



DRAFT

**Foundation Investigation and
Design Report – Replacement of
Median Sewer and New
Stormwater Management Facility
- Highway 401 Rehabilitation
From Wellington Road to
Highbury Avenue, Design-Build
Project**

Highway 401, City of London, ON

West Region

DB Contract Number: 2022-3004

GWP 3032-11-00

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Longitude -81.193864

Geocres No. TBD

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**DRAFT FOUNDATION INVESTIGATION AND DESIGN REPORT – REPLACEMENT OF MEDIAN
SEWER AND NEW STORMWATER MANAGEMENT FACILITY - HIGHWAY 401 REHABILITATION
FROM WELLINGTON ROAD TO Highbury Avenue, Design-Build Project**

Table of Contents

1.0	INTRODUCTION.....	1
2.0	SITE DESCRIPTION	2
2.1	SITE LOCATION	2
2.2	GENERAL SITE DESCRIPTION	2
2.3	GEOLOGICAL INFORMATION	2
3.0	REVIEW OF PREVIOUS INVESTIGATIONS	3
4.0	INVESTIGATION PROCEDURES.....	3
4.1	FIELD INVESTIGATION.....	3
4.2	LOCATION AND ELEVATION SURVEY	4
4.3	LABORATORY TESTING.....	5
5.0	SUBSURFACE CONDITIONS	5
5.1	FRAMEWORK & OVERVIEW	5
5.2	OVERBURDEN	6
5.2.1	Pavement.....	6
5.2.2	Topsoil	6
5.2.3	Fill	7
5.2.4	Upper Clayey Silt to Silty Clay to Clay.....	8
5.2.5	Upper Silt.....	9
5.2.6	Lower Clayey Silt to Silty Clay.....	10
5.2.7	Lower Silty Sand to Silt	11
5.3	BEDROCK	11
5.4	GROUNDWATER CONDITIONS	11
5.5	CHEMICAL ANALYSIS	12
6.0	MISCELLANEOUS	13
7.0	CLOSURE.....	14
8.0	DISCUSSIONS AND ENGINEERING RECOMMENDATIONS	15
8.1	PROJECT OVERVIEW	15
8.1.1	Scope of Report	15
8.1.2	Project Description	15
8.1.3	Proposed Median Sewer Replacement and New Stormwater Management Facility Details	16
8.2	GENERAL DESIGN AND CONSTRUCTION CONSIDERATIONS	16
8.2.1	Median Sewer	16
8.2.2	Stormwater Management Facility	18
8.2.3	Groundwater and Surface Water Control	18
8.3	CEMENT TYPE AND CORROSION PROTECTION.....	19
8.4	INSTRUMENTATION AND MONITORING.....	20



**DRAFT FOUNDATION INVESTIGATION AND DESIGN REPORT – REPLACEMENT OF MEDIAN
SEWER AND NEW STORMWATER MANAGEMENT FACILITY - HIGHWAY 401 REHABILITATION
FROM WELLINGTON ROAD TO Highbury Avenue, Design-Build Project**

9.0	SPECIFICATIONS	20
10.0	REFERENCES.....	21
11.0	CLOSURE.....	22

LIST OF TABLES

Table 4.1:	Borehole Information Summary	4
Table 4.2:	Laboratory Testing Program	5
Table 5.1:	Measured and Inferred Groundwater Levels.....	11
Table 5.2:	Results of Chemical Analysis	12
Table 8.1:	Recommended Static Earth Pressure Parameters (horizontal ground surface)	17
Table 8.2:	Results of Corrosion Potential Assessment	19
Table 10.1:	Specifications Referenced in Report.....	20

LIST OF APPENDICES

APPENDIX A	A.1
A.1	Drawing Nos. 1 to 4 – Borehole Location Plan..... A.1
APPENDIX B	B.1
B.1	Symbols and Terms Used on Borehole Records
B.2	Borehole Records.....
APPENDIX C	C.1
C.1	Laboratory Test Results
APPENDIX D	D.1
D.1	Median Sewer Drawings.....
D.2	Stormwater management facility sections.....



DRAFT FOUNDATION INVESTIGATION AND DESIGN REPORT – REPLACEMENT OF MEDIAN SEWER AND NEW STORMWATER MANAGEMENT FACILITY - HIGHWAY 401 REHABILITATION FROM WELLINGTON ROAD TO Highbury Avenue, DESIGN-BUILD PROJECT

Introduction
November 17, 2022

DRAFT FOUNDATION INVESTIGATION REPORT

For

G.W.P. 3032-11-00

DB Contract Number 2022-3004

Replacement of Median Sewer and New Stormwater Management Facility
Highway 401 Rehabilitation from Wellington Road to Highbury Avenue, Design-Build Project
West Region
City of London, Ontario

1.0 INTRODUCTION

CRH Canada Group Inc. (CRH) is constructing the Highway 401 Five Structure Replacement project, which includes the Highbury Avenue Interchange improvements, and the Highway 401 rehabilitation and improvements in the City of London, on behalf of the Ontario for the Ministry of Transportation (MTO), under a Design-Build (DB) agreement. Stantec Consulting Ltd. (Stantec) was retained by CRH to undertake additional foundation investigations and detailed foundation designs for the project.

The overall project extends along Highway 401 from 675 m east of Wellington Road easterly 5.5 km to 630 m west of Old Victoria Road, along Pond Mill Road from 60 m north to 60 m south of Highway 401, and along Highbury Avenue from Bradley Avenue to Wilton Grove Road. The project includes following foundations engineering components:

- All deep cut areas and foundations for the new bridge structures, including:
 - CNR Overhead (London-Port Stanley Railway (Site No. 19X-0371/B0);
 - Pond Mills Overpass (Site No. 19X-0372/B0);
 - Highbury Avenue Underpass (Site No. 19X-0373/B0);
- Structural culvert replacements, including:
 - Tributary to Murray Drain Culvert (Site No. 19X-650/C0);
 - Elliot-Laidlaw Drain Culvert (Site No. 19X-651/C0);
- High mast lights;
- Overhead signs;
- Retaining walls (at the bridges and Overhead sign footings);
- 1.5:1 reinforced side slope between Station 25+110 and Station 25+270 westbound (changed to 2H:1V slopes); and
- Sewers and stormwater management facilities.

The MTO reference numbers for this DB project are as follows:

GWP: 3032-11-00

DB Contract Number: 2022-3004



DRAFT FOUNDATION INVESTIGATION AND DESIGN REPORT – REPLACEMENT OF MEDIAN SEWER AND NEW STORMWATER MANAGEMENT FACILITY - HIGHWAY 401 REHABILITATION FROM WELLINGTON ROAD TO Highbury Avenue, DESIGN-BUILD PROJECT

Site Description
November 17, 2022

This foundation investigation report has been prepared specifically for the proposed median sewer replacement and new stormwater management facility, and other project foundations engineering components are reported under separate covers.

2.0 SITE DESCRIPTION

2.1 SITE LOCATION

The median sewer to be replaced is located below the Highway 401 median, from approximately Station 24+300 at its west end to approximately Station 26+130 at its east end, in the City of London, Ontario. The site location is shown on Drawing Nos. 1 to 4 included in Appendix A.

2.2 GENERAL SITE DESCRIPTION

At the project location, Highway 401 is a divided six-lane freeway with three lanes in each direction and paved shoulders on both sides. Chainage increases from west to east on Highway 401. From the west to the east, Highway 401 crosses CNR rail tracks and Pond Mills Road with overpass structures, and Highbury Avenue via an underpass structure. The orientation of the highway is approximately southwest to northeast. For the purposes of this report, the orientation of Highway 401 and Highbury Avenue are taken as west to east and north-south, respectively.

Along the proposed median sewer replacement, Highway 401 is mostly constructed on an embankment. The elevation of the existing travelled surface of the highway is approximately 264 m on the west (near the Exeter Road exit) , approximately 276.5 m at the location of the CNR overhead structure, approximately 271 m at the Elliot Laidlaw Drain culvert, and approximately 276 m at the Highbury Avenue interchange. In general, the travelled surface of the highway is approximately 1 m to 8 m higher than the surrounding lands on both sides of the highway.

The overall topography surrounding the highway is relatively flat to gently sloping.

The surrounding lands generally consist of open fields and industrial/commercial properties.

2.3 GEOLOGICAL INFORMATION

This project lies within a physiographic region known as the Westminster Moraine. The physiographic mapping indicates that the culvert site is situated on an undrumlinized till plane (Chapman and Putnam, 1984). Geology mapping indicates that the surficial material consists of Port Stanley silty clay till and clayey silt till, in places covered by thin patches of lacustrine silt. The rock formation in the area of the culvert site is described as medium brown, microcrystalline limestone of the Dundee Formation which belongs to the Hamilton Group of Middle Devonian Age. The bedrock surface is estimated to be at about elevation 210 m, which is more than 60 m below ground surface at the site location.



DRAFT FOUNDATION INVESTIGATION AND DESIGN REPORT – REPLACEMENT OF MEDIAN SEWER AND NEW STORMWATER MANAGEMENT FACILITY - HIGHWAY 401 REHABILITATION FROM WELLINGTON ROAD TO Highbury Avenue, Design-Build Project

Review of Previous Investigations
November 17, 2022

3.0 REVIEW OF PREVIOUS INVESTIGATIONS

No foundation reports were available in the GEOCRE database for the proposed median sewer replacement. However, several available GEOCRE reports at the structural locations within the proposed median sewer replacement limit and stormwater management facility site were available. These include the preliminary foundation investigation and design reports for the Tributary to Murray Drain Culvert, CNR Overhead, Pond Mills Road Overpass, and the Elliot-Laidlaw Drain Culverts. Details relating to the soil conditions at these sites are available in each of these reports.

4.0 INVESTIGATION PROCEDURES

4.1 FIELD INVESTIGATION

The foundation investigation for the detailed design of the proposed median sewer replacement included ten (10) boreholes drilled specifically for the sewer, designated as Boreholes MS-01 to MS-10. Boreholes S-01, HL-01 to HL-08, MC-02, MC-03, CN-01, PM-01, PM-04, EL-01, and EL-03, advanced for other foundation components along the median sewer replacement alignment, supplement the MS-series boreholes.

For the proposed stormwater management facility (SWMF) to be located between the CNR Overhead and Pond Mills Road structures, boreholes PM-06, HF-13 and HF-17, and the monitoring wells installed in boreholes PM-06 and HF-13, to monitor a long-term stabilized groundwater level, are to be used.

All median sewer boreholes were located within the paved median, or the closest edge of lane. The SWMF boreholes were advanced at the existing highway embankment toe area. The locations of these boreholes are shown on the Borehole Locations Plan, Drawing Nos. 1 and 4, 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 CME 75, CME 55, and B57 truck and track-mounted drill rigs equipped for soil sampling, between the dates of June 23 and August 19, 2022. The boreholes were advanced using continuous flight hollow and solid 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. All recovered SPT samples were returned to our Markham laboratory for detailed classification and testing. The undrained shear strengths of cohesive soils were determined using an in-situ shear vane (MTO N-vane) wherever applicable. A pocket penetrometer was also utilized to estimate the strength of clayey soil samples at the site.



DRAFT FOUNDATION INVESTIGATION AND DESIGN REPORT – REPLACEMENT OF MEDIAN SEWER AND NEW STORMWATER MANAGEMENT FACILITY - HIGHWAY 401 REHABILITATION FROM WELLINGTON ROAD TO Highbury Avenue, Design-Build Project

Investigation Procedures
November 17, 2022

Groundwater was also observed in open boreholes during and upon completion of drilling. Two monitoring wells were also installed for the SWMF area to monitor the long-term stabilized groundwater level.

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

Boreholes advanced on the highway were sealed with cold patch asphalt.

4.2 LOCATION AND ELEVATION SURVEY

The borehole locations and respective ground surface elevations were surveyed by Stantec Geomatics personnel. The borehole survey data is considered accurate to 0.1 m for coordinates and elevations.

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 10 Coordinates		Ground Surface Elevation (m)	Total Depth Drilled or Advanced (m)	End of Borehole Elevation (m)	Number of Soil Samples
	Northing	Easting				
MS-01	4755057.3	410433.8	264.3	5.2	259.2	7
MS-02	4755115.6	410490.3	264.6	5.8	258.8	8
MS-03	4755188.9	410571.0	264.9	5.2	259.7	7
MS-04	4755242.5	410635.8	265.2	5.2	260.0	7
MS-05	4755537.4	411177.8	272.9	5.2	267.7	7
MS-06	4755773.9	411740.8	271.9	6.7	265.2	9
MS-07	4755828.8	411910.0	270.7	6.7	264.0	9
MS-08	4755882.7	412083.5	269.8	6.7	263.6	9
MS-09	4755971.5	412376.4	271.9	6.7	265.2	9
MS-10	4756003.9	412478.7	274.3	6.7	267.6	9
CN-01	4755604.9	411337.9	276.3	17.4	258.9	14
S-01	4755297.0	410709.4	265.3	8.2	257.1	11
PM-01	4755685.0	411524.8	275.9	18.9	257.0	15
PM-04	4755725.493	411619.625	274.5	18.9	255.6	15
PM-06	4755752.6	411593.6	269.2	15.1	254.1	13
MC-02	4755445.6	410923.5	265.8	15.9	249.9	18
MC-03	4755424.6	410923.4	265.8	15.8	250.4	17
EL-01	4755922.9	412218.5	270.7	15.9	254.9	18
EL-03	4755943.4	412281.8	271.0	15.9	255.1	18
HL-01	4755334.5	410763.9	265.3	12.8	252.5	14



DRAFT FOUNDATION INVESTIGATION AND DESIGN REPORT – REPLACEMENT OF MEDIAN SEWER AND NEW STORMWATER MANAGEMENT FACILITY - HIGHWAY 401 REHABILITATION FROM WELLINGTON ROAD TO Highbury Avenue, Design-Build Project

Subsurface Conditions
November 17, 2022

Investigation Borehole	MTM Zone 10 Coordinates		Ground Surface Elevation (m)	Total Depth Drilled or Advanced (m)	End of Borehole Elevation (m)	Number of Soil Samples
	Northing	Easting				
HL-02	4755506.6	411105.8	270.6	15.7	254.9	16
HL-03	4755582.3	411284.4	275.5	12.8	262.7	13
HL-04	4755655.1	411453.8	276.5	12.8	263.7	14
HL-05	4755736.9	411647.7	273.8	12.8	261.0	14
HL-06	4755799.7	411815.8	271.2	12.7	258.5	14
HL-07	4755855.6	411997.2	270.3	12.8	257.5	14
HL-08	4755911.1	412177.1	270.7	12.8	257.9	14
HF-13	4755549.2	411322.8	266.5	12.0	254.5	11
HF-17	4755621.5	411491.8	268.5	15.1	253.4	13

4.3 LABORATORY TESTING

All samples were taken to Stantec's Markham laboratory 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.

Table 4.2: Laboratory Testing Program

Laboratory Test Type	Number of Tests
Moisture Content	392
Gradation Analysis	92
Atterberg Limits	66
Chemical Analysis	12

Nine soil samples were forwarded to AGAT Laboratories. The samples were tested for pH, soluble sulphate content, chloride content, electrical conductivity, resistivity, and redox potential.

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

5.0 SUBSURFACE CONDITIONS

5.1 FRAMEWORK & OVERVIEW

The detailed soil and groundwater conditions encountered in the boreholes and the results of the in-situ and laboratory testing are shown on the Borehole Records included in Appendix 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 C1 to C9 contained in Appendix D.



DRAFT FOUNDATION INVESTIGATION AND DESIGN REPORT – REPLACEMENT OF MEDIAN SEWER AND NEW STORMWATER MANAGEMENT FACILITY - HIGHWAY 401 REHABILITATION FROM WELLINGTON ROAD TO Highbury Avenue, Design-Build Project

Subsurface Conditions

November 17, 2022

A borehole location plan is provided on Drawing Nos. 1 to 4 in Appendix A.

The stratigraphic boundaries on the borehole records and the strata plot are inferred from non-continuous sampling and therefore represent transitions between soil types rather than exact boundaries between geological units. The subsurface conditions will vary between and beyond the borehole locations.

In general, the subsurface stratigraphy encountered in the boreholes consisted of:

- Ground surface cover (asphalt and pavement structure/grass and topsoil); underlain by,
- Fill comprised of sand and gravel/silty sand with gravel/silty sand/silty clayey sand and clayey silt to silty clay to the depths of approximately 1.5 m to 8.7 m below grade; underlain by,
- Upper clayey silt to silty clay; underlain by,
- Upper silt to sandy silt to silt with sand to silty sand, underlain by,
- Lower clayey silt to silty clay; underlain by,
- Lower silt to sandy silt to silt with sand to silty sand

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

5.2 OVERBURDEN

5.2.1 Pavement

Asphalt was encountered at all boreholes advanced from the highway level. The thickness of the asphalt ranged from approximately 120 mm to 480 mm.

The asphalt was underlain by a pavement granular fill layer in most boreholes, comprising the base and/or the subbase materials. The thickness of the granular fill ranged from approximately 100 mm to 600 mm (average 300 mm). A buried topsoil was also encountered in borehole CN-01 under the base and subbase components of the pavement structure.

N-values of 29 to 71 were obtained from the SPTs advanced in the granular fill layer, indicating a compact to very dense condition.

Laboratory tests conducted on samples of the granular fill associated with the pavement structure yielded natural moisture contents ranging from approximately 2% to 3%.

5.2.2 Topsoil

Surficial vegetation underlain by topsoil was encountered at ground surface in the three boreholes drilled at the existing embankment toe area (BH PM-06, HF-13 and HF-17). A layer of buried topsoil was also encountered below the pavement structure in borehole CN-01. The thickness of the topsoil ranged from approximately 100 mm to 250 mm.



DRAFT FOUNDATION INVESTIGATION AND DESIGN REPORT – REPLACEMENT OF MEDIAN SEWER AND NEW STORMWATER MANAGEMENT FACILITY - HIGHWAY 401 REHABILITATION FROM WELLINGTON ROAD TO Highbury Avenue, Design-Build Project

Subsurface Conditions

November 17, 2022

5.2.3 Fill

Fill materials were encountered below the pavement structure or topsoil in all boreholes. The fill generally comprised of granular fill materials (sand and gravel/sand/silty sand with gravel/silty sand/silty clayey sand) underlain by cohesive fill materials (clayey silt to sandy silty clay to silty clay with sand to clay).

Further details on these fill materials are provided below:

5.2.3.1 Cohesionless Fill

Cohesionless fill materials encountered below the pavement structure was mostly comprised of variable cohesionless soils ranging from sand and gravel/silty sand with gravel/silty sand to silty clayey sand. Construction debris were also noted in the samples obtained from the cohesionless fill. A clayey silt seam and rock fragments were noted in the cohesionless fill in Borehole HL-03.

The cohesionless fill layer was approximately 0.2 m to 5.2 m thick and extended to depths ranging from approximately 0.8 m to 5.7 m below grade, corresponding to elevations of approximately 273.6 m and 262.8 m.

N-values ranging from 3 to 64 blows per 0.3 m (average of 21 blows per 0.3 m) were obtained from the SPTs advanced in the cohesionless fill materials, indicating a very loose to very dense condition.

Laboratory tests conducted on samples of the cohesionless fill yielded natural moisture contents ranging from approximately 1% to 22%, averaging 6%.

Gradation analyses were carried out on seven (7) retrieved soil samples from this cohesionless fill layer. The test results are illustrated on the borehole records in Appendix B and on the gradation curves on Figure No. C1 in Appendix C. The tests yielded the following results:

- Gravel: 15 to 34%
- Sand: 36 to 68%
- Silt: 11 to 31 %
- Clay: 3 to 15%

Based on the results of the laboratory tests, the sample obtained from the cohesionless fill can be generally classified as silty sand with gravel and silty clayey sand with gravel, with a group symbol of SM and SC-SM, respectively; based on the Unified Soil Classification System (USCS).

5.2.3.2 Cohesive Fill

Cohesive fill materials consisted of brown to grey clayey silt/ clayey silt with sand to silty clay/silty clay with sand were encountered in most boreholes below the cohesionless fills (except for boreholes HL-01, HL-06, HL-08, MS-06, MS-07 and PM-06). Samples obtained from the cohesive fill layer contained trace to some sand and gravel, and trace rootlets, organics and construction debris at variable depths.



DRAFT FOUNDATION INVESTIGATION AND DESIGN REPORT – REPLACEMENT OF MEDIAN SEWER AND NEW STORMWATER MANAGEMENT FACILITY - HIGHWAY 401 REHABILITATION FROM WELLINGTON ROAD TO Highbury Avenue, Design-Build Project

Subsurface Conditions

November 17, 2022

Borehole MS-05 was terminated at a depth of 5.2 m below ground surface (elevation 267.7 m) within this fill.

The cohesive fill layer was approximately 0.7 m to 8.0 m thick and extended to depths ranging from approximately 1.5 m to 8.7 m below grade, corresponding to elevations of approximately 270.5 m to 262.1 m.

N-values ranging from 2 to 38 blows per 0.3 m (average of 15 blows per 0.3 m) were obtained from the SPTs advanced in the cohesive fill materials, indicating soft to hard condition.

A single field shear vane test was attempted in the cohesive fill immediately below the SPT N-value of 8 blows per 0.3 m sample in Borehole HL-03, but the vane could not be turned which indicating undrained shear strength greater than 100 kPa.

Laboratory tests conducted on samples of the cohesionless fill yielded natural moisture contents ranging from approximately 9% to 30%, averaging 16%.

Gradation analyses were carried out on 18 samples of the cohesive fill materials obtained from the boreholes. The test results are illustrated on the borehole records in Appendix B and on the gradation curve on Figure No. C2 in Appendix C. The tests yielded the following results:

- Gravel: 0 to 10%
- Sand: 5 to 36%
- Silt: 31 to 45 %
- Clay: 29 to 55%

Atterberg Limits tests were conducted on all the samples referenced above. The tests yielded Liquid Limits of 23% to 44%, Plastic Limits of 11% to 21%, corresponding to Plasticity Indices of 9% to 24%. The test results are illustrated on the borehole records in Appendix B and on the chart on Figure No. C3 in Appendix C.

Based on the results of the laboratory tests, the samples tested can be classified as clayey silt to silty clay with group symbols of CL to CI based on the Unified Soil Classification System (USCS).

5.2.4 Upper Clayey Silt to Silty Clay to Clay

A stratum of brown to grey clayey silt to silty clay to clay was encountered underlying the fill materials in most boreholes (except for boreholes MS-05, HL-08, EI-01, EL-03, MS-09 and MS-10). Samples obtained from the clayey silt to silty clay to clay stratum typically contained trace sand and gravel. Silt partings were also noted in the samples obtained from this stratum.

Twelve (12) of the boreholes were terminated in this stratum. Where fully penetrated, the clayey silt to silty clay to clay stratum was approximately 1.5 m to 11.7 m thick and extended to the depths of approximately 4.0 m to 15.4 m below grade, corresponding to elevations of approximately 267.3 m to 250.4 m.



DRAFT FOUNDATION INVESTIGATION AND DESIGN REPORT – REPLACEMENT OF MEDIAN SEWER AND NEW STORMWATER MANAGEMENT FACILITY - HIGHWAY 401 REHABILITATION FROM WELLINGTON ROAD TO Highbury Avenue, Design-Build Project

Subsurface Conditions

November 17, 2022

N-values ranging from 5 to 86 blows per 0.3 m (average of 26 blows per 0.3 m) were obtained from the SPTs advanced in the clayey silt to silty clay to clay stratum, indicating a firm to hard condition.

Laboratory tests conducted on samples of the clayey silt layer yielded natural moisture contents ranging from approximately 9% to 25%, averaging 16%.

Gradation analyses were carried out on selected samples of the clayey silt to silty clay to clay soils. The test results are illustrated on the borehole records in Appendix B and on the gradation curves on Figure No. C4 in Appendix C. The tests yielded the following results:

- Gravel: 0 to 6%
- Sand: 0 to 28%
- Silt: 32 to 74 %
- Clay: 19 to 66%

Atterberg Limits tests were conducted on the samples referenced above. The tests yielded Liquid Limits of 18% to 44%, Plastic Limits of 12% to 21%, and Plasticity Indices of 4% to 23%. The test results are illustrated on the borehole records in Appendix B and on the chart on Figure No. C5 in Appendix C.

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

5.2.5 Upper Silt

A layer of brown to grey silt was encountered underlying the fill materials (boreholes HF-13, HL-08, EL-01, EL-03, MS-09 and MS-10) or the native cohesive soils described in the preceding sections (boreholes MC-02, CN-01, PM-04, PM-06, HL-05, HL-06, MS-07, HL-07 and MS-08). Samples obtained from this layer typically contained trace clay; a sample retrieved from borehole HL-05 was found to be more likely sandy silt. Slightly cohesive silt zones were locally noted within this deposit.

Thirteen (13) of the boreholes were terminated in this layer, after penetrating it approximately 1.1 m to 10.6 m. The layer was fully penetrated in boreholes EL-01, EL-03, MC-02, PM-04 and PM-06, where it was approximately 2.8 m to 11.1 m thick, and extended to depths ranging from 10.3 m to 18.1 m below grade, corresponding to elevations ranging from 260.1 m to 255.5 m.

N-values ranging from 0 to 83 blows per 0.3 m (average of 34 blows per 0.3 m) were obtained from the SPTs advanced in the silt layer. A very loose silt layer, approximately 2 m thick, was observed in borehole PM-04 at a depth below grade of 15.5 m.

Laboratory tests conducted on samples of the silty sand stratum yielded natural moisture contents ranging from approximately 13% to 25%, averaging 18%.



