECKED BY

SOIL PROFILE		SAMPLES			ELEV. SCALE	DYNAMIC PENETRATION RESISTANCE BLOWS / FOOT					LIQUID LIMIT ——— $w_L$ PLASTIC LIMIT ——— $w_p$ WATER CONTENT ——— $w$			BULK DENSITY $\gamma$ P.C.F. GR. SA. SI. CL.	REMARKS
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE		20	40	60	80	100	WATER CONTENT % $w_p$ ——— $w$ ——— $w_L$				
787.8	Ground level.														
0.0															
	Clayey silt, some sand, trace of gravel.		1	SS	12										
			2	SS	34										
			3	SS	31	780									
			4	SS	31										
			5	SS	31										
			6	SS	29										
	Stiff to hard.		7	SS	35	770									2 14 51 33
			8	SS	28										
			9	SS	34	760									
			10	SS	25										
748.8			11	SS	27	750									752.8
39.0	End of borehole.														
						740									

DEPARTMENT OF HIGHWAYS- ONTARIO  
MATERIALS & TESTING OFFICE

RECORD OF BOREHOLE No.8

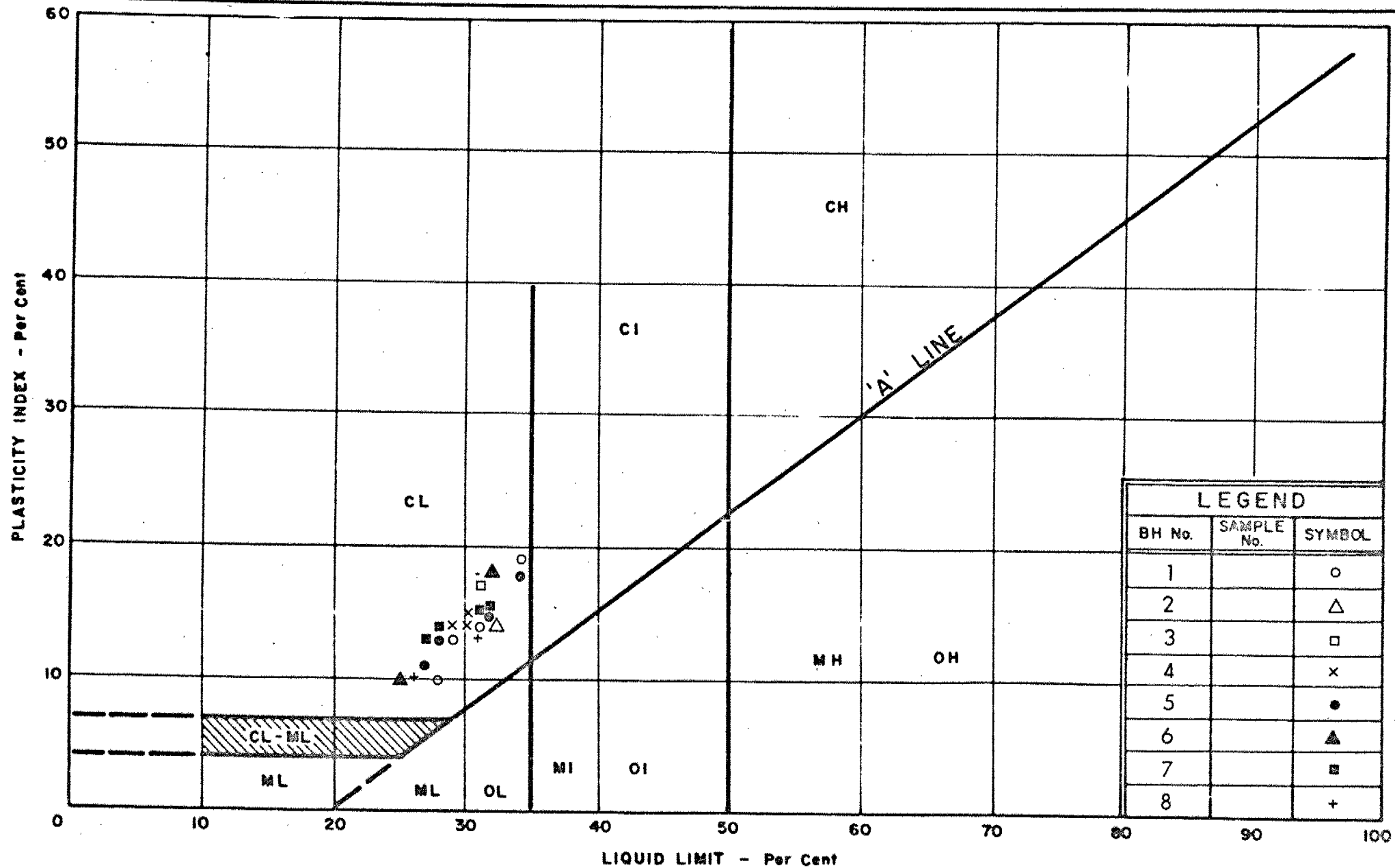
FOUNDATION SECTION

JOB 71-11068      LOCATION Co-Ord's 557, 988 N. 339, 33. E.      ORIGINATED BY P.P.

W.P. 89-69-05 & 06      BORING DATE July 26, 1971      COMPILED BY P.P.

DATUM Geodetic      BOREHOLE TYPE Continuous Flight Auger.      CHECKED BY

SOIL PROFILE		SAMPLES			ELEV. SCALE	DYNAMIC PENETRATION RESISTANCE					LIQUID LIMIT ——— w <sub>L</sub> PLASTIC LIMIT ——— w <sub>p</sub> WATER CONTENT ——— w			BULK DENSITY γ <sub>s</sub> P.C.F.	REMARKS
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE		BLOWS / FOOT	20	40	60	80	100	w <sub>p</sub>	w		
788.0	Ground level.														
0.0			1	SS	13										
	Clayey silt, some sand, trace of gravel.		2	TS	PH	780									
			3	SS	26										
	Stiff to hard.		4	TS	PH	770									
			5	SS	36										
			6	TS	PH	760									139 3 14 53 30
			7	SS	43										
			8	SS	57	750									
			9	SS	50	740									
729.0			10	SS	35	730									
59.0	End of borehole.														
						720									



