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FOUNDATION INVESTIGATION AND DESIGN REPORT
REPLACEMENT OF TWO CULVERTS ON HIGHWAY 6
CENTERLINE OPEN FOOTING CULVERT (ID 451)
NEGRO CREEK CULVERT (ID 453)
TOWNSHIP OF BENTINCK AND TOWNSHIP OF HOLLAND
GREY COUNTY, ONTARIO
AGREEMENT 3022-E-0008
G.W.P. 3015-20-00

GEOCRES NO. 41A02-001
LAT: 44.21380405, LONG: -80.82889834 (CULVERT ID 451)
LAT: 44.36152250, LONG: -80.86789807 (CULVERT ID 453)

Client Name: Egis
Date: March 18, 2025
File: 36459

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THURBER ENGINEERING LTD.

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REPLACEMENT OF TWO CULVERTS ON HIGHWAY 6, DURHAM TO CHATSWORTH
CENTRELINE OPEN FOOTING CULVERT (ID 451) AND NEGRO CREEK CULVERT (ID 453)
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PART 1: FACTUAL INFORMATION

1. INTRODUCTION

Thurber Engineering (Thurber) has been retained by Egis on behalf of the Ministry of Transportation, Ontario (MTO) to provide foundation engineering services to support the detailed design of the replacement of the following two culverts:

- Centerline Open Footing Culvert (ID 451) (Site No. 08X-0451-C0)
- Negro Creek Culvert (ID 453) (Site No. 08X-0453-C0)

This report presents the results of a foundation investigation carried out for the detailed design of the proposed culvert replacements.

The purpose of this investigation was to explore the subsurface conditions at the culvert sites by borehole drilling and laboratory testing and to prepare a borehole location plan, stratigraphic profiles, records of boreholes, laboratory test results, and a description of the subsurface conditions at each culvert site.

It is a condition of this report that Thurber's performance of its professional services is subject to the attached Statement of Limitations and Conditions.

2. SITE DESCRIPTION

2.1 Centerline Open Footing Culvert (ID 451)

The existing Centerline Open Footing Culvert (ID 451) is located on Highway 6 at chainage 17+311 in the Township of Bentinck, approximately 4 km north of Town of Durham, Ontario. The existing culvert is a rigid frame open footing culvert measuring 3048 mm wide and 1219 mm high with a length of 24.08 m.

This culvert site is surrounded by dense vegetation consisting of shrubs and trees. To the west of the culvert, the landscape is characterized by expansive farmland with open fields and sporadic agricultural buildings. The existing culvert carries two lanes of highway traffic over a narrow stream from an upstream reservoir just east of highway to the farmland west of highway. The local terrain is relatively flat with no visible rock outcrops.

2.2 Negro Creek Culvert (ID 453)

The existing Negro Creek Culvert (ID 453) is located on Moto Park Road approximately 50 m West of Highway 6 in the Township of Holland, Ontario. The site is approximately 11 km south of the community of Chatsworth. The existing culvert is a corrugated steel pipe (CSP) elliptical culvert measuring 3.2 m in diameter and 22 m in length.

The local terrain at the existing culvert location is characterized by forest areas to the northwest and southwest, and a relatively large swathe of flat grassed area to the north and a small wetland to the southeast. Negro creek crosses westerly under Highway 6 just south of the intersection and gradually changes to a south to north direction after passing under Moto Park Road just west of the intersection.

3. INVESTIGATION PROCEDURES

3.1 Field Investigation

The field investigation and testing for Culvert 451 was carried out between July 31 and Aug 7, 2024, and consisted of drilling and sampling seven boreholes, designated as Boreholes 451-1 through 451-7. All boreholes except boreholes 451-2 and 451-6 were advanced through the highway embankment, to depths of between 4.8 m and 9.7 m (Elev. 341.0 m and 336.2 m). Boreholes 451-2 and 451-6 were advanced at the culvert outlet and inlet, respectively, near the toe of the highway embankment, to depths of 6.7 m and 8.0 m (Elev. 337.4 and 335.9 m).

The field investigation and testing for Culvert 453, conducted from August 9 to 14, 2024, involved drilling and sampling seven boreholes: 453-1, 453-2, 453-3A, 453-3B, 453-4, 453-5A, and 453-5B. All boreholes, except 453-1, 453-5A, and 453-5B, were drilled through the embankment to depths between 6.1 m (Elev. 316.4 m) and 11.3 m (Elev. 310.3 m). Borehole 453-1 was drilled at the culvert outlet north of Moto Park Road, and 453-5A and 453-5B near the culvert inlet to the south. Boreholes 453-1, 453-5A, and 453-5B reached depths of 4.6 m (Elev. 315.5 m), 3.9 m (Elev. 315.9 m), and 9.8 m (Elev. 310.1 m), respectively.

The Record of Borehole sheets for the boreholes are included in Appendix B.

Utility clearances were obtained prior to mobilization to the site. The borehole co-ordinates and elevations were determined relative to site features (i.e. the existing culverts). The coordinate system MTM NAD 83, Zone 16 was used for the boreholes.

All boreholes were drilled with a rubber track mounted Diedrich D50 drill rig. At Culvert 451, the boreholes were advanced using hollow stem augers in the overburden and HQ coring in the bedrock. At Culvert 453 a combination of hollow stem augers and wash boring / triconing were used to advance the boreholes in the soils. Soil samples were obtained at selected intervals using split-spoon samplers in general accordance with ASTM D1586.

The drilling and sampling operations were supervised on a full-time basis by a member of Thurber’s technical staff, who logged the boreholes and processed the recovered soil and rock core samples for transport to Thurber’s laboratory for further examination and testing.

Groundwater conditions observed in open boreholes are not considered stabilized due to the introduction of water throughout the drilling operations. Two monitoring wells were installed at each culvert location i.e. (BH451-2, 451-3, 453-1 and 453-5B). The monitoring wells consisted of a 50 mm Schedule 40 PVC pipe with a 3.05 m long slotted screen. All other boreholes were backfilled with bentonite and soil cuttings mixture to the ground surface off the road or up to 0.15 m depth on the road and then backfilled with cold patch asphalt to reinstate the pavement surface. Groundwater level readings observed upon completion of drilling are shown on the Record of Borehole sheets.

A summary of borehole elevations, termination depths and elevations, and monitoring well tip are provided in the table below:

Culvert ID	Borehole	Ground Surface Elevation (m)	Borehole Depth / Borehole Termination Elevation (m)
Culvert 451	451-1	346.0	6.5 / 339.6
	451-2	343.9	8.0 / 335.9
	451-3	345.9	9.6 / 336.3
	451-4	345.7	9.5 / 336.2
	451-5	345.9	9.7 / 336.2
	451-6	344.1	6.7 / 337.4
	451-7	345.7	4.8 / 341.0
Culvert 453	453-1	320.1	4.6 / 315.5
	453-2	322.5	6.1 / 316.4
	453-3A	321.7	7.6 / 314.0
	453-3B	321.6	11.3 / 310.3
	453-4	322.1	11.3 / 310.8
	453-5A	319.8	3.9 / 315.9
	453-5B	319.9	9.8 / 310.1

3.2 Laboratory Testing

All recovered soil samples were subjected to visual identification (VI) and natural moisture content determination. Selected samples were subjected to grain size distribution analyses (sieve and / or hydrometer) and Atterberg Limits testing where applicable. Selected intact rock core samples from Culvert 451 were subjected to unconfined compressive strength (UCS) testing and point load testing (PLT). Organic content testing were also carried out on selected samples recovered from boreholes at Culvert 453. The results of this testing program are summarized on the Record of Borehole sheets in Appendix B and are shown on the figures included in Appendix C.

Analytical testing was carried out on soil samples to assess the potential for sulphate attack on buried concrete structures, as well as the potential for corrosion associated with buried steel elements of the structures. The results of the analytical testing are summarized in Section 5 of this report and presented in Appendix C.

4. SITE GEOLOGY AND SUBSURFACE CONDITIONS

4.1 Regional Geology

Based on the Ontario Geological Survey data, Culvert 451 and Culvert 453 site area lie within the physiographic region known as the Horseshoe Moraines.

Quaternary Geology Map indicates the surficial geology of the Culvert 451 area is glaciofluvial outwash deposits consisting of gravel and sand, including proglacial river and deltaic deposits. The surficial geology at Culvert 453 area generally consisted of glaciofluvial ice-contact deposits consisting of gravel and sand, minor till, including esker, kame, end moraine, ice-marginal delta and subaqueous fan deposits.

The published bedrock geology map indicates both culvert sites are underlain by sandstone, shale, dolostone and siltstone of Guelph Formation.

4.2 Subsurface Conditions

The soil stratigraphy encountered at both culverts is detailed on the Record of Borehole sheets in Appendix B, with interpreted stratigraphic profiles and sections presented on Borehole logs and soil strata drawings in Appendix D. A general description of the stratigraphy is provided in the following sections, though the factual data in the Record of Borehole sheets takes precedence. Soil classifications follow ASTM D2487 for coarse soils and MTO's Soil Classification Manual (as amended) for fine-grained soils.

Soil boundaries in the Record of Boreholes were inferred from non-continuous sampling, drilling observations, and test results. These boundaries indicate transitions between soil deposits, not exact geological planes. Variations in stratigraphic boundaries are expected between and beyond boreholes.

4.3 Culvert 451 (BH 451-1 through BH 451-7)

In general, the subsurface conditions encountered below the existing embankment fill or topsoil consisted of a thin layer of clayey silt underlain by sand and gravel to gravelly sand extending to Dolomitic bedrock north of the existing culvert and predominantly sand and gravel to gravelly sand over the bedrock south of the existing culvert.

4.3.1 Asphalt

Boreholes 451-1 and 451-5 were advanced through the paved portion of Highway 6 and the measured asphalt thickness was 190 mm at Borehole 451-1 and 230 mm at Borehole 451-5.

4.3.2 Topsoil

Boreholes 451-2 and 451-6 were advanced through the native ground at the toe of highway embankment and Borehole 451-3 was advanced at the edge of the gravel shoulder. Topsoil thickness ranging between 75 and 200 mm was encountered at the ground surface. It should be noted that topsoil thickness may vary.

4.3.3 Embankment Fill

Embankment fill generally consisting of gravelly sand to sand and gravel to sand and silt some gravel was encountered at the ground surface in Boreholes 451-4 and 451-7, below the asphalt in Boreholes 451-1 and 451-5 and below the topsoil in Borehole 451-3. The embankment fill had a thickness ranging between 1.7 and 2.5 m and extended to depths between 1.8 and 2.7 m (Elev. 344.0 m and 343.1 m).

SPT 'N' values recorded generally ranged from 11 to 64, indicating compact to very dense relative density. SPT 'N' values of 3 and 9 were recorded in Boreholes 451-3 and 451-5 near the base of embankment, indicating loose condition. Natural moisture contents generally ranged from 1 to 18 percent.

The results of grain size analyses carried out on selected samples of the embankment fill are provided on the Record of Borehole sheets in Appendix B and presented in Figure 1 of Appendix C. The results are summarized as follows:

Soil Particle	Sand and Gravel to Gravelly Sand Fill (%)	Sand to Sand and Silt Fill (%)
Gravel	28 to 52	2 - 3
Sand	35 to 59	38 - 77
Silt	-	16 - 53
Clay	-	4 - 7
Silt + Clay	10 to 26	-

4.3.4 Clayey Silt

A deposit of clayey silt was encountered below the embankment fill at depths of 2.2 m and 1.8 m (Elev. 343.8 m and 344.0 m) in Boreholes 451-1 and 451-3, respectively. In Borehole 451-2, this

deposit was encountered below topsoil at 0.1 m depth (Elevation 343.8 m). The deposit was 0.6 to 1.3 m thick.

SPT ‘N’ values recorded generally ranged from 3 to 12, indicating soft to stiff consistency. Natural moisture contents ranged from 10 to 22 percent.

The results of grain size analyses carried out on a selected sample of clayey silt is provided on the Record of Borehole Sheet in Appendix B and presented in Figure 3 of Appendix C. The result is summarized as follows:

Soil Particle	(%)
Gravel	0
Sand	29
Silt	60
Clay	11

The results of the Atterberg Limits test carried out on a sample of clayey silt is shown on the Record of Borehole Sheets in Appendix B and presented in Figure 10 of Appendix C. The result is summarized as follows:

Index Property	Percentage (%)
Liquid Limit	27
Plastic Limit	17
Plastic Index	10

The results of the Atterberg Limits testing indicate the material is of low plasticity (CL).

4.3.5 Sand and Silt to Silty Sand

A deposit of sand and silt to silty sand was encountered below clayey silt deposit at depths 3.0 m, 1.4 m and 2.4 m (Elev. 343.1 m, 342.4 m and 343.5 m) in Boreholes 451-1, 451-2 and 451-3 respectively. The thickness of this deposit ranged between 0.5 and 3.1 m (Base Elev. 339.9 m and 343.4 m). In Borehole 451-3, this deposit becomes gravelly with pockets of gravel encountered at an approximate depth of 4.0 m. In Borehole 451-6, this deposit was encountered below topsoil at a depth of 0.2 m (Elev. 343.9 m).

SPT ‘N’ values recorded generally ranged from 6 to 51, indicating loose to very dense relative density. Natural moisture contents ranged from 9 to 21 percent.

The results of grain size analyses carried out on selected samples of sand and silt to silty sand are provided on the Record of Borehole log in Appendix B and presented in Figure 5 of Appendix C. The result is summarized as follows:

Soil Particle	(%)
Gravel	4 to 9
Sand	47 to 72
Silt	19 to 46
Clay	0 to 3

4.3.6 Sand and Gravel

A native deposit of sand and gravel to gravelly sand was encountered below the existing fill at depths ranging between 2.2 m and 2.7 m (Elev. 343.5 m to 343.1 m) in Boreholes 451-4, 451-5 and 451-7. In Borehole 451-6, this deposit was encountered below silty sand at a depth of 0.7 m (Elev. 343.4 m). The thickness of this deposit ranged between 3.1 and 3.3 m (Base Elev. 340.1 m to 340.2 m). BH 451-7 was terminated in this deposit at a depth of 4.8 m (Elev. 341.0 m).

SPT 'N' values recorded generally ranged from 8 to 37, indicating loose to dense relative density. Natural moisture contents ranged from 8 to 20 percent.

The results of grain size analyses carried out on selected samples of sand and gravel are provided on the Record of Borehole log in Appendix B and presented in Figure 7 of Appendix C. The result is summarized as follows:

Soil Particle	(%)
Gravel	35 to 58
Sand	29 to 55
Silt	-
Clay	-
Silt + Clay	10 to 17

4.3.7 Bedrock

Dolomitic bedrock was encountered at depths ranging between 4.0 m and 5.8 m (Elev.340.5 m and 339.9 m) and was proven by coring in all the boreholes except in Borehole 451-7 which was terminated upon auger refusal on bedrock.

The bedrock consisted of dolomite, slightly to faintly weathered to fresh, fine to medium grained, crystalline, and light grey in color. Photographs of the rock cores are provided in Appendix C. The

rock core quality parameters are summarized below:

Total Core Recovery (TCR) and Solid Core Recovery SCR) in the core runs ranged from 87 to 100 percent and 71 to 100 percent, respectively. The Rock Quality Designation (RQD) determined from the cores recovered ranged from 57 to 98 percent, indicating fair to excellent quality. The Fracture Index (FI) of the rock, expressed as number of fractures per 0.3 m of core, ranged from 0 to 4.

Average unconfined compressive strengths (UCS) of the rock ranged between 61.3 and 151.4 MPa. These estimated rock strength values are interpreted from point load tests that were carried out on select samples from recovered bedrock core.

Unconfined Compressive Strength testing was carried out on two select samples from the recovered bedrock core. Based on the range of the UCS results, the dolomite bedrock is classified as strong to very strong.

4.4 Culvert 453 (BH 453-1, 2, 3A, 3B, 4, 5A and 5B)

In general, the subsurface conditions encountered below the existing embankment fill or topsoil at this culvert site consist of a thin layer of sand and silt to sandy silt underlain by sand and gravel. Auger refusal was encountered in the sand and gravel layer in most of the boreholes. Where the sand and gravel was penetrated through, a layer of clayey silt to silt was encountered before transitioning back to sand and gravel deposit.

4.4.1 Asphalt

Borehole 453-3A was advanced through the paved portion of Moto Park Road and the measured thickness of the asphalt ranged between 130 mm.

4.4.2 Topsoil

Boreholes 453-1 and 453-5A were advanced on the north and south side of Moto Park Road, at the toe of embankment where topsoil approximately 600 mm thick was encountered at the ground surface. Topsoil thickness may vary in other areas of the site.

4.4.3 Embankment Fill

Non-cohesive embankment fill generally consisting of gravelly sand to sand and gravel to sandy silt some gravel was encountered at the ground surface in Boreholes 453-2 and 453-4, below the asphalt in Borehole 453-3A. The embankment fill had a thickness ranging between 2.1 and 3.0 m

and extended to depths ranging between 2.2 and 3.0 m (Elev. 320.3 m and 319.1 m)

SPT 'N' values recorded generally ranged from 12 to 75, indicating compact to very dense condition. Natural moisture contents generally ranged from 2 to 15 percent except in Borehole 453-2 where a moisture content of 44 percent was encountered at depth of 0.5 m.

The results of grain size analyses carried out on selected samples of the embankment fill are provided on the Record of Borehole sheets in Appendix B and presented in Figure 2 of Appendix C. The results are summarized as follows:

Soil Particle	Sand and Gravel to Gravelly Sand Fill (%)	Sandy Silt Fill (%)
Gravel	30 - 36	3
Sand	50 to 53	23
Silt	-	68
Clay	-	6
Silt + Clay	14 to 17	-

The result of the Atterberg Limits test carried out on a sample of the sandy silt fill is shown on the Record of Borehole logs in Appendix B and presented in Figure 9 of Appendix C. The result is summarized as follows:

Index Property	Percentage (%)
Liquid Limit	21
Plastic Limit	17
Plastic Index	4

The results of the Atterberg Limits testing indicate the material can be classified as silt (ML).

4.4.4 Sand and Silt

A deposit generally consisting of sand and silt measuring 0.8 m in thickness, was encountered below the topsoil at a depth of 0.6 m (Elev. 319.5 m) in Borehole 453-1. In Boreholes 453-2, 453-3A, and 453-4, this deposit, ranging from 0.8 to 1.5 m in thickness, was encountered beneath the embankment fill at depths of 2.2 to 3.0 m (Elev. 320.3 to 319.1 m). Additionally, in Boreholes 453-4 and 453-5B, a 1.4 to 3.0 m thick layer of this deposit was also encountered at depths ranging from 4.6 to 7.2 m (Elevation 315.3 to 314.9 m) within the sand and gravel deposit.

In Borehole 453-2 and 453-4, some organic inclusions and rootlets were also encountered at an approximate depth ranging between 2.5 m and 3.1 m (Elev. 320 and 319 m). The measured

organic content in these samples ranged between 6.6 percent and 16.8 percent. Natural moisture content ranged between 75 to 112 percent.

SPT ‘N’ values recorded generally ranged from 4 to 9, indicating loose relative density. Natural moisture contents generally ranged from 15 to 22 percent.

The results of grain size analyses carried out on selected samples of this deposit are provided on the Record of Borehole log in Appendix B and presented in Figure 6 of Appendix C. The result is summarized as follows:

Soil Particle	(%)
Gravel	0 to 11
Sand	13 to 74
Silt	25 to 81
Clay	1 to 6

The result of the Atterberg Limits test carried out on a sample of the sand and silt is shown on the Record of Borehole logs in Appendix B and presented in Figure 12 of Appendix C. The result is summarized as follows:

Index Property	Percentage (%)
Liquid Limit	22
Plastic Limit	19
Plastic Index	3

The results of the Atterberg Limits testing indicate the material can be classified as silt (ML).

4.4.5 Clayey Silt

A 1.6 m thick deposit of clayey silt was encountered below the topsoil at a depth of 0.6 m (elevation 319.2 m) in Borehole 453-5A.

SPT ‘N’ values ranged from 3 to 8, indicating soft to firm consistency. Natural moisture contents ranged from 20 to 39 percent.

The results of grain size analyses carried out on a selected sample of clayey silt is provided on the Record of Borehole log in Appendix B and presented in Figure 4 of Appendix C. The result is summarized as follows:

Soil Particle	(%)
Gravel	0
Sand	14
Silt	77
Clay	9

The results of the Atterberg Limits test carried out on sample of clayey silt deposit is shown on the Record of Borehole logs in Appendix B and presented in Figure11 of Appendix C. The result is summarized as follows:

Index Property	Percentage (%)
Liquid Limit	29
Plastic Limit	19
Plastic Index	10

The results of the Atterberg Limits testing indicate the material is clay of low plasticity (CL).

4.4.6 Sand and Gravel

A deposit of sand and gravel was encountered below the sand and silt deposit at depths ranging between 1.4 m and 4.5 m (318.6 m and 317.6 m) in all the boreholes except Borehole 453-5A and extended to the termination depth in all the boreholes. In Borehole 453-5A, this deposit was encountered below clayey silt deposit at a depth 2.2 m (Elev. 317.6 m).

Borehole 453-3A encountered auger refusal at 7.6 m (Elev. 314.0 m), due to which Borehole 453-3B was drilled at 2.0 m east. Borehole 453-3B was advanced without sampling to 7.6 m (Elev. 314.0 m) and advanced further with sampling within sand and gravel deposit extending up to termination depth at 11.3 m (Elev. 310.3 m). Layer of clayey silt to silt was encountered within sand and gravel deposit.

Borehole 453-5A encountered auger refusal at 3.9 m (Elev. 315.6 m), due to which Borehole 453-5B was drilled at 1.0 m east. Borehole 453-5B was advanced without sampling to 4.6 m (Elev. 315.3 m) and advanced further with sampling within sand and gravel deposit extending to termination depth at 9.8 m (Elev. 310.1 m). A layer of silty sand underlain by a layer of clayey silt was encountered within the sand and gravel deposit.

SPT ‘N’ values recorded generally ranged from 10 to more than 50 blows, indicating compact to very dense relative density. Natural moisture contents ranged from 4 to 24 percent.

The results of grain size analyses carried out on selected samples of sand and gravel are provided on the Record of Borehole log in Appendix B and presented in Figure 8 of Appendix C. The result is summarized as follows:

Soil Particle	(%)
Gravel	30 to 70
Sand	26 to 60
Silt	-
Clay	-
Silt + Clay	4 to 15

4.4.7 Sand and Silt

A layer of sand and silt approximately 1.4 to 3.0 m thick was encountered at an approximate depth ranging between 4.6 m and 7.2 m (Elev. 315.3 m and 314.9 m) within sand and gravel deposit in Boreholes 453-4 and 453-5B.

SPT 'N' values ranged from 12 to 30, indicating compact relative density. Natural moisture contents ranged from 17 to 21 percent

The results of grain size analyses carried out on a selected sample of sand and silt is provided on the Record of Borehole log in Appendix B and presented in Figure 6 of Appendix C. The result is summarized as follows:

Soil Particle	(%)
Gravel	0
Sand	2 to 74
Silt	25 to 96
Clay	2

4.4.8 Clayey Silt

A layer of clayey silt approximately 1.5 m to 1.6 m thick was encountered at an approximate depth ranging between 6.0 m and 8.7 m (Elev. 313.9 m and 312.9 m) within sand and gravel deposit in Boreholes 453-3B and 453-5B.

SPT 'N' value of 48 and 6 blows were encountered in Boreholes 453-3B and 453-5B, respectively, indicating hard to firm consistency. Natural moisture contents ranged from 16 to 20 percent.

The results of grain size analyses carried out on a selected sample of clayey silt is provided on the Record of Borehole log in Appendix B and presented in Figure 4 of Appendix C. The result is summarized as follows:

Soil Particle	(%)
Gravel	2
Sand	8
Silt	73
Clay	17

The results of the Atterberg Limits test carried out on sample of clayey silt deposit is shown on the Record of Borehole logs in Appendix B and presented in Figure 11 of Appendix C. The result is summarized as follows:

Index Property	Percentage (%)
Liquid Limit	21
Plastic Limit	13
Plastic Index	8

The results of the Atterberg Limits testing indicate the material is clay of low plasticity (CL).

4.5 Groundwater Conditions

Details of the water level observed in the monitoring wells are presented on the record of boreholes and summarized below.

Borehole	Date of Measurement	Groundwater Level	
		Depth (m)	Elevation (m)
Culvert 451			
451-2	Aug 7, 2024 Sept 24, 2024	2.4 1.7	341.5 342.2
451-3	Aug 2, 2024 Sept 24, 2024	3.4 3.4	342.5 342.5
Culvert 453			
453-1	Aug 14, 2024 Sept 24, 2024	1.6 0.2	318.5 319.9
453-5B	Aug 14, 2024 Sept 24, 2024	1.0 0.1	318.9 319.8

The water levels measured in the monitoring wells, and creek are short-term observations and subject to seasonal fluctuations. In particular, the water levels may be at a higher elevation during spring and after periods of significant or prolonged precipitation.

5. ANALYTICAL LABORATORY TESTING

A total of four samples, i.e. two samples from Culvert 451 and two samples from Culvert 453 were submitted for corrosivity analysis and sulphide content. The analytical results for the native soil are presented in Appendix C and are summarized below.

Borehole	Culvert 451		Culvert 453	
	451-4 SS5	451-5 SS4	453-3A SS5A	453-2 SS5B
Depth (m)	3.0 to 3.6	3.0 to 3.6	3.0 to 3.5	3.1 to 3.6
Elevation (m)	342.7	342.9	318.7	319.4
Sulphide (%)	<0.01	<0.01	0.03	0.03
Chloride (µg/g)	70	110	50	10
Sulphate (µg/g)	11	12	160	37
pH	8.90	9.12	8.49	7.96
Conductivity (mS/cm)	202	200	199	498
Resistivity (Ohm-cm)	4,950	5,000	5,030	2,010

6. MISCELLANEOUS

Walker Drilling Ltd. Of Utopia, Ontario supplied and operated the drilling, sampling, and in-situ testing equipment for the field investigation.

The coordinates and elevations for the boreholes were obtained by Thurber using a Trimble R10.

The field investigation was supervised on a full-time basis by Mr. Oleksandr Pogurzhelskyy, EIT. The overall management of the field program was conducted by Ms. Alysha Kobylinski, P.Eng.

Geotechnical laboratory testing on soil samples was carried out in Thurber's geotechnical laboratory. Testing for corrosivity potential of soil was carried out by SGS Laboratories, a CALA accredited analytical laboratory in Lakefield, Ontario.

Interpretation of the field data and preparation of this report was carried out by Mr. Puneet Verma, P.Eng. The report was reviewed by Mr. Keli Shi, P.Eng., and Dr. P.K. Chatterji, Ph.D., P.Eng., a Designated Principal Contact for MTO Foundations projects.

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PART 2: ENGINEERING DISCUSSION AND RECOMMENDATIONS

7. GENERAL

This report provides an interpretation of the geotechnical data in the foundation investigation report and presents foundation design recommendations for the detailed design of replacement of Culvert 451 and Culvert 453.