DRAFT FOUNDATION INVESTIGATION AND DESIGN REPORT – REPLACEMENT OF MEDIAN SEWER AND NEW STORMWATER MANAGEMENT FACILITY - HIGHWAY 401 REHABILITATION FROM WELLINGTON ROAD TO Highbury Avenue, Design-Build Project

Subsurface Conditions

November 17, 2022

Gradation analyses were carried out on representative samples of the cohesionless layer. The test results are illustrated on the borehole records in Appendix B and on the gradation curves on Figure No. C6 in Appendix C. The tests yielded the following results:

- Gravel: 0 %
- Sand: 0 to 53%
- Silt: 42 to 89 %
- Clay: 4 to 22%

Six (6) Atterberg Limit tests were also carried out to confirm that representative soil samples retrieved from this deposit are non-plastic.

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

5.2.6 Lower Clayey Silt to Silty Clay

A stratum of grey clayey silt to silty clay was encountered underlying the silt in boreholes EL-01, MC-02, M-04 and PM-06.

Three (3) of the boreholes terminated in this stratum after 0.3 m to 5.3 m penetration into the lower clayey silt to silty clay deposit. Where fully penetrated (borehole EL-01), the clayey silt to silty clay was approximately 2.5 m thick and extended to a depth 13.2 m below grade, corresponding to an elevation of 257.6 m.

N-values ranging from 11 to 39 blows per 0.3 m (average – 20 blows per 0.3 m) were obtained from the SPTs advanced in the lower clayey silt to silty clay stratum, indicating a firm to hard condition.

Laboratory tests conducted on samples of the clayey silt layer yielded natural moisture contents ranging from approximately 17% to 22%, averaging 19%.

Gradation analyses were carried out on selected samples of the clayey silt to silty clay to clay soils. The test results are illustrated on the borehole records in Appendix B and on the gradation curves on Figure No. C7 in Appendix C. The tests yielded the following results:

- Gravel: 0 %
- Sand: 0 to 2%
- Silt: 41 to 68 %
- Clay: 30 to 58 %

Atterberg Limits tests were conducted on the samples referenced above. The tests yielded Liquid Limits of 19% to 33%, Plastic Limits of 12% to 13%, and Plasticity Indices of 6% to 20%. The test results are illustrated on the borehole records in Appendix B and on the chart on Figure No. C8 in Appendix C.

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



DRAFT FOUNDATION INVESTIGATION AND DESIGN REPORT – REPLACEMENT OF MEDIAN SEWER AND NEW STORMWATER MANAGEMENT FACILITY - HIGHWAY 401 REHABILITATION FROM WELLINGTON ROAD TO Highbury Avenue, Design-Build Project

Subsurface Conditions

November 17, 2022

5.2.7 Lower Silty Sand to Silt

A layer of grey silt to silty sand was encountered underlying the clayey silt to silty clay deposit in boreholes MC-03 and EL-01, and below Silt in borehole EL-03. Three boreholes penetrated 0.4 to 2.6 m into the lower silty sand to silt deposit and terminated at depths ranging from 15.8 m to 15.9 m below ground surface (corresponding elevations from 255.1 m to 250.0 m).

N-values ranging from 12 to more than 100 blows per 0.3 m were obtained from the SPTs advanced in the silty sand to silt layer, indicating a compact to very dense condition.

Laboratory tests conducted on samples of the silty sand to silt stratum yielded natural moisture contents ranging from approximately 14% to 23%.

Gradation analyses were carried out on representative samples of the cohesionless layer. The test results are illustrated on the borehole records in Appendix B and on the gradation curves on Figure No. C9 in Appendix C. The tests yielded the following results:

- Gravel: 0 %
- Sand: 23 to 85%
- Silt: 12 to 57 %
- Clay: 3 to 20%

Based on the results of the laboratory tests, the samples tested can be classified as silt and silty sand with group symbols of ML and SM 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

Groundwater conditions were observed during drilling operations and upon drilling completion in open boreholes. Cave-in depths were also recorded. A monitoring well was installed in Borehole HF-13 to monitor the long-term stabilized groundwater level. The groundwater levels recorded in the monitoring well and 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	
MS-01	Upon Completion		Dry	Borehole Open
MS-03	Upon Completion		Dry	Borehole Open
MS-04	Upon Completion		Dry	Borehole Open
MS-05	Upon Completion		Dry	Cave-in at 4.1 m
MS-06	Upon Completion		Dry	Borehole Open
MS-08	Upon Completion	4.3	266.0	Borehole Open



DRAFT FOUNDATION INVESTIGATION AND DESIGN REPORT – REPLACEMENT OF MEDIAN SEWER AND NEW STORMWATER MANAGEMENT FACILITY - HIGHWAY 401 REHABILITATION FROM WELLINGTON ROAD TO Highbury Avenue, Design-Build Project

Subsurface Conditions

November 17, 2022

Borehole No	Date	Groundwater Level (m)		Remark
		Depth	Elevation	
MS-09	Upon Completion	3.8	268.1	Cave-in at 4.3 m
MS-10	Upon Completion	4.9	269.4	Cave-in at 5.8 m
CN-01	Upon Completion	13.7	262.6	Cave-in at 14.9 m
S-01	Upon Completion	Dry		Borehole Open
PM-01	Upon Completion	10.9	265.0	Cave-in at 18.0 m
PM-04	Upon Completion	9.1	265.4	Cave-in at 13.4 m
PM-06	Sept 12, 2022	2.8	266.4	Monitoring Well
MC-02	Upon Completion	4.0	262.6	Cave-in at 13.7 m
MC-03	Upon Completion	3.0	262.8	Caved in at 5.2 m
EL-01	Sept 12, 2022	4.0	266.7	Based on MW EL-04 near by
EL-03	Sept 12, 2022	4.0	266.7	Based on MW EL-04 nearby
HL-01	Upon Completion	11.3	254.0	Cave-in at 11.9 m
HL-02	Upon Completion	Dry		Cave-in at 6.7 m
HL-03	Upon Completion	12.5	263.0	Borehole Open
HL-04	Upon Completion	Dry		Cave-in at 10.7 m
HL-05	Upon Completion	9.9	263.9	Cave-in at 10.7 m
HL-06	Upon Completion	5.8	265.4	Cave-in at 6.1 m
HL-07	Upon Completion	7.0	263.3	Cave-in at 7.6 m
HL-08	Upon Completion	6.6	264.1	Cave-in at 6.6 m
HF-13	Sept 12, 2022	2.1	264.4	Monitoring Well
HF-17	Upon Completion	Dry		Cave-in at 9.2 m

Fluctuations in the groundwater level due to seasonal variations or in response to a particular precipitation event should be anticipated.

5.5 CHEMICAL ANALYSIS

Nine (9) soil samples were forwarded to AGAT Laboratories to be tested for pH, soluble sulphate content, chloride content, electrical conductivity, resistivity, and redox potential. The results are provided in below table.

Table 5.2: Results of Chemical Analysis

Borehole No	Sample No.	Depth (m)	pH	Chloride (µg/g)	Sulphate (µg/g)	Resistivity (Ohm-cm)
HL-01	SS4	2.3 – 2.9	8.18	460	36	1090
HL-02	SS4	2.3 – 2.9	7.84	253	28	1760
HL-03	SS5	3.1 – 3.7	7.72	304	19	1590
HL-04	SS3	1.5 – 2.1	8.47	985	61	500
HL-05	SS7	4.6 – 5.2	7.85	337	28	1450



DRAFT FOUNDATION INVESTIGATION AND DESIGN REPORT – REPLACEMENT OF MEDIAN SEWER AND NEW STORMWATER MANAGEMENT FACILITY - HIGHWAY 401 REHABILITATION FROM WELLINGTON ROAD TO Highbury Avenue, Design-Build Project

November 17, 2022

Borehole No	Sample No.	Depth (m)	pH	Chloride (µg/g)	Sulphate (µg/g)	Resistivity (Ohm-cm)
HL-06	SS9	6.1 – 6.7	7.95	423	142	1090
HL-07	SS3	1.5 – 2.1	8.50	1650	83	292
HL-08	SS5	3.1 – 3.7	9.68	702	28	735
MS-01	SS4	2.3 – 2.9	7.45	296	29	1460
S-01	SS5	3 - 3.6	7.30	438	27	1140
MC-01	SS8	5.3 – 5.9	6.68	470	97	1090
EL-02	SS6	3.8 – 4.4	7.38	1290	155	376

6.0 MISCELLANEOUS

The field work was carried out under the supervision of Akshat Shukla, EIT, Wuhib Tamrat, EIT, Binoy Debnath, EIT, and Justin Moleta, 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 DBW Drilling based in North York, Ontario and Landshark Drilling based in Brantford, Ontario.

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

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

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



DRAFT FOUNDATION INVESTIGATION AND DESIGN REPORT – REPLACEMENT OF MEDIAN SEWER AND NEW STORMWATER MANAGEMENT FACILITY - HIGHWAY 401 REHABILITATION FROM WELLINGTON ROAD TO Highbury Avenue, Design-Build Project

Closure

November 17, 2022

7.0 CLOSURE

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

Respectfully Submitted,

STANTEC CONSULTING LTD.

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DRAFT FOUNDATION INVESTIGATION AND DESIGN REPORT – REPLACEMENT OF MEDIAN SEWER AND NEW STORMWATER MANAGEMENT FACILITY - HIGHWAY 401 REHABILITATION FROM WELLINGTON ROAD TO Highbury Avenue, Design-Build Project

Discussions and Engineering Recommendations
November 17, 2022

DRAFT FOUNDATION INVESTIGATION AND DESIGN REPORT

For

G.W.P. 3032-11-00

DB Contract Number 2022-3004

Replacement of Median Sewer and New Stormwater Management Facility
Highway 401 Rehabilitation from Wellington Road to Highbury Avenue, Design-Build Project
West Region
City of London, Ontario

8.0 DISCUSSIONS AND ENGINEERING RECOMMENDATIONS

8.1 PROJECT OVERVIEW

8.1.1 Scope of Report

This section provides foundation design recommendations for the proposed replacement of the median sewer and new stormwater management facility at the site referenced above. The recommendations are based on interpretation of the factual data obtained from the subsurface investigation and the results of the laboratory testing program completed on samples obtained from the subsurface investigation. The discussion and input presented herein is intended to provide the designers with sufficient information to complete the design of the foundations for the median sewer replacement and the new stormwater management facility.

8.1.2 Project Description

CRH Canada Group Inc. (CRH) is constructing the Highway 401 five structure replacement, Highbury Avenue Interchange improvement and Highway 401 pavement rehabilitation and reconstruction in the City of London, Ontario, for the Ministry of Transportation (MTO) under a Design-Build (DB) agreement. Stantec Consulting Ltd. (Stantec) was retained by CRH to undertake the additional foundation investigation and detailed foundations design for the project.

The project extends along Highway 401 from 675 m east of Wellington Road easterly 5.5 km to 630 m west of Old Victoria Road, along Pond Mill extending from 60 m north to 60 m south of Highway 401, and along Highbury Avenue, from Bradley Avenue to Wilton Grove Road.

This foundation investigation and design report has been prepared specifically for the proposed median sewer replacement and new stormwater management facility. Other project foundations engineering components are reported under separate covers.



DRAFT FOUNDATION INVESTIGATION AND DESIGN REPORT – REPLACEMENT OF MEDIAN SEWER AND NEW STORMWATER MANAGEMENT FACILITY - HIGHWAY 401 REHABILITATION FROM WELLINGTON ROAD TO Highbury Avenue, DESIGN-BUILD PROJECT

Discussions and Engineering Recommendations

November 17, 2022

8.1.3 Proposed Median Sewer Replacement and New Stormwater Management Facility Details

It is our understanding that the existing median sewer between Wellington Road to Highbury Avenue within the Highway 401 grade raise limit is proposed to be replaced as part of the design build highway improvement. The new stormwater management facility will be constructed in between the CNR overhead and Pond Mills Road structures on the south side of the highway, to temporarily retain stormwater. These will be designed to meet the requirements of the MTO Drainage Design Standards and Drainage Management Manual.

Based on the proposed median sewer drawing provided by the Stantec Transportation Team, the proposed 375 mm to 675 mm diameter median sewer, and 1200 to 1500 mm diameter catch basins will be installed at or below the minimum frost depth of 1.2 m below the proposed highway grade between Station 24+300 and 26+130. Median sewer will be discharged the storm water via structural and non-structural culverts crossing Highway 401 except for two locations between CNR Overhead and Pond Mills Road Overpass where the water will be discharged directly to the storm water management facility. It is our understanding that median sewer, catch basin, and possible outlet pipes will be installed using open cut construction.

As per the stormwater management facility drawing provided by Stantec Water Resources Team, the new stormwater management facility will be constructed between the CNR Overhead and Pond Mills Road structures, on the south side of highway. The proposed stormwater management facility will a flat bottom ditch, less than a metre deep, located at the proposed embankment side slope toe area, with proposed ditch side slopes of 3H:1V. It is also our understanding that the main purpose of this stormwater facility is temporary stormwater detention, and that no foundation input such as liner requirements or inlet and outlet structure foundation design parameters are required

8.2 GENERAL DESIGN AND CONSTRUCTION CONSIDERATIONS

General design & construction considerations for the proposed median sewer replacement and stormwater management facility are provided below.

8.2.1 Median Sewer

8.2.1.1 Excavation and Groundwater Control (Unwatering)

According to the median sewer plan and profile drawings (see Appendix D), the proposed median sewer and catch basins will be installed about 2 to 3 m depth below the proposed highway grade. A 0.5 m to 1.5 m grade raise is proposed from Station 24+800 to Station 26+000, and the actual excavation depths below the existing highway grade is anticipated to be less than 2.0 m for almost the entire length of the sewer. Temporary excavation in highway embankment and grading fill materials and native overburden may be carried out using conventional open cut procedure with trenches having nominal side slopes conforming to the latest version of the provincial Occupational Health and Safety Act (OHSA) if enough



DRAFT FOUNDATION INVESTIGATION AND DESIGN REPORT – REPLACEMENT OF MEDIAN SEWER AND NEW STORMWATER MANAGEMENT FACILITY - HIGHWAY 401 REHABILITATION FROM WELLINGTON ROAD TO Highbury Avenue, Design-Build Project

Discussions and Engineering Recommendations
November 17, 2022

workspace is available and traffic offset from excavation during construction can be maintained. Excavation should be undertaken in accordance with OPSS.PROV 401.

Due to the anticipated space limitation, consideration can be given to the use of a temporary protection system. Based on the subsurface condition, soldier pile and lagging, interlocking steel sheet piles, or a slide rail support system may be suitable with additional reinforcements such as tiebacks, rakers and internal bracing as necessary. Possible cobbles and boulders and other obstruction with embankment and grading fills should be considered for those support systems. An interlocking sheet pile system has an advantage with respect to controlling possible high groundwater and perched water conditions, however, most of the excavation depth will be within the embankment fill and significant groundwater issues would not be anticipated.

All temporary support system should be designed and construction in accordance with DB SP 539 (amendment to OPSS.PROV 539) and a performance level 2 should be considered for this application. Below foundation design parameters can be considered for a temporary support system design.

Table 8.1: Recommended Static Earth Pressure Parameters (horizontal ground surface)

Parameter	Existing Fill (Highway Embankment)	Clayey Silt to Silty Clay to Clay	Silt/Sandy Silt/Silty Sand
Bulk Unit Weight, γ (kN/m ³)	21.0	20.0	20.5
Effective Friction Angle, Φ (°)	30	30	30
Coefficient of Earth Pressure at Rest, K_o	0.50	0.50	0.50
Coefficient of Active Earth Pressure, K_a	0.33	0.33	0.33
Coefficient of Passive Earth Pressure, K_p	3.00	3.00	3.00

Note: The submerged unit weight of the soil should be assumed below the groundwater table. The temporary support system should be designed to resist the hydrostatic pressure in addition to the earth pressure in case of using a watertight shoring system.

8.2.1.2 Bedding and Backfill

Sewer pipe bedding and backfill should be compatible with the type and class of pipe, subsurface and anticipated loading conditions, and should be designed and constructed as per OPSS.PROV 401 and OPSD 802 series or suitable equivalent. A minimum bedding thickness 200 mm below the pipe invert should be considered and overall bedding thickness should be decided depending on the bedding type. Clear stone should not be used as bedding material in order to eliminate migration of fine material into the open voids of the stone, which will result in subsequent loss of ground resulting in surface settlement of the highway. In case clear stone is used, it should be surrounded by suitable geotextile to prevent migration of fine material from the subgrade and wall of the trench. The placement of bedding and cover materials shall be in accordance with OPSS.PROV 401 and OPSD 802 series. Consideration may be also given to the use of trench plug due to the proposed median sewer configuration.



DRAFT FOUNDATION INVESTIGATION AND DESIGN REPORT – REPLACEMENT OF MEDIAN SEWER AND NEW STORMWATER MANAGEMENT FACILITY - HIGHWAY 401 REHABILITATION FROM WELLINGTON ROAD TO Highbury Avenue, Design-Build Project

Discussions and Engineering Recommendations
November 17, 2022

Any loose, soft or unsuitable materials observed at the founding level of the median sewer pipes should be sub-excavated and replaced with Granular A or Granular B Type II, and compacted in accordance with OPSS.PROV 501.

All trench backfill should be placed in accordance with OPSS.PROV 401 and 501 to at least 95% of its maximum dry density, and at least top 1 m of trench backfill under highway and highway shoulder should be compacted to 98% of backfill material's SPMDD. Backfilling operation during winter should avoid inclusions of frozen materials, snow and ice. Self-settlement of the compacted trench backfill using OPSS 1010 granular material with proper compaction should be minimal, and majority of such settlement should take place within three months following the backfill completion. If the asphalt binder course is placed shortly after the completion of trench backfilling, any settlement that may be reflected by subsidence of the surface of the binder asphalt should be compensated for by placing an additional thickness of binder asphalt or by padding.

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

The excavated embankment and grading fills may be reused as non-structural backfill provided they are free of frozen, topsoil, organics and other deleterious materials, are at suitable water contents for placement and compaction.

8.2.2 Stormwater Management Facility

As per the discussion with Stantec Water Resources Team, no specific foundation design input is required for the proposed stormwater management facility. There are no liner and inlet/outlet structure foundation requirements. The proposed embankment side slopes (2H:1V) are assessed and the factor of safety against global instability higher than 1.3 is obtained. The proposed stormwater management facility, which is shallower than 1 m depth flat base ditch with 3H:1V side slopes, will not have any adverse impacts on the overall highway embankment slope global stability.

Based on the cross sections provided (see Appendix D), the proposed ditch base level about elev. 268 m about 2 m higher than the highest groundwater table measured in the monitoring wells installed in boreholes HF-13 and PM-06.

8.2.3 Groundwater and Surface Water Control

Based on the provided median sewer profile and stormwater management facility sections, no significant groundwater issues are anticipated for the median sewer replacement and stormwater management facility construction. Although it is very unlikely, dewatering will be required if deeper excavation below the prevailing groundwater level is anticipated. Ultimately, 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.



DRAFT FOUNDATION INVESTIGATION AND DESIGN REPORT – REPLACEMENT OF MEDIAN SEWER AND NEW STORMWATER MANAGEMENT FACILITY - HIGHWAY 401 REHABILITATION FROM WELLINGTON ROAD TO Highbury Avenue, Design-Build Project

Discussions and Engineering Recommendations

November 17, 2022

Surface water and perched groundwater within the granular fills should be properly controlled during the construction to maintain the dry excavation condition for the proposed median sewer replacement.

8.3 CEMENT TYPE AND CORROSION PROTECTION

The results of the analytical tests on nine (9) samples of the native soils are presented in Section 5.5 and Appendix D.

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

- Water-soluble sulphate (SO_4) content of the adjacent soil is equal to or greater than 0.10%; or,
- Sulphate (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 as required by Special Provision CONC0006. Based on the test results, concrete will not be subject to sulphate attack for the proposed median sewer replacement (water soluble sulphate in soil samples <0.10% which is equivalent to 1000 $\mu\text{g/g}$).

In addition, the analytical test results were compared to CSA A23.1 Table 3 Additional requirements for concrete subject to sulphate attack on concrete. The sulphate concentrations measured in the tested samples are below the exposure class of S-3 (Moderate). Therefore, based on the samples tested, when the designer is selecting the exposure class for the structure, the effects of sulphates may not need to be considered.

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 8.2.

Table 8.2: Results of Corrosion Potential Assessment

Borehole No	Sample No.	Depth (m)	Corrosion Potential	pH
HL-01	SS4	2.3 – 2.9	Aggressive	8.18
HL-02	SS4	2.3 – 2.9	Aggressive	7.84
HL-03	SS5	3.1 – 3.7	Aggressive	7.72
HL-04	SS3	1.5 – 2.1	Aggressive	8.47
HL-05	SS7	4.6 – 5.2	Aggressive	7.85
HL-06	SS9	6.1 – 6.7	Aggressive	7.95
HL-07	SS3	1.5 – 2.1	Aggressive	8.50
HL-08	SS5	3.1 – 3.7	Aggressive	9.68
MS-01	SS4	2.3 – 2.9	Aggressive	7.45
S-01	SS5	3-3.6	Aggressive	7.30
MC-01	SS8	5.3 – 5.9	Aggressive	6.68



DRAFT FOUNDATION INVESTIGATION AND DESIGN REPORT – REPLACEMENT OF MEDIAN SEWER AND NEW STORMWATER MANAGEMENT FACILITY - HIGHWAY 401 REHABILITATION FROM WELLINGTON ROAD TO Highbury Avenue, Design-Build Project

November 17, 2022

Borehole No	Sample No.	Depth (m)	Corrosion Potential	pH
EL-02	SS6	3.8 – 4.4	Aggressive	7.38

Based on the results of the samples tests consideration should be given by the designer to designing for a “C” type exposure class as defined by CSA A23.1 Table 1.

It should be noted that the final selection of exposure class and corrosion mitigation measures should be a decision of the design engineer who takes into account all design considerations including CSA A23.1 Section 4.1.1 durability requirements.

8.4 INSTRUMENTATION AND MONITORING

Depending on the depth of the temporary shoring system used for installation of the median sewer, an Instrumentation and Monitoring Plan may be required as per DB SP 539.

9.0 SPECIFICATIONS

The following specifications are referenced in this report:

Table 9.1: Specifications Referenced in Report

Document	Title
OPSD 208.010	Benching of Earth Slopes
OPSD 803.010	Backfill and Cover for Concrete Culverts
OPSD 3090.101	Foundation Frost Depths for Southern Ontario
OPSS.PROV 206	Construction Specification for Grading
OPSS.PROV401	Construction Specification for Trenching, Backfilling and Compacting
OPSS.PROV 501	Construction Specification for Compacting
OPSS.PROV 517	Construction Specification for Dewatering of Pipeline, Utility, and Associated Structure Excavation
OPSS.PROV 539	Construction Specification for Temporary Protection System
OPSS.PROV 902	Construction Specification for Excavation and Backfilling – Structures
OPSS.PROV 1010	Material Specification for Aggregates
OPSS.PROV 1205	Material Specification for Clay Seal
SP517F01	Dewatering System – Item No. Temporary Flow Passage System – Item No.
SP105S10	Construction Specification for Compaction
SP105S21	MTO's Special Provision (Amendment to OPSS 501).
SP 206S03	Earth Excavation, Grading
DB SP 539	Amendment to OPSS.PROV 539



DRAFT FOUNDATION INVESTIGATION AND DESIGN REPORT – REPLACEMENT OF MEDIAN SEWER AND NEW STORMWATER MANAGEMENT FACILITY - HIGHWAY 401 REHABILITATION FROM WELLINGTON ROAD TO Highbury Avenue, Design-Build Project

November 17, 2022

10.0 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.
- Golder Associates. 2015. Preliminary Foundation Investigation and Design Report , Structural Culvert Replacement, Elliot-Laidlaw Drain Culvert, Site Number 19-651/C, Highway 401 Interchange Improvements/ Structural Replacement, GWP 3054-11-00, Assignment No. 1 (3011-E-0046), Ministry of Transportation, Ontario – West Region
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- Stantec. 2022. Draft Foundation Investigation and Design Report – Replacement of Tributary to Murray Drain Culvert – Highway 401 Rehabilitation from Wellington Road to Highbury Avenue, Design Build Project.
- Stantec. 2022. Draft Foundation Investigation and Design Report – Replacement of Elliot Laidlaw Drain Culvert - Highway 401 Rehabilitation from Wellington Road to Highbury Avenue, Design Build Project.
- Stantec. 2022. Draft Foundation Investigation and Design Report – Replacement of CNR Overhead - Highway 401 Rehabilitation from Wellington Road to Highbury Avenue, Design Build Project.
- Stantec. 2022. Draft Foundation Investigation and Design Report – Replacement of Pond Mills Road Overpass - Highway 401 Rehabilitation from Wellington Road to Highbury Avenue, Design Build Project.



