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Highway 427 Expansion
Hwy 427 High Fills and Deep Cuts (100% Submission)
between Zenway Boulevard and Major Mackenzie Drive

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TABLE OF CONTENTS

1.	INTRODUCTION	4
2.	SITE DESCRIPTION AND LOCAL GEOLOGY	4
3.	HIGH FILL AND DEEP CUT SECTIONS	4
4.	GEOTECHNICAL INVESTIGATION	5
5.	SUBSURFACE CONDITIONS	6
5.1	Zenway Boulevard Underpass Approach Embankments – Sta. 9+840 to 10+100.....	6
5.1.1	Asphalt.....	6
5.1.2	Topsoil/Organics	6
5.1.3	Fill	6
5.1.4	Surficial Clayey Silt	6
5.1.5	Upper Clayey Silt to Silty Clay Till	6
5.1.6	Sand and Silt Till	6
5.1.7	Lower Clayey Silt to Silty Clay Till	6
5.1.8	Shale Bedrock.....	7
5.1.9	Groundwater Levels.....	7
5.2	Rainbow Creek Bridge Approach Embankments – Mainline Sta. 11+560 to 11+670	7
5.2.1	Topsoil	7
5.2.2	Surficial Clayey Silt	7
5.2.3	Upper Clayey Silt to Silty Clay Till	7
5.2.4	Sand and Silt Till	8
5.2.5	Lower Clayey Silt to Silty Clay Till	8
5.2.6	Shale Bedrock.....	8
5.2.7	Groundwater Levels.....	8
5.3	Langstaff Road Underpass Embankment – Mainline Sta. 11+800 to 12+400	9
5.3.1	Asphalt.....	10
5.3.2	Topsoil	10
5.3.3	Fill	10
5.3.4	Surficial Silty Clay	10
5.3.5	Clayey Silt to Silty Clay Till	10
5.3.6	Groundwater Levels.....	10
5.4	Embankment at Culvert U022 – Mainline 11+100 to 11+150.....	11
5.4.1	Topsoil	11
5.4.2	Surficial Clayey Silt	11
5.4.3	Clayey Silt to Silty Clay Till	11

5.4.4	Silty Sand to Sand and Silt Till	11
5.4.5	Shale Bedrock	11
5.4.6	Groundwater Levels	11
5.5	Rutherford Road Overpass Approaches – Mainline Sta. 13+500 to 14+550	12
5.5.1	Topsoil	12
5.5.2	Surficial Silty Clay	12
5.5.3	Clayey Silt to Silty Clay Till	12
5.5.4	Sandy Silt Till	12
5.5.5	Groundwater Levels	12
5.6	West Robinson Creek Bridge North Approach - Mainline Sta. 15+600 to 15+700	13
5.6.1	Topsoil	13
5.6.2	Surficial Clayey Silt to Silty Clay	13
5.6.3	Upper Clayey Silt to Silty Clay Till	13
5.6.4	Silt to Sand	13
5.6.5	Silt and Sand Till Interlayer	14
5.6.6	Lower Clayey Silt to Silty Clay Till	14
5.6.7	Shale Bedrock	14
5.6.8	Groundwater Levels	14
5.7	CPR/McGillivray Road/Major Mackenzie Drive Overpass – Mainline Sta. 15+700 to 16+800	15
5.7.1	Topsoil/Organics	15
5.7.2	Surficial Clayey Silt to Silty Clay	15
5.7.3	Clayey Silt to Silty Clay Till	15
5.7.4	Sandy Silt Till	16
5.7.5	Groundwater Levels	16
5.8	Major Mackenzie Drive at West Robinson Creek West Approach – Sta. 9+300 to 9+400	16
5.8.1	Asphalt	16
5.8.2	Topsoil	17
5.8.3	Sand Fill	17
5.8.4	Clayey Silt to Silty Clay	17
5.8.5	Clayey Silt to Silty Clay Till	17
5.8.6	Silt and Sand Till	17
5.8.7	Sand	17
5.8.8	Silt	17
5.8.9	Sand and Gravel	17
5.8.10	Shale Bedrock	17
5.8.11	Groundwater Levels	17
5.9	Cut Section North of Zenway Boulevard – Sta. 10+750 to 11+000	18
5.9.1	Topsoil	18
5.9.2	Surficial Clayey Silt to Silty Clay	18
5.9.3	Clayey Silt to Silty Clay Till	18
5.9.4	Groundwater Levels	18
5.10	Fill Section South of Rainbow Creek (Sta. 11+380 to 11+410)	19
5.10.1	Topsoil	19
5.10.2	Clayey Silt to Silty Clay Till	19
5.10.3	Groundwater Levels	19
6.	ENGINEERING RECOMMENDATIONS	19
6.1	Deep Cut	19

6.1.1	Stability	19
6.1.2	Cut Slope Construction	20
6.2	High Fill Embankments	20
6.2.1	Subgrade Preparation	20
6.2.2	Embankment Materials and Construction	20
6.2.3	Embankment Stability	21
6.2.4	Embankment Settlement.....	21
6.2.5	Settlement Mitigation	22
6.3	Monitoring Program	23

Statement of Limitations and Conditions

DRAWINGS

Borehole Locations and Soil Strata Drawings

TABLES

Table 1 – Summary of Settlement Analysis

APPENDICES

Appendix A – Zenway Boulevard Underpass Embankment (Sta. 9+840 to 10+100)

Appendix B – Rainbow Creek Bridge Approach Embankments (Mainline Sta. 11+560 to 11+670)

Appendix C – Langstaff Road Underpass Embankment (Mainline Sta. 11+800 to 12+400)

Appendix D – Embankment at Culvert U022 (Mainline Sta. 11+100 to 11+150)

Appendix E – Rutherford Road Overpass Embankment (Mainline Sta. 13+500 to 14+550)

Appendix F – West Robinson Creek Bridge North Approach (Mainline Sta. 15+600 to 15+700)

Appendix G – CPR/McGillivray Road/Major Mack. Drive Overpass (Mainline Sta. 15+700 to 16+800)

Appendix H – Major Mack. Drive at West Robinson Creek Bridge West Approach (Sta. 9+300 to 9+400)

Appendix I – Cut Section North of Zenway Boulevard (Sta. 10+750 to 11+000)

Appendix J – Fill Section South of Rainbow Creek (Sta. 11+380 to 11+410)

Appendix K – Supply and Installation of Embankment Monitoring Equipment

1. INTRODUCTION

This report presents recommendations for the design and construction of the proposed high fill embankments and deep cuts between Zenway Boulevard and Major Mackenzie Drive. The project is part of the proposed 6.6 km long extension of Highway 427 from Highway 7 to Major Mackenzie Drive in the City of Vaughan, Ontario.

The recommendations presented in this report were based on the interpretation of the subsurface information obtained during recently completed geotechnical investigation by Thurber Engineering. Reference has also been made to available subsurface information from previous investigations documented in the reports listed below:

1. GEOCRES 30M13-177: Preliminary Foundation Investigation and Design Report, High Fill Embankments, Highway 427 Extension from Highway 7 to Major Mackenzie Drive, Ministry of Transportation, Ontario, W.O. 05-20012, dated August 2009, prepared by Golder Associates.
2. GEOCRES 30M13-216: Preliminary Foundation Investigation and Design Report, Highway 427 Expansion Project, Extension from Highway 7 to Major Mackenzie Drive, City of Vaughan, Ontario, W.O. 18, dated March 2016, prepared by Peto MacCallum Ltd.

The recommendations for the high fill embankments and deep cuts presented in this report were based on the highway profile design drawings provided by WSP.

A revised highway profile has been proposed between Zenway Boulevard and Langstaff Road in April 2018, which results in up to approximately 2.8 m grade raise.

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 AND LOCAL GEOLOGY

The topography along the proposed Highway 427 alignment generally consists of flat to gently sloping agricultural lands with localized ground depressions and tributaries. Within the limits of the alignment, the ground surface profile generally slopes upward towards the north increasing from approximately Elevation 182 at Zenway Boulevard to Elevation 204 at Major Mackenzie Drive. Some residential, commercial, and industrial developments are present along Zenway Boulevard, Langstaff Road, and Rutherford Road.

The site is situated within the Peel Plain physiographic region. The local quaternary geology generally comprises a till deposit consisting of clayey silt to silty clay with interlayers of sand and silt, which is mapped as the Halton Till. Localized recent deposits of sands, silts and soft clays formed in small glacial meltwater ponds throughout the region can be encountered overlying the till near the river and creek valleys. The site is underlain by the Georgian Bay Formation bedrock consisting of grey shale with siltstone and limestone interlayers.

3. HIGH FILL AND DEEP CUT SECTIONS

Major structures within the proposed Highway 427 extension limits include, from south to north, Zenway Boulevard, Rainbow Creek, Langstaff Road, Street 'A', Rutherford Road, CPR/McGillivray Road, West Robinson Creek, and Major Mackenzie Drive. The foundation recommendations associated with these structures are addressed in separate reports.

The high fill ($H > 4.5$ m) embankments and deep cut sections ($D > 4.5$ m) along the proposed highway alignment are summarized in Table 3.1 below, including mainline embankments and cuts, ramps embankments at various interchanges, approach embankments to underpasses and overpasses, and Major Mackenzie Drive crossing at West Robinson Creek.

Table 3.1 – Summary of High Fill and Deep Cut Sections

Location	Approx. Station Limits	Description	Maximum Fill Height / Cut Depth
Zenway Boulevard Underpass	9+840 to 10+100	High Fill	Up to 10.0 m
Mainline Embankment at Culvert U022	11+100 to 11+150	High Fill	Up to 6.6 m
Mainline Rainbow Creek Bridge	11+560 to 11+670	High Fill	Up to 8.5 m
Langstaff Road Underpass	11+800 to 12+400	Deep Cut	Up to 6.8 m
Rutherford Road Overpass	13+500 to 14+550	High Fill	Up to 9.2 m
Mainline West Robinson Creek Bridge North Approach	15+600 to 15+700	High Fill	Up to 7.2 m
CPR/McGillivray Road Overhead to Major Mackenzie Drive Overpass	15+700 to 16+800	High Fill	Up to 12.2 m
Major Mackenzie Drive at West Robinson Creek West Approach	9+300 to 9+400	High Fill	Up to 6.1 m
Cut Section North of Zenway Boulevard	10+750 to 11+000	Deep Cut	Up to 8.0 m
Fill Section South of Rainbow Creek	11+380 to 11+410	High Fill	Up to 6.2 m

4. GEOTECHNICAL INVESTIGATION

The current field investigation for the high fill embankments was conducted between May 19 and June 16, 2017, and consisted of drilling and sampling nineteen (19) boreholes (FCPR 17-01 to 17-03, FLR 17-01 to 17-06, FMMO 17-01 to 17-05, FRRO 17-01 to 17-03, and FWR 17-01 and 17-02) along the proposed Hwy 427 extension alignment. These boreholes were drilled to depths ranging from 8.2 to 12.8 m.

In addition, five (5) boreholes (ZB17-01 to 17-05) were advanced along the proposed Zenway Boulevard underpass high fill embankments; six (6) boreholes (Boreholes RC17-01 to 17-06) were advanced at the proposed Rainbow Creek bridge abutments; two (2) boreholes (CLRN17-02 and 17-03) were advanced within the vicinity of the proposed Culvert U022; six (6) boreholes (WR17-01 to WR17-06) were advanced within the vicinity of the proposed West Robinson Creek bridge.

The ground surface elevations for the boreholes were derived from a topographic drawing (Base Plan) provided by WSP. The coordinate system MTM NAD 83, Zone 16 was used to establish locations of the boreholes. The Record of Borehole sheets and as-drilled locations of the boreholes are shown on the Borehole Locations and Soil Strata Drawings following the text of this report.

Track-mounted CME 55 drill rigs supplied by Landshark Drilling Ltd., of Brantford Ontario, and Walker Drilling Ltd., of Utopia Ontario, were used to advance the boreholes. Soil samples were obtained at selected intervals using a 50mm nominal diameter split spoon sampler in conjunction with Standard Penetration Testing (SPT) procedures as per ASTM D1586. Where soft to firm cohesive soils were encountered, field vane tests were performed to obtain a measurement of undrained shear strength. Shelby tube samples of the cohesive soils were also collected in selected boreholes for Oedometer testing.

Groundwater conditions were observed in the open boreholes throughout the drilling operations and measured upon completion of drilling. Standpipe piezometers were installed in selected boreholes for longer term groundwater monitoring. Other boreholes were decommissioned as per O. Reg. 903 upon completion. Well decommissioning will be carried out by Project Co. in general accordance with O. Reg. 903 following a final round of ground water level monitoring.

5. SUBSURFACE CONDITIONS

5.1 Zenway Boulevard Underpass Approach Embankments – Sta. 9+840 to 10+100

Details of the soil stratigraphy are shown on the Record of Borehole sheets contained in Appendix A. The approximate locations of the boreholes are shown on the Borehole Locations and Soil Strata Drawing.

In general, the soil stratigraphy encountered in the current investigation consists of a surficial layer of clayey silt underlain by silty clay to clayey silt till transitioning to sand and silt till and lower clayey silt till over shale bedrock.

Detailed descriptions of the encountered strata are summarized below.

5.1.1 Asphalt

Asphalt was encountered from ground surface in the boreholes advanced through the existing Zenway Boulevard (Boreholes ZB 17-02 to 17-04). The thickness of the asphalt was typically 125 mm.

5.1.2 Topsoil/Organics

Topsoil/organics was encountered from ground surface in Boreholes ZB 17-01 and 17-05, which were advanced outside the shoulder of the roadway. The thickness of the topsoil ranged from 75 to 100 mm.

5.1.3 Fill

Brown to grey gravelly sand fill was encountered underlying the asphalt in Boreholes ZB17-02 to 17-04. The depth to the base of the gravelly sand fill was 0.7 m below ground surface in the boreholes (Elevation 182.6 to 180.9 m). SPT-N values recorded in the granular fill ranged from 41 to 62 blows, indicating a dense to very dense relative density.

Brown silty clay fill was encountered underlying the gravelly sand fill. The depth to the base of the cohesive fill ranged from 1.5 to 2.2 m below ground surface in the boreholes (Elevation 181.6 to 180.1 m). SPT-N values recorded in the cohesive fill ranged from 7 to 10 blows, indicating a firm to stiff consistency.

5.1.4 Surficial Clayey Silt

A surficial layer of brown clayey silt was encountered in boreholes ZB17-01 and 17-05 beneath topsoil/organics. The depth to the base of the clayey silt ranged from 0.6 to 1.5 m below ground surface in the boreholes (Elevation 181.9 to 181.5 m). SPT-N values in the cohesive till ranged from 5 to 26 blows per 0.3 m of penetration, indicating a firm to very stiff consistency. Trace roots were noted in the deposit.

5.1.5 Upper Clayey Silt to Silty Clay Till

Brown to grey clayey silt to silty clay till was encountered underlying the fill in Boreholes ZB17-02 to 17-04, and underlying the surficial clayey silt in Boreholes ZB17-01 and 17-05. The depth to the base of cohesive till ranged from 8.7 to 10.2 m below ground surface in the boreholes (Elevation 174.6 to 171.4 m). SPT-N values in the cohesive till ranged from 5 to 61 blows, indicating a firm to hard consistency. Occasional cobbles were noted in the deposit.

5.1.6 Sand and Silt Till

Grey sand and silt till was encountered underlying the clayey silt to silty clay till. The depth to the base sand and silt till ranged from 13.4 to 18.0 m below ground surface in the borehole (Elevation 168.2 to 164.8 m). SPT-N values in the sand and silt till ranged from 62 blows per 0.3 m of penetration to 100 blows per 0.05 m of penetration, indicating a very dense relative density.

5.1.7 Lower Clayey Silt to Silty Clay Till

Grey clayey silt till was encountered underlying the sand and silt till in Borehole ZB17-02. The depth to the base

cohesive till was 16.5 m below ground surface (Elevation 165.1 m). SPT-N values in the clayey silt till were typically above 100 blows, indicating a hard consistency.

5.1.8 Shale Bedrock

Shale bedrock was encountered underlying the clayey silt till in Borehole ZB17-02 and underlying the sand and silt till in Borehole ZB17-03. The bedrock depth ranged from 16.5 to 18.0 m in the boreholes (Elevation 165.1 to 164.8 m).

5.1.9 Groundwater Levels

Water levels measured in the piezometers installed during the current investigation are summarized in Table 5.1.

Table 5.1 – Piezometer Details and Groundwater Level Measurements

Borehole	Measurement Date	Water Level (m)		Screen Location (m)		Native Material at Screen
		Depth	Elevation	Depth	Elevation	
ZB17-05	July 7, 2017	8.6	174.4	8.1-9.6	173.4	Clayey silt to silty clay till / sand and silt till
	Aug 9, 2017	2.2	180.8			
	Oct 24, 2017	2.4	180.6			

The above groundwater levels represent relatively short-term readings and seasonal fluctuations of the groundwater level are to be expected. The groundwater level may be at higher elevations after the spring snowmelt or after periods of heavy rainfall. Perched water may be present at higher levels in lenses or zones of more permeable sands and silts within the till.

5.2 Rainbow Creek Bridge Approach Embankments – Mainline Sta. 11+560 to 11+670

Details of the soil stratigraphy are shown on the Record of Borehole sheets contained in Appendix B. The approximate locations of the boreholes are shown on the Borehole Locations and Soil Strata Drawing.

In general, the subsurface conditions at the site consist of a layer of surficial clayey silt overlying clayey silt to silty clay till grading to sand and silt till which is underlain by a lower layer of clayey silt to silty clay till followed by shale bedrock. Occasional cobbles and boulders were reported in the till deposits. The groundwater level monitored in Borehole S-5 on the south valley slope was at 4.5 to 4.9 m below the ground surface or Elevation 177. Water level monitored in Borehole S-9 located within the flood plain was at 0.5 m below the ground surface or Elevation 175.5. Artesian conditions were encountered in piezometers with screens installed in the lower cohesive till. The measured short-term groundwater levels were at 0.8 m and 0.6 m above the ground surface in RC17-01 and RC17-02, respectively.

Detailed descriptions of the encountered strata are summarized below.

5.2.1 Topsoil

Topsoil was encountered in all boreholes except RC17-04. Topsoil thickness varies from 50 to 100 mm.

5.2.2 Surficial Clayey Silt

A surficial deposit of brown clayey silt with trace to some sand and trace gravel was encountered in all six boreholes either beneath the topsoil or from the ground surface. Trace organic matter (rootlets) were noted in the deposit. The base of the clayey silt ranged from depths of 0.7 m to 1.5 m (Elev. 176.8 to 174.4). The SPT-N values ranged from 0 to 10 blows per 0.3 m of penetration indicating a very soft to stiff consistency.

5.2.3 Upper Clayey Silt to Silty Clay Till

Brown to grey clayey silt to silty clay till was encountered underlying the surficial clayey silt in all boreholes advanced in the current investigation. The depth to the base of the cohesive till ranged from 4.0 to 5.2 m or

Elevation 170.6 to 173.5. SPT-N values recorded in the cohesive till ranged from 8 to 82 blows per 0.3 m of penetration indicating a firm to hard consistency.

Glacial tills inherently contain cobbles and boulders, which should be expected to be present within the deposit.

5.2.4 Sand and Silt Till

A grey sand and silt till was encountered underneath the cohesive till. The cohesionless till was 3.5 to 6.7 m in thickness and extended to depths ranging from 7.6 to 11.5 m (Elev. 164.5 to 169.9). The SPT-N values ranged typically from 91 blows for 0.3 m of penetration to 100 blows for 100 mm penetration, indicating a very dense relative density.

A discontinuous layer of sandy clayey silt till approximately 1.3 m thick was encountered embedded in the sand and silt till in Borehole RC17-05 at 7.2 m depth (Elev. 169.0 to 167.7). A SPT-N value of 78 blows for 0.3 m of penetration was obtained in this layer.

Glacial tills inherently contain cobbles and boulders, which should be expected to be present within the deposit.

5.2.5 Lower Clayey Silt to Silty Clay Till

A layer of grey clayey silt to silty clay till was encountered underlying the cohesionless till in all boreholes in the current investigation. Where penetrated, the depth to the bottom of the lower cohesive till ranged from 12.4 to 15.2 m or Elevation 160.6 to 164.6. Boreholes RC17-05 and RC17-06 were terminated within this layer at 15.3 m and 12.6 m depth, respectively. SPT-N values recorded in the lower cohesive till ranged from 45 blows per 0.3 m of penetration to 100 blows for 125 mm penetration, indicating a hard consistency.

Glacial tills inherently contain cobbles and boulders, which should be expected to be present within the deposit.

5.2.6 Shale Bedrock

Grey shale bedrock of the Georgian Bay Formation was encountered in Boreholes RC17-01 to RC17-04 at depths from 12.4 to 15.2 m (Elev. 160.6 to 164.6). Typically, the upper zone of the shale bedrock was described as highly weathered and highly fractured beneath which the shale becomes moderately weathered to fresh, thinly bedded with occasional strong limestone interbeds. Occasional clay seams were noted at various depths in the shale bedrock.

The depths to bedrock and bedrock elevations encountered in the boreholes are summarized in the Table 5.2.

Table 5.2 – Depths and Elevations of Bedrock Surface

Borehole	Depth to Bedrock below Ground Surface (m)	Bedrock Elevation (m)
RC17-01	12.4	164.6
RC17-02	15.2	160.6
RC17-03	14.7	161.1
RC17-04	13.6	162.7

5.2.7 Groundwater Levels

Water levels measured in the piezometers installed during the current investigation and from the previous investigations by others are summarized in Table 5.3 below.

The measured groundwater levels represent relatively short-term readings and seasonal fluctuations of the groundwater level are to be expected. The groundwater level may be at higher elevations after the spring snowmelt or after periods of heavy rainfall. Perched water may be present at higher levels in lenses or zones of more permeable sands and silts within the till.

Table 5.3 – Piezometer Details and Groundwater Level Measurements

Borehole	Measurement Date	Water Level (m)		Screen Location (m)		Native Material at Screen
		Depth	Elevation	Depth	Elevation	
RC17-01	June 19, 2017	-0.8*	177.8	9.2-10.7	167.8-166.3	Lower Clayey Silt Till
	June 29, 2017	-0.7*	177.7			
	Oct 24, 2017	-0.3*	177.3			
RC17-02	June 19, 2017	-0.6*	176.4	14.3-15.8	161.5-160.0	Lower Clayey Silt Till/Shale
	June 29, 2017	-0.7*	176.5			
	Oct 18, 2017	-0.2*	176.0			
RC17-03 (S)	June 28, 2017	0.6	175.2	1.5-3.0	174.3-172.8	Upper Clayey Silt Till
	Oct 18, 2017	1.9	173.9			
RC17-03 (D)	June 28, 2017	-0.4*	176.2	9.2-10.7	166.6-165.1	Lower Clayey Silt Till
	Oct 18, 2017	0.0	175.8			
RC17-05 (S)	June 19, 2017	0.7	175.5	1.5-3.0	174.7-173.2	Upper Clayey Silt Till
	June 28, 2017	0.5	175.7			
	Oct 18, 2017	2.9	173.3			
RC17-05 (D)	June 19, 2017	0.0	176.2	7.6-9.1	168.6-167.1	Interbedded Clayey Silt Till
	June 28, 2017	-0.1*	176.3			
	Oct 18, 2017	0.7	175.5			
S5	April 24, 2009	4.4	177.2	9.2-10.7	172.4-170.9	Sand and Silt Till
	May 13, 2009	4.4	177.2			
	May 21, 2009	4.6	177.0			
	June 15, 2009	4.7	176.9			
	July 09, 2009	4.9	176.7			
S9	May 13, 2009	1.2	174.8	6.1-7.6	169.9-168.4	Sand and Silt Till
	May 21, 2009	0.9	175.1			
	June 15, 2009	0.5	175.4			
	July 09, 2009	0.5	175.5			

* Groundwater level above ground surface, i.e. artesian condition

(S) denotes Shallow piezometer, (D) denotes Deep piezometer

Within the creek flood plain, the groundwater levels measured in the standpipe piezometers were up to 0.8 m and 0.6 m above ground surface at the proposed south and north abutments, respectively, indicating artesian groundwater conditions in the lower cohesive till.

At the crest of the south valley slope, the groundwater was approximately 4.4 to 4.9 m below the ground surface (Elevations 177.2 to 176.7) as measured in piezometer installed in sand and silt till in Borehole S5. The groundwater monitored in a piezometer installed in the sand and silt till in Borehole S9 drilled within the flood plain was between 0.5 m and 1.2 m below the ground surface (Elevations 175.5 to 174.8).

The preliminary General Arrangement drawing indicates a 100-year flood level at Elevation 9175.97 and a regional storm level at Elevation 177.19.

5.3 Langstaff Road Underpass Embankment – Mainline Sta. 11+800 to 12+400

Details of the soil stratigraphy are shown on the Record of Borehole sheets contained in Appendix C. The approximate locations of the boreholes are shown on the Borehole Locations and Soil Strata Drawing.

In general, the soil stratigraphy encountered in the current investigation boreholes drilled along the proposed deep cut located at Langstaff Road consists of fill underlain by surficial silty clay underlain by clayey silt to silty clay till.

Detailed descriptions of the encountered strata are summarized below.

5.3.1 Asphalt

Asphalt was encountered from ground surface in Borehole FLR17-05. The thickness of the asphalt was 50 mm.

5.3.2 Topsoil

Topsoil was encountered in Borehole FLR17-06 from ground surface. The thickness of the topsoil was 150 mm.

5.3.3 Fill

Brown silty sand to sandy silt fill was encountered from ground surface in Boreholes FLR17-01 to 17-03. The depth to the base of the silty sand to sandy silt fill ranged from 0.9 to 1.7 m below ground surface in the boreholes (Elevation 190.7 to 186.7 m). SPT-N values recorded in the silty clay ranged from 11 to 39 blows, indicating a compact to dense relative density. Trace organics and asphalt fragments were noted in recovered samples.

Brown gravelly sand fill was encountered from ground surface in Borehole FLR17-04 and below the asphalt in Borehole FLR17-05. The depth to the base of the gravelly sand fill was located 0.4 to 0.5 m below ground surface in the boreholes (Elevation 187.7 to 187.6 m). SPT-N values recorded in the silty clay ranged from 7 to 10 blows per 0.3 m of penetration indicating a loose to compact relative density. Trace asphalt fragments were noted in a recovered sample of the fill.

5.3.4 Surficial Silty Clay

Brown silty clay was encountered underlying the gravelly sand fill in Borehole FLR17-04 and underlying the topsoil in Boreholes FLR17-06. The depth to the base of the silty clay deposit ranged from 1.4 to 3.0 m below ground surface in the boreholes (Elevation 186.8 to 185.6 m). The SPT-N values measured in the silt clay ranged from 4 to 9 blows indicating a firm to stiff consistency.

5.3.5 Clayey Silt to Silty Clay Till

Brown to grey clayey silt to silty clay till was encountered underlying the fill in Boreholes FLR17-01 to 17-03 and 17-05, and underlying the silty clay in Boreholes FLR17-04 and 17-06. All the boreholes were terminated in this till. SPT-N values recorded in the cohesive till ranged from 6 to 24 blows per 0.3 m of penetration indicating a firm to very stiff consistency.

Occasional cobbles and boulders were encountered within the deposit.

5.3.6 Groundwater Levels

Water levels measured in the piezometers installed during the current investigation are summarized in Table 5.4.

Table 5.4 – Piezometer Details and Groundwater Level Measurements

Borehole	Measurement Date	Water Level (m)		Screen Location (m)		Native Material at Screen
		Depth	Elevation	Depth	Elevation	
FLR17-02	June 19, 2017	2.5	186.3	12.2	176.6	Clayey silt to silty clay till
	Oct 18, 2017	2.5	186.3			
FLR17-03	May 18, 2017	5.0	183.4	7.6	180.8	Clayey silt to silty clay till
	June 19, 2017	0.9	187.5			
	Oct 18, 2017	2.6	185.8			
FLR17-04	May 18, 2017	Dry	-	7.6	180.6	Clayey silt to silty clay till
	June 19, 2017	0.6	187.6			
	Oct 18, 2017	2.2	186.0			
FLR17-06	June 19, 2017	4.5	184.1	7.6	181.0	Clayey silt to silty clay till
	Oct 30, 2017	1.1	187.5			

The above groundwater levels represent relatively short-term readings and seasonal fluctuations of the groundwater level are to be expected. The groundwater level may be at higher elevations after the spring snowmelt or after periods of heavy rainfall. Perched water may be present at higher levels in lenses or zones of more permeable sands and silts within the till.

5.4 Embankment at Culvert U022 – Mainline 11+100 to 11+150

Two (2) boreholes (CLRN 17-02 and 17-03) were advanced for the high fill embankment located at Culvert U022 as part of the current investigation.

Details of the soil stratigraphy are shown on the Record of Borehole sheets contained in Appendix D. The approximate locations of the boreholes are shown on the Borehole Locations and Soil Strata Drawing.

In general, the soil stratigraphy encountered below the topsoil consists of surficial clayey silt underlain by clayey silt to silty clay till grading into silty sand to sand and silt till over shale bedrock.

Detailed descriptions of the encountered strata are summarized below.

5.4.1 Topsoil

Topsoil was encountered in all boreholes from ground surface. Topsoil thickness varies from 125 to 150 mm.

5.4.2 Surficial Clayey Silt

Brown clayey silt was encountered underlying the topsoil in the boreholes advanced in the current investigation. The depth to the base of the cohesive clayey silt was located 0.7 to 0.8 m below ground surface (Elevation 179.5 to 178.8 m). Two SPT-N values of 3 blows were measured in the clayey silt, indicating a soft consistency. Trace organics were noted in recovered samples of the clayey silt.

5.4.3 Clayey Silt to Silty Clay Till

Brown to grey clayey silt to silty clay till was encountered underlying the clayey silt. The depth to the base of the cohesive till ranged from 8.7 to 12.0 m below ground surface (Elevation 170.8 to 168.3 m). SPT-N values recorded in the till ranged from 7 blows per 0.3 m of penetration to 100 blows per 0.025 m of penetration, indicating a firm to hard consistency. Occasional cobbles were noted in the till deposit.

5.4.4 Silty Sand to Sand and Silt Till

Grey silty sand to sand and silt till was encountered underlying the clayey silt to silty clay till. The depth to the base of the cohesive silty clay till was 12.4 m below ground surface (Elevation 167.1) in CLRN17-03. SPT-N values recorded in the cohesionless till ranged from 35 to 58 blows, indicating a dense to very dense relative density.

5.4.5 Shale Bedrock

Shale bedrock was encountered underlying the silty sand to sand and silt till in CLRN17-03 at a depth of 12.4 m (Elevation 167.1 m). CLRN17-03 was advanced 0.4 m into the highly weathered zone of the shale.

5.4.6 Groundwater Levels

Piezometers were not installed in the boreholes advanced within the vicinity of the high fill embankment located at Culvert U022 (CLRN17-02 and 17-03); however, piezometers were installed in Boreholes CLRN17-01 and 17-04, which were advanced outside of the embankment footprint, at the ends of the culvert. The water levels measured in these piezometers are summarized in Table 5.5 below.

Table 5.5 – Piezometer Details and Groundwater Level Measurements

Borehole	Measurement Date	Water Level (m)		Screen Location (m)		Native Material at Screen
		Depth	Elevation	Depth	Elevation	
CLRN17-01A (S)	July 10, 2017	1.5	179.5	4.9	176.1	Clayey silt to silty clay till
	Oct 24, 2017	1.5	179.5			
CLRN17-01 (D)	July 10, 2017	4.6	176.4	9.1	171.9	Silt/clay to sand/silt till
	Oct 24, 2017	1.5	179.5			
CLRN17-04	July 10, 2017	0.9	178.5	12.5	166.9	Silty sand till
	Oct 24, 2017	0.8	178.6			

(S) denotes Shallow piezometer, (D) denotes Deep piezometer

The above groundwater levels represent relatively short-term readings and seasonal fluctuations of the groundwater level are to be expected. The groundwater level may be at higher elevations after the spring snowmelt or after periods of heavy rainfall. Perched water may be present at higher levels in lenses or zones of more permeable sands and silts within the till.