This foundation investigation and design report with the interpretation and recommendations are intended for the use of the Ministry of Transportation, Ontario, and the designer, Egis, to carry out the detailed design of the culvert replacements and shall not be used or relied upon for any other purposes or by any other parties including the constructor or design-build contractor. The constructor or contractor must make their own interpretation based on the data provided in the factual portion of the report (Part 1).

Where comments are made on construction, they are provided to highlight those aspects which could affect the design of the project. The constructor or contractor must make their own interpretation of the factual data as such interpretation may affect equipment selection, proposed construction methods, scheduling, and the like.

The existing Culvert 451 is a rigid frame open footing culvert measuring 3048 mm wide and 1219 mm high with a length of 24.08 m. The year of construction of this culvert is unknown. The culvert accommodates two lanes of Highway 6, oriented in the north-south direction. At culvert's centerline, the surface of the highway is approximately at Elev. 346.0 m and the base of the existing open footings is at approximate elevation 342.0 m. The height of embankment is approximately 3.0 m. The existing culvert allows flow in an east to west direction under the highway embankment.

The existing Culvert 453 is a corrugated steel pipe (CSP) ellipse culvert measuring 3.2 m in diameter and 22 m in length. The culvert was built in 1950 and accommodates two lanes of Moto Park Road, located west of Highway 6. At the culvert's centerline, the road surface elevation is about 322.0 m, and the base of the existing culvert is at approximate elevation 319.3 m. The height of the embankment is approximately 3.0 m. The culvert facilitates water flow from south to north direction beneath the Moto Park Road embankment.

The discussion and recommendations presented in this report are based on the factual data obtained during the course of the investigation. The preliminary General Arrangement (GA) drawings used for the preparation of this report were provided by Egis. GA drawings are also provided in Appendix G.

8. CULVERT DESIGN

8.1 Culvert Alternatives

Based on the General Arrangement (GA) Drawings for the culvert replacement options from Egis, it is understood that:

The existing Culvert 451 is proposed to be replaced by a new precast concrete open footing culvert with footing bases founded at an approximate elevation 342 m. The new culvert, 3.9 m wide and 2.4 m high, will be installed along the same alignment as the existing culvert, and staged construction will be required for the culvert replacement. The soil cover above the new culvert will be approximately 614 mm.

The existing Culvert 453 is proposed to be replaced by a new concrete box culvert founded at elevation of 319 m. The new box culvert, 3.6 m wide and 1.8 m high, will be installed along the same alignment as the existing culvert. The soil cover above the new culvert will be approximately 350 mm. The existing creek will be diverted through a 1.8 m diameter Corrugated Steel Pipe (CSP) temporary bypass culvert to be constructed at about 7.5 m east of the existing culvert.

Based on the preliminary GA drawings, two culvert options, i.e. Concrete box (closed) culvert and Precast Concrete Open Footing culvert are discussed in the following sections.

8.2 Summary of Subsurface Conditions

8.2.1 Culvert 451

In general, the subsurface conditions encountered below the existing embankment fill or topsoil at this culvert site consists of a thin layer of clayey silt underlain by sand and gravel to gravelly

sand extending to dolomitic bedrock north of the existing culvert and predominantly sand and gravel to gravelly sand over the bedrock south of the existing culvert. The bedrock surface, where encountered, was at elevation ranging between 340.5 and 339.9 m or at depths of 4.0 to 5.8 m below the ground surface.

The groundwater table measured in the monitoring wells at the culvert ends ranged between 1.7 m and 3.4 m below ground surface, i.e. Elev. ranging between 342.5 and 342.2 m.

8.2.2 Culvert 453

In general, the subsurface conditions encountered below the existing embankment fill or topsoil at this culvert site consist of a thin layer of sand and silt to sandy silt underlain by sand and gravel. Auger refusal was encountered in the sand and gravel layer in most of the boreholes. Where the upper sand and gravel layer was penetrated through, a 1.5 to 3 m layer of clayey silt to silt was encountered before transitioning back to sand and gravel deposit.

The groundwater table measured in the monitoring wells at culvert ends ranged between 0.2 m and 0.1 m below ground surface i.e. Elev. ranging between 319.9 and 319.8 m.

8.3 Foundation Design for Culverts

The following sections provide geotechnical recommendations for two culvert alternatives, i.e. Concrete Box culvert and Open footing culvert at both culvert locations.

CSP pipe culvert is considered feasible from a geotechnical perspective. However, the structural designer indicated that CSP culvert was not chosen to be the preferred alternative due to its shorter service life and higher environmental impacts when compared to concrete culverts. Therefore, the CSP culvert alternative was not pursued further.

8.3.1 Culvert 451

Both open footing culvert and concrete box culvert are considered feasible at this location. Consideration should be given to the use of box culvert at this culvert location to reduce dewatering requirements. At the proposed culvert founding elevation of 342 m, the base of culvert will be supported on compact to dense sand and gravel to sand and silt containing some gravel to gravelly.

- Precast Concrete Open Footing Culvert

Construction dewatering will be required to permit subgrade preparation for the footing

construction in the dry. Following excavation to the design base elevation, a minimum 100 mm thick mass concrete working pad should be placed at the base of the excavation to protect the native subgrade. The native subgrade should be protected from all disturbances including construction equipment and vehicles and weather elements.

The following geotechnical resistances are recommended for the culvert design with a minimum 1.35 m wide footing founded at or below Elevation 342.0 m.

- Factored Geotechnical Resistance at ULS of 225 kPa
- Geotechnical Resistance at SLS (less than 25 mm settlement) of 150 kPa.

The ULS resistance and settlement are dependent on the footing/culvert size, configuration and applied loads; the geotechnical resistances should, therefore, be reviewed if the culvert width or founding elevation differs significantly from that given above.

The geotechnical resistances are for vertical, concentric loads. Where eccentric or inclined loads are applied, the resistance used in design must be reduced in accordance with the latest Canadian Highway Bridge Design Code (CHBDC).

Resistance to lateral forces/sliding between concrete footing and native subgrade should be evaluated in accordance with the CHBDC assuming an ultimate/unfactored coefficient of friction of 0.4. A resistance factor of 0.8 should be applied to this ultimate value.

The culvert should be designed to resist external loadings, including lateral earth pressure, hydrostatic pressure, weight of embankment fill, traffic loadings and surcharge due to construction equipment and activities.

- Concrete Box Culvert

To provide a uniform foundation subgrade, a minimum 300 mm thick layer of bedding material conforming to OPSS.PROV 1010 Granular A or Granular B Type II requirements should be provided under the base of the box culvert as shown on OPSD 803.010. The bedding material should be placed on the native, undisturbed, prepared subgrade as soon as practicable following its inspection and approval. Any buried topsoil, soft and very loose organic or other deleterious material encountered during subgrade preparation should be sub-excavated and replaced with compacted granular material to provide a uniformly competent subgrade condition. The subgrade preparation and placement and compaction of the bedding material should be carried out in the dry. The bedding layer prepared to support the box units should have a 75 mm minimum thick top levelling course consisting of uncompacted Granular A as per OPSS.PROV 422. Construction

equipment should not be allowed to travel on the bedding or the prepared subgrade, which should be protected from disturbance during construction.

Alternatively, if construction dewatering is not feasible, subgrade and bedding preparation for the placement of concrete box culvert may be carried out in wet conditions.

It is understood that no grade raise or embankment widening is proposed at this culvert site. Therefore, the subgrade soils within the culvert footprint will not be subjected to significant additional loading due to the culvert replacement.

Groundwater lowering in the cohesionless soils below the groundwater level is expected to be difficult without the installation of watertight cofferdam at this site. Construction in the wet is an option for the culvert installation, including subgrade preparation, culvert bedding and backfilling. This approach will require temporary diversion of the upstream flow and surface water so that the excavations can be done within stagnant water. Pumping to remove groundwater seepage up to the daily flow allowance (assessed by project hydrogeologist) should also be used to lower the groundwater level in the excavation as much as possible for bedding placement. Pumping within excavation must not cause base stability issues such as basal heave or piping. If the water level cannot be lowered below the culvert bedding level, 53 mm clear stone should be used for bedding. The minimum thickness of clear stone bedding should be 300 mm (recommended 450 mm).

53 mm clear stone, as per OPSS.PROV 1004 could be used for backfilling in the wet below the culvert. To help provide a level surface for placement of the box culvert, 19 mm Type II clear stone may be used for the top 150 mm of bedding placed below the water level.

Once clear stone backfill is above the water level, granular bedding for the culvert may be placed in the dry. The granular bedding placed above the water may consist of OPSS.PROV 1010 Granular A or Granular B Type II. The granular bedding should be placed in the dry so that it can be compacted as per OPSS.PROV 501. A separation layer consisting of a non-woven geotextile should be placed between the clear stone and the granular bedding. The geotextile should meet the specifications for the OPSS.PROV 1860 Class II and have a fabric opening size (FOS) not greater than 212 µm. The bedding should be completely wrapped with geotextile to minimize migration of the fines into the clear stone.

The following geotechnical resistances are recommended for the design of a 4 to 5 m wide concrete box culvert founded at or below Elevation 342.0 m.

- Factored Geotechnical Resistance at ULS of 225 kPa
- Geotechnical Resistance at SLS (up to 25 mm settlement) of 150 kPa.

The geotechnical resistances are for vertical, concentric loads. Where eccentric or inclined loads are applied, the resistance used in design must be reduced in accordance with the latest Canadian Highway Bridge Design Code (CHBDC).

Resistance to lateral forces/sliding between concrete box and clear stone bedding should be evaluated in accordance with the CHBDC assuming an ultimate/unfactored coefficient of friction of 0.55. A resistance factor of 0.8 should be applied to this ultimate value.

The culvert should be designed to resist external loadings, including lateral earth pressure, hydrostatic pressure, weight of embankment fill, traffic loadings and surcharge due to construction equipment and activities.

8.3.2 Culvert 453

- Precast Concrete Open Footing Culvert

Excavation for footing construction will extend approximately 2.5 m below the groundwater table to reach competent sand and gravel subgrade. Construction dewatering would be required to permit subgrade preparation for the footing construction in the dry. A robust dewatering system would need to be designed and constructed to minimize disturbance to load bearing subgrade soil associated with dewatering in the cohesionless deposit below ground water level. Considering the requirement for extensive dewatering in cohesionless soils and the potential for differential settlement between the two footings, open footing culvert is not recommended at this site.

- Concrete Box Culvert

To provide a uniform foundation subgrade, a minimum 300 mm thick layer of bedding material conforming to OPSS.PROV 1010 Granular A or Granular B Type II requirements should be provided under the base of the box culvert as shown on OPSD 803.010. The bedding material should be placed on the native, undisturbed, prepared subgrade as soon as practicable following its inspection and approval.

Any buried topsoil, soft and very loose organic or other deleterious material encountered during subgrade preparation should be sub-excavated and replaced with compacted granular material to provide a uniformly competent subgrade condition. The subgrade preparation and placement and compaction of the bedding material should be carried out in the dry. The bedding layer prepared to support the box units should have a 75 mm minimum thick top levelling course consisting of uncompacted Granular A as per OPSS.PROV 422. Construction equipment should

not be allowed to travel on the bedding or the prepared subgrade, which should be protected from disturbance during construction.

The loose sand and silt containing organic matter encountered underlying the embankment fill should be removed down to an approximate Elev. 317 m and backfilled with compacted granular material to reinstate the culvert founding elevation at 319 m.

The following geotechnical resistances are recommended for the design of approximately 4.0 m wide new box culvert constructed within properly dewatered excavation:

- Factored Geotechnical Resistance at ULS of 225 kPa
- Geotechnical Resistance at SLS (less than 25 mm settlement) of 150 kPa.

Alternatively, if construction dewatering is not feasible, subgrade and bedding preparation for the placement of box culvert may be carried out in wet conditions as described for Culvert 451.

It is understood that no grade raise or embankment widening is proposed at this culvert site. Therefore, the subgrade soils within the culvert footprint will not be subjected to significant additional loading due to the culvert replacement.

The following geotechnical resistances are recommended for the design of approximately 4 m wide concrete box culvert constructed in wet and founded at or below Elevation 319 m.

- Factored Geotechnical Resistance at ULS of 200 kPa
- Geotechnical Resistance at SLS (up to 25 mm settlement) of 125 kPa.

The geotechnical resistances are for vertical, concentric loads. Where eccentric or inclined loads are applied, the resistance used in design must be reduced in accordance with the latest Canadian Highway Bridge Design Code (CHBDC).

Resistance to lateral forces/sliding between concrete box and clear stone bedding should be evaluated in accordance with the CHBDC assuming an ultimate/unfactored coefficient of friction of 0.55. A resistance factor of 0.8 should be applied to this ultimate value.

The culvert should be designed to resist external loadings, including lateral earth pressure, hydrostatic pressure, weight of embankment fill, traffic loadings and surcharge due to construction equipment and activities.

8.4 Depth of Frost Penetration

The depth of frost penetration at Culvert 451 and Culvert 453 is 1.6 m based on OPSD 3090.101. The footings for an open footing culvert must be founded below the depth of frost. The frost cover requirement does not apply to the box culvert option.

Frost treatment / tapers should be in accordance with OPSD 803.010. Pavement designers should be consulted on whether a new frost taper is required at this site.

8.5 Excavation and Groundwater Control

All excavations should be carried out in accordance with the Occupational Health and Safety Act (OHSA). For the purposes of the OHSA, and for relatively shallow temporary excavation, the cohesionless fill / soils at this site are classified as Type 3 soil above the water table. Below the water table, the cohesionless fill / soils would be classified as Type 4 soils.

Based on the preliminary general arrangement drawings, the depth of excavation will be approximately 4 m and 3.5 m at Culvert 451 and Culvert 453, respectively. Temporary cut slopes for culvert replacement should be constructed to 1.5H:1V or flatter, provided that the groundwater table is lowered to a minimum of 0.5 m below the final base of the excavation. All temporary cut slopes must remain stable throughout the construction until the excavation is fully backfilled.

For Culvert 451, excavation for footing construction will extend approximately 0.5 m below the highest measured ground water table. Construction dewatering for the proposed culvert replacement should lower the ground water table to a minimum of 0.5 m below the final base of excavation or approximate elevation 341.5 m. This requires lowering the groundwater by approximately 1.0 m to allow dry construction conditions and to ensure proper compaction of the bedding and backfill materials. A properly designed dewatering system consisting of cofferdam and wellpoints should be considered. The design of dewatering system is the responsibility of the contractor. In light of the requirement for dewatering for footing construction, box culvert should be considered for Culvert 451.

For Culvert 453, the excavation for culvert construction will extend up to 2.5 m below the groundwater table to remove the loose sand and silt and to reach the competent sand and gravel subgrade. Construction dewatering for the proposed culvert replacement should lower the ground water table to a minimum of 0.5 m below the final base of excavation or approximate elevation 317 m. This is approximately 3 m of ground water lowering within the excavation to permit bedding placement and culvert construction in the dry and to facilitate compaction of the bedding and backfill materials. It is understood that the creek will be diverted through 1.8 m diameter temporary diversion pipe during construction. Surface runoff and groundwater seepage from the

embankment fill should be anticipated and will accumulate in the excavations if not controlled. A combination of cofferdam enclosures and stream diversion along with pumping from properly filtered sumps within an enclosure will be required to maintain dry excavations for the duration of construction. The design of dewatering system is the responsibility of the contractor.

The Contract Documents must alert the Contractor to this responsibility and to design the system in accordance with OPSS.PROV 517 and its amendment SP 517F01. A preconstruction survey is not required at this site, thus Designer Fill-In (Note 3) in Table 1 of SP 517F01 should be “N/A”.

The groundwater level will fluctuate and the minimum groundwater elevation at the time of the proposed work should be taken as the creek water level or the design storm return period defined by the contract documents for the temporary dewatering system.

It is understood that PTTW or EASR requirements for construction dewatering will be assessed by others.

9. CULVERT BACKFILL AND LATERAL EARTH PRESSURES

Backfill to the culvert should consist of free-draining, non-frost susceptible granular materials such as Granular A or B Type II conforming to the requirements of OPSS.PROV 1010. Reference should be made to the backfill arrangements stipulated in OPSD 802.010 or 803.010, as appropriate. Backfilling for the culvert should be in accordance with OPSS.PROV 902. All fills should be placed in regular lifts and be compacted in accordance with OPSS.PROV 501. The backfill should be placed and compacted in simultaneous lifts on both sides of the culvert, and the top of backfill elevation should not differ by more than 500 mm on each side of the culvert at all times. Heavy compaction equipment should not be used adjacent to the walls and on the roof / obvert of the culverts. Compaction equipment to be used adjacent to the culvert should be restricted in accordance with OPSS.PROV 501.

Lateral earth pressures acting on the culvert walls may be assumed to be a triangular distribution. For a fully drained backfill, the pressures should be computed in accordance with the CHBDC 2019, but are generally given by the expression:

$$p_h = K(\gamma h + q)$$

where

p_h	=	horizontal pressure on the wall at depth h (kPa)
K	=	earth pressure coefficient (see table below)
γ	=	bulk unit weight of retained soil (see table below)
h	=	depth below top of fill where pressure is computed (m)

q = value of any surcharge (kPa)

Earth pressure coefficients for backfill to the culvert walls are dependent on the material used as backfill. Recommended unfactored values are shown in the table below.

Loading Condition	OPSS Granular A or Granular B Type II $\phi = 35°$; $\gamma = 22$ kN/m^3	
	Horizontal Backfill	Sloping Backfill (2H:1V)
Active (Unrestrained Wall)	0.27	0.40
At-rest (Restrained Wall)	0.43	0.62
Passive	3.7	-

Note: Submerged unit weight should be used below the groundwater level

For rigid structures such as concrete box culverts, at-rest horizontal earth pressures should be used for design. Active earth pressures should be used for any unrestrained wall.

In accordance with Clause 6.12.3 of the CHBDC 2019, a compaction surcharge should be added.

10. SEISMIC CONSIDERATIONS

In accordance with the CHBDC 2019, the selection of the seismic site classification is based on the soil conditions encountered in the upper 30 m of the stratigraphy. The seismic site class is classified in accordance with Table 4.1, Clause 4.4.3.2 of the CHBDC.

Based on the presence of generally compact to dense sand and gravel to sand and silt underlain by shallow bedrock at Culvert 451, the site is classified as Seismic Site Class C. The peak ground acceleration, PGA, for a 2% in 50-year probability of exceedance at this site is 0.074 g as per the National Building Code of Canada (NBCC 2020).

Based on the presence of generally loose sand and silt underlain by compact to dense sand and gravel at Culvert 453, the site is classified as Seismic Site Class D. The peak ground acceleration, PGA, for a 2% in 50-year probability of exceedance at this site is 0.113 g as per the National Building Code of Canada (NBCC 2020).

In accordance with Section 6.14.7 of the CHBDC 2019, the culvert walls should be designed using active (K_{AE}) and passive (K_{PE}) earth pressure coefficients that incorporate the effects of earthquake loading. The coefficients of horizontal earth pressure for seismic loading presented in the table below may be used:

Condition	Earth Pressure Coefficient (K)			
	OPSS Granular A or Granular B Type II $\phi = 35°, \gamma = 22$ kN/m^3		Existing Granular Fill $\phi = 32°, \gamma = 22$ kN/m^3	
	Culvert 451	Culvert 453	Culvert 451	Culvert 453
Active (K_{AE})	0.29	0.30	0.33	0.34
At Rest (K_{OE})	0.50	0.54	0.54	0.58
Passive (K_{PE})	3.6	3.6	3.2	3.1

In view of the low potential for seismic activity in the area, liquefaction is not considered to be a concern at both culvert sites.

11. COFFERDAMS

Construction of cofferdams will be required for stream diversion and constructing the culvert replacement in the dry. Options for cofferdams may include interlocking sheet piles and water-filled inflatable cofferdams such as Aquadam. Water-filled inflatable cofferdams are anticipated to be feasible at Culvert 451 and sheet pile cofferdams are anticipated to be feasible at Culvert 453 as it can be driven into the clayey silt to silt within the sand and gravel deposit. The recommendations provided below for Temporary Protection Systems are also applicable to sheet pile cofferdams.

12. TEMPORARY PROTECTION SYSTEMS

A temporary roadway protection system should be implemented at Culvert 451 to facilitate the staged construction in accordance with OPSS.PROV 539 and designed for Performance Level 2. It is understood that a temporary protection system will not be required at Culvert 453 as full roadway closure will be provided during culvert replacement.

The soil parameters in the table below may apply for the design of the temporary roadway protection system with horizontal backfill.

Soil Parameter	Existing Granular Fill	Native Clayey Silt	Native Sand and Silt	Native Sand and Gravel
Φ (angle of internal friction)	32˚	28˚	30˚	31˚
γ (total unit weight)	22 kN/m^3	19 kN/m^3	20 kN/m^3	21 kN/m^3
γ' (submerged unit weight)	12 kN/m^3	9 kN/m^3	10 kN/m^3	11 kN/m^3
K_a	0.31	0.36	0.33	0.32
K_p	3.25	2.77	3.00	3.12

Due to the presence of shallow bedrock at Culvert 451, the embedment depth of the temporary protection system may not be sufficient to provide lateral stability. Consideration should be given to use of horizontal restraining system such as deadman anchors, rock anchors or internal struts.

Full hydrostatic pressure should be considered assuming a water level at least equal to the design creek water level.

The temporary protection system may be removed or partially removed upon completion of the work. Care must be taken when removing the piles as to not incur damage to the subgrade of the newly installed culverts.

The design of the temporary protection system is the responsibility of the Contractor. The actual pressure distribution acting on the protection/shoring system is a function of the construction sequence and the relative flexibility of the wall, and these factors must be considered when designing the shoring system. All protection systems should be designed by a Professional Engineer experienced in such designs, who will determine an appropriate support system.

13. EMBANKMENT RESTORATION

Embankment restoration after completion of the culvert replacement should be carried out in accordance with OPSS.PROV 206. The embankment reconstruction material should consist of imported Granular B Type II. The restored embankment beyond the culvert should be reinstated at the existing slope inclination, but no steeper than 2H:1V if constructed with granular fill or 1.5H:1V if constructed with rock fill. Soils generated from the culvert excavation should not be used for reinstatement of the embankment.

In general, surface vegetation, peat, topsoil, organic deposits, disturbed material or otherwise loose/soft soils should be stripped from the areas around the culvert inlets and outlets, and within

the embankment footprints. Inspection and approval of the foundation surfaces by qualified geotechnical personnel should be conducted.

If any slope instability is observed during the work (e.g. signs of sloughing, seepage, cracking or movement), remedial actions (e.g. slope flattening or backfilling the excavation) must be taken immediately to ensure the stability of the excavation and the safety of workers.

The magnitude of the embankment self-compression constructed with granular materials is in order of 0.5% of the newly reconstructed embankment height and is expected to occur predominantly during fill placement.

14. SCOUR AND EROSION PROTECTION

Erosion protection should be provided at the culvert inlet and outlet. Design of the erosion protection measures should consider hydrologic and hydraulic factors and should be carried out by specialists experienced in this field in accordance with OPSD 810.010, OPSS.PROV 511 and OPSS.PROV 804.

Typically, rock protection should be provided over all surfaces with which creek water is likely to be in contact. A vegetation cover should be established on all other exposed earth surfaces to protect against surficial erosion in general accordance with OPSS.PROV 804.

A concrete cut-off wall (for box culvert options only) and a clay seal (only at the inlet) should be used to minimize the potential for erosion or piping around the culvert. The clay seal should extend to approximately 0.3 m above the high-water level and laterally for the width of the granular backfill material against the culvert, and have a minimum thickness of 0.5 m. The material requirements should be in accordance with OPSS.PROV 1205. A geosynthetic clay liner may be used in place of a compacted clay seal.

Selection of streambed material should be in accordance with OPSS.PROV 1005.

15. CORROSION POTENTIAL

Based on results of corrosivity testing on samples of the native sand and gravel, the following statements can be made in reference to the MTO Gravity Pipe Design Guideline. However, it should be noted that effects of road de-icing salts/chemicals should be considered when selecting pipe material and/or corrosion mitigation measures.

- The resistivity of the native soils was measured to be 2,010 ohm-cm and 5,030 ohm-cm, which indicates the soil has a low to moderate corrosion potential according to Table 3.2 of the MTO Gravity Pipe Design Guideline.
- The sulphate concentration of the native soils was measured to be 11 µg/g to 160 µg/g, which is considered to have a negligible to moderate degree of sulphate attack on concrete according to Table 7.2 of the MTO Gravity Pipe Design Guideline.
- The pH level of the native soils was measured to be 7.96 to 9.12, and according to Section 7.1.1 of the MTO Gravity Pipe Design Guideline, pH levels between 5.5 and 8.5 in soil or water are not considered detrimental to the durability of the culvert. Whereas the pH levels of 8.5 or greater are strongly alkaline.

16. CONSTRUCTION CONCERNS

During construction, qualified geotechnical personnel should be retained to observe activities related to the culvert replacement and advise the Contract Administrator on construction concerns related to performance of the embankment and instability of slopes.

Potential construction concerns include, but are not necessarily limited to:

- The complete removal and replacement of unsuitable foundation soils (such as loose sand and silt containing organics at Culvert 453) with compacted granular backfill should be carried out in the area of the culvert replacement as outlined in the preceding sections.
- An adequate dewatering system should be implemented to avoid the instability/boiling of the base of the sub-excavation. The contractor should be prepared to take appropriate measures to construct the bedding and backfill in a dry and stable environment.
- Disturbance of subgrade soil. Where fine-grained soils are exposed at the culvert subgrade, these areas will become softened and moisture sensitive and may become heavily disturbed when subjected to construction traffic. Construction traffic must not be allowed on the final foundation subgrade. The final subgrade should be protected with geotextile and granular bedding materials or a mud slab.

17. CLOSURE

Preparation of the design report and engineering analysis was carried out by Mr. Puneet Verma, P.Eng., a Geotechnical Engineer. The report was reviewed by Mr. Keli Shi, P.Eng., and Dr. P.K. Chatterji, Ph.D., P.Eng., a Designated Principal Contact for MTO Foundations Projects.