DRAFT FOUNDATION INVESTIGATION AND DESIGN REPORT – REPLACEMENT OF MEDIAN SEWER AND NEW STORMWATER MANAGEMENT FACILITY - HIGHWAY 401 REHABILITATION FROM WELLINGTON ROAD TO Highbury Avenue, Design-Build Project

Closure

November 17, 2022

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

Respectfully submitted,

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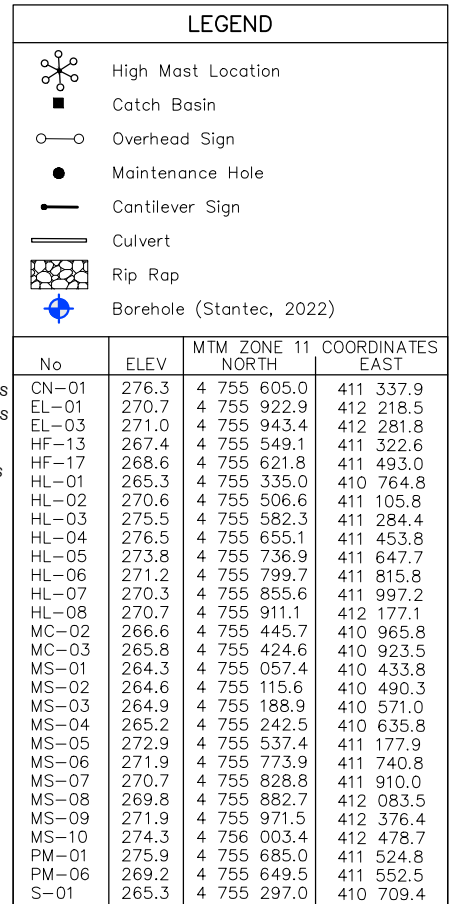
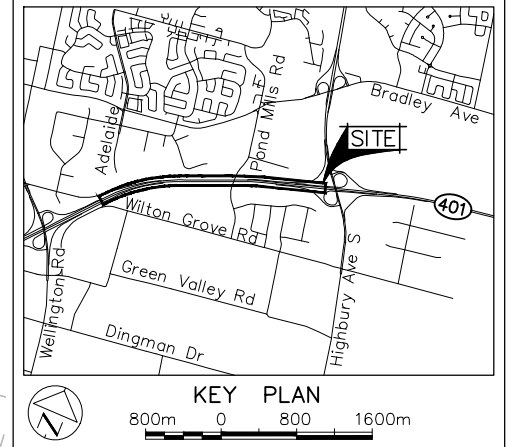
APPENDIX A

A.1 DRAWING NOS. 1 TO 4 – BOREHOLE LOCATION PLAN

DRAFT



PLATE No	
CONT 2022-3004	
WP 3032-11-00	
MEDIAN SEWER & SWMF STA 24+190 TO STA 24+800 BOREHOLE LOCATIONS PLAN	

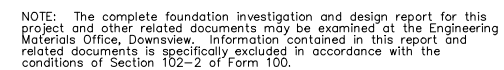
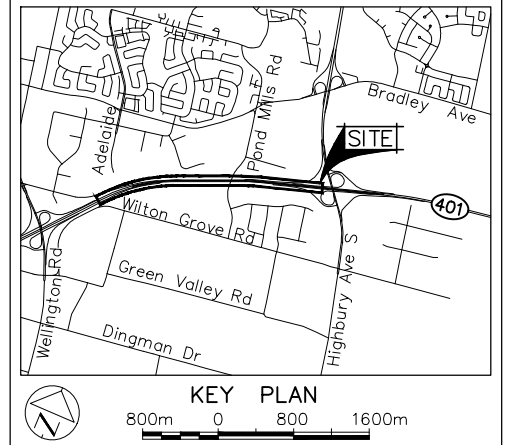


SCALE

20m 0 20 40m

REVISIONS				
	DATE	BY	DESCRIPTION	
GEOCRES No				
HWY No 401			DIST	
SUBM'D GR	CHECKED	DATE 2022-11-08		SITE
DRAWN GBB	CHECKED	APPROVED		DWG 1

PLATE No	
CONT 2022-3004	(
WP 3032-11-00	
MEDIAN SEWER & SWMF STA 24+800 TO STA 25+400 BOREHOLE LOCATIONS PLAN	

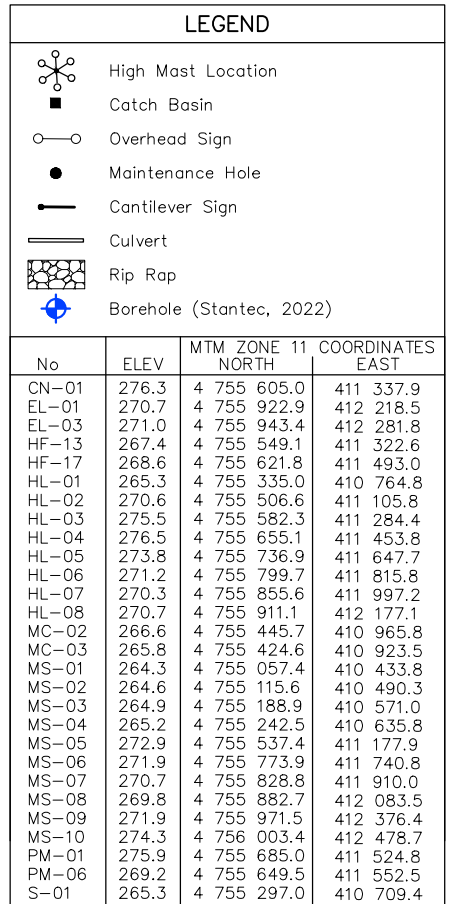
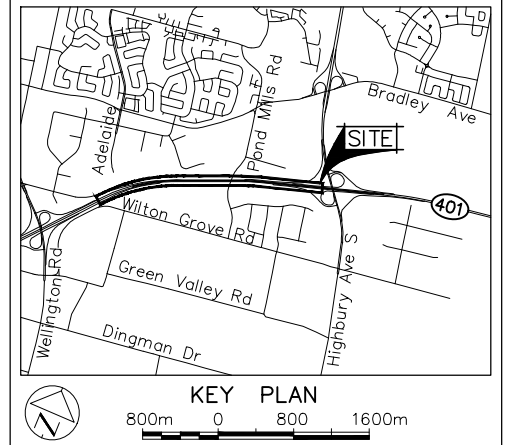


LEGEND			
	High Mast Location		
	Catch Basin		
	Overhead Sign		
	Maintenance Hole		
	Cantilever Sign		
	Culvert		
	Rip Rap		
	Borehole (Stantec, 2022)		

No	ELEV	MTM_ZONE 11		COORDINATES
		NORTH	EAST	
CN-01	276.3	4 755	605.0	411 337.9
EL-01	270.7	4 755	922.9	412 218.5
EL-03	271.0	4 755	943.4	412 281.8
HF-13	267.4	4 755	549.1	411 322.6
HF-17	268.6	4 755	621.8	411 493.0
HL-01	265.3	4 755	335.0	410 764.8
HL-02	270.6	4 755	506.6	411 105.8
HL-03	275.5	4 755	582.3	411 284.4
HL-04	276.5	4 755	655.1	411 453.8
HL-05	273.8	4 755	736.9	411 647.7
HL-06	271.2	4 755	799.7	411 815.8
HL-07	270.3	4 755	855.6	411 997.2
HL-08	270.7	4 755	911.1	412 177.1
MC-02	266.6	4 755	445.7	410 965.8
MC-03	265.8	4 755	424.6	410 923.5
MS-01	264.3	4 755	057.4	410 433.8
MS-02	264.6	4 755	115.6	410 490.3
MS-03	264.9	4 755	188.9	410 571.0
MS-04	265.2	4 755	242.5	410 635.8
MS-05	272.9	4 755	537.4	411 177.9
MS-06	271.9	4 755	773.9	411 740.8
MS-07	270.7	4 755	828.8	411 910.0
MS-08	269.8	4 755	882.7	412 083.5
MS-09	271.9	4 755	971.5	412 376.4
MS-10	274.3	4 756	003.4	412 478.7
PM-01	275.9	4 755	685.0	411 524.8
PM-06	269.2	4 755	649.5	411 552.5
S-01	265.3	4 755	297.0	410 709.4

REVISIONS			
DATE	BY	DESCRIPTION	
GEOCRESS No			
HWY No 401		DIST	
SUBM'D GR	CHECKED	DATE 2022-11-08	SITE
DRAWN GR	CHECKED	APPROVED	DWG 2

PLATE No	
CONT 2022-3004	
WP 3032-11-00	
MEDIAN SEWER & SWMF STA 25+900 TO 26+000	
BOREHOLE LOCATIONS PLAN	



SCALE

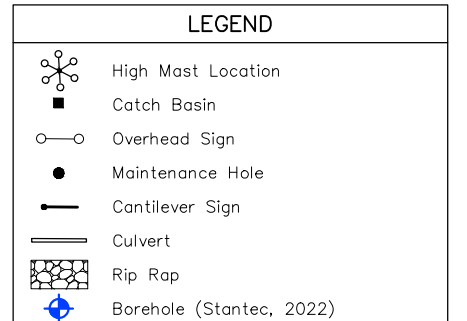
20m 0 20 40m

A horizontal scale bar with tick marks at 20m, 0, 20, and 40m. The bar is divided into four equal segments by these tick marks. The segments between 20m and 0, and between 0 and 20, are shaded grey. The segments between 20 and 40m, and between 40m and the end, are white.

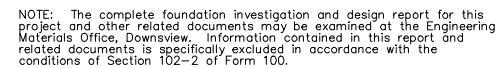
REVIEWS			
	DATE	BY	DESCRIPTION
GEOCRES No			
HWY No 401			DIST
SUBM'D GR	CHECKED	DATE 2022-11-08	SITE
DRAWN GBB	CHECKED	APPROVED	DWG 3

SCALE

20m 0 20 40m



REVISIONS				
	DATE	BY	DESCRIPTION	
GEOCRESS No				
HWY No 401				DIST
SUBM'D GR	CHECKED	DATE 2022-11-08	SITE	
DRAWN GBB	CHECKED	APPROVED	DWG	4



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.

APPENDIX B

B.1 SYMBOLS AND TERMS USED ON BOREHOLE RECORDS

B.2 BOREHOLE RECORDS

DRAFT



SYMBOLS AND TERMS USED ON BOREHOLE AND TEST PIT RECORDS

SOIL DESCRIPTION

Terminology describing common soil genesis:

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

Terminology describing soil structure:

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

Terminology describing soil types:

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

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

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

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

Terminology describing compactness of cohesionless soils:

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

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

Terminology describing consistency of cohesive soils:

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

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

ROCK DESCRIPTION

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

Terminology describing rock quality:

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

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

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

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

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

Terminology describing rock with respect to discontinuity and bedding spacing:

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

Terminology describing rock strength:

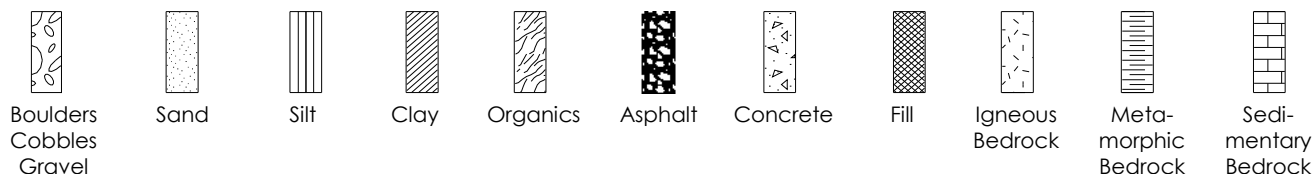
Strength Classification	Grade	Unconfined Compressive Strength (MPa)
Extremely Weak	R0	<1
Very Weak	R1	1 – 5
Weak	R2	5 – 25
Medium Strong	R3	25 – 50
Strong	R4	50 – 100
Very Strong	R5	100 – 250
Extremely Strong	R6	>250

Terminology describing rock weathering:

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

STRATA PLOT

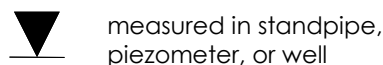
Strata plots symbolize the soil or bedrock description. They are combinations of the following basic symbols. The dimensions within the strata symbols are not indicative of the particle size, layer thickness, etc.



SAMPLE TYPE

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

WATER LEVEL MEASUREMENT



RECOVERY

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

N-VALUE

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

DYNAMIC CONE PENETRATION TEST (DCPT)

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

OTHER TESTS

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

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

RECORD OF BOREHOLE No CN-01

1 OF 2

METRIC

W.P. 3032-11-00 LOCATION CNR Overhead, Highway 401/ Highbury, London, Ontario ORIGINATED BY AS
 DIST West HWY 401 BOREHOLE TYPE Hollow Stem Augers COMPILED BY RR
 DATUM Geodetic DATE 2022.07.07 - 2022.07.07 LATITUDE 42.9327941 LONGITUDE -81.1947423 CHECKED BY GR

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa							WATER CONTENT (%)
								○ UNCONFINED ● QUICK TRIAXIAL	+ FIELD VANE × LAB VANE						
276.3							20 40 60 80 100								
276.0	180 mm ASPHALT														
276.1	230 mm GRAVEL		1	SS	69										
275.8															
276.7	130 mm TOPSOIL with gravel														
0.5	FILL: Silty SAND with Gravel (SM), trace clay. Brown Compact Dry		2	SS	14										
			3	SS	15										
			4	SS	21										
			5	SS	13										
			6	SS	11										
270.6															
5.7	POSSIBLE FILL: SILTY CLAY (CL), some sand, trace gravel. Brown Very Soft Moist		7	SS	2										
269.2															
7.1	SILTY CLAY to CLAY (Cl), some sand, trace gravel Brown Stiff Moist		8	SS	12										
	SS9 contains grey silt partings		9	SS	10										

Continued Next Page

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

ONTARIO MTO 165001239_MTO_HWY_401_HIGHBURY.GPJ ONTARIO MTO.GDT 11/8/22

RECORD OF BOREHOLE No CN-01

2 OF 2

METRIC

W.P. 3032-11-00 LOCATION CNR Overhead, Highway 401/ Highbury, London, Ontario ORIGINATED BY AS
 DIST West HWY 401 BOREHOLE TYPE Hollow Stem Augers COMPILED BY RR
 DATUM Geodetic DATE 2022.07.07 - 2022.07.07 LATITUDE 42.9327941 LONGITUDE -81.1947423 CHECKED BY GR

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT w _p	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)					
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa								WATER CONTENT (%)				
								○ UNCONFINED	+	FIELD VANE						● QUICK TRIAXIAL	×	LAB VANE		
							20	40	60	80	100	20	40	60	GR	SA	SI	CL		
266.0							266													
10.3	SILT (ML) Compact to dense Brown Moist		10	SS	20							○								
							265													
	Grey below 12.2 m		11	SS	38		264					○								
							263													
	Wet below 13.7 m		12	SS	23		262					○								
							261													
			13	SS	42							■					0	0	83	17
							260													
			14	SS	39							○								
258.9							259													
17.4	END OF BOREHOLE																			
	Groundwater and cave-in measured at approximately 13.7 m and 14.9 m below grade, respectively, upon completion of drilling.																			

METRIC

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

RECORD OF BOREHOLE No EL-01

2 OF 2

METRIC

W.P. 3032-11-00 LOCATION Highway 401/ Highbury, London, Ontario ORIGINATED BY JM
 DIST West HWY 401 BOREHOLE TYPE Solid Stem Augers COMPILED BY JM
 DATUM Geodetic DATE 2022.07.15 - 2022.07.15 LATITUDE 42.935532 LONGITUDE -81.1838962 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/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																					
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa			WATER CONTENT (%)					GR	SA	SI	CL																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																	
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RECORD OF BOREHOLE No EL-03

1 OF 2

METRIC

W.P. 3032-11-00 LOCATION Highway 401/ Highbury, London, Ontario ORIGINATED BY JM
DIST West HWY 401 BOREHOLE TYPE Solid Stem Augers COMPILED BY RR
DATUM Geodetic DATE 2022.07.24 - 2022.07.24 LATITUDE 42.9357076 LONGITUDE -81.1831165 CHECKED BY GR

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL			
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa								WATER CONTENT (%)		
								○ UNCONFINED	+	FIELD VANE								
						● QUICK TRIAXIAL	×	LAB VANE										
271.0 0.0	400 mm ASPHALT		1	SS	50/ 75													
270.6 0.4	400 mm GRANULAR FILL																	
270.2 0.8	FILL: CLAYEY SILT with Sand (CL), trace gravel, trace organics and asphalt Brown Firm to stiff Moist		2	SS	14		270											
			3	SS	15		269								4 29 32 35			
			4	SS	4		268											
			5	SS	6													
267.3 3.7	SILT (ML), some clay, trace sand to Silty SAND (SM), trace clay Grey Compact to very dense Wet		6	SS	22		267								0 7 77 16			
			7	SS	44		266											
			8	SS	71		265											
			9	SS	34		264											
			10	SS	49													
			11	SS	38		263								0 53 42 5			
			12	SS	34		262											
			13	SS	31													

Continued Next Page

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

METRIC

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

METRIC

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

ONTARIO MTO 165001239 MTO HWY 401 Highbury.GPJ ONTARIO MTO.GDT 11/8/22

RECORD OF BOREHOLE No HF-13

2 OF 2

METRIC

W.P. 3032-11-00 LOCATION Highway 401/ Highbury, London, Ontario ORIGINATED BY WT
 DIST West HWY 401 BOREHOLE TYPE Solid Stem Augers COMPILED BY RR
 DATUM Geodetic DATE 2022.08.10 - 2022.08.10 LATITUDE 42.9322941 LONGITUDE -81.1949384 CHECKED BY GR

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)			
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa										WATER CONTENT (%)		
								○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE												
							20	40	60	80	100	20	40	60						
	SILT (ML), some clay, trace sand Grey Dense to very dense Moist (continued)		10	SS	43															
			11	SS	66															
254.5																				
12.0	END OF BOREHOLE Cave-in measured at approximately 5.0 m below grade upon completion of drilling. Monitoring well installed in borehole, screened from approximately 5.5 m to 7.0 m below grade. Groundwater level measured in monitoring well at approximately 2.1 m below grade on September 12, 2022.															0 1 77 22 Non-Plastic				

RECORD OF BOREHOLE No HF-17

1 OF 2

METRIC

W.P. 3032-11-00 LOCATION Highway 401/ Highbury, London, Ontario ORIGINATED BY BD
 DIST West HWY 401 BOREHOLE TYPE Hollow Stem Augers COMPILED BY RR
 DATUM Geodetic DATE 2022.08.19 - 2022.08.19 LATITUDE 42.9329213 LONGITUDE -81.1928546 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/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)			
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa							W _p W W _L		
															20 40 60 80 100		
268.5																	
0.0	250 mm TOPSOIL																
268.3																	
0.3	FILL: CLAYEY SILT (CL), trace sand, gravel, rootlets and grass Brown Soft to stiff Moist		1	SS	3		268							PP=3.0			
			2	SS	10									PP=2.5			
267.1							267							PP=max			
1.5	SILTY CLAY to CLAYEY SILT (CL), trace sand Brown Firm to very stiff Moist		3	SS	17												
			4	SS	24		266							PP=4.25			
	Grey below 3 m		5	SS	19		265							0 9 40 51 PP=max			
			6	SS	11		264							PP=2.75			
							263										
			7	SS	6		262							Su > 100 kPa 0 6 52 42 PP=0.5			
							261										
			8	SS	5									Su > 100 kPa PP=0.5			
							260										
			9	SS	13		259							PP=2.5			

Continued Next Page

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

METRIC





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

RECORD OF BOREHOLE No HL-01

1 OF 2

METRIC

W.P. 3032-11-00 LOCATION Highway 401/ Highbury, London, Ontario ORIGINATED BY WT
 DIST West HWY 401 BOREHOLE TYPE Solid Stem Augers COMPILED BY RR
 DATUM Geodetic DATE 2022.07.14 - 2022.07.15 LATITUDE 42.9304397 LONGITUDE -81.2018245 CHECKED BY GR

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa						
								○ UNCONFINED ● QUICK TRIAXIAL	+ FIELD VANE × LAB VANE					
265.3 0.0	280 mm ASPHALT		1	SS	62									
265.0 0.4	150 mm GRANULAR FILL													
	FILL: SAND and GRAVEL (SP/GP) Brown Compact Dry		2	SS	14									
263.5 1.8	CLAYEY SILT (CL-ML to CL), trace sand and gravel. Brown Very stiff to hard Dry to moist		3	SS	23									PP=max
			4	SS	21									2 3 54 41 PP=max
			5	SS	25									PP=4.25
			6	SS	49									PP=4.5
	Grey below 4.2 m		7	SS	39									PP=3.0
			8	SS	27									PP=3.0
			9	SS	83									0 0 68 32 PP=max
			10	SS	56									PP=3.25
			11	SS	28									PP=3.5
			12	SS	22									PP=1.0
255.3														

Continued Next Page

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

RECORD OF BOREHOLE No HL-01

2 OF 2

METRIC

W.P. 3032-11-00 LOCATION Highway 401/ Highbury, London, Ontario ORIGINATED BY WT
 DIST West HWY 401 BOREHOLE TYPE Solid Stem Augers COMPILED BY RR
 DATUM Geodetic DATE 2022.07.14 - 2022.07.15 LATITUDE 42.9304397 LONGITUDE -81.2018245 CHECKED BY GR


SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL		
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa							WATER CONTENT (%)	
								○ UNCONFINED	+ FIELD VANE						W _p W W _L	
							● QUICK TRIAXIAL	× LAB VANE								
							20	40	60	80	100	20	40	60		
10.0	SILTY CLAY (CL) Grey Firm to stiff Moist to wet						255								0 0 38 62 PP=0.5 Su > 100 kPa PP=0.5	
			13	SS	8		254									
							253									
252.5			14	SS	11									○		
12.8	END OF BOREHOLE Groundwater level and cave-in measured at approximately 11.3 m and 11.9 below grade, respectively; in open borehole.															

RECORD OF BOREHOLE No HL-02

1 OF 2

METRIC

W.P. 3032-11-00 LOCATION Highway 401/ Highbury, London, Ontario ORIGINATED BY WT
 DIST West HWY 401 BOREHOLE TYPE Solid Stem Augers COMPILED BY RR
 DATUM Geodetic DATE 2022.07.07 - 2022.07.08 LATITUDE 42.9319408 LONGITUDE -81.1976043 CHECKED BY GR

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL			
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa								WATER CONTENT (%)		
								○ UNCONFINED ● QUICK TRIAXIAL	+ FIELD VANE × LAB VANE									
270.6 0.0 270.4 0.2 270.1 0.6 268.9 1.7 265.3 5.3	230 mm ASPHALT 180 mm GRANULAR FILL FILL: SAND (SP), some gravel Brown Compact Dry FILL: SILTY CLAY with Sand (CL), trace gravel Brown Very stiff Dry CLAYEY SILT (CL-ML to CL), trace sand Brown Very stiff to hard Moist Grey below 9.4 m																	
			1	SS	48													
			2	SS	28		270											
			3	SS	28		269								PP=max			
			4	SS	26		268								4 28 31 38 PP=max			
			5	SS	22		267								PP=max			
			6	SS	23		266								PP=max			
			7	SS	19		265								PP=max			
			8	SS	34		264								PP=0.5			
			9	SS	17		263								0 1 71 28 PP=2.0			
			10	SS	58		262								PP=max			
			11	SS	57		261								PP=2.0			
			12	SS	27										0 0 64 36 PP=3.0			

Continued Next Page

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

2 OF 2

METRIC

ELEV. DEPTH	SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)			
	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	"N" VALUES										
								SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE							

[illegible]

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

RECORD OF BOREHOLE No HL-03

1 OF 2

METRIC

W.P. 3032-11-00 LOCATION Highway 401/ Highbury, London, Ontario ORIGINATED BY WT
 DIST West HWY 401 BOREHOLE TYPE Solid Stem Augers COMPILED BY RR
 DATUM Geodetic DATE 2022.07.10 - 2022.07.10 LATITUDE 42.9325974 LONGITUDE -81.1954017 CHECKED BY GR

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT w _p	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa									
○ UNCONFINED + FIELD VANE																	
● QUICK TRIAXIAL × LAB VANE																	
							WATER CONTENT (%)										
							20 40 60 80 100					20 40 60					
275.5																	
275.0	150 mm ASPHALT																
0.2	330 mm GRANULAR FILL																
275.0			1	SS	55		275										
0.5	FILL: SAND and GRAVEL (SP/GP) Brown Loose to compact Dry																
	180 mm clayey silt seam at 1 m		2	SS	16												
	Rock at the tip of SS3						274										
			3	SS	5												
273.3																	
2.2	FILL: SILTY CLAY with Sand (CL), some gravel. Brown Stiff to very stiff Dry		4	SS	21		273										
			5	SS	14		272									10 22 32 35 PP=2.0	
			6	SS	14		271										
			7	SS	8												
				VANE			270									Su > 100 kPa	
269.7																	
5.8	POSSIBLE FILL: SILTY CLAY (CL), trace sand and gravel Brown Stiff Dry to moist		8	SS	11		269									PP=0.75	
			9	SS	13											PP=1.5	
268.0							268										
7.5	SILTY CLAY with Sand (CL) to CLAY (Cl), trace gravel. Brown Very stiff Dry to moist		10	SS	21											2 23 32 43 PP=2.25	
							267										
	SS11 contains black organic inclusions		11	SS	16		266									PP=3.75	

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

ONTARIO MTO 165001239_MTO_HWY_401_HIGHBURY.GPJ ONTARIO MTO.GDT 11/8/22

RECORD OF BOREHOLE No HL-03

2 OF 2

METRIC

W.P. 3032-11-00 LOCATION Highway 401/ Highbury, London, Ontario ORIGINATED BY WT
 DIST West HWY 401 BOREHOLE TYPE Solid Stem Augers COMPILED BY RR
 DATUM Geodetic DATE 2022.07.10 - 2022.07.10 LATITUDE 42.9325974 LONGITUDE -81.1954017 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 (%) GR SA SI CL	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa		WATER CONTENT (%)					
								○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE							
							20 40 60 80 100	20 40 60							
262.7 12.8	SILTY CLAY with Sand (CL) to CLAY (Cl), trace gravel. Brown Very stiff Dry to moist (continued)					▽	265							PP=max	
			12	SS	20										
							264								
			13	SS	22		263								
END OF BOREHOLE															
Borehole open and groundwater level measured at approximatey 12.5 below grade in open borehole.															