5.5 Rutherford Road Overpass Approaches – Mainline Sta. 13+500 to 14+550

Three (3) boreholes (FRRO 17-01 to FRRO 17-03) were advanced along the alignment of the high fill embankment located at Rutherford Road as part of the current investigation.

Details of the soil stratigraphy are shown on the Record of Borehole sheets contained in Appendix E. The approximate locations of the boreholes are shown on the Borehole Locations and Soil Strata Drawing.

In general, the soil stratigraphy encountered below the topsoil consists of a surficial layer of silty clay underlain by clayey silt to silty clay till over sandy silt till.

Detailed descriptions of the encountered strata are summarized below.

5.5.1 Topsoil

Topsoil was encountered in all boreholes from ground surface. Topsoil thickness varies from 100 to 200 mm.

5.5.2 Surficial Silty Clay

Brown silty clay was encountered below the topsoil in all boreholes. The depth to the base of the silty clay was located 0.7 m below ground surface (Elevation 193.2 to 190.0). SPT-N values recorded in the silty clay ranged from 6 to 8 blows, indicating a firm consistency. Trace organics were noted in the silty clay.

5.5.3 Clayey Silt to Silty Clay Till

Brown to grey clayey silt to silty clay till was encountered underlying the silty clay. Boreholes FRRO17-02 and 17-03 were terminated in this till. The depth to the base of the till deposit was 8.5 m (Elevation 182.2) in Borehole FRRO17-01. SPT-N values recorded in the cohesive till ranged from 9 to 43 blows, indicating a stiff to hard consistency.

Occasional cobbles and boulders were encountered within the deposit.

5.5.4 Sandy Silt Till

Grey sandy silt till was encountered underneath the clayey silt to silty clay till in Borehole FRRO17-01. This borehole was terminated in the sandy silt till at a depth of 9.8 m below ground surface (Elevation 180.9 m). An SPT-N value of 73 blows was measured in the sandy silt till, indicating a very dense relative density.

5.5.5 Groundwater Levels

Water levels measured in the piezometers installed during the current investigation are summarized in Table 5.6.

Table 5.6 – Piezometer Details and Groundwater Level Measurements

Borehole	Measurement Date	Water Level (m)		Screen Location (m)		Native Material at Screen
		Depth	Elevation	Depth	Elevation	
FRRO17-02	June 19, 2017	7.5	186.3	9.1	184.7	Clayey silt to silty clay till
	Oct 23, 2017	3.0	190.8			
FRRO17-03	May 31, 2017	6.7	187.2	9.1	184.8	Clayey silt to silty clay till
	June 29, 2017	3.4	190.5			
	Oct 23, 2017	3.6	190.3			

The above groundwater levels represent relatively short-term readings and seasonal fluctuations of the groundwater level are to be expected. The groundwater level may be at higher elevations after the spring snowmelt or after periods of heavy rainfall. Perched water may be present at higher levels in lenses or zones of more permeable sands and silts within the till.

5.6 West Robinson Creek Bridge North Approach - Mainline Sta. 15+600 to 15+700

Six (6) boreholes (WR17-01 to WR17-06) were advanced within the vicinity of the proposed West Robinson Creek Bridge to depths ranging between 9.8 m and 42.1 m.

Details of the soil stratigraphy are shown on the Record of Borehole sheets contained in Appendix F. The approximate locations of the boreholes are shown on the Borehole Locations and Soil Strata Drawing.

In general, the subsurface conditions at the site consist of a layer of surficial silty clay overlying an upper cohesive till which is underlain by a silt to sand layer over a lower deposit of cohesive till which is in turn underlain by shale bedrock. Interlayers of non-cohesive till were also encountered at the borehole locations. Occasional auger grinding, hard augering, and/or split spoon bouncing were noted during advancing the boreholes in both cohesive and non-cohesive till deposits which are indications of presence of cobbles and/or boulders as expected to be present in till deposits of southern Ontario.

Detailed descriptions of the encountered strata are summarized below.

5.6.1 Topsoil

Topsoil with its thickness ranging from 125 mm to 300 mm was encountered at the ground surface in Boreholes WR17-01, 02, 04 to 06.

5.6.2 Surficial Clayey Silt to Silty Clay

A 0.5 m to 1.4 m thick deposit of clayey silt to silty clay was encountered in all current boreholes and extended to depths ranging between 0.7 m and 1.7 m (Elev. 192.0 m and 199.1 m). The SPT-N values within the deposit ranged from 2 to 14 blows per 0.3 m of penetration indicating a soft to stiff (predominantly firm) consistency.

5.6.3 Upper Clayey Silt to Silty Clay Till

Clayey silt to silty clay till was encountered underlying the topsoil and/or clayey silt to silty clay, and extended to depths ranging between 8.7 m and 16.3 m (Elev. 185.0 m and 178.4 m).

SPT-N values within the upper cohesive till ranged from 8 blows to greater than 100 blows per 0.3 m of penetration indicating a stiff to hard (predominantly very stiff to hard) consistency.

5.6.4 Silt to Sand

A deposit of silt, silty sand and/or sand was encountered below the upper cohesive till in all boreholes except WR17-01 and extended to depths ranging between 16.3 m and 28.5 m (Elev. 166.2 m and 177.8 m).

SPT-N values within the deposit ranged from 13 to 117 blows per 0.3 m of penetration indicating the deposit is

compact to very dense (predominantly dense).

5.6.5 Silt and Sand Till Interlayer

Interlayers of silty sand to silt and sand till were encountered below the upper cohesive and/or non-cohesive tills, and below the silt to sand in Boreholes WR17-02 to -04 and -06 and extended to depths ranging between 32.4 m and 37.2 m (Elev. 159.4 m and 164.1 m). The SPT-N values within the layer ranged from 19 blows to greater than 100 blows per 0.3 of penetration indicating that the layer is compact to very dense (predominantly very dense).

5.6.6 Lower Clayey Silt to Silty Clay Till

A lower deposit of clayey silt to silty clay till was encountered below or within the silt to sand and extended to depths ranging between 19.7 m and 40.2 m (Elev. 174.0 m and 154.5 m).

SPT-N values within the lower cohesive till ranged from 14 blows to greater than 100 blows per 0.3 m of penetration indicating a stiff to hard (predominantly very stiff to hard) consistency.

5.6.7 Shale Bedrock

Grey shale bedrock of the Georgian Bay Formation was confirmed by coring in Boreholes WR17-02 and 05. The bedrock surface was encountered at depths of 34.4 m and 38.1 m (Elev. 164.1 m and 155.6 m), respectively. The TCR, SCR, and RQD values recorded in Borehole WR17-02 are not considered reliable due to coring equipment deficiencies.

5.6.8 Groundwater Levels

Water levels measured in the piezometers installed during the current investigation are summarized in Table 5.7.

Table 5.7 – Piezometer Details and Groundwater Level Measurements

Borehole	Measurement Date	Water Level (m)		Screen Location (m)		Soil Stratum at Screen
		Depth	Elevation	Depth	Elevation	
WR17-02	August 8, 2017	18.1	180.4	18.3	180.2	Sand
	Oct 23, 2017	17.9	181.2			
WR17-03 (S)	August 8, 2017	1.3	192.4	4.6	189.1	Upper cohesive till
	Oct 23, 2017	1.6	192.1			
WR17-03 (D)	August 8, 2017	4.3	189.4	10.4	183.3	Silty sand
	Oct 23, 2017	4.6	189.1			
WR17-04	August 8, 2017	3.7	191.0	25.9	168.8	Silt
	Oct 23, 2017	3.9	190.8			
WR17-05 (S)	August 8, 2017	1.6	192.1	4.3	189.4	Upper cohesive till
	Oct 23, 2017	2.5	191.2			
WR17-05 (D)	August 8, 2017	11.0	182.7	14.9	178.8	Sand
	Oct 23, 2017	12.1	181.6			
WR17-06	August 8, 2017	18.7	178.8	18.3	179.2	Sand
	Oct 23, 2017	16.8	180.7			

(S) denotes Shallow piezometer, (D) denotes Deep piezometer

The above groundwater levels represent relatively short-term readings and seasonal fluctuations of the groundwater level are to be expected. The groundwater level may be at higher elevations after the spring snowmelt or after periods of heavy rainfall. Perched water may be present at higher levels in lenses or zones of more permeable sands and silts within the till.

5.7 CPR/McGillivray Road/Major Mackenzie Drive Overpass – Mainline Sta. 15+700 to 16+800

Ten (10) boreholes (FWR17-01 and 17-02, FCPR17-01 to 17-03, FMMO17-01 to 17-05) were advanced along the alignment of the high fill embankment located at CPR/McGillivray Road/Major Mackenzie Drive as part of the current investigation.

Details of the soil stratigraphy are shown on the Record of Borehole sheets contained in Appendix G. The approximate locations of the boreholes are shown on the Borehole Locations and Soil Strata Drawing.

The stratigraphic boundaries shown on the borehole sheets and on the interpreted stratigraphic profile and cross-sections are inferred observations of drilling progress and from non-continuous sampling and, therefore, represent transitions between soil types rather than exact planes of geological change. The subsoil conditions will vary between and beyond the borehole locations.

In general, the soil stratigraphy encountered in the current investigation boreholes drilled along the CPR/McGillivray Road/Major Mackenzie Drive high fill embankment consists of topsoil/organics underlain by, in succession, clayey silt to silty clay, clayey silt to silty clay till, and sandy silt till.

Detailed descriptions of the encountered strata are summarized below.

5.7.1 Topsoil/Organics

Topsoil/organics was encountered from ground surface. Layer thickness varies from 75 to 175 mm.

5.7.2 Surficial Clayey Silt to Silty Clay

Brown clayey silt to silty clay was encountered underlying the topsoil in all the boreholes. The depth to the base of the cohesive silty clay ranged from 0.7 to 1.7 m below ground surface (Elevation 203.8 to 200.0 m). SPT-N values recorded in the silty clay ranged from 3 to 16 blows per 0.3 m of penetration, indicating a soft to very stiff consistency. Trace organics were noted in some of the clayey silt to silty clay samples.

5.7.3 Clayey Silt to Silty Clay Till

Brown to grey clayey silt to silty clay till was encountered underlying the clayey silt to silty clay in all boreholes. SPT-N values recorded in the till ranged from 5 blows per 0.3 m of penetration to 50 blows per 0.225 m of penetration, indicating a firm to hard consistency.

Occasional cobbles and boulders were encountered within the deposit.

The results of Oedometer (one-dimensional consolidation) tests carried out on two samples of the silty clay till are summarized in Table 5.8 below. The test results are graphically presented in Appendix G following the grain size distribution and plasticity charts.

Table 5.8 – Oedometer Test Results

Borehole	FMMO 17-04	TS 17-46
Sample No.	TW-1	TW-1
Depth (m)	8.8	5.7
Elevation (m)	195.0	196.4
Soil Type	Silty Clay Till	Silty Clay Till
Clay Content (%)	42	54
Moisture Content (%)	20.2	23.3
Liquid Limit (%)	28.3	37.7
Plasticity Index (%)	13.1	19.3
γ_b – Bulk Unit Weight (kN/m ³)	20.4	20.1
G_s - Specific Gravity	2.76	2.78

Borehole	FMMO 17-04	TS 17-46
e_o - Initial Void Ratio	0.597	0.668
σ_{vo}' - In situ effective vertical stress (kPa)	180	115
σ_p' - Preconsolidation Pressure (kPa)	400 - 450	350
OCR - Overconsolidation Ratio	2.2 – 2.5	3.0
C_{ce} - Compression Ratio	0.102	0.150
C_{re} - Recompression Ratio	0.013	0.013
C_v - Coefficient of Consolidation in NC range (m ² /yr)	16 - 101	37 - 102
C_{vr} - Coefficient of Consolidation in OC range (m ² /yr)	211 - 218	423 - 492

5.7.4 Sandy Silt Till

Grey sandy silt till was encountered underlying the clayey silt to silty clay till in Boreholes FWR17-01, FCPR17-02, FMMO17-01, and FMMO17-02. These boreholes were terminated within this layer. SPT-N values recorded in the sandy silt till ranged from 57 blows per 0.3 m of penetration to 50 blows for 0.1 m of penetration, indicating a very dense relative density.

5.7.5 Groundwater Levels

Water levels measured in the piezometers installed during the current investigation are summarized in Table 5.9.

Table 5.9 – Piezometer Details and Groundwater Level Measurements

Borehole	Measurement Date	Water Level (m)		Screen Location (m)		Native Material at Screen
		Depth	Elevation	Depth	Elevation	
FWR 17-02	June 29, 2017	7.9	193.5	10.7	190.7	Clayey silt to silty clay till
	Oct 23, 2017	8.5	192.9			
FMMO 17-02	June 29, 2017	11.9	193.2	12.2	192.9	Clayey silt to silty clay till / Sandy Silt Till
	Oct 23, 2017	7.1	198.0			
FMMO 17-04	June 29, 2017	Dry	-	7.6	196.2	Clayey silt to silty clay till
	Oct 23, 2017	3.8	200.0			

The above groundwater levels represent relatively short-term readings and seasonal fluctuations of the groundwater level are to be expected. The groundwater level may be at higher elevations after the spring snowmelt or after periods of heavy rainfall. Perched water may be present at higher levels in lenses or zones of more permeable sands and silts within the till.

5.8 Major Mackenzie Drive at West Robinson Creek West Approach – Sta. 9+300 to 9+400

Five (5) boreholes (MMW17-01 to MMW17-05) were advanced within the vicinity of the proposed Major Mackenzie Drive at West Robinson Creek Bridge to depths ranging between 9.3 m and 35.3 m.

Details of the soil stratigraphy are shown on the Record of Borehole sheets contained in Appendix H.

In general, the soil stratigraphy encountered in the current investigation consists of topsoil/organics underlain by surficial clayey silt to silty clay underlain by clayey silt till or silt and sand till grading to sand to sand and gravel over shale bedrock. Asphalt pavement and sand and gravel fill was encountered overlying the clayey silt in the boreholes advanced on the existing roadway of Major Mackenzie Drive (Boreholes MMW17-01 and 17-05).

Detailed descriptions of the encountered strata are summarized below.

5.8.1 Asphalt

Asphalt was encountered from ground surface in Borehole MMW17-01 and 17-05. Thickness of the asphalt ranges between 25 and 125 mm.

5.8.2 Topsoil

Topsoil was encountered in Boreholes MMW17-02 to 17-04. Topsoil thickness varies from 100 to 225 mm.

5.8.3 Sand Fill

Brown sand fill was encountered underlying the asphalt in Boreholes MMW17-01 and 17-05. The depth to the base of the sand fill ranged from 1.5 to 2.2 m below ground surface (Elevation 199.3 to 198.8 m). SPT-N values recorded in the fill ranged from 13 to 28 blows, indicating a compact relative density.

5.8.4 Clayey Silt to Silty Clay

Brown clayey silt to silty clay was encountered underlying the sand fill in Boreholes MMW17-01 and 17-05, and underlying the topsoil in Boreholes MMW17-02 to 17-04. The depth to the base of the clayey silt to silty clay ranged from 0.8 to 4.4 m below ground surface (Elevation 201.9 to 196.8 m). SPT-N values recorded in the fill ranged from 2 to 10 blows per 0.3 m of penetration, indicating a soft to stiff consistency.

5.8.5 Clayey Silt to Silty Clay Till

Brown to grey clayey silt to silty clay till was encountered underlying the clayey silt to silty clay in Boreholes MMW 17-02 and MMW 17-04. The depth to the base of the cohesive till deposit was 5.6 m below ground surface (Elevation 197.2 to 197.1 m). SPT-N values recorded in the till ranged from 19 to 51 blows per 0.3 m of penetration, indicating a stiff to hard consistency.

5.8.6 Silt and Sand Till

Grey silt and sand till was encountered underlying the clayey silt to silty clay in Boreholes MMW17-01, 17-03, and 17-05, and underlying the clayey silt to silty clay till in Boreholes MMW17-02 and 17-04. The depth to the base of the silt and sand till deposit ranged from 10.2 to 30.5 m below ground surface (Elevation 189.2 to 172.2 m). SPT-N values recorded in the till ranged from 24 blows per 0.3 m of penetration to 47 blows for 0.075 m penetration, indicating a compact to very dense relative density.

5.8.7 Sand

Grey sand was encountered underlying the silt and sand till in Borehole MMW17-05. The depth to the base of the sand deposit was 20.9 m below ground surface (Elevation 180.1 m). SPT-N values recorded in the sand were above 100 blows, indicating a very dense relative density.

5.8.8 Silt

Grey silt was encountered underlying the sand in Borehole MMW17-05. The depth to the base of the silt deposit was 23.8 m below ground surface (Elevation 177.2 m). An SPT-N value of 44 blows was recorded in the silt, indicating a dense relative density.

5.8.9 Sand and Gravel

Grey sand and gravel was encountered underlying the silt in Borehole MMW 17-05 and underlying the silt and sand till in Borehole MMW17-03. The depth to the base of this deposit was 28.5 m below ground surface (Elevation 172.5 m). SPT-N values recorded in the sand and gravel ranged from 12 blows per 0.3 m of penetration to 100 blows for 0.075 m penetration, indicating a compact to very dense relative density.

5.8.10 Shale Bedrock

Grey shale bedrock of the Georgian Bay Formation was confirmed by coring in Boreholes MMW17-04 and 17-05. The bedrock surface was encountered at depths of 30.5 and 28.5 m (Elevation 172.2 and 172.5 m), respectively.

5.8.11 Groundwater Levels

Water levels measured in the piezometers installed during the current investigation are summarized in Table 5.10.

Table 5.10 – Piezometer Details and Groundwater Level Measurements

Borehole	Measurement Date	Water Level (m)		Screen Location (m)		Native Material at Screen
		Depth	Elevation	Depth	Elevation	
MMW 17-03	July 10, 2017	N/A	N/A	9.1	190.3	Silt and Sand
MMW 17-04 (S)	August 8, 2017	Dry	-	4.6	198.1	Clayey Silt
	August 9, 2017	Dry	-			
	Oct 24, 2017	3.5	199.2			
MMW 17-04 (D)	August 9, 2017	1.9	200.8	19.8	182.9	Silt and Sand
	Oct 24, 2017	2.0	200.7			

(S) denotes Shallow piezometer, (D) denotes Deep piezometer

The above groundwater levels represent relatively short-term readings and seasonal fluctuations of the groundwater level are to be expected. The groundwater level may be at higher elevations after the spring snowmelt or after periods of heavy rainfall. Perched water may be present at higher levels in lenses or zones of more permeable sands and silts within the till.

5.9 Cut Section North of Zenway Boulevard – Sta. 10+750 to 11+000

Three (3) boreholes (TS 17-26, TS 17-27, and HM 17-19) were advanced to depths ranging from 6.7 to 8.2 m within the vicinity of the proposed cut section located approximately 100 m north of Zenway Boulevard.

Details of the soil stratigraphy are shown on the Record of Borehole sheets contained in Appendix I.

In general, the soil stratigraphy encountered in the current investigation consists of topsoil/organics underlain by surficial clayey silt to silty clay underlain by silty clay till.

Detailed descriptions of the encountered strata are summarized below.

5.9.1 Topsoil

Topsoil was encountered in all boreholes. The topsoil was typically 150 mm thick in boreholes.

5.9.2 Surficial Clayey Silt to Silty Clay

Dark brown to brown clayey silt to silty clay was encountered underlying the topsoil in all boreholes. The depth to the base of the clayey silt to silty clay ranged from 0.7 to 1.7 m (Elevation 185.0 to 182.3 m). SPT-N values recorded in the clayey silt to silty clay ranged from 4 to 19 blows, indicating a firm to very stiff consistency.

5.9.3 Clayey Silt to Silty Clay Till

Brown to grey clayey silt to silty clay till was encountered underlying the surficial clayey silt to silty clay in all boreholes. All boreholes were terminated within this layer at Elevation 179.8 to 174.8 m. SPT-N values recorded in the till ranged from 4 to 28 blows, indicating a firm to very stiff consistency.

5.9.4 Groundwater Levels

Water levels measured in the piezometers installed during the current investigation are summarized in Table 5.11.

Table 5.11 – Piezometer Details and Groundwater Level Measurements

Borehole	Measurement Date	Water Level (m)		Screen Location (m)		Native Material at Screen
		Depth	Elevation	Depth	Elevation	
TS 17-27	July 7, 2017	0.8	184.5	6.1	179.2	Clayey silt to silty clay till
	Oct 25, 2017	1.6	183.7			

Borehole	Measurement Date	Water Level (m)		Screen Location (m)		Native Material at Screen
		Depth	Elevation	Depth	Elevation	
HM 17-19	July 7, 2017	0.4	182.6	7.9	175.1	Clayey silt to silty clay till
	Oct 24, 2017	1.2	181.8			

The above groundwater levels represent relatively short-term readings and seasonal fluctuations of the groundwater level are to be expected. The groundwater level may be at higher elevations after the spring snowmelt or after periods of heavy rainfall. Perched water may be present at higher levels in lenses or zones of more permeable sands and silts within the till.

5.10 Fill Section South of Rainbow Creek (Sta. 11+380 to 11+410)

Two (3) boreholes (E6 and E7) were advanced to a depth of 5.2 m within this section by Golder in 2009.

Details of the soil stratigraphy are shown on the Record of Borehole sheets contained in Appendix J.

In general, the soil stratigraphy consisted of topsoil/organics underlain by clayey silt to silty clay till.

Detailed descriptions of the encountered strata are summarized below.

5.10.1 Topsoil

Topsoil was encountered in both boreholes. The topsoil was typically 100 mm thick in boreholes.

5.10.2 Clayey Silt to Silty Clay Till

Brown to grey clayey silt to silty clay till was encountered below the topsoil in both boreholes. Both boreholes were terminated within this layer at Elevation 173.9 to 173.2 m. SPT-N values recorded in the till ranged from 4 to 53 blows, indicating a firm to hard consistency.

5.10.3 Groundwater Levels

Both boreholes were observed to be dry upon completion of drilling.

6. ENGINEERING RECOMMENDATIONS

This section presents interpretation of the geotechnical data in the factual report and provides foundation design recommendations for the Hwy 427 mainline deep cuts and high fill embankments.

6.1 Deep Cut

Excavation for the deep cuts will advance into firm to very stiff native silty clay/clayey silt till along the deep cut sections located approximately 100 m north of Zenway Boulevard (Sta. 10+750 to 11+000) and from 300 m south to 300 m north of Langstaff Boulevard (Sta. 11+800 to 12+400).

6.1.1 Stability

Global stability analysis has been carried out on a critical deep cut cross-section to evaluate the stable inclination of the cut slopes. The analysis was performed using the commercially available program Slope/w from GEO-SLOPE and Morgenstern-Price method of analysis. The critical section was selected and analyzed based on a review of the cut depths and subsurface conditions. The design groundwater levels were assumed to be at Elev. 184.5 for the cut section north of Zenway Boulevard and Elev. 187.5 for Langstaff Road.

The results of the analysis are presented in Appendix C and Appenidx I. The results of the analysis indicate a Factor of Safety of greater than 1.3 under short-term conditions and greater than 1.5 under long-term conditions. A factor of safety of greater than 1.1 was obtained under seismic loading conditions. The cut slopes are expected to be stable at 2H:1V inclination or flatter.

6.1.2 Cut Slope Construction

Excavation for cut slope construction should be carried out in accordance with OPSS.PROV 206.

Slope inclination of earth cuts should not be steeper than 2H:1V. A 2 m wide mid-height bench should be incorporated along the length of earth cut with depths at or exceeding 6 m. The bench should maintain a 2% slope to shed surface runoff.

During construction of earth cuts some areas may reveal a final subgrade to be soft and moisture sensitive. Any soft and weak soils in the exposed subgrade should be removed and replaced with suitable earth or granular material compacted as per OPSS.PROV 501. Extent of the soft and weak soils for removal should be determined on site through construction inspection (visual identification, pocket penetrometer, etc.). Proof-rolling may be considered as an expeditious and effective means in identifying soft and weak spots.

Temporary drainage of the cuts should be provided to maintain a relatively dry, stable excavation. Permanent drainage of the cuts must be provided. Roadside ditches are expected to provide an adequate level of surface drainage in most areas. An interceptor ditch should be provided at the top of the earth cuts as per OPSD 200.020 and 201.020.

Where fine-grained silt and clay soils are exposed on a cut slope, the native soils are soft and moisture sensitive and may become negatively impacted after spring thaw and/or ingress of surface water and/or changes in the water table. The properties of the soils are such that the fluctuation in moisture content is likely to soften the soils and to result in erosion and/or sloughing of the soils and resulting in instability of the cut slopes. Such areas must be protected from erosion both on a temporary and permanent basis as per OPSS 804. Treatment of cut slopes should be completed as soon as practical. Vegetation must be sufficiently established before the winter season.

6.2 High Fill Embankments

6.2.1 Subgrade Preparation

Stripping of soft and compressible soil and existing topsoil should be subject to construction inspection and completed in accordance with OPSS.PROV 206 and OPSS 802. Should topsoil deposits be encountered with thickness in excess of 250 mm, they should be excavated as per OPSD 203.010. All topsoil and organic deposits encountered in areas where the existing ground slope is steeper than 3H:1V or within 75 m of each structure abutment must be stripped from under the proposed footprint of the embankment as per OPSS.PROV 206.

Following stripping/organic removal, the exposed subgrade should be backfilled with suitable earth/granular materials compacted as per OPSS.PROV 501. The work should be carried out in accordance with OPSS 902 and construction should be carried out in the dry. Once the subgrade is prepared the construction traffic and equipment should not travel on the subgrade.

6.2.2 Embankment Materials and Construction

The embankments may be constructed with granular fill and/or cohesive earth fill (reused till) compacted as per OPSS.PROV 501. All fills must be free of organics, frozen soils, and deleterious materials. Careful selection and/or treatment of the earth fill prior to reuse will be required. Within one metre of the pavement subgrade level, the earth fill material should consist of low frost susceptible soils.

Mid-height berms comprising 2 m wide benches should be incorporated along the length of embankments

with heights at or exceeding 8 m as per OPSD 202.010. Where new embankment fill is placed against existing embankment slopes or on a sloping ground surface steeper than 3H:1V, the existing earth or fill slope must be benched in accordance with OPSD 208.010.

Embankment construction should be carried out in accordance with Special Provision OPSS.PROV 206. Slope face treatment/surficial erosion protection for embankment slopes should be provided in general accordance with OPSS.PROV 804.

6.2.3 Embankment Stability

Stability analyses were carried out on critical embankment cross-sections to evaluate the stable inclination of the embankment side slopes and to determine any requirements for embankment staging. The analyses were performed using the commercially available program Slope/w from GEO-SLOPE and Morgenstern-Price method of analysis. The critical sections were selected and analyzed based on a review of the embankment heights and subsurface conditions. The analysis assumed single-stage embankment construction (i.e. earth fill embankment constructed to full height with no wait period). The assumed groundwater levels for design are summarized in the following table.

Location	Assumed Groundwater Table Elevation (m)
Zenway Boulevard Underpass	181.0
Mainline Embankment at Culvert U022	178.5
Mainline Rainbow Creek Bridge	176.5
Rutherford Road Overpass	190.5
Mainline West Robinson Creek Bridge North Approach	193.5
CPR/McGillivray Road Overhead to Major Mackenzie Drive Overpass	195.0
Major Mackenzie Drive at West Robinson Creek West Approach	199.0
Fill Section South of Rainbow Creek (Sta. 11+380 to 11+410)	180.0 (short term) 178.0 (long term)

Critical sections were analyzed for each of the high fill embankments. The results of the analyses are included in the Appendices following the text of the report. The analyses indicate that the proposed embankments will be stable if constructed with side slopes not steeper than 2H:1V. The computed factors of safety (FOS) meet the typically accepted values of 1.3, 1.5 and 1.1 for the short-term, long-term and seismic conditions, respectively. Based on the results of the analyses, embankment slope no steeper than 2H:1V is anticipated to be stable except for the high fill section south of Rainbow Creek between Sta. 11+380 and 11+410 where an elevated drainage ditch (or linear pond) is proposed along the NBL. The side slope downstream of the elevated drainage ditch should be no steeper than 3H:1V. Embankment construction staging is not required for the embankment.

6.2.4 Embankment Settlement

The proposed embankments will experience settlement resulting from embankment loading of the foundation soils as well as self-compression of the embankment fill. The following sections outline the estimated magnitude and rate of settlement of the embankments based on the design embankment heights and subsurface conditions.

In accordance with MTO's Embankment Settlement Criteria for Design (March 2, 2010) included as part of

the project requirement in Schedule 15-2 Article 5 of the Project Agreement, one of the criteria adopted for embankment design is to limit post-construction settlement to maximum permissible settlement of 100 mm or less, within 20 years following paving, with a differential settlement allowance of 200:1.

For bridge approach areas, the following post-construction settlement criteria (within 20 years following paving) have been adopted for the design:

- No more than 25 mm within 20 m behind the bridge abutment;
- 25 mm to 50 mm from 20 m to 50 m from the bridge abutment;
- 50 mm to 75 mm from 50 m to 75 m from the bridge abutment; and
- 75 mm to 100 mm greater than 75 m from the bridge abutment.

6.2.4.1 Foundation Settlement

Settlement analyses were carried out for the high fill embankments to assess the magnitudes and rates of foundation settlements during construction and post construction (long term) using the commercially available software Settle3D developed by Rocscience.

The engineering parameters used in the in the settlement analyses were determined from the geotechnical laboratory testing (e.g. 1D incremental consolidation test), in-situ testing (e.g. Standard Penetration Test (SPT) and empirical soil index correlations.

Results of the settlement analysis are provided in the attached Table 1. Settlements have been provided for the critical mainline sections and cross-roads which were selected based on the embankment heights and subsurface conditions. Settlements have not been provided for the ramps however the fill heights at the ramps are generally less than the mainline fill heights and consequentially the ramps are expected to experience less settlement than the mainline. The settlements at the ramps can be assumed to be less than the settlement estimated at the nearest corresponding mainline section.

The results of settlement analyses indicate that approximately 70% to 85% of the foundation settlement is estimated to occur during construction assuming a construction rate of 1.5 m of fill placement per week. The remaining foundation settlement is anticipated to occur within 2 to 4 months following completion of embankment construction. The actual rates of foundation settlement will be confirmed by the monitoring program to be implemented at the critical locations.

6.2.4.2 Fill Compression

An assessment of the long-term fill compression under self-weight was also carried out. Settlement due to fill compression typically occurs due to rearrangement of soil particles under its own weight, upon traffic loading, and due to wetting and drying cycles. The magnitude of fill compression largely depends on the height of the fill, material type and degree of compaction achieved during construction. The exact amount of settlement due to fill compression is difficult to assess. It is our understanding that the proposed embankments will be constructed using earth fill and/or granular fill materials. Post-construction settlement due to fill compression (granular fill or earth fill) has been estimated at 0.25% of the embankment height.

Estimates of the magnitude of the post-construction fill compression are provided in the attached Table 1. The embankment fill should be compacted in accordance with OPSS.PROV 501.

6.2.5 Settlement Mitigation

Based on the results of the settlement analysis, it is recommended that foundation preloading be carried out

at the Zenway Boulevard Underpass, Rutherford Road Overpass, CPR/McGillivray Road Overpass, and Major Mackenzie Drive Overpass, to reduce the post-construction embankment settlements. Details of the embankment preloading, including the locations of the preload areas and the preload waiting times, are summarized in the Preload Embankment drawings (H427-D-H-1-HWY-000-DWG-0045 and H427-D-H-9B-HWY-000-DWG-0069 to -DWG-0071) and Table 6.1 below. Lateral extent of the preload should cover the footprint of the permanent embankment.