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THURBER

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5. INTERPRETATION OF THE REPORT

a) Nature and Exactness of Soil and Contaminant Description: Classification and identification of soils, rocks, geological units, contaminant materials and quantities have been based on investigations performed in accordance with the standards set out in Paragraph 1. Classification and identification of these factors are judgmental in nature. Comprehensive sampling and testing programs implemented with the appropriate equipment by experienced personnel may fail to locate some conditions. All investigations utilizing the standards of Paragraph 1 will involve an inherent risk that some conditions will not be detected and all documents or records summarizing such investigations will be based on assumptions of what exists between the actual points sampled. Actual conditions may vary significantly between the points investigated and the Client and all other persons making use of such documents or records with our express written consent should be aware of this risk and the Report is delivered subject to the express condition that such risk is accepted by the Client and such other persons. Some conditions are subject to change over time and those making use of the Report should be aware of this possibility and understand that the Report only presents the conditions at the sampled points at the time of sampling. If special concerns exist, or the Client has special considerations or requirements, the Client should disclose them so that additional or special investigations may be undertaken which would not otherwise be within the scope of investigations made for the purposes of the Report.

b) Reliance on Provided Information: The evaluation and conclusions contained in the Report have been prepared on the basis of conditions in evidence at the time of site inspections and on the basis of information provided to Thurber. Thurber has relied in good faith upon representations, information and instructions provided by the Client and others concerning the site. Accordingly, Thurber does not accept responsibility for any deficiency, misstatement or inaccuracy contained in the Report as a result of misstatements, omissions, misrepresentations, or fraudulent acts of the Client or other persons providing information relied on by Thurber. Thurber is entitled to rely on such representations, information and instructions and is not required to carry out investigations to determine the truth or accuracy of such representations, information and instructions.

c) Design Services: The Report may form part of design and construction documents for information purposes even though it may have been issued prior to final design being completed. Thurber should be retained to review final design, project plans and related documents prior to construction to confirm that they are consistent with the intent of the Report. Any differences that may exist between the Report's recommendations and the final design detailed in the contract documents should be reported to Thurber immediately so that Thurber can address potential conflicts.

d) Construction Services: During construction Thurber should be retained to provide field reviews. Field reviews consist of performing sufficient and timely observations of encountered conditions in order to confirm and document that the site conditions do not materially differ from those interpreted conditions considered in the preparation of the report. Adequate field reviews are necessary for Thurber to provide letters of assurance, in accordance with the requirements of many regulatory authorities.

6. RELEASE OF POLLUTANTS OR HAZARDOUS SUBSTANCES

Geotechnical engineering and environmental consulting projects often have the potential to encounter pollutants or hazardous substances and the potential to cause the escape, release or dispersal of those substances. Thurber shall have no liability to the Client under any circumstances, for the escape, release or dispersal of pollutants or hazardous substances, unless such pollutants or hazardous substances have been specifically and accurately identified to Thurber by the Client prior to the commencement of Thurber's professional services.

7. INDEPENDENT JUDGEMENTS OF CLIENT

The information, interpretations and conclusions in the Report are based on Thurber's interpretation of conditions revealed through limited investigation conducted within a defined scope of services. Thurber does not accept responsibility for independent conclusions, interpretations, interpolations and/or decisions of the Client, or others who may come into possession of the Report, or any part thereof, which may be based on information contained in the Report. This restriction of liability includes but is not limited to decisions made to develop, purchase or sell land.

THURBER ENGINEERING LTD.

APPENDIX A
SITE PHOTOGRAPHS

Photograph #1 – Existing Reservoir (Culvert 451 Inlet) east of Highway 6. (August 2024)

Photograph taken facing east.

Photograph #2 – Culvert 451 outlet, at the west toe of Highway 6 embankment, facing southeast. (August 2024). Monitoring well at BH 451-2 is visible.

Photograph taken facing southeast.

Photograph #3 – Culvert 453 outlet, Monitoring well at BH 453-1 is visible. (August 2024)

Photograph taken facing east

Photograph #4 – Culvert 453 inlet, Monitoring well at BH 453-5B is visible. (August 2024)

Photograph taken facing south.

THURBER ENGINEERING LTD.

APPENDIX B
RECORD OF BOREHOLE SHEETS

SYMBOLS, ABBREVIATIONS AND TERMS USED ON RECORDS OF BOREHOLES

1. TEXTURAL CLASSIFICATION OF SOILS

CLASSIFICATION	PARTICLE SIZE	VISUAL IDENTIFICATION
Boulders	Greater than 200mm	same
Cobbles	75 to 200mm	same
Gravel	4.75 to 75mm	5 to 75mm
Sand	0.075 to 4.75mm	Not visible particles to 5mm
Silt	0.002 to 0.075mm	Non-plastic particles, not visible to the naked eye
Clay	Less than 0.002mm	Plastic particles, not visible to the naked eye

2. COARSE GRAIN SOIL DESCRIPTION (50% greater than 0.075mm)

TERMINOLOGY	PROPORTION
Trace or Occasional	Less than 10%
Some	10 to 20%
Adjective (e.g. silty or sandy)	20 to 35%
And (e.g. sand and gravel)	35 to 50%

3. TERMS DESCRIBING CONSISTENCY (COHESIVE SOILS ONLY)

DESCRIPTIVE TERM	UNDRAINED SHEAR STRENGTH (kPa)	APPROXIMATE SPT[(1)] 'N' VALUE
Very Soft	12 or less	Less than 2
Soft	12 to 25	2 to 4
Firm	25 to 50	4 to 8
Stiff	50 to 100	8 to 15
Very Stiff	100 to 200	15 to 30
Hard	Greater than 200	Greater than 30

NOTE: Hierarchy of Soil Strength Prediction

1) Laboratory Triaxial Testing
2) Field Insitu Vane Testing
3) Laboratory Vane Testing
4) SPT value
5) Pocket Penetrometer

4. TERMS DESCRIBING DENSITY (COHESIONLESS SOILS ONLY)

DESCRIPTIVE TERM	SPT "N" VALUE
Very Loose	Less than 4
Loose	4 to 10
Compact	10 to 30
Dense	30 to 50
Very Dense	Greater than 50

5. LEGEND FOR RECORDS OF BOREHOLES

SYMBOLS AND ABBREVIATIONS FOR SAMPLE TYPE	SS Split Spoon Sample	WS Wash Sample	AS Auger (Grab) Sample
	TW Thin Wall Shelby Tube Sample		TP Thin Wall Piston Sample
	PH Sampler Advanced by Hydraulic Pressure		PM Sampler Advanced by Manual Pressure
	WH Sampler Advanced by Self Static Weight	RC Rock Core	SC Soil Core

$$\text{Sensitivity} = \frac{\text{Undisturbed Shear Strength}}{\text{Remoulded Shear Strength}}$$

▼ Water Level

C_{pen} Shear Strength Determination by Pocket Penetrometer

(1) SPT 'N' Value Standard Penetration Test 'N' Value – refers to the number of blows from a 63.5kg hammer free falling a height of 0.76m to advance a standard 50 mm outside diameter split spoon sampler for 0.3 m depth into undisturbed ground.

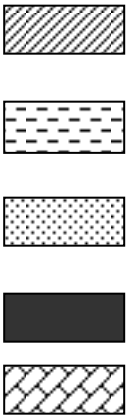
(2) DCPT Dynamic Cone Penetration Test – Continuous penetration of a 50 mm outside diameter, 60° conical steel point attached to "A" size rods driven by a 63.5 kg hammer free falling a height of 0.76 m. The resistance to cone penetration is the number of hammer blows required for each 0.3 m advance of the conical point into undisturbed ground.

EXPLANATION OF ROCK LOGGING TERMS

ROCK WEATHERING CLASSIFICATION

Fresh (FR)	No visible signs of weathering.
Fresh Jointed (FJ)	Weathering limited to the surface of major discontinuities.
Slightly Weathered (SW)	Penetrative weathering developed on open discontinuity surfaces, but only slight weathering of rock material.
Moderately Weathered (MW)	Weathering extends throughout the rock mass, but the rock material is not friable.
Highly Weathered (HW)	Weathering extends throughout the rock mass and the rock is partly friable.
Completely Weathered (CW)	Rock is wholly decomposed and in a friable condition, but the rock texture and structure are preserved.

SYMBOLS



CLAYSTONE

SILTSTONE

SANDSTONE

COAL

Bedrock (general)

DISCONTINUITY SPACING

Bedding	Bedding Plane Spacing
Very thickly bedded	Greater than 2m
Thickly bedded	0.6 to 2m
Medium bedded	0.2 to 0.6m
Thinly bedded	60mm to 0.2m
Very thinly bedded	20 to 60mm
Laminated	6 to 20mm
Thinly Laminated	Less than 6mm

TERMS

Total Core Recovery: (TCR)	Core recovered as a percentage of total core run length.
Solid Core Recovery: (SCR)	Percent Ratio of solid core of full cylindrical shape recovered. Expressed with respect to the total length of core run.
Rock Quality Designation: (RQD)	Total length of sound core recovered in pieces 0.1m in length or larger as a percentage of total core run length.
Uniaxial Compressive Strength (UCS)	Axial stress required to break the specimen
Fracture Index: (FI)	Frequency of natural fractures per 0.3m of core run.

STRENGTH CLASSIFICATION

Rock Strength	Approximate Uniaxial Compressive Strength (MPa)	(psi)	Field Estimation of Hardness*
Extremely Strong	Greater than 250	Greater than 36,000	Specimen can only be chipped with a geological hammer
Very Strong	100-250	15,000 to 36,000	Requires many blows of geological hammer to break
Strong	50-100	7,500 to 15,000	Requires more than one blow of geological hammer to break
Medium Strong	25.0 to 50.0	3,500 to 7,500	Breaks under single blow of geological hammer.
Weak	5.0 to 25.0	750 to 3,500	Can be peeled by a pocket knife with difficulty
Very Weak	1.0 to 5.0	150 to 750	Can be peeled by a pocket knife, crumbles under firm blows of geological pick.
Extremely Weak (Rock)	0.25 to 1.0	35 to 150	Indented by thumbnail

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RECORD OF BOREHOLE No 451-1 1 OF 1 METRIC

W.P. 3091-20-01 LOCATION Culvert 451; MTM NAD83-10: N 4 897 962.1 E 198 609.1 ORIGINATED BY OP

DIST West Grey HWY 6 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN

DATUM Geodetic DATE 2024.07.31 - 2024.07.31 LATITUDE 44.213930 LONGITUDE -80.828887 CHECKED BY PV

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH kPa (○ UNCONFINED, ● QUICK TRIAXIAL, + FIELD VANE, × LAB VANE)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%)	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
346.0	GROUND SURFACE						346				
0.0	**ASPHALT:** (190mm)										
0.2	Gravelly **SAND**, some silt Compact to Very Dense Brown Moist (FILL)		1	GS					○		
			1	SS	64		345		○		28 59 13 (SI+CL)
			2	SS	23				○		
343.8							344				
2.2	Clayey **SILT**, trace sand, trace gravel Stiff Brown Moist		3	SS	12				○		
343.1							343				
3.0	**SAND** and **SILT** to Silty **SAND**, some gravel to gravelly, with pockets of gravel Compact to Very Dense Brown Becoming grey and wet at 3.8m		4	SS	11				○		
			5	SS	12		342		○		45 38 17 (SI+CL)
			6	SS	51				○		
340.5			7	SS	50/0.050		341		○		
5.5	**DOLOMITE,** slightly weathered to fresh, crystalline, grey, fine to medium grained Strong		1	RUN							RUN #1 TCR=100% SCR=94% RQD=82% UCS=95.1MPa (PLT Average)
339.6							340				
6.5	END OF BOREHOLE AT 6.5m. BOREHOLE BACKFILLED WITH HOLEPLUG MIXED WITH SOIL CUTTINGS TO SURFACE.										

$+^3$, $\times^3$: Numbers refer to Sensitivity

20 / 15 5 / 10 (%) STRAIN AT FAILURE

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RECORD OF BOREHOLE No 451-2 1 OF 1 METRIC

W.P. 3091-20-01 LOCATION Culvert 451; MTM NAD83-10: N 4 897 952.4 E 198 593.5 ORIGINATED BY OP

DIST West Grey HWY 6 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN

DATUM Geodetic DATE 2024.08.07 - 2024.08.07 LATITUDE 44.213840 LONGITUDE -80.829080 CHECKED BY PV

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH kPa (○ UNCONFINED, ● QUICK TRIAXIAL, + FIELD VANE, × LAB VANE)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%)	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
343.9	GROUND SURFACE										
0.0	**TOPSOIL:** (125mm)										
0.1	Clayey **SILT**, some sand, trace gravel, trace rootlets Firm Brown Moist		1	SS	8						
			2	SS	6		343				0 29 60 11
342.4											
1.4	**SAND** and **SILT** to Silty **SAND**, some gravel to gravelly, with pockets of gravel Loose to Compact Brown to Grey Wet		3	SS	9		342				
			4	SS	6						
			5	SS	17		341				9 56 35 0
	Spoon bouncing		6	SS	30/0.025					FI	
339.9							340			1	
4.0	**DOLOMITE,** fairly weathered to fresh crystalline, grey, fine to medium grained		1	RUN						1 2	RUN #1 TCR=100% SCR=100% RQD=90%
							339			1	
										4	RUN #2 TCR=96% SCR=93% RQD=87% UCS=116.7MPa (PLT Average)
	Strong		2	RUN			338			0 2 0 0	
							337			2 0	RUN #3 TCR=91% SCR=98% RQD=98% UCS=151.4MPa UCS=124.4MPa (PLT Average)
	Strong		3	RUN						1 0	
335.9							336			0	
8.0	END OF BORREHOLE AT 8.0m. Well installation consists of 50mm diameter Schedule 40 PVC pipe with a 1.52m slotted screen.										

WATER LEVEL READINGS

DATE	DEPTH(m)	ELEV.(m)
2024.08.07	2.4	341.5
2024.09.24	1.7	342.2

+ ^{3}, × ^{3}: Numbers refer to Sensitivity

20 / 15 5 / 10 (%) STRAIN AT FAILURE

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RECORD OF BOREHOLE No 451-3 1 OF 2 METRIC

W.P. 3091-20-01 LOCATION Culvert 451; MTM NAD83-10: N 4 897 957.6 E 198 615.1 ORIGINATED BY OP

DIST West Grey HWY 6 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN

DATUM Geodetic DATE 2024.08.02 - 2024.08.02 LATITUDE 44.213890 LONGITUDE -80.828811 CHECKED BY PV

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH kPa (○ UNCONFINED, ● QUICK TRIAXIAL, + FIELD VANE, × LAB VANE)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
345.9	GROUND SURFACE							20 40 60 80 100	20 40 60		
0.0	**TOPSOIL:** (75mm)										
0.1	**SAND**, some silt, trace gravel Compact Brown Moist (FILL)		1	SS	11				○		3 77 16 4
	Gravelly		2	SS	13		345		○		
344.0	Loose		3	SS	3				○		
1.8	Clayey **SILT**, trace gravel Firm Grey						344		○		
343.5	Wet		4	SS	50/						
2.4	**SAND** and **SILT** to Silty **SAND**, some gravel to gravelly, with pockets of gravel Compact to Dense Grey Wet				0.075				○		4 47 46 3
			5	SS	14		343		○		
			6	SS	38		342				
			7	SS	29		341		○		6 72 19 3
340.4											
5.5	**DOLOMITE,** slightly weathered to fresh, crystalline, grey, fine to medium grained		1	RUN			340			FI 2 1	RUN #1 TCR=100% SCR=87% RQD=57% UCS=104.3MPa (PLT Average)
	Strong									2	
	Strong		2	RUN			339			0 1 3	RUN #2 TCR=96% SCR=85% RQD=93% UCS=104.8MPa (PLT Average)
							338			1 0 0	
	Strong		3	RUN			337			0 1 0	RUN #3 TCR=100% SCR=98% RQD=98% UCS=140.4MPa (PLT Average)
336.3										1 0	
9.6	END OF BOREHOLE AT 9.6m. Well installation consists of 50mm										

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+ ³, × ³: Numbers refer to Sensitivity

20 / 15 5 / 10 (%) STRAIN AT FAILURE

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RECORD OF BOREHOLE No 451-3 2 OF 2 METRIC

W.P. 3091-20-01 LOCATION Culvert 451; MTM NAD83-10: N 4 897 957.6 E 198 615.1 ORIGINATED BY OP

DIST West Grey HWY 6 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN

DATUM Geodetic DATE 2024.08.02 - 2024.08.02 LATITUDE 44.213890 LONGITUDE -80.828811 CHECKED BY PV

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa: ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P — NATURAL MOISTURE CONTENT w — LIQUID LIMIT w_L / WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						GR SA SI CL
	Continued From Previous Page										
	diameter Schedule 40 PVC pipe with a 1.52m slotted screen.										
	WATER LEVEL READINGS DATE DEPTH(m) ELEV.(m) 2024.08.02 3.4 342.5 2024.09.24 3.4 342.5										

$+^3$, $\times^3$: Numbers refer to Sensitivity

$\frac{20}{15 \oplus 5}$ (%) STRAIN AT FAILURE
10

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RECORD OF BOREHOLE No 451-4 1 OF 2 METRIC

W.P. 3091-20-01 LOCATION Culvert 451; MTM NAD83-10: N 4 897 942.2 E 198 602.8 ORIGINATED BY OP

DIST West Grey HWY 6 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN

DATUM Geodetic DATE 2024.08.01 - 2024.08.02 LATITUDE 44.213750 LONGITUDE -80.828962 CHECKED BY PV

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
345.7	GROUND SURFACE										
0.0	**SAND** and **GRAVEL**, some silt Compact to Dense Brown Moist (FILL)		1	SS	36		345		○		
			2	SS	27				○		42 45 13 (SI+CL)
343.5			3	SS	44		344		○		35 39 26 (SI+CL)
2.2	**SAND** and **GRAVEL**, some silt Loose to Dense Brown Moist		4	SS	15		343				
	Becoming grey and wet at 3.2m		5	SS	8				○		
			6	SS	25		342		○ ○		52 35 13 (SI+CL)
340.2			7	SS	35		341		○		
5.5	**DOLOMITE**, moderately weathered to fresh crystalline, grey, fine to medium grained		1	RUN			340			FI 1 2 2	RUN #1 TCR=92% SCR=71% RQD=58% UCS=159.0MPa (PLT Average)
			2	RUN			339				RUN #2 TCR=87% SCR=82% RQD=68% UCS=81.1MPa (PLT Average)
			3	RUN			338 337			1 3 3 2 2	RUN #3 TCR=100% SCR=96% RQD=83% UCS=131.6MPa (PLT Average)
336.2											
9.5	END OF BORHOLE AT 9.5m. BOREHOLE BACKFILLED WITH HOLEPLUG MIXED WITH SOIL										

Continued Next Page

+ ³, × ³: Numbers refer to Sensitivity

20 / 15 5 / 10 (%) STRAIN AT FAILURE

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RECORD OF BOREHOLE No 451-4 2 OF 2 METRIC

W.P. 3091-20-01 LOCATION Culvert 451; MTM NAD83-10: N 4 897 942.2 E 198 602.8 ORIGINATED BY OP

DIST West Grey HWY 6 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN

DATUM Geodetic DATE 2024.08.01 - 2024.08.02 LATITUDE 44.213750 LONGITUDE -80.828962 CHECKED BY PV

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						GR SA SI CL
	Continued From Previous Page										
	CUTTINGS TO SURFACE.										

$+^3$, $\times^3$: Numbers refer to Sensitivity

15 20 10 5 (%) STRAIN AT FAILURE

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Ministry of Transportation
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THURBER

RECORD OF BOREHOLE No 451-5 1 OF 2 METRIC

W.P. 3091-20-01 LOCATION Culvert 451; MTM NAD83-10: N 4 897 946.3 E 198 611.4 ORIGINATED BY OP

DIST West Grey HWY 6 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN

DATUM Geodetic DATE 2024.08.01 - 2024.08.01 LATITUDE 44.213788 LONGITUDE -80.828855 CHECKED BY PV

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
345.9	GROUND SURFACE										
0.0	**ASPHALT:** (230mm)										
0.2	**SAND** and **GRAVEL** Dense Brown Moist (FILL)										
344.8			1	SS	44		345		○		40 50 10 (SI+CL)
1.1	**SAND** and **SILT**, trace to some gravel Loose to Compact Brown Moist (FILL)		2	SS	26		344		○		
343.1			3	SS	9				○		2 38 53 7
2.7	**SAND** and **GRAVEL**, some silt Compact to Dense Brown Wet		4	SS	14		343		○		
			5	SS	25		342		○		
			6	SS	37		341		○		40 45 15 (SI+CL)
340.1											
5.8	**DOLOMITE**, moderately weathered, strong		1	RUN			340			Fl 2 1 1	RUN #1 TCR=98% SCR=85% RQD=93% UCS=95.1MPa (PLT Average)
	Strong		2	RUN			339			1 2 2 1	RUN #2 TCR=98% SCR=90% RQD=66% UCS=61.3MPa
			3	RUN			338 337			2 3 2 2 2 2	RUN #3 TCR=100% SCR=90% RQD=82% UCS=115.0MPa (PLT Average)
336.2											
9.7	END OF BOREHOLE AT 9.5m.									1	

Continued Next Page

$+^3$, $\times^3$: Numbers refer to Sensitivity

20 / 15 5 / 10 (%) STRAIN AT FAILURE

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RECORD OF BOREHOLE No 451-5 2 OF 2 METRIC

W.P. 3091-20-01 LOCATION Culvert 451; MTM NAD83-10: N 4 897 946.3 E 198 611.4 ORIGINATED BY OP

DIST West Grey HWY 6 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN

DATUM Geodetic DATE 2024.08.01 - 2024.08.01 LATITUDE 44.213788 LONGITUDE -80.828855 CHECKED BY PV

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						
	Continued From Previous Page										
	BOREHOLE BACKFILLED WITH HOLEPLUG MIXED WITH SOIL CUTTINGS TO SURFACE.										

$+^3$, $\times^3$: Numbers refer to Sensitivity

15 20 10 5 (%) STRAIN AT FAILURE

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THURBER

RECORD OF BOREHOLE No 451-6 1 OF 1 METRIC

W.P. 3091-20-01 LOCATION Culvert 451; MTM NAD83-10: N 4 897 946.6 E 198 621.6 ORIGINATED BY OP

DIST West Grey HWY 6 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN

DATUM Geodetic DATE 2024.08.06 - 2024.08.07 LATITUDE 44.213792 LONGITUDE -80.828728 CHECKED BY PV

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
344.1	GROUND SURFACE										
0.0	**TOPSOIL:** (200mm)						344				
0.2	Silty **SAND**, some gravel Loose Brown Moist		1	SS	9				○		
343.4							343		○		
0.7	**SAND** and **GRAVEL** to Gravelly **SAND**, trace to some silt Compact to Dense Grey Moist Becoming wet below 1.5m		2	SS	20						
			3	SS	28		342		○		
			4	SS	22				○		35 55 10 (SI+CL)
			5	SS	33		341		○ ○		
340.2											FI
4.0	**DOLOMITE,** faintly weathered to fresh, crystalline, grey, fine to medium grained		1	RUN			340				0 1 2 0 RUN #1 TCR=100% SCR=82% RQD=81% UCS=128.5MPa (PLT Average)
			2	RUN			339				2 1 1 2 0 RUN #2 TCR=96% SCR=95% RQD=58% UCS=111.2MPa (PLT Average)
337.4							338				
6.7	END OF BOREHOLE AT 6.7m. BOREHOLE BACKFILLED WITH HOLEPLUG MIXED WITH SOIL CUTTINGS TO SURFACE.										

$+^3$, $\times^3$: Numbers refer to Sensitivity

20
15 5
10
(%) STRAIN AT FAILURE

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Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No 451-7 1 OF 1 METRIC

W.P. 3091-20-01 LOCATION Culvert 451; MTM NAD83-10: N 4 897 937.9 E 198 603.5 ORIGINATED BY OP

DIST West Grey HWY 6 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN

DATUM Geodetic DATE 2024.07.31 - 2024.07.31 LATITUDE 44.213711 LONGITUDE -80.828952 CHECKED BY PV

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH kPa (○ UNCONFINED, ● QUICK TRIAXIAL, + FIELD VANE, × LAB VANE)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%)	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
345.7	GROUND SURFACE										
0.0	**SAND** and **GRAVEL**, some silt Compact to Dense Brown Moist (FILL)		1	SS	35		345		○		
			2	SS	21				○		52 35 13 (SI+CL)
343.5			3	SS	26		344		○		
2.2	**SAND** and **GRAVEL**, some silt Loose to Dense Brown to Grey Moist to Wet		4	SS	9		343		○		
			5	SS	19				○		53 31 16 (SI+CL)
			6	SS	20		342		○		58 29 13 (SI+CL)
341.0			7	SS	50/		341		○		
4.8	END OF BOREHOLE AT 4.8m UPON AUGER REFUSAL. BOREHOLE BACKFILLED WITH HOLEPLUG MIXED WITH SOIL CUTTINGS TO SURFACE.				0.050						

+ ^{3}, × ^{3}: Numbers refer to Sensitivity

20 / 15 5 / 10 (%) STRAIN AT FAILURE

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Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No 453-1 1 OF 1 METRIC

W.P. 3040-20-01 LOCATION Culvert 453; MTM NAD83-10: N 4 914 421.8 E 195 762.3 ORIGINATED BY OP

DIST Chatsworth HWY 6 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN

DATUM Geodetic DATE 2024.08.14 - 2024.08.14 LATITUDE 44.361611 LONGITUDE -80.867935 CHECKED BY PV

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (20 40 60 80 100) ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
320.1	GROUND SURFACE						320				
0.0 / 319.5	**TOPSOIL:** (600mm) Clayey, organics, trace sand Very Soft Dark Brown Moist		1	SS	2	▽			85		
0.6 / 318.6	**SAND** and **SILT**, trace clay Loose Grey Wet		2	SS	8		319				1 53 41 5
1.4	**SAND**, some gravel to gravelly, trace silt Compact to Very Dense Grey Wet		3	SS	12		318				
			4	SS	19						39 51 10 (SI+CL)
			5	SS	20		317				
			6	SS	54/ 0.025		316				
315.5			7	SS	50/ 0.025						
4.6	END OF BOREHOLE AT 4.6m UPON AUGER REFUSAL. Well installation consists of 50mm diameter Schedule 40 PVC pipe with a 1.52m slotted screen.										

WATER LEVEL READINGS

DATE	DEPTH(m)	ELEV.(m)
2024.08.14	1.6	318.5
2024.09.24	0.2	319.9

$+^3$, $\times^3$: Numbers refer to Sensitivity

20 / 15 5 / 10 (%) STRAIN AT FAILURE

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Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No 453-2 1 OF 1 METRIC

W.P. 3040-20-01 LOCATION Culvert 453; MTM NAD83-10: N 4 914 411.8 E 195 744.1 ORIGINATED BY OP

DIST Chatsworth HWY 6 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN

DATUM Geodetic DATE 2024.08.13 - 2024.08.13 LATITUDE 44.361518 LONGITUDE -80.868163 CHECKED BY PV

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa: ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
322.5	GROUND SURFACE										
0.0	Gravelly **SAND**, some silt Very Dense to Compact Grey Moist (FILL)		1	SS	75		322				
			2	SS	24						30 53 17 (SI+CL)
			3	SS	12		321				
320.3											
2.2	Sandy **SILT**, trace clay, some rootlets Loose Dark Brown Moist		4	SS	7		320				Organic Content 6.9%
			5	SS	5						Organic Content 6.6% 0 19 77 4
318.8	Becoming grey and wet at 3.1m						319				
3.7	**SAND** and **GRAVEL**, trace silt Compact Grey Wet		6	SS	10						
			7	SS	22		318				53 38 9 (SI+CL)
316.4	Auger grinding with no advancement		8	SS	50/ 0.050		317				
6.1	END OF BOREHOLE AT 6.1m UPON AUGER REFUSAL. BOREHOLE BACKFILLED WITH HOLEPLUG MIXED WITH SOIL CUTTINGS TO SURFACE.										