RECORD OF BOREHOLE No HL-04

1 OF 2

METRIC

W.P. 3032-11-00 LOCATION Highway 401/ Highbury, London, Ontario ORIGINATED BY JM
 DIST West HWY 401 BOREHOLE TYPE Solid Stem Augers COMPILED BY RR
 DATUM Geodetic DATE 2022.07.10 - 2022.07.11 LATITUDE 42.9332293 LONGITUDE -81.1933136 CHECKED BY GR

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa							WATER CONTENT (%)
								○ UNCONFINED ● QUICK TRIAXIAL	+ FIELD VANE × LAB VANE						
276.5 0.0	280 mm ASPHALT						20 40 60 80 100								
276.2 0.3	400 mm GRANULAR FILL		1	SS	29					○					
275.8 0.7	FILL: CLAYEY SILT with sand (CL), trace gravel, rootlets and construction debris Brown Stiff to very stiff Moist		2	SS	9					○				PP=3.0	
			3	SS	16					○				2 30 33 35 PP=3.5	
			4	SS	12					○				PP=3.5	
			5	SS	14					○				PP=2.5	
	Sand seam at the top of SS6		6	SS	17					○					
272.4 4.1	FILL: SILTY CLAY with sand (CL), trace gravel and organics Light to dark brown Stiff to very stiff Moist		7	SS	14					○				PP=3.0	
			8	SS	12					○				1 19 36 44 PP=4.0	
			9	SS	12					○				PP=4.25	
			10	SS	17					○				PP=4.25	
			11	SS	12					○				PP=3.75	
267.8 8.7	SILTY CLAY (CI), trace sand Brown Very stiff Moist		12	SS	23					○					

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

RECORD OF BOREHOLE No HL-04

2 OF 2

METRIC

W.P. 3032-11-00 LOCATION Highway 401/ Highbury, London, Ontario ORIGINATED BY JM
 DIST West HWY 401 BOREHOLE TYPE Solid Stem Augers COMPILED BY RR
 DATUM Geodetic DATE 2022.07.10 - 2022.07.11 LATITUDE 42.9332293 LONGITUDE -81.1933136 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/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)			
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa		W _p	W	W _L			WATER CONTENT (%)	GR	SA
	SILTY CLAY (CI), trace sand Brown Very stiff Moist (continued)						266										
			13	SS	21												
264.8 11.7	CLAYEY SILT (CL), trace sand Grey Hard Moist						265										
263.7 12.8	END OF BOREHOLE Borehole dry and cave-in measured at approximately 10.7 m below grade upon completion of drilling.		14	SS	56		264										
						</											

RECORD OF BOREHOLE No HL-05

1 OF 2

METRIC

W.P. 3032-11-00 LOCATION Highway 401/ Highbury, London, Ontario ORIGINATED BY WT
 DIST West HWY 401 BOREHOLE TYPE Solid Stem Augers COMPILED BY JM
 DATUM Geodetic DATE 2022.07.15 - 2022.07.15 LATITUDE 42.9339381 LONGITUDE -81.1909232 CHECKED BY GR

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa									
273.8 0.0	280 mm ASPHALT		1	SS	46												
273.5 273.5 273.5 0.4	100 mm GRANULAR FILL FILL: SAND and GRAVEL (SP/GP) Brown Loose to dense Dry		2	SS	7												
			3	SS	10												
271.7 2.1	FILL: CLAYEY SILT with Sand (CL), trace gravel Brown Stiff to hard Dry		4	SS	14												4 27 35 34 PP=4.25
			5	SS	35												PP=4.25
270.1 3.7	SILTY CLAY with Sand (CI), trace gravel Brown Very stiff to hard Dry		6	SS	26												PP=4.0
			7	SS	34												3 25 32 40
	Grey below 5.3 m		8	SS	20												PP=3.75
			9	SS	21												PP=3.0
267.0 6.8	CLAYEY SILT (CL-ML), trace to some sand Grey Hard Dry		10	SS	86												PP=max
	SS11 and SS12 contain sand seams		11	SS	57												PP=3.75
			12	SS	55												0 9 62 28
									</								

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

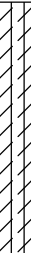
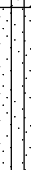
ONTARIO MTO 165001239_MTO_HWY_401_HIGHBURY.GPJ ONTARIO MTO.GDT 11/8/22

RECORD OF BOREHOLE No HL-05

2 OF 2

METRIC

W.P. 3032-11-00 LOCATION Highway 401/ Highbury, London, Ontario ORIGINATED BY WT
 DIST West HWY 401 BOREHOLE TYPE Solid Stem Augers COMPILED BY JM
 DATUM Geodetic DATE 2022.07.15 - 2022.07.15 LATITUDE 42.9339381 LONGITUDE -81.1909232 CHECKED BY GR

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				PLASTIC LIMIT w _p	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa									
								○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE									
								20	40	60	80	100	WATER CONTENT (%)				
								20	40	60	80	100	20	40	60		
	CLAYEY SILT (CL-ML), trace to some sand Grey Hard Dry (continued)						263									0 7 66 27 PP=2.5	
262.1 11.7	SANDY SILT Grey Very dense Moist						262										
261.0 12.8	END OF BOREHOLE						261										
	Groundwater level and cave-in measured at approximately 9.9 m and 10.7 m below grade, respectively; in open borehole.																

RECORD OF BOREHOLE No HL-06

1 OF 2

METRIC

W.P. 3032-11-00 LOCATION Highway 401/ Highbury, London, Ontario ORIGINATED BY WT
 DIST West HWY 401 BOREHOLE TYPE Solid Stem Augers COMPILED BY RR
 DATUM Geodetic DATE 2022.07.12 - 2022.07.13 LATITUDE 42.93448 LONGITUDE -81.1888524 CHECKED BY GR

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT w _p	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa							
								○ UNCONFINED	+ FIELD VANE						
								● QUICK TRIAXIAL	× LAB VANE						
271.2							20	40	60	80	100				
270.9	150 mm ASPHALT														
0.2	FILL: SAND and GRAVEL Brown Compact to very dense Dry		1	SS	64										
			2	SS	17										
269.8															
1.5	CLAYEY SILT (CL-ML), some sand, trace gravel. Brown Stiff to hard Dry to moist		3	SS	60										1 15 65 19
	Grey below 2.6 m		4	SS	13										PP=1.75
			5	SS	51										PP=1.75
			6	SS	53										PP=1.5
			7	SS	56										PP=1.5
265.9															
5.3	SILT (ML), some sand and clay Grey Dense to very dense Moist to wet		8	SS	53										
			9	SS	57										0 10 75 15
			10	SS	34										
			11	SS	32										

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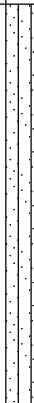
+ 3, X 3: Numbers refer to Sensitivity ○ 3% STRAIN AT FAILURE

RECORD OF BOREHOLE No HL-06

2 OF 2

METRIC

W.P. 3032-11-00 LOCATION Highway 401/ Highbury, London, Ontario ORIGINATED BY WT
 DIST West HWY 401 BOREHOLE TYPE Solid Stem Augers COMPILED BY RR
 DATUM Geodetic DATE 2022.07.12 - 2022.07.13 LATITUDE 42.93448 LONGITUDE -81.1888524 CHECKED BY GR

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT w _p	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL		
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa									
								○ UNCONFINED	+	FIELD VANE						● QUICK TRIAXIAL	×
							20	40	60	80	100	20	40	60			
10.0	Sandy SILT (ML), some clay Grey Compact to dense Moist to wet						261										
			13	SS	29		260										
							259										
			14	SS	35												
258.5																	
12.7	END OF BOREHOLE																
	Groundwater level and cave-in measured at approximately 5.8 m and 6.1 below grade, respectively; in open borehole.																

RECORD OF BOREHOLE No HL-07

1 OF 2

METRIC

W.P. 3032-11-00 LOCATION Highway 401/ Highbury, London, Ontario ORIGINATED BY JM
DIST West HWY 401 BOREHOLE TYPE Solid Stem Augers COMPILED BY JM
DATUM Geodetic DATE 2022.07.12 - 2022.07.13 LATITUDE 42.9349573 LONGITUDE -81.1866188 CHECKED BY GR

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)				
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa										
								○ UNCONFINED	+ FIELD VANE						● QUICK TRIAXIAL	× LAB VANE	WATER CONTENT (%)	
270.3	0.0	330 mm ASPHALT					20	40	60	80	100	20	40	60	GR	SA	SI	CL
269.9	0.3	180 mm GRANULAR FILL		1	SS	60												
269.7	0.5	FILL: SILTY SAND (SM), trace gravel. Contains cement. Brown Compact Dry		2	SS	12												
268.8	1.4	FILL: SILTY CLAY (CI), trace sand and gravel Brown Stiff Moist		3	SS	13												1 8 37 55 PP=4.75
				4	SS	14												PP=4.5
267.3	3.0	CLAYEY SILT (CL-ML), trace sand Grey Stiff to hard Moist to wet		5	SS	15												PP=4.5
		Wet below 3.8 m		6	SS	30												0 6 67 26 PP=4.5
265.8	4.5	SILT, trace sand to Sandy SILT (ML) Grey Compact to very dense Wet		7	SS	30												
				8	SS	36												
				9	SS	56												
				10	SS	32												0 4 88 8
				11	SS	36												
				12	SS	34												

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

RECORD OF BOREHOLE No HL-07

2 OF 2

METRIC

W.P. 3032-11-00 LOCATION Highway 401/ Highbury, London, Ontario ORIGINATED BY JM
 DIST West HWY 401 BOREHOLE TYPE Solid Stem Augers COMPILED BY JM
 DATUM Geodetic DATE 2022.07.12 - 2022.07.13 LATITUDE 42.9349573 LONGITUDE -81.1866188 CHECKED BY GR

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT w _p	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)		
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa								WATER CONTENT (%)	
								20	40	60	80	100					
								○ UNCONFINED + FIELD VANE									
								● QUICK TRIAXIAL × LAB VANE									
								20	40	60	80	100	20	40	60		
	SILT, trace sand to Sandy SILT (ML) Grey Compact to very dense Wet (continued)						260										
	600 mm layer of SILTY SAND in SS13		13	SS	13		259										0 35 60 4
							258										
257.5			14	SS	27												
12.8	END OF BOREHOLE																
	Groundwater level and cave-in measured at approximately 7.0 m and 7.6 m below grade, respectively; in open borehole.																

RECORD OF BOREHOLE No HL-08

1 OF 2

METRIC

W.P. 3032-11-00 LOCATION Highway 401/ Highbury, London, Ontario ORIGINATED BY JM
 DIST West HWY 401 BOREHOLE TYPE Solid Stem Augers COMPILED BY RR
 DATUM Geodetic DATE 2022.07.13 - 2022.07.13 LATITUDE 42.9354314 LONGITUDE -81.1844049 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/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)						
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa						W _p W W _L			GR	SA	SI	CL
								○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE	20 40 60 80 100					20 40 60						
270.7 0.0	350 mm ASPHALT		1	SS	40															
270.3 0.4	FILL: Silty SAND with Gravel (SM), trace cement and asphalt Brown Dense Dry to moist		2	SS	35															
			3	SS	30													30 36 31 3		
268.5 2.2	SILT (ML), trace to some clay, trace sand Brown Compact to very dense Wet		4	SS	24															
			5	SS	24															
			6	SS	56															
			7	SS	40													0 7 77 16		
			8	SS	43															
			9	SS	43															
			10	SS	22															
	Grey below 7.6 m		11	SS	19															
			12	SS	22													0 6 88 6		

Continued Next Page

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

RECORD OF BOREHOLE No HL-08

2 OF 2

METRIC

W.P. 3032-11-00 LOCATION Highway 401/ Highbury, London, Ontario ORIGINATED BY JM
 DIST West HWY 401 BOREHOLE TYPE Solid Stem Augers COMPILED BY RR
 DATUM Geodetic DATE 2022.07.13 - 2022.07.13 LATITUDE 42.9354314 LONGITUDE -81.1844049 CHECKED BY GR

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT w _p	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL			
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa								WATER CONTENT (%)		
								20 40 60 80 100	○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE									
	SILT (ML), trace to some clay, trace sand Brown Compact to very dense Wet (continued)																	
			13	SS	31		260											
							259											
257.9			14	SS	38		258											
12.8	END OF BOREHOLE Groundwater level and cave-in measured at approximately 6.6 m below grade upon completion of drilling.																	

RECORD OF BOREHOLE No MC-02

1 OF 2

METRIC

W.P. 3032-11-00 LOCATION Highway 401/ Highbury, London, Ontario ORIGINATED BY DB
 DIST West HWY 401 BOREHOLE TYPE Solid Stem Augers COMPILED BY JM
 DATUM Geodetic DATE 2022.06.23 - 2022.06.23 LATITUDE 42.9314128 LONGITUDE -81.1993304 CHECKED BY GR

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL		
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa							WATER CONTENT (%)	
								○ UNCONFINED ● QUICK TRIAXIAL	+ FIELD VANE × LAB VANE							
266.6 0.0 266.4 0.2	180 mm ASPHALT 600 mm GRANULAR FILL		1	SS	59											
265.8 0.8	FILL: Silty SAND with Gravel (SM), trace clay Brown Loose to very dense Dry		2	SS	32									34 48 13 5		
			3	SS	5											
			4	SS	9											
263.6 3.0	FILL: CLAYEY SILT to SILTY CLAY (CL), trace gravel and rootlets Brown Stiff to very stiff Moist		5	SS	8									PP=2.25		
			6	SS	16									PP=1.25		
262.1 4.5	CLAYEY SILT (CL), trace sand Brown Stiff to hard Moist		7	SS	12									0 1 64 35 PP=2.0		
	Grey below 5.3 m		8	SS	14									PP=2.25		
			9	SS	36									PP=3.0		
			10	SS	46											
259.1 7.5	SILT (ML), trace sand, some clay Grey Dense to very dense Moist		11	SS	41									0 0 76 23		
			12	SS	32											
	Wet below 9.1 m		13	SS	45											

Continued Next Page

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

RECORD OF BOREHOLE No MC-02

2 OF 2

METRIC

W.P. 3032-11-00 LOCATION Highway 401/ Highbury, London, Ontario ORIGINATED BY DB
DIST West HWY 401 BOREHOLE TYPE Solid Stem Augers COMPILED BY JM
DATUM Geodetic DATE 2022.06.23 - 2022.06.23 LATITUDE 42.9314128 LONGITUDE -81.1993304 CHECKED BY GR

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)							
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa								WATER CONTENT (%)			GR	SA	SI	CL
								○ UNCONFINED	+	FIELD VANE						W _p W W _L						
								● QUICK TRIAXIAL	×	LAB VANE												
						20	40	60	80	100	20	40	60									
256.0	SILT (ML), trace sand, some clay Grey Dense to very dense Moist (continued)		14	SS	52																	
10.6	CLAYEY SILT (CL-ML) Grey Very stiff to hard Wet						256										0 0 64 36					
							255															
				16	SS	24											PP=3.0					
							254															
							253										PP=2.5					
			17	SS	23																	
251.8	SILTY CLAY (CL), trace sand Grey Stiff Wet					252																
14.8																						
			18	SS	11											0 1 41 58 PP=0.75						
250.7	END OF BOREHOLE																					
15.9	Groundwater and cave-in measured at approximately 4.0 m and 13.7 m below grade, respectively.																					

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

ONTARIO MTO 165001239_MTO_HWY_401_HIGHBURY.GPJ ONTARIO MTO.GDT 11/8/22

RECORD OF BOREHOLE No MC-03

1 OF 2

METRIC

W.P. 3032-11-00 LOCATION Highway 401/ Highbury, London, Ontario ORIGINATED BY WT
DIST West HWY 401 BOREHOLE TYPE Solid Stem Augers COMPILED BY RR
DATUM Geodetic DATE 2022.07.11 - 2022.07.11 LATITUDE 42.9312289 LONGITUDE -81.1998531 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/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa		W _p	W	W _L		
								○ UNCONFINED ● QUICK TRIAXIAL	+ FIELD VANE × LAB VANE	WATER CONTENT (%)				
265.8	180 mm ASPHALT						20 40 60 80 100							GR SA SI CL
265.6	280 mm GRANULAR FILL		1	SS	71									
265.4														
0.5	FILL: SAND (SP), trace gravel Brown Loose Dry													
264.9														
1.0	FILL: SILTY CLAY with Sand (Cl), trace gravel and rootlets Brown Stiff Dry		2	SS	8									PP=4.0
			3	SS	13									PP=2.0
			4	SS	8									1 24 32 43 PP=1.75
262.8														
3.0	POSSIBLE FILL: SILTY CLAY (Cl) Brown to grey Firm Dry		5	SS	5									PP=0.5
262.1														
3.7	CLAYEY SILT (CL) Brown Very stiff Dry to moist			VANE										Su > 100 kPa
			6	SS	20									PP=1.75
	Grey below 5.3 m		7	SS	24									PP=1.75
			8	SS	20									0 1 66 34 PP= max
259.0														
6.8	SILTY CLAY (CL) Grey Stiff to very stiff Moist to wet		9	SS	17									PP=1.75
			10	SS	16									PP=2.75
			11	SS	19									0 0 50 50 PP=0.5
			12	SS	28									PP=2.5

Continued Next Page

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

RECORD OF BOREHOLE No MC-03

2 OF 2

METRIC

W.P. 3032-11-00 LOCATION Highway 401/ Highbury, London, Ontario ORIGINATED BY WT
 DIST West HWY 401 BOREHOLE TYPE Solid Stem Augers COMPILED BY RR
 DATUM Geodetic DATE 2022.07.11 - 2022.07.11 LATITUDE 42.9312289 LONGITUDE -81.1998531 CHECKED BY GR

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT w _p	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)			
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa										WATER CONTENT (%)		
								○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE												
	SILTY CLAY (CL) Grey Stiff to very stiff Moist to wet (continued)		13	SS	24												PP=0.5			
			14	SS	13		255										PP=0.25			
							254													
	100 mm silt seam at 12.6 m		15	SS	20		253										PP=0.75			
							252										PP=0.5			
			16	SS	11		251										Su > 100 kPa			
			VANE																	
250.4			17	SS	79												0 23 57 20 PP= max			
15.4	SILT with Sand (ML), some clay Grey Very dense Wet																			
250.0	END OF BOREHOLE																			
15.8	Groundwater level and cave-in measured at approximately 3 m and 5.2 below grade, respectively; in open borehole.																			

RECORD OF BOREHOLE No MS-01

1 OF 1

METRIC

W.P. 3032-11-00 LOCATION Highway 401/ Highbury, London, Ontario ORIGINATED BY AS
 DIST West HWY 401 BOREHOLE TYPE Hollow Stem Augers COMPILED BY RR
 DATUM Geodetic DATE 2022.07.07 - 2022.07.07 LATITUDE 42.9279914 LONGITUDE -81.2059203 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/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa		W _p W W _L				
								20 40 60 80 100						
								20 40 60 80 100						

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

RECORD OF BOREHOLE No MS-02

1 OF 1

METRIC

W.P. 3032-11-00 LOCATION Highway 401/ Highbury, London, Ontario ORIGINATED BY AS
 DIST West HWY 401 BOREHOLE TYPE Hollow Stem Augers COMPILED BY RR
 DATUM Geodetic DATE 2022.07.07 - 2022.07.07 LATITUDE 42.9285079 LONGITUDE -81.205217 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/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa		W _p	W	W _L		
								○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE	WATER CONTENT (%)					
264.6							20 40 60 80 100	20 40 60						
260.6	120 mm ASPHALT													
0.1	FILL: SAND (SP), some gravel Brown Compact Dry		1	SS	25									
263.9														
0.7	FILL: CLAYEY SILT (CL), trace to some sand Brown Firm Dry to moist		2	SS	6									
			3	SS	4									
262.4														
2.2	SILTY CLAY (CL), some sand, trace gravel Brown Stiff to very stiff Moist		4	SS	10									
			5	SS	17									
			6	SS	19									
260.2														
4.4	CLAYEY SILT (CL), trace sand Grey Stiff to very stiff Wet		7	SS	8									
			8	SS	17									
258.8														
5.8	END OF BOREHOLE													
	Borehole was open and dry upon completion of drilling.													

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

RECORD OF BOREHOLE No MS-03

1 OF 1

METRIC

W.P. 3032-11-00 LOCATION Highway 401/ Highbury, London, Ontario ORIGINATED BY WT
 DIST West HWY 401 BOREHOLE TYPE Hollow Stem Augers COMPILED BY JM
 DATUM Geodetic DATE 2022.07.08 - 2022.07.07 LATITUDE 42.9291559 LONGITUDE -81.2042143 CHECKED BY GR

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL			
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa							WATER CONTENT (%)		
								○ UNCONFINED ● QUICK TRIAXIAL	+ FIELD VANE × LAB VANE								
264.9								20	40	60	80	100					
264.8	150 mm ASPHALT																
0.2	400 mm GRANULAR FILL		1	SS	47												
264.4																	
0.6	FILL: SAND and GRAVEL (SP/GP) Brown Compact to dense Dry																
263.8			2	SS	14		264										
1.1	FILL: CLAYEY SILT (CL), trace sand and gravel Brown Stiff Dry																
			3	SS	11		263										
262.7																	
2.2	CLAYEY SILT with Sand (CL), trace gravel Brown Stiff to very stiff Moist		4	SS	15		262										3 28 36 33
			5	SS	26												
261.2																	
3.7	SILTY CLAY (CL), trace sand and gravel Grey Stiff Wet		6	SS	15		261										1 7 40 52
	Layer of silt and sand at the top of SS7		7	SS	12		260										
259.7																	
5.2	END OF BORHEOLE Borehole open and dry upon completion.																




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

RECORD OF BOREHOLE No MS-04

1 OF 1

METRIC

W.P. 3032-11-00 LOCATION Highway 401/ Highbury, London, Ontario ORIGINATED BY WT
 DIST West HWY 401 BOREHOLE TYPE Solid Stem Augers COMPILED BY RR
 DATUM Geodetic DATE 2022.07.06 - 2022.07.06 LATITUDE 42.9296294 LONGITUDE -81.2034103 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 (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa		W _p	W	W _L		
								○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE	WATER CONTENT (%)					
265.2								20 40 60 80 100						
269.9	150 mm ASPHALT													
0.2	FILL: Silty Clayey SAND with Gravel (SC-SM) Brown Loose to dense Dry		1	SS	40		265							
			2	SS	16		264							
	50 mm clayey silt seam at the bottom of SS2													
			3	SS	9		263							15 46 24 15
262.8														
2.4	SILTY CLAY (CL), trace sand Brown Very stiff Dry		4	SS	17		262							
			5	SS	25		261							
	Grey below 3.8 m													
			6	SS	19									0 7 41 52
			7	SS	15									
260.0														
5.2	END OF BOREHOLE Borehole open and dry upon completion.													

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

RECORD OF BOREHOLE No MS-05

1 OF 1

METRIC

W.P. 3032-11-00 LOCATION Highway 401/ Highbury, London, Ontario ORIGINATED BY AS
 DIST West HWY 401 BOREHOLE TYPE Hollow Stem Augers COMPILED BY JM
 DATUM Geodetic DATE 2022.07.07 - 2022.07.07 LATITUDE 42.9322084 LONGITUDE -81.1967157 CHECKED BY GR

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)		
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa							WATER CONTENT (%)	
								○ UNCONFINED	+ FIELD VANE						● QUICK TRIAXIAL	× LAB VANE
272.9	180 mm of ASPHALT															
272.7	200 mm GRANULAR FILL		1	SS	42											
272.5	SILTY CLAY with Sand (CL), trace gravel, trace organics Brown Stiff to very stiff Moist		2	SS	17											
0.4			3	SS	15									2 21 35 42		
			4	SS	19											
			5	SS	15											
			6	SS	17											
			7	SS	12									1 20 36 43		
267.7	END OF BOREHOLE															
5.2	Borehole dry and cave-in measured at approximately 4.1 m below grade; upon completion.															

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

RECORD OF BOREHOLE No MS-06

1 OF 1

METRIC

W.P. 3032-11-00 LOCATION Highway 401/ Highbury, London, Ontario ORIGINATED BY WT
 DIST West HWY 401 BOREHOLE TYPE Solid Stem Augers COMPILED BY JM
 DATUM Geodetic DATE 2022.07.13 - 2022.07.13 LATITUDE 42.9342585 LONGITUDE -81.1897756 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/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)			
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa				W _p W W _L				GR	SA	SI	CL
												○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE	WATER CONTENT (%)						
271.9								20	40	60	80	100							
0.0																			
271.7	200 mm ASPHALT		1	SS	69														
0.2	180 mm GRANULAR FILL																		
271.5	FILL: SAND (SP), some gravel Brown Compact Moist																		
0.4			2	SS	26														
270.2																			
1.7	CLAYEY SILT (CL-ML to CL), trace to some sand, trace gravel Brown Stiff to hard Moist		3	SS	20														
			4	SS	28														
			5	SS															
	Grey below 3.5 m																		
			6	SS	24														
			7	SS	44														
			8	SS	25														
			9	SS	11														
265.2																			
6.7	END OF BOREHOLE																		
	Borehole open and dry upon completion.																		

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

ONTARIO MTO 165001239_MTO_HWY_401_HIGHBURY.GPJ ONTARIO MTO.GDT 11/8/22

RECORD OF BOREHOLE No MS-07

1 OF 1

METRIC

W.P. 3032-11-00 LOCATION Highway 401/ Highbury, London, Ontario ORIGINATED BY JM
DIST West HWY 401 BOREHOLE TYPE Solid Stem Augers COMPILED BY RR
DATUM Geodetic DATE 2022.07.13 - 2022.07.13 LATITUDE 42.9347286 LONGITUDE -81.1876922 CHECKED BY GR

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT w _p	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE						
270.7 0.0	330 mm ASPHALT													
270.4 0.3	FILL: Silty SAND (SM), trace gravel, clay, asphalt pieces and cement. Brown Compact to very dense Dry		1	SS	61									
			2	SS	27									
269.3 1.5	SILTY CLAY (CL), trace sand and gravel Brown Stiff to very stiff Dry to moist Grey below 2.3 m		3	SS	13									
			4	SS	18									1 8 40 51
			5	SS	15									
266.7 4.0	SILT (ML), some sand and clay Grey Loose to compact Wet		6	SS	16									
			7	SS	17									
			8	SS	9									0 14 70 16
			9	SS	17									
264.0 6.7	END OF BOREHOLE Cave-in measured at approximately 5.2 m below grade upon completion of drilling.													