Table 6.1 – Embankment Preload Details

Preload Area	Longitudinal Extent of Preload	Anticipated Preload Time*
Zenway Boulevard Underpass	From abutments to 50 m behind abutments	3 months
Rutherford Road Overpass	From abutments to 50 m behind abutments	2 months
CPR/McGillivray Road Overpass	From abutments to 75 m behind abutments	4 months
Major Mackenzie Drive Overpass	From abutments to 75 m behind abutments	4 months

* Following construction to full height

The embankment platform should be overbuilt to accommodate the anticipated foundation settlements and fill compression. The following platform widening is recommended:

- 100 mm platform widening on each side for fill height greater than 7m between Sta. 13+800 south of Rutherford Road and Sta. 14+300 north of Rutherford Road
- 200 mm platform widening on each side for fill height greater than 7m between Sta. 15+850 south of CPR/ McGillivray Road Overpass and Sta. 16+750 north of Major Mackenzie Drive

6.3 Monitoring Program

As part of the embankment preloading, a geotechnical instrumentation and monitoring program should be implemented to monitor embankment settlements and to confirm that the foundation settlements beneath the embankment are essentially complete prior to paving and approach slab construction. It is recommended that settlement rods be installed at the base of the preload embankments to assess the foundation settlement during construction and waiting period.

A specification for supply and installation of embankment monitoring equipment is included in Appendix K.

A total of 6, 8, 12 and 12 settlement rods are required for Zenway Boulevard Underpass, Rutherford Road Overpass approach embankments, CPR/McGillivray Overpass approach embankments and Major Mackenzie Drive Overpass approach embankments, respectively, assuming a 25 m spacing between settlement rods. Details of the proposed monitoring program are shown on the Preload Embankment drawings H427-D-H-1-HWY-000-DWG-0044 and H427-D-H-9B-HWY-000-DWG-0068.

Monitoring frequencies for each settlement rod are recommended as follows:

- Baseline reading: 3 readings on 3 consecutive days following installation and prior to fill placement;
- During fill placement: Once every 1.5 m lift and following placement of last lift;
- During preload period: Minimum twice a week at Zenway site, and once every 2 weeks during 1st

month and monthly from 2nd month onward at the other three sites.

The monitoring data will be assessed to confirm stabilization of the foundation settlement prior to construction of approach slabs and final paving. The actual number of monitoring readings required for each site will be governed by the foundation behaviour assessed from the settlement monitoring data and approved by the foundation designer.



STATEMENT OF LIMITATIONS AND CONDITIONS

1. STANDARD OF CARE

This Report has been prepared in accordance with generally accepted engineering or environmental consulting practices in the applicable jurisdiction. No other warranty, expressed or implied, is intended or made.

2. COMPLETE REPORT

All documents, records, data and files, whether electronic or otherwise, generated as part of this assignment are a part of the Report, which is of a summary nature and is not intended to stand alone without reference to the instructions given to Thurber by the Client, communications between Thurber and the Client, and any other reports, proposals or documents prepared by Thurber for the Client relative to the specific site described herein, all of which together constitute the Report.

IN ORDER TO PROPERLY UNDERSTAND THE SUGGESTIONS, RECOMMENDATIONS AND OPINIONS EXPRESSED HEREIN, REFERENCE MUST BE MADE TO THE WHOLE OF THE REPORT. THURBER IS NOT RESPONSIBLE FOR USE BY ANY PARTY OF PORTIONS OF THE REPORT WITHOUT REFERENCE TO THE WHOLE REPORT.

3. BASIS OF REPORT

The Report has been prepared for the specific site, development, design objectives and purposes that were described to Thurber by the Client. The applicability and reliability of any of the findings, recommendations, suggestions, or opinions expressed in the Report, subject to the limitations provided herein, are only valid to the extent that the Report expressly addresses proposed development, design objectives and purposes, and then only to the extent that there has been no material alteration to or variation from any of the said descriptions provided to Thurber, unless Thurber is specifically requested by the Client to review and revise the Report in light of such alteration or variation.

4. USE OF THE REPORT

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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.

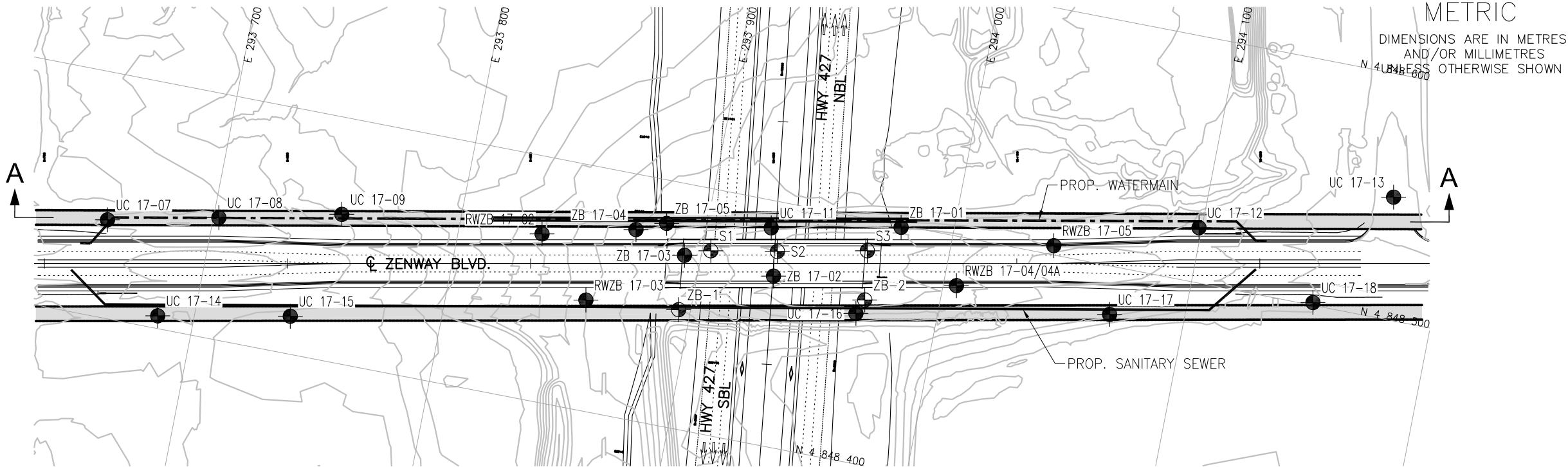
6. RELEASE OF POLLUTANTS OR HAZARDOUS SUBSTANCES

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.

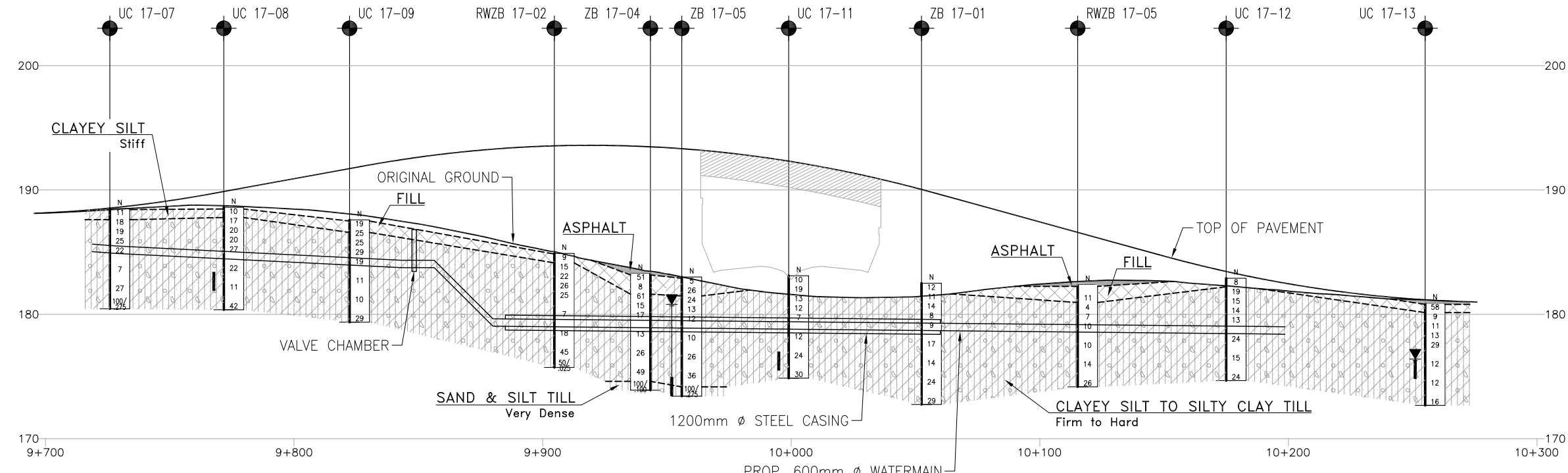
7. INDEPENDENT JUDGEMENTS OF CLIENT

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.

DRAWINGS



PLAN



PROFILE A-A ALONG ZENWAY BLVD. WBL (WATERMAIN)

CONT No
WP No



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
- Head Artesian Water
- Piezometer
- 90% Rock Quality Designation (RQD)
- A/R Auger Refusal

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RWZB 17-03	184.1000	4848445.1000	293856.9000
RWZB 17-04/04A	181.9000	4848480.0000	294005.4000
RWZB 17-05	182.4000	4848503.8000	294041.6000
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S2	181.4000	4848479.8000	293930.4000
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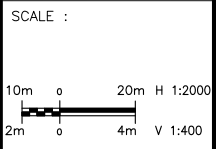
-NOTES-

- The boundaries between soil strata have been established only at Borehole locations. Between Boreholes the boundaries are assumed from geological evidence.
- This drawing is for subsurface information only. Surface details and features are for conceptual illustration.

GEOCRES No.

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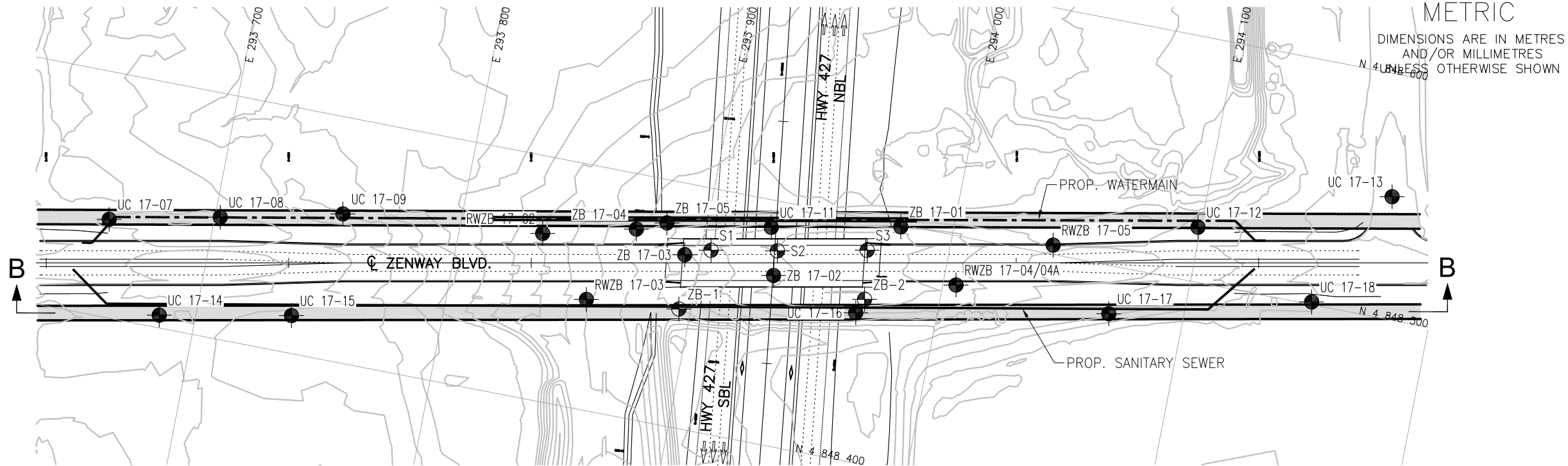


DESIGNED	M. BOUCHER	MB	17/09/15
DRAWN	A. NOOR	AN	17/09/15
CHECKED	J. LEE	JL	17/09/15
APPROVED LEAD ENGINEER	J. LEE	JL	17/09/15
APPROVED PROJ. MANAGER	J. LEE	JL	17/09/15
NAME (PRINT)	INIT.	DATE	

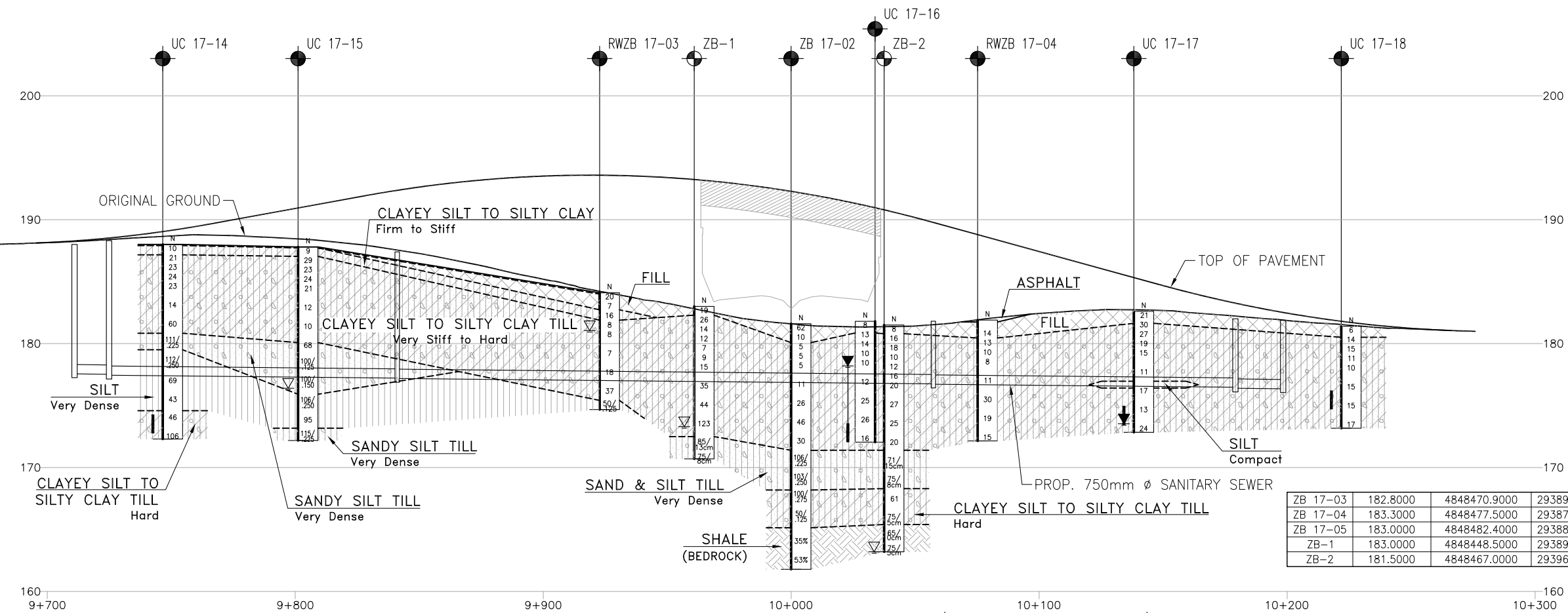


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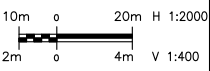


PLAN



PROFILE B-B ALONG ZENWAY BLVD. EBL (SANITARY SEWER)

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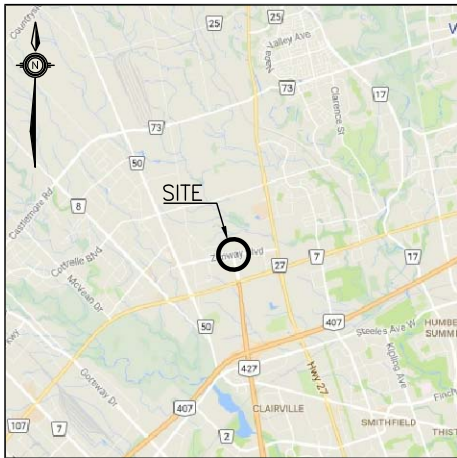


DESIGNED	M. BOUCHER	MB	17/09/15
DRAWN	A. NOOR	AN	17/09/15
CHECKED	J. LEE	JL	17/09/15
APPROVED LEAD ENGINEER	J. LEE	JL	17/09/15
APPROVED PROJ. MANAGER	J. LEE	JL	17/09/15
NAME (PRINT)	INIT.	DATE	



TITLE						
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PROJECT ID.	STAGE IDENTIFIER	DESIGN PACKAGE NUMBER	DISCIPLINE	STRUCTURE NUMBER	DOCUMENT TYPE	DRAWING NUMBER
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CONT No
WP No



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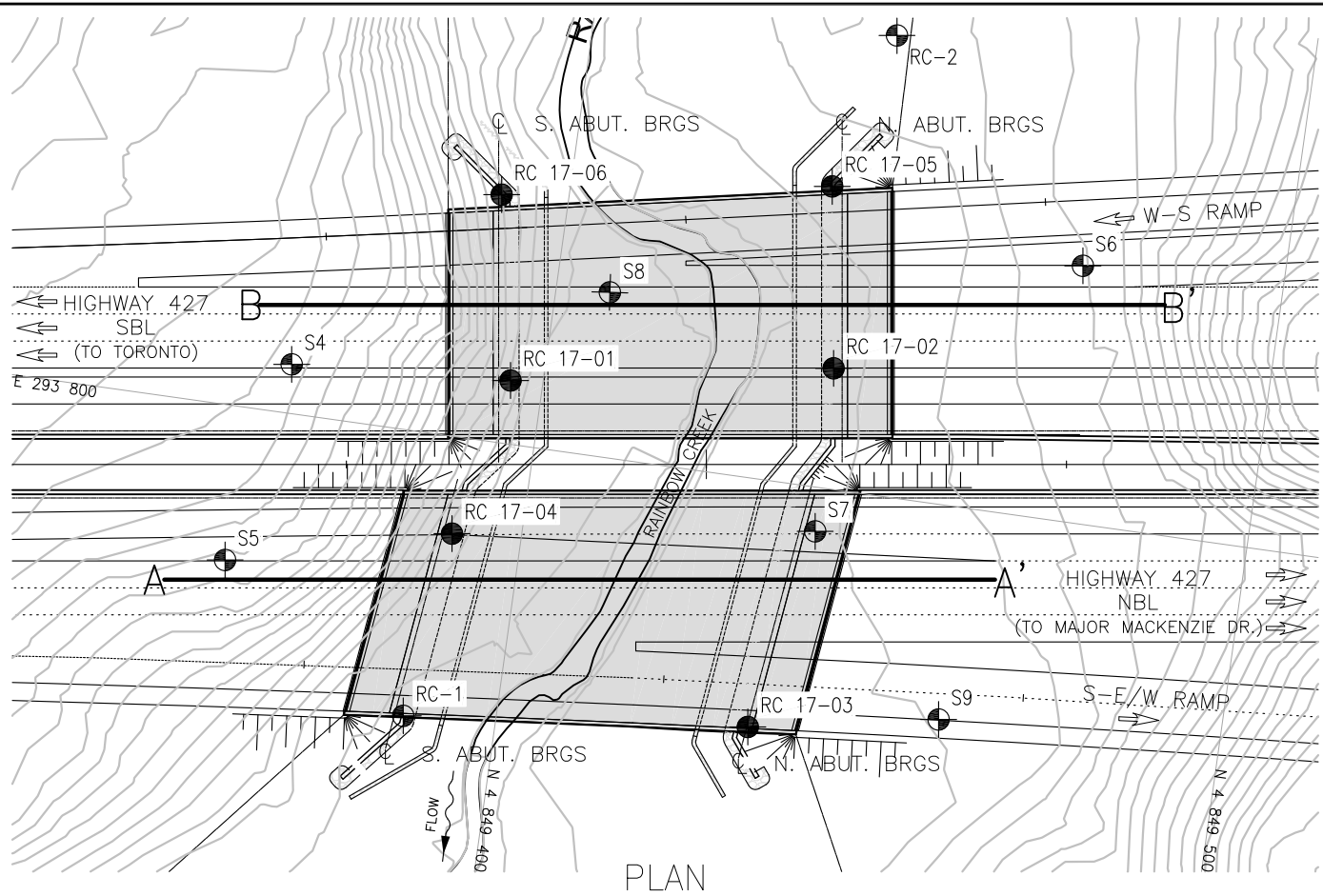
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⊕	Borehole and Cone
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CONE	Blows /0.3m (60' Cone, 475J/blow)
PH	Pressure, Hydraulic
W	Water Level
↓	Head Artesian Water
⊕	Piezometer
90%	Rock Quality Designation (RQD)
A/R	Auger Refusal

NO	ELEVATION	NORTHING	EASTING
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RWZB 17-03	184.1000	4848445.1000	293856.9000
RWZB 17-04/04A	181.9000	4848480.0000	294005.4000
RWZB 17-05	182.4000	4848503.8000	294041.6000
S1	182.2000	4848474.8000	293903.5000
S2	181.4000	4848479.8000	293930.4000
S3	181.1000	4848487.1000	293966.7000
UC 17-07	188.5000	4848440.0000	293657.4000
UC 17-08	188.6000	4848449.6000	293702.2000
UC 17-09	187.6000	4848460.6000	293751.6000
UC 17-11	183.1000	4848488.8000	293926.1000
UC 17-12	182.9000	4848522.4000	294098.8000
UC 17-13	180.9000	4848550.0000	294175.0000
UC 17-14	188.0000	4848405.2000	293685.2000
UC 17-15	187.8000	4848415.4000	293738.8000
UC 17-16	181.8000	4848460.9000	293967.0000
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UC 17-18	181.4000	4848501.1000	294150.7000
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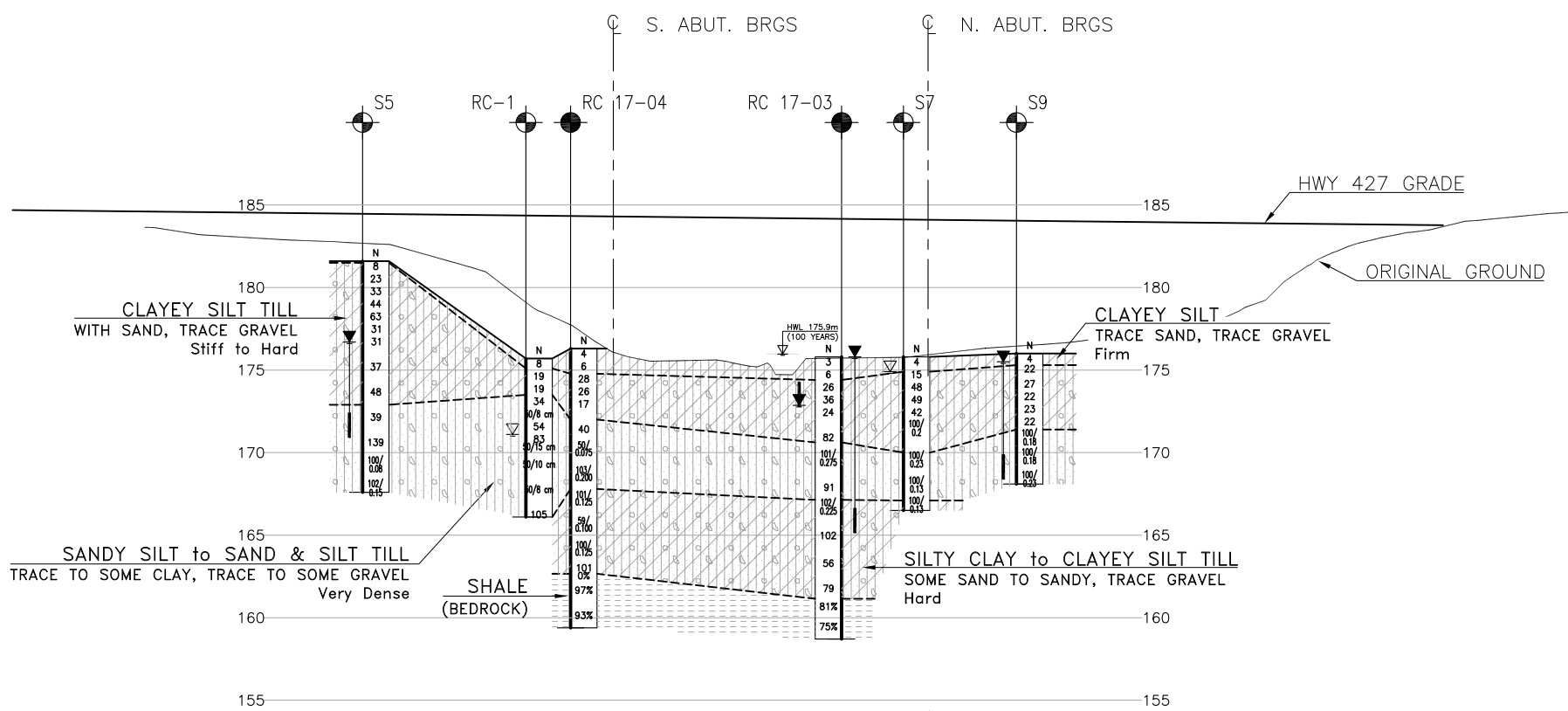
-NOTES-

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GEOCRES No.

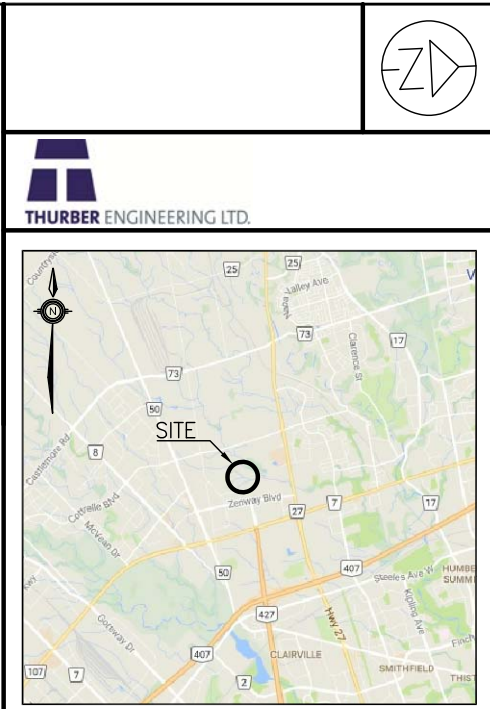


PLAN



PROFILE ALONG A-A'

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



KEYPLAN

LEGEND

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⊕	Borehole (By Others)
N	Blows /0.3m (Std Pen Test, 475J/blow)
CONE	Blows /0.3m (60° Cone, 475J/blow)
PH	Pressure, Hydraulic
▽	Water Level
⌵	Head Artesian Water
⌵	Piezometer
90%	Rock Quality Designation (RQD)
A/R	Auger Refusal

NO	ELEVATION	NORTHING	EASTING
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RC 17-02	175.8	4 849 439.7	293 783.3
RC 17-03	175.8	4 849 434.8	293 834.3
RC 17-04	176.3	4 849 390.4	293 813.4
RC 17-05	176.2	4 849 436.0	293 758.3
RC 17-06	177.5	4 849 390.7	293 765.8
RC-1	175.7	4 849 387.2	293 839.4
S4	182.5	4 849 365.1	293 793.2
S5	181.6	4 849 359.7	293 821.4
S6	177.6	4 849 472.0	293 764.4
S7	175.8	4 849 440.3	293 806.1
S8	175.8	4 849 407.5	293 777.2
S9	176.0	4 849 460.9	293 829.6

-NOTES-

- The boundaries between soil strata have been established only at Borehole locations. Between Boreholes the boundaries are assumed from geological evidence.
- This drawing is for subsurface information only. Surface details and features are for conceptual illustration.

GEOCRES No.

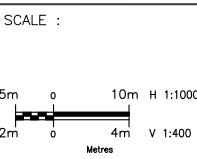
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HWY 427 EXPANSION
HWY 427 NBL RAINBOW CREEK OVERPASS

BOREHOLE LOCATIONS AND SOIL STRATA

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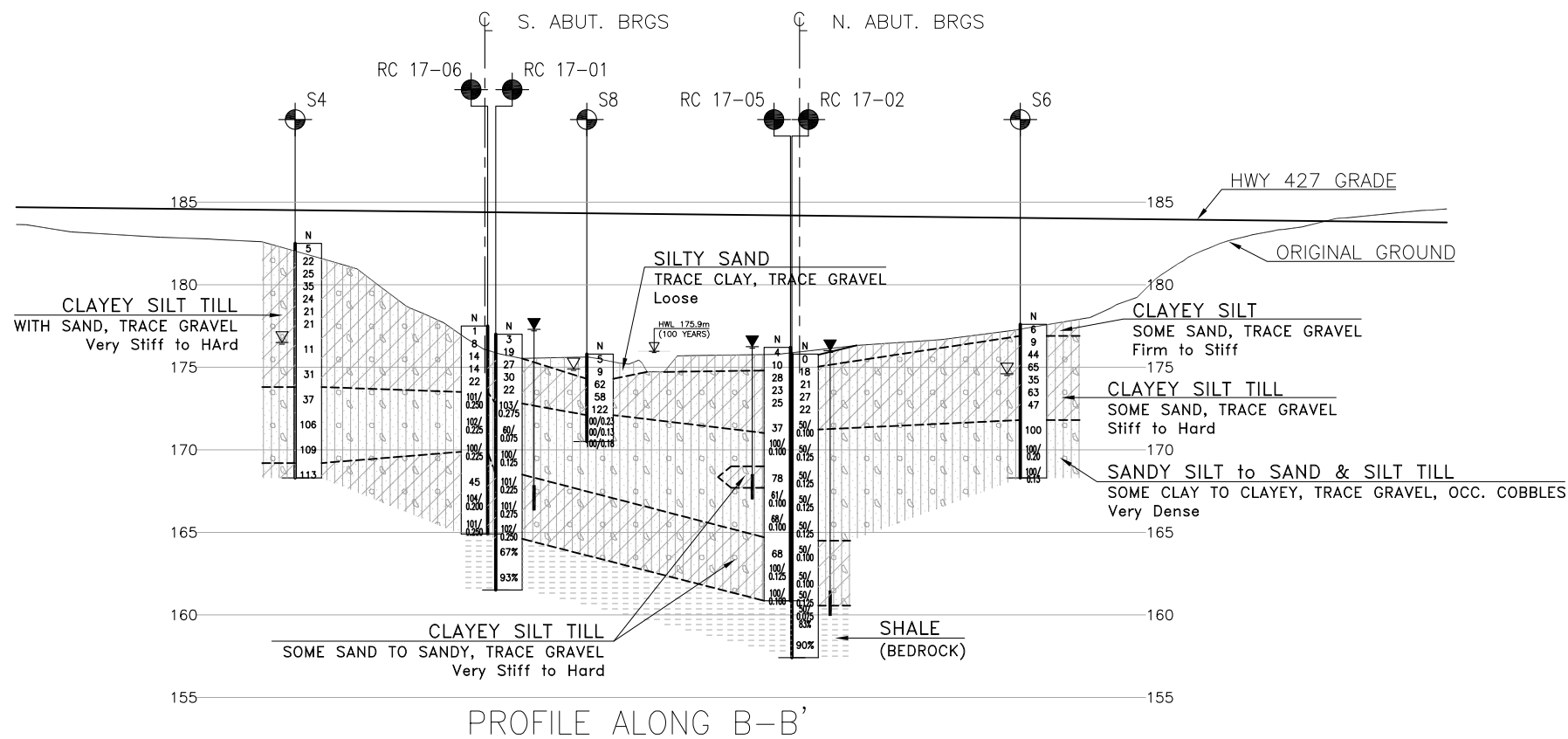
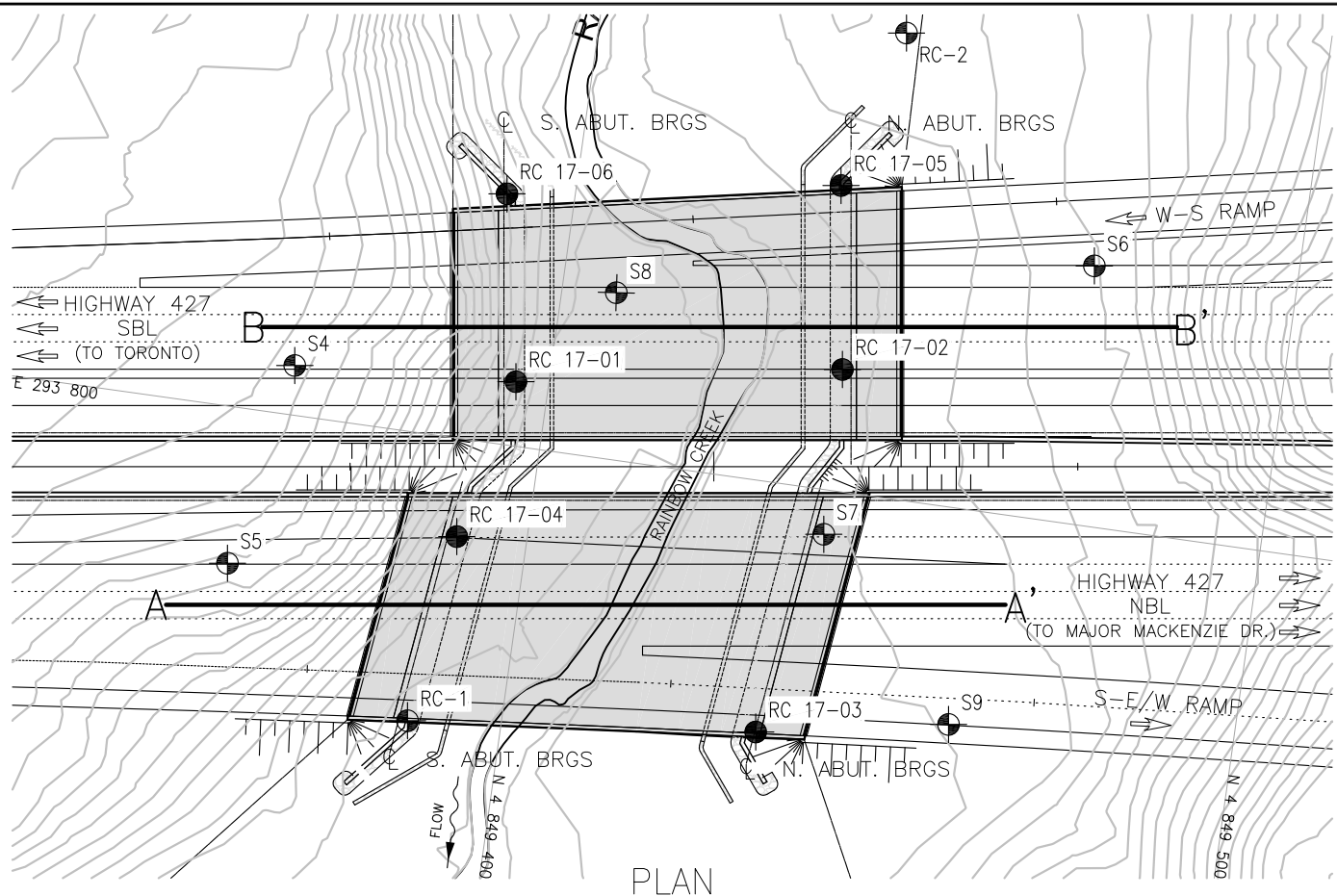
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C	18/06/26	90% SUBMISSION TO CA	AN	KS	JL	JL
B	18/03/16	90% SUBMISSION TO CA	AN	KS	JL	JL
A	18/01/12	90% SUBMISSION TO CA	AN	KS	JL	JL