DEPARTMENT OF HIGHWAYS  
MATERIALS and  
TESTING  
DIVISION

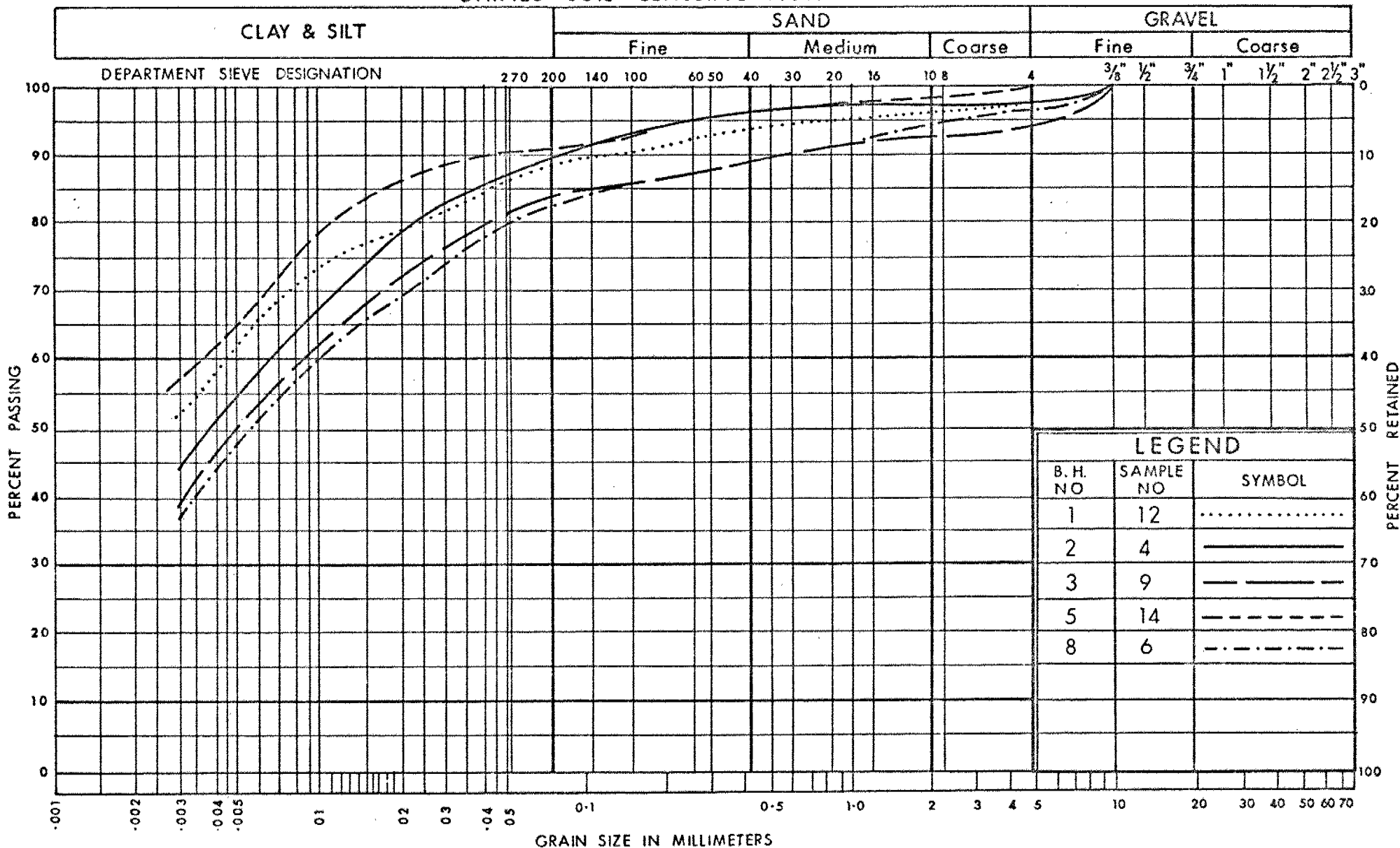
# PLASTICITY CHART CLAYEY SILT, SOME SAND, TRACE OF GRAVEL

WP No. 89-69-05 & 06

JOB No. 71-11068

FIG No 1

# UNIFIED SOIL CLASSIFICATION SYSTEM



DEPARTMENT  
OF  
TRANSPORTATION AND COMMUNICATIONS



DESIGN SERVICES  
BRANCH

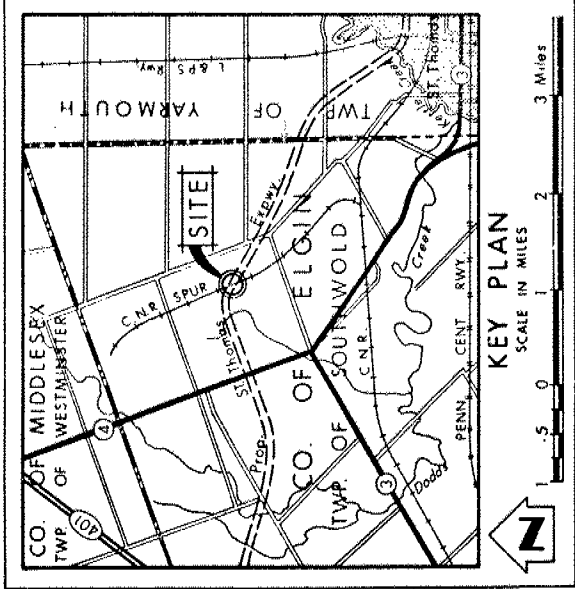
GRAIN SIZE DISTRIBUTION  
CLAYEY SILT, SOME SAND, TRACE OF GRAVEL





W.P. No. 89-69-05 & 06

JOB No. 71-11068

FIG. No 2





LEGEND			
	Bore Hole		
	Cone Penetration Test		
	Bore Hole & Cone Test		
	Water Levels established at time of field investigation, July 1971		
NO.	ELEVATION	CO-ORDINATES	
		NORTH	EAST
1	788.1	557,826	339,591
2	787.0	557,929	339,505
3	787.0	557,920	339,456
4	787.9	558,019	339,370
5	788.3	558,163	339,320
6	788.4	558,074	339,402
7	787.8	558,080	339,453
8	788.0	557,988	339,533

— 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.

REVISIONS		DESCRIPTION
DATE	BY	

DEPARTMENT OF TRANSPORTATION & COMMUNICATIONS  
DESIGN SERVICES BRANCH — FOUNDATION OFFICE

C. N. R. SPUR LINE

HIGHWAY NO. 2 PROP. ST. THOMAS EXPWY. DIST. NO. 2  
CO. ELGIN

TWP. SOUTHWOLD LOT 42 & 43 CON. E.S.T.R.