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

RECORD OF BOREHOLE No MS-08

1 OF 1

METRIC

W.P. 3032-11-00 LOCATION Highway 401/ Highbury, London, Ontario ORIGINATED BY WT
 DIST West HWY 401 BOREHOLE TYPE Solid Stem Augers COMPILED BY JM
 DATUM Geodetic DATE 2022.07.19 - 2022.07.21 LATITUDE 42.9351894 LONGITUDE -81.185557 CHECKED BY GR

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL			
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa								WATER CONTENT (%)		
								○ UNCONFINED ● QUICK TRIAXIAL	+ FIELD VANE × LAB VANE									
270.3 0.0	480 mm ASPHALT		1	SS	86													
269.8 0.5 269.6	200mm GRANULAR FILL																	
0.7	FILL: SAND and GRAVEL Brown Dense Dry		2	SS	33													
268.8																		
1.5	FILL: SILTY CLAY (Cl), some sand, trace gravel Brown Stiff to very stiff Dry		3	SS	14													
			4	SS	26										1 11 37 51			
267.3 3.1	SILTY CLAY (CL), some sand, trace gravel Brown Very stiff to hard Dry to moist Grey below 3.8m		5	SS	37													
			6	SS	19										1 13 40 46			
			7	SS	21													
265.0 5.3	SILT (ML), trace sand and clay Grey Compact Moist to wet		8	SS	18													
			9	SS	20										0 5 89 6 Non-Plastic			
263.6 6.7	END OF BOREHOLE Borehole open and groundwater level measured at approximately 4.3 m below grade upon completion of drilling.																	

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

ONTARIO MTO 165001239_MTO_HWY_401_HIGHBURY.GPJ ONTARIO MTO.GDT 11/8/22

RECORD OF BOREHOLE No MS-09

1 OF 1

METRIC

W.P. 3032-11-00 LOCATION Highway 401/ Highbury, London, Ontario ORIGINATED BY WT
 DIST West HWY 401 BOREHOLE TYPE Solid Stem Augers COMPILED BY JM
 DATUM Geodetic DATE 2022.07.19 - 2022.07.19 LATITUDE 42.935947 LONGITUDE -81.1819525 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 (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa		W _p	W	W _L		
271.9	150 mm ASPHALT							20 40 60 80 100						GR SA SI CL
270.8	480 mm GRANULAR FILL		1	SS	54									
271.3	FILL: Silty SAND with Gravel (SM), trace clay Brown Dense Dry						271							28 53 12 7
270.4			2	SS	36									
270.4	FILL: CLAYEY SILT (CL), trace gravel Black Stiff Moist						270							
269.7			3	SS	14									
269.7	SILT with Sand (ML) Brown Compact to very dense Moist						269							
			4	SS	13									
			5	SS	21									
								268						
			6	SS	39									
								267						0 24 68 8
			7	SS	83									
							266							
			8	SS	33									
			9	SS	49									
265.2	END OF BOREHOLE													
6.7	Groundwater level and cave-in measured at approximately 3.8 m and 4.3 m below grade, respectively; in open borehole.													

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

RECORD OF BOREHOLE No MS-10

1 OF 1

METRIC

W.P. 3032-11-00 LOCATION Highway 401/ Highbury, London, Ontario ORIGINATED BY WT
 DIST West HWY 401 BOREHOLE TYPE Solid Stem Augers COMPILED BY JM
 DATUM Geodetic DATE 2022.07.19 - 2022.07.19 LATITUDE 42.9362198 LONGITUDE -81.1806927 CHECKED BY GR

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE								
274.3 0.0	330 mm ASPHALT		1	SS	38		274									
274.0 0.3	355 mm GRANULAR FILL															
273.6 0.7	FILL: Silty Clayey SAND with Gravel (SC-SM) Brown Compact Moist		2	SS	24		273									
			3	SS	10											24 47 17 12
272.1 2.2	FILL: SILTY CLAY (CL), trace sand Brown Stiff Moist		4	SS	14		272									
			5	SS	14		271									0 9 45 46
270.5 3.8	SILT (ML), trace sand and clay Brown Dense to very dense Moist		6	SS	63		270									
			7	SS	43		269									0 15 77 8
			8	SS	40											
			9	SS	48		268									
267.6 6.7	END OF BOREHOLE															
	Groundwater level and cave-in measured at approximately 4.9 m and 5.8 m below grade, respectively; in open borehole.															

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

RECORD OF BOREHOLE No PM-01

1 OF 2

METRIC

W.P. 3032-11-00 LOCATION Pond Mills Road Overhead/ Highbury, London, Ontario ORIGINATED BY WT
 DIST West HWY 401 BOREHOLE TYPE Solid Stem Augers COMPILED BY JM
 DATUM Geodetic DATE 2022.07.13 - 2022.07.14 LATITUDE 42.9334885 LONGITUDE -81.1924381 CHECKED BY GR

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL			
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa										WATER CONTENT (%)		
								○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE												
275.9 0.0	280 mm ASPHALT		1	SS	40		20	40	60	80	100									
275.6 0.3	FILL: Silty SAND with Gravel (SM). Contains clayey inclusions. Brown Compact to dense Dry																			
			2	SS	15															
			3	SS	16												20 59 13 8			
273.6 2.3	FILL: CLAYEY SILT with Sand (CL), trace gravel Brown Stiff to hard Moist		4	SS	15												PP=2.25			
			5	SS	25															
	125 mm seam of fine sand in SS6		6	SS	18												PP=0.75			
	Layer of black organic material in SS7		7	SS	29												2 36 33 29 PP=max			
			8	SS	38												PP=max			
267.2 8.7	CLAYEY SILT to SILTY CLAY with Sand (CL), trace gravel Brown to grey Very stiff to hard Moist		9	SS	31												PP=4.25			

Continued Next Page

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

ONTARIO MTO 165001239_MTO_HWY_401_HIGHBURY.GPJ ONTARIO MTO.GDT 11/8/22

METRIC

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

RECORD OF BOREHOLE No PM-04

1 OF 2

METRIC

W.P. 3032-11-00 LOCATION Pond Mills Road Overhead/ Highbury, London, Ontario ORIGINATED BY JM
DIST West HWY 401 BOREHOLE TYPE Solid Stem Augers COMPILED BY JM
DATUM Geodetic DATE 2022.07.15 - 2022.07.15 LATITUDE 42.9338394 LONGITUDE -81.191269 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	REMARKS & GRAIN SIZE DISTRIBUTION (%)		
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa		W _p	W	W _L				
								○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE	WATER CONTENT (%)							
274.5	280 mm ASPHALT						20 40 60 80 100	20 40 60					GR	SA	SI	CL
0.0																
274.2			1	SS	40											
0.3	FILL: SILTY SAND (SM), trace gravel. Contains construction debris. Brown Compact to dense Moist															
			2	SS	19											
272.9																
1.5	FILL: CLAYEY SILT (CL), trace sand and gravel Brown Stiff Moist		3	SS	9											PP=0.0
			4	SS	14											Su > 100 kPa 2 32 33 33 PP=2.5
	SS5 contains trace rootlets		5	SS	13											
	Sandy silt to silty sand layer at the top of SS6		6	SS	9											
268.9																
5.6	CLAY SILT (CL), trace sand and gravel Brown Very stiff Moist		7	SS	16											Su > 100 kPa
267.3																
7.2	SILT with Sand (ML), trace clay Brown to grey Very loose to very dense Moist to wet Grey below 7.6 m		8	SS	53											1 8 51 40 PP=2.5
			9	SS	46											

Continued Next Page

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

ONTARIO MTO 165001239_MTO_HWY_401_HIGHBURY.GPJ ONTARIO MTO.GDT 11/7/22

RECORD OF BOREHOLE No PM-04

2 OF 2

METRIC

W.P. 3032-11-00 LOCATION Pond Mills Road Overhead/ Highbury, London, Ontario ORIGINATED BY JM
DIST West HWY 401 BOREHOLE TYPE Solid Stem Augers COMPILED BY JM
DATUM Geodetic DATE 2022.07.15 - 2022.07.15 LATITUDE 42.9338394 LONGITUDE -81.191269 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/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)					
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa							W _p W W _L				
								○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE							WATER CONTENT (%)				
							20	40	60	80	100	20	40	60		GR	SA	SI	CL
	SILT with Sand (ML), trace clay Brown to grey Very loose to very dense Moist to wet (<i>continued</i>)						264												
			10	SS	26								○						
							263												
			11	SS	18		262						○						
							261												
	Wet below 13.7 m		12	SS	22		260						○						
							259												
	SS13 and SS14 very loose		13	SS	0		258												
							257												
			14	SS	0		256						○					0 29 67 4	
							255												
256.4 18.1	CLAYEY SILT (CL) Grey Very stiff Moist to wet		15	SS	21		254						○					0 0 68 32	
255.6 18.9	END OF BOREHOLE Groundwater level and cave-in measured at approximately 9.1 m and 13.4 m below grade, respectively.						253												

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

ONTARIO MTO 165001239_MTO_HWY_401_HIGHBURY.GPJ ONTARIO MTO.GDT 11/7/22

RECORD OF BOREHOLE No PM-06

1 OF 2

METRIC

W.P. 3032-11-00 LOCATION Pond Mills Road Overhead/ Highbury, London, Ontario ORIGINATED BY BD
 DIST West HWY 401 BOREHOLE TYPE Solid Stem Augers COMPILED BY JM
 DATUM Geodetic DATE 2022.08.19 - 2022.08.19 LATITUDE 42.9331649 LONGITUDE -81.1921059 CHECKED BY GR

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)		
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa							WATER CONTENT (%)	
								○ UNCONFINED ● QUICK TRIAXIAL	+ FIELD VANE × LAB VANE							
269.2 0.0	250 mm TOPSOIL						20 40 60 80 100	20 40 60								
268.9 0.3	FILL: SILTY SAND (SM), trace gravel and rootlets Brown Very Loose Moist		1	SS	3					○						
268.4 0.8	SILTY CLAY (CL), trace gravel and sand Brown Compact Moist		2	SS	12					○						
			3	SS	15					○				PP= max		
			4	SS	17					○				PP= 4.0		
			5	SS	10					○				PP= 4.25		
	Grey below 4.6 m		6	SS	8					○				6 8 37 49 PP= 3.0		
263.1 6.1	SILT (ML), some clay, trace sand Grey Compact Moist to wet		7	SS	26					○						
			8	SS	22					○						
			9	SS	19					○				0 6 72 22 Non-Plastic		

Continued Next Page

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

RECORD OF BOREHOLE No PM-06

2 OF 2

METRIC

W.P. 3032-11-00 LOCATION Pond Mills Road Overhead/ Highbury, London, Ontario ORIGINATED BY BD
 DIST West HWY 401 BOREHOLE TYPE Solid Stem Augers COMPILED BY JM
 DATUM Geodetic DATE 2022.08.19 - 2022.08.19 LATITUDE 42.9331649 LONGITUDE -81.1921059 CHECKED BY GR

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa							WATER CONTENT (%)
								○ UNCONFINED ● QUICK TRIAXIAL	+ FIELD VANE × LAB VANE						
							20 40 60 80 100	20 40 60						GR SA SI CL	
	SILT (ML), some clay, trace sand Grey Compact Moist to wet (continued)						259								
			10	SS	25		258			○					
							257			○					
			11	SS	13		256								
255.5							255			○					
13.7	CLAYEY SILT (CL) Grey Stiff to very stiff Wet		12	SS	17										
			13	SS	14					—e—				0 0 45 55 PP=2.25	
254.1	END OF BOREHOLE														
15.1	Groundwater level measured at approximately 4.6 m below grade in open borehole upon completion of drilling. Monitoring well installed in borehole, screened from approximately 10.7 m to 12.2 m below grade. Groundwater level recorded at approximately 2.8 m below grade in monitoring well on September 12-14, 2022.														

RECORD OF BOREHOLE No S-01

1 OF 1

METRIC

W.P. 3032-11-00 LOCATION Highway 401/ Highbury, London, Ontario ORIGINATED BY WT
 DIST West HWY 401 BOREHOLE TYPE Solid Stem Augers COMPILED BY RR
 DATUM Geodetic DATE 2022.07.21 - 2022.07.21 LATITUDE 42.9301101 LONGITUDE -81.2024993 CHECKED BY GR

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)		
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa								WATER CONTENT (%)	
265.3	Asphalt							20	40	60	80	100					
0.0	255 mm ASPHALT		1	SS	37		265										
265.0																	
0.3	FILL: SAND and GRAVEL (SP/GP) Brown Loose to dense Dry		2	SS	15		264										
			3	SS	4												
263.1							263										
2.2	FILL: SILTY CLAY (CL), trace sand and gravel Brown Very stiff Moist		4	SS	17												
262.3							262										
3.0	SILTY CLAY (CL), trace sand and gravel Brown Stiff to hard Moist		5	SS	32												
			6	SS	18		261										
			7	SS	15												
							260										
			8	SS	13												
							259										
			9	SS	15												
							258										
			10	SS	15												
			11	SS	15												
257.1																	
8.2	END OF BOREHOLE Borehole open and dry upon completion of drilling.																

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

ONTARIO MTO 165001239_MTO_HWY_401_HIGHBURY.GPJ ONTARIO.MTO.GDT 10/17/22

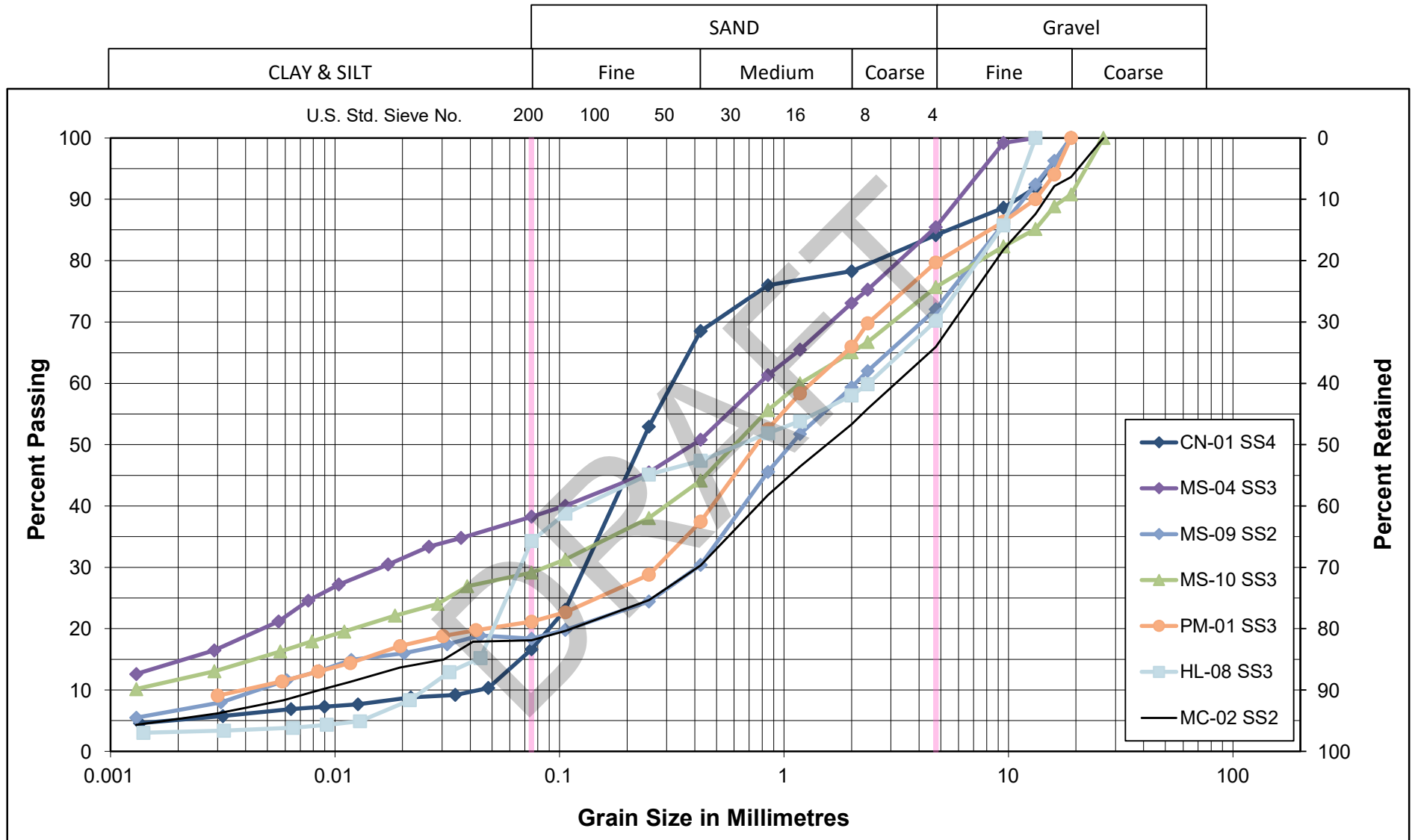
APPENDIX C

C.1 LABORATORY TEST RESULTS

DRAFT



Unified Soil Classification System

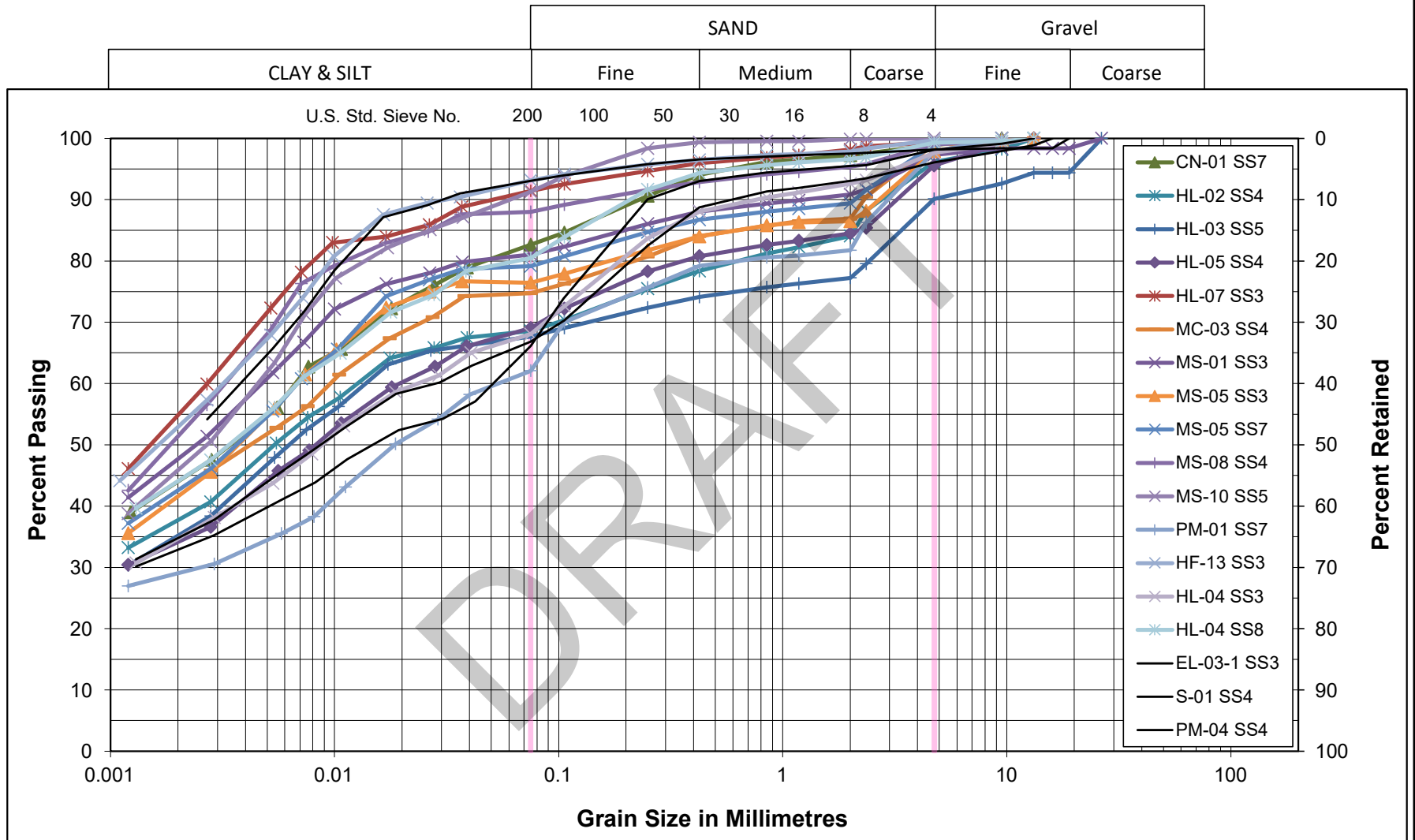


FILL: Silty SAND with Gravel (SM) to Silty Clayey
SAND with Gravel (SC-SM)
Ministry of Transportation (MTO)
HWY 401 - Median Sewer & SWMF

Figure No. C1

Project No. 165001239

Unified Soil Classification System

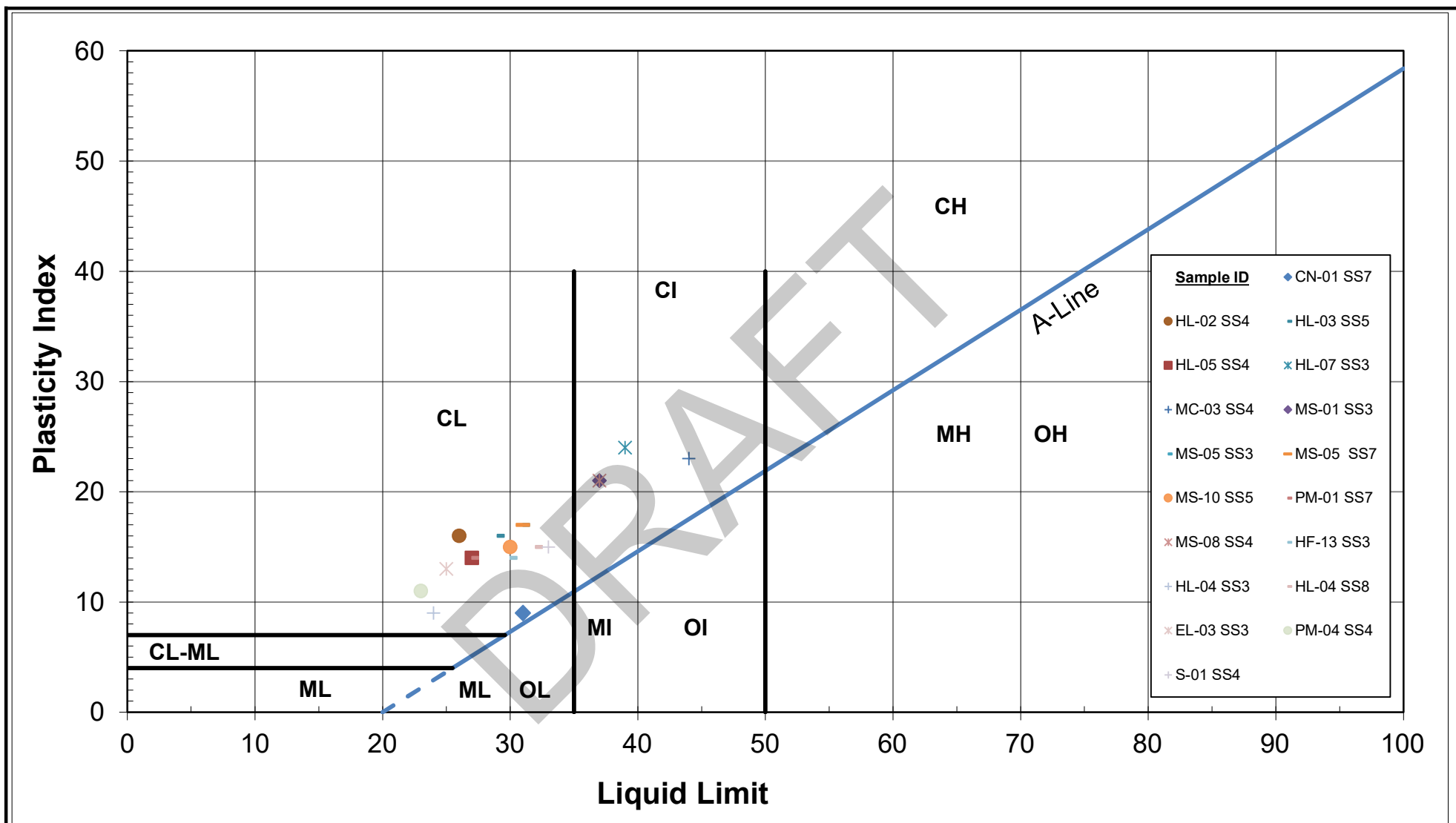


FILL: CLAYEY SILT to SILTY CLAY (CL to CI)