DESIGNED	A. PIASIK	AP	18/06/26
DRAWN	A. NOOR	AN	18/06/26
CHECKED	K. SHI	KS	18/06/26
APPROVED	J. LEE	JL	18/06/26
PROJ. MGR.	J. LEE	JL	18/06/26
NAME (PRINT)	INIT.	DATE	





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



KEYPLAN		LEGEND	
	Borehole (By Thurber)		Borehole (By Others)
N	Blows /0.3m (Std Pen Test, 475J/blow)	N	Blows /0.3m (Std Pen Test, 475J/blow)
CONE	Blows /0.3m (60° Cone, 475J/blow)	CONE	Blows /0.3m (60° Cone, 475J/blow)
PH	Pressure, Hydraulic	PH	Pressure, Hydraulic
W	Water Level	W	Water Level
↓	Head Artesian Water	↓	Head Artesian Water
90%	Rock Quality Designation (RQD)	90%	Rock Quality Designation (RQD)
A/R	Auger Refusal	A/R	Auger Refusal

NO	ELEVATION	NORTHING	EASTING
RC 17-01	177.0	4 849 395.5	293 791.2
RC 17-02	175.8	4 849 439.7	293 783.3
RC 17-03	175.8	4 849 434.8	293 834.3
RC 17-04	176.3	4 849 390.4	293 813.4
RC 17-05	176.2	4 849 436.0	293 758.3
RC 17-06	177.5	4 849 390.7	293 765.8
RC-1	175.7	4 849 387.2	293 839.4
S4	182.5	4 849 365.1	293 793.2
S5	181.6	4 849 359.7	293 821.4
S6	177.6	4 849 472.0	293 764.4
S7	175.8	4 849 440.3	293 806.1
S8	175.8	4 849 407.5	293 777.2
S9	176.0	4 849 460.9	293 829.6

- NOTES-**
- The boundaries between soil strata have been established only at Borehole locations. Between Boreholes the boundaries are assumed from geological evidence.
 - This drawing is for subsurface information only. Surface details and features are for conceptual illustration.

GEOCRES No.

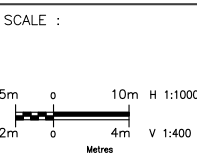
**HWY 427 EXPANSION
HWY 427 SBL RAINBOW CREEK OVERPASS**

BOREHOLE LOCATIONS AND SOIL STRATA

PROJECT ID.	STAGE IDENTIFIER	DESIGN PACKAGE NUMBER	DISCIPLINE	STRUCTURE TYPE	DOCUMENT TYPE	DRAWING NUMBER	REVISION NUMBER
H427-D	N	1A	STR	B11B	DWG	701	C

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NO.	DATE	REVISIONS	BY	CHK	LEAD	PROJ. MGR.
C	18/06/26	90% SUBMISSION TO CA	AN	KS	JL	JL
B	18/03/16	90% SUBMISSION TO CA	AN	KS	JL	JL
A	18/01/12	90% SUBMISSION TO CA	AN	KS	JL	JL



DESIGNED	A. PIASIK	AP	18/06/26
DRAWN	A. NOOR	AN	18/06/26
CHECKED	K. SHI	KS	18/06/26
APPROVED	J. LEE	JL	18/06/26
PROJ. MGR.	J. LEE	JL	18/06/26
NAME (PRINT)		INIT.	DATE



METRIC

DIMENSIONS ARE IN METRES
AND/OR MILLIMETRES
UNLESS OTHERWISE SHOWN



THURBER ENGINEERING LTD.



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
W	Water Level
↕	Head Artesian Water
⊥	Piezometer
90%	Rock Quality Designation (RQD)
A/R	Auger Refusal

NO	ELEVATION	NORTHING	EASTING
FLR 17-01	192.1	4 849 642.9	293 831.1
FLR 17-02	188.8	4 849 967.1	293 713.8
FLR 17-03	188.4	4 850 023.9	293 736.3
FLR 17-04	188.2	4 850 089.8	293 708.5
FLR 17-05	188.0	4 850 139.3	293 741.8
FLR 17-06	188.6	4 850 317.5	293 587.1
HM 17-16	188.4	4 849 845.1	293 741.5
LR-1	187.9	4 849 889.6	293 691.2
LR-2	188.1	4 849 915.7	293 767.2
S13	187.7	4 849 885.0	293 730.1
STM 17-19	187.6	4 850 191.9	293 699.4

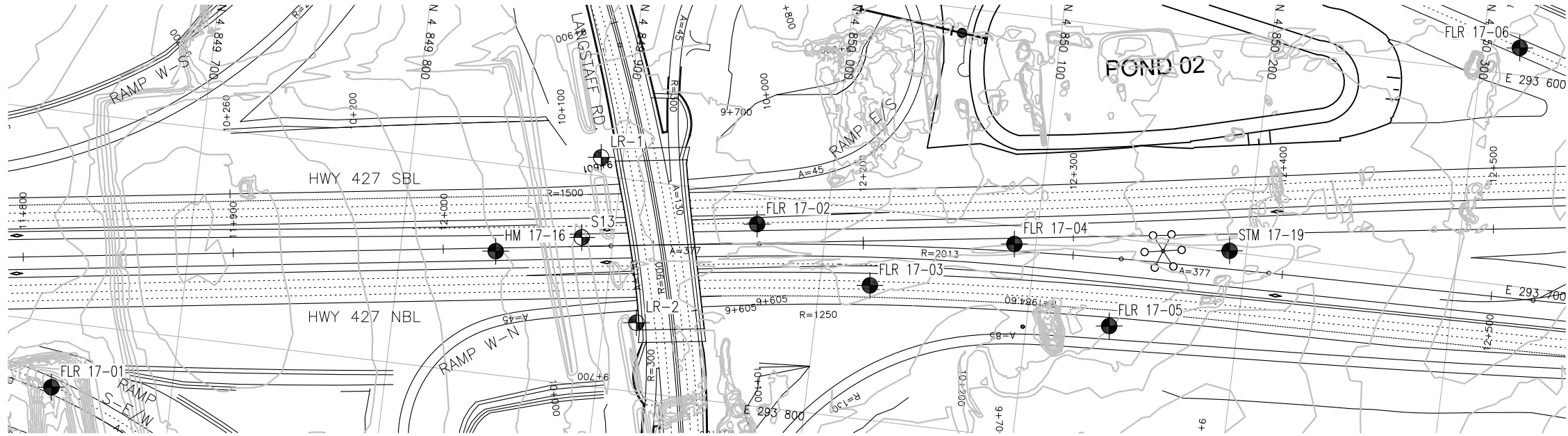
-NOTES-

- The boundaries between soil strata have been established only at Borehole locations. Between Boreholes the boundaries are assumed from geological evidence.
- This drawing is for subsurface information only. Surface details and features are for conceptual illustration.

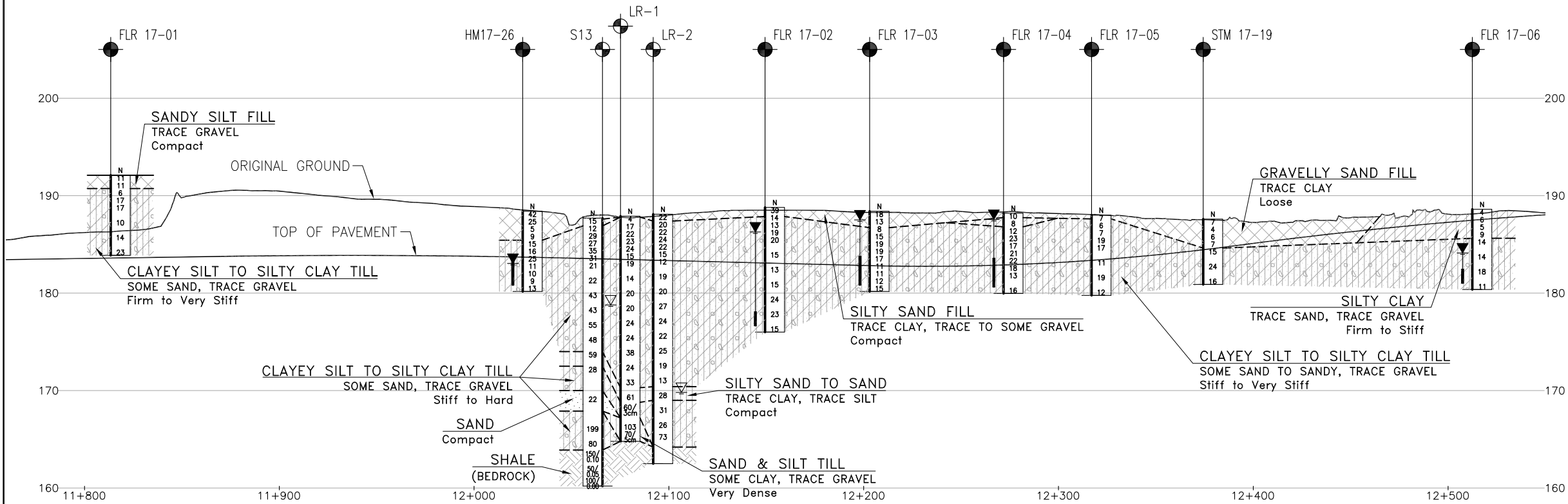
GEOCRES No.

TITLE
HWY 427 EXPANSION
HIGHWAY 427 AT LANGSTASS ROAD UNDERPASS
STA. 11+800 TO STA. 12+500
BOREHOLE LOCATIONS AND SOIL STRATA

PROJECT ID.	STAGE IDENTIFIER	DESIGN PACKAGE NUMBER	DISCIPLINE	STRUCTURE TYPE	DOCUMENT NUMBER	DRAWING NUMBER	REVISION NUMBER
H427-D	F	0	FND		DWG		A

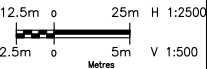


PLAN



PROFILE ALONG C HWY 427

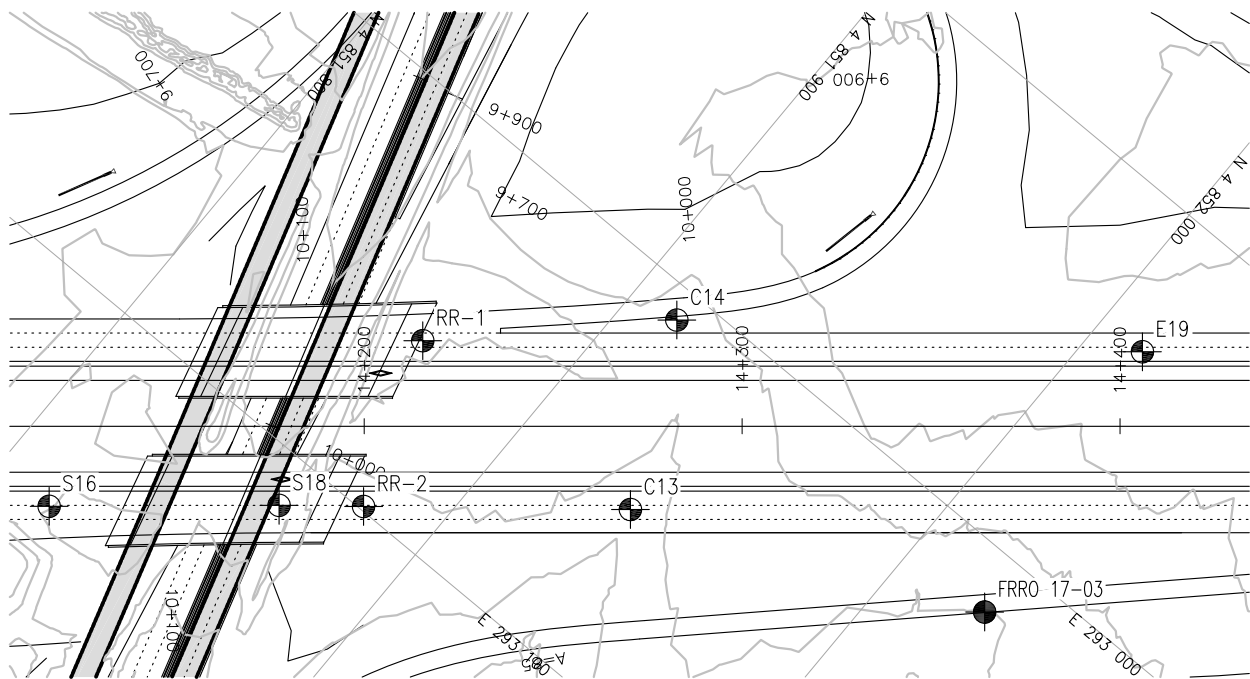
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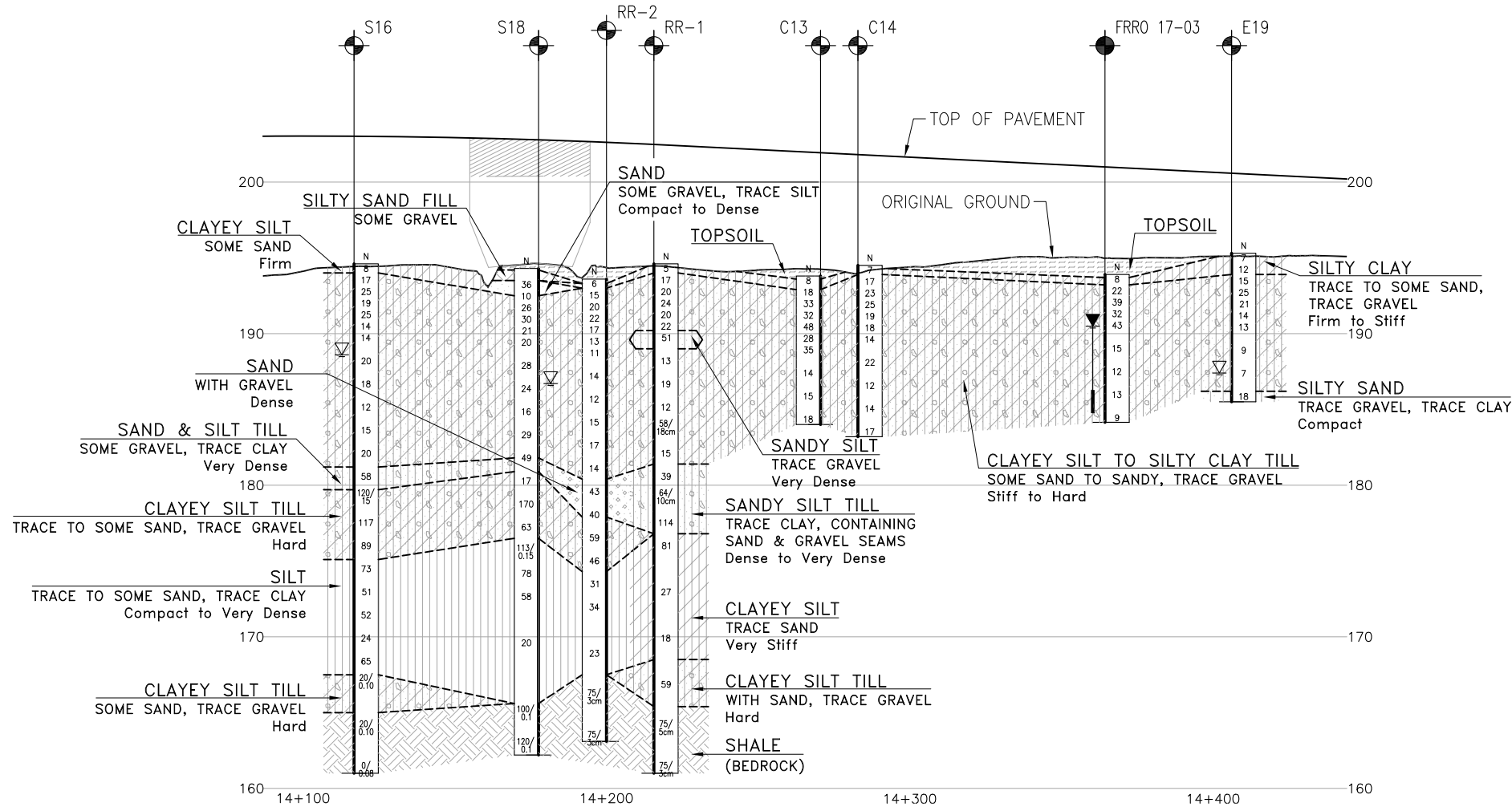
CONSULTANT	DESIGNED			
	DRAWN			
	CHECKED			
	APPROVED LEAD ENGINEER			
	APPROVED PROJ. MANAGER			
	NAME (PRINT)	INIT.	DATE	



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PLOTDATE: 10/27/2017 7:11 PM



PLAN



PROFILE ALONG \varnothing HIGHWAY 427

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



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
	Head Artesian Water
	Piezometer
90%	Rock Quality Designation (RQD)
A/R	Auger Refusal

NO	ELEVATION	NORTHING	EASTING
C10	188.6	4 851 421.5	293 435.4
C13	193.8	4 851 936.1	293 054.4
C14	194.5	4 851 913.5	293 008.0
C9	188.3	4 851 338.9	293 427.6
E14	191.5	4 851 566.2	293 346.5
E15	192.2	4 851 627.8	293 257.3
E16	193.2	4 851 722.2	293 228.0
E18	193.2	4 851 727.6	293 147.0
E19	195.3	4 852 013.6	292 935.7
FRRO 17-01	190.7	4 851 490.7	293 344.3
FRRO 17-02	193.8	4 851 774.5	293 155.9
FRRO 17-03	193.9	4 852 025.5	293 015.3
RR-1	194.6	4 851 865.3	293 055.2
RR-2	193.6	4 851 881.3	293 098.9
S16	194.6	4 851 817.3	293 152.1
S18	194.3	4 851 863.9	293 113.0

-NOTES-

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GEOCRES No.

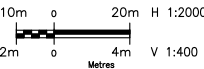
TITLE
HWY 427 EXPANSION
HWY 427 AT RUTHERFORD RD ROAD UNDERPASS
STA. 14+100 TO STA. 14+400
BOREHOLE LOCATIONS AND SOIL STRATA

PROJECT ID.	STAGE IDENTIFIER	DESIGN PACKAGE NUMBER	DISCIPLINE	STRUCTURE NUMBER	DOCUMENT TYPE	DRAWING NUMBER	REVISION NUMBER
H427-D	F	0	FND		DWG		A

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NO.	DATE	REVISIONS	BY	CHK	LEAD ENG.	PROJ. MGR.

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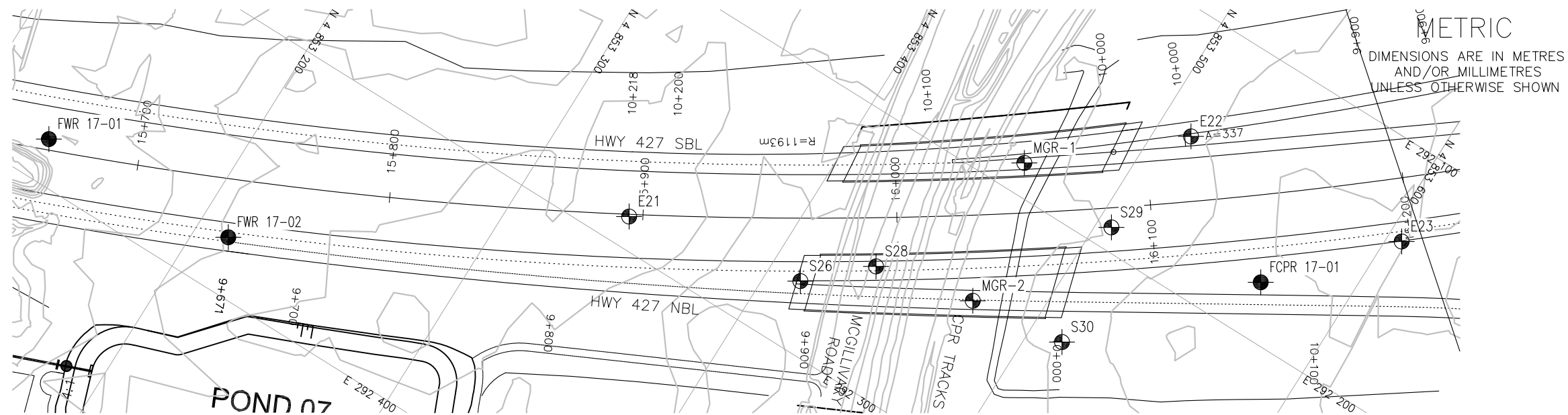


DESIGNED	DRAWN	CHECKED	APPROVED LEAD ENGINEER	APPROVED PROJ. MANAGER

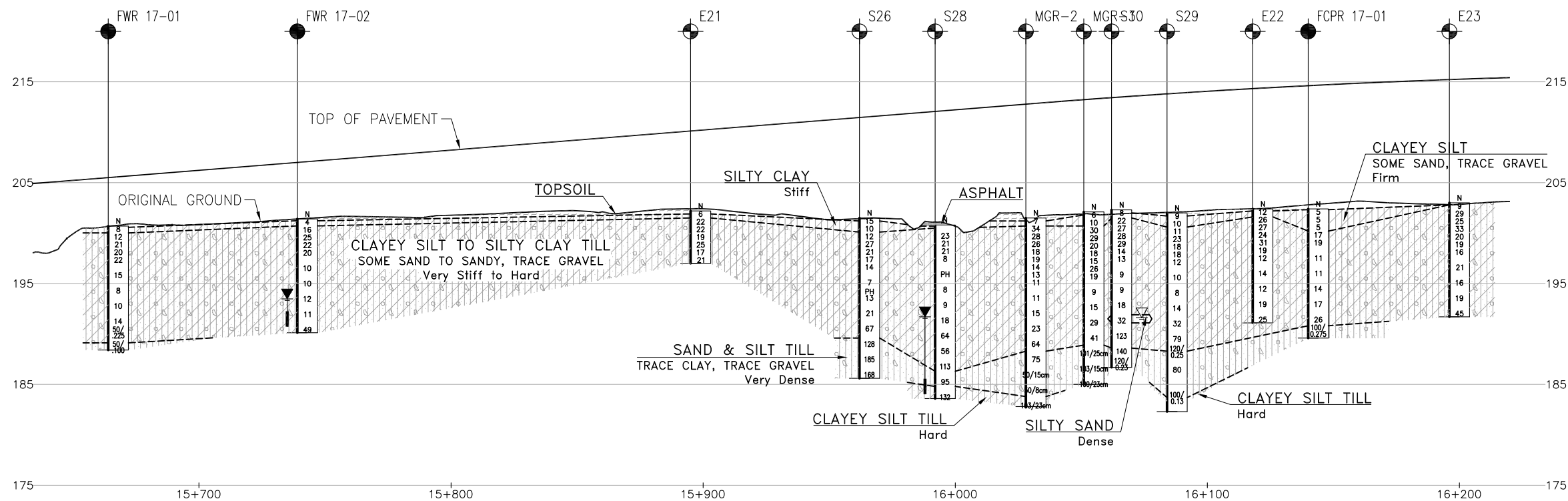


Ontario










PLAN



PROFILE ALONG C HWY 427

KEYPLAN

L E G E N D	
	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
	Head Artesian Water
	Piezometer
90%	Rock Quality Designation (RQD)
A/R	Auger Refusal

NO	ELEVATION	NORTHING	EASTING
E21	202.2	4 853 342.4	292 288.1
E23	203.0	4 853 605.7	292 135.4
E24	203.8	4 853 674.7	292 003.8
E25	203.8	4 853 706.3	292 116.8
E26	204.3	4 853 709.4	291 872.6
E27	203.8	4 853 771.2	291 968.0
FCPR 17-01	202.4	4 853 567.2	292 178.4
FCPR 17-02	203.2	4 853 644.8	292 143.0
FCPR 17-03	203.2	4 853 613.1	292 068.8
FMMO 17-01	205.4	4 853 899.5	291 680.0
FMMO 17-02	205.1	4 853 911.5	291 748.4
FMMO 17-03	205.0	4 853 897.4	291 797.8
FMMO 17-04	203.8	4 853 726.4	292 024.4
FMMO 17-05	203.5	4 853 679.8	292 063.9
FWR 17-01	200.7	4 853 132.4	292 383.2
FWR 17-02	201.4	4 853 212.8	292 378.6
MGR-1	202.1	4 853 463.3	292 187.8
MGR-2	201.5	4 853 474.8	292 244.6
MMD-1	204.9	4 853 836.0	291 910.8
MMD-2	204.5	4 853 805.7	291 861.1
MMD-3	204.9	4 853 879.3	291 858.6

-NOTES-

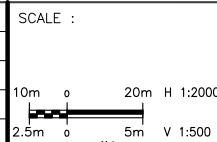
- 1) The boundaries between soil strata have been established only at Borehole locations. Between Boreholes the boundaries are assumed from geological evidence.
- 2) This drawing is for subsurface information only. Surface details and features are for conceptual illustration.

1	GEOCRES No.
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TITLE	HWY 427 EXPANSION HWY 427 AT MCGILLIVARY RD/CPR TRACKS STA. 15+700 TO STA. 16+200 BOREHOLE LOCATIONS AND SOIL STRATA
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PROJECT ID.	STAGE IDENTIFIER	DESIGN PACKAGE NUMBER	DISCIPLINE	STRUCTURE NUMBER	DOCUMENT TYPE	DRAWING NUMBER	REVISION NUMBER
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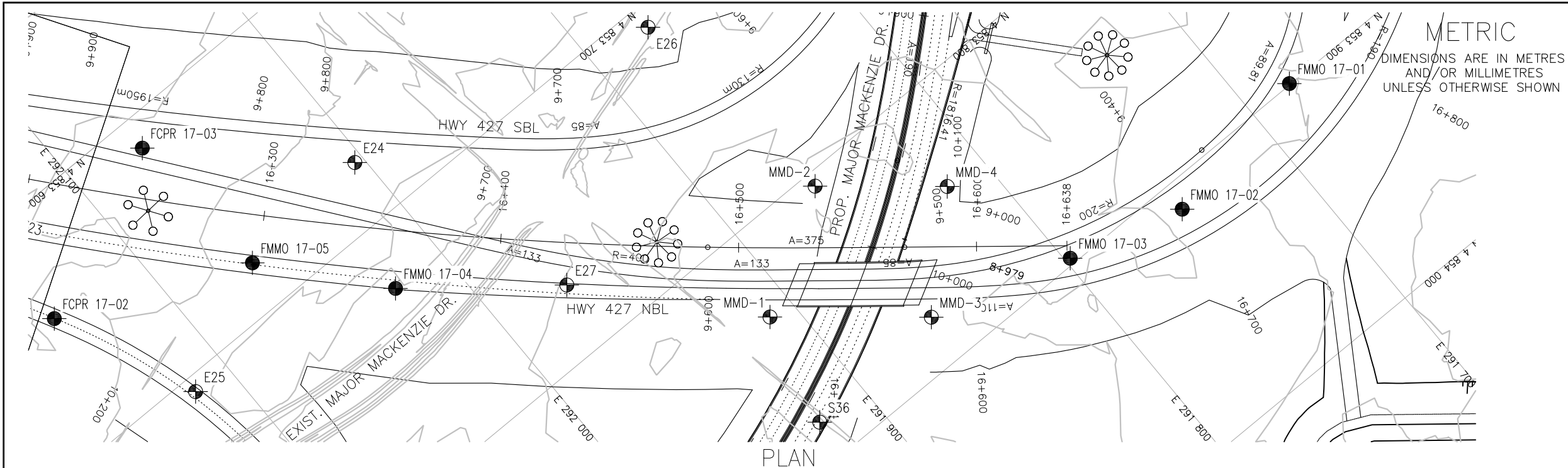
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NO.	DATE	REVISIONS			BY	CHK	LEAD DESC.	PROD. MAN.