+ ^{3}, × ^{3}: Numbers refer to Sensitivity

15 20 10 5 (%) STRAIN AT FAILURE

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Ontario

THURBER

RECORD OF BOREHOLE No 453-3A 1 OF 1 METRIC

W.P. 3040-20-01 LOCATION Culvert 453; MTM NAD83-10: N 4 914 411.5 E 195 772.5 ORIGINATED BY OP

DIST Chatsworth HWY 6 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN

DATUM Geodetic DATE 2024.08.08 - 2024.08.09 LATITUDE 44.361520 LONGITUDE -80.867805 CHECKED BY PV

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH kPa (○ UNCONFINED, ● QUICK TRIAXIAL, + FIELD VANE, × LAB VANE)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%)	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
321.7	GROUND SURFACE										
0.0	**ASPHALT:** (130mm)										
0.1	Gravelly **SAND**, trace silt Dense Grey Moist (FILL)		1	SS	33		321				
320.9											
0.7	Sandy **SILT**, trace to some gravel, trace clay Compact Grey Moist (FILL)		2	SS	12						3 23 68 6
			3	SS	15		320				
319.5											
2.2	Silty **SAND**, some gravel Loose Grey Wet		4	SS	9		319				11 54 31 4
318.7											
3.0	Gravelly **SAND** to **SAND** and **GRAVEL**, trace to some silt Compact to Very Dense Grey Wet		5	SS	24		318				
			6	SS	21						
			7	SS	16		317				
							316				
	Augers grinding from 6.4m to 8.1m		8	SS	24						30 60 10 (SI+CL)
314.0							315				
7.6	END OF BOREHOLE AT 7.6m DUE TO AUGER REFUSAL. BOREHOLE BACKFILLED WITH HOLEPLUG MIXED WITH SOIL CUTTINGS TO SURFACE. BOREHOLE DRILLING AND SAMPLING CONTINUED IN BOREHOLE 453-3B LOCATED APPROXIMATE 2.0m EAST OF 453-3A.										

$+^3$, $\times^3$: Numbers refer to Sensitivity

$\frac{20}{15}\oplus\frac{5}{10}$ (%) STRAIN AT FAILURE

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Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No 453-3B 1 OF 2 METRIC

W.P. 3040-20-01 LOCATION Culvert 453; MTM NAD83-10: N 4 914 412.6 E 195 774.7 ORIGINATED BY OP

DIST Chatsworth HWY 6 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN

DATUM Geodetic DATE 2024.08.12 - 2024.08.12 LATITUDE 44.361530 LONGITUDE -80.867778 CHECKED BY PV

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
321.6	GROUND SURFACE										
0.0	Advanced borehole to a depth of 7.6m prior to start soil sampling. Refer to Borehole 453-3A for the stratigraphy of the upper 7.6m of soil. Borehole 453-3A is located 2.0m West of Borehole 453-3B.						321				
							320				
							319				
							318				
							317				
							316				
							315				
314.0							314				
7.6	**SAND** and **GRAVEL**, trace silt Compact Grey Wet		9	SS	29				○		48 43 9 (SI+CL)
312.9							313				
8.7	Clayey **SILT**, trace sand, trace gravel Hard Grey Moist		10	SS	48				⊢●		2 8 73 17
							312				

Continued Next Page

$+^3$, $\times^3$: Numbers refer to Sensitivity

20 / 15 5 / 10 (%) STRAIN AT FAILURE

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Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No 453-3B 2 OF 2 METRIC

W.P. 3040-20-01 LOCATION Culvert 453; MTM NAD83-10: N 4 914 412.6 E 195 774.7 ORIGINATED BY OP

DIST Chatsworth HWY 6 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN

DATUM Geodetic DATE 2024.08.12 - 2024.08.12 LATITUDE 44.361530 LONGITUDE -80.867778 CHECKED BY PV

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa: ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						GR SA SI CL
311.4	Continued From Previous Page										
10.2	**SAND** and **GRAVEL**, trace silt Dense Grey Wet		11	SS	47		311		○		
310.3											
11.3	END OF BOREHOLE AT 11.3m. BOREHOLE BACKFILLED WITH HOLEPLUG MIXED WITH SOIL CUTTINGS TO SURFACE.										

$+^3$, $\times^3$: Numbers refer to Sensitivity

15 20 10 5 (%) STRAIN AT FAILURE

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Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No 453-4 1 OF 2 METRIC

W.P. 3040-20-01 LOCATION Culvert 453; MTM NAD83-10: N 4 914 406.7 E 195 756.1 ORIGINATED BY OP

DIST Chatsworth HWY 6 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN

DATUM Geodetic DATE 2024.08.13 - 2024.08.13 LATITUDE 44.361474 LONGITUDE -80.868010 CHECKED BY PV

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (20 40 60 80 100) ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
322.1	GROUND SURFACE						322				
0.0	**SAND** and **GRAVEL**, trace silt Dense to Very Dense Grey Moist (FILL)		1	SS	36				○		36 50 14 (SI+CL)
			2	SS	52		321		○		
			3	SS	24		320				
319.1			4	SS	16				○		
3.0	**SILT**, some sand, trace clay, organic inclusions Loose Grey Moist		5	SS	5		319			○ 112	Organic Content 16.8%
317.6			6	SS	4		318		○		0 13 81 6
4.5	Gravelly **SAND** to Sandy **GRAVEL** Compact to Dense Grey Wet		7	SS	15		317		○		
			8	SS	47		316		○		70 26 4 (SI+CL)
314.9							315				
7.2	**SILT**, trace sand, trace clay Compact Grey Wet		9	SS	30		314		○		
			10	SS	25		313		○		0 2 96 2

Continued Next Page

$+^3$, $\times^3$: Numbers refer to Sensitivity

$\frac{20}{15}$ $\frac{5}{10}$ (%) STRAIN AT FAILURE

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No 453-4 2 OF 2 METRIC

W.P. 3040-20-01 LOCATION Culvert 453; MTM NAD83-10: N 4 914 406.7 E 195 756.1 ORIGINATED BY OP

DIST Chatsworth HWY 6 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN

DATUM Geodetic DATE 2024.08.13 - 2024.08.13 LATITUDE 44.361474 LONGITUDE -80.868010 CHECKED BY PV

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (20 40 60 80 100): ○ UNCONFINED, + FIELD VANE, ● QUICK TRIAXIAL, × LAB VANE	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						GR SA SI CL
311.8	Continued From Previous Page						312				
10.2	**SAND** and **GRAVEL** Compact Grey Wet		11	SS	21		311		○		
310.8											
11.3	END OF BOREHOLE AT 11.3m. BOREHOLE BACKFILLED WITH HOLEPLUG MIXED WITH SOIL CUTTINGS TO SURFACE.										

$+^3$, $\times^3$: Numbers refer to Sensitivity

$\frac{20}{15 \oplus 5}$ (%) STRAIN AT FAILURE
10

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Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No 453-5A 1 OF 1 METRIC

W.P. 3040-20-01 LOCATION Culvert 453; MTM NAD83-10: N 4 914 399.8 E 195 765.3 ORIGINATED BY OP

DIST Chatsworth HWY 6 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN

DATUM Geodetic DATE 2024.08.14 - 2024.08.14 LATITUDE 44.361414 LONGITUDE -80.867894 CHECKED BY PV

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
319.8	GROUND SURFACE							20 40 60 80 100	20 40 60		
0.0 319.2	**TOPSOIL:** (600mm) Clayey, organics Very Soft Dark Grey Moist		1	SS	2				○		
0.6	Clayey **SILT** to **SILT**, some sand Soft to Firm Dark Brown Wet		2	SS	3		319		⊖		0 14 77 9
317.6			3	SS	8		318		○		
2.2	**SAND** and **GRAVEL** to Sandy **GRAVEL** Compact Grey Wet		4	SS	17		317		○		
315.9			5	SS	16				○		53 38 9 (SI+CL)
			6	SS	50/ 0.050		316		○		
3.9	END OF BOREHOLE AT 3.9m UPON AUGER REFUSAL. BOREHOLE BACKFILLED WITH HOLEPLUG MIXED WITH SOIL CUTTINGS TO SURFACE. BOREHOLE DRILLING AND SAMPLING CONTINUED IN BOREHOLE 453-5B LOCATED APPROXIMATE 1.0m EAST OF 453-5A.										

+ ³, × ³: Numbers refer to Sensitivity

20 15 5 10 (%) STRAIN AT FAILURE

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Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No 453-5B 1 OF 2 METRIC

W.P. 3040-20-01 LOCATION Culvert 453; MTM NAD83-10: N 4 914 400.0 E 195 764.3 ORIGINATED BY OP

DIST Chatsworth HWY 6 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN

DATUM Geodetic DATE 2024.08.14 - 2024.08.14 LATITUDE 44.361415 LONGITUDE -80.867906 CHECKED BY PV

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH kPa (○ UNCONFINED, ● QUICK TRIAXIAL, + FIELD VANE, × LAB VANE) 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
319.9	GROUND SURFACE										
0.0	Advanced borehole to a depth of 4.6m prior to start soil sampling. Refer to Borehole 453-5A for the stratigraphy of the upper 4.6m of soil. Borehole 453-5A is located 1.0m West of Borehole 453-5B.						319				
							318				
							317				
							316				
315.3											
4.6	Silty **SAND** Compact Grey Wet		1	SS	12		315				
			2	SS	13						0 74 25 1
313.9							314				
6.0	Clayey **SILT** to **SILT** Firm Grey Moist		3	SS	6						
312.3							313				
7.6	**SAND** and **GRAVEL**, some silt Very Dense Grey Wet		4	SS	51		312				
			5	SS	59		311				47 38 15 (SI+CL)
310.1											
9.8	END OF BOREHOLE AT 9.8m.										

Continued Next Page

+ ³, × ³: Numbers refer to Sensitivity

20 / 15 5 / 10 (%) STRAIN AT FAILURE

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Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No 453-5B 2 OF 2 METRIC

W.P. 3040-20-01 LOCATION Culvert 453; MTM NAD83-10: N 4 914 400.0 E 195 764.3 ORIGINATED BY OP

DIST Chatsworth HWY 6 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN

DATUM Geodetic DATE 2024.08.14 - 2024.08.14 LATITUDE 44.361415 LONGITUDE -80.867906 CHECKED BY PV

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa: ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						GR SA SI CL
	Continued From Previous Page										
	Well installation consists of 50mm diameter Schedule 40 PVC pipe with a 1.52m slotted screen. WATER LEVEL READINGS DATE DEPTH(m) ELEV.(m) 2024.08.14 1.0 318.9 2024.09.24 0.1 319.8										

$+^3$, $\times^3$: Numbers refer to Sensitivity

20 / 15 5 / 10 (%) STRAIN AT FAILURE

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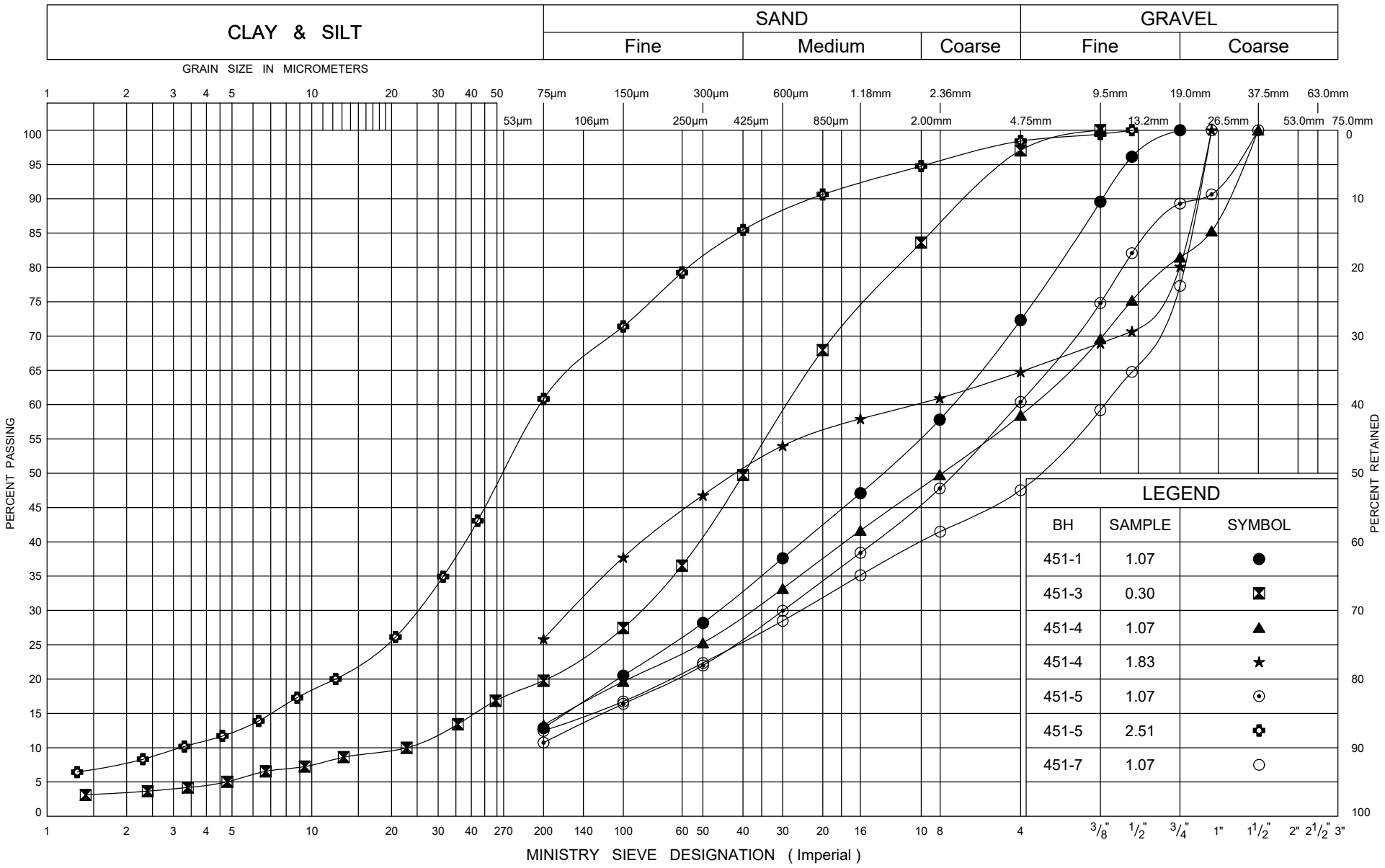
THURBER ENGINEERING LTD.

APPENDIX C
GEOTECHNICAL AND ANALYTICAL LABORATORY TEST RESULTS



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GRAIN SIZE DISTRIBUTION

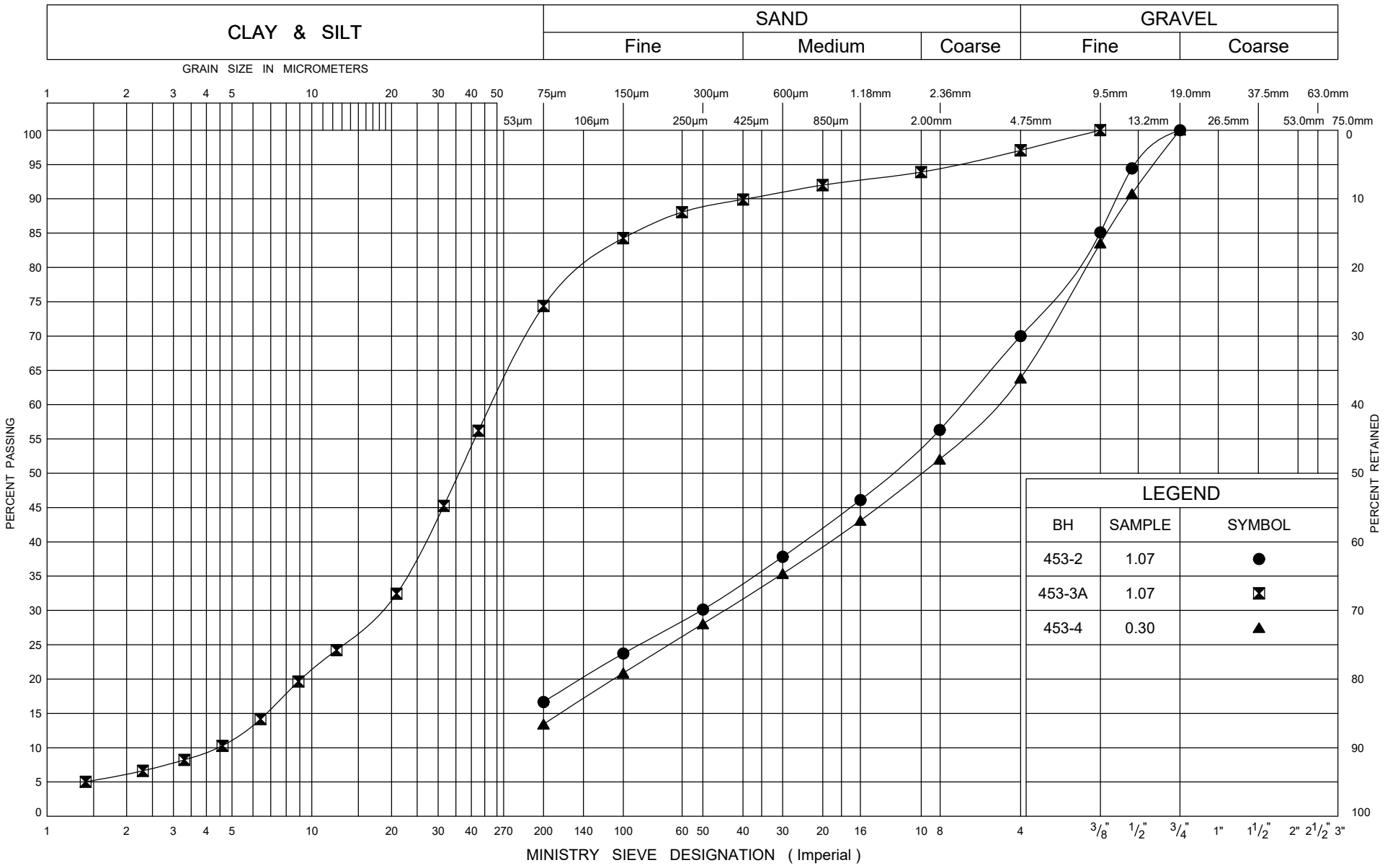
Embankment FILL

FIG No 1

W.P. 3091-20-01

Culvert 451

ONTARIO MOT GRAIN SIZE 2 MTO-36459.GPJ ONTARIO MOT.GDT 10/29/24



ONTARIO MOT GRAIN SIZE 2 MTO-36459.GPJ ONTARIO MOT.GDT 10/29/24

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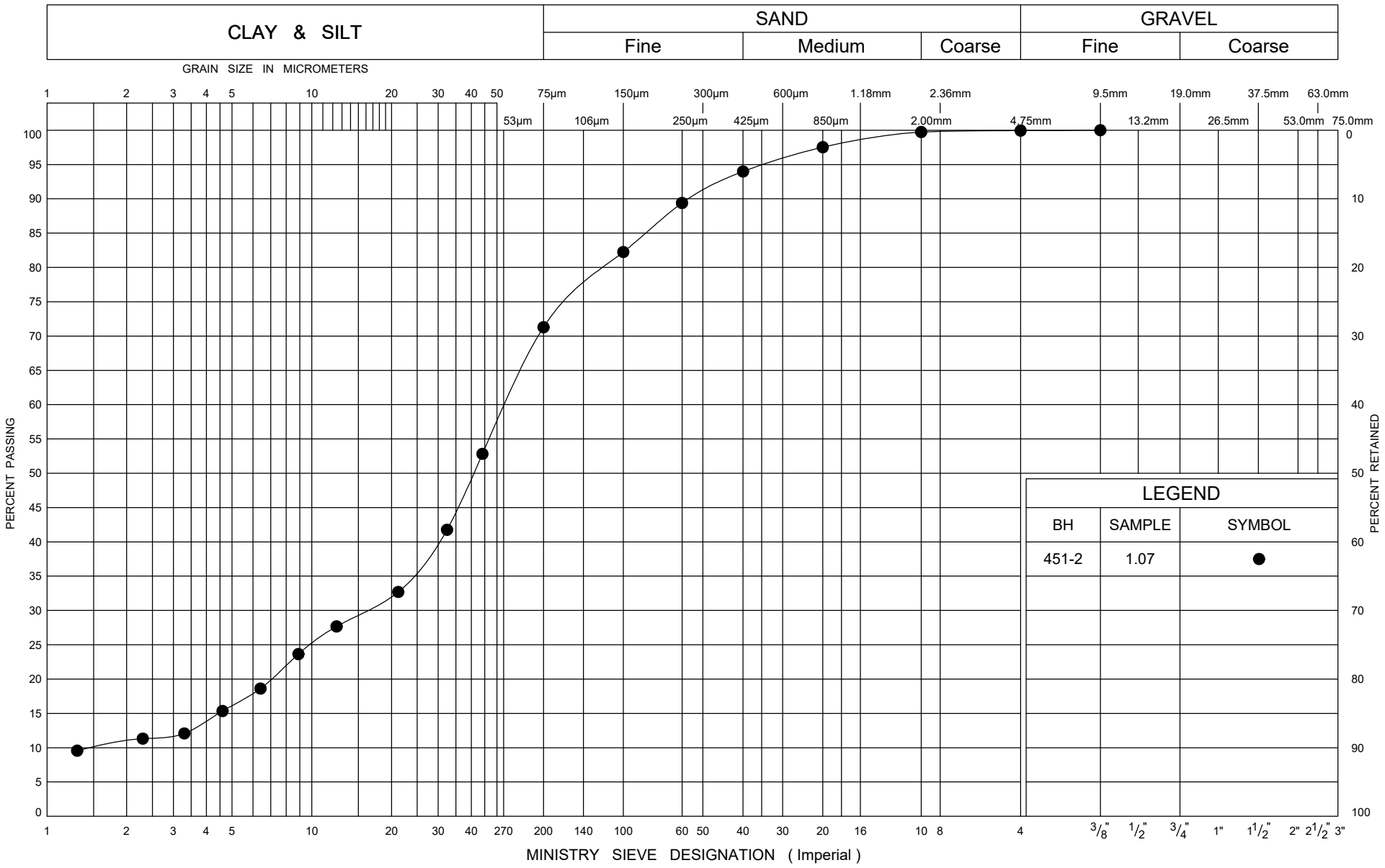
GRAIN SIZE DISTRIBUTION