Ministry of Transportation (MTO)
HWY 401 - Median Sewer & SWMF

Figure No. C2

Project No. 165001239

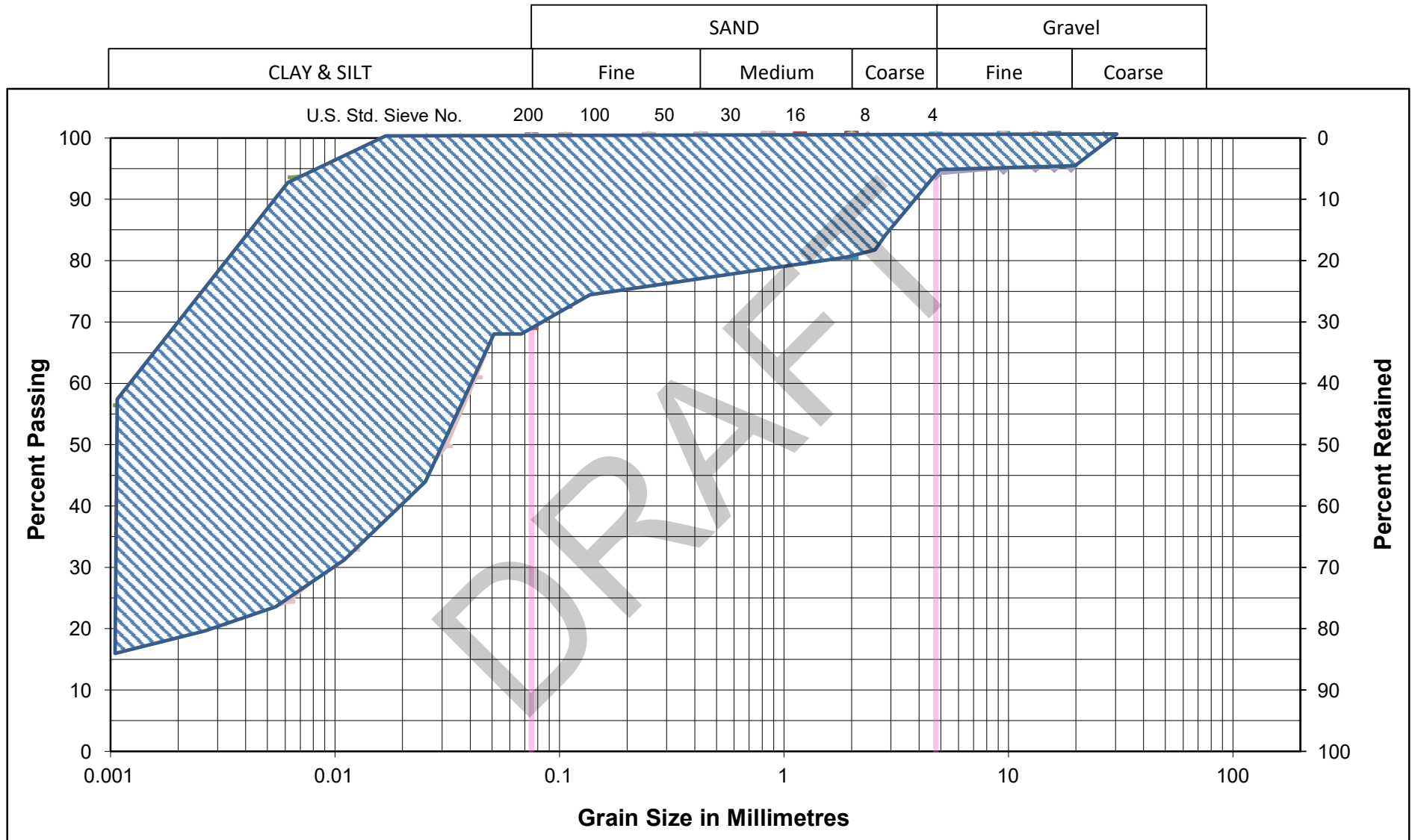


Ministry of Transportation (MTO)
 HWY 401 - Median Sewer & SWMF
 FILL: CLAYEY SILT to SILTY CLAY (CL to CI)

Figure No. C3

Project No. 165001239

Unified Soil Classification System



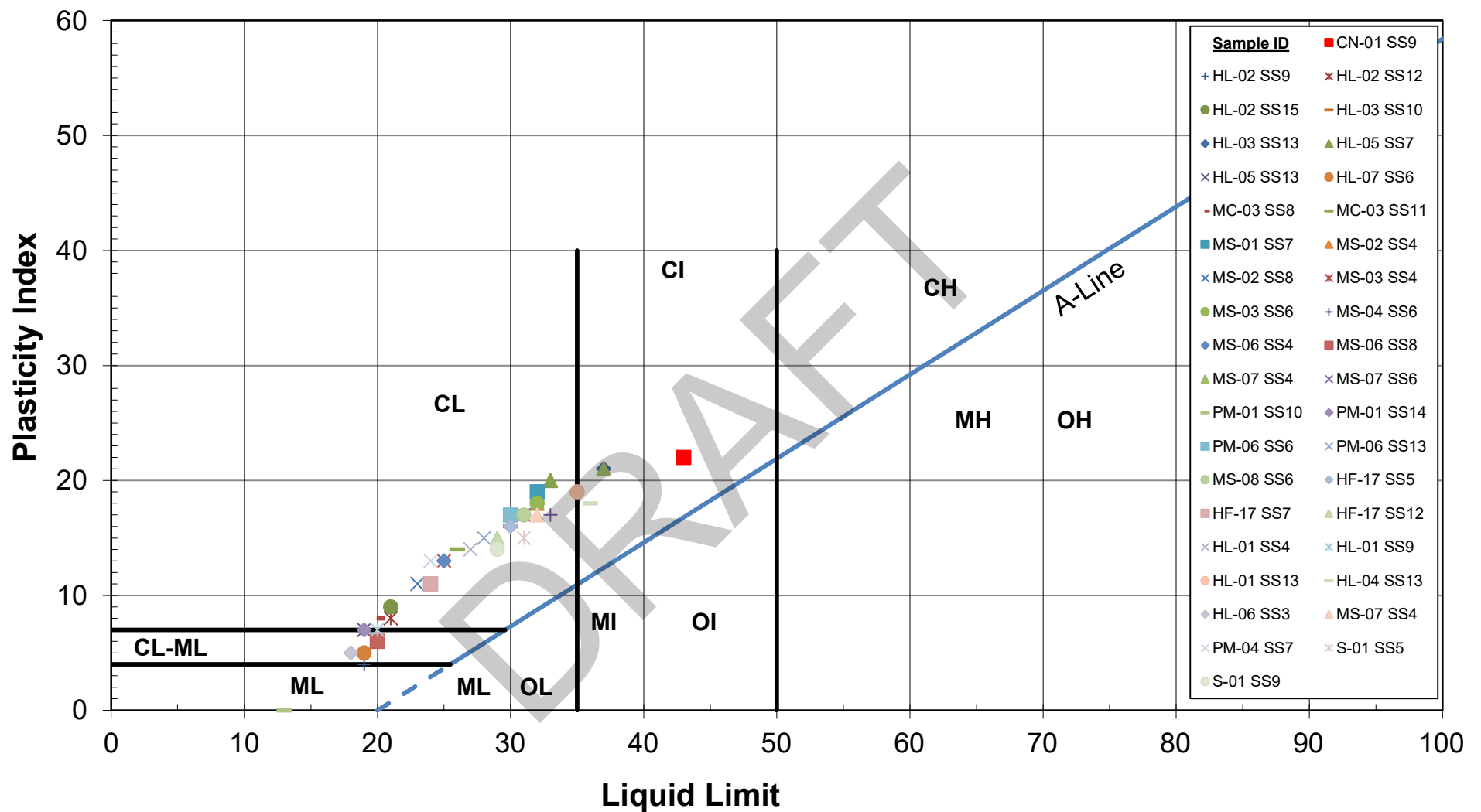
CLAYEY SILT to SILTY CLAY to CLAY (CL-ML/CL/CI)

Ministry of Transportation (MTO)

HWY 401 - Median Sewer & SWMF

Figure No. C4

Project No. 165001239

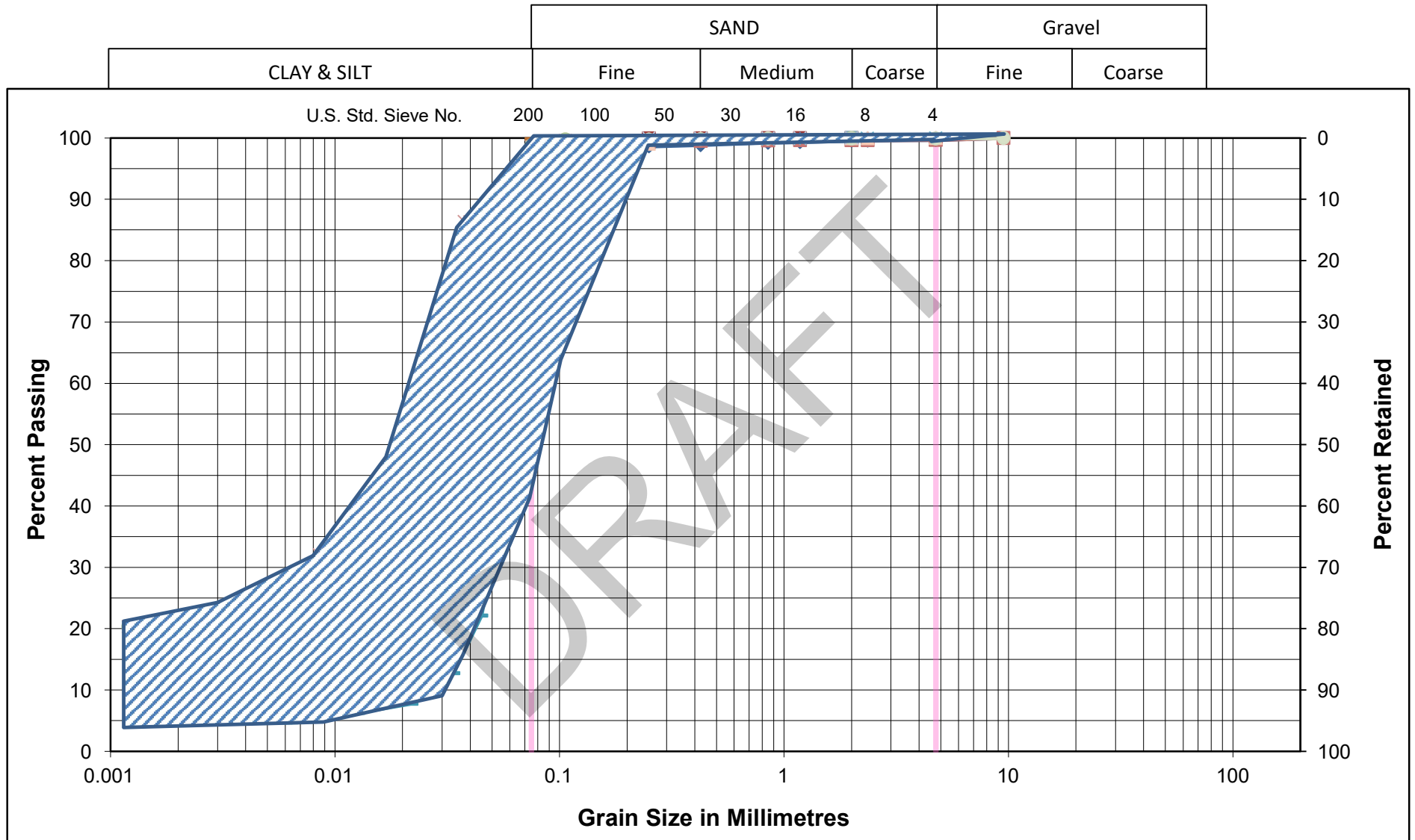


Ministry of Transportation (MTO)
 HWY 401 - Median Sewer & SWMF
 CLAYEY SILT to SILTY CLAY to CLAY
 (CL-ML/CL/CI)

Figure No. C5

Project No. 165001239

Unified Soil Classification System

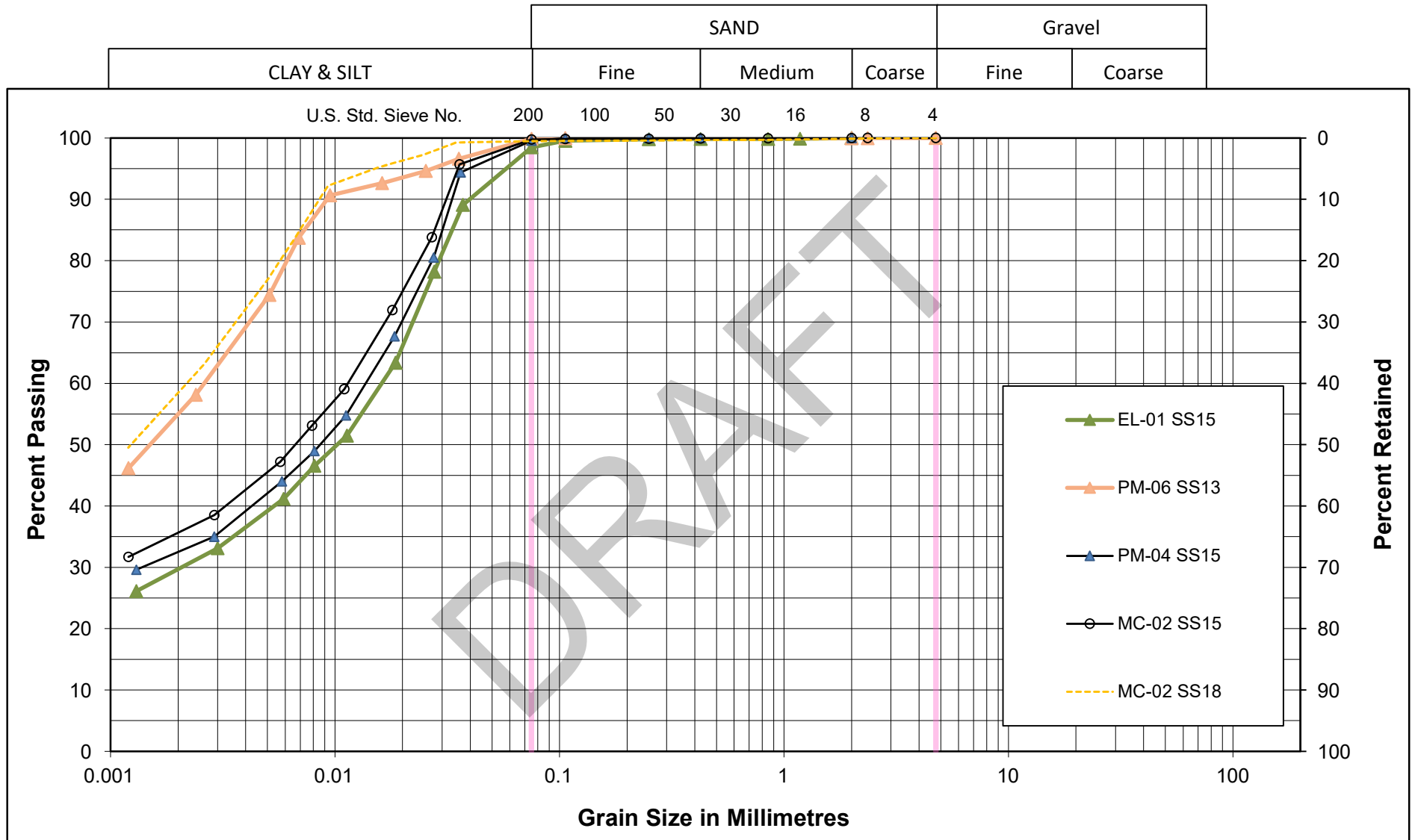


SILT to Sandy SILT (ML) to Silty SAND (SM)
 Ministry of Transportation (MTO)
 HWY 401 - Median Sewer & SWMF

Figure No. C6

Project No. 165001239

Unified Soil Classification System



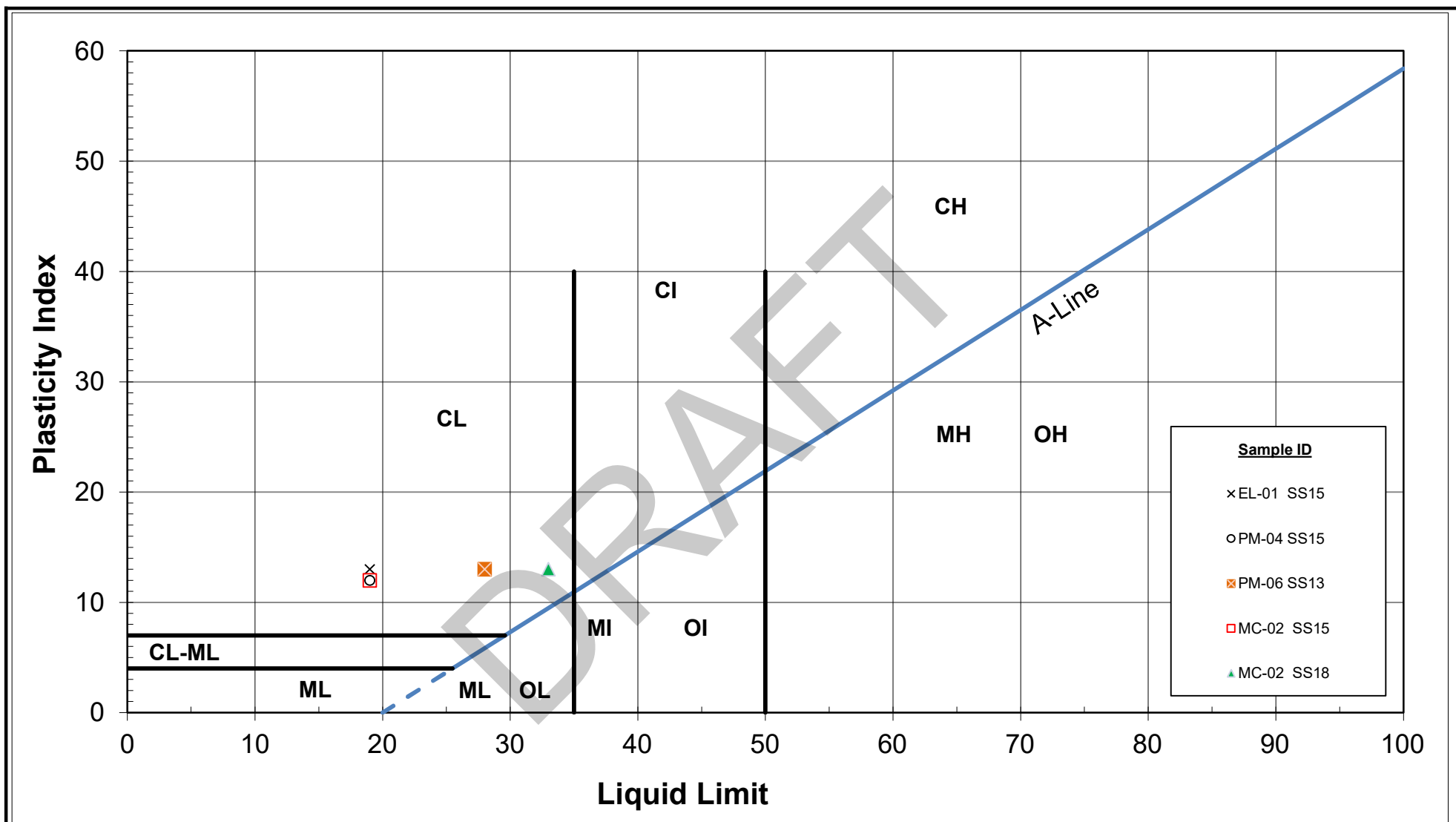
Lower Clayey Silt to Silty Clay (CL-ML to CL)

Ministry of Transportation (MTO)

HWY 401 - Median Sewer & SWMF

Figure No. C7

Project No. 165001239

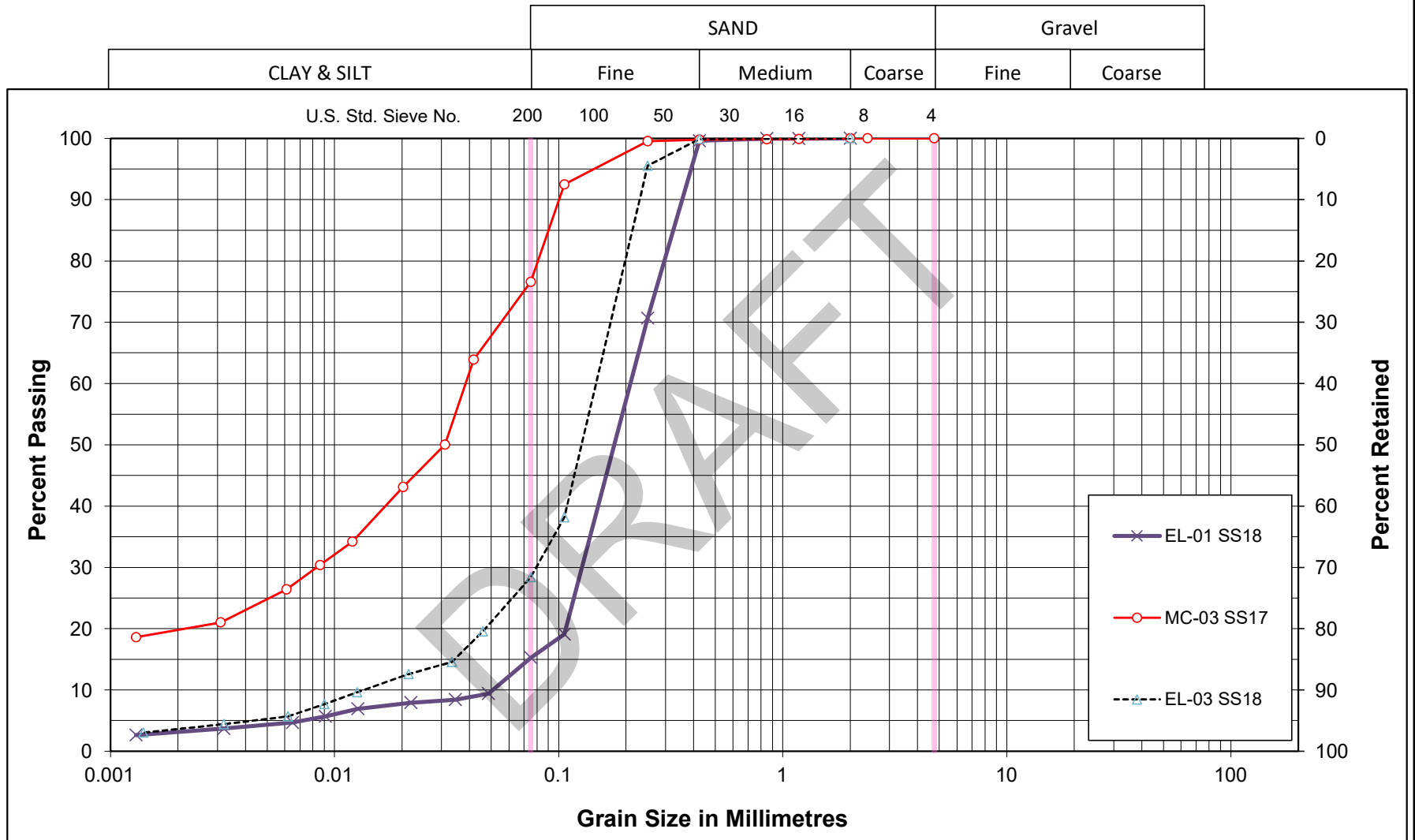


Ministry of Transportation (MTO)
 HWY 401 - Median Sewer & SWMF
 Lower CLAYEY SILT to SILTY CLAY (CL to CL-ML)

Figure No. C8

Project No. 165001239

Unified Soil Classification System



Lower SILT to Sandy SILT (ML to SM)
 Ministry of Transportation (MTO)
 HWY 401 - Median Sewer & SWMF