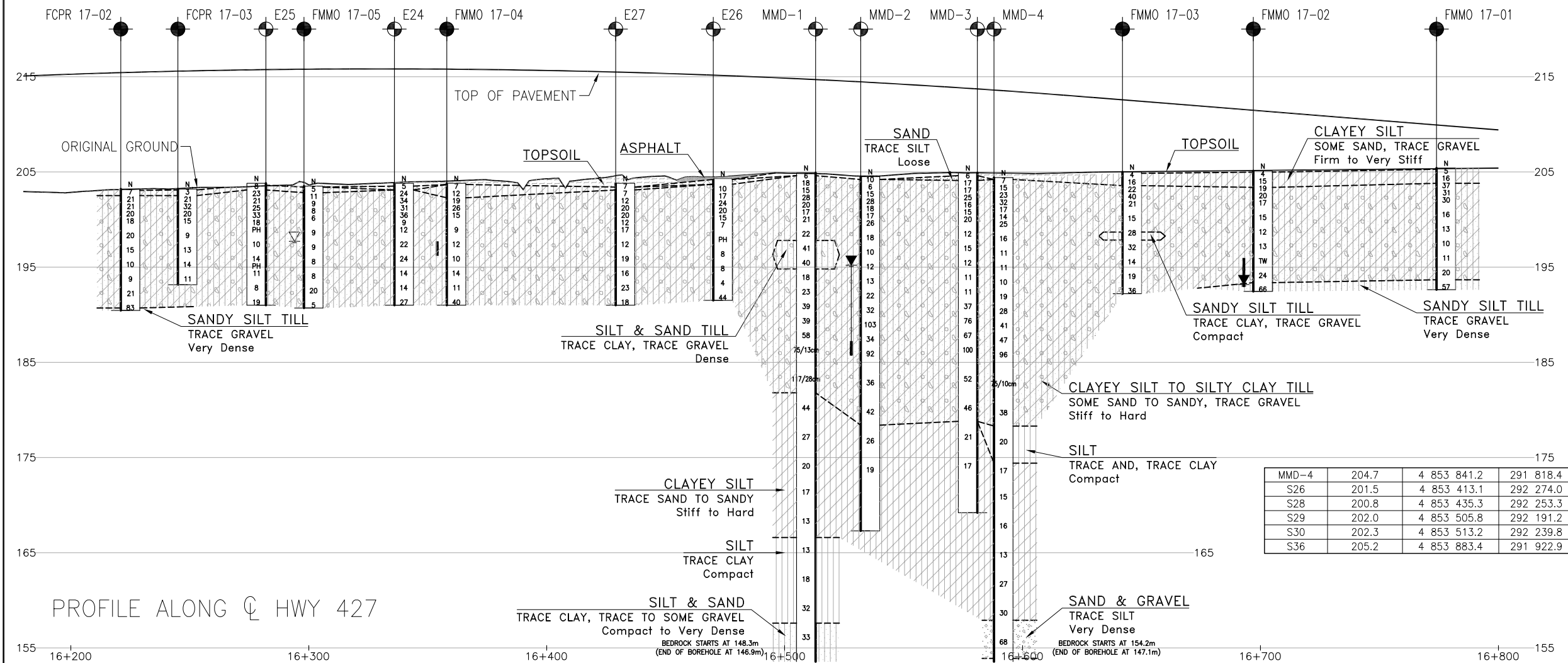
CONSULTANT	DESIGNED			
	DRAWN			
	CHECKED			
	APPROVED LEAD ENGINEER			
	APPROVED PROJ. MANAGER			
		NAME (PRINT)	INIT.	DATE



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PLOT DATE: 10/27/2017 7:19 PM

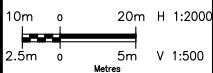


PLAN



PROFILE ALONG Q-HWY 427

SCALE :



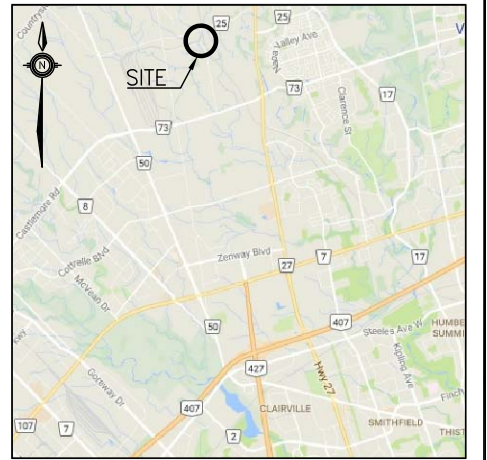
DESIGNED
DRAWN
CHECKED
APPROVED
LEAD ENGINEER
APPROVED
PROJ. MANAGER

NAME (PRINT) INIT. DATE



TITLE
HWY 427 EXPANSION
HWY 427 AT MCGILLIVRAY RD/CPR TRACKS
STA. 15+200 TO STA. 16+800
BOREHOLE LOCATIONS AND SOIL STRATA

PROJECT ID.	STAGE IDENTIFIER	DESIGN PACKAGE NUMBER	DISCIPLINE	STRUCTURE NUMBER	DOCUMENT TYPE	DRAWING NUMBER	REVISION NUMBER
H427-D	F	0	FND		DWG		A



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
W	Water Level
⬇	Head Artesian Water
⊕	Piezometer
90%	Rock Quality Designation (RQD)
A/R	Auger Refusal

NO	ELEVATION	NORTHING	EASTING
E21	202.2	4 853 342.4	292 288.1
E23	203.0	4 853 605.7	292 135.4
E24	203.8	4 853 674.7	292 003.8
E25	203.8	4 853 706.3	292 116.8
E26	204.3	4 853 709.4	291 872.6
E27	203.8	4 853 771.2	291 968.0
FCPR 17-01	202.4	4 853 567.2	292 178.4
FCPR 17-02	203.2	4 853 644.8	292 143.0
FCPR 17-03	203.2	4 853 613.1	292 068.8
FMMO 17-01	205.4	4 853 899.5	291 680.0
FMMO 17-02	205.1	4 853 911.5	291 748.4
FMMO 17-03	205.0	4 853 897.4	291 797.8
FMMO 17-04	203.8	4 853 726.4	292 024.4
FMMO 17-05	203.5	4 853 679.8	292 063.9
FWR 17-01	200.7	4 853 132.4	292 383.2
FWR 17-02	201.4	4 853 212.8	292 378.6
MGR-1	202.1	4 853 463.3	292 187.8
MGR-2	201.5	4 853 474.8	292 244.6
MMD-1	204.9	4 853 836.0	291 910.8
MMD-2	204.5	4 853 805.7	291 861.1
MMD-3	204.9	4 853 879.3	291 858.6

-NOTES-

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

GEOCRES No.

TABLES



**TABLE 1 - Hwy 427 Expansion - High Fill Embankments
Summary of Settlement Analysis**

Location		Approx. Maximum Embankment Height (m)	Estimated Foundation Settlement (mm)	Approximate Post-Construction Fill Compression (*) (mm)
Structure / Embankment (Mainline Station)	Location of Analysis			
Zenway Boulevard Underpass	Sta. 9+950 (Zenway Station) West Approach Embankment	10	40 - 50	25
Rainbow Creek Bridge	Sta. 11+625 North Approach Embankment	8.5	40 - 50	21
Rutherford Road Overpass	Sta. 14+080 South Approach Embankment	9.2	35 - 50	23
West Robinson Creek Bridge	Sta. 15+575 North Approach Embankment South Bound	8.0	30 - 35	20
	Sta. 15+600 North Approach Embankment North Bound	10.6	40 - 45	27
CPR/McGillvary Road Overpass	Sta. 16+080 North Approach Embankment	11.6	50 - 75	29
Embankment between CPR/McGillvary Road and Major Mackenzie Overpasses	Sta. 16+300 Embankment	12.2	60 - 95	31
Major Mackenzie Road Overpass	Sta. 16+520 South Approach Embankment	9.8	55 - 85	25
Major Mackenzie Overpass over West Robinson	Sta. 9+390 West Approach Embankment	6.1	25 - 35	15
Fill Section South of Rainbow Creek	Sta. 11+380	6.2	25 - 35	16

Note: (*) assuming 0.25% of embankment fill thickness occurring after completion of fill construction

APPENDICES

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
 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.

UNIFIED SOILS CLASSIFICATION

MAJOR DIVISIONS		GROUP SYMBOL	TYPICAL DESCRIPTION
COARSE GRAINED SOILS	GRAVEL AND GRAVELLY SOILS	GW	Well-graded gravels or gravel-sand mixtures, little or no fines.
		GP	Poorly-graded gravels or gravel-sand mixtures, little or no fines.
		GM	Silty gravels, gravel-sand-silt mixtures.
		GC	Clayey gravels, gravel-sand-clay mixtures.
	SAND AND SANDY SOILS	SW	Well-graded sands or gravelly sands, little or no fines.
		SP	Poorly-graded sands or gravelly sands, little or no fines.
		SM	Silty sands, sand-silt mixtures.
		SC	Clayey sands, sand-clay mixtures.
FINE GRAINED SOILS	SILTS AND CLAYS $W_L < 50\%$	ML	Inorganic silts and very fine sands, rock flour, silty or clayey fine sands or clayey silts with slight plasticity.
		CL	Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays. ($W_L < 30\%$).
		CI	Inorganic clays of medium plasticity, silty clays. ($30\% < W_L < 50\%$).
		OL	Organic silts and organic silty-clays of low plasticity.
	SILTS AND CLAYS $W_L > 50\%$	MH	Inorganic silts, micaceous or diatomaceous fine sandy or silty soils, elastic silts.
		CH	Inorganic clays of high plasticity, fat clays.
		OH	Organic clays of medium to high plasticity, organic silts.
HIGHLY ORGANIC SOILS		Pt	Peat and other highly organic soils.
CLAY SHALE			
SANDSTONE			
SILTSTONE			
CLAYSTONE			
COAL			

EXPLANATION OF ROCK LOGGING TERMS

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

<u>DISCONTINUITY SPACING</u>		<u>STRENGTH CLASSIFICATION</u>			
Bedding	Bedding Plane Spacing	Rock Strength	Approximate Uniaxial Compressive Strength		Field Estimation of Hardness*
			(MPa)	(psi)	
Very thickly bedded	Greater than 2m	Extremely Strong	Greater than 250	Greater than 36,000	Specimen can only be chipped with a geological hammer
Thickly bedded	0.6 to 2m				
Medium bedded	0.2 to 0.6m	Very Strong	100-250	15,000 to 36,000	Requires many blows of geological hammer to break
Thinly bedded	60mm to 0.2m	Strong	50-100	7,500 to 15,000	Requires more than one blow of geological hammer to break
Very thinly bedded	20 to 60mm				
Laminated	6 to 20mm	Medium Strong	25.0 to 50.0	3,500 to 7,500	Breaks under single blow of geological hammer.
Thinly Laminated	Less than 6mm				

<u>TERMS</u>					
Total Core Recovery: (TCR)	Core recovered as a percentage of total core run length.	Weak	5.0 to 25.0	750 to 3,500	Can be peeled by a pocket knife with difficulty
Solid Core Recovery: (SCR)	Percent Ratio of solid core of full cylindrical shape recovered. Expressed with respect to the total length of core run.	Very Weak	1.0 to 5.0	150 to 750	Can be peeled by a pocket knife, crumbles under firm blows of geological pick.
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.	Extremely Weak (Rock)	0.25 to 1.0	35 to 150	Indented by thumbnail
Uniaxial Compressive Strength (UCS)	Axial stress required to break the specimen				
Fracture Index: (FI)	Frequency of natural fractures per 0.3m of core run.				

Appendix A
Zenway Boulevard Underpass Embankment
(Sta. 9+840 to 10+100)

RECORD OF BOREHOLE No ZB 17-01

1 OF 2

METRIC

W.P. _____ LOCATION Zenway Blvd. Underpass N 4 848 499.2 E 293 978.5 ORIGINATED BY TF
 HWY 427 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN
 DATUM Geodetic DATE 2017.06.16 - 2017.06.16 CHECKED BY ME

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)			
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE				W _P W W _L WATER CONTENT (%)				GR	SA	SI	CL
182.5	GROUND SURFACE																		
0.0	TOPSOIL: (75mm) Clayey SILT , some sand, trace gravel Very Stiff Brown Moist																		
0.1																			
181.9	Clayey SILT to Silty CLAY , sandy, trace gravel, occasional cobbles and boulders Firm to Very Stiff Brown to Grey Moist (TILL) Becoming grey		1	SS	12									○					
0.6																			
			2	SS	11										○				
			3	SS	14										○				
			4	SS	8										○				
			5	SS	9										○				
			6	SS	17									○					
			7	SS	14									○					
			8	SS	24									○					
			9	SS	29									○					
172.7																			
9.8	END OF BOREHOLE AT 9.8m.																		

ONTMT4S MTO-19484.GPJ 2017TEMPLATE(MTO).GDT 10/31/17

Continued Next Page

+³, ×³: Numbers refer to Sensitivity 20 15 10 5 (%) STRAIN AT FAILURE

RECORD OF BOREHOLE No ZB 17-01

2 OF 2

METRIC

W.P. _____ LOCATION Zenway Blvd. Underpass N 4 848 499.2 E 293 978.5 ORIGINATED BY TF
 HWY 427 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN
 DATUM Geodetic DATE 2017.06.16 - 2017.06.16 CHECKED BY ME

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa									
	Continued From Previous Page																
	BOREHOLE DRY UPON COMPLETION. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG AND CUTTINGS TO SURFACE.																

METRIC

[illegible]

+³, ×³: Numbers refer to Sensitivity

RECORD OF BOREHOLE No ZB 17-02

2 OF 3

METRIC

W.P. _____ LOCATION Zenway Blvd. Underpass N 4 848 469.5 E 293 930.8 ORIGINATED BY OA
 HWY 427 BOREHOLE TYPE Hollow Stem Augers/HQ Coring COMPILED BY AN
 DATUM Geodetic DATE 2017.07.10 - 2017.07.14 CHECKED BY ME

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa						
	Continued From Previous Page							20 40 60 80 100 ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE						
								20 40 60 80 100						
								PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT W _P W W _L WATER CONTENT (%)						
171.4														
10.2	SAND and SILT , trace gravel Very Dense Grey Moist (TILL)		10	SS	106/ 0.225		171							
							170							
			11	SS	103/ 0.250		169							
168.2														
13.4	Clayey SILT to Silty CLAY , some sand to sandy, trace gravel, occasional shale fragments Hard Grey Moist (TILL)		12	SS	100/ 0.275		168							8 19 55 18
							167							
			13	SS	50/ 0.125		166							
165.1														
16.5	SHALE , highly weathered to fresh, thinly bedded, weak, grey, with limestone interbeds: (Georgian Bay Formation) Highly fractured zone (125mm) at 16.8m, 17.0m, (50mm) at 17.9m and (25mm) at 18.2m Clay seam (25mm) at 16.9m and 17.0m Thinly bedded, with limestone interbeds < 25mm		1	RUN			165						FI >10 >10 3 7 6 3	RUN #1 TCR=100% SCR=77% RQD=35% UCS=8.3MPa (Shale)
							164							
			2	RUN			163							RUN #2 TCR=100% SCR=97% RQD=53% UCS=9.2MPa (Shale)
161.8							162							
19.8	END OF BOREHOLE AT 19.8m.													

Continued Next Page

+³, ×³: Numbers refer to
Sensitivity

20
15
10

(%) STRAIN AT FAILURE

RECORD OF BOREHOLE No ZB 17-02

3 OF 3

METRIC

W.P. _____ LOCATION Zenway Blvd. Underpass N 4 848 469.5 E 293 930.8 ORIGINATED BY OA
 HWY 427 BOREHOLE TYPE Hollow Stem Augers/HQ Coring COMPILED BY AN
 DATUM Geodetic DATE 2017.07.10 - 2017.07.14 CHECKED BY ME

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa									
							20	40	60	80	100						
	Continued From Previous Page BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG, THEN ASPHALT TO SURFACE.																

RECORD OF BOREHOLE No ZB 17-03

1 OF 3

METRIC

W.P. _____ LOCATION Zenway Blvd. Underpass N 4 848 470.9 E 293 893.2 ORIGINATED BY KK
 HWY 427 BOREHOLE TYPE Hollow Stem Augers/HQ Coring COMPILED BY AN
 DATUM Geodetic DATE 2017.07.12 - 2017.07.13 CHECKED BY ME

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa					
182.8	GROUND SURFACE												
0.0	ASPHALT: (125mm)												
0.1	Gravelly SAND , trace silt Dense Brown Moist (FILL)		1	SS	41								
182.1													
0.7	Silty CLAY , sandy, trace gravel Firm Brown Moist (FILL)		2	SS	8								
			3	SS	7								
180.6													
2.2	Clayey SILT to Silty CLAY , some sand to sandy, trace gravel Firm to Hard Grey Moist (TILL)		4	SS	8								
			5	SS	7								
			6	SS	13								
			7	SS	13								
			8	SS	59								
174.1													
8.7	SAND and SILT , trace clay, trace gravel Very Dense Grey Moist (TILL)		9	SS	62								

Continued Next Page

+³, ×³: Numbers refer to
Sensitivity

20
15 10 5
(%) STRAIN AT FAILURE

RECORD OF BOREHOLE No ZB 17-03

2 OF 3

METRIC

W.P. _____ LOCATION Zenway Blvd. Underpass N 4 848 470.9 E 293 893.2 ORIGINATED BY KK
 HWY 427 BOREHOLE TYPE Hollow Stem Augers/HQ Coring COMPILED BY AN
 DATUM Geodetic DATE 2017.07.12 - 2017.07.13 CHECKED BY ME

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE	WATER CONTENT (%)					
Continued From Previous Page														
			10	SS	100/ 0.075		172							
			11	SS	100/ 0.100		171							
			12	SS	100/ 0.125		170							
			13	SS	100/ 0.125		169							
			14	SS	100/ 0.050		168							
			15	SS	100/ 0.50		167							
164.8			1	RUN			166							
18.0	SHALE highly weathered to fresh, thinly bedded, very weak to weak with medium strong to strong limestone interbeds, grey: (Georgian Bay Formation) Vertical fracture (25mm) at 18.0m Highly fractured zone (150mm) at 18.0m Clay seam (50mm) at 18.1m Limestone interbed (50mm) at 18.2m and 18.3m		2	RUN			165							
							164							
							163							

Continued Next Page

+³, ×³: Numbers refer to Sensitivity
 20
 15
 10
 (%) STRAIN AT FAILURE

ONTMT4S MTO-19484.GPJ 2017TEMPLATE(MTO).GDT 10/31/17

RECORD OF BOREHOLE No ZB 17-03

3 OF 3

METRIC

W.P. _____ LOCATION Zenway Blvd. Underpass N 4 848 470.9 E 293 893.2 ORIGINATED BY KK
 HWY 427 BOREHOLE TYPE Hollow Stem Augers/HQ Coring COMPILED BY AN
 DATUM Geodetic DATE 2017.07.12 - 2017.07.13 CHECKED BY ME

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE					WATER CONTENT (%) W _p W W _L				
	Continued From Previous Page																
161.1	Limestone interbed (25mm) at 18.9m and (50mm) at 19.3m Vertical fracture (25mm) at 18.9m Sub-vertical fracture (75mm) at 19.1m Limestone interbed (100mm) at 20.2m, (25mm to 75mm) at 20.4m, 20.8m, 20.9m, 21.2m and 21.4m Vertical fracture (25mm) at 20.1m and 21.4m		3	RUN		162										2 2 3 0 1 0	RUN #3 TCR=100% SCR=95% RQD=72% UCS=11.7MPa (Shale) UCS=56.3MPa (Limestone)
21.7	END OF BOREHOLE AT 21.7m. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG AND GROUT, THEN ASPHALT TO SURFACE.																

RECORD OF BOREHOLE No ZB 17-04

1 OF 2

METRIC

W.P. _____ LOCATION Zenway Blvd. Underpass N 4 848 477.5 E 293 871.6 ORIGINATED BY KK
 HWY 427 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN
 DATUM Geodetic DATE 2017.07.13 - 2017.07.13 CHECKED BY ME

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				PLASTIC LIMIT w _P	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa								
183.3	GROUND SURFACE															
0.0	ASPHALT: (125mm)															
0.1	Gravelly SAND, trace silt Very Dense Brown		1	SS	51		183									29 51 20 (SI+CL)
182.6	Moist (FILL)															
0.7	Silty CLAY, trace sand, trace gravel Firm Brown Moist (FILL)		2	SS	8		182									
181.6																
1.7	Clayey SILT to Silty CLAY, sandy, trace gravel, occasional cobbles Stiff to Hard Grey Moist (TILL)		3	SS	61		181									
			4	SS	15											
			5	SS	17		180									
							179									
			6	SS	13		178									
							177									
			7	SS	26											
							176									
			8	SS	49		175									
174.6																
8.7	SAND and SILT, trace gravel, trace clay Very Dense Grey Moist (TILL)		9	SS	100/ 0.100		174									
173.9																
9.4	END OF BOREHOLE AT 9.4m. BOREHOLE DRY UPON															

Continued Next Page

+³, ×³: Numbers refer to
Sensitivity

20
15
10
(%) STRAIN AT FAILURE

ONTMT4S MTO-19484 GPJ 2017TEMPLATE(MTO).GDT 10/31/17

RECORD OF BOREHOLE No ZB 17-04

2 OF 2

METRIC

W.P. _____ LOCATION Zenway Blvd. Underpass N 4 848 477.5 E 293 871.6 ORIGINATED BY KK
 HWY 427 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN
 DATUM Geodetic DATE 2017.07.13 - 2017.07.13 CHECKED BY ME

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa									
	Continued From Previous Page																
	COMPLETION. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG AND CUTTINGS, THEN ASPHALT TO SURFACE.																

RECORD OF BOREHOLE No ZB 17-05

1 OF 2

METRIC

W.P. _____ LOCATION Zenway Blvd. Underpass N 4 848 482.4 E 293 883.5 ORIGINATED BY ES
 HWY 427 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN
 DATUM Geodetic DATE 2017.07.04 - 2017.07.04 CHECKED BY ME

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa									
						○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE					WATER CONTENT (%)						
						20	40	60	80	100	20	40	60				
183.0	GROUND SURFACE																
0.0	ORGANICS: (100mm)																
0.1	Clayey SILT , some sand, trace gravel, trace roots Firm to Very Stiff Brown Moist		1	SS	5												
			2	SS	26												
181.5	Clayey SILT to Silty CLAY , sandy, trace gravel, occasional sand seams Stiff to Hard Brown to Grey Moist (TILL)		3	SS	24												
1.5			4	SS	13												
			5	SS	12												
			6	SS	10												
			7	SS	26												
			8	SS	36												
174.2	SAND and SILT , trace to some clay, trace gravel Very Dense Grey Moist (TILL)		9	SS	100/ 0.275												
8.8																	
173.4	END OF BOREHOLE AT 9.8m.																
9.6																	

Continued Next Page

+³, ×³: Numbers refer to Sensitivity
 20
 15
 10
 (%) STRAIN AT FAILURE

RECORD OF BOREHOLE No ZB 17-05

2 OF 2

METRIC

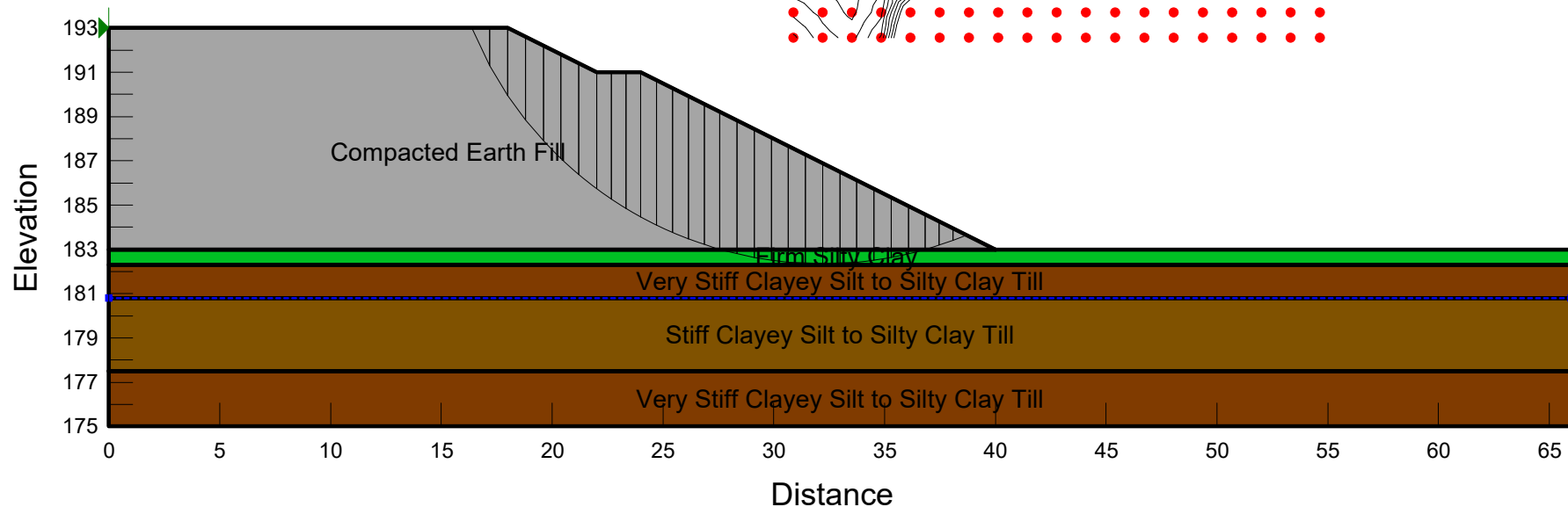
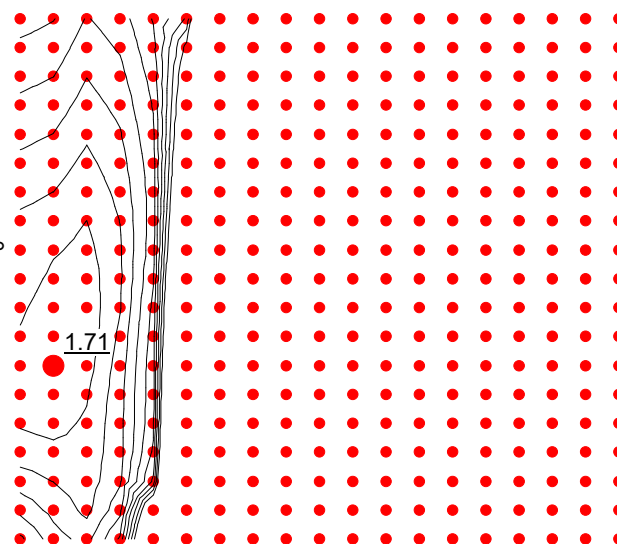
W.P. _____ LOCATION Zenway Blvd. Underpass N 4 848 482.4 E 293 883.5 ORIGINATED BY ES
 HWY 427 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN
 DATUM Geodetic DATE 2017.07.04 - 2017.07.04 CHECKED BY ME

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE					W _p	W	W _L		
	Continued From Previous Page							20	40	60	80	100					
	BOREHOLE DRY UPON COMPLETION. Piezometer installation consists of 25mm diameter Schedule 40 PVC pipe with a 1.52m slotted screen.																
	WATER LEVEL READINGS DATE DEPTH(m) ELEV.(m) 2017.07.07 8.6 174.4 2017.08.09 2.2 180.8																

CRITICAL TRANSVERSE SECTION (STA. 9+950) **SHORT-TERM CONDITION**

Firm Silty Clay	18 kN/m ³	50 kPa	0 °
Compacted Earth Fill	20 kN/m ³	0 kPa	30 °
Very Stiff Clayey Silt to Silty Clay Till	21 kN/m ³	100 kPa	0 °
Stiff Clayey Silt to Silty Clay Till	20 kN/m ³	75 kPa	0 °

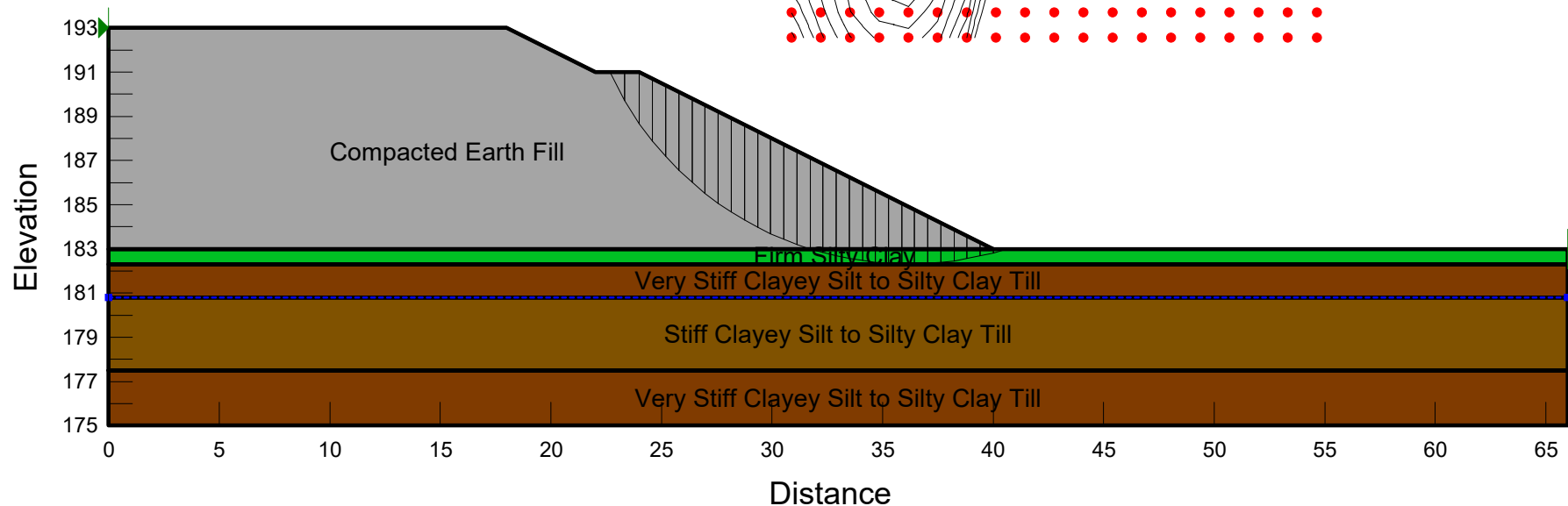
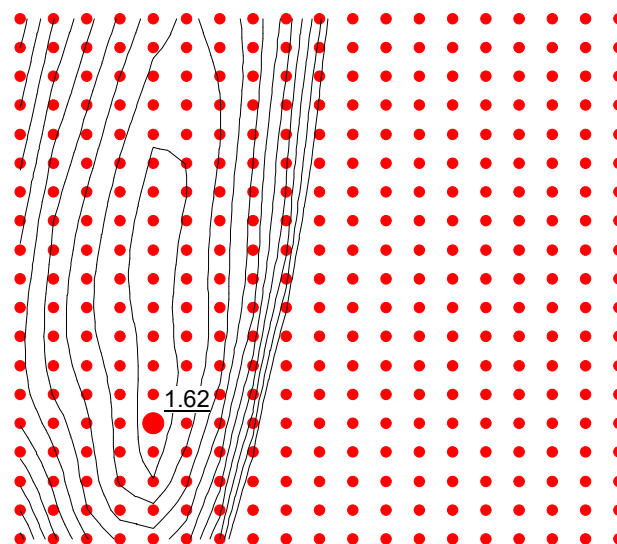
Method: Morgenstern-Price, Half Sine
 Minimum Slip Surface Depth: 1 m
 Seismic: 0



CRITICAL TRANSVERSE SECTION (STA. 9+950) LONG-TERM CONDITION

Firm Silty Clay	18 kN/m ³	5 kPa	29 °
Compacted Earth Fill	20 kN/m ³	0 kPa	30 °
Very Stiff Clayey Silt to Silty Clay Till	21 kN/m ³	5 kPa	32 °
Stiff Clayey Silt to Silty Clay Till	20 kN/m ³	0 kPa	30 °