Embankment FILL

FIG No 2

W.P. 3040-20-01

Culvert 453



Ministry of Transportation
Ontario

GRAIN SIZE DISTRIBUTION

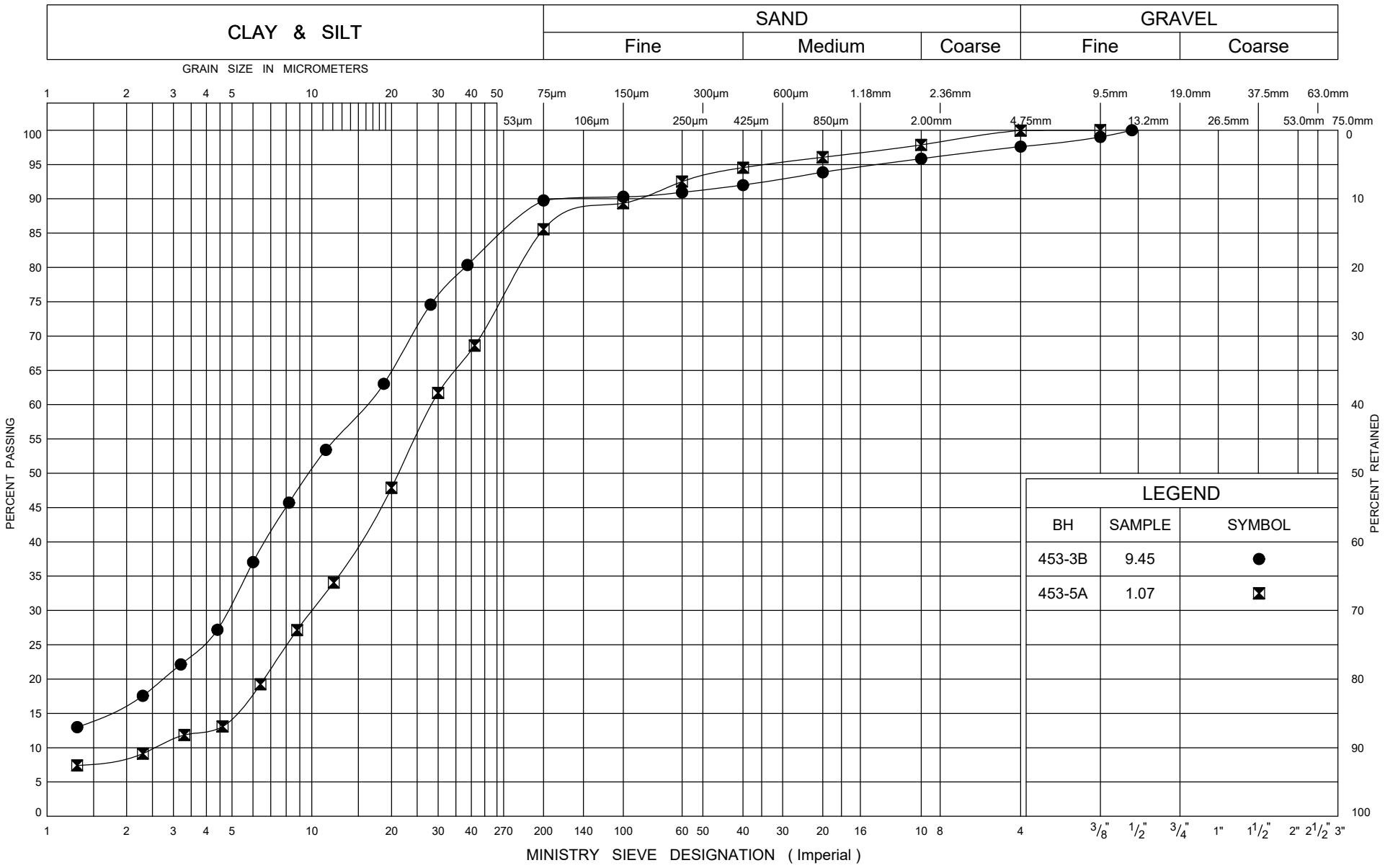
Clayey SILT

FIG No 3

W.P. 3091-20-01

Culvert 451

ONTARIO MOT GRAIN SIZE 2 MTO-36459.GPJ ONTARIO MOT.GDT 10/29/24



Ministry of Transportation
Ontario

GRAIN SIZE DISTRIBUTION

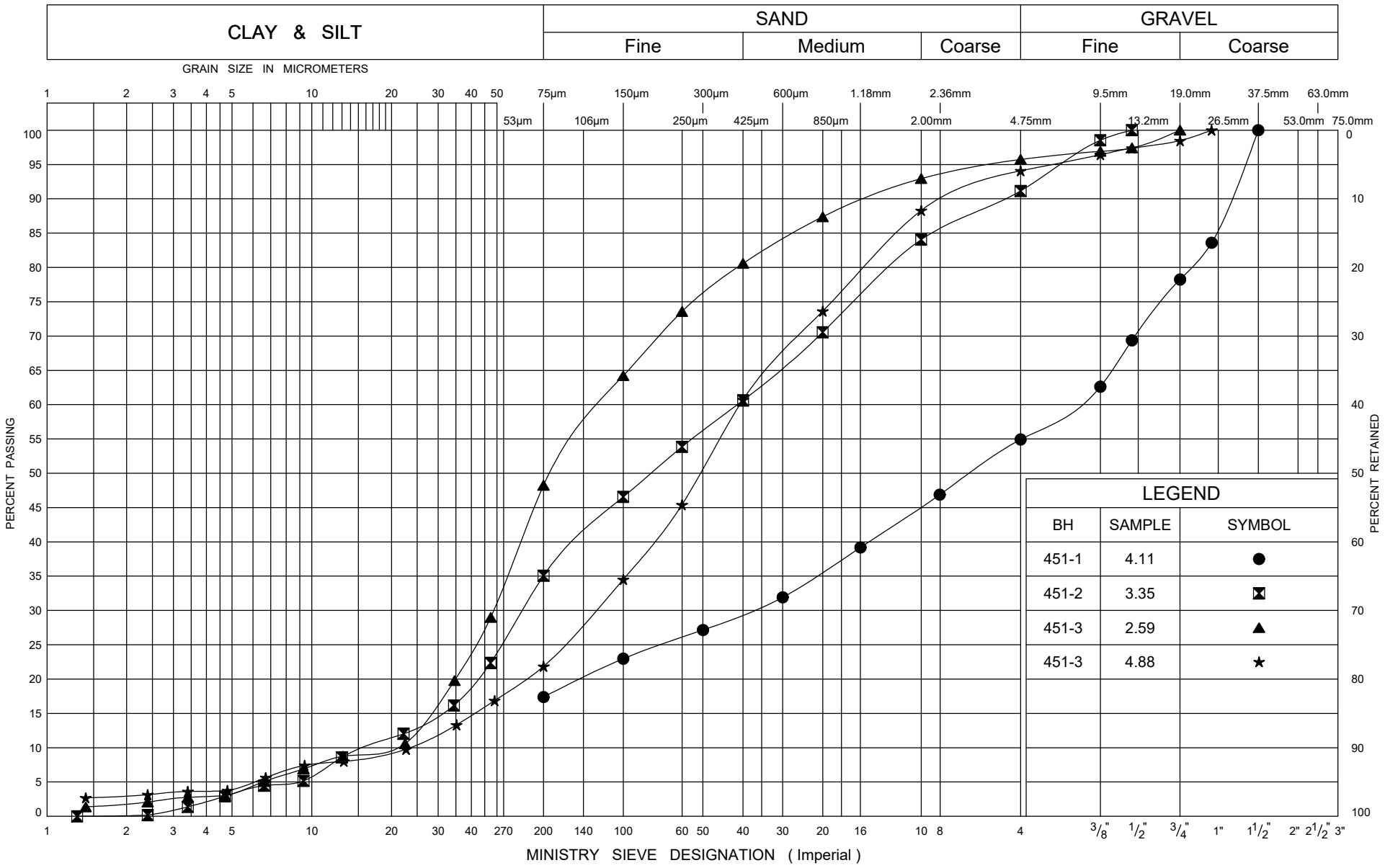
Clayey SILT

FIG No 4

W.P. 3040-20-01

Culvert 453

ONTARIO MOT GRAIN SIZE 2 MTO-36459.GPJ ONTARIO MOT.GDT 10/29/24



Ministry of Transportation
Ontario

GRAIN SIZE DISTRIBUTION

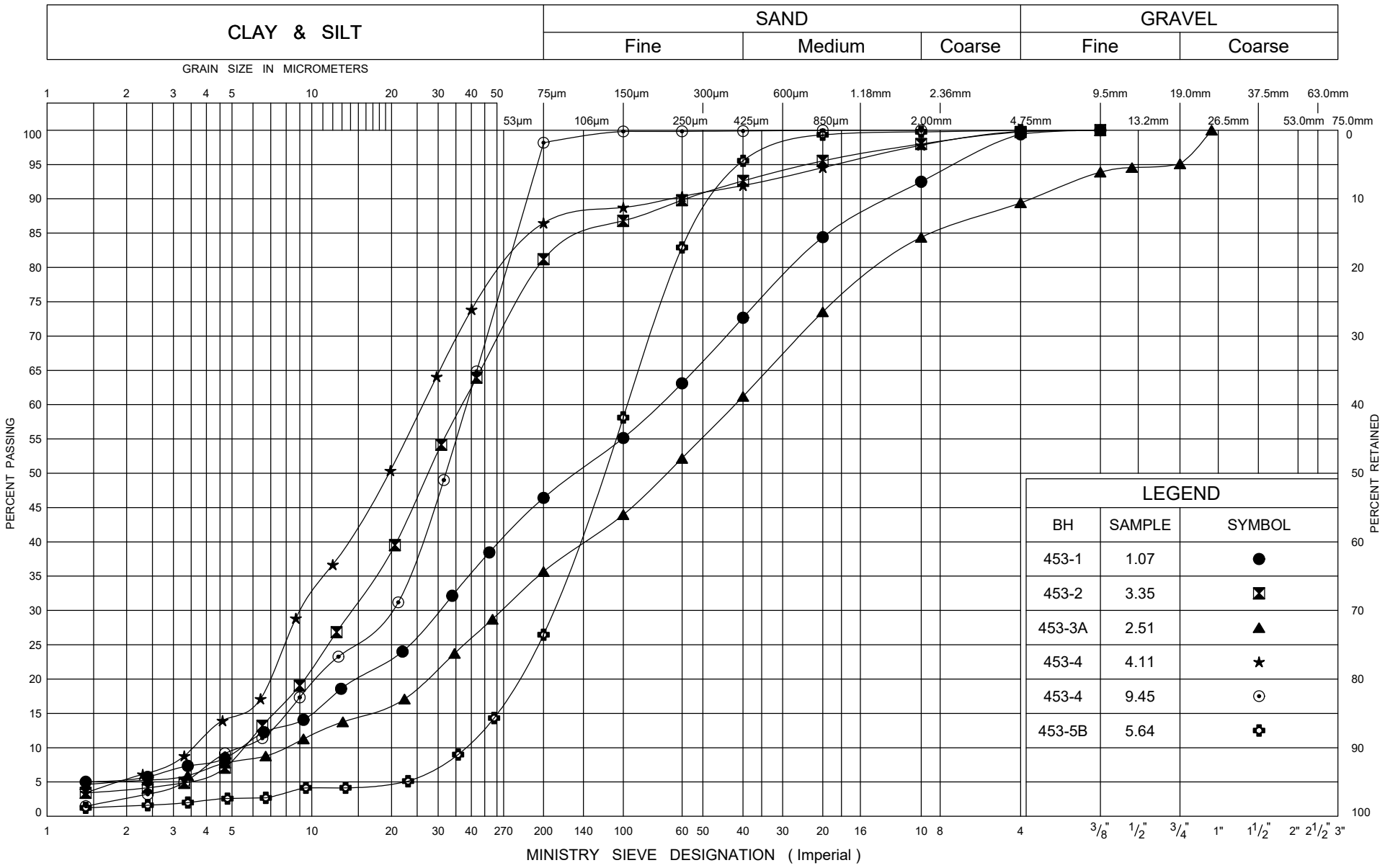
SAND and SILT to Silty SAND

FIG No 5

W.P. 3091-20-01

Culvert 451

ONTARIO MOT GRAIN SIZE 2 MTO-36459.GPJ ONTARIO MOT.GDT 10/29/24



Ministry of Transportation
Ontario

GRAIN SIZE DISTRIBUTION

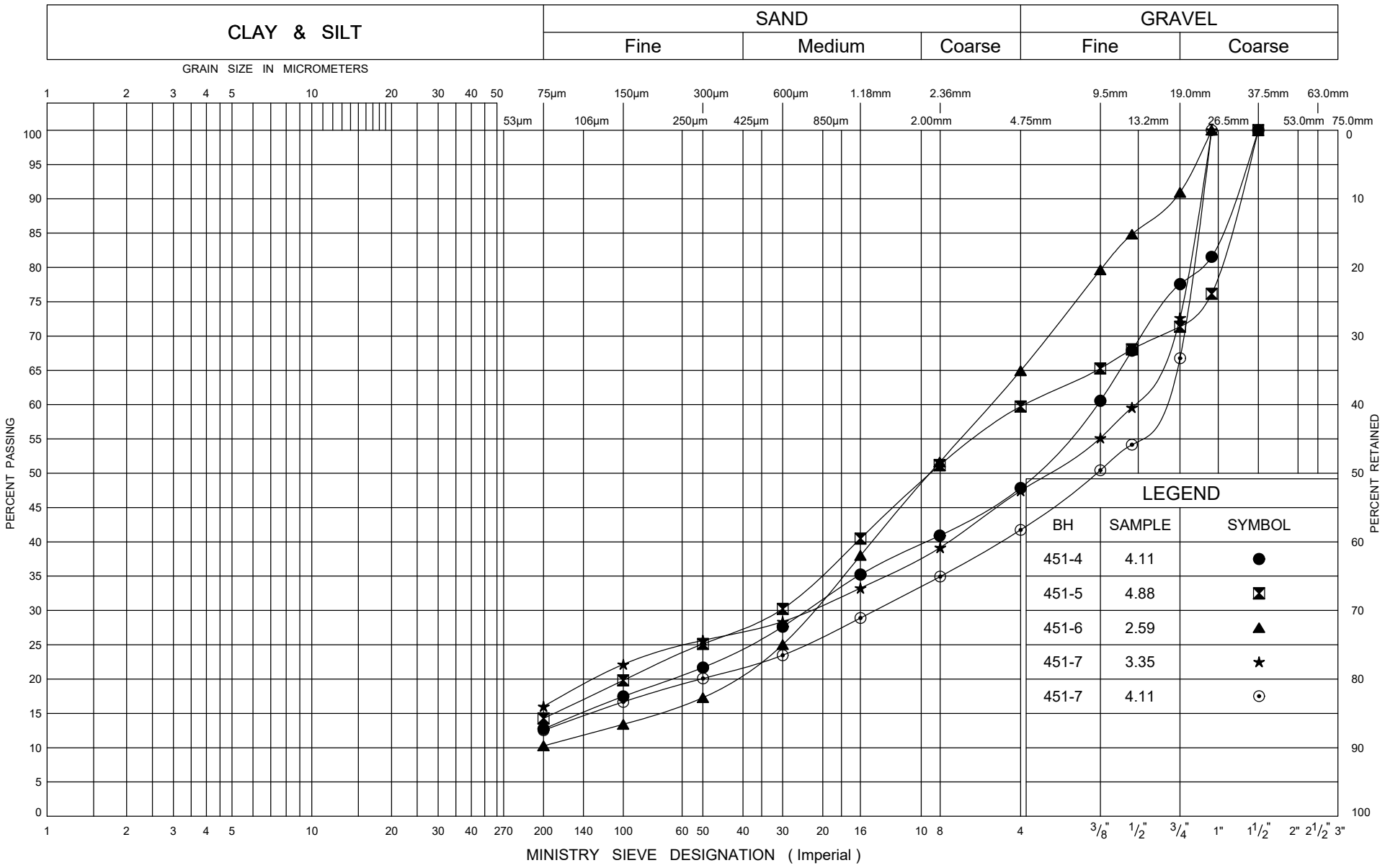
SAND and SILT to Silty SAND

FIG No 6

W.P. 3040-20-01

Culvert 453

ONTARIO MOT GRAIN SIZE 2 MTO-36459.GPJ ONTARIO MOT.GDT 10/29/24



Ministry of Transportation
Ontario

GRAIN SIZE DISTRIBUTION

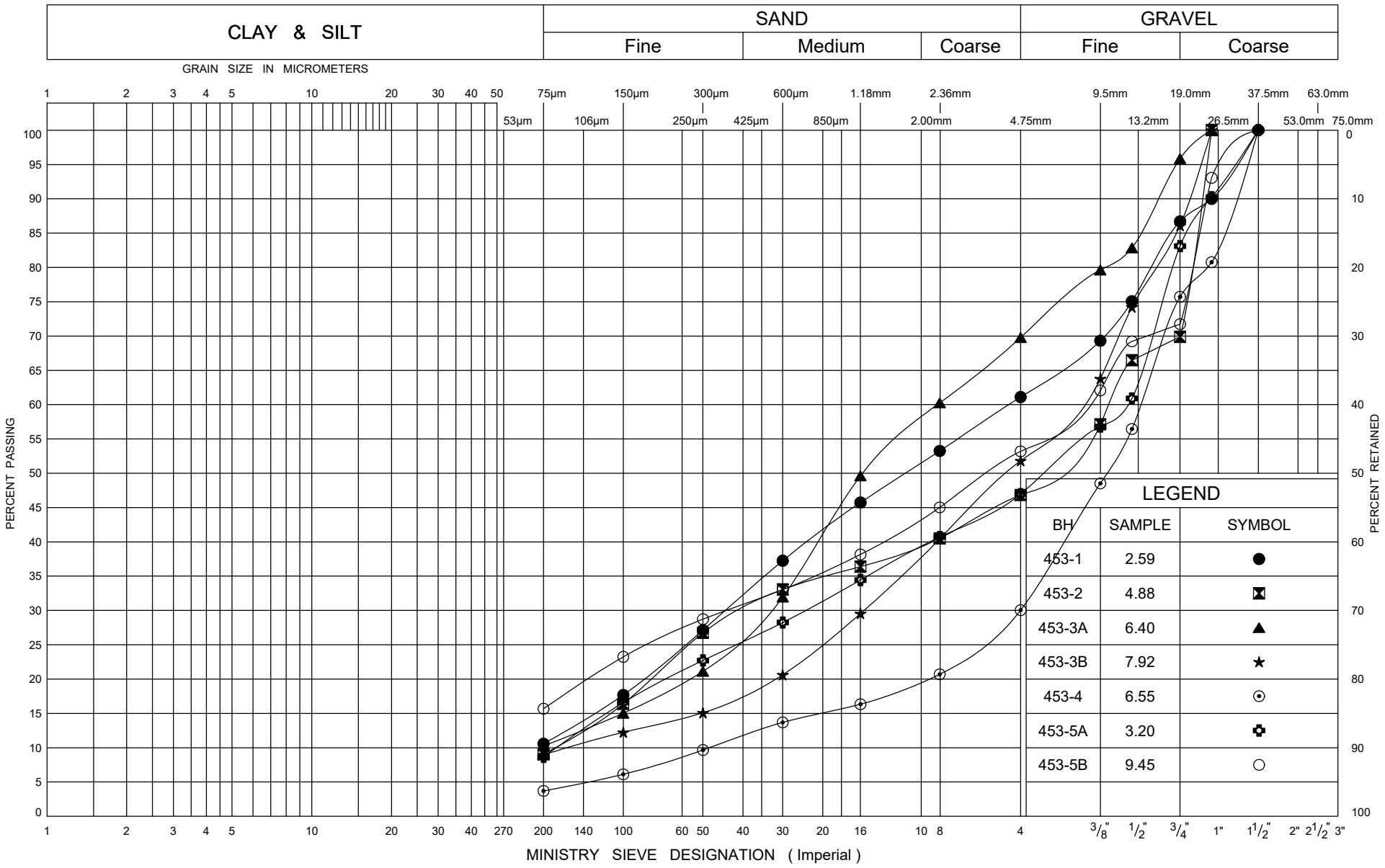
SAND and GRAVEL

FIG No 7

W.P. 3091-20-01

Culvert 451

ONTARIO MOT GRAIN SIZE 2 MTO-36459.GPJ ONTARIO MOT.GDT 10/29/24



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Ontario

GRAIN SIZE DISTRIBUTION

SAND and GRAVEL

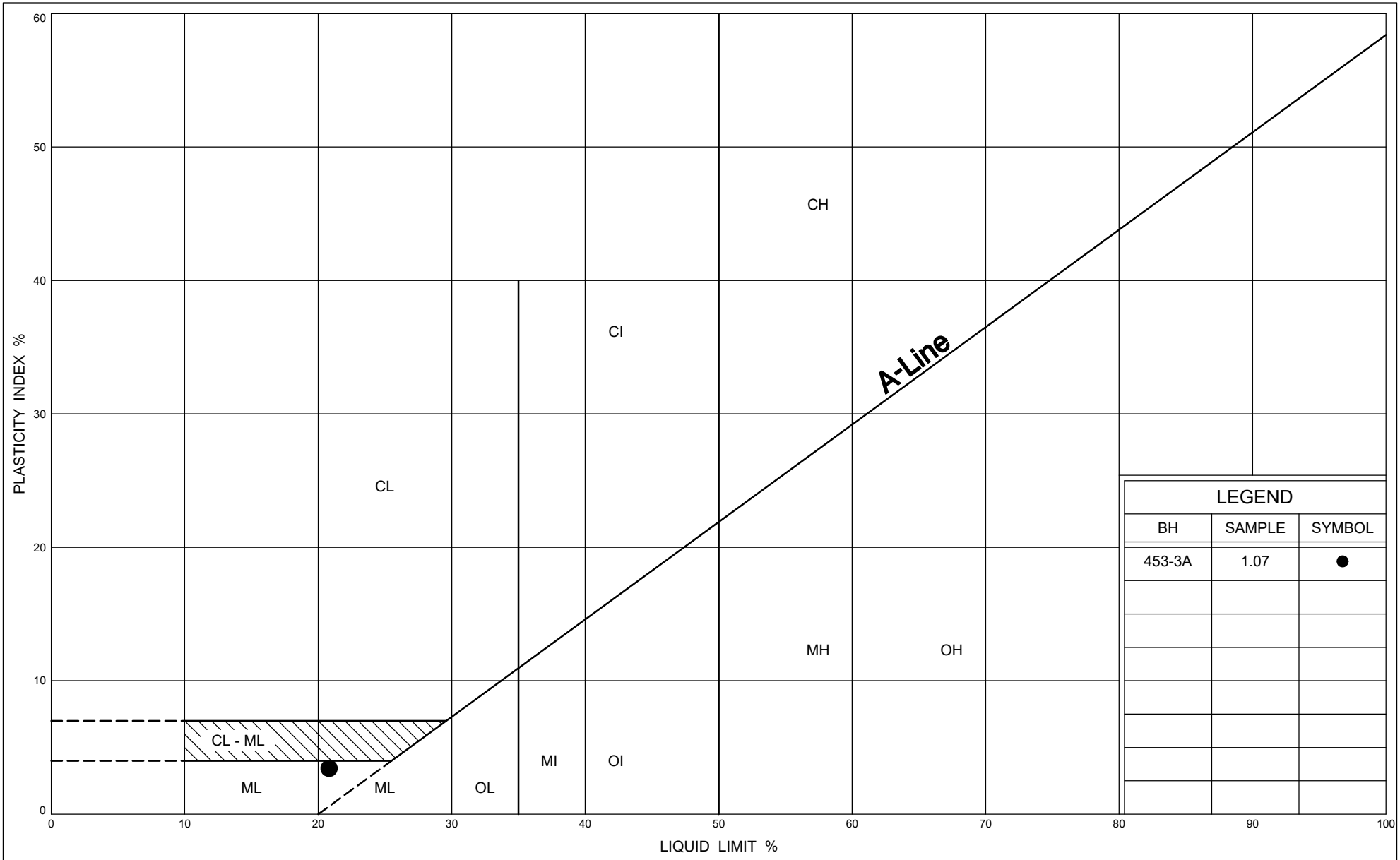
FIG No 8

W.P. 3040-20-01

Culvert 453

ONTARIO MOT GRAIN SIZE 2 MTO-36459.GPJ ONTARIO MOT.GDT 10/29/24

Oct 75, FF - S - 21



ONTARIO MOT PLASTICITY CHART MTO-36459.GPJ ONTARIO MOT.GDT 10/29/24

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Ontario

PLASTICITY CHART

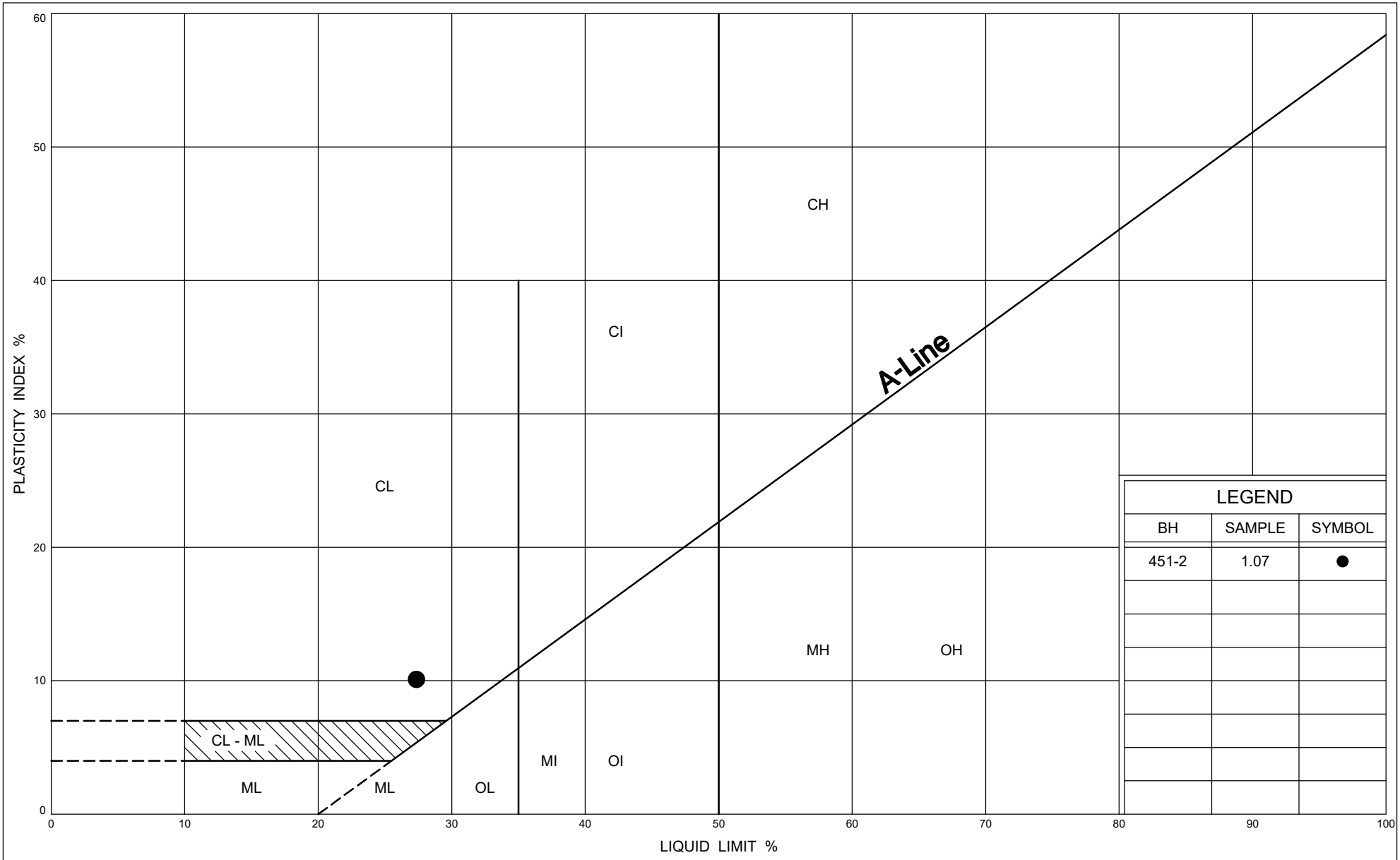
Embankment FILL

FIG No 9

W.P. 3040-20-01

Culvert 453

Oct 75, FF - S - 21



ONTARIO MOT PLASTICITY CHART MTO-36459.GPJ ONTARIO MOT.GDT 10/29/24

Ministry of Transportation
Ontario

PLASTICITY CHART

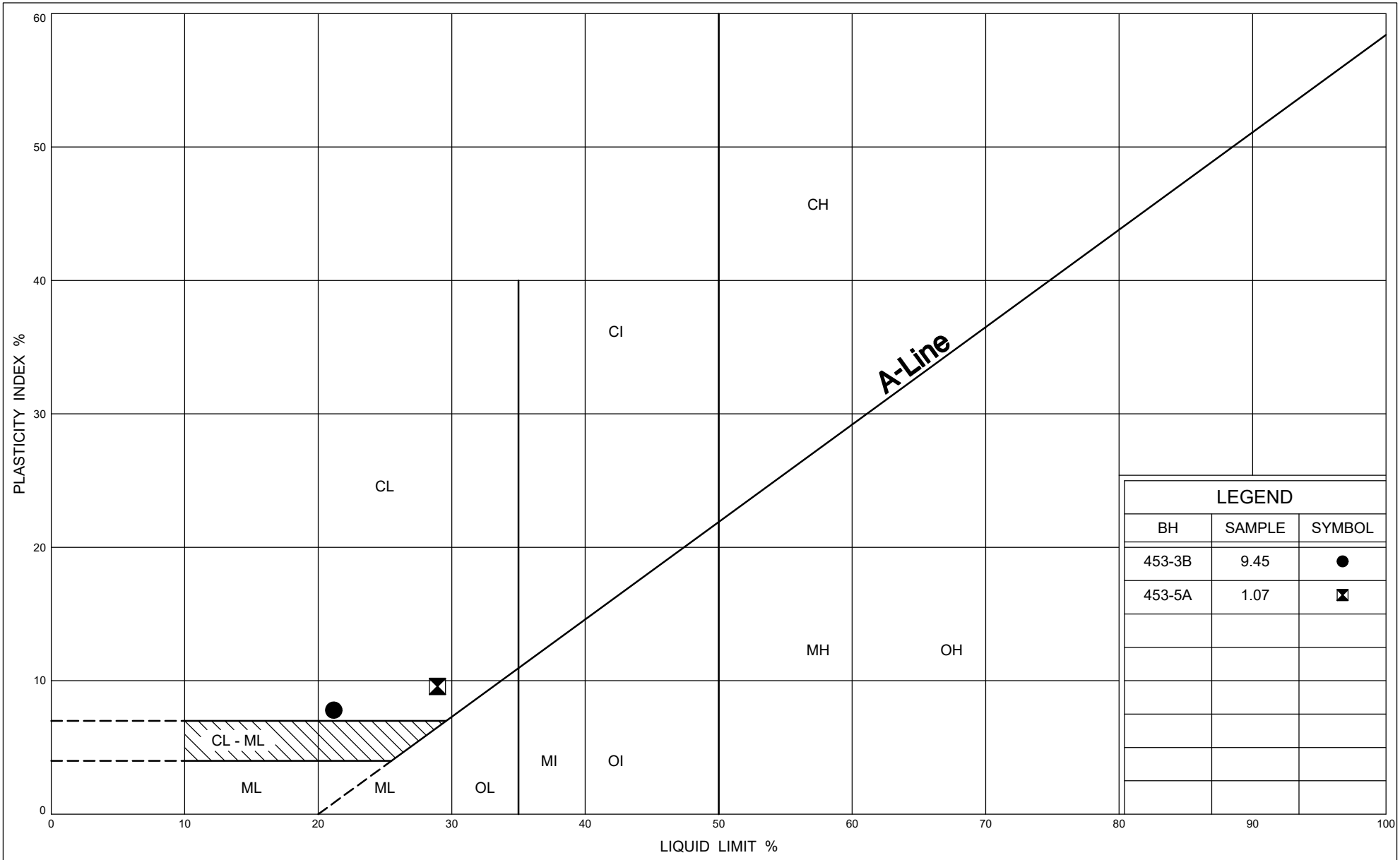
Clayey SILT

FIG No 10

W.P. 3091-20-01

Culvert 451

Oct 75, FF - S - 21



ONTARIO MOT PLASTICITY CHART MTO-36459.GPJ ONTARIO MOT.GDT 10/29/24

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Ontario

PLASTICITY CHART

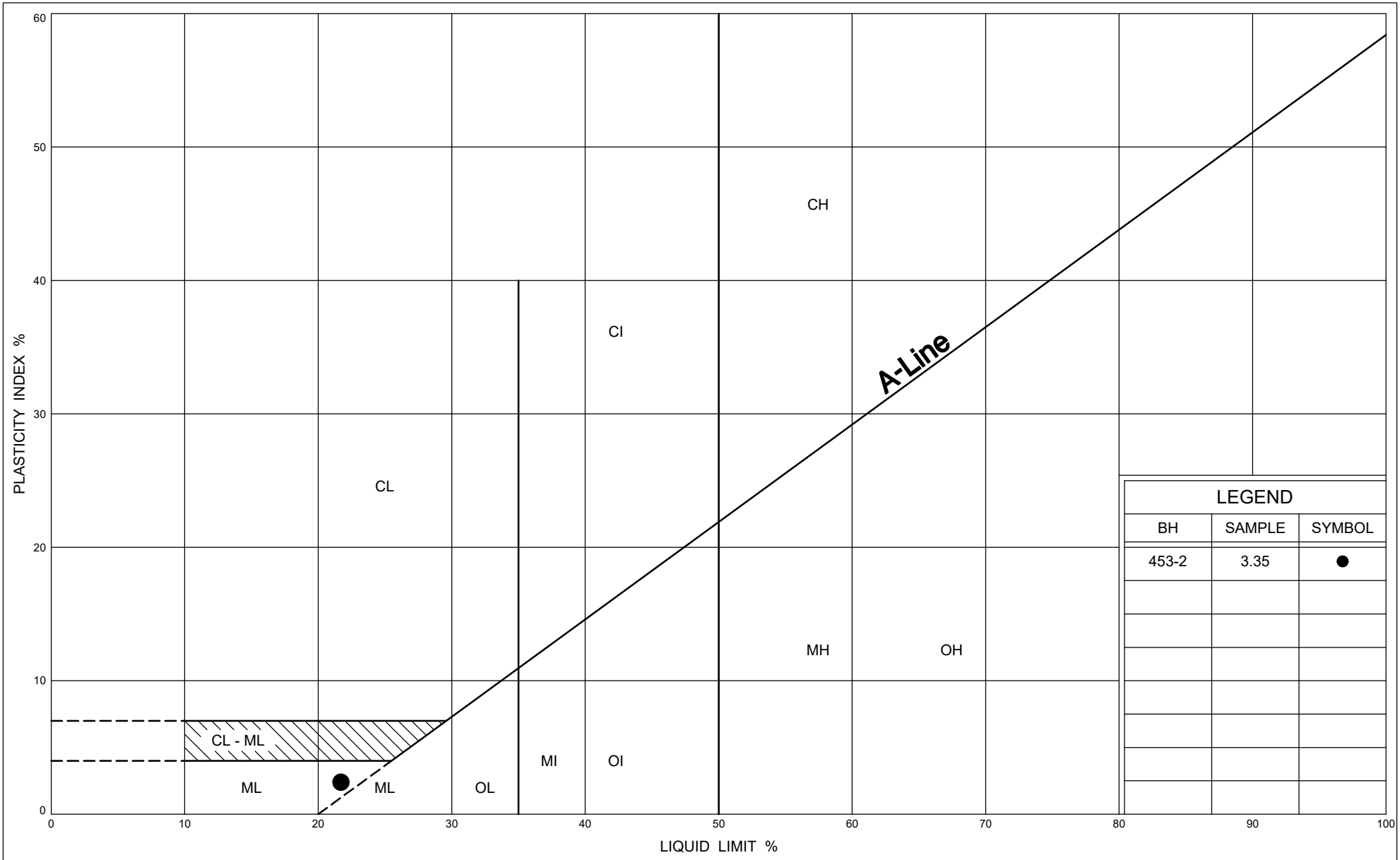
Clayey SILT

FIG No 11

W.P. 3040-20-01

Culvert 453

Oct 75, FF - S - 21



ONTARIO MOT PLASTICITY CHART MTO-36459.GPJ ONTARIO MOT.GDT 10/29/24

Ministry of Transportation
Ontario

PLASTICITY CHART

SAND to SILT to Silty SAND

FIG No 12

W.P. 3040-20-01

Culvert 453

Analysis Report
GS24-03892

THURBER ENGINEERING LTD
SUITE 202 - 1908 IRONOAK WAY
OAKVILLE ON L6H 0N1
CANADA

Received: 13-Sep-2024
Completed: 19-Sep-2024
Description: Alysha - PO# 36459

Report File Reference Number: 0000331646

Sample ID	Laboratory ID	pH	BpH	Total Salts (mmhos/cm)	Organic Matter (%) W-B	Organic Matter (%) LOI	Phosphorus - P (ppm) Sodium Bicarb.	Phosphorus - P (ppm) Bray Phosph.	Potassium K (ppm)	Magnesium Mg (ppm)	Calcium Ca (ppm)
SS4 BH-453-2	GS24-03892.001	-	-	-	-	6.9	-	-	-	-	-
SS5A BH-453-2	GS24-03892.002	-	-	-	-	6.6	-	-	-	-	-
SS5 BH-453-4	GS24-03892.003	-	-	-	-	16.8	-	-	-	-	-

Sample ID	Zinc Zn (ppm)	Zn Index	Manganese Mn (ppm)	Mn Index	Copper Cu (ppm)	Iron Fe (ppm)	Boron B (ppm)	Texture	Cation Exchange MEQ/100g	Base Saturation K%	Base Saturation Mg%	Base Saturation Ca%
SS4	-	-	-	-	-	-	-	-	-	-	-	-
SS5A	-	-	-	-	-	-	-	-	-	-	-	-
SS5	-	-	-	-	-	-	-	-	-	-	-	-

Sample ID	Sodium Na (ppm)	Sulpahte Sulphur SO4-S (ppm)	Chloride Cl (ppm)	Aluminum Al (ppm)	K/Mg Ratio	Exchangeable Acidity	Ammonium (ppm)	Nitrogen NO3-N (ppm)
SS4	-	-	-	-	-	-	-	-
SS5A	-	-	-	-	-	-	-	-
SS5	-	-	-	-	-	-	-	-

NOTE:
The analysis report above refers to the time and place of testing, and strictly to the supplied sample(s) only, without reference to any other matter. This report does not evidence or refer to any consignment or shipment or/and SGS sampling and inspection.

For and on behalf of SGS Canada Inc., Agriculture and Food

Jack Legg, CCA-ON, 4R NMS
Branch Manager, Agronomist

Signed and dated in Guelph, ON
On 19-Sep-2024

Borehole 451-1 – Bedrock (5.5 m – 6.5 m)

Run 1: 5.5 m – 6.5 m
(End of Borehole)

Borehole 451-2 – Bedrock (4.0 – 8.0 m)

Run 1: 4.0 m – 5.1 m

Run 2: 5.1 m – 6.7 m

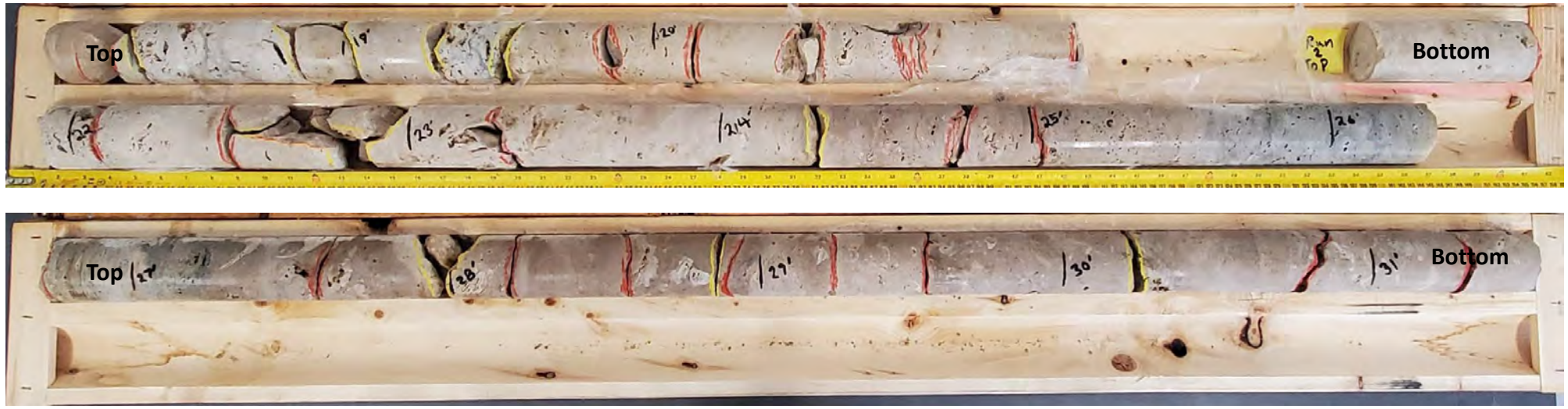
Run 3: 6.7 m – 8.0 m
(End of Borehole)

THURBER ENGINEERING LTD.

Centerline Open Footing Culvert (ID 451) Replacement
Core Photographs - Bedrock

Figure B2-2

Borehole 451-3 – Bedrock (5.5 m – 9.6 m)



Run 1: 5.5 m – 6.5 m

Run 2: 6.5 m – 8.1 m

Run 3: 8.1 m – 9.6 m
(End of Borehole)

Borehole 451-4 – Bedrock (5.5 m – 9.5 m)

Run 1: 5.5 m – 6.5 m

Run 2: 6.5 m – 7.9 m

Run 3: 7.9 m – 9.5 m
(End of Borehole)

THURBER ENGINEERING LTD.

Centerline Open Footing Culvert (ID 451) Replacement
Core Photographs - Bedrock

Figure B2-3

Borehole 451-5 – Bedrock (5.8 m – 9.7 m)

Run 1: 5.8 m – 6.8 m

Run 2: 6.8 m – 8.1 m

Run 3: 8.1 m – 9.7 m
(End of Borehole)

Borehole 451-6 – Bedrock (4.0 m – 6.7 m)

Run 1: 4.0 m – 5.2 m

Run 2: 5.2 m – 6.7 m
(End of Borehole)

THURBER ENGINEERING LTD.

POINT LOAD TEST SHEET

ASTM D5731-08

Job No:	36459	**Date Drilled:**	2nd August 2024
Client:	MTO	**Date Tested:**	14th August 2024
Project Name:	HWY 6 - Culvert	**Tester:**	SP
Core Size:	63 **BH No :** 451	**Reviewed by:**	GL

Test No.	Run No.	Depth (m)	Axial or Diametral	Gauge (MPa)	Diameter (mm)	Length (mm)	$I_{s(50)}$ (MPa)	UCS (MPa)	Rock Type	Rock Strength (after Hoek & Brown, 1997)
1	451-1 #3	6.0	D	15.8	63.0	84.7	4.2	100.6	Dolomite	Very Strong
2	451-1 #3	6.4	D	14.2	63.0	82.2	3.8	90.5	Dolomite	Strong
3	451-2 #2	4.0	D	14.8	63.0	114.6	3.9	94.3	Dolomite	Strong
4	451-2 #2	4.5	D	23.7	63.0	137.5	6.3	150.9	Dolomite	Very Strong
5	451-2 #2	4.7	D	21.1	63.0	113.5	5.6	134.3	Dolomite	Very Strong
6	451-2 #2	5.2	D	5.6	63.0	154.3	1.5	35.5	Dolomite	Medium Strong
7	451-2 #2	5.8	D	19.9	63.0	154.0	5.3	126.3	Dolomite	Very Strong
8	451-2 #2	6.4	D	25.0	63.0	181.4	6.6	159.0	Dolomite	Very Strong
9	451-2 #3	6.7	D	21.5	63.0	86.0	5.7	136.7	Dolomite	Very Strong
10	451-2 #3	7.1	D	18.7	63.0	86.0	5.0	119.0	Dolomite	Very Strong
11	451-2 #3	8.0	D	18.5	63.0	131.0	4.9	117.4	Dolomite	Very Strong
12	451-3 #1	5.8	D	17.7	63.0	95.0	4.7	112.8	Dolomite	Very Strong
13	451-3 #1	5.9	D	18.0	63.0	88.0	4.8	114.6	Dolomite	Very Strong
14	451-3 #1	6.1	D	13.4	63.0	111.0	3.6	85.5	Dolomite	Strong
15	451-3 #2	6.7	D	10.8	63.0	112.0	2.9	68.6	Dolomite	Strong
16	451-3 #2	7.4	D	15.7	63.0	128.0	4.2	100.1	Dolomite	Very Strong
17	451-3 #2	7.9	D	22.9	63.0	124.0	6.1	145.7	Dolomite	Very Strong
18	451-3 #3	8.4	D	23.2	63.0	94.0	6.1	147.3	Dolomite	Very Strong
19	451-3 #3	8.9	D	21.9	63.0	90.0	5.8	139.2	Dolomite	Very Strong
20	451-3 #3	9.4	D	21.2	63.0	115.0	5.6	134.8	Dolomite	Very Strong
21	451-4 #1	5.8	D	25.0	63.0	82.0	6.6	159.0	Dolomite	Very Strong
22	451-4 #2	6.7	D	10.7	63.0	88.0	2.8	68.0	Dolomite	Strong
23	451-4 #2	7.0	D	7.6	63.0	85.0	2.0	48.1	Dolomite	Medium Strong
25	451-4 #2	7.3	D	20.0	63.0	88.0	5.3	127.3	Dolomite	Very Strong
26	451-4 #3	8.0	D	23.2	63.0	82.0	6.1	147.4	Dolomite	Very Strong
27	451-4 #3	8.2	D	23.1	63.0	84.0	6.1	146.9	Dolomite	Very Strong
28	451-4 #3	9.0	D	15.8	63.0	85.0	4.2	100.4	Dolomite	Very Strong
29	451-5 #1	5.9	D	11.3	63.0	82.0	3.0	71.6	Dolomite	Strong
30	451-5 #1	6.4	D	14.8	63.0	85.0	3.9	94.0	Dolomite	Strong
31	451-5 #1	6.7	D	18.8	63.0	82.0	5.0	119.6	Dolomite	Very Strong
32	451-5 #2	7.5	D	17.1	63.0	83.0	4.5	108.9	Dolomite	Very Strong
33	451-5 #2	7.8	D	12.0	63.0	83.0	3.2	76.5	Dolomite	Strong
34	451-5 #3	7.8	D	23.4	63.0	84.0	6.2	149.0	Dolomite	Very Strong
35	451-5 #3	8.7	D	12.1	63.0	82.0	3.2	76.9	Dolomite	Strong
36	451-5 #3	9.6	D	18.7	63.0	82.0	5.0	119.1	Dolomite	Very Strong
37	451-6 #1	4.1	D	25.0	63.0	94.0	6.6	159.0	Dolomite	Very Strong
38	451-6 #1	4.6	D	19.9	63.0	113.0	5.3	126.5	Dolomite	Very Strong
39	451-6 #1	5.1	D	15.7	63.0	101.0	4.2	100.0	Dolomite	Strong
40	451-6 #2	5.3	D	10.3	63.0	101.0	2.7	65.8	Dolomite	Strong
41	451-6 #3	6.2	D	25.8	63.0	115.0	6.8	164.1	Dolomite	Very Strong
42	451-6 #4	6.5	D	16.3	63.0	101.0	4.3	103.7	Dolomite	Very Strong

* It is ideal to perform axial test on core specimens with D/L ratio of 1.1 ± 0.1
  Long pieces of core can be tested diametrically to produce suitable lengths for axial testing
* Diametral Test should have 0.7 x D on either side of test point.
* Correlation factor to obtain UCS values is 24.

Geomechanica Inc.
#14-1240 Speers Rd.
Oakville ON
L6L 2X4 Canada

September 24, 2024

Alysha Kobylinski
Thurber Engineering Ltd
Unit 3, 250 Thompson Drive
Cambridge, ON
Canada, N1T 2E3

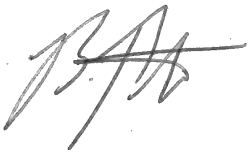
Re: UCS Testing (Thurber Engineering Ltd Project No. 36459)

Dear Alysha Kobylinski:

On September 11, 2024 a series of three (3) core samples (HQ-sized) were received by Geomechanica Inc. via drop-off by Thurber personnel. These samples were identified as being from Thurber Engineering Ltd Project No. 36459. From these samples, 2 Uniaxial Compressive Strength (UCS) tests were completed.