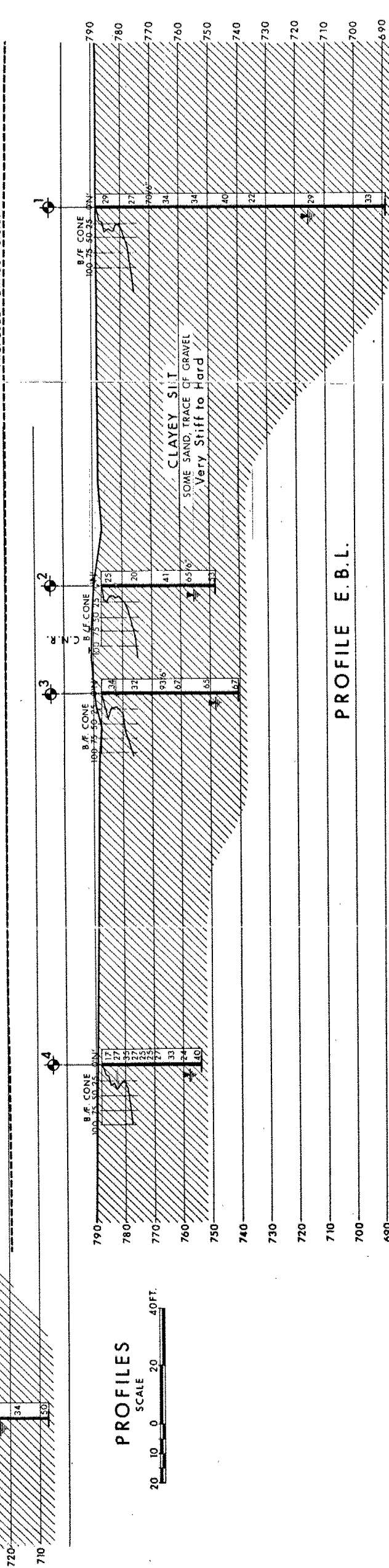
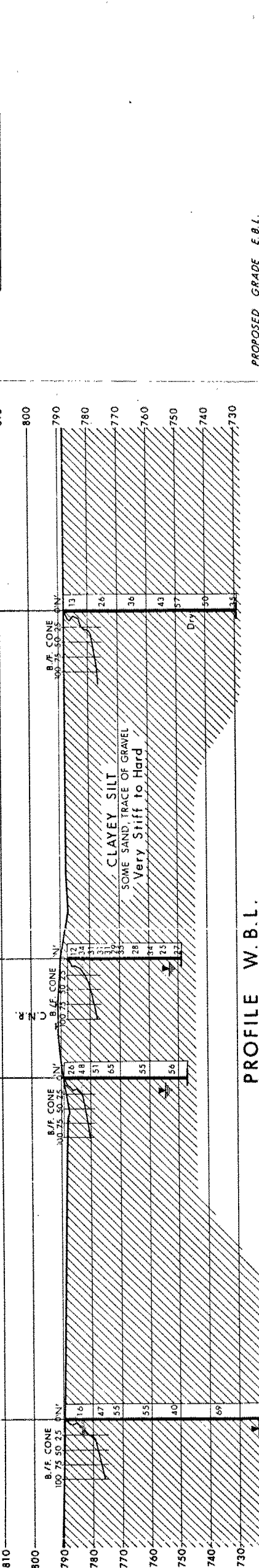
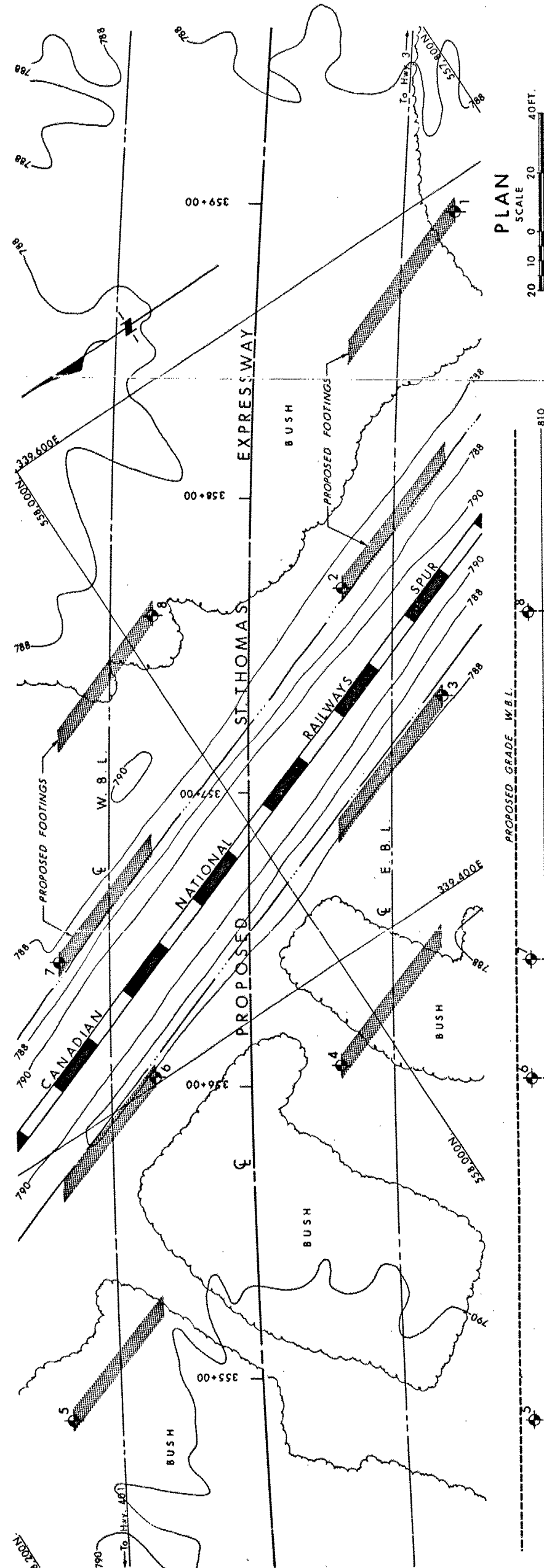
BORE HOLE LOCATIONS & SOIL STRATA

SUBNO. P.P. CHECKED W.P. NO. 89-69-05.06 DRAWING NO.

DRAWN CHECKED JOB NO. 71-110.68 71-11068A

DATE AUG. 31, 1971 SITE NO. BRIDGE DRAWING NO.

APPROVED CONT. NO.



PROFILE E.B.L.



DESIGN SERVICES BRANCH

FOUNDATIONS OFFICE

## RECORD OF BOREHOLE NO 11

JOB 71-11068

LOCATION Co-ords. 558,021 N; 339,473 E.

ORIGINATED BY LJH

W.P. 89-69-05/06

BORING DATE Nov. 7, 1973

COMPILED BY LJH

DATUM Geodetic

BOREHOLE TYPE Cont. Flight Auger

CHECKED BY

SOIL PROFILE			SAMPLES			ELEV. SCALE	DYNAMIC PENETRATION RESISTANCE BLOWS / FOOT 20 40 60 80 100	LIQUID LIMIT — $w_L$ PLASTIC LIMIT — $w_p$ WATER CONTENT — $w$ $w_p$ — $w$ — $w_L$ WATER CONTENT %	BULK DENSITY $\gamma$	REMARKS
ELEV. DEPTH	DESCRIPTION	STRAT. PLT	NUMBER	TYPE	BLOWS/FOOT					
787.5	Ground Level									
0.0	Clayey silt, some sand, trace of gravel		1	SS	20					
	Very Stiff		2	SS	19					
	Hard		3	SS	26					
771.0			4	SS	35					
16.5	End of Borehole									

OFFICE REPORT SOIL EXPLORATION

DESIGN SERVICES BRANCH

FOUNDATIONS OFFICE

## RECORD OF BOREHOLE NO 12

JOB 71-11068

LOCATION Co-ords. 558,098 N; 339,398 E.

ORIGINATED BY L.J.H.

W.P. 89-69-05/06

BORING DATE Nov. 8, 1973

COMPILED BY L.J.H.

DATUM Geodetic

BOREHOLE TYPE Cont. Flight Auger

CHECKED BY

SOIL PROFILE			SAMPLES			ELEV. SCALE	DYNAMIC PENETRATION RESISTANCE BLOWS / FOOT		LIQUID LIMIT $W_L$ PLASTIC LIMIT $W_P$ WATER CONTENT $W$		BULK DENSITY $\gamma$ P.C.F.	REMARKS
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	BLOWS/FOOT		SHEAR STRENGTH P.S.F. O UNCONFINED + FIELD VANE ● QUICK TRIAXIAL X LAB VANE		WATER CONTENT %			
788.2	Ground Level											
0.0	Clayey silt, some sand traces of gravel.  Very Stiff to Hard		1	SS	28	780						Hole Dry
			2	SS	54							
			3	SS	33							
771.7			4	SS	45							
16.5	End of Borehole					770						

OFFICE REPORT SOIL EXPLORATION

DESIGN SERVICES BRANCH

FOUNDATIONS OFFICE

## RECORD OF BOREHOLE NO 13

JOB 71-11068

LOCATION Co-ords. 558,208 N; 339,405 E.

ORIGINATED BY LJH

W.P. 89-69-05/06

BORING DATE Nov. 7, 1973

COMPILED BY LJH

DATUM Geodetic

BOREHOLE TYPE Cont. Flight Auger

CHECKED BY

SOIL PROFILE			SAMPLES			ELEV. SCALE	DYNAMIC PENETRATION RESISTANCE BLOWS / FOOT		LIQUID LIMIT $W_L$ PLASTIC LIMIT $W_P$ WATER CONTENT $W$		BULK DENSITY $\gamma$ P.C.F.	REMARKS
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	BLOWS/FOOT		SHEAR STRENGTH P.S.F. ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB VANE		WATER CONTENT %			
789.0	Ground Level											
0.0	Clayey silt, some sand, traces of gravel.		1	SS	11							
			2	SS	10							
	Stiff to Hard		3	SS	30	780						
772.5			4	SS	38							
16.5	End of Borehole					770						

OFFICE REPORT SOIL EXPLORATION

DESIGN SERVICES BRANCH

FOUNDATIONS OFFICE

## RECORD OF BOREHOLE NO 14

JOB 71-11068

LOCATION Co-ords. 558,263 N; 339,337 E.