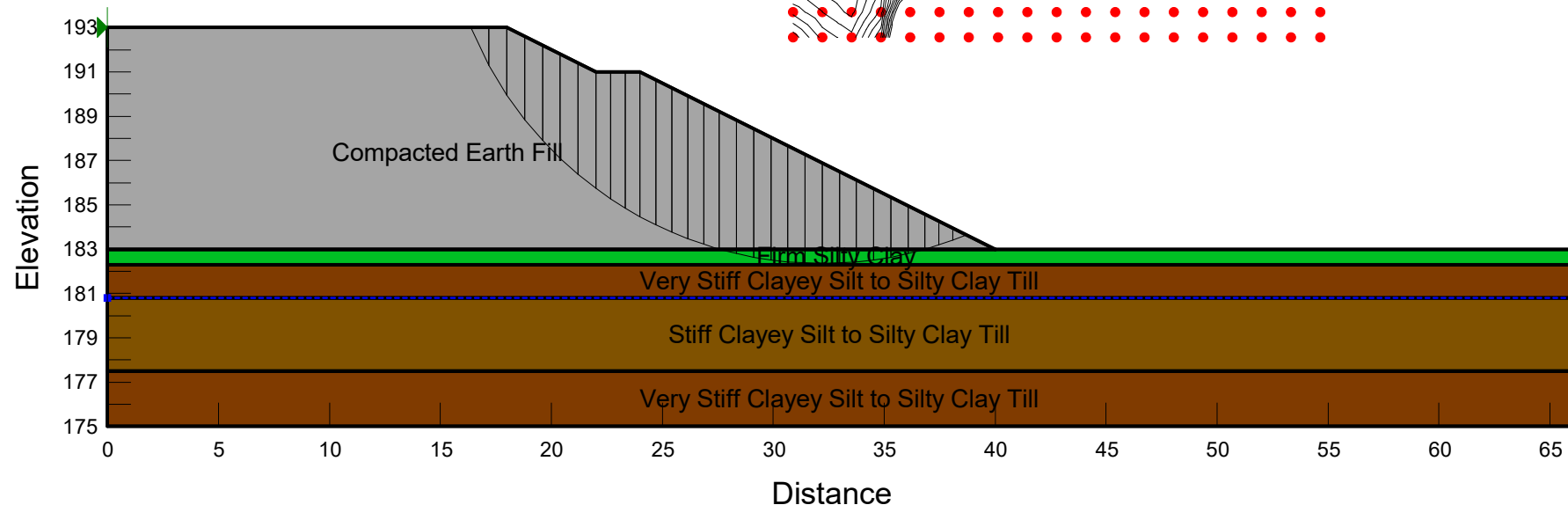
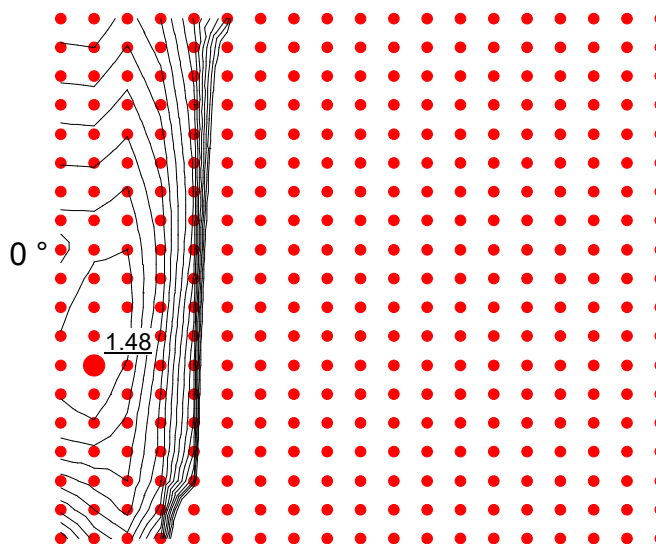
Method: Morgenstern-Price, Half Sine
Minimum Slip Surface Depth: 1 m
Seismic: 0



CRITICAL TRANSVERSE SECTION (STA. 9+950) **SEISMIC CONDITION**

Firm Silty Clay	18 kN/m ³	50 kPa	0 °
Compacted Earth Fill	20 kN/m ³	0 kPa	30 °
Very Stiff Clayey Silt to Silty Clay Till	21 kN/m ³	100 kPa	0 °
Stiff Clayey Silt to Silty Clay Till	20 kN/m ³	75 kPa	0 °

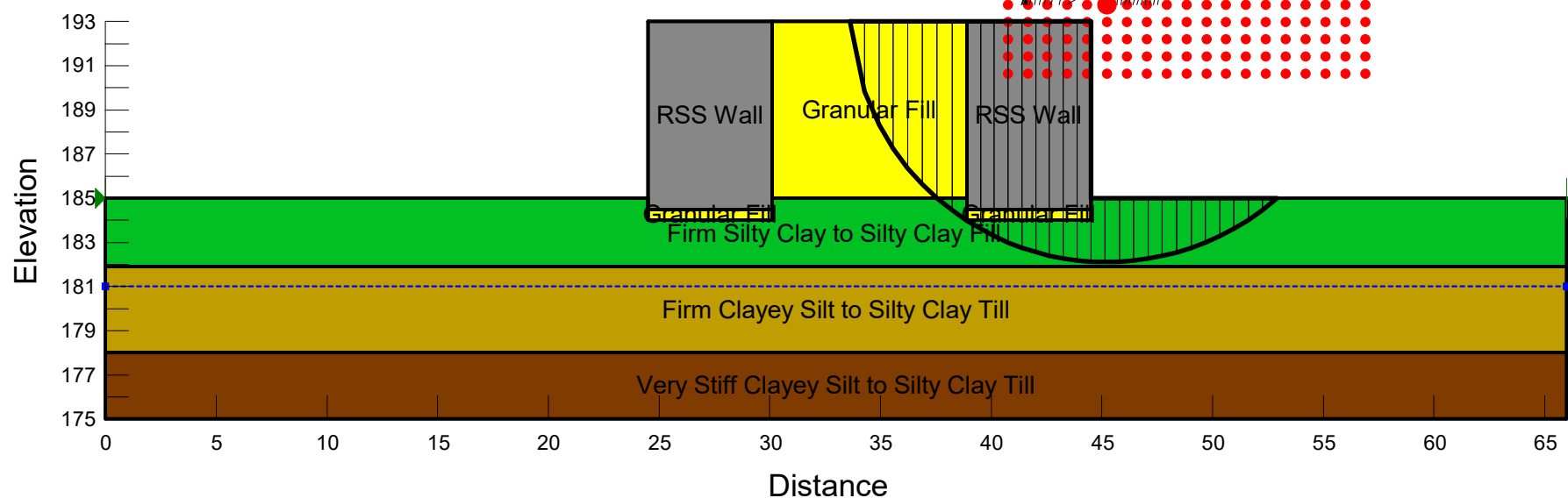
Method: Morgenstern-Price, Half Sine
 Minimum Slip Surface Depth: 1 m
 Seismic: 0.055g



CRITICAL TRANSVERSE SECTION (STA. 9+900) SHORT-TERM CONDITION

Firm Silty Clay to Silty Clay Fill	18 kN/m ³	50 kPa	0 °
RSS Wall	22 kN/m ³	200 kPa	34 °
Granular Fill	21 kN/m ³	0 kPa	35 °
Very Stiff Clayey Silt to Silty Clay Till	21 kN/m ³	100 kPa	0 °
Firm Clayey Silt to Silty Clay Till	20 kN/m ³	65 kPa	0 °

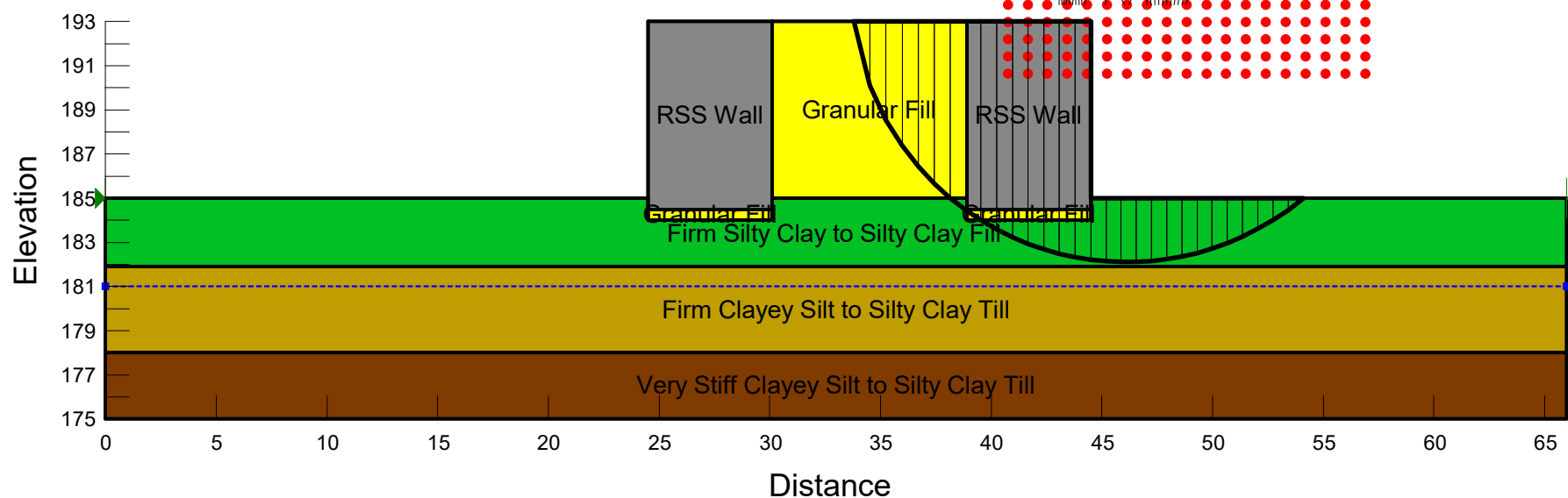
Method: Morgenstern-Price, Half Sine
Minimum Slip Surface Depth: 1 m
Seismic: 0



CRITICAL TRANSVERSE SECTION (STA. 9+900) LONG-TERM CONDITION

Firm Silty Clay to Silty Clay Fill	18 kN/m ³	5 kPa	29 °
RSS Wall	22 kN/m ³	200 kPa	34 °
Granular Fill	21 kN/m ³	0 kPa	35 °
Very Stiff Clayey Silt to Silty Clay Till	21 kN/m ³	5 kPa	32 °
Firm Clayey Silt to Silty Clay Till	20 kN/m ³	0 kPa	30 °

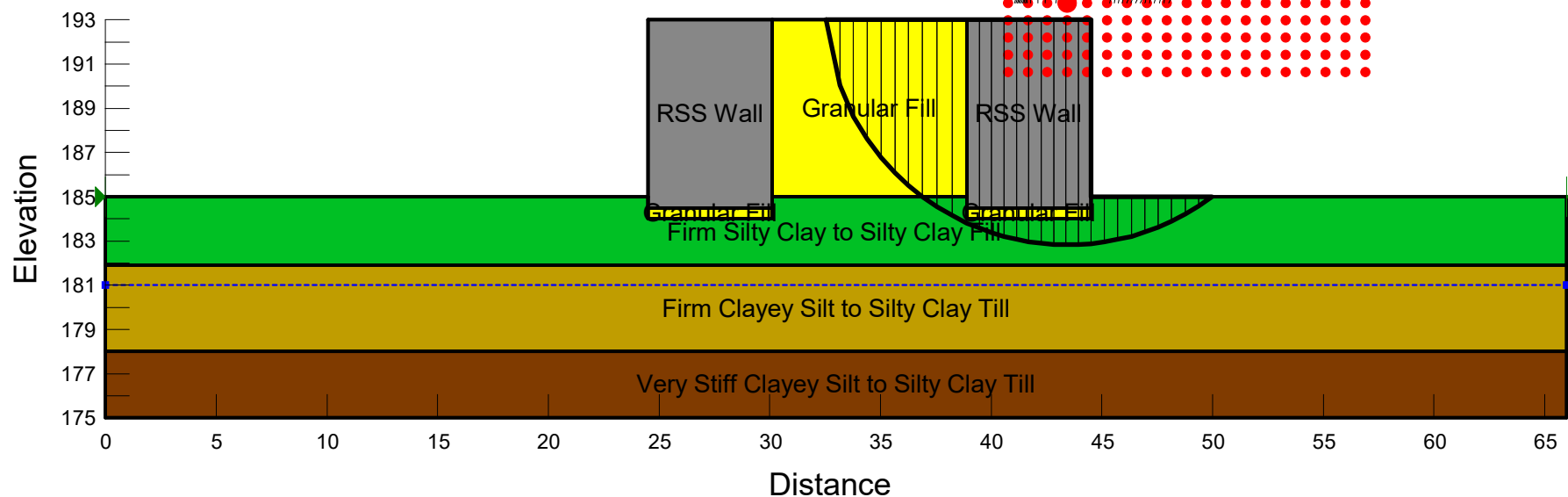
Method: Morgenstern-Price, Half Sine
 Minimum Slip Surface Depth: 1 m
 Seismic: 0



CRITICAL TRANSVERSE SECTION (STA. 9+900) SEISMIC CONDITION

Firm Silty Clay to Silty Clay Fill	18 kN/m ³	50 kPa	0 °
RSS Wall	22 kN/m ³	200 kPa	34 °
Granular Fill	21 kN/m ³	0 kPa	35 °
Very Stiff Clayey Silt to Silty Clay Till	21 kN/m ³	100 kPa	0 °
Firm Clayey Silt to Silty Clay Till	20 kN/m ³	65 kPa	0 °

Method: Morgenstern-Price, Half Sine
Minimum Slip Surface Depth: 1 m
Seismic: 0.055g



Appendix B
Rainbow Creek Bridge Approach Embankments
(Mainline Sta. 11+560 to 11+670)

RECORD OF BOREHOLE No RC 17-01

1 OF 2

METRIC

W.P. _____ LOCATION Rainbow Creek N 4 849 395.5 E 293 791.2 ORIGINATED BY KK
 HWY 427 BOREHOLE TYPE Hollow Stem Augers/Tricone/HQ Coring COMPILED BY AN
 DATUM Geodetic DATE 2017.06.08 - 2017.06.09 CHECKED BY ANP

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa						
177.0	GROUND SURFACE							20 40 60 80 100						
0.0	TOPSOIL: (50mm) Clayey SILT , trace to some sand, trace gravel, trace organics (rootlets) Soft to Very Stiff Brown Moist		1	SS	3									
176.3														
0.7			2	SS	19		176							
	Clayey SILT , trace to some sand, trace gravel Very Stiff Brown to Grey Moist (TILL)													
			3	SS	27		175							
			4	SS	30		174							
			5	SS	22									
172.8							173							
4.2	SILT and SAND , trace gravel, occasional cobbles Veyr Dense Grey Moist (TILL)		6	SS	103/ 0.275		172							
			7	SS	60/ 0.075		171							
			8	SS	100/ 0.125		170							
							169							
168.5														
8.5	SILT , some clay to clayey, trace to some sand, trace gravel, occasional cobbles and boulders Hard Grey Moist (TILL)		9	SS	101/ 0.225		168							5 28 51 16

Continued Next Page

+³, ×³: Numbers refer to
Sensitivity

20
15
10

(%) STRAIN AT FAILURE

METRIC

SOIL PROFILE							SAMPLES			DYNAMIC CONE PENETRATION RESISTANCE PLOT						PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT		REMARKS & GRAIN SIZE DISTRIBUTION (%)			
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE						WATER CONTENT (%) w _P w w _L			γ kN/m ³							
	Continued From Previous Page																							
164.6	SILT, some clay to clayey, trace to some sand, trace gravel, occasional cobbles and boulders Hard Grey Moist (TILL)		10	SS	101/ 0.275		166																	
12.4	SHALE, highly weathered to fresh, thinly bedded, grey, weak: (Georgian Bay Formation) Highly broken zone (50mm) at 12.4m, (150mm) at 12.5m and (50mm) at 12.7m Sub-vertical fracture (50mm) at 13.1m Limestone interbed (50mm) at 13.4m Clay seam (75mm) at 12.8m		11	SS	102/ 0.250		165											FI	RUN #1 TCR=100% SCR=67% RQD=67%					
			1	RUN			164											>10 4 3 3						
			2	RUN			163											0 0 0	RUN #2 TCR=100% SCR=100% RQD=93%					
161.5							162											2 4						
15.5	END OF BOREHOLE AT 15.5m. Piezometer installation consists of 25mm diameter Schedule 40 PVC pipe with a 1.52m slotted screen. WATER LEVEL READINGS DATE DEPTH(m) ELEV.(m) 2017.06.19 -0.8 177.8 "." Above ground surface																							

+³, ×³: Numbers refer to Sensitivity

METRIC

[illegible]

+³, ×³: Numbers refer to Sensitivity

ONTMT4S MTO-19340.GPJ 2017TEMPLATE(MTO).GDT 17/6/26

RECORD OF BOREHOLE No RC 17-02

2 OF 2

METRIC

W.P. _____ LOCATION Rainbow Creek N 4 849 439.7 E 293 783.3 ORIGINATED BY TM
 HWY 427 BOREHOLE TYPE Hollow Stem Augers/Tricone/HQ Coring COMPILED BY AN
 DATUM Geodetic DATE 2017.05.30 - 2017.05.31 CHECKED BY ANP

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				PLASTIC NATURAL LIQUID LIMIT MOISTURE CONTENT			UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE				WATER CONTENT (%) w _P w w _L				
	Continued From Previous Page							20 40 60 80 100								
164.5			10	SS	50/ 0.125		165								0 20 69 11	
11.3	SILT , some clay to clayey, trace to some sand, trace gravel, occasional cobbles Hard Grey Moist (TILL)		11	SS	50/ 0.100		164									
			12	SS	50/ 0.100		162									
160.6			13	SS	50/ 0.125		160									
15.2	SHALE highly weathered to fresh, thinly bedded, weak, with strong to very strong limestone interbeds, grey: (Georgian Bay Formation)		14	SS	50/ 0.075		159									
			1	RUN			158									
			2	RUN												
157.4	Vertical fracture (50mm) at 17.8m and (75mm) at 17.9															
18.4	END OF BOREHOLE AT 18.4m. Piezometer installation consists of 25mm diameter Schedule 40 PVC pipe with a 1.52m slotted screen. WATER LEVEL READINGS DATE DEPTH(m) ELEV.(m) 2017.06.19 -0.6 176.4 "-" Above ground surface															

+³, ×³: Numbers refer to Sensitivity 20 15 10 5 0 (%) STRAIN AT FAILURE

RECORD OF BOREHOLE No RC 17-03

1 OF 2

METRIC

W.P. _____ LOCATION Rainbow Creek N 4 849 434.8 E 293 834.3 ORIGINATED BY KK
 HWY 427 BOREHOLE TYPE Hollow Stem Augers/Tricone/HQ Coring COMPILED BY AN
 DATUM Geodetic DATE 2017.06.02 - 2017.06.05 CHECKED BY ANP

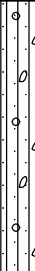
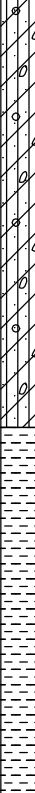
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa						
175.8	GROUND SURFACE							20 40 60 80 100						
0.0	TOPSOIL: (100mm)							○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE						
0.1	Clayey SILT , trace sand, trace gravel, rootlets Firm Brown Moist		1	SS	3		175	20 40 60 80 100						
			2	SS	6			20 40 60 80 100						
174.4								20 40 60 80 100						
1.4	Clayey SILT , trace to some sand, trace gravel Very Stiff Brown Moist (TILL)		3	SS	26		174	20 40 60 80 100						
			4	SS	36		173	20 40 60 80 100						
			5	SS	24		172	20 40 60 80 100						
171.6								20 40 60 80 100						
4.2	SAND and SILT , trace to some gravel, trace to some clay, occasional cobbles Very Dense Grey Moist to Wet (TILL)		6	SS	82		171	20 40 60 80 100						
			7	SS	101/ 0.275		170	20 40 60 80 100						9 41 34 16
			8	SS	91		168	20 40 60 80 100						
			9	SS	102/ 0.225		167	20 40 60 80 100						
							166	20 40 60 80 100						

Continued Next Page

+³, ×³: Numbers refer to
Sensitivity

20
15
10
(%) STRAIN AT FAILURE

METRIC

SOIL PROFILE			SAMPLES		
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES
Continued From Previous Page					
164.0 11.8	SAND and SILT, trace to some gravel, trace to some clay, occasional cobbles Very Dense Grey Moist to Wet (TILL)		10	SS	102
	SILT, some clay to clayey, trace to some sand Hard Grey Moist (TILL)		11	SS	56
161.1 14.7	SHALE highly to moderately weathered, thinly bedded, weak to medium strong to strong limestone interbeds, grey: (Georgian Bay Formation) Limestone interbed (50mm) at 15.0m Limestone interbed (175mm) at 16.0m and (100mm) at 16.9m Vertical fracture (50mm) at 16.3m and (200mm) at 16.5m		1	RUN	
			2	RUN	
158.7 17.1	END OF BOREHOLE AT 17.1m. Piezometer installation consists two 25mm and 50mm diameter Schedule 40 PVC pipe with a 1.52m slotted screen.				

+³, ×³: Numbers refer to Sensitivity

RECORD OF BOREHOLE No RC 17-04

1 OF 2

METRIC

W.P. _____ LOCATION Rainbow Creek N 4 849 390.4 E 293 813.4 ORIGINATED BY KK
 HWY 427 BOREHOLE TYPE Hollow Stem Augers/Tricone/HQ Coring COMPILED BY AN
 DATUM Geodetic DATE 2017.06.08 - 2017.06.08 CHECKED BY ANP

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa						
176.3	GROUND SURFACE							<div>20406080100</div> <div>○ UNCONFINED + FIELD VANE</div> <div>● QUICK TRIAXIAL × LAB VANE</div> <div>20406080100</div>						
0.0	Clayey SILT , some sand, trace gravel, trace organics (rootlets) Firm Brown Moist		1	SS	4		176							
			2	SS	6		175							
174.8														
1.5	Clayey SILT , with sand, trace gravel Very Stiff Brown to Grey Moist (TILL)		3	SS	28		174							
			4	SS	26		173							
			5	SS	17		172							
172.0														
4.3	SILT and SAND , trace clay, trace to some gravel, occasional cobbles Dense to Very Dense Grey Moist (TILL)		6	SS	40		171							
			7	SS	50/ 0.075		170							
			8	SS	103/ 0.200		169							
167.8							168							
8.5	SILT , some clay to clayey, trace to some sand, trace gravel, occasional cobbles Hard Grey Moist (TILL)		9	SS	101/ 0.125		167							

Continued Next Page

+³, ×³: Numbers refer to Sensitivity
 20
 15
 10
 (%) STRAIN AT FAILURE

METRIC

[illegible]

+³, ×³: Numbers refer to Sensitivity

RECORD OF BOREHOLE No RC 17-05

1 OF 2

METRIC

W.P. _____ LOCATION Rainbow Creek N 4 849 436.0 E 293 758.3 ORIGINATED BY TM
 HWY 427 BOREHOLE TYPE Hollow Stem Augers/Tricone COMPILED BY AN
 DATUM Geodetic DATE 2017.06.01 - 2017.06.01 CHECKED BY ANP

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																				
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																									
176.2	GROUND SURFACE							20 40 60 80 100																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																									
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175.8	Clayey SILT , trace sand, trace gravel, trace cobbles Stiff to Very Stiff Brown Moist		1	SS	4		176																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																										
0.4			2	SS	10		175																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																										
174.8	Clayey SILT , trace to some sand, trace gravel, occasional cobbles Very Stiff Brown Moist (TILL)		3	SS	28		174																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																										
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172.2	SAND and SILT , trace to some clay, trace gravel Dense to Very Dense Grey Wet (TILL)		7	SS	100/ 0.100		170																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																										
4.0			8	SS	78		169																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																										
			9	SS	61/ 0.100		168																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																										
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RECORD OF BOREHOLE No RC 17-05

2 OF 2

METRIC

W.P. _____ LOCATION Rainbow Creek N 4 849 436.0 E 293 758.3 ORIGINATED BY TM
 HWY 427 BOREHOLE TYPE Hollow Stem Augers/Tricone COMPILED BY AN
 DATUM Geodetic DATE 2017.06.01 - 2017.06.01 CHECKED BY ANP

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE								
	Continued From Previous Page							20	40	60	80	100				
164.7			10	SS	68/ 0.100		166									
11.5	SILT , some clay to clayey, some sand, trace gravel, occasional cobbles Hard Grey Moist (TILL)		11	SS	68		165									
			12	SS	100/ 0.125		164									
							163									
							162									
160.9			13	SS	100/ 0.100		161									
15.3	END OF BOREHOLE AT 15.3m. Piezometer installation consists of two 25mm and 50mm diameter Schedule 40 PVC pipe with a 1.52m slotted screen. WATER LEVEL READINGS DATE DEPTH(m) ELEV.(m) 2017.06.19 0.0 176.2 WATER LEVEL READINGS DATE DEPTH (m) ELEV. (m) 2017.06.19 0.7 175.5 "- Above ground surface															

ONTMT4S MTO-19340.GPJ 2017TEMPLATE(MTO).GDT 17/6/26

RECORD OF BOREHOLE No RC 17-06

1 OF 2

METRIC

W.P. _____ LOCATION Rainbow Creek N 4 849 390.7 E 293 765.8 ORIGINATED BY KK
 HWY 427 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN
 DATUM Geodetic DATE 2017.06.09 - 2017.06.09 CHECKED BY ANP

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa					
177.5	GROUND SURFACE												
0.0	TOPSOIL: (100mm)												
0.1	Clayey SILT , trace to some sand, trace gravel, trace rootlets Very Soft Brown Moist		1	SS	1								
176.8													
0.7	Silty CLAY , trace to some sand, trace gravel Stiff Brown Moist (TILL)		2	SS	8								
			3	SS	14								
			4	SS	14								
			5	SS	22								
173.5													
4.0	SAND and SILT , trace to some clay, trace gravel, occasional cobbles Very Dense Grey Moist (TILL)		6	SS	101/ 0.250								
			7	SS	102/ 0.225								
			8	SS	100/ 0.225								
169.2													
8.3	SILT , some clay to clayey, trace to some sand, trace gravel, occasional cobbles and boulders Hard Grey Moist to Wet (TILL)		9	SS	45								

Continued Next Page

+³, ×³: Numbers refer to
Sensitivity

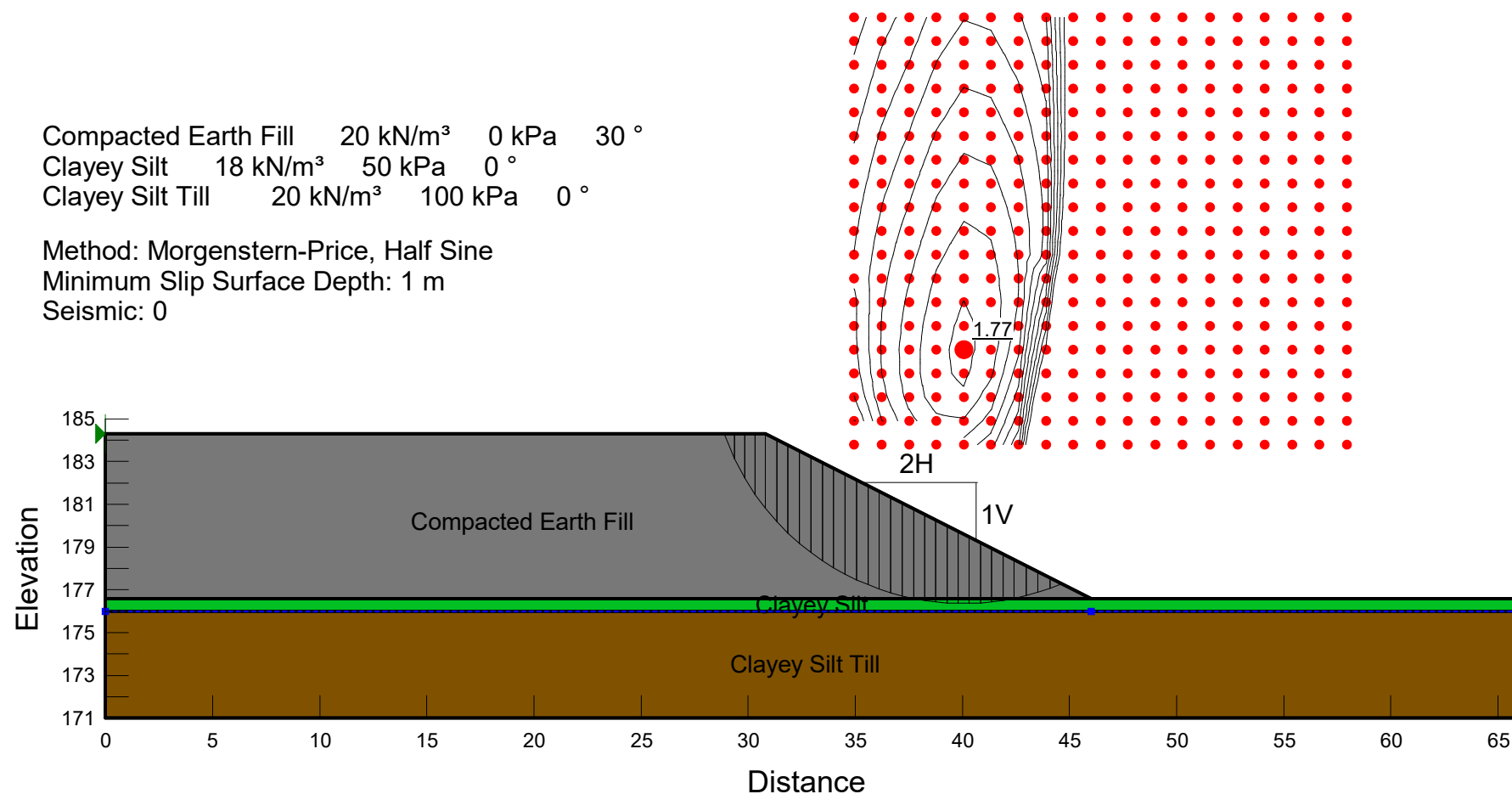
20
15
10
(%) STRAIN AT FAILURE

METRIC

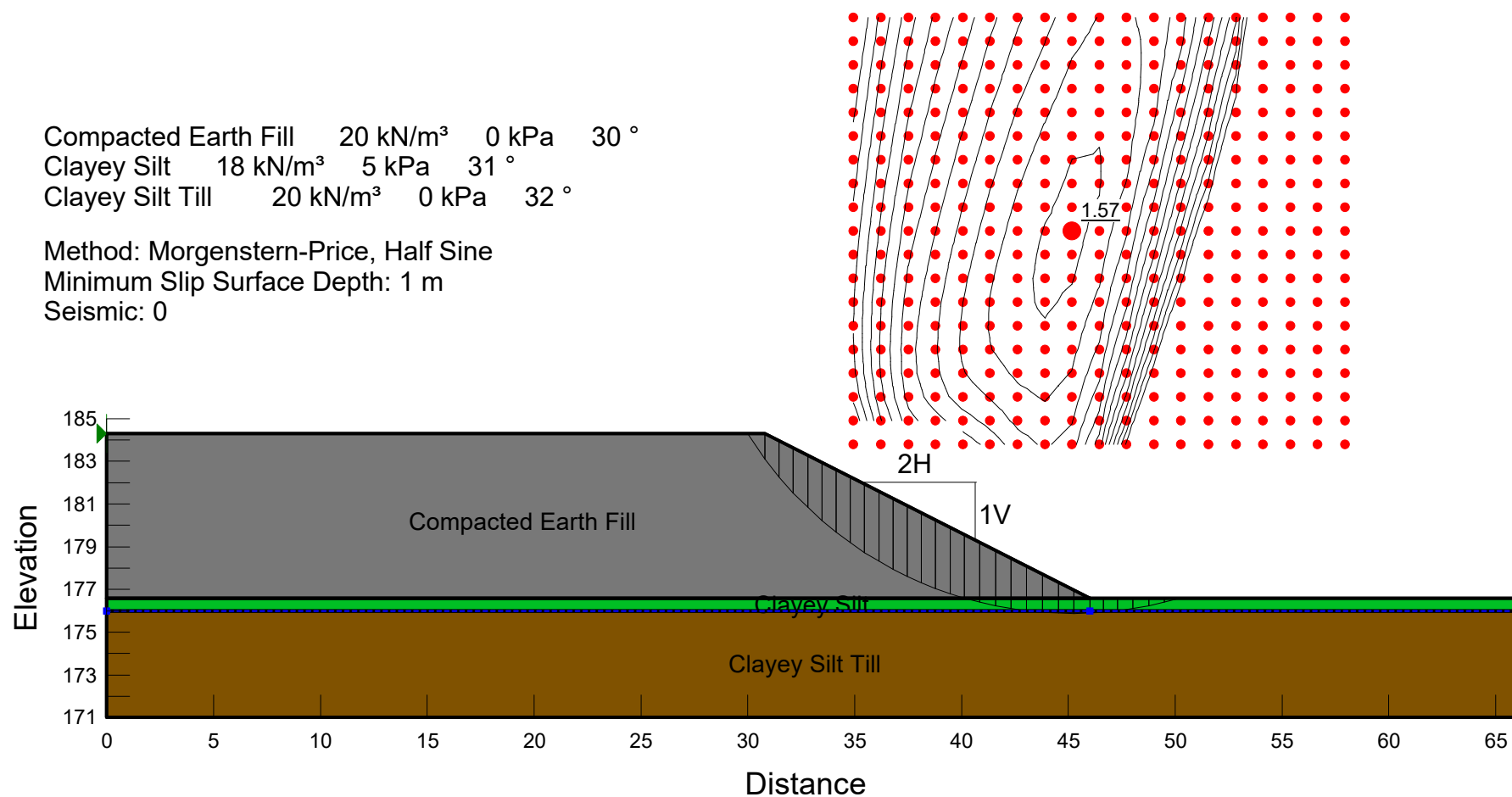
[illegible]