Details regarding the steps of specimen preparation and testing along with the test results are presented in the accompanying laboratory report and summary spreadsheet.

Sincerely,



Bryan Tatone, PhD, PEng

Geomechanica Inc.
Tel: +1-647-478-9767
lab@geomechanica.com

GEOMECHANICA

Rock Laboratory Testing Results

A report submitted to:

Alysha Kobylinski
Thurber Engineering Ltd
Unit 3, 250 Thompson Drive
Cambridge, ON
Canada, N1T 2E3

Prepared by:

Bryan Tatone, PhD, PEng

Omid Mahabadi, PhD, PEng
Geomechanica Inc.
#14-1240 Speers Rd.
Oakville ON
L6L 2X4 Canada
Tel: +1-647-478-9767
lab@geomechanica.com

September 24, 2024
Project number: 36459

Abstract

This document summarizes the results of rock laboratory testing, including 2 Uniaxial Compressive Strength (UCS) tests. The UCS values along with photographs of specimens before and after testing are presented herein.

In this document:

1 Uniaxial Compressive Strength Tests

1.1 Overview

This section summarizes the results of uniaxial compressive strength (UCS) testing. The testing was performed in Geomechanica Inc.'s rock testing laboratory using a 150 ton (1.3 MN) Forney loading frame equipped with pressure-compensated control valve to maintain an axial displacement rate of approximately 0.05 mm/min (Figure 1). The preparation and testing procedure for each specimen included the following:

1. Unwrapping the core sample, inspecting it for damage, and re-wrapping it in electrical tape to avoid potential damages during subsequent specimen preparation.
2. Diamond cutting the core sample to obtain a cylindrical specimens with an appropriate length (length:diameter = 2:1) and nearly parallel end faces.
3. Diamond grinding the specimen to obtain flat (within ± 0.025 mm) and parallel end faces (within 0.25°).
4. Placing the specimen into the loading frame, applying a 1 kN axial load, and removing the electrical tape.
5. Axially loading the specimen to rupture while continuously recording axial force to determine the peak strength (UCS).

Figure 1: Forney loading frame setup for UCS testing.

Using a precision V-block mounted on the magnetic chuck of the surface grinder, test specimens met the end flatness, end parallelism, and perpendicularity criteria set out in ASTM D4543-19. The side straightness criteria, as checked with a feeler gauge, and the minimum length:diameter criteria were met for all specimens unless noted otherwise in Table 1. Testing of the specimens followed ASTM D7012-14 Method C.

1.2 Results

The results of UCS testing are summarized in Table 1. Additional specimen and testing details are provided on the summary spreadsheet that accompanies this report.

Table 1: Summary of UCS test results.

Sample	Depth (ft' in")	Bulk density ρ (g/cm^3)	UCS (MPa)	Lithology	Failure description
BH 451-5, Run 2	23'7" - 24'4"	2.561	61.3	Dolomite	1
BH 451-2, Run 3	19'2" - 20'10"	2.749	151.4	Dolomite	1

[1] Inclined shear fracture and axial splitting failure

1.3 Specimen photographs

Photographs of the specimens before and after testing are presented in the Appendix of this report.

Appendices

Specimen sheets

- BH 451-5, Run 2
- BH 451-2, Run 3

GEOMECHANICA

Uniaxial Compression Test

Client	Thurber Engineering Ltd	**Project**	36459
Sample	BH 451-5, Run 2	**Depth**	23’7” - 24’4”

Specimen parameters	
Diameter (mm) [a]	62.65
Length (mm) [a]	125.45
Bulk density ρ (g/cm^3)	2.561
UCS (MPa)	61.3
Lithology	Dolomite
Failure description [b]	1

[a] Additional specimen measurement/details provided in accompanying summary spreadsheet.
[b] Failure description: [1] Inclined shear fracture and axial splitting failure;

Prior to testing

After testing

Remarks: Displacement rate: 0.05 mm/min.

Performed by	AP	**Date**	2024-09-24

GEOMECHANICA

Uniaxial Compression Test

Client	Thurber Engineering Ltd	**Project**	36459
Sample	BH 451-2, Run 3	**Depth**	19’2” - 20’10”

Specimen parameters	
Diameter (mm) [a]	62.64
Length (mm) [a]	124.28
Bulk density ρ (g/cm^3)	2.749
UCS (MPa)	151.4
Lithology	Dolomite
Failure description [b]	1

[a] Additional specimen measurement/details provided in accompanying summary spreadsheet.
[b] Failure description: [1] Inclined shear fracture and axial splitting failure;

Prior to testing

After testing

Remarks: Displacement rate: 0.05 mm/min.

Performed by	AP	**Date**	2024-09-24

FINAL REPORT

CA40065-SEP24 R1

36459

Prepared for

Thurber Engineering Ltd.

FINAL REPORT

First Page

CLIENT DETAILS

Client	Thurber Engineering Ltd.
Address	1908 Ironoak Way, Suite 202 Cambridge, ON L6H 0N1. Canada
Contact	Alysha Kobylinski
Telephone	226-748-9593
Facsimile	
Email	akobylinski@thurber.ca
Project	36459
Order Number	
Samples	Soil (4)

LABORATORY DETAILS

Project Specialist	Maarit Wolfe, Hon.B.Sc
Laboratory	SGS Canada Inc.
Address	185 Concession St., Lakefield ON, K0L 2H0
Telephone	705-652-2000
Facsimile	705-652-6365
Email	Maarit.Wolfe@sgs.com
SGS Reference	CA40065-SEP24
Received	09/11/2024
Approved	09/17/2024
Report Number	CA40065-SEP24 R1
Date Reported	09/17/2024

COMMENTS

Temperature of Sample upon Receipt: 8 degrees C
Cooling Agent Present: yes
Custody Seal Present: yes

Chain of Custody Number: n/a

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

SIGNATORIES

Maarit Wolfe, Hon.B.Sc

TABLE OF CONTENTS

Client: Thurber Engineering Ltd.
Project: 36459
Project Manager: Alysha Kobylinski
Samplers: G. Lowery

MATRIX: SOIL

Sample Number	5	6	7	8
Sample Name	453-3A SS5A	453-2 SS5B	451-4 SS5	451-5 SS4
Sample Matrix	Soil	Soil	Soil	Soil
Sample Date	08/08/2024	08/08/2024	01/08/2024	01/08/2024

Parameter	Units	RL		Result	Result	Result	Result
Corrosivity Index							
Corrosivity Index	none	1		4	10	4	4
pH	pH Units	0.05		8.49	7.96	8.90	9.12
Soil Redox Potential	mV	no		267	177	290	318
Sulphide (Na2CO3)	%	0.01		0.03	0.03	< 0.01	< 0.01
Resistivity (calculated)	ohms.cm	-9999		5030	2010	4950	5000
General Chemistry							
Conductivity	uS/cm	2		199	498	202	200
Metals and Inorganics							
Sulphate	µg/g	0.4		160	37	11	12
Other (ORP)							
Chloride	µg/g	0.4		50	10	70	110

QC SUMMARY

Anions by IC

Method: EPA300/MA300-Ions1.3 | Internal ref.: ME-CA-[ENV]IC-LAK-AN-001

Parameter	QC batch Reference	Units	RL	Method Blank	Duplicate		LCS/Spike Blank			Matrix Spike / Ref.		
					RPD	AC (%)	Spike Recovery (%)	Recovery Limits (%)		Spike Recovery (%)	Recovery Limits (%)	
								Low	High		Low	High
Chloride	DIO0227-SEP24	µg/g	0.4	<0.4	21	35	94	80	120	101	75	125
Sulphate	DIO0227-SEP24	µg/g	0.4	<0.4	ND	35	93	80	120	NV	75	125

Carbon/Sulphur

Method: ASTM E1915-07A | Internal ref.: ME-CA-[ENV]ARD-LAK-AN-020

Parameter	QC batch Reference	Units	RL	Method Blank	Duplicate		LCS/Spike Blank			Matrix Spike / Ref.		
					RPD	AC (%)	Spike Recovery (%)	Recovery Limits (%)		Spike Recovery (%)	Recovery Limits (%)	
								Low	High		Low	High
Sulphide (Na2CO3)	ECS0035-SEP24	%	0.01	< 0.01								

Conductivity

Method: SM 2510 | Internal ref.: ME-CA-[ENV]EWL-LAK-AN-006

Parameter	QC batch Reference	Units	RL	Method Blank	Duplicate		LCS/Spike Blank			Matrix Spike / Ref.		
					RPD	AC (%)	Spike Recovery (%)	Recovery Limits (%)		Spike Recovery (%)	Recovery Limits (%)	
								Low	High		Low	High
Conductivity	EWL0225-SEP24	uS/cm	2	< 2	1	20	98	90	110	NA		

QC SUMMARY

pH

Method: SM 4500 I Internal ref.: ME-CA-[ENV]EWL-LAK-AN-001

Parameter	QC batch Reference	Units	RL	Method Blank	Duplicate		LCS/Spike Blank			Matrix Spike / Ref.		
					RPD	AC (%)	Spike Recovery (%)	Recovery Limits (%)		Spike Recovery (%)	Recovery Limits (%)	
								Low	High		Low	High
pH	EWL0225-SEP24	pH Units	0.05	NA	0		100			NA		

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

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

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

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

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

RL: Reporting limit

RPD: Relative percent difference

AC: Acceptance criteria

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

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

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

LEGEND

FOOTNOTES

NSS Insufficient sample for analysis.
RL Reporting Limit.
↑ Reporting limit raised.
↓ Reporting limit lowered.
NA The sample was not analysed for this analyte
ND Non Detect

Results relate only to the sample tested.
Data reported represent the sample as submitted to SGS. Solid samples expressed on a dry weight basis.
"Temperature Upon Receipt" is representative of the whole shipment and may not reflect the temperature of individual samples.
Analysis conducted on samples submitted pursuant to or as part of Reg. 153/04, are in accordance to the "Protocol for Analytical Methods Used in the Assessment of Properties under Part XV.1 of the Environmental Protection Act and Excess Soil Quality" published by the Ministry and dated March 9, 2004 as amended.