ORIGINATED BY LJH

W.P. 89-69-05/06

BORING DATE Nov. 8, 1973

COMPILED BY LJH

DATUM Geodetic

BOREHOLE TYPE Cont. Flight Auger

CHECKED BY

SOIL PROFILE			SAMPLES			ELEV. SCALE	DYNAMIC PENETRATION RESISTANCE BLOWS / FOOT				LIQUID LIMIT $W_L$ PLASTIC LIMIT $W_P$ WATER CONTENT $W$				BULK DENSITY $\gamma$ P.C.F. GR. SA. SI. CL.	REMARKS
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	BLOWS/FOOT		SHEAR STRENGTH P.S.F. O UNCONFINED + FIELD VANE ● QUICK TRIAXIAL X LAB VANE				WATER CONTENT % $W_P$ — $W$ — $W_L$					
789.4	Ground Level															
0.0	Clayey silt, some sand, traces of gravel.		1	SS	9	780										
			2	SS	23											
	Very Stiff to Hard		3	SS	30											
772.9			4	SS	52											
16.5	End of Borehole					770										

OFFICE REPORT SOIL EXPLORATION

DESIGN SERVICES BRANCH

FOUNDATIONS OFFICE

## RECORD OF BOREHOLE NO 15

JOB 71-11068

LOCATION Co-ords. 558,286 N; 339,400 E.

ORIGINATED BY WJH

W.P. 89-69-05/06

BORING DATE November 7, 1973

COMPILED BY LJH

DATUM Geodetic

BOREHOLE TYPE Cont. Flight Auger

CHECKED BY

SOIL PROFILE			SAMPLES			ELEV. SCALE	DYNAMIC PENETRATION RESISTANCE					LIQUID LIMIT — $w_L$			BULK DENSITY	REMARKS
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	BLOWS/FOOT		BLOWS / FOOT	20	40	60	80	100	PLASTIC LIMIT — $w_p$	WATER CONTENT — $w$		
789.3	Ground Level															
0.0	Clayey silt, some sand, traces of gravel.		1	SS	16											
			2	SS	45											
			3	SS	24											
	Very Stiff to Hard		4	SS	27											
772.8			5	SS	54											
16.5	End of Borehole															

OFFICE REPORT SOIL EXPLORATION



**FOUNDATION INVESTIGATION AND DESIGN REPORT – LINDSAY DRAIN CULVERT –HIGHWAY 4  
WIDENING FROM CLINTON LINE TO NEW TALBOTVILLE BYPASS AND NEW TALBOTVILLE  
BYPASS FROM HIGHWAY 4 TO HIGHWAY 3 AT RON MCNEIL LINE**

April 2025

## **APPENDIX C**

### **C.1 SYMBOLS AND TERMS USED ON BOREHOLE RECORDS**

### **C.2 BOREHOLE RECORDS**



## 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, 4<sup>th</sup> 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:

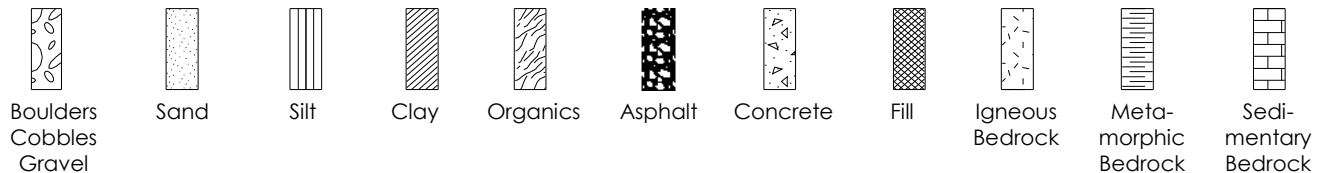
Strength Classification	Grade	Unconfined Compressive Strength (MPa)
Extremely Weak	R0	<1
Very Weak	R1	1 – 5
Weak	R2	5 – 25
Medium Strong	R3	25 – 50
Strong	R4	50 – 100
Very Strong	R5	100 – 250
Extremely Strong	R6	>250

### 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

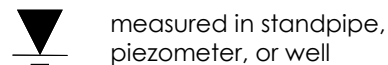
Strata plots symbolize the soil or bedrock description. They are combinations of the following basic symbols. The dimensions within the strata symbols are not indicative of the particle size, layer thickness, etc.



## 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 <sub>s</sub>	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 <sub>u</sub>	Unconfined compression
I <sub>p</sub>	Point Load Index (I <sub>p</sub> on Borehole Record equals I <sub>p</sub> (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 DCC1

1 OF 1

METRIC

W.P. 3041-22-00 LOCATION Lindsay Creek Drain, St. Thomas, Ontario N: 4742624 E:407117.6 ORIGINATED BY AS  
DIST West HWY Hwy 3 BOREHOLE TYPE Hollow Stem Auger COMPILED BY RR  
DATUM Geodetic DATE 2024.02.22 - 2024.02.23 LATITUDE 42.81654 LONGITUDE -81.2488 CHECKED BY GR

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 (%)  SA SI CL	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa			WATER CONTENT (%)					
								○ UNCONFINED	+ FIELD VANE	● QUICK TRIAXIAL	× LAB VANE	W <sub>P</sub>	W			W <sub>L</sub>
237.3	Grass						20	40	60	80	100		20	40	60	
237.0	180 mm TOPSOIL															
0.2	CLAYEY SILT (farmed layer), trace to some sand (FILL)		1	SS	8								○			
236.5	Stiff												○			
0.9	Dark brown/black		2	SS	7								○			
235.9	Moist															
1.4	SILTY CLAY, trace sand and gravel															
	Firm		3	SS	19								○			
	Dark brown															
	Moist															
	CLAYEY SILT (CL), some sand, trace gravel (TILL)		4	SS	28								○	—		
	Very stiff															
	Brown															
	Moist															
	Grey below 3 m		5	SS	28								○			
			6	SS	28								○			
			7	SS	22								○			
			8	SS	22								○			
			9	SS	20								○			
	Inferred cobbles/boulder based on rock fragments in SS9															
			10	SS	22								○	—		
			11	SS	24								○			
			12	SS	24								○			
			13	SS	23								○			
			14	SS	21								○	—		

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RECORD OF BOREHOLE No DCC2

1 OF 2

METRIC

W.P. 3041-22-00 LOCATION Lindsay Creek Drain, St. Thomas, Ontario N: 4742609 E:407154.4 ORIGINATED BY AS  
DIST West HWY Hwy 3 BOREHOLE TYPE Hollow Stem Auger COMPILED BY RR  
DATUM Geodetic DATE 2024.02.22 - 2024.02.27 LATITUDE 42.8164 LONGITUDE -81.2484 CHECKED BY GR

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa								
								○ UNCONFINED	+ FIELD VANE	● QUICK TRIAXIAL	× LAB VANE					
237.4	Grass						20	40	60	80	100	20	40	60		
237.0	200 mm TOPSOIL		1	SS	7							○				
0.2	CLAYEY SILT (farmed layer), trace sand, trace rootlets (FILL) Firm Brown		2	SS	9							○				PP = 125 kPa
236.4	Moist 300 mm thick silty sand layer at the top of SS2		3	SS	24							○	—			2 13 44 41 PP > 450 kPa
1.0	CLAYEY SILT (CL), some sand, trace gravel (TILL) Very stiff to hard Brown		4	SS	27							○				PP > 450 kPa
	Moist		5	SS	24							○				PP > 450 kPa
	Grey below 3 m		6	SS	20							○	—			2 15 49 34 PP > 450 kPa
			7	SS	16							○				PP > 450 kPa
			8	SS	18							○				PP > 450 kPa
			9	SS	19							○				PP > 450 kPa
			10	SS	22							○				PP = 325 kPa
			11	SS	13							○				PP > 450 kPa
			12	SS	23							○	—			8 13 45 34 PP = 400 kPa
			13	SS	45							○				PP > 450 kPa
			14	SS	25							○				PP > 450 kPa
			15	SS	21							○				PP > 450 kPa
221.5	END OF BOREHOLE															
15.9	Monitoring well installed in borehole, screened from approximately 4.6 m to 6.1 m below grade.															