Figure No. C9

Project No. 165001239

APPENDIX D

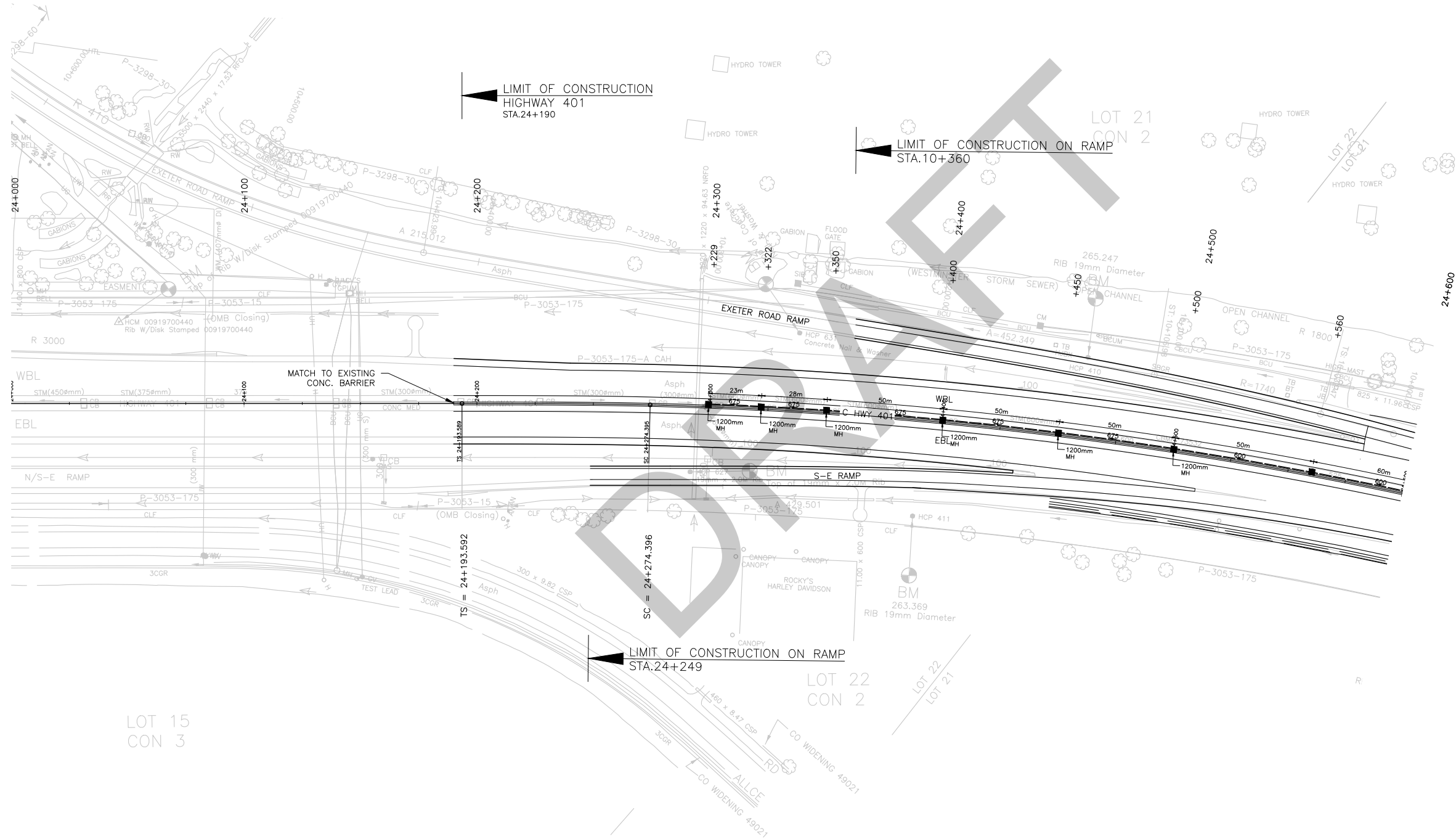
D.1 MEDIAN SEWER DRAWINGS

D.2 STORMWATER MANAGEMENT FACILITY SECTIONS

DRAFT



Median Sewer Replacement Drawings



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

PLATE No
CONT 2022-3004
WP 3032-11-00

DRAINAGE
STA TO STA
Survey ENTER DATE Revised



SHEET
1

SCALE
5 10
Horizontal

SHEET
2



SCALE

10
horizontal

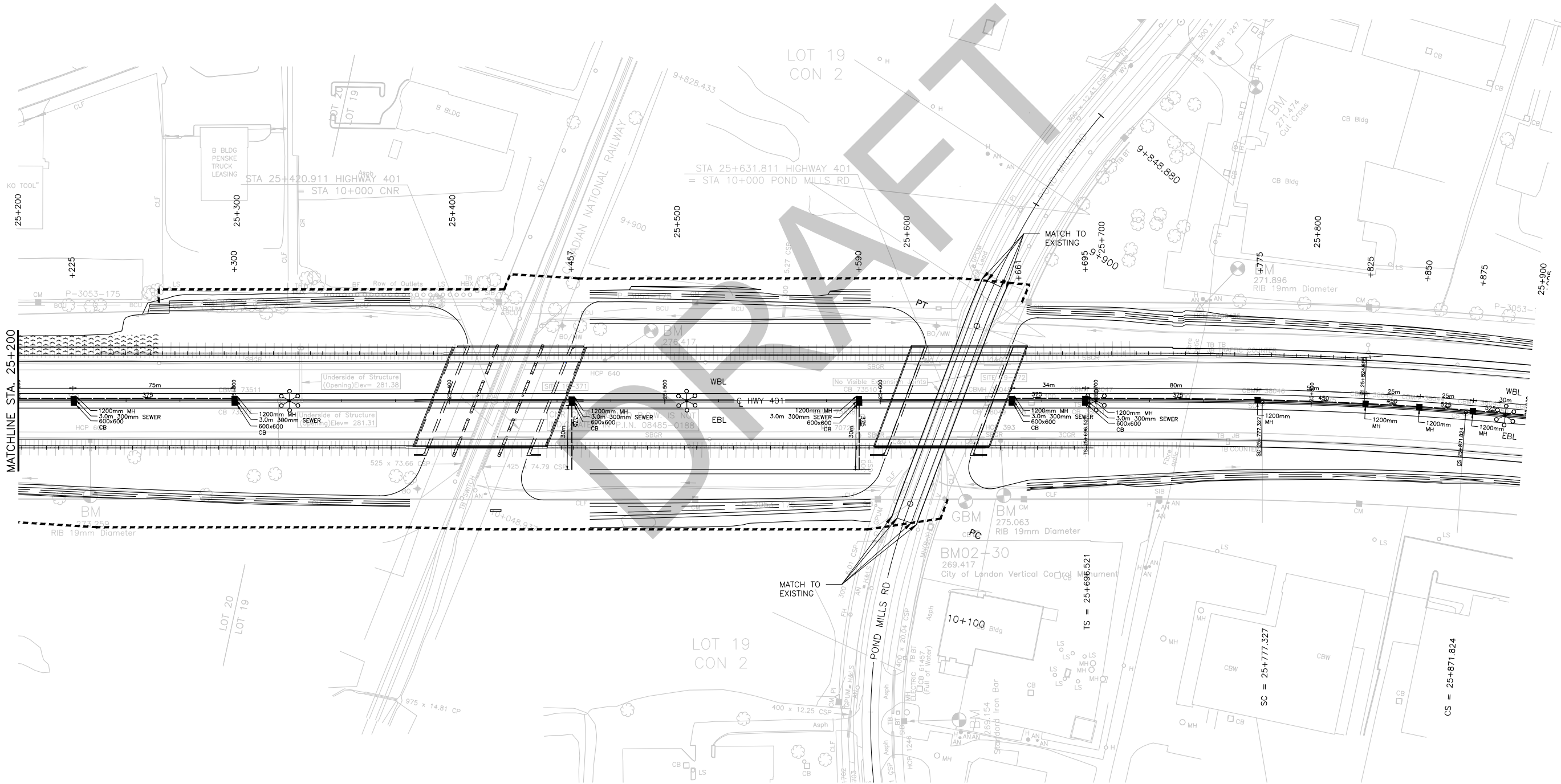
METRIC
DIMENSIONS ARE IN METRES
AND/OR MILLIMETRES
UNLESS OTHERWISE SHOWN

PLATE No
CONT 2022-3004
WP 3032-11-00

DRAINAGE
STA TO STA
Survey ENTER DATE Revised



SHEET
3



SCALE
5 10
Horizontal

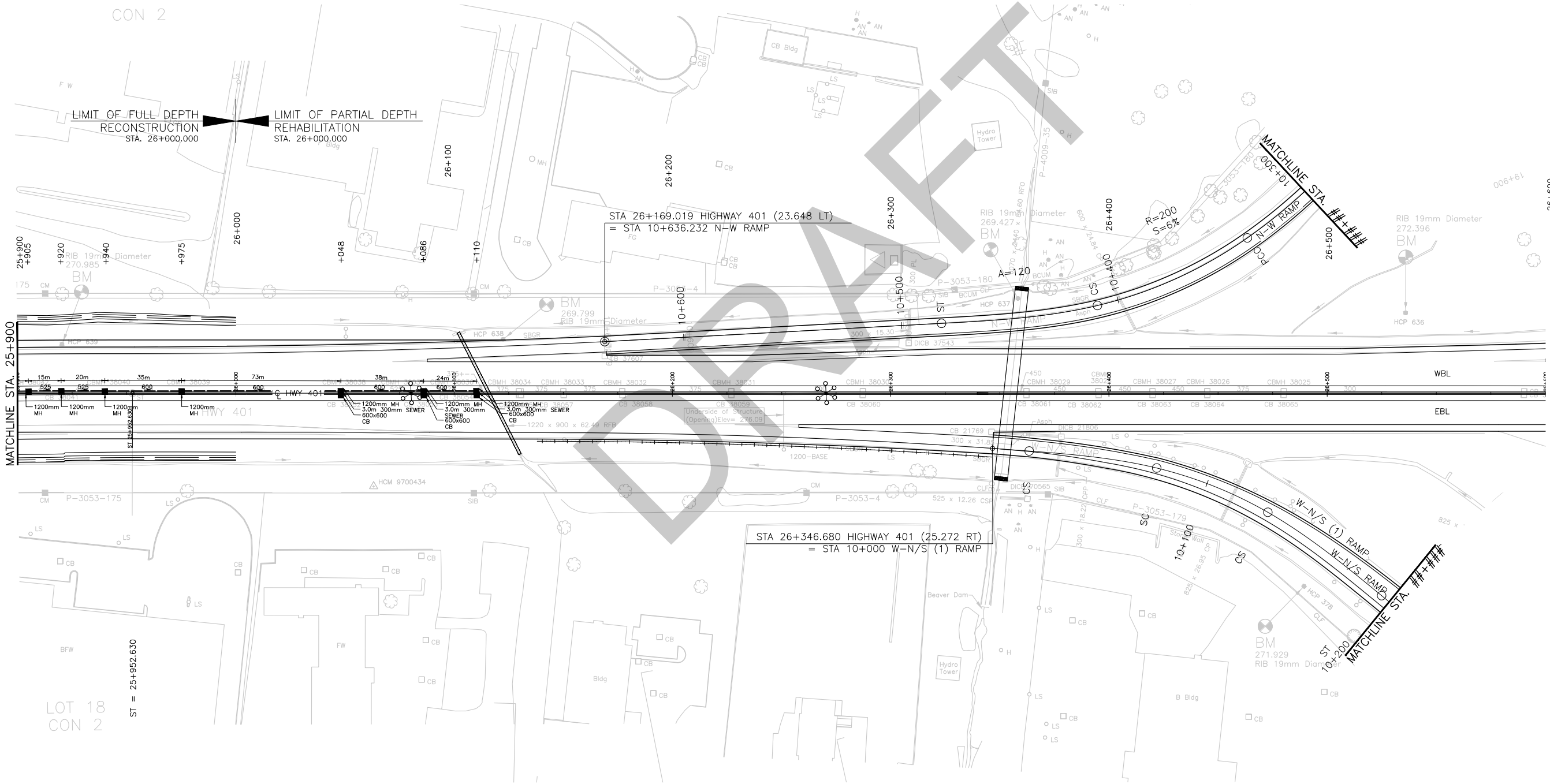
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DIMENSIONS ARE IN METRES
AND/OR MILLIMETRES
UNLESS OTHERWISE SHOWN

PLATE No
CONT 2022-3004
WP 3032-11-00



DRAINAGE
STA TO STA
Survey ENTER DATE Revised

SHEET
4

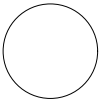


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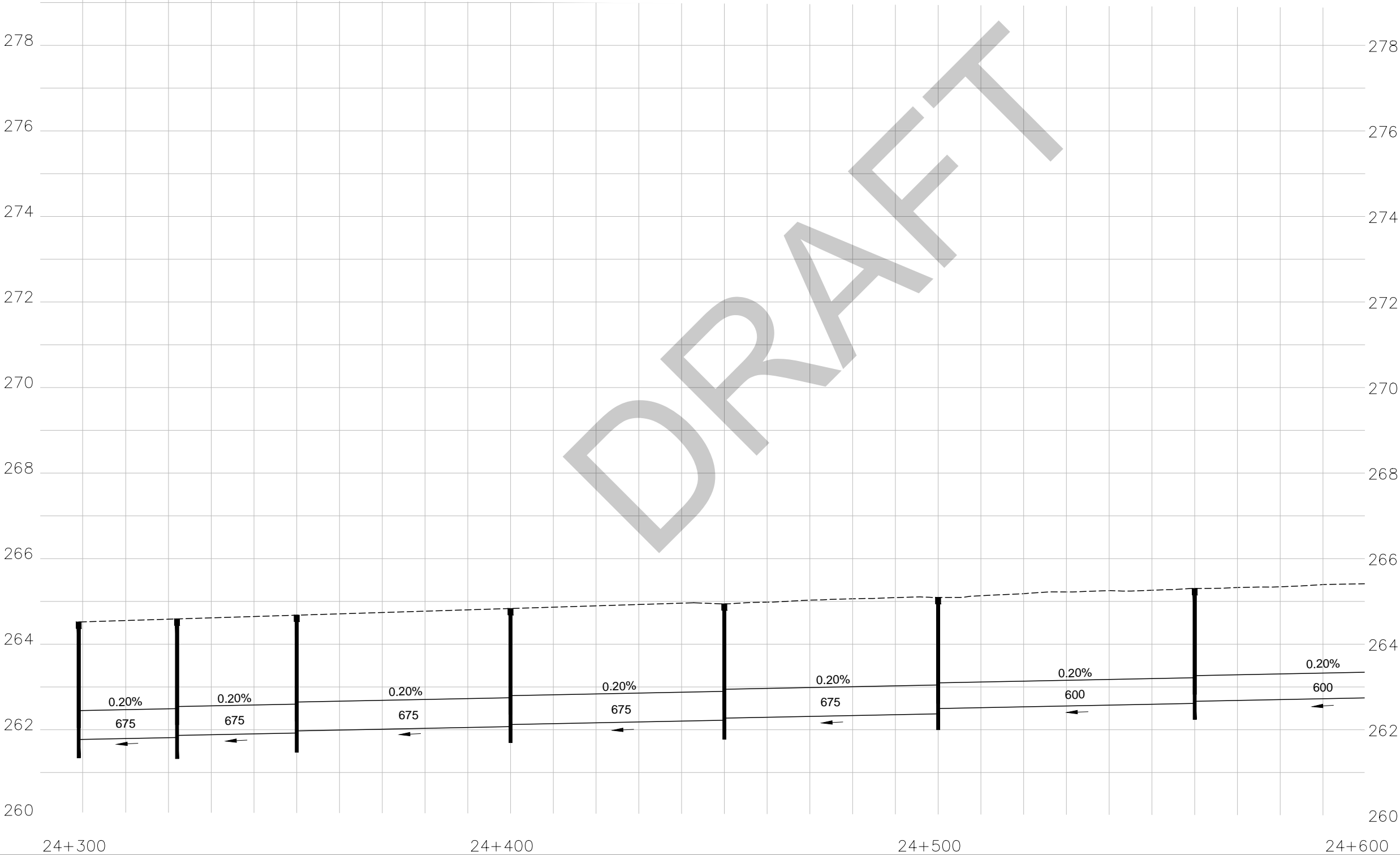
METRIC
DIMENSIONS ARE IN METRES
AND/OR MILLIMETRES
UNLESS OTHERWISE SHOWN

PLATE No
CONT 2022-3004
WP 3032-11-00

PROFILES
STA 24+300 TO STA 24+600
Survey _____ Revised _____



SHEET
1

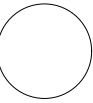


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Vertical
SCALE
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Horizontal

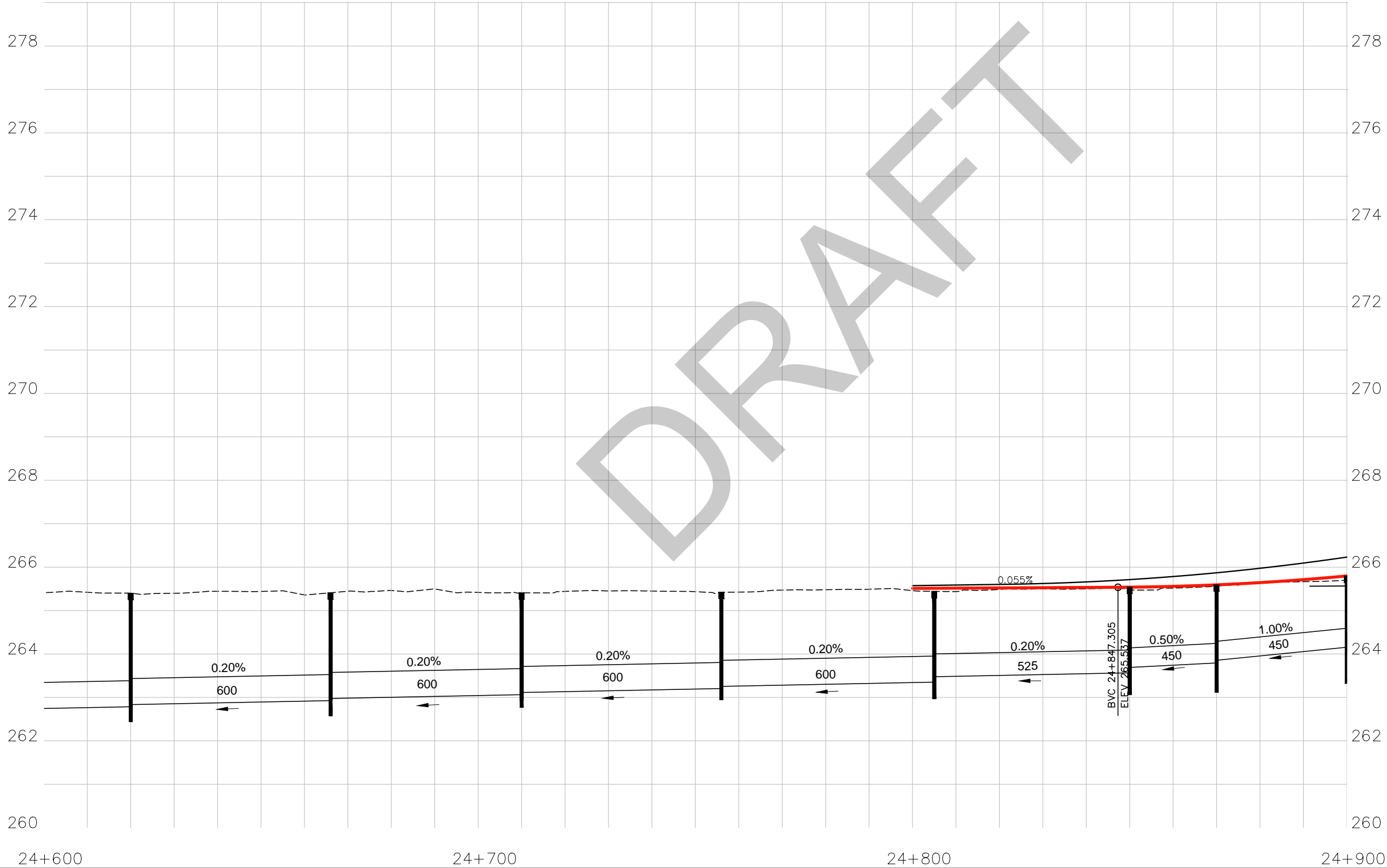
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AND/OR MILLIMETRES
UNLESS OTHERWISE SHOWN

PLATE No
CONT 2022-3004
WP 3032-11-00

PROFILES
STA 24+600 TO STA 24+900
Survey _____ Revised _____



SHEET
2

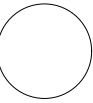


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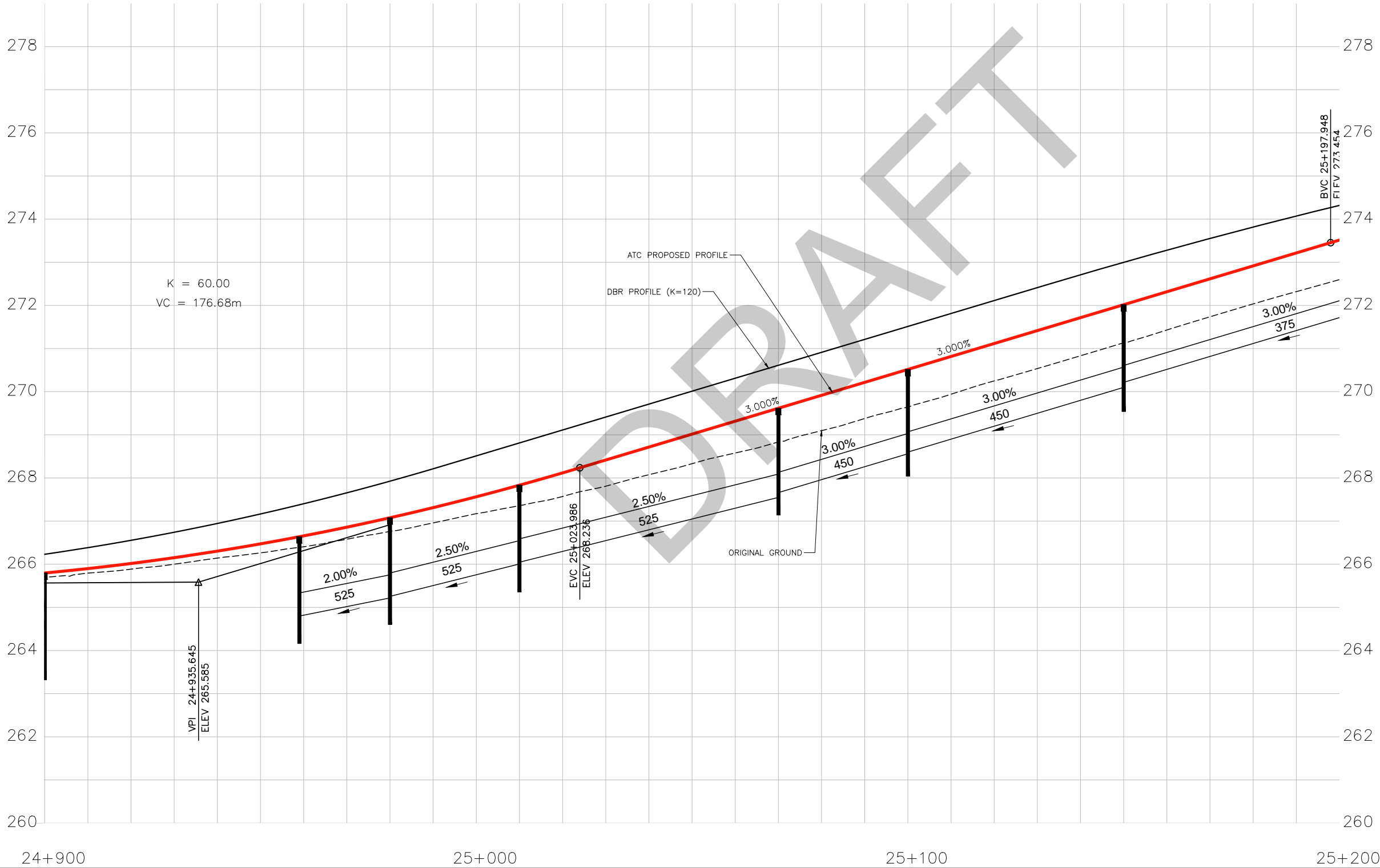
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AND/OR MILLIMETRES
UNLESS OTHERWISE SHOWN

PLATE No
CONT 2022-3004
WP 3032-11-00

PROFILES
STA 24+900 TO STA 25+200
Survey _____ Revised _____



SHEET
3

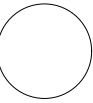


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Vertical
SCALE
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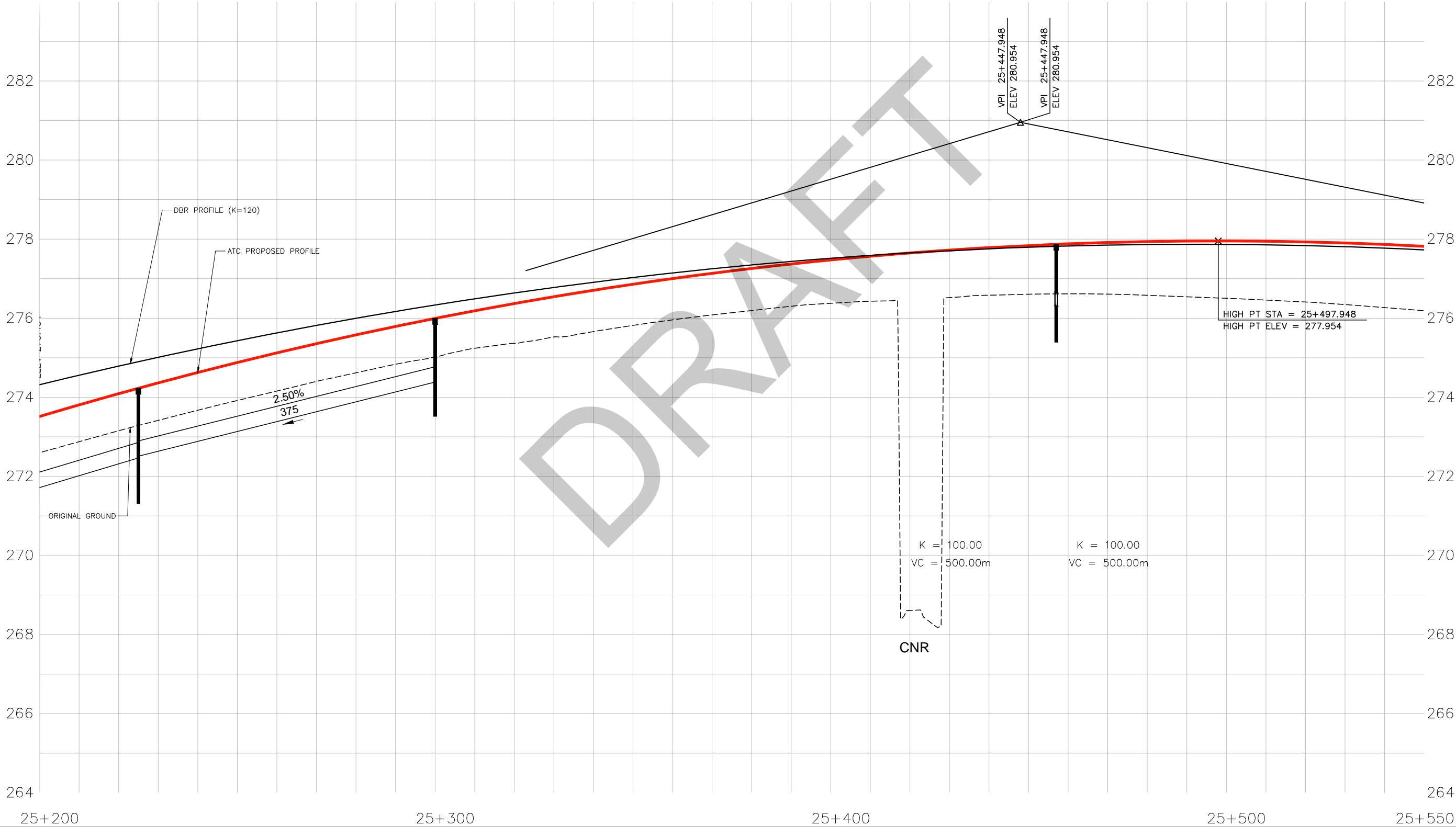
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AND/OR MILLIMETRES
UNLESS OTHERWISE SHOWN

PLATE No
CONT 2022-3004
WP 3032-11-00

PROFILES
STA 25+200 TO STA 25+550
Survey _____ Revised _____



SHEET
4



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Vertical
SCALE
2.5 5
Horizontal