SGS provides criteria information (such as regulatory or guideline limits and summary of limit exceedances) as a service. Every attempt is made to ensure the criteria information in this report is accurate and current, however, it is not guaranteed. Comparison to the most current criteria is the responsibility of the client and SGS assumes no responsibility for the accuracy of the criteria levels indicated.

SGS Canada Inc. statement of conformity decision rule does not consider uncertainty when analytical results are compared to a specified standard or regulation.

This report supersedes all previous versions.

-- End of Analytical Report --

Request for Laboratory Services and CHAIN OF CUSTODY

SGS Industries & Environment - Lakefield: 185 Concession St., Lakefield, ON K0L 2H0 Phone: 705-652-2000 Fax: 705-652-6365 Web: www.sgs.com/environment
- London: 657 Consortium Court, London, ON, N6E 2S8 Phone: 519-672-4500 Toll Free: 877-848-8060 Fax: 519-672-0361

No:

Page 1 of 1

Laboratory Information Section - Lab use only

Received By: ED
Received Date: 9 / 11 / 24 (mm/dd/yy)
Received Time: 10 : 25 (hr : min)
Received By (signature):
Custody Seal Present: Yes ☑ No ☐
Custody Seal Intact: Yes ☐ No ☐
Cooling Agent Present: Yes ☑ No ☐ Type: ICE
Temperature Upon Receipt (°C) 6.3
LAB LIMS #: CA-40065-SEP24

REPORT INFORMATION

Company: THURBER ENGINEERING LTD
Contact: ALYSHA KOBYLINSKI
Address: 1908 IRONOAK WY SUITE 202, OAKVILLE, ON L6H 7G4
Phone: 2267489593
Fax:
Email: akobylinski@thurber.ca

INVOICE INFORMATION

☑ (same as Report Information)
Company:
Contact:
Address:
Phone:
Email:

Quotation #:
P.O. #: 36459
Project #: 36459
Site Location/ID:

TURNAROUND TIME (TAT) REQUIRED

☑ Regular TAT (5-7days)
TAT's are quoted in business days (exclude statutory holidays & weekends). Samples received after 6pm or on weekends: TAT begins next business day

RUSH TAT (Additional Charges May Apply): ☐ 1 Day ☐ 2 Days ☐ 3 Days ☐ 4 Days
PLEASE CONFIRM RUSH FEASIBILITY WITH SGS REPRESENTATIVE PRIOR TO SUBMISSION

Specify Due Date:
*NOTE: DRINKING (POTABLE) WATER SAMPLES FOR HUMAN CONSUMPTION MUST BE SUBMITTED WITH SGS DRINKING WATER CHAIN OF CUSTODY

REGULATIONS

☐ O.Reg 153/04 ☐ O.Reg 406/19
☐ Table 1 ☐ Res/Park Soil Texture: ☐ Coarse
☐ Table 2 ☐ Ind/Com ☐ Medium/Fine
☐ Table 3 ☐ Agri/Other
☐ Table ____ App. ____
Soil Volume ☐ <350m3 ☐ >350m3

Other Regulations:
☐ Reg 347/558 (3 Day min TAT)
☐ PWQO ☐ MMER
☐ CCME ☐ Other:
☐ MISA
☐ ODWS Not Reportable *See note

Sewer By-Law:
☐ Sanitary
☐ Storm
Municipality:

RECORD OF SITE CONDITION (RSC) ☐ YES ☐ NO

ANALYSIS REQUESTED

	SAMPLE IDENTIFICATION	DATE SAMPLED	TIME SAMPLED	# OF BOTTLES	MATRIX	Field Filtered (Y/N)	M&I: Metals & Inorganics (incl CrVI, CN,Hg pH,(B(HWS),EC,SAR-soil) (Cl, Na-water)	M&I: Full Metals Suite (ICP metals plus B(HWS-soil only) Hg, CrVI	M&I: ICP Metals only (Sb,As,Ba,Be,B,Cd,Cr,Co,Cu,Pb,Mo,Ni, Se,Ag,Tl,U,V,Zn	SVOC: PAHs only	SVOC: SVOCs all incl PAHs, ABNs, CPs	PCB: PCBs Total ☐ Aroclor ☐	PHC: F1-F4 + BTEX	PHC: F1-F4 only no BTEX	VOC: VOCs all incl BTEX	VOC: BTEX only	Pest: Pesticides Organochlorine or specify other	Other:	Other: CORROSIVITY PACKAGE + SULFIDE	Other:	Other:	Other: Sewer Use: Specify pkg:	Other: Water Characterization Pkg ☐ General ☐ Extended	SPLP: Specify tests ☐ Metals ☐ VOC ☐ 1,4-Dioxane ☐ OCP ☐ ABN	TCLP: Specify tests ☐ M&I ☐ VOC ☐ PCB ☐ B(a)P ☐ ABN ☐ Ignit.	COMMENTS:
1	453-3A SS5A	Aug 8, 24					☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☑	☐	☐	☐	☐	☐	☐	
2	453-2 SS5B ✓	Aug 8, 24					☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☑	☐	☐	☐	☐	☐	☐	
3							☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	
4	451-4 SS5 ✓	Aug 1, 24					☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☑	☐	☐	☐	☐	☐	☐	
5	451-5 SS4 ✓	Aug 1, 24					☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☑	☐	☐	☐	☐	☐	☐	
6							☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	
7							☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	
8							☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	
9							☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	
10							☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	
11							☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	
12							☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	

Observations/Comments/Special Instructions

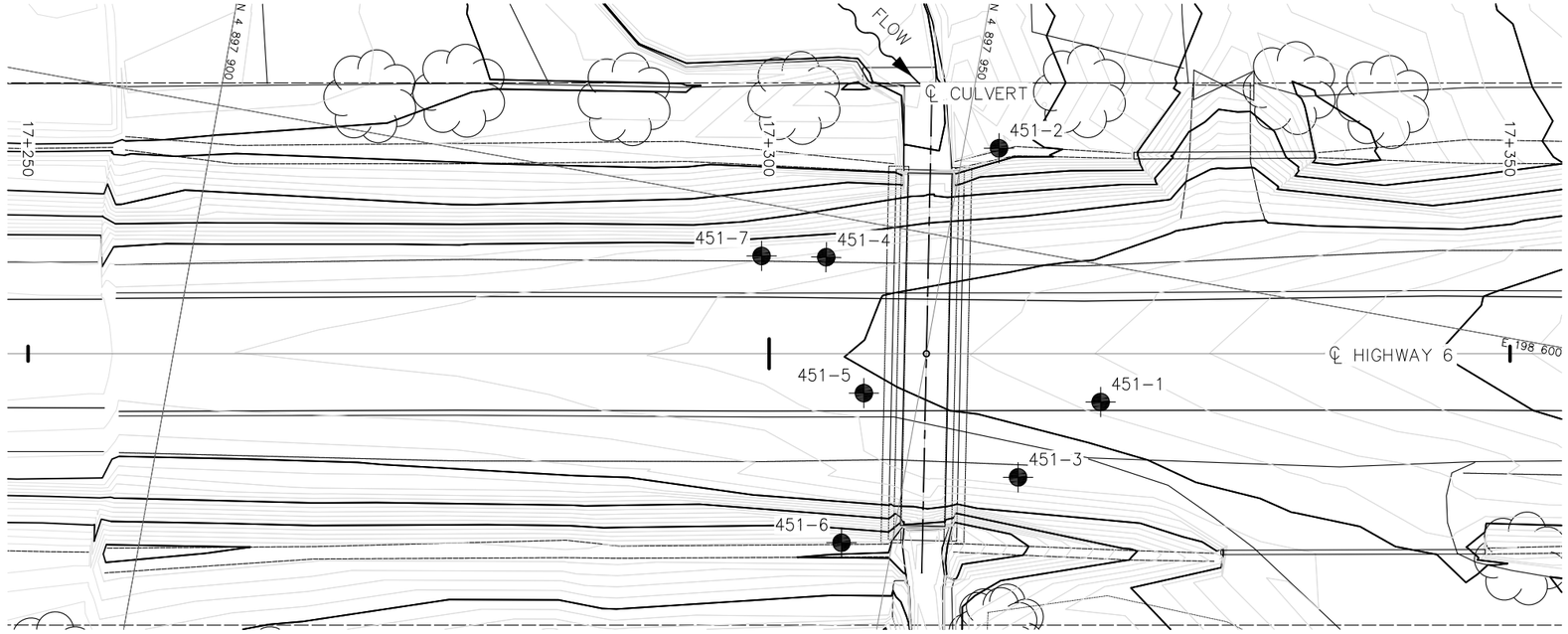
Sampled By (NAME): Graeme Lowry Signature: Date: 9 / 11 / 2024 (mm/dd/yy) Pink Copy - Client
Relinquished by (NAME): Graeme Lowry Signature: Date: 9 / 11 / 2024 (mm/dd/yy) Yellow & White Copy - SGS

Revision #: 1.6
Date of Issue: 11 June 2021

THURBER ENGINEERING LTD.

APPENDIX D
BOREHOLE LOCATIONS AND SOIL STRATA DRAWINGS

MINISTRY OF TRANSPORTATION, ONTARIO



PLAN

8 0 8 16m

SCALE 1:400

METRIC

DIMENSIONS ARE IN METRES AND/OR MILLIMETRES UNLESS OTHERWISE SHOWN

LICENSED PROFESSIONAL ENGINEER
P. K. CHATTERJI
MAR. 18, 2025
PROVINCE OF ONTARIO

LICENSED PROFESSIONAL ENGINEER
K. L. SHI
100141639
MAR. 18, 2025
PROVINCE OF ONTARIO

CONT No
WP No 3091–20–01

HIGHWAY 6
CULVERT REPLACEMENT
STA. 17+310.62
BOREHOLE LOCATIONS AND SOIL STRATA

SHEET

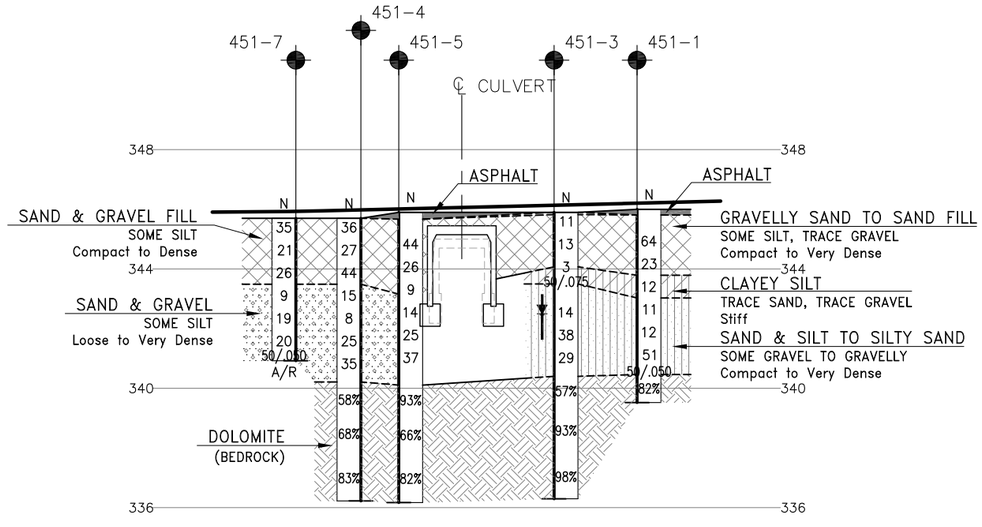
THURBER

KEYPLAN

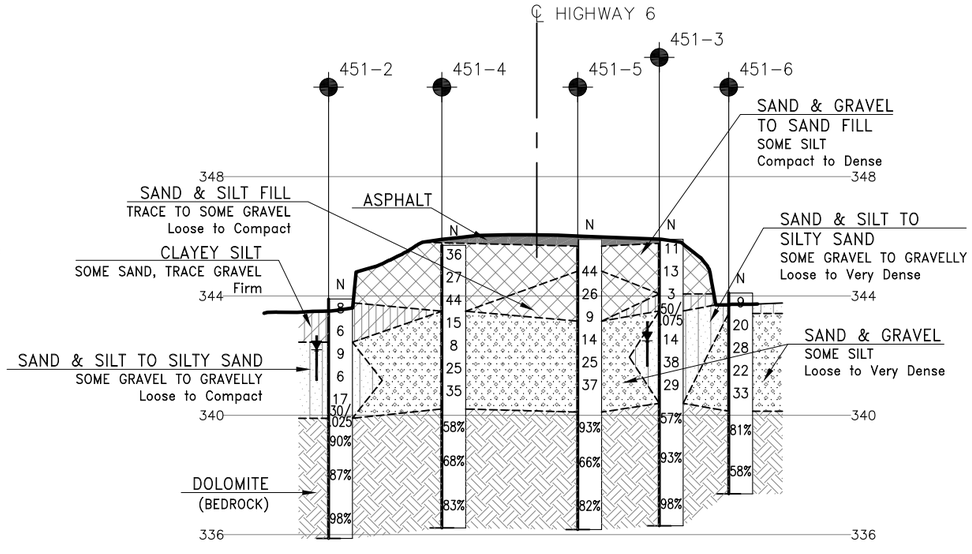
LEGEND

●	Borehole
⊕	Borehole and Cone
N	Blows /0.3m (Std Pen Test, 475J/blow)
CONE	Blows /0.3m (60° Cone, 475J/blow)
PH	Pressure, Hydraulic
▽	Water Level Upon Completion of Drilling
▼	Water Level in Monitoring Well/Piezometer
	Monitoring Well/Piezometer Screen
90%	Rock Quality Designation (RQD)
A/R	Auger Refusal

NO	ELEVATION	NORTHING	EASTING
451–1	346.0	4 897 962.1	198 609.1
451–2	343.9	4 897 952.4	198 593.5
451–3	345.9	4 897 957.6	198 615.1
451–4	345.7	4 897 942.2	198 602.8
451–5	345.9	4 897 946.3	198 611.4
451–6	344.1	4 897 946.6	198 621.6
451–7	345.7	4 897 937.9	198 603.5



PROFILE ALONG ℄ HWY 6



PROFILE ALONG ℄ CULVERT

8 0 8 16m H 1:400

4 0 4 8m V 1:200

-NOTES-

1) The boundaries between soil strata have been established only at Borehole locations. Between Boreholes the boundaries are assumed from geological evidence.
2) This drawing is for subsurface information only. Surface details and features are for conceptual illustration.
3) Coordinate system is MTM NAD 83 Zone 10.

GEOCRES No. 41A02-001

REVISIONS		
DATE	BY	DESCRIPTION

DESIGN	PV	CHK	KS	CODE	LOAD
DRAWN	AN	CHK	PV	SITE	STRUCT

DATE MAR 2025
DWG 1

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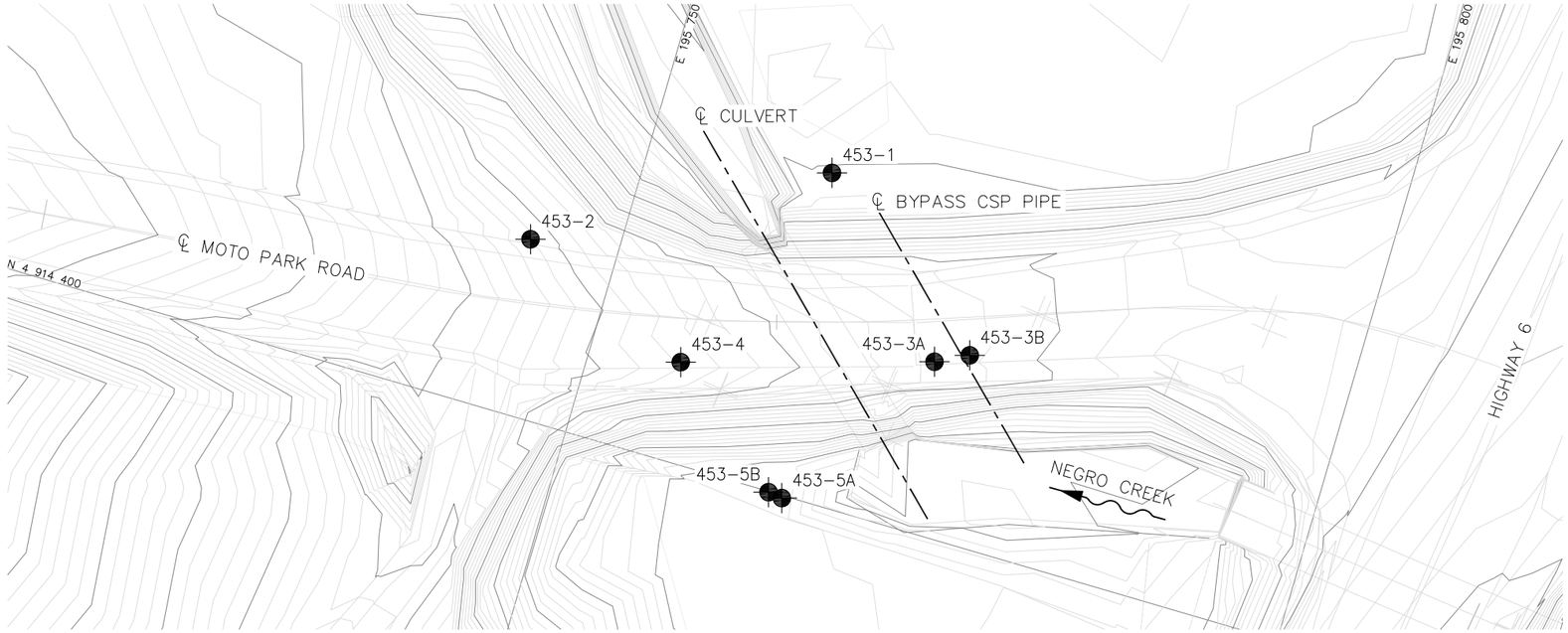
MINISTRY OF TRANSPORTATION, ONTARIO



PLAN

8 0 8 16m

SCALE 1:400

METRIC

DIMENSIONS ARE IN METRES AND/OR MILLIMETRES UNLESS OTHERWISE SHOWN

LICENSED PROFESSIONAL ENGINEER
P. K. CHATTERJI
MAR. 18, 2025
PROVINCE OF ONTARIO

LICENSED PROFESSIONAL ENGINEER
K. L. SHI
100141639
MAR. 18, 2025
PROVINCE OF ONTARIO

CONT No
WP No 3040-20-01

MOTO PARK ROAD
CULVERT REPLACEMENT
STA. 9+952.52
BOREHOLE LOCATIONS AND SOIL STRATA

SHEET

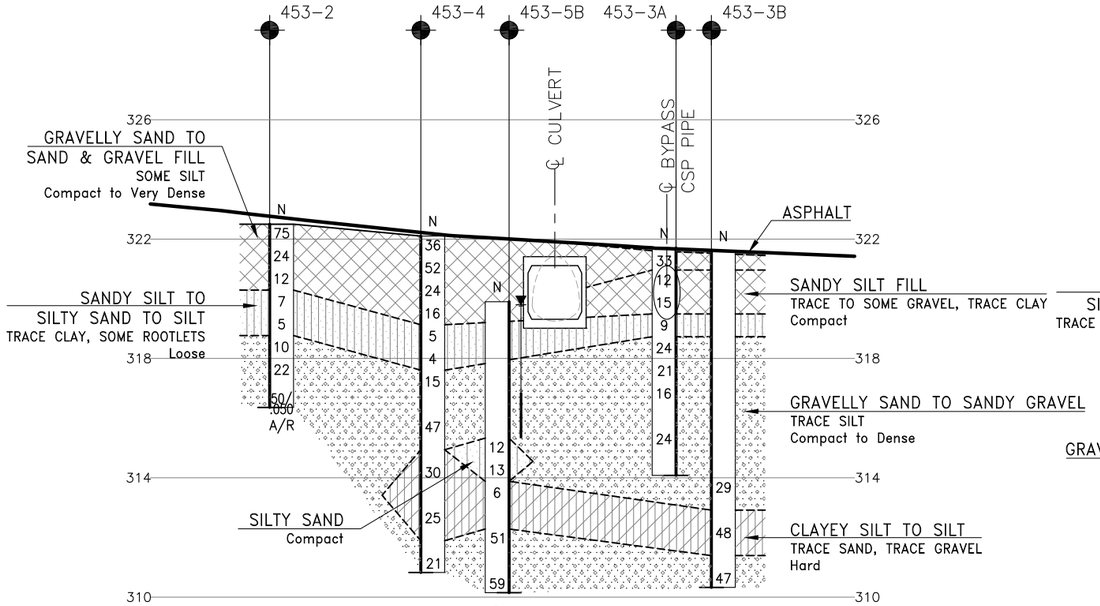
THURBER

KEYPLAN

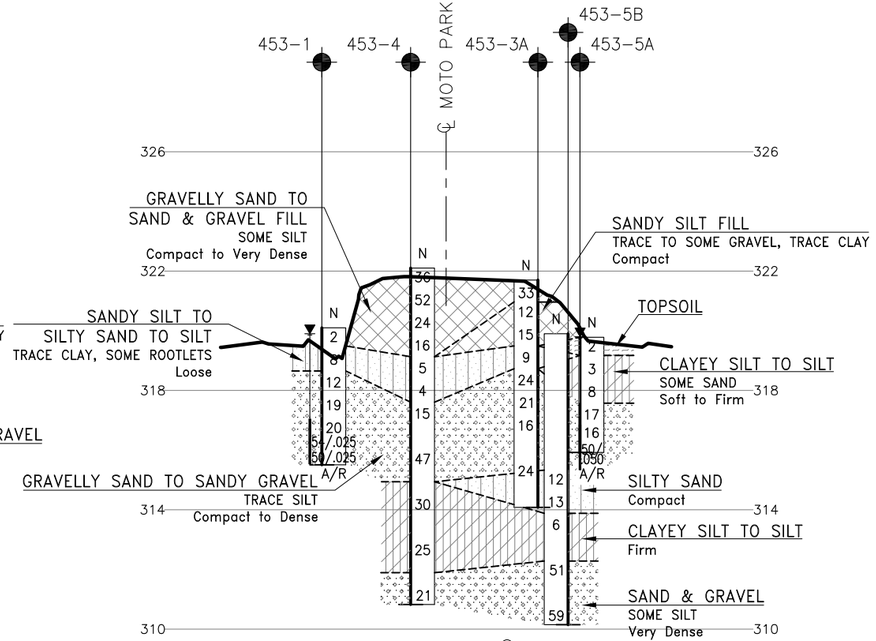
LEGEND

●	Borehole
⊕	Borehole and Cone
N	Blows /0.3m (Std Pen Test, 475J/blow)
CONE	Blows /0.3m (60° Cone, 475J/blow)
PH	Pressure, Hydraulic
▽	Water Level Upon Completion of Drilling
▼	Water Level in Monitoring Well/Piezometer
	Monitoring Well/Piezometer Screen
90%	Rock Quality Designation (RQD)
A/R	Auger Refusal

NO	ELEVATION	NORTHING	EASTING
453-1	320.1	4 914 421.8	195 762.3
453-2	322.5	4 914 411.8	195 744.1
453-3A	321.7	4 914 411.5	195 772.5
453-3B	321.6	4 914 412.6	195 774.7
453-4	322.1	4 914 406.7	195 756.1
453-5A	319.8	4 914 399.8	195 765.3
453-5B	319.9	4 914 400.0	195 764.3



PROFILE ALONG ℄ MOTO PARK RD.



PROFILE ALONG ℄ CULVERT

8 0 8 16m H 1:400

4 0 4 8m V 1:200

-NOTES-

1) The boundaries between soil strata have been established only at Borehole locations. Between Boreholes the boundaries are assumed from geological evidence.
2) This drawing is for subsurface information only. Surface details and features are for conceptual illustration.
3) Coordinate system is MTM NAD 83 Zone 10.

GEOCRES No. 41A02-001

REVISIONS		
DATE	BY	DESCRIPTION

DESIGN	PV	CHK	KS	CODE	LOAD
DRAWN	AN	CHK	PV	SITE	STRUCT

DATE MAR 2025
DWG 1

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THURBER ENGINEERING LTD.

APPENDIX E
COMPARISON OF CULVERT ALTERNATIVES

Appendix E

Comparison of Foundation Alternatives for Culvert Replacement

	Culvert 451		Culvert 453	
	Concrete Open Footing Culvert	**Concrete Box Culvert**	**Concrete Open Footing Culvert**	**Concrete Box Culvert**
Advantages	a) Ease of construction b) Potentially smaller excavation at each footing location compared to box culvert. c) Potentially less dewatering effort at each footing location compared to box culvert founded at same elevation.	a) Ease of construction b) Segmental box units can accommodate some potential differential settlement along culvert axis. c) Potentially shallower excavation than open footing culvert. d) May be constructed in wet conditions. e) Relatively lower bearing capacity may be required compared to open footing culvert	a) Ease of construction b) Potentially smaller excavation at each footing location compared to box culvert. c) Potentially less dewatering effort at each footing location compared to box culvert founded at same elevation.	a) Ease of construction b) Segmental box units can accommodate some potential differential settlement along culvert axis. c) Potentially shallower excavation than open footing culvert. d) May be constructed in wet conditions. e) Relatively lower bearing capacity may be required compared to open footing culvert
Disadvantages	a) Deeper excavation to provide frost cover for footings. b) Potential differential settlement between adjacent footings. c) Higher bearing capacity required for footings compared to box culvert. d) A robust dewatering system will be required to construct footing in the dry in cohesionless soil below groundwater table.	a) Larger excavation area compared to open footing culvert b) Heavy equipment may be required to install precast box units.	a) Deeper excavation to provide frost cover for footings. b) Potential differential settlement between adjacent footings. c) Higher bearing capacity required for footings compared to box culvert. d) A robust dewatering system will be required to construct footing in the dry in cohesionless soil below groundwater table.	a) Larger excavation area compared to open footing culvert b) Heavy equipment may be required to install precast box units.
	Feasible	**Preferred**	**Feasible**	**Preferred**

THURBER ENGINEERING LTD.

APPENDIX F
LIST OF OPSS AND OPSD AND SUGGESTED WORDING FOR NSSP

THURBER ENGINEERING LTD.