Continued Next Page

+<sup>3</sup>, ×<sup>3</sup>: Numbers refer to Sensitivity ○ 3% STRAIN AT FAILURE

ONTARIO MTO 165001308\_MTO\_HWY3-TWINNING\_20241127.GPJ ONTARIO MTO.GDT 12/3/24

## METRIC

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

RECORD OF BOREHOLE No DCC3

1 OF 1

METRIC

W.P. 3041-22-00 LOCATION Lindsay Creek Drain, St. Thomas, Ontario N: 4742591 E: 407191.9 ORIGINATED BY KL  
DIST West HWY Hwy 3 BOREHOLE TYPE Hollow Stem Auger COMPILED BY RR  
DATUM Geodetic DATE 2024.01.10 - 2024.01.10 LATITUDE 42.81623 LONGITUDE -81.2479 CHECKED BY GR

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT $\gamma$ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) SA SI CL		
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa					WATER CONTENT (%)				
								○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB VANE					w <sub>p</sub> w w <sub>L</sub>				
237.3 237.0 0.2	Grass 150 mm TOPSOIL CLAY (CH), some sand Firm Brown Moist		1	SS	4												
			2	SS	7										0 15 43 42 PP = 250 kPa		
235.9 1.4	CLAYEY SILT (CL), some sand, trace gravel (TILL) Very stiff to hard Brown Moist SS3 contains trace rock fragments Grey below 2.3 m		3	SS	22										PP = 350 kPa		
			4	SS	19										PP > 450 kPa		
			5	SS	21										2 14 47 37 PP > 450 kPa		
			6	SS	15										PP > 450 kPa		
	SS7 contains sand seams		7	SS	16										PP = 425 kPa		
			8	SS	20										4 13 47 35 PP > 450 kPa		
			9	SS	22										PP > 450 kPa		
			10	SS	31										PP > 450 kPa		
	clayey silt (CL-ML) layer from 10.7 m to 11.2 m		11	SS	84										2 8 71 19		
			12	SS	34										PP > 450 kPa		
			13	SS	24										PP = 450 kPa		
221.5 15.9	END OF BOREHOLE  Borehole caved in to 14.9 m below grade and was dry on completion.		14	SS	23										PP = 350 kPa		

ONTARIO MTO 165001308\_MTO\_HWY3-TWINNING\_20241127.GPJ ONTARIO MTO.GDT 12/3/24

**FOUNDATION INVESTIGATION AND DESIGN REPORT – LINDSAY DRAIN CULVERT –HIGHWAY 4  
WIDENING FROM CLINTON LINE TO NEW TALBOTVILLE BYPASS AND NEW TALBOTVILLE  
BYPASS FROM HIGHWAY 4 TO HIGHWAY 3 AT RON MCNEIL LINE**