FIGURE B1

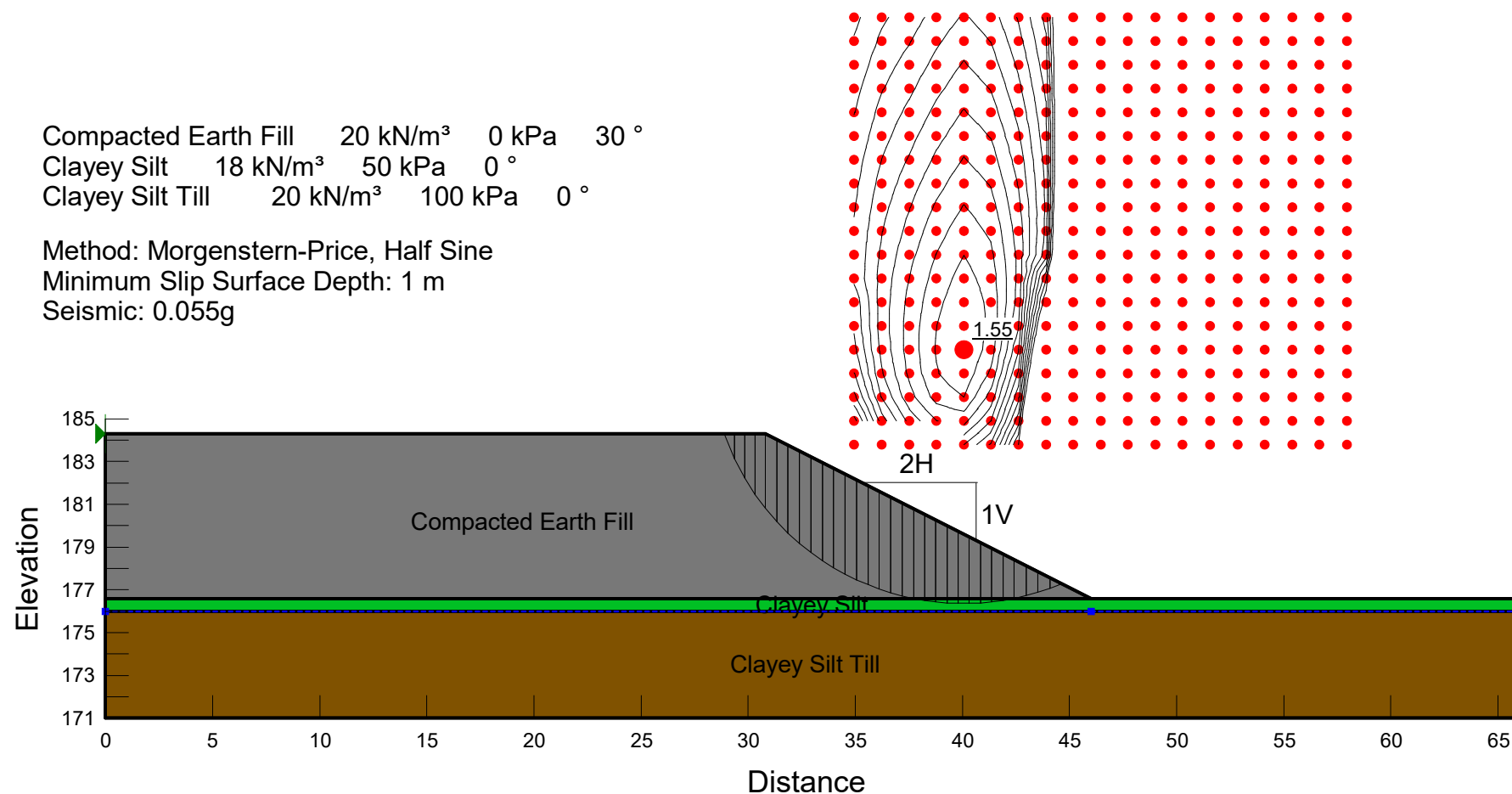
CRITICAL APPROACH EMBANKMENT SECTION SHORT-TERM CONDITION



CRITICAL APPROACH EMBANKMENT SECTION LONG-TERM CONDITION



CRITICAL APPROACH EMBANKMENT SECTION SEISMIC CONDITION



Appendix C
Langstaff Road Underpass Embankment
(Mainline Sta. 11+800 to 12+400)

RECORD OF BOREHOLE No FLR 17-01

1 OF 1

METRIC

W.P. _____ LOCATION N 4 849 642.9 E 293 831.1 ORIGINATED BY KK
 HWY 427 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN
 DATUM Geodetic DATE 2017.06.05 - 2017.06.05 CHECKED BY ME

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL			
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa							WATER CONTENT (%)		
								○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE							w _p w w _L		
192.1	GROUND SURFACE						20 40 60 80 100										
0.0	Sandy SILT , trace gravel, trace organics Compact Brown Moist (FILL)		1	SS	11												
			2	SS	11												
190.7																	
1.4	Clayey SILT to Silty CLAY , some sand, trace gravel Firm to Very Stiff Brown to Grey Moist (TILL)		3	SS	6												
			4	SS	17												
	Becoming grey		5	SS	17												
			6	SS	10												
			7	SS	14												
			8	SS	23												
183.9																	
8.2	END OF BOREHOLE AT 8.2m. BOREHOLE DRY UPON COMPLETION. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG AND CUTTINGS TO SURFACE.																

ONTMT4S MTO-19484.GPJ 2017TEMPLATE(MTO).GDT 10/31/17

METRIC

[illegible]

+³, ×³: Numbers refer to Sensitivity

RECORD OF BOREHOLE No FLR 17-02

2 OF 2

METRIC

W.P. _____ LOCATION N 4 849 967.1 E 293 713.8 ORIGINATED BY CAR
 HWY 427 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN
 DATUM Geodetic DATE 2017.05.19 - 2017.05.19 CHECKED BY ME

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE					WATER CONTENT (%) W _p W W _L				
	Continued From Previous Page																
			10	SS	23		178										
							177										
176.0			11	SS	15												
12.8	END OF BOREHOLE AT 12.8m. Piezometer installation consists of 25mm diameter Schedule 40 PVC pipe with a 1.52m slotted screen. WATER LEVEL READINGS DATE DEPTH(m) ELEV.(m) 2017.06.19 2.5 186.3						176										

RECORD OF BOREHOLE No FLR 17-03

1 OF 1

METRIC

W.P. _____ LOCATION N 4 850 023.9 E 293 736.3 ORIGINATED BY CAR
 HWY 427 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN
 DATUM Geodetic DATE 2017.05.17 - 2017.05.17 CHECKED BY ME

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa									
188.4	GROUND SURFACE							20	40	60	80	100					
0.0	Silty SAND , trace clay, trace to some gravel, some asphalt Compact Brown Moist (FILL)		1	SS	18		188										
			2	SS	13		187										
186.7																	
1.7	Clayey SILT to Silty CLAY , some sand to sandy, trace gravel Firm to Very Stiff Brown to Grey Moist (TILL)		3	SS	8		186										
			4	SS	15		185										
			5	SS	19		184										
	Becoming grey		6	SS	19		183										
			7	SS	17		182										
			8	SS	11		181										
			9	SS	11												
			10	SS	12												
			11	SS	15												
180.2																	
8.2	END OF BOREHOLE AT 8.2m. Monitoring well installation consists of 50mm diameter Schedule 40 PVC pipe with a 3.0m slotted screen. WATER LEVEL READINGS DATE DEPTH(m) ELEV.(m) 2017.05.18 5.0 183.4 2017.06.19 0.9 187.5																

+³, ×³: Numbers refer to Sensitivity 20 15 10 5 0 (%) STRAIN AT FAILURE

RECORD OF BOREHOLE No FLR 17-04

1 OF 1

METRIC

W.P. _____ LOCATION N 4 850 089.8 E 293 708.5 ORIGINATED BY CAR
 HWY 427 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN
 DATUM Geodetic DATE 2017.05.18 - 2017.05.18 CHECKED BY ME

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)							
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa												
188.2	GROUND SURFACE							20	40	60	80	100								
0.0	Gravelly SAND , some silt, trace clay, some asphalt fragments		1	SS	10		188													
187.7	Compact																			
0.5	Brown Moist (FILL)																			
	Silty CLAY , trace sand, trace gravel, trace organics		2	SS	8		187													
186.8	Firm																			
1.4	Brown Moist																			
	Clayey SILT to Silty CLAY , some sand to sandy, trace gravel, occasional cobbles		3	SS	12		186													
	Stiff to Very Stiff																			
	Brown Moist (TILL)		4	SS	23		185													
			5	SS	17		184													
			6	SS	21		183													
			7	SS	22		182													
	Becoming grey		8	SS	18		181													
			9	SS	13		180													
			10	SS	16															
180.0	END OF BOREHOLE AT 8.2m. Monitoring well installation consists of 50mm diameter Schedule 40 PVC pipe with a 3.0m slotted screen.																			
8.2	WATER LEVEL READINGS DATE DEPTH(m) ELEV.(m) 2017.05.18 Dry - 2017.06.19 0.6 187.6																			

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+³, ×³: Numbers refer to
Sensitivity

20
15
10
(%) STRAIN AT FAILURE

RECORD OF BOREHOLE No FLR 17-05

1 OF 1

METRIC

W.P. _____ LOCATION N 4 850 139.3 E 293 741.8 ORIGINATED BY CAR
 HWY 427 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN
 DATUM Geodetic DATE 2017.05.23 - 2017.05.23 CHECKED BY ME

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				PLASTIC LIMIT W _P	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE								
188.0	GROUND SURFACE															
0.0	ASPHALT: (50mm)															
187.6	Gravelly SAND , trace clay Loose Brown Moist (FILL)		1	SS	7											
0.4	Clayey SILT to Silty CLAY , some sand to sandy, trace gravel Firm to Very Stiff Brown to Grey Moist (TILL)		2	SS	6											2 34 35 29
			3	SS	7											
			4	SS	19											
			5	SS	17											
			6	SS	11											
			7	SS	19											
179.8	END OF BOREHOLE AT 8.2m. BOREHOLE OPEN TO 7.0m AND DRY UPON COMPLETION. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG AND CUTTINGS TO SURFACE.		8	SS	12											
8.2																

ONTMT4S MTO-19484.GPJ 2017TEMPLATE(MTO).GDT 10/31/17

RECORD OF BOREHOLE No FLR 17-06

1 OF 1

METRIC

W.P. _____ LOCATION N 4 850 317.5 E 293 587.1 ORIGINATED BY CAR
 HWY 427 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN
 DATUM Geodetic DATE 2017.05.24 - 2017.05.24 CHECKED BY ME

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa									
						○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE					WATER CONTENT (%)						
						20	40	60	80	100	20	40	60				
188.6	GROUND SURFACE																
0.0	TOPSOIL: (150mm)																
0.2	Silty CLAY , trace sand, trace gravel, trace organics Firm to Stiff Brown Moist		1	SS	4												
			2	SS	6												
			3	SS	5												
			4	SS	9												
185.6	Clayey SILT to Silty CLAY , some sand to sandy, trace gravel Stiff to Very Stiff Brown Moist (TILL)		5	SS	14												
	Becoming grey		6	SS	14												
			7	SS	18												
			8	SS	11												
180.4	END OF BOREHOLE AT 6.7m. Piezometer installation consists of 25mm diameter Schedule 40 PVC pipe with a 1.52m slotted screen.																
8.2	WATER LEVEL READINGS DATE DEPTH(m) ELEV.(m) 2017.06.19 4.5 184.1																

ONTMT4S MTO-19484.GPJ 2017TEMPLATE(MTO).GDT 10/31/17

FIGURE C1

**CRITICAL EMBANKMENT SECTION (STA. 12+260)
SHORT-TERM CONDITION**

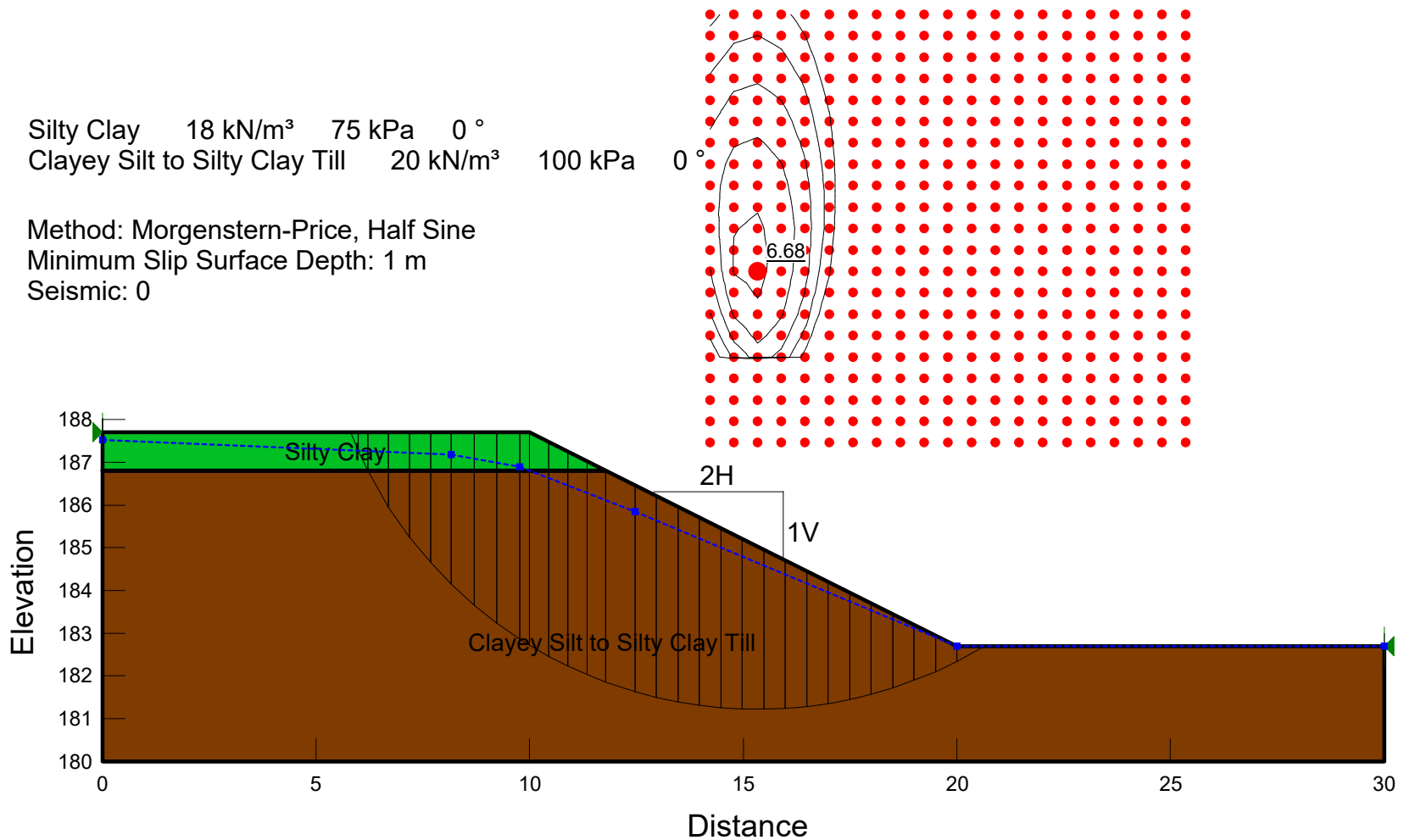


FIGURE C2

**CRITICAL EMBANKMENT SECTION (STA. 12+260)
LONG-TERM CONDITION**

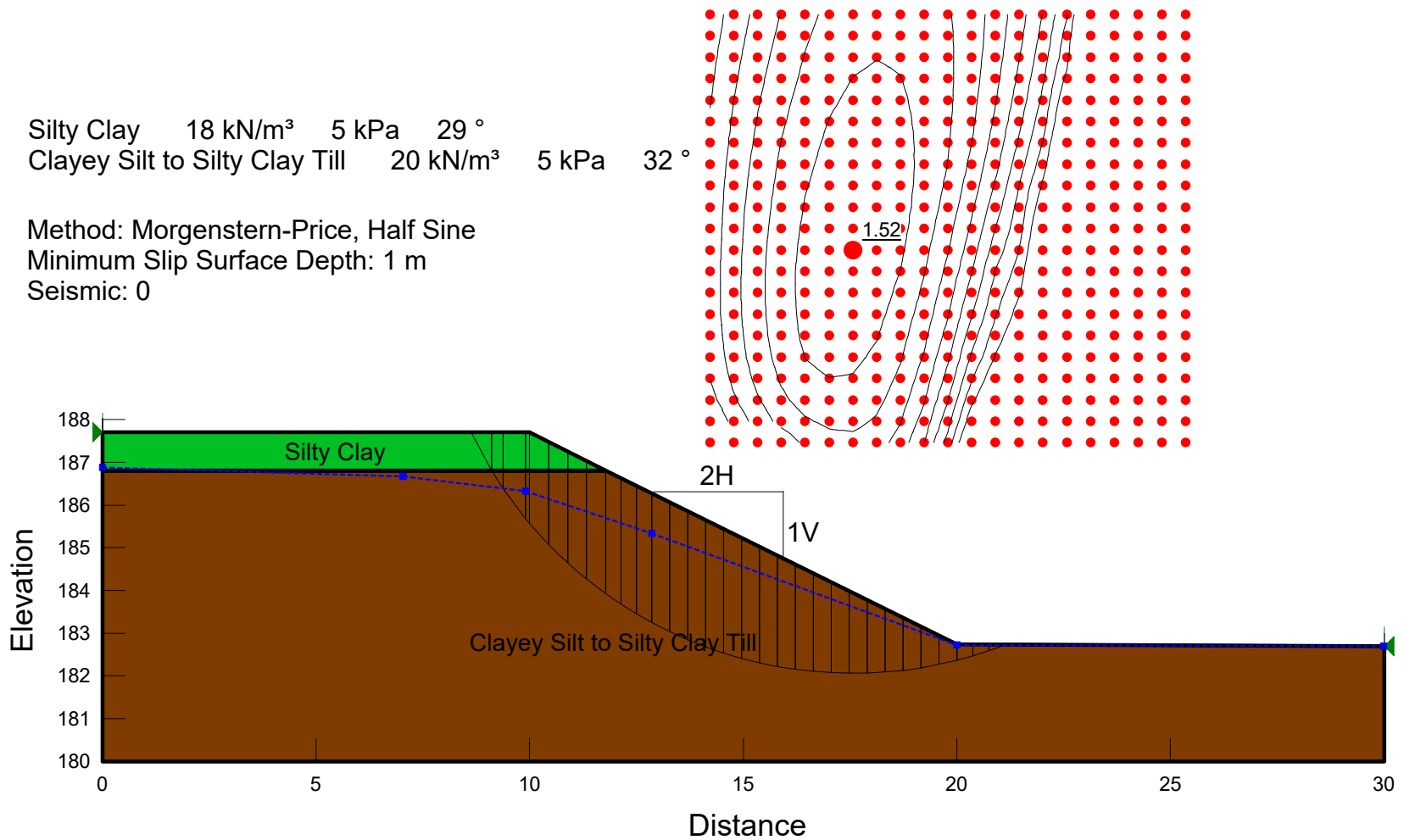


FIGURE C3

CRITICAL EMBANKMENT SECTION (STA. 12+260) SEISMIC CONDITION

Silty Clay 18 kN/m³ 75 kPa 0 °

Clayey Silt to Silty Clay Till 20 kN/m³ 100 kPa 0 °

Method: Morgenstern-Price, Half Sine

Minimum Slip Surface Depth: 1 m

Seismic: 0.055g

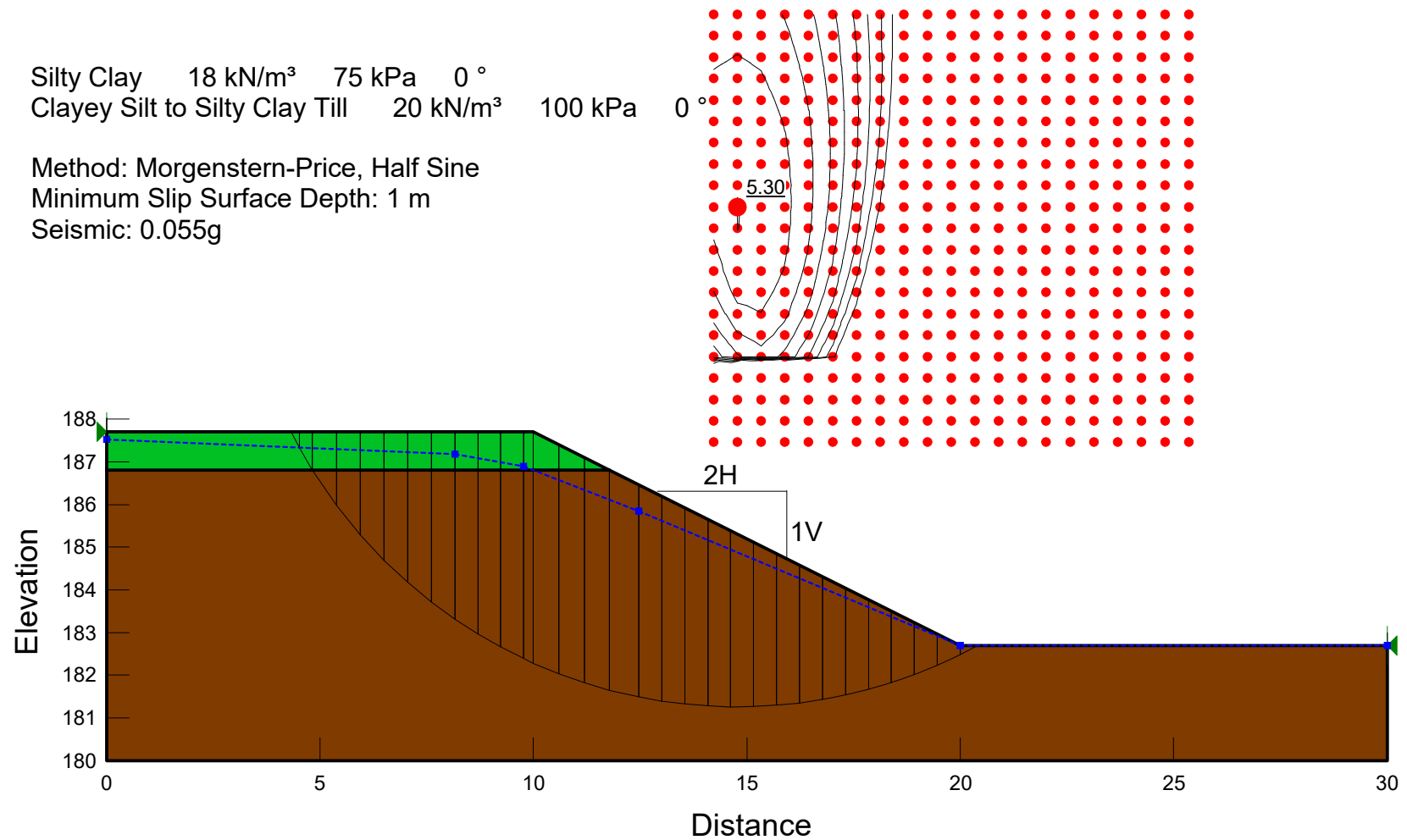


FIGURE C4

CRITICAL EMBANKMENT SECTION (STA. 12+370) SHORT-TERM CONDITION

Silty Clay Till (Upper)	18 kN/m ³	50 kPa	0 °
Gravelly Sand Fill	20 kN/m ³	0 kPa	30 °
Silty Clay Till (Lower)	21 kN/m ³	100 kPa	0 °

Method: Morgenstern-Price, Half Sine
Minimum Slip Surface Depth: 1 m
Seismic: 0

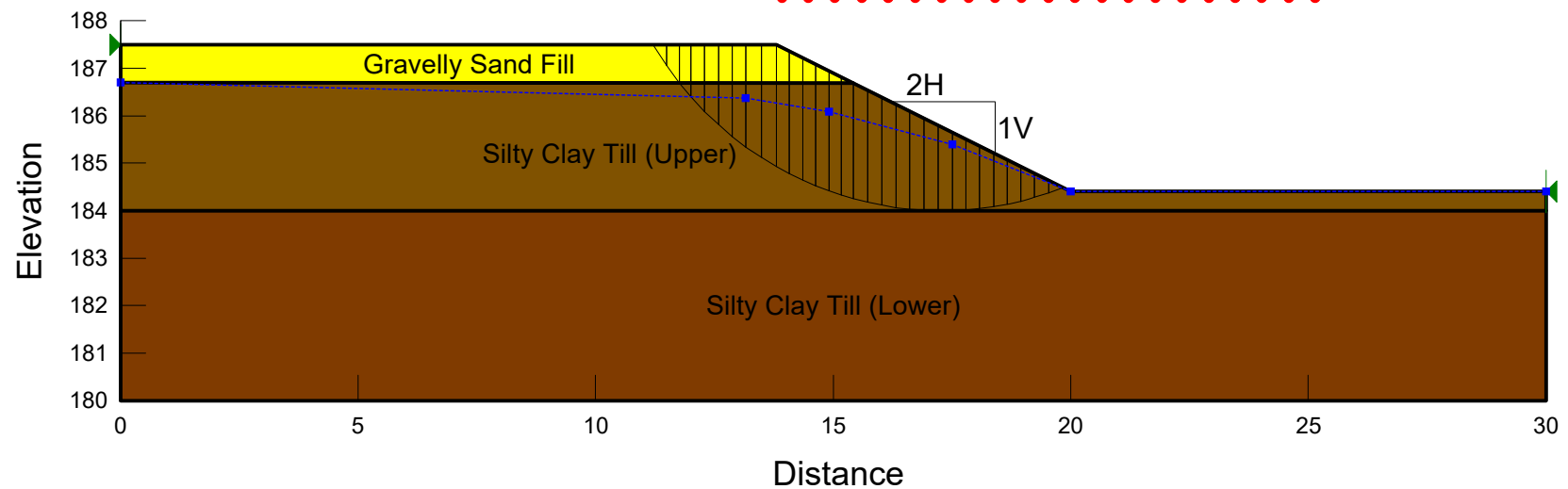
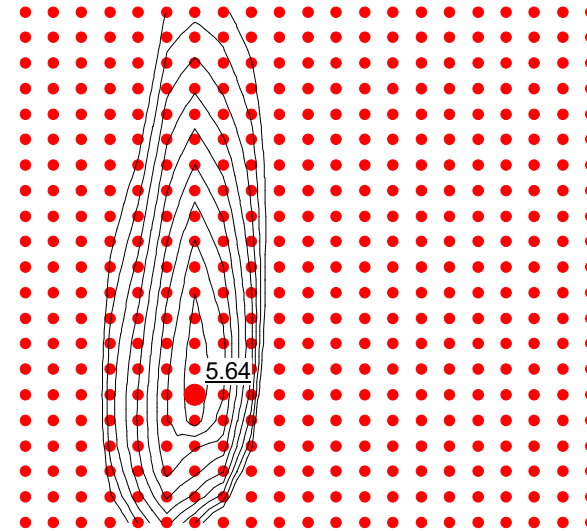


FIGURE C5

CRITICAL EMBANKMENT SECTION (STA. 12+370) LONG-TERM CONDITION

Silty Clay Till (Upper)	18 kN/m ³	5 kPa	29 °
Gravelly Sand Fill	20 kN/m ³	0 kPa	30 °
Silty Clay Till (Lower)	21 kN/m ³	5 kPa	31 °

Method: Morgenstern-Price, Half Sine
Minimum Slip Surface Depth: 1 m
Seismic: 0

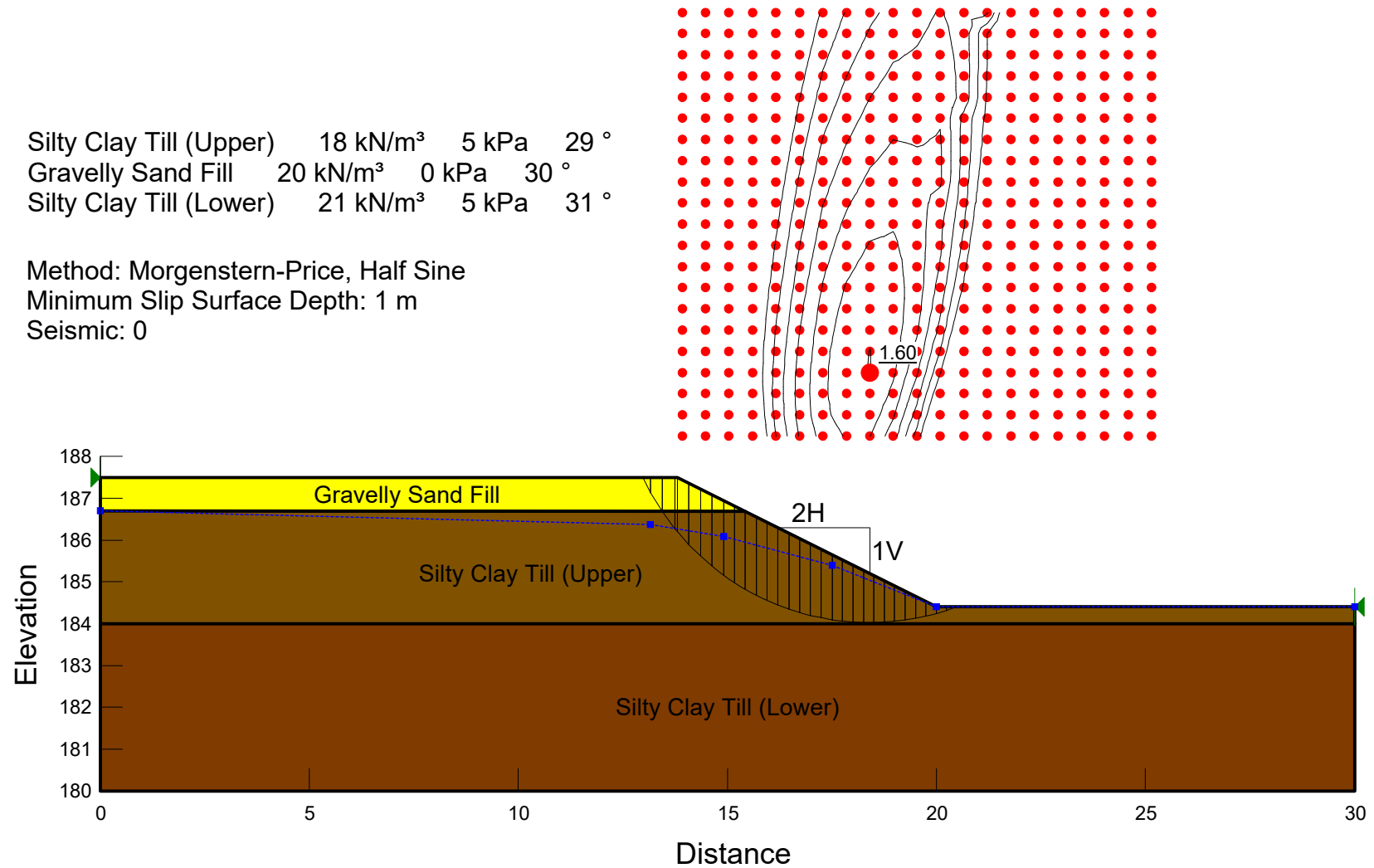
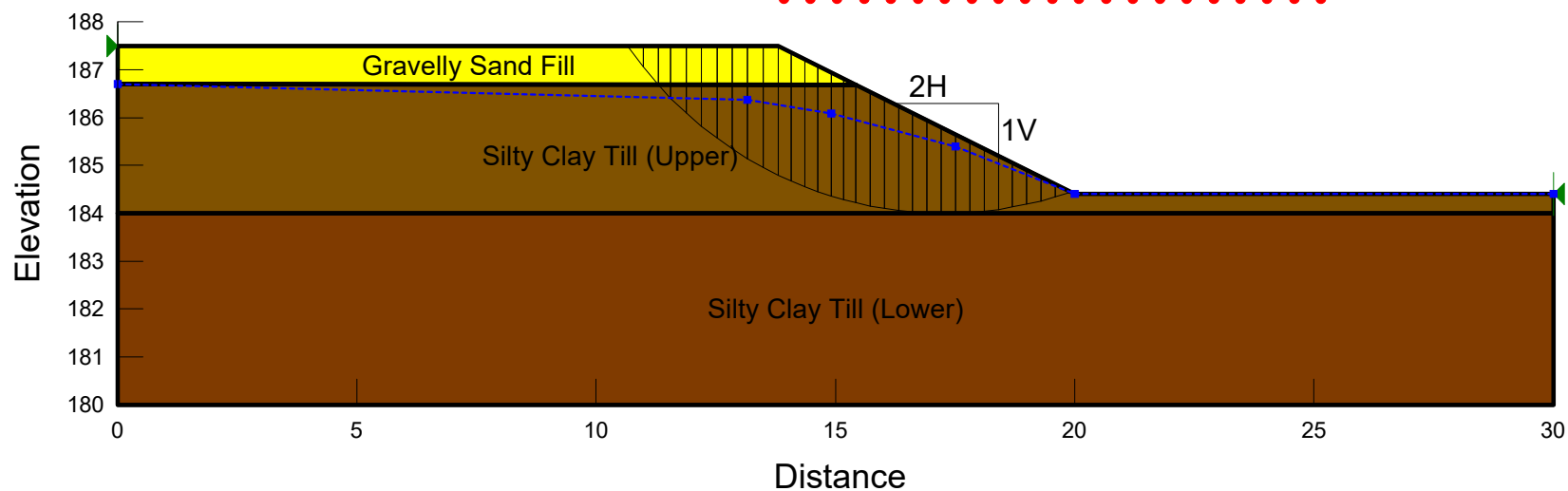
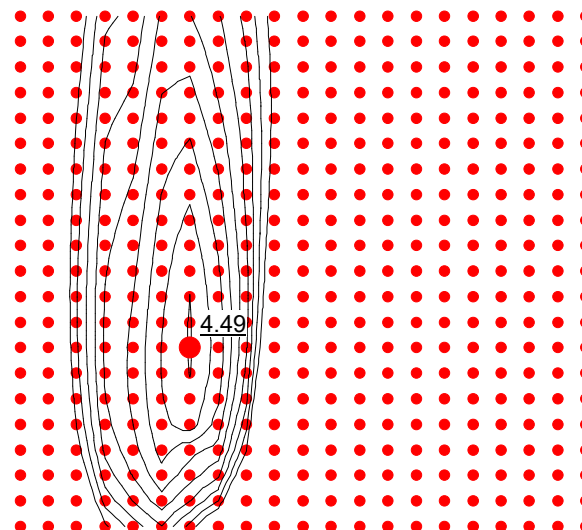