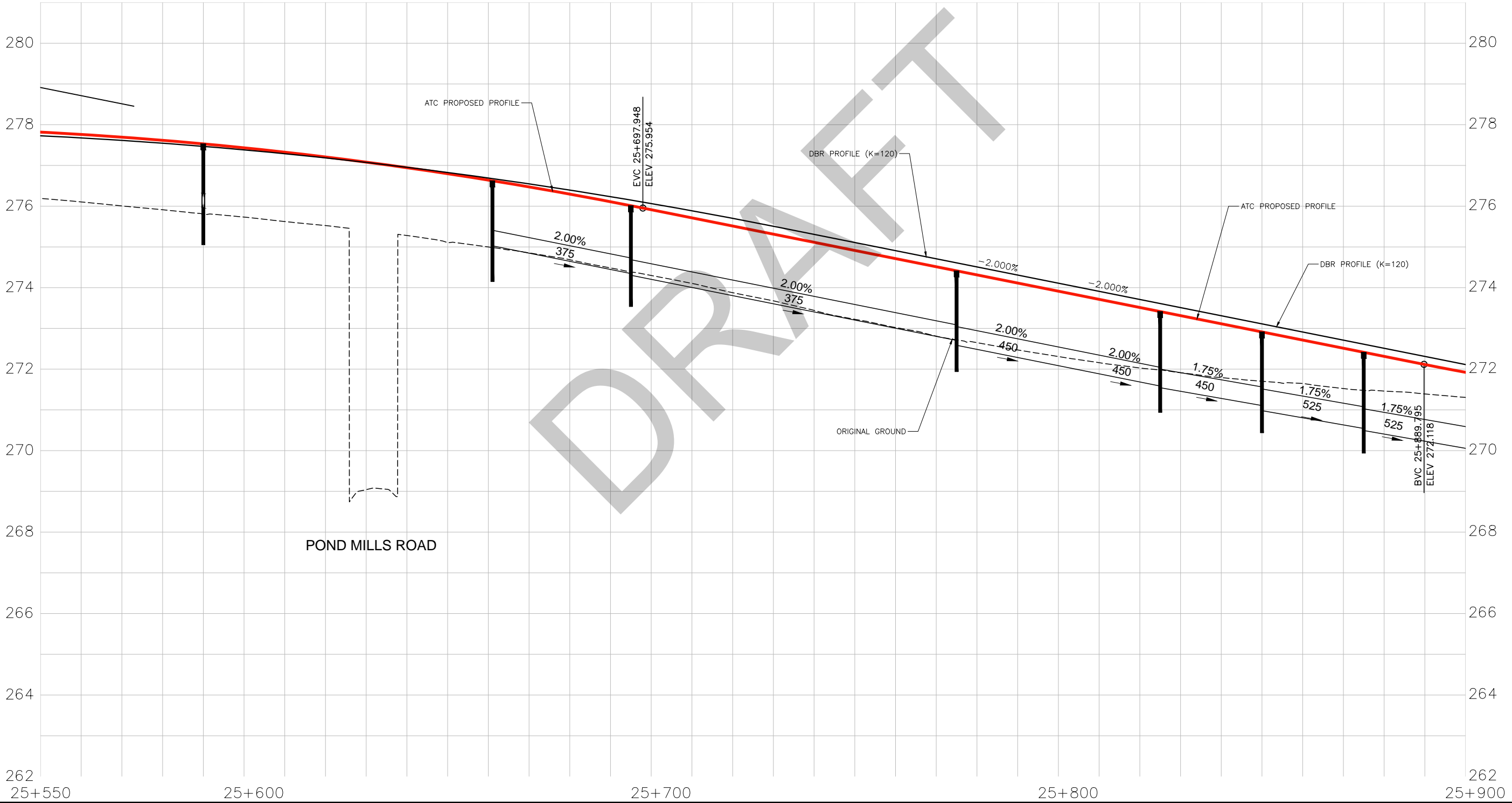
METRIC
DIMENSIONS ARE IN METRES
AND/OR MILLIMETRES
UNLESS OTHERWISE SHOWN

PLATE No
CONT 2022-3004
WP 3032-11-00

PROFILES
STA 25+550 TO STA 25+900
Survey _____ Revised _____



SHEET
5



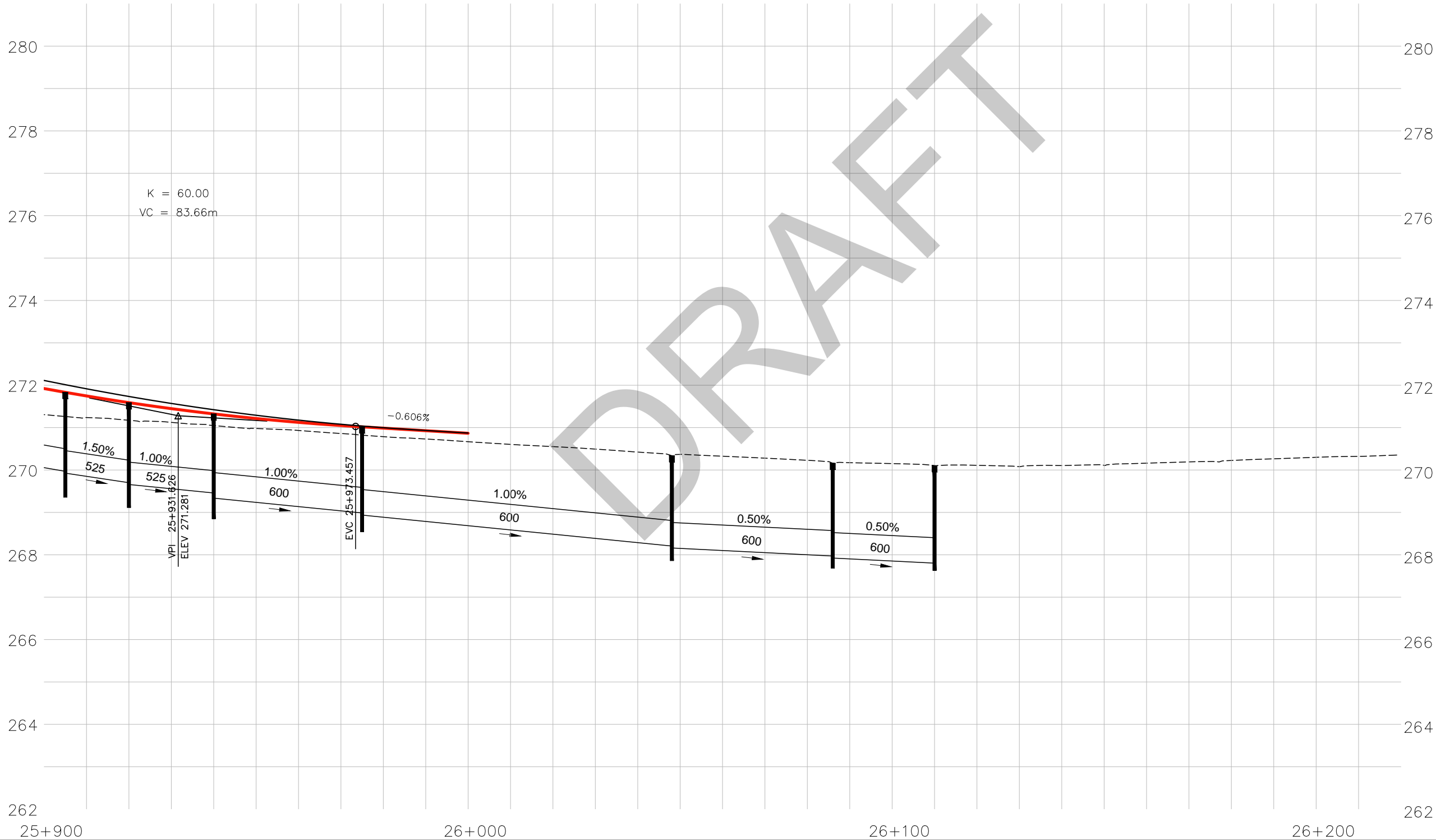
METRIC
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AND/OR MILLIMETRES
UNLESS OTHERWISE SHOWN

PLATE No
CONT 2022-3004
WP 3032-11-00

PROFILES
STA 25+900 TO STA 26+200
Survey Revised



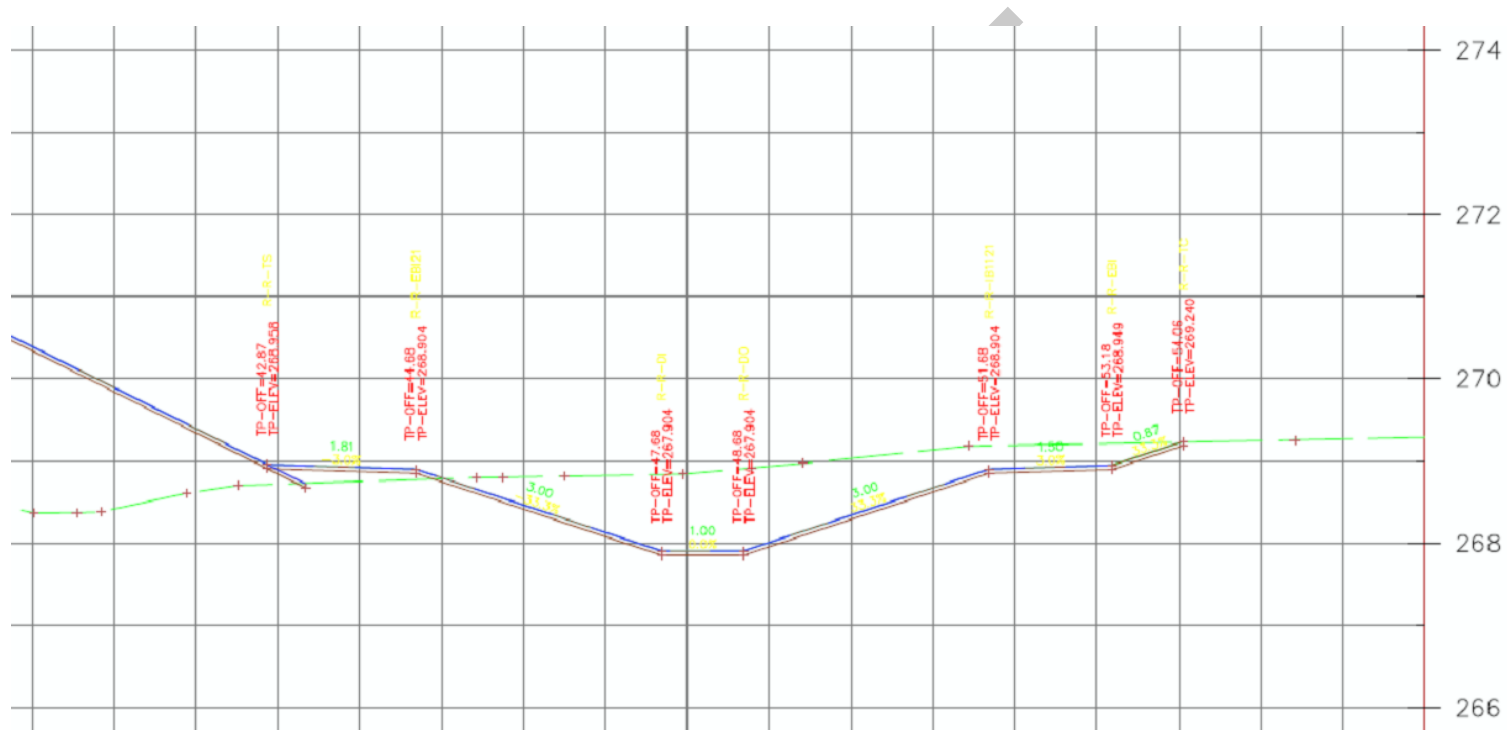
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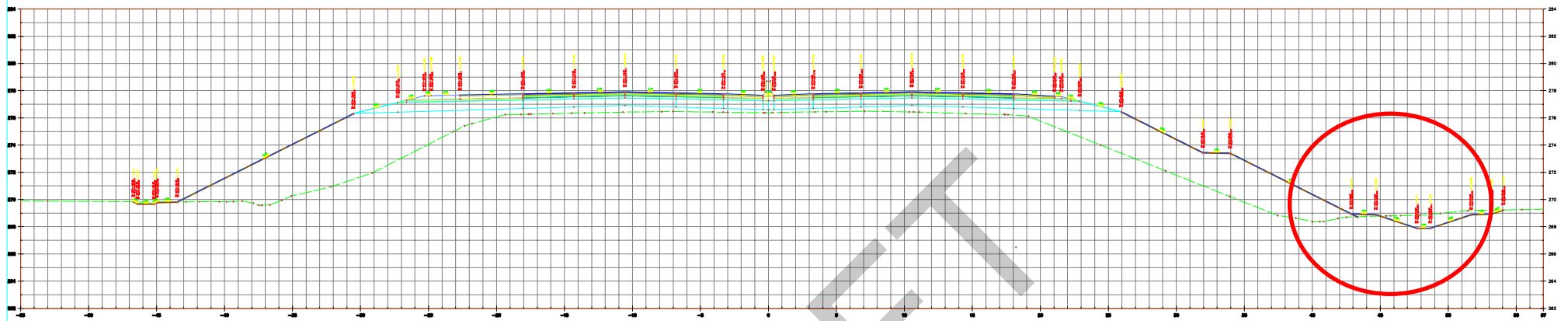


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SCALE
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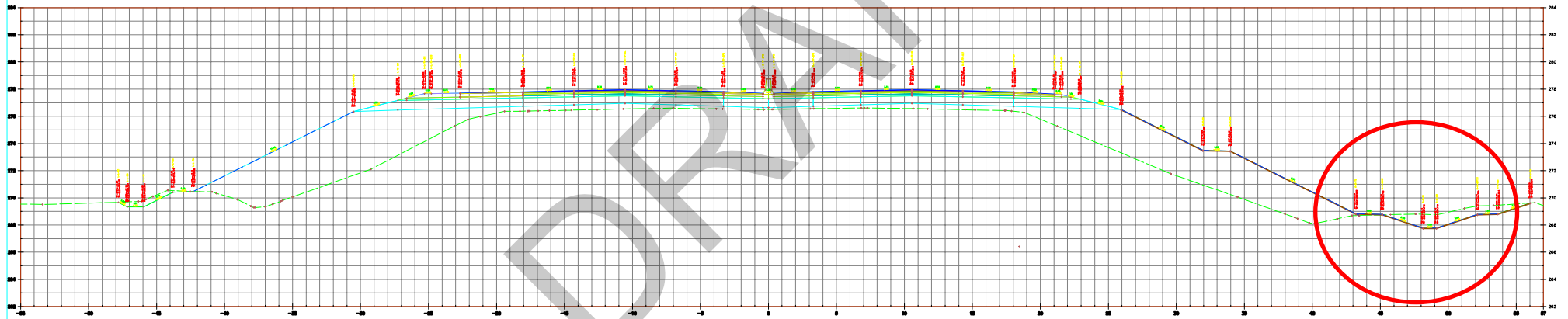
Stormwater Management Facility Cross-Sections

Typical Proposed Storm Water Management Facility Section (1 m deep flat bottom ditch with 3H:1V side slope)

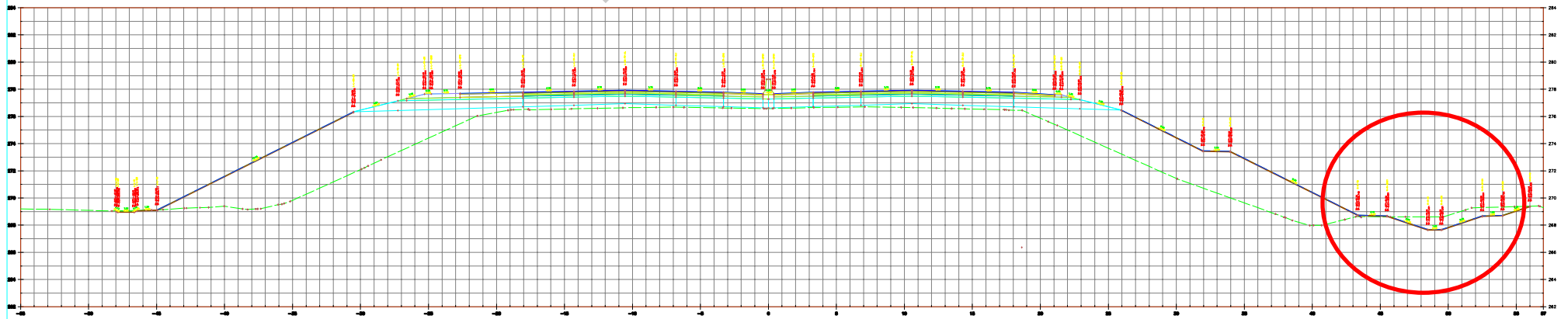




25+525.00



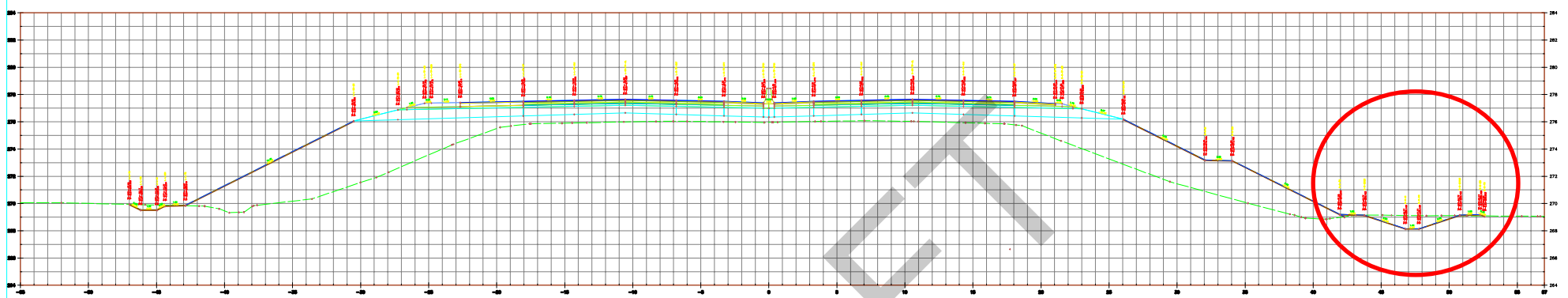
25+500.00



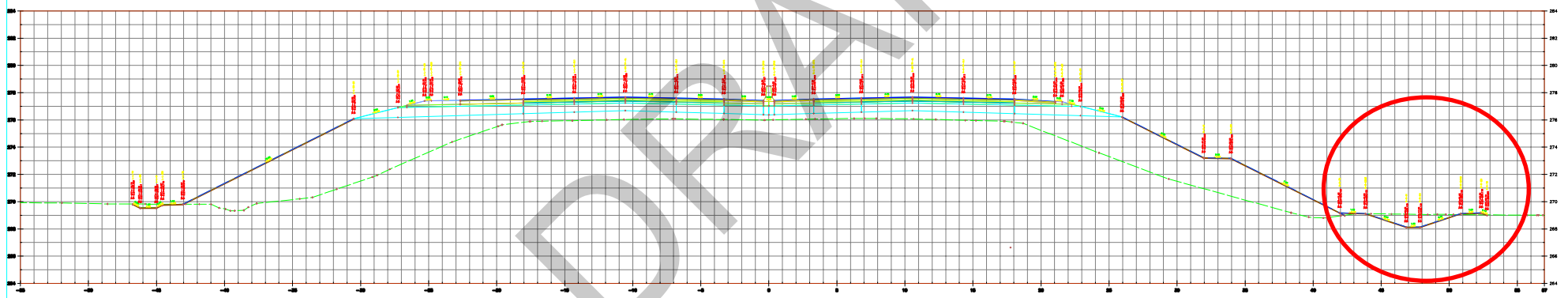
25+480.20

STA 25+480.20 TO STA 25+525.00

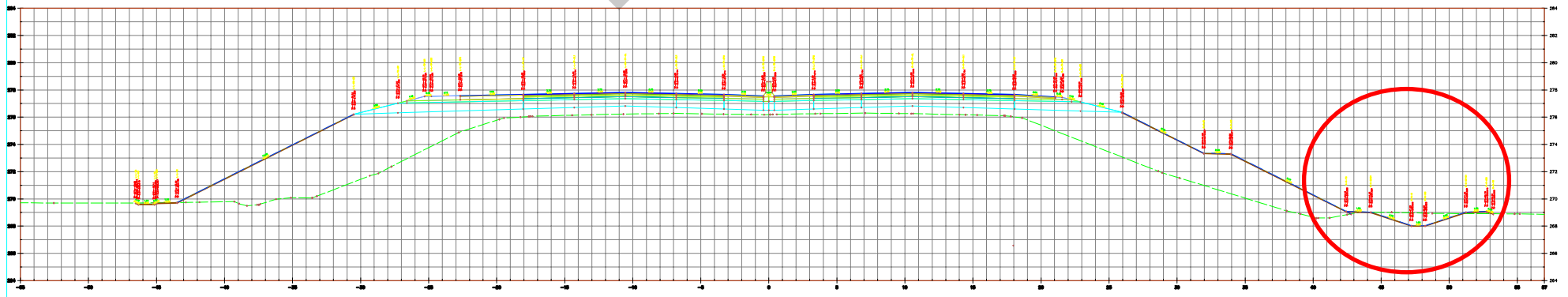
STA 25+550.00 TO STA 25+575.00



25+575.00

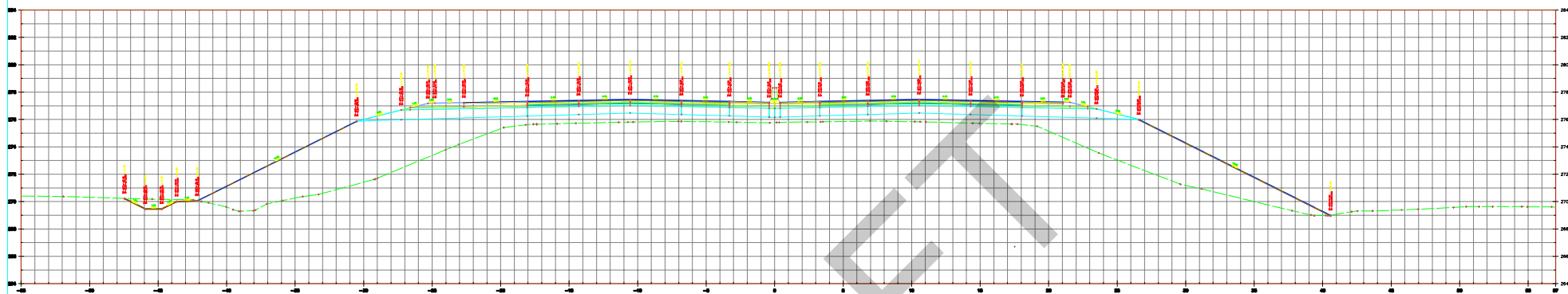


25+570.90

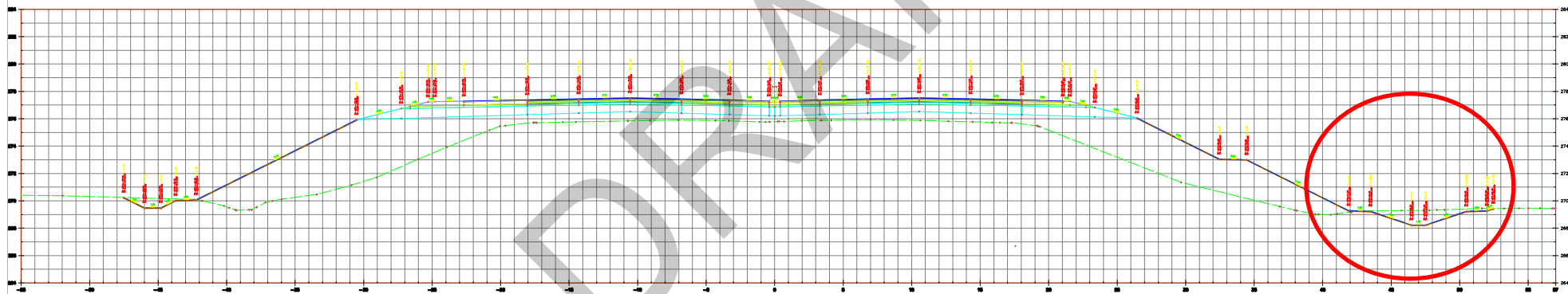


25+550.00

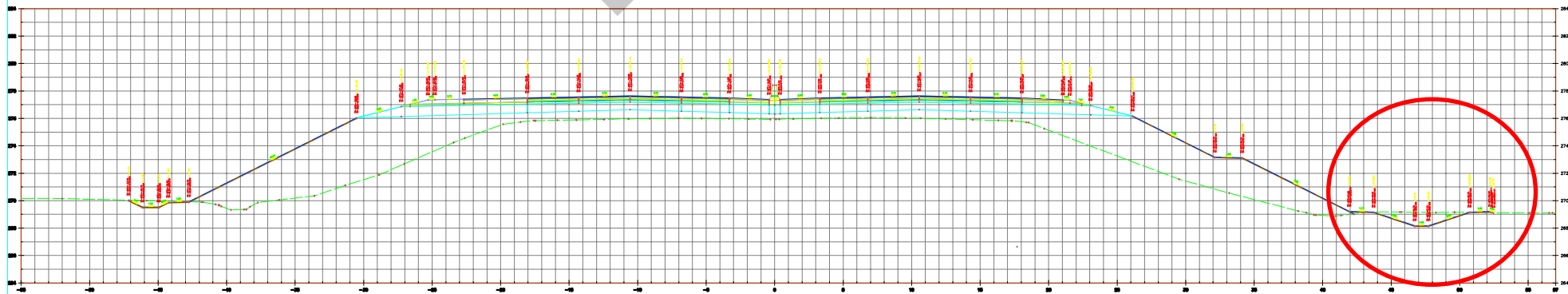
STA 25+577.65 TO STA 25+595.42



25+595.42



25+590.48



25+577.65