April 2025

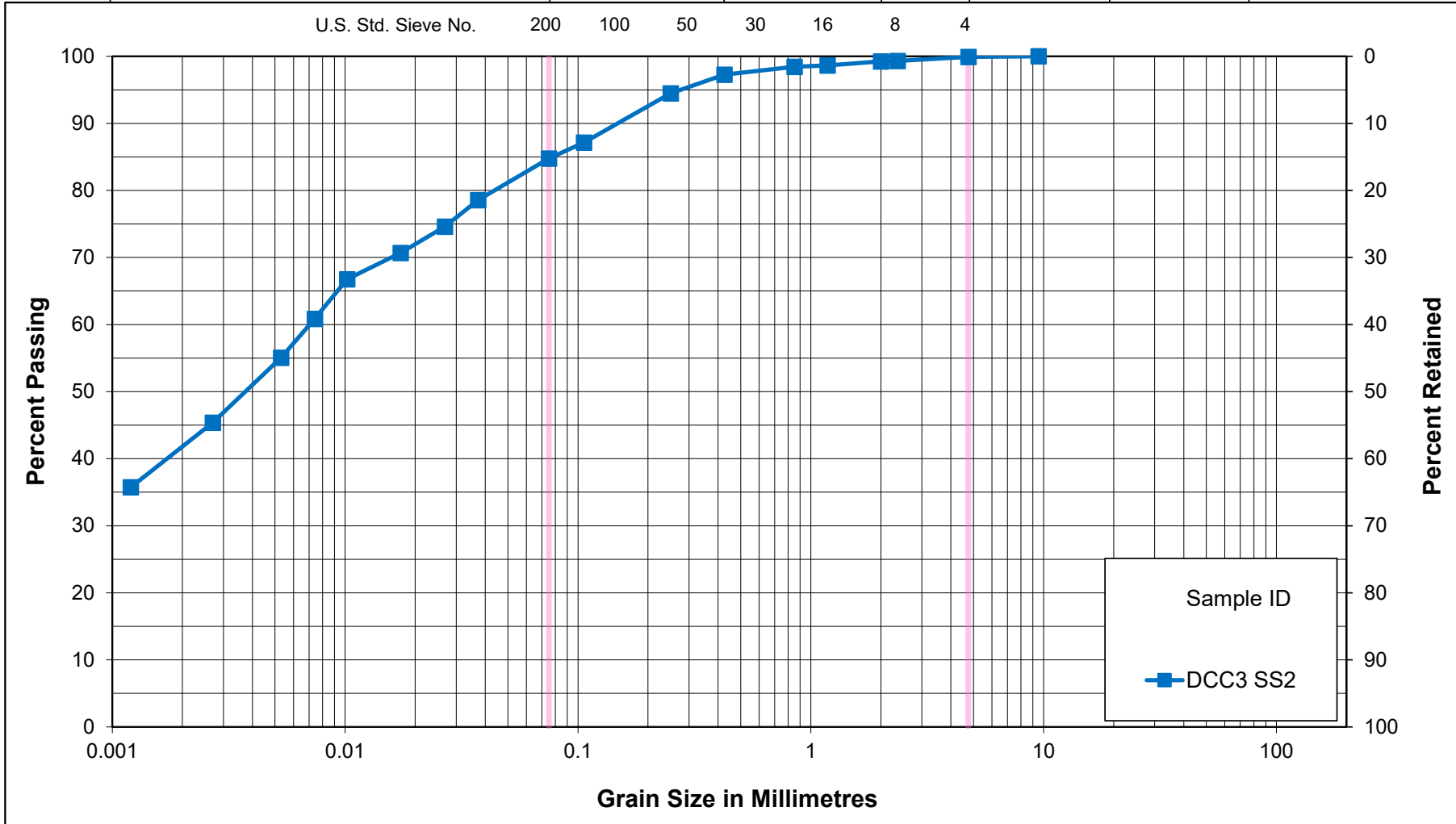
## **APPENDIX D**

### **D.1 LABORATORY TEST RESULTS**



# Unified Soil Classification System

CLAY & SILT			SAND			Gravel	
			Fine	Medium	Coarse	Fine	Coarse



**CLAY (CH)**  
**Ministry of Transportation (MTO)**  
**HWY 3 Twinning - Lindsay Drain Culvert**

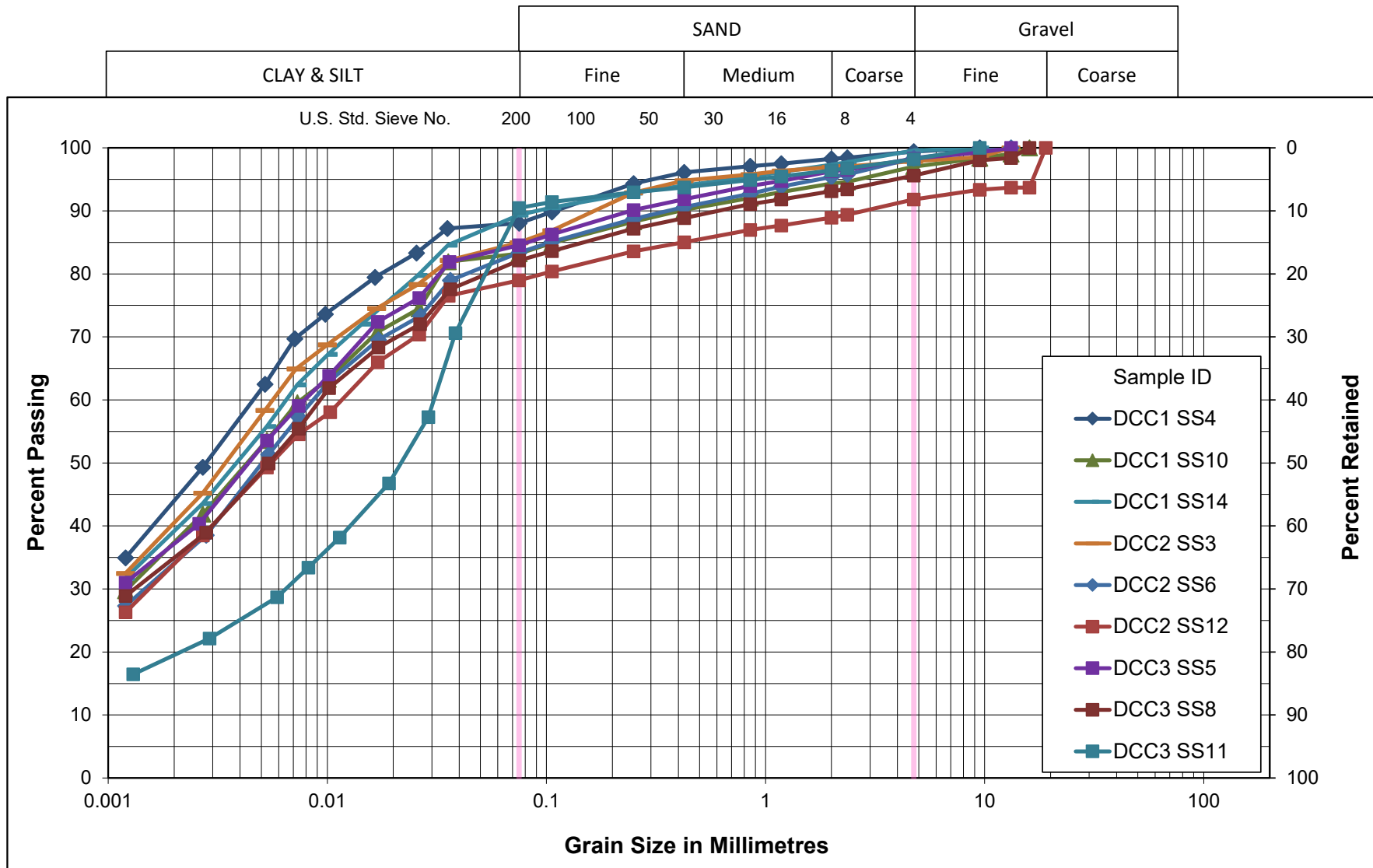
Figure No. D1

Project No. 165001308





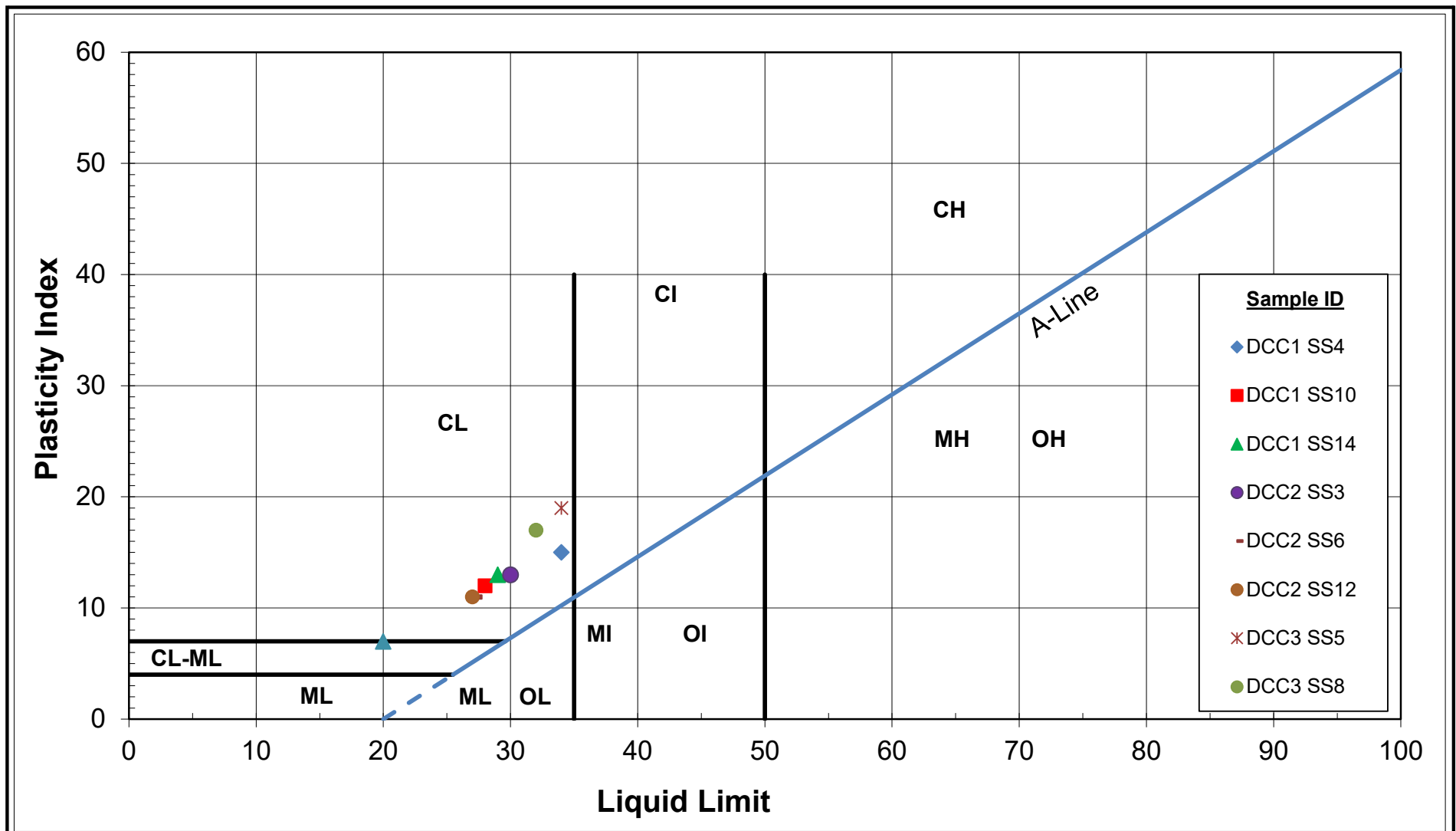
# Unified Soil Classification System



**TILL: CLAYEY SILT (CL-ML to CL)**  
**Ministry of Transportation (MTO)**  
**HWY 3 Twinning - Lindsay Drain Culvert**

Figure No. D3

Project No. 165001308



**TILL: CLAYEY SILT (CL-ML to CL)**  
**Ministry of Transportation (MTO)**  
**HWY 3 Twinning - Linday Drain Culvert**

Figure No. D4

Project No. 165001308

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

**ATTENTION TO: Bahram Siavash**

**PROJECT: 165001308.551.102**

**AGAT WORK ORDER: 24T149317**

**ROCK ANALYSIS REVIEWED BY: Ali Reza Khosh Kish, Report Writer**

**SOIL ANALYSIS REVIEWED BY: Sukhwinder Randhawa, Inorganic Team Lead**

**DATE REPORTED: May 18, 2024**

**PAGES (INCLUDING COVER): 7**

**VERSION\*: 1**

Should you require any information regarding this analysis please contact your client services representative at (403) 735-2005

\*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.
- For environmental samples in the Province of Quebec: The analysis is performed on and results apply to samples as received. A temperature above 6°C upon receipt, as indicated in the Sample Reception Notification (SRN), could indicate the integrity of the samples has been compromised if the delay between sampling and submission to the laboratory could not be minimized.