1. List of OPSS and OPSD Documents Relevant to this Project

- OPSS.PROV 1004 and amendment SSP 110S16
- OPSS.PROV 1005
- OPSS.PROV 1010 and amendment SSP 110S06
- OPSS.PROV 1205
- OPSS.PROV 1860
- OPSS.PROV 206 and amendment SSP 206F06
- OPSS.PROV 422
- OPSS.PROV 501 and amendment SSP 105S22
- OPSS.PROV 511
- OPSS.PROV 517 and amendment SSP 517F01
- OPSS.PROV 539 and amendment SSP 105S09
- OPSS.PROV 804 and amendment SSP 804F02
- OPSS.PROV 902 and amendment SSP 109S61

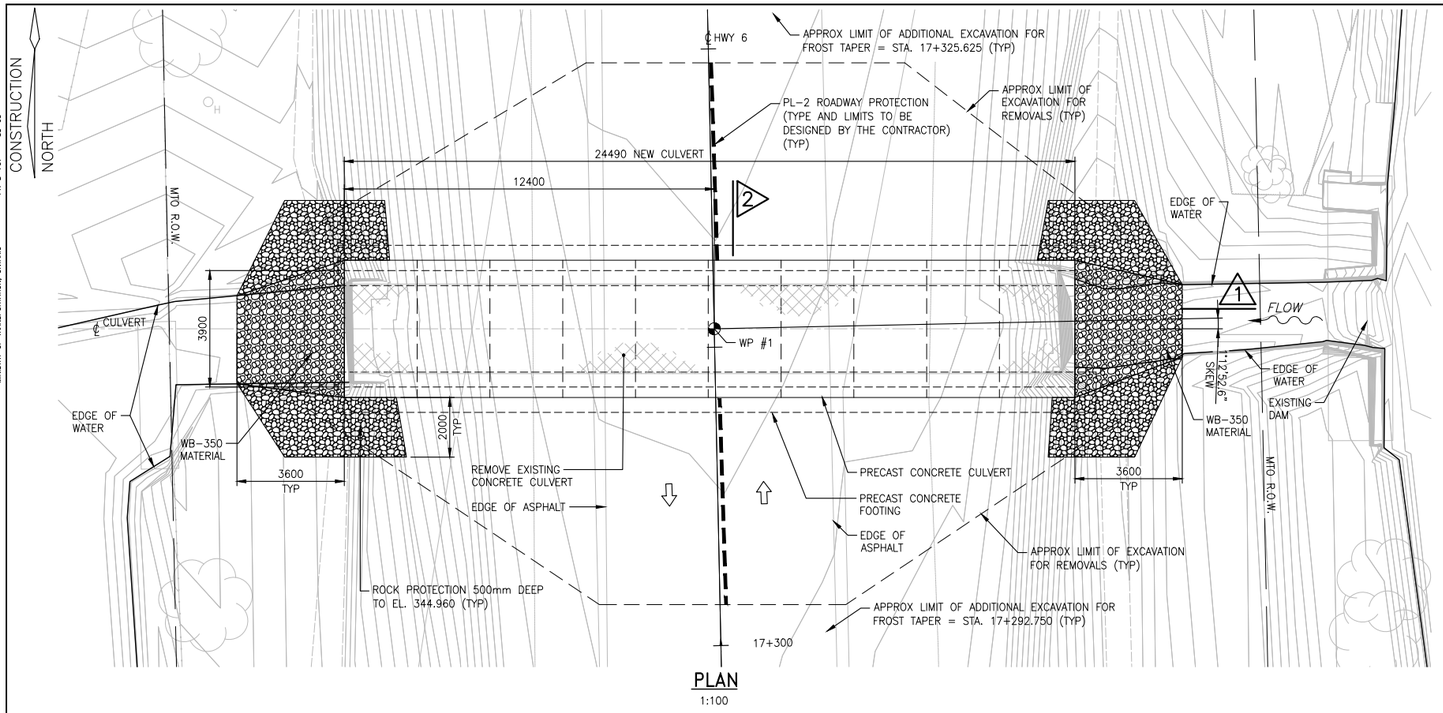
- OPSD 802.010
- OPSD 803.010
- OPSD 810.010
- OPSD 3090.101

2. Suggested Text for NSSP on Construction Dewatering

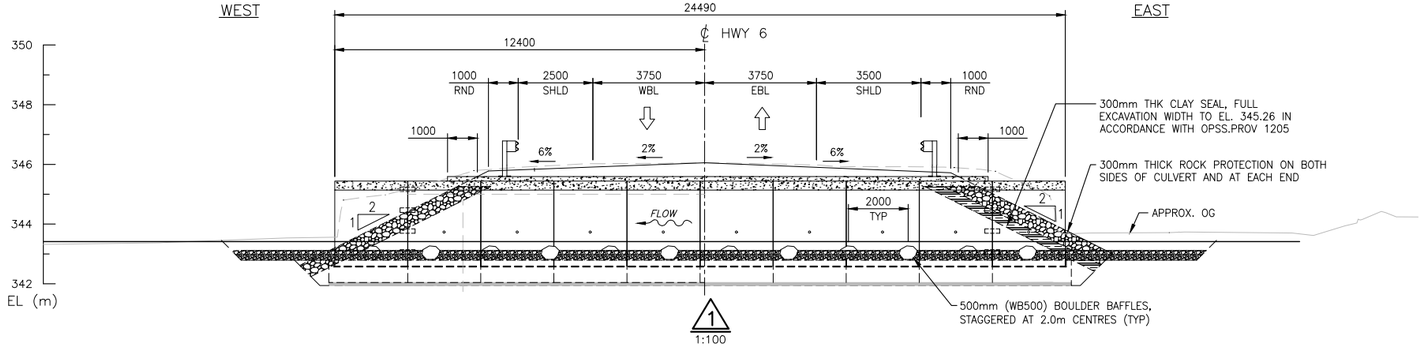
Construction dewatering is required to permit subgrade preparation and compaction of bedding, cover and backfill material in the dry. The design and construction of an effective dewatering system is the responsibility of the Contractor and shall be undertaken by a dewatering specialist retained by the Contractor. The dewatering system must be capable of lowering the groundwater table and maintaining the groundwater table at a minimum of 0.5 m below the base of excavation. The dewatering system shall effectively prevent any seepage in the base or side slopes that could destabilize the exposed soil.

THURBER ENGINEERING LTD.

APPENDIX G
GENERAL ARRANGEMENT DRAWINGS



PLAN
1:100



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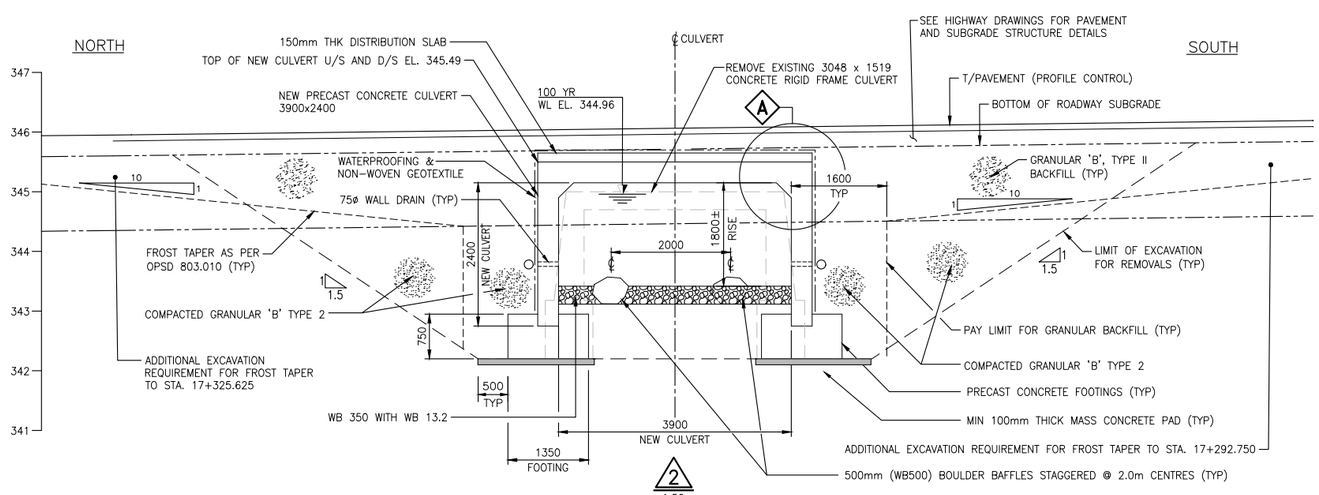


1:50

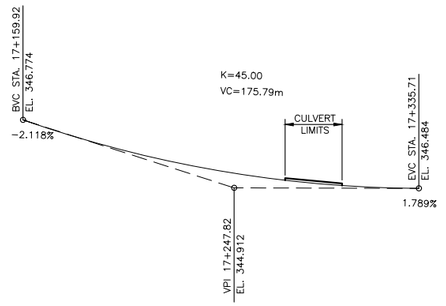
LEGEND:

- REMOVALS
- NEW CONCRETE
- NEW ASPHALT
- WB-350 WATERBODY MATERIAL
- CLAY SEAL
- 300mm THICK ROCK PROTECTION

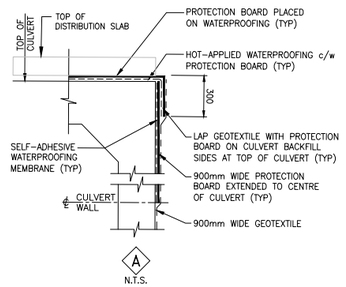
LIST OF DRAWINGS:

FOUNDATION DESIGN:

FACTORED GEOTECHNICAL RESISTANCE AT SLS 150 kPa
FACTORED GEOTECHNICAL RESISTANCE AT ULS 225 kPa



PROFILE OF HIGHWAY 6



WORKING POINTS (m)

WP No.	STATION	NORTHING	EASTING
1	17+310.618	4897950.003	198608.016

DRAWING NOT TO BE SCALED
100mm ON ORIGINAL DRAWING

METRIC

DIMENSIONS ARE IN METRES AND/OR MILLIMETRES UNLESS OTHERWISE SHOWN

90% SUBMISSION

HIGHWAY 6
CONT No. 2025-XXXX
WP No. - - - -

CULVERT @ STA. 17+310.618
CULVERT REPLACEMENT

GENERAL ARRANGEMENT

SHEET 8

egis

GENERAL NOTES:

CLASS OF CONCRETE

PRECAST	35 MPa
MASS CONCRETE	30 MPa
REMAINDER	30 MPa

1. CLEAR COVER TO REINFORCING STEEL

PRECAST	50 ± 10
FOOTING	100 ± 25
REMAINDER	70 ± 20

UNLESS OTHERWISE NOTED

2. REINFORCING STEEL
   REINFORCING STEEL SHALL BE GRADE 500W UNLESS OTHERWISE SPECIFIED.
   UNLESS SHOWN OTHERWISE, TENSION LAP SPLICES SHALL BE CLASS B.
   BAR HOOKS SHALL HAVE STANDARD HOOK DIMENSIONS USING MINIMUM BEND DIAMETERS, WHILE STIRRUPS AND TIES SHALL HAVE MINIMUM HOOK DIMENSIONS. ALL HOOKS SHALL BE IN ACCORDANCE WITH THE STRUCTURAL STANDARD DRAWING SS112-1 UNLESS INDICATED OTHERWISE.
3. GEOTEXTILE
   THE GEOTEXTILE SHALL BE NON-WOVEN AND MEET THE SPECIFICATIONS FOR THE OPSS.PROV 1860 CLASS II AND HAVE A FABRIC OPENING SIZE NOT GREATER THAN 212µm.
4. WATERBODY MATERIAL:
   WATERBODY MATERIAL SHALL BE WB-350 WITH WB-13.2 TO FILL VOIDS.

CONSTRUCTION NOTES:

1. THE CONTRACTOR SHALL VERIFY ALL DIMENSIONS, DETAILS AND ELEVATIONS OF THE EXISTING STRUCTURE THAT ARE RELEVANT TO THE WORK SHOWN ON THE DRAWINGS PRIOR TO COMMENCEMENT OF THE WORK. ANY DISCREPANCIES SHALL BE REPORTED TO THE CONTRACT ADMINISTRATOR AND THE PROPOSED ADJUSTMENT OF THE WORK REQUIRED TO MATCH THE EXISTING STRUCTURE SHALL BE SUBMITTED FOR APPROVAL.
2. THE CONTRACTOR SHALL CARRY OUT SITE SURVEYS TO DETERMINE THE EXISTING ELEVATIONS OF ASPHALT PRIOR TO REMOVALS.
3. THE CONTRACTOR SHALL BE RESPONSIBLE FOR THE DESIGN OF THE DEWATERING AND TEMPORARY FLOW PASSAGE SYSTEMS.
4. THE TEMPORARY FLOW CONTROL SHALL BE DESIGNED FOR THE FIVE (5) YEAR DESIGN STORM RETURN PERIOD OF 3.9 m^3/s.
5. PROTECTION SYSTEMS SHALL MEET REQUIREMENTS FOR PERFORMANCE LEVEL 2 AS SPECIFIED IN THE CONTRACT DOCUMENTS.
6. BACKFILLING ON EACH SIDE OF THE BOX CULVERT SHALL BE COMPLETED SIMULTANEOUSLY. AT NO TIME SHALL THE LEVELS ON EACH SIDE DIFFER BY MORE THAN 400 mm.
7. ALL AREAS AFFECTED BY CONSTRUCTION ACTIVITIES SHALL BE FULLY REINSTATED TO PRE-CONSTRUCTION OR BETTER CONDITIONS TO THE SATISFACTION OF THE CONTRACT ADMINISTRATOR INCLUDING THE REINSTATEMENT OF ALL VEGETATION, PATHWAYS, FENCES, AND AREAS USED FOR SITE ACCESS.
8. THE CONTRACTOR SHALL CONTROL EXCAVATION TO PREVENT ENTRY OF DELETERIOUS MATERIAL INTO WATER COURSE.
9. GROUNDWATER LEVEL MUST BE MAINTAINED AT LEAST 300mm BELOW THE BASE OF THE EXCAVATION BY MEANS OF DEWATERING, AS REQUIRED, TO ENSURE THAT CONSTRUCTION IS CARRIED OUT IN THE DRY.
10. EXISTING UNDERGROUND BELL UTILITY TO REMAIN. REQUIREMENTS FOR WORKING AROUND UTILITIES SHALL BE AS DETAILED IN CONTRACT DOCUMENTS.
11. ALL EXPOSED EDGE TO BE FINISHED WITH 20x20 CHAMFERS.

LIST OF ABBREVIATIONS:

APPROX	APPROXIMATE	SHLD	SHOULDER
EXIST	EXISTING	STA	STATION
FIN	FINISH	TYP	TYPICAL
OG	ORIGINAL GROUND	WP	WORKING POINT

SCOPE OF WORK:

- INSTALL & MAINTAIN TRAFFIC CONTROL MEASURES AND DIVERT TRAFFIC
- INSTALL COFFERDAM AND TEMPORARY FLUME AND DIVERT WATER FLOW DURING CONSTRUCTION PERIOD
- CONSTRUCT ROADWAY PROTECTION FOR STAGED CULVERT CONSTRUCTION
- REMOVE EXISTING PAVEMENT, EXCAVATION AND REMOVE EXISTING CULVERT
- INSTALL NEW PRECAST CONCRETE FOOTINGS, CONSTRUCT CREEK BED AND PLACE RIVER STONE INSIDE CULVERT
- INSTALL NEW PRECAST CULVERT BARRELS, CONSTRUCT DISTRIBUTION SLAB, AND WATERPROOFING STRUCTURES
- BACKFILL INSIDE AND OUTSIDE CULVERT, CONSTRUCT ROADWAY BASE AND SURFACE COURSE ASPHALT

APPLICABLE STANDARD DRAWINGS:

OPSD 3950.100 JOINT CONCRETE EXPANSION AND CONSTRUCTION ON STRUCTURE
MTOD 3941.2100 FIGURES IN CONCRETE SITE NUMBER AND LAYOUT

REVISIONS				
FEB. 2025	CC	B	ISSUED FOR 90% SUBMISSION	
DATE	BY	REV	DESCRIPTION	

DESIGN	CC	CHK	WK	CODE	CHBDC-19	LOAD	CL-625-ONT	DATE FEB/2025
DRAWN	GP	CHK	CC	SITE 08X-0451/C0				DWG R2-1

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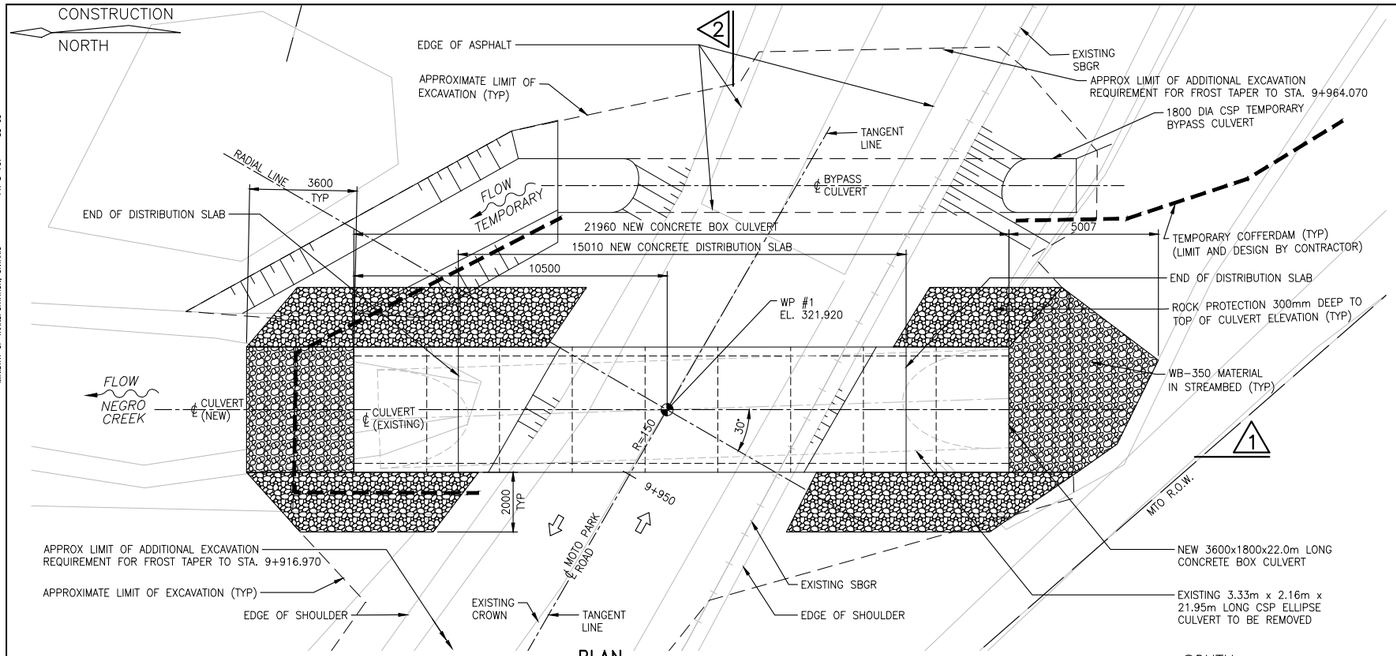
MODIFIED: 2/5/2025 12:52:09 PM BY: G.PENNY
DATE PLOTTED: 2/5/2025 1:05:55 PM BY: GREG PENNY

MINISTRY OF TRANSPORTATION, ONTARIO PR-3-707 88-05



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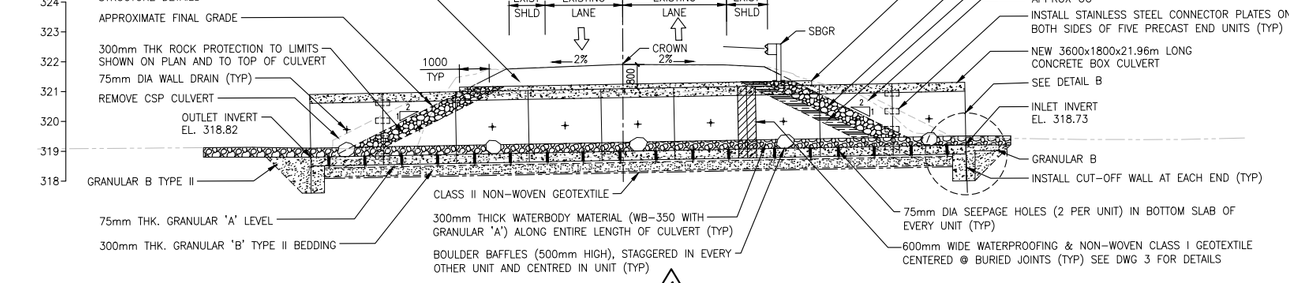
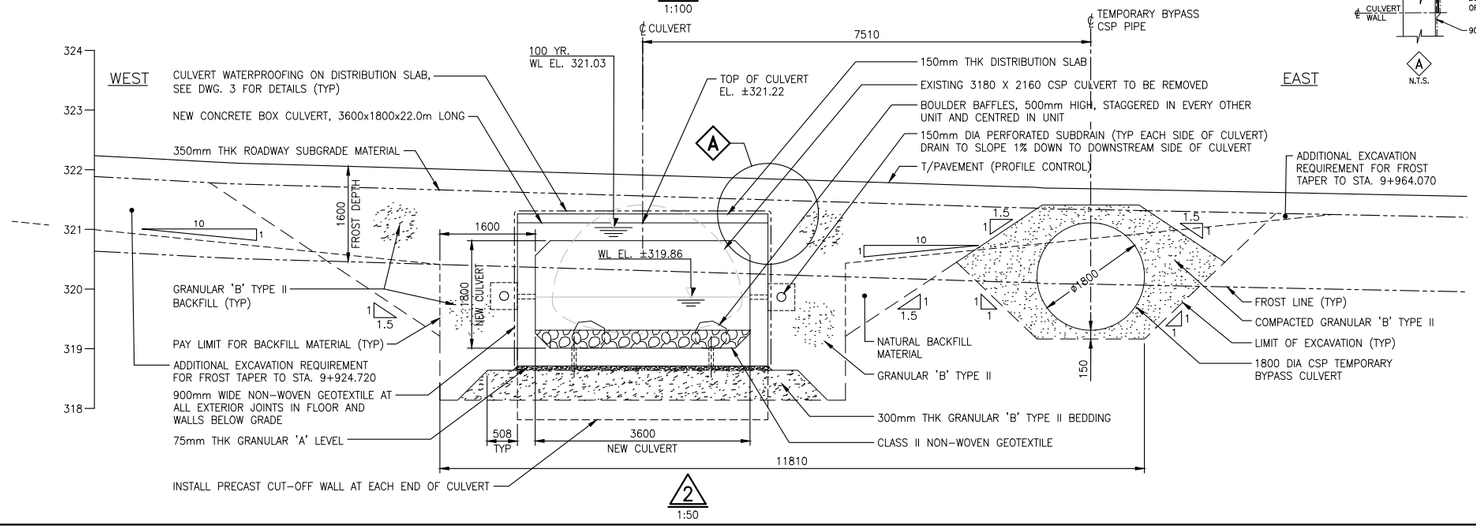




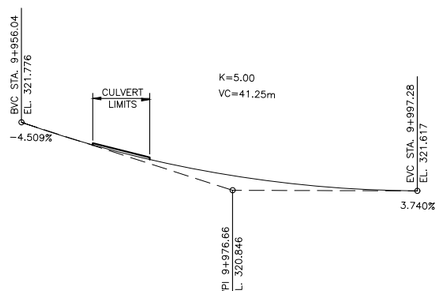
LEGEND:

- REMOVALS
- NEW CONCRETE
- NEW ASPHALT
- WB-350 WATERBODY MATERIAL
- CLAY SEAL
- 300mm THICK ROCK PROTECTION

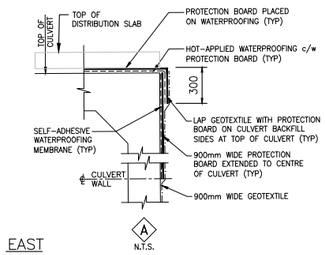
LIST OF DRAWINGS:

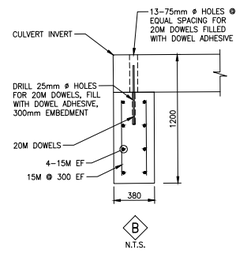
FOUNDATION DESIGN:

FACTORED GEOTECHNICAL RESISTANCE AT SLS 150 kPa
FACTORED GEOTECHNICAL RESISTANCE AT ULS 225 kPa



PROFILE OF MOTO PARK ROAD





WORKING POINTS (m)

WP No.	STATION	NORTHING	EASTING
1	9+952.520	4914411.8120	195764.0010

DRAWING NOT TO BE SCALED
100mm ON ORIGINAL DRAWING

METRIC

DIMENSIONS ARE IN METRES AND/OR MILLIMETRES UNLESS OTHERWISE SHOWN

90% SUBMISSION

MOTO PARK ROAD
CONT No. 2025-XXXX
WP No. - - - -

CULVERT @ STA. 9+952.520
CULVERT REPLACEMENT

GENERAL ARRANGEMENT

SHEET 39

egis

GENERAL NOTES:

CLASS OF CONCRETE
PRECAST 35 MPa
REMAINDER 30 MPa

1. CLEAR COVER TO REINFORCING STEEL
PRECAST 50 ± 10
REMAINDER 70 ± 20
UNLESS OTHERWISE NOTED

2. REINFORCING STEEL
REINFORCING STEEL SHALL BE GRADE 500W UNLESS OTHERWISE SPECIFIED.
UNLESS SHOWN OTHERWISE, TENSION LAP SPLICES SHALL BE CLASS B.
BAR HOOKS SHALL HAVE STANDARD HOOK DIMENSIONS USING MINIMUM BEND DIAMETERS, WHILE STIRRUPS AND TIES SHALL HAVE MINIMUM HOOK DIMENSIONS. ALL HOOKS SHALL BE IN ACCORDANCE WITH THE STRUCTURAL STANDARD DRAWING SS112-1 UNLESS INDICATED OTHERWISE.

3. GEOTEXTILE
NON-WOVEN, CLASS I, FOS 75 TO 150um. AND FREE OF FOLDS, TEARS AND WRINKLES.

4. WATERBODY MATERIAL:
WATERBODY MATERIAL SHALL BE WB-350 WITH WB-13.2 TO FILL VOIDS.

CONSTRUCTION NOTES:

1. THE CONTRACTOR SHALL VERIFY ALL DIMENSIONS, DETAILS AND ELEVATIONS OF THE EXISTING STRUCTURE THAT ARE RELEVANT TO THE WORK SHOWN ON THE DRAWINGS PRIOR TO COMMENCEMENT OF THE WORK. ANY DISCREPANCIES SHALL BE REPORTED TO THE CONTRACT ADMINISTRATOR AND THE PROPOSED ADJUSTMENT OF THE WORK REQUIRED TO MATCH THE EXISTING STRUCTURE SHALL BE SUBMITTED FOR APPROVAL.
2. THE CONTRACTOR SHALL CARRY OUT SITE SURVEYS TO DETERMINE THE EXISTING ELEVATIONS OF ASPHALT PRIOR TO REMOVALS.
3. THE CONTRACTOR SHALL BE RESPONSIBLE FOR THE DESIGN OF THE DEWATERING AND TEMPORARY FLOW PASSAGE SYSTEMS.
4. THE TEMPORARY FLOW CONTROL SHALL BE DESIGNED FOR THE TWO (2) YEAR DESIGN STORM RETURN PERIOD OF 4.9 m^3/s.
5. PROTECTION SYSTEMS SHALL MEET REQUIREMENTS FOR PERFORMANCE LEVEL 2 AS SPECIFIED IN THE CONTRACT DOCUMENTS.
6. BACKFILLING ON EACH SIDE OF THE BOX CULVERT SHALL BE COMPLETED SIMULTANEOUSLY. AT NO TIME SHALL THE LEVELS ON EACH SIDE DIFFER BY MORE THAN 400 mm.
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DATE PLOTTED: 2/5/2025 1:08:35 PM BY: GREG PENNY
PR-3-707 88-05
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