## Certificate of Analysis

AGAT WORK ORDER: 24T149317

PROJECT: 165001308.551.102

2910 12TH STREET NE  
CALGARY, ALBERTA  
CANADA T2E 7P7  
TEL (403)735-2005  
FAX (403)735-2771  
<http://www.agatlabs.com>

CLIENT NAME: STANTEC CONSULTING LTD

SAMPLING SITE:

ATTENTION TO: Bahram Siavash

SAMPLED BY:

### (284-137) Sulfide (CGY)

DATE RECEIVED: 2024-05-10

DATE REPORTED: 2024-05-18

		SAMPLE DESCRIPTION:		DCC2-SS3	KCBA1-SS12	KCBA2-SS11	KCBP1-SS12	KCBP2-SS5
		SAMPLE TYPE:		Soil	Soil	Soil	Soil	Soil
		DATE SAMPLED:		2024-05-09	2024-05-09	2024-05-09	2024-05-09	2024-05-09
Parameter	Unit	G / S	RDL	5850929	5850950	5850951	5850952	5850953
Sulfide	%	0.01	0.01	0.01	0.06	<0.01	0.02	0.08

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

Analysis performed at AGAT Calgary (unless marked by \*)

Certified By:



## Certificate of Analysis

AGAT WORK ORDER: 24T149317

PROJECT: 165001308.551.102

2910 12TH STREET NE  
CALGARY, ALBERTA  
CANADA T2E 7P7  
TEL (403)735-2005  
FAX (403)735-2771  
<http://www.agatlabs.com>

CLIENT NAME: STANTEC CONSULTING LTD

SAMPLING SITE:

ATTENTION TO: Bahram Siavash

SAMPLED BY:

### Corrosivity Package

DATE RECEIVED: 2024-05-10

DATE REPORTED: 2024-05-18

		SAMPLE DESCRIPTION:		DCC2-SS3	KCBA1-SS12	KCBA2-SS11	KCBP1-SS12	KCBP2-SS5
		SAMPLE TYPE:		Soil	Soil	Soil	Soil	Soil
		DATE SAMPLED:		2024-05-09	2024-05-09	2024-05-09	2024-05-09	2024-05-09
Parameter	Unit	G / S	RDL	5850929	5850950	5850951	5850952	5850953
Chloride (2:1)	µg/g	2	17	12	10	13	18	
Sulphate (2:1)	µg/g	2	24	290	281	93	90	
pH (2:1)	pH Units	NA	8.40	8.16	8.14	8.85	8.58	
Electrical Conductivity (2:1)	mS/cm	0.005	0.184	0.573	0.277	0.181	0.205	
Resistivity (2:1) (Calculated)	ohm.cm	1	5430	1750	3610	5520	4880	
Redox Potential 1	mV	NA	216	208	247	243	223	
Redox Potential 2	mV	NA	221	210	245	245	232	
Redox Potential 3	mV	NA	218	208	244	243	232	

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

**5850929-5850953** 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:



*Koor*

## Quality Assurance

CLIENT NAME: STANTEC CONSULTING LTD

PROJECT: 165001308.551.102

SAMPLING SITE:

AGAT WORK ORDER: 24T149317

ATTENTION TO: Bahram Siavash

SAMPLED BY:

### Rock Analysis

RPT Date: May 18, 2024			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		Recovery	Acceptable Limits	
								Lower	Upper		Lower	Upper		Lower	Upper

#### (284-137) Sulfide (CGY)

Total Sulfur	5850929	5850929	0.01	0.01	19.5%	< 0.01	104%	80%	120%
Sulfate	5853092		<0.01	<0.01	0.0%	< 0.01	108%	80%	120%

Comments: RPDs are calculated using raw analytical data and not the rounded duplicate values reported.  
Duplicate/ Replicate NA: Results are less than 10X the RDL and RPD will not be calculated

#### (284-137) Sulfide (CGY)

Sulfate	5850929	5850929	<0.01	<0.01	0%	< 0.01		80%	120%
---------	---------	---------	-------	-------	----	--------	--	-----	------

Comments: RPDs are calculated using raw analytical data and not the rounded duplicate values reported.  
Duplicate/ Replicate NA: Results are less than 10X the RDL and RPD will not be calculated

#### (284-000) Re-Work (CGY)

Total Sulfur	5856796		0.11	0.12	6.3%	< 0.01	107%	90%	110%
--------------	---------	--	------	------	------	--------	------	-----	------

Certified By:



## Quality Assurance

CLIENT NAME: STANTEC CONSULTING LTD

PROJECT: 165001308.551.102

SAMPLING SITE:

AGAT WORK ORDER: 24T149317

ATTENTION TO: Bahram Siavash

SAMPLED BY:

### Soil Analysis

RPT Date: May 18, 2024			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		Recovery	Acceptable Limits	
								Lower	Upper		Lower	Upper		Lower	Upper

#### Corrosivity Package

Chloride (2:1)	5856796		<2	<2	NA	< 2	95%	70%	130%	96%	80%	120%	96%	70%	130%
Sulphate (2:1)	5856796		1480	1480	0.0%	< 2	96%	70%	130%	97%	80%	120%	NA	70%	130%
pH (2:1)	5856856		6.20	6.53	5.2%	NA	98%	80%	120%						
Electrical Conductivity (2:1)	5856856		0.339	0.371	9.0%	< 0.005	96%	80%	120%						
Redox Potential 1	5850929					NA	100%	90%	110%						

Comments: NA signifies Not Applicable.

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

Duplicate NA: results are under 5X the RDL and will not be calculated.

Matrix spike NA: Spike level &lt; native concentration. Matrix spike acceptance limits do not apply and are not calculated.

Certified By:


*Subhinder Kaur Randhawa*



## Method Summary

CLIENT NAME: STANTEC CONSULTING LTD

PROJECT: 165001308.551.102

SAMPLING SITE:

AGAT WORK ORDER: 24T149317

ATTENTION TO: Bahram Siavash

SAMPLED BY:

PARAMETER	AGAT S.O.P	LITERATURE REFERENCE	ANALYTICAL TECHNIQUE
<b>Rock Analysis</b>			
Total Sulfur	MIN-283-12001	ASTM E1915; ASTM E1019; ASTM D5373	LECO
<b>Soil Analysis</b>			
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-93-6075	modified from MSA PART 3, CH 14 and SM 2510 B	PC TITRATE
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	ASTM G200-20, SM 2580 B	REDOX POTENTIAL ELECTRODE
Redox Potential 3	INOR-93-6066	ASTM G200-20, SM 2580 B	REDOX POTENTIAL ELECTRODE



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Ph.: 905.712.5100 • Fax: 905.712.5122 • Toll Free: 800.856.6261

Company:	Stantec Consulting Ltd.	
Contact:	Bahram Siavash	
Address:	300-675 Cochran Drive West Tower	
Phone:	905-479-9345	Fax: 905-474-9889
Project:	165001308.551.102	PO: _____
AGAT Quotation #:		

Please note, if quotation number is not provided,  
client will be billed full price for analysis.

Same: Yes ☒ No ☐

Company: \_\_\_\_\_  
Contact: \_\_\_\_\_  
Address: \_\_\_\_\_

**GW** Ground Water    **O** Oil  
**SW** Surface Water    **P** Paint  
**SD** Sediment        **S** Soil

1.	Name:	Bahram Siavash
	Email:	Bahram.Siavash@stantec.com
2.	Name:	Kirby Lales
	Email:	kirby.lales@stantec.com

☐ Regulation 153/09  
(reg. 511 Amend.)

Table

Indicate one

☐ Ind/Com

☐ Res/Park

☐ Agriculture

Soil Texture (check one)

☐ Coarse      ☐ Fine☐ Sewer Use

Region                       
Indicate one

☐ Sanitary

☐ Storm

Regulation 558

☐ CCME☐ Other (specify) \_\_\_\_\_☐ Prov. Water Quality Objectives (PWOO)☐ None

**Is this a drinking water sample?**  
(potable water intended for human consumption)

☐ Yes      ☐ No

If "Yes", please use the  
***Drinking Water Chain of Custody Form***

Is this submission for a **Record of Site Condition?**

☐ Yes      ☐ No[illegible]

Samples Relinquished by (print name & sign):

Date/Time
-----------

Samples Received by (Print name & sign):

Date/Time

PipkCopy - Client

Samples Relinquished by (print name & sign): \_\_\_\_\_

Date/Time

Samples Received by (Print name & sign):

Date/Time

Yellow + Golden Copy - AGAT  
White Copy - AGAT

Page \_\_\_\_ of \_\_\_\_

NO:

**FOUNDATION INVESTIGATION AND DESIGN REPORT – LINDSAY DRAIN CULVERT –HIGHWAY 4  
WIDENING FROM CLINTON LINE TO NEW TALBOTVILLE BYPASS AND NEW TALBOTVILLE  
BYPASS FROM HIGHWAY 4 TO HIGHWAY 3 AT RON MCNEIL LINE**

April 2025

## **APPENDIX E**

### **E.1 2020 NATIONAL BUILDING CODE SEISMIC HAZARD CALCULATION SHEET**





Government  
of Canada

Gouvernement  
du Canada

[Canada.ca](#) › [Natural Resources Canada](#) › [Earthquakes Canada](#)

# 2020 National Building Code of Canada Seismic Hazard Tool

**i** This application provides seismic values for the design of buildings in Canada under Part 4 of the National Building Code of Canada (NBC) 2020 as prescribed in Article 1.1.3.1. of Division B of the NBC 2020.

## Seismic Hazard Values

### User requested values

Code edition	NBC 2020
Site designation $X_S$	$X_D$
Latitude (°)	42.816
Longitude (°)	-81.249

Please select one of the tabs below.

NBC 2020

Additional Values

Plots

API

Background Information

The 5%-damped spectral acceleration ( $S_a(T, X)$ , where  $T$  is the period, in s, and  $X$  is the site designation) and peak ground acceleration ( $PGA(X)$ ) values are given in units of acceleration due to gravity ( $g$ ,  $9.81 \text{ m/s}^2$ ). Peak

ground velocity. (PGV(X)) values are given in m/s. Probability is expressed in terms of percent exceedance in 50 years. Further information on the calculation of seismic hazard is provided under the *Background Information* tab.

The 2%-in-50-year seismic hazard values are provided in accordance with Article 4.1.8.4. of the NBC 2020. The 5%- and 10%-in-50-year values are provided for additional performance checks in accordance with Article 4.1.8.23. of the NBC 2020.

See the *Additional Values* tab for additional seismic hazard values, including values for other site designations, periods, and probabilities not defined in the NBC 2020.

#### NBC 2020 - 2%/50 years (0.000404 per annum) probability

$S_a(0.2, X_D)$	$S_a(0.5, X_D)$	$S_a(1.0, X_D)$	$S_a(2.0, X_D)$	$S_a(5.0, X_D)$	$S_a(10.0, X_D)$	PGA( $X_D$ )	PGV( $X_D$ )
0.242	0.229	0.133	0.0619	0.0157	0.00491	0.142	0.139

The log-log interpolated 2%/50 year  $S_a(4.0, X_D)$  value is : **0.0219**

#### ▼ Tables for 5% and 10% in 50 year values

##### NBC 2020 - 5%/50 years (0.001 per annum) probability

$S_a(0.2, X_D)$	$S_a(0.5, X_D)$	$S_a(1.0, X_D)$	$S_a(2.0, X_D)$	$S_a(5.0, X_D)$	$S_a(10.0, X_D)$	PGA( $X_D$ )	PGV( $X_D$ )
0.143	0.137	0.0769	0.0345	0.00815	0.00258	0.0834	0.0775

The log-log interpolated 5%/50 year  $S_a(4.0, X_D)$  value is : **0.0116**

##### NBC 2020 - 10%/50 years (0.0021 per annum) probability

$S_a(0.2, X_D)$	$S_a(0.5, X_D)$	$S_a(1.0, X_D)$	$S_a(2.0, X_D)$	$S_a(5.0, X_D)$	$S_a(10.0, X_D)$	PGA( $X_D$ )	PGV( $X_D$ )
-----------------	-----------------	-----------------	-----------------	-----------------	------------------	--------------	--------------

$S_a(0.2, X_D)$	$S_a(0.5, X_D)$	$S_a(1.0, X_D)$	$S_a(2.0, X_D)$	$S_a(5.0, X_D)$	$S_a(10.0, X_D)$	PGA( $X_D$ )	PGV( $X_D$ )
0.0893	0.0852	0.0468	0.0202	0.00441	0.00139	0.0514	0.0456

The log-log interpolated 10%/50 year  $S_a(4.0, X_D)$  value is : **0.0064**

Download CSV

← Go back to the [seismic hazard calculator form](#)

**Date modified:** 2021-04-06

**FOUNDATION INVESTIGATION AND DESIGN REPORT – LINDSAY DRAIN CULVERT –HIGHWAY 4  
WIDENING FROM CLINTON LINE TO NEW TALBOTVILLE BYPASS AND NEW TALBOTVILLE  
BYPASS FROM HIGHWAY 4 TO HIGHWAY 3 AT RON MCNEIL LINE**

April 2025

## **APPENDIX F**

### **F.1 NON-STANDARD SPECIAL PROVISIONS**



## **Working Slab – Item No.**

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Special Provision No. xxx

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### **1.0 Scope**

This Specification covers the requirement for the supply and placement of a concrete working slab under structure foundations

### **2.0 References**

This specification refers to the following standards, specification or publications:

#### **Ontario Provision Standard Specifications, Construction**

OPSS 902 Excavating and Backfilling-Structures

### **3.0 Definitions - Not Used**

### **4.0 Design And Submission Requirements- Not Used**

### **5.0 Materials**

Concrete for working slabs (mud slab using lean concrete) shall have a minimum 28 day strength of 5 MPa.

### **6.0 Equipment-Not Used**

### **7.0 Construction**

#### **7.01 Excavation**

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

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

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

#### **7.03 Dewatering**

Dewatering shall be carried out according to OPSS 902.

### **8.0 Quality Assurance - Not Used**

### **9.0 Measurement For Payment - Not Used**



## **10.0 Basis of Payment**

### **10.01 Working Slab – Item**

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