FIGURE C6

CRITICAL EMBANKMENT SECTION (STA. 12+370) SEISMIC CONDITION

Silty Clay Till (Upper) 18 kN/m³ 50 kPa 0 °
Gravelly Sand Fill 20 kN/m³ 0 kPa 30 °
Silty Clay Till (Lower) 21 kN/m³ 100 kPa 0 °

Method: Morgenstern-Price, Half Sine
Minimum Slip Surface Depth: 1 m
Seismic: 0.055g



Appendix D
Embankment at Culvert U022
(Mainline Sta. 11+100 to 11+150)

RECORD OF BOREHOLE No CLRN 17-02 1 OF 2 METRIC

W.P. _____ LOCATION Culvert at Sta 11+130 N 4 848 956.3 E 293 845.5 ORIGINATED BY ES/KK
 HWY 427 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN
 DATUM Geodetic DATE 2017.06.12 - 2017.06.13 CHECKED BY ME

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa		WATER CONTENT (%)				
180.3	GROUND SURFACE							20 40 60 80 100						
0.0	TOPSOIL: (150mm)							○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE						
0.2	Clayey SILT , trace sand, trace roots Soft Dark Brown Moist		1	SS	3		180							
179.5														
0.8	Clayey SILT to Silty CLAY , some sand, trace gravel, occasional oxide stains in upper 0.5m zone Stiff to Hard Brown to Grey Moist (TILL)		2	SS	18		179							
			3	SS	24		178							
			4	SS	36		177							
			5	SS	12		176							
			6	SS	20		175							
			7	SS	24		174							
							173							
	Occasional sand seam		8	SS	23		172							
							171							
	Cobbles at 9.2m depth													

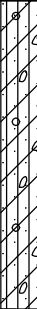
Continued Next Page

+³, ×³: Numbers refer to
Sensitivity

20
15
10
(%) STRAIN AT FAILURE

RECORD OF BOREHOLE No CLRN 17-02 2 OF 2 METRIC

W.P. _____ LOCATION Culvert at Sta 11+130 N 4 848 956.3 E 293 845.5 ORIGINATED BY ES/KK
 HWY 427 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN
 DATUM Geodetic DATE 2017.06.12 - 2017.06.13 CHECKED BY ME

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa						
Continued From Previous Page								○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE						
168.3	Silty SAND , some clay, trace gravel, trace shale fragments Dense Grey Moist (TILL)		10	SS	101/ 0.225		170							
12.0														
167.5							169							
12.8	END OF BOREHOLE AT 12.8m. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG AND CUTTINGS TO SURFACE.						168							

RECORD OF BOREHOLE No CLRN 17-03

1 OF 2

METRIC

W.P. _____ LOCATION Culvert at Sta 11+130 N 4 848 962.9 E 293 889.9 ORIGINATED BY KK
 HWY 427 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN
 DATUM Geodetic DATE 2017.06.13 - 2017.06.13 CHECKED BY ME

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)				
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20 40 60 80 100	W _P W W _L	WATER CONTENT (%)			GR SA SI CL							
179.5	GROUND SURFACE																			
0.0	TOPSOIL: (125mm)																			
0.1	Clayey SILT , trace sand, trace gravel Firm Brown		1	SS	3		179						○							
178.8	Moist																			
0.7	Clayey SILT to Silty CLAY , some sand to sandy, trace gravel Firm to Hard Brown to 4.0m depth then Grey Moist (TILL)		2	SS	7		178						○							
			3	SS	8								○							
			4	SS	32		177						○	—		0 20 46 34				
			5	SS	35		176						○							
							175													
			6	SS	17								○	—		0 26 45 29				
							174													
			7	SS	24		173						○							
							172													
			8	SS	24								○	—						
							171													
170.8																				
8.7	SAND and SILT , trace clay, trace gravel Dense to Very Dense Grey Moist (TILL)		9	SS	58		170						○			5 43 43 9				

Continued Next Page

+³, ×³: Numbers refer to
Sensitivity

20
15
10
(%) STRAIN AT FAILURE

RECORD OF BOREHOLE No CLRN 17-03 2 OF 2 METRIC

W.P. _____ LOCATION Culvert at Sta 11+130 N 4 848 962.9 E 293 889.9 ORIGINATED BY KK
 HWY 427 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN
 DATUM Geodetic DATE 2017.06.13 - 2017.06.13 CHECKED BY ME

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL				
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa										
								20 40 60 80 100										
Continued From Previous Page																		
			10	SS	35		169											
							168											
167.1			11	SS	102/													
12.4	SHALE highly weathered, thinly bedded, weak, grey: (Probably Bedrock)				0.200		167											
166.7																		
12.8																		
	END OF BOREHOLE AT 12.8m. BOREHOLE DRY UPON COMPLETION. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG AND CUTTINGS TO SURFACE.																	

CRITICAL EMBANKMENT SECTION (STA. 11+120) SHORT-TERM CONDITION

Compacted Earth Fill	20 kN/m ³	0 kPa	30 °
Clayey Silt	18 kN/m ³	35 kPa	0 °
Clayey Silt to Silty Clay Till	20 kN/m ³	75 kPa	0 °

Method: Morgenstern-Price, Half Sine
 Minimum Slip Surface Depth: 1 m
 Seismic: 0

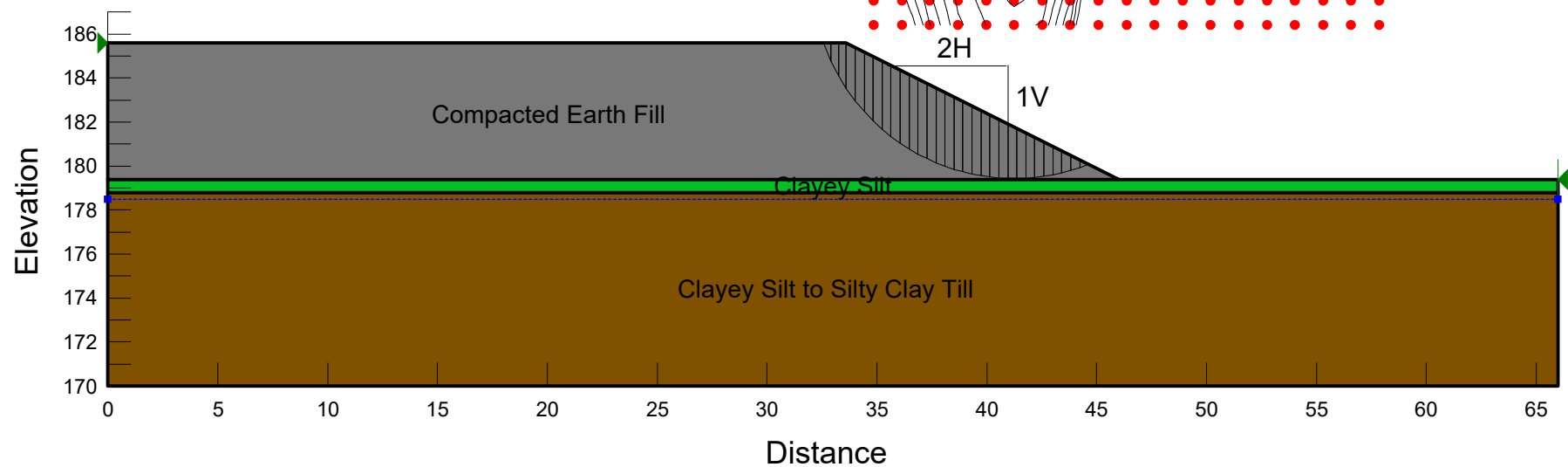


FIGURE D2

CRITICAL EMBANKMENT SECTION (STA. 11+120) LONG-TERM CONDITION

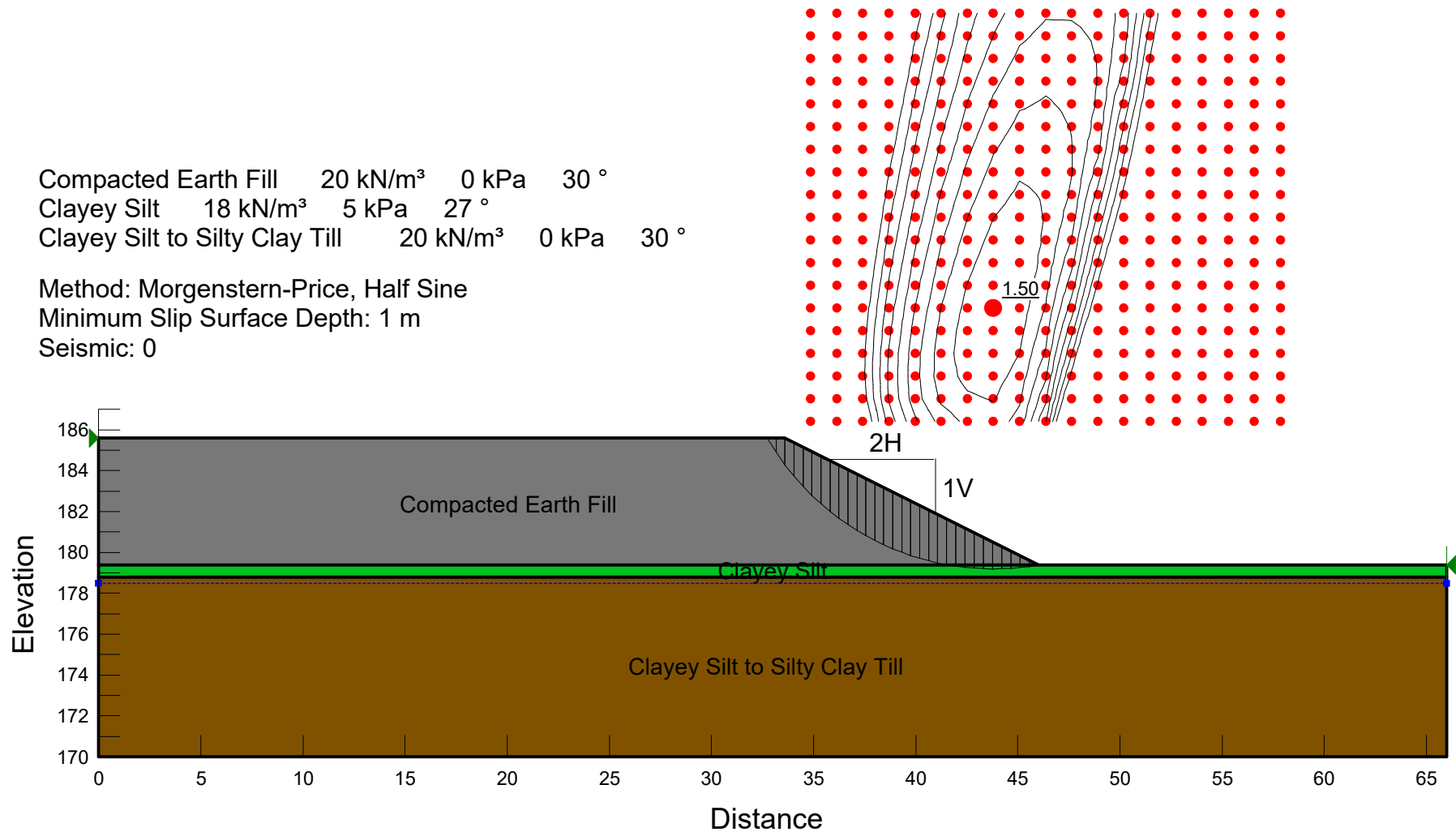
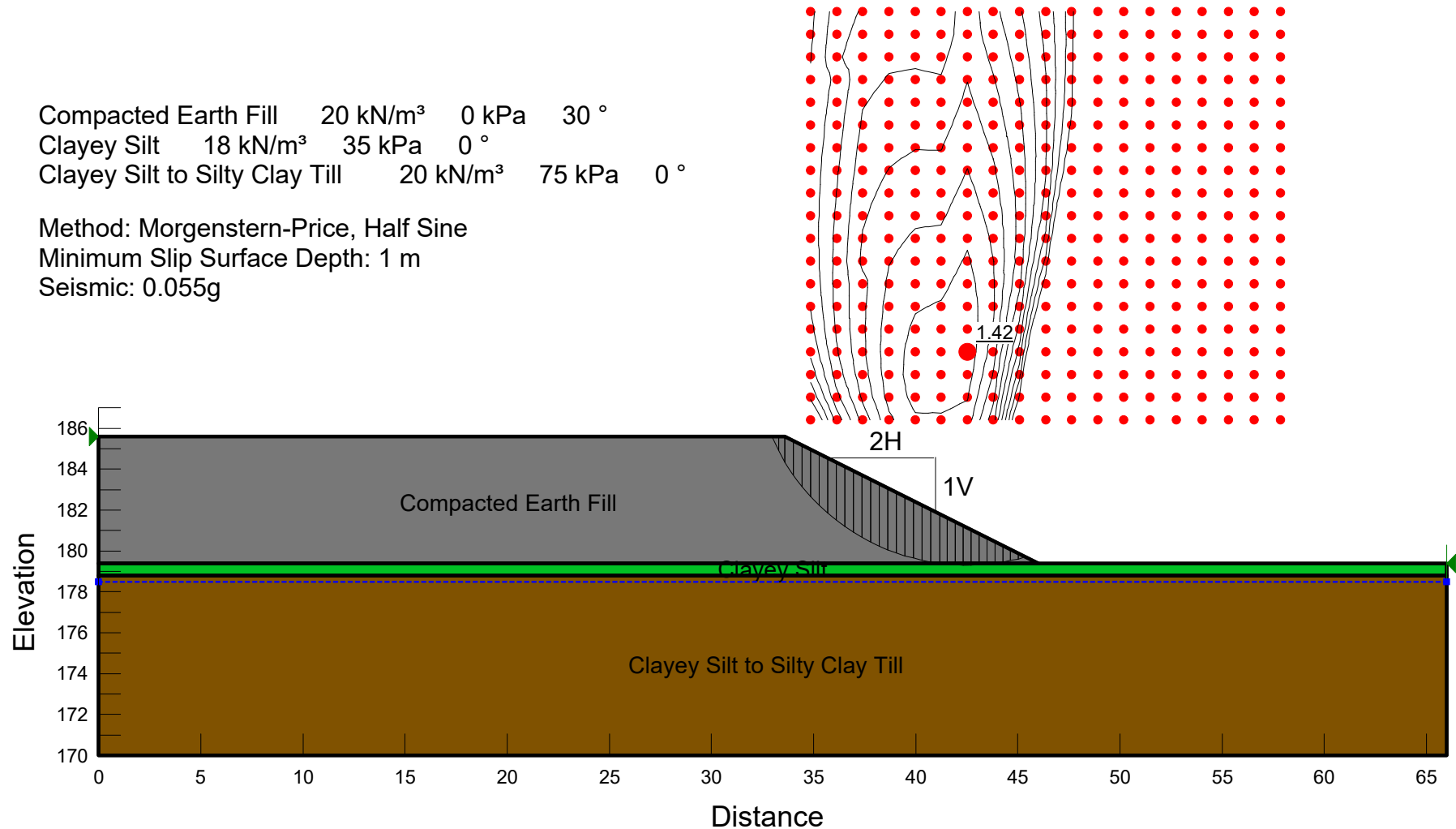


FIGURE D3

CRITICAL EMBANKMENT SECTION (STA. 11+120) SEISMIC CONDITION



Appendix E
Rutherford Road Overpass Approach Embankments
(Mainline Sta. 13+500 to 14+550)

RECORD OF BOREHOLE No FRRO 17-01 1 OF 2 METRIC

W.P. _____ LOCATION N 4 851 490.7 E 293 344.3 ORIGINATED BY OA
 HWY 427 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN
 DATUM Geodetic DATE 2017.06.09 - 2017.06.09 CHECKED BY ME

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa						
190.7	GROUND SURFACE							<div><div>20406080100</div><div>○ UNCONFINED + FIELD VANE</div><div>● QUICK TRIAXIAL × LAB VANE</div></div>						
0.0	TOPSOIL: (100mm)							<div><div>20406080100</div><div>○ UNCONFINED + FIELD VANE</div><div>● QUICK TRIAXIAL × LAB VANE</div></div>						
0.1	Silty CLAY , trace sand, trace gravel Firm Brown		1	SS	6		190							
190.0	Brown													
0.7	Moist													
	Clayey SILT to Silty CLAY , trace sand, trace gravel Stiff to Hard Brown to Grey Moist (TILL)		2	SS	13									
			3	SS	18		189							
			4	SS	23		188							
			5	SS	35		187							
			6	SS	19		186							
							185							
			7	SS	15		184							
							183							
			8	SS	14									
182.2							182							
8.5	Sandy SILT , some gravel, some clay Very Dense Grey Moist (TILL)													
			9	SS	73		181							14 35 38 13
180.9														
9.8	END OF BOREHOLE AT 9.8m.													

Continued Next Page

+³, ×³: Numbers refer to Sensitivity 20 15 10 5 0 (%) STRAIN AT FAILURE

RECORD OF BOREHOLE No FRRO 17-01 2 OF 2 METRIC

W.P. _____ LOCATION N 4 851 490.7 E 293 344.3 ORIGINATED BY OA
 HWY 427 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN
 DATUM Geodetic DATE 2017.06.09 - 2017.06.09 CHECKED BY ME

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa									
	Continued From Previous Page																
	BOREHOLE DRY UPON COMPLETION. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG AND CUTTINGS TO SURFACE.																

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RECORD OF BOREHOLE No FRRO 17-02 1 OF 2 METRIC

W.P. _____ LOCATION N 4 851 774.5 E 293 155.9 ORIGINATED BY CAR
 HWY 427 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN
 DATUM Geodetic DATE 2017.06.06 - 2017.06.06 CHECKED BY ME

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)				
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa										
193.8	GROUND SURFACE							20	40	60	80	100						
0.0	TOPSOIL: (200mm)							20	40	60	80	100						
0.2	Silty CLAY , trace sand, gravelly, trace organics		1	SS	6		193											
193.1	Firm																	
0.7	Brown																	
	Moist																	
	Clayey SILT to Silty CLAY , some sand to sandy, trace gravel, occasional cobbles and boulders		2	SS	19													
	Stiff to Very Stiff																	
	Brown to Grey																	
	Moist (TILL)																	
			3	SS	12		192											
			4	SS	24		191											
			5	SS	22		190											
			6	SS	21		189											
							188											
			7	SS	12		187											
			8	SS	10		186											
			9	SS	12		185											
184.0																		
9.8	END OF BOREHOLE AT 9.8m.																	

Continued Next Page

+³, ×³: Numbers refer to Sensitivity
 20
 15
 10
 (%) STRAIN AT FAILURE

RECORD OF BOREHOLE No FRRO 17-02 2 OF 2 METRIC

W.P. _____ LOCATION N 4 851 774.5 E 293 155.9 ORIGINATED BY CAR
 HWY 427 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN
 DATUM Geodetic DATE 2017.06.06 - 2017.06.06 CHECKED BY ME

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa					WATER CONTENT (%)				
							20	40	60	80	100	W _p	W	W _L			
	Continued From Previous Page																
	Piezometer installation consists of 25mm diameter Schedule 40 PVC pipe with a 1.52m slotted screen. WATER LEVEL READINGS DATE DEPTH(m) ELEV.(m) 2017.06.19 7.5 186.3																

RECORD OF BOREHOLE No FRRO 17-03 1 OF 2 METRIC

W.P. _____ LOCATION N 4 852 025.5 E 293 015.3 ORIGINATED BY JZ
 HWY 427 BOREHOLE TYPE Solid Stem Augers COMPILED BY AN
 DATUM Geodetic DATE 2017.05.19 - 2017.05.19 CHECKED BY ME

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa						
193.9	GROUND SURFACE													
0.0	TOPSOIL: (200mm)													
0.2	Silty CLAY , trace sand, trace gravel Firm Brown Moist		1	SS	8									
193.2														
0.7	Clayey SILT to Silty CLAY , trace sand, trace gravel, occasional cobbles Stiff to Hard Brown Moist (TILL)		2	SS	22									
			3	SS	39									
			4	SS	32									
			5	SS	43									
	Occasional sand pockets													
			6	SS	15									
			7	SS	12									
			8	SS	13									
			9	SS	9									
184.1														
9.8	END OF BOREHOLE AT 9.8m.													

Continued Next Page

+³, ×³: Numbers refer to Sensitivity
 20
 15
 10
 (%) STRAIN AT FAILURE

RECORD OF BOREHOLE No FRRO 17-03 2 OF 2 METRIC

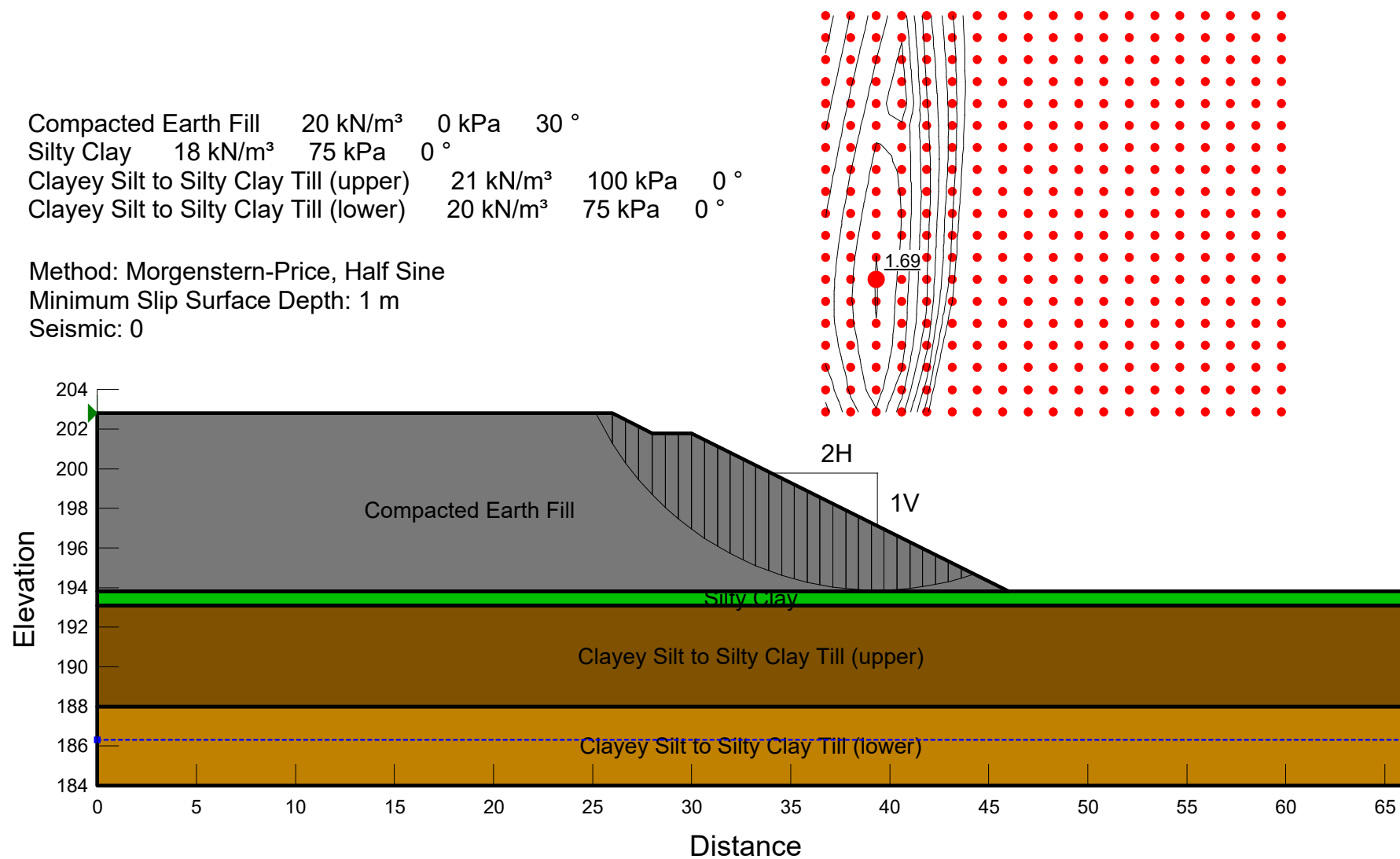
W.P. _____ LOCATION N 4 852 025.5 E 293 015.3 ORIGINATED BY JZ
 HWY 427 BOREHOLE TYPE Solid Stem Augers COMPILED BY AN
 DATUM Geodetic DATE 2017.05.19 - 2017.05.19 CHECKED BY ME

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa									
	Continued From Previous Page																
	BOREHOLE DRY UPON COMPLETION. Piezometer installation consists of 25mm diameter Schedule 40 PVC pipe with a 1.52m slotted screen. WATER LEVEL READINGS DATE DEPTH(m) ELEV.(m) 2017.05.31 6.7 187.2 2017.06.29 3.4 190.5																

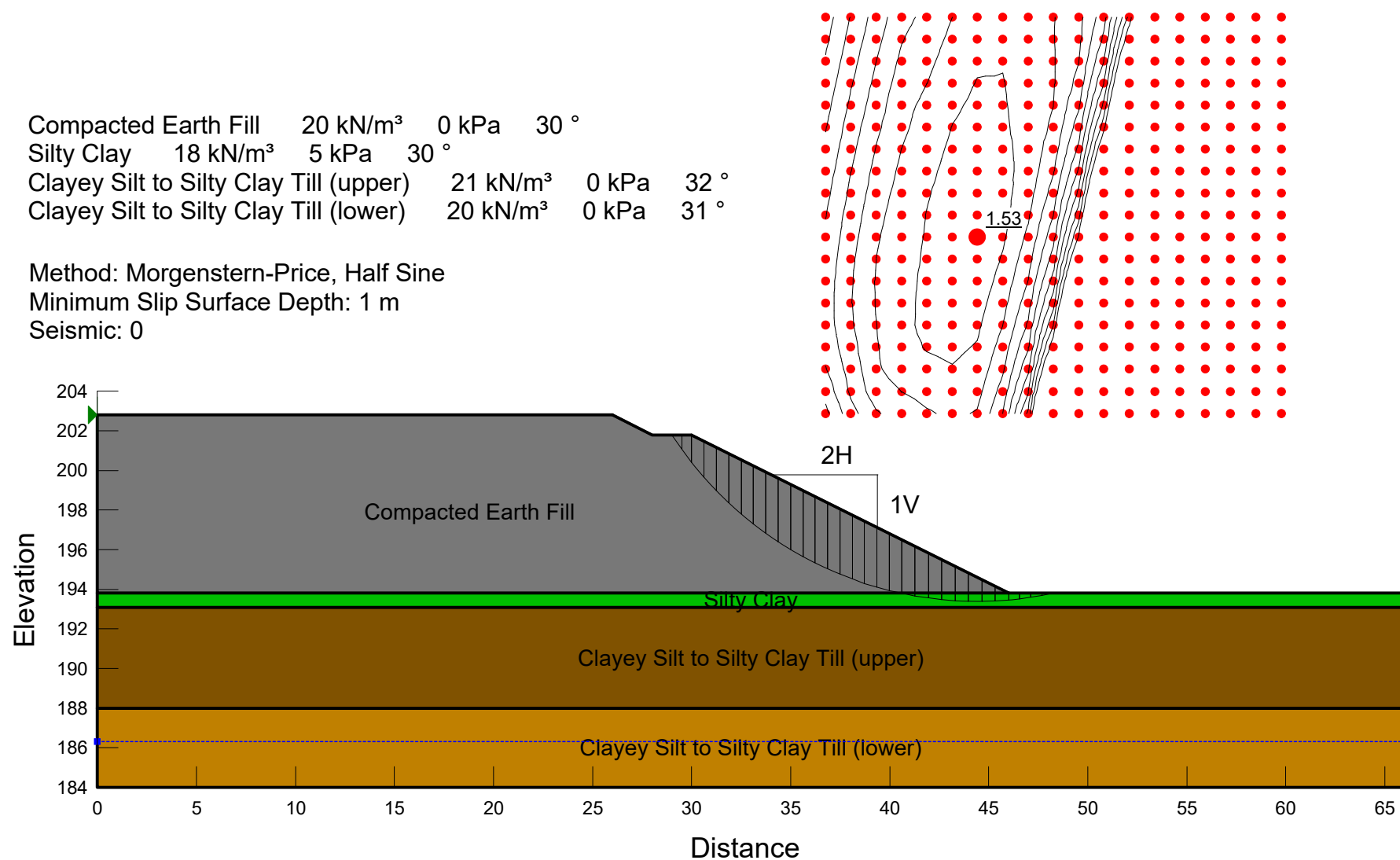
CRITICAL EMBANKMENT SECTION (STA. 14+080) SHORT-TERM CONDITION

Compacted Earth Fill	20 kN/m ³	0 kPa	30 °
Silty Clay	18 kN/m ³	75 kPa	0 °
Clayey Silt to Silty Clay Till (upper)	21 kN/m ³	100 kPa	0 °
Clayey Silt to Silty Clay Till (lower)	20 kN/m ³	75 kPa	0 °

Method: Morgenstern-Price, Half Sine
Minimum Slip Surface Depth: 1 m
Seismic: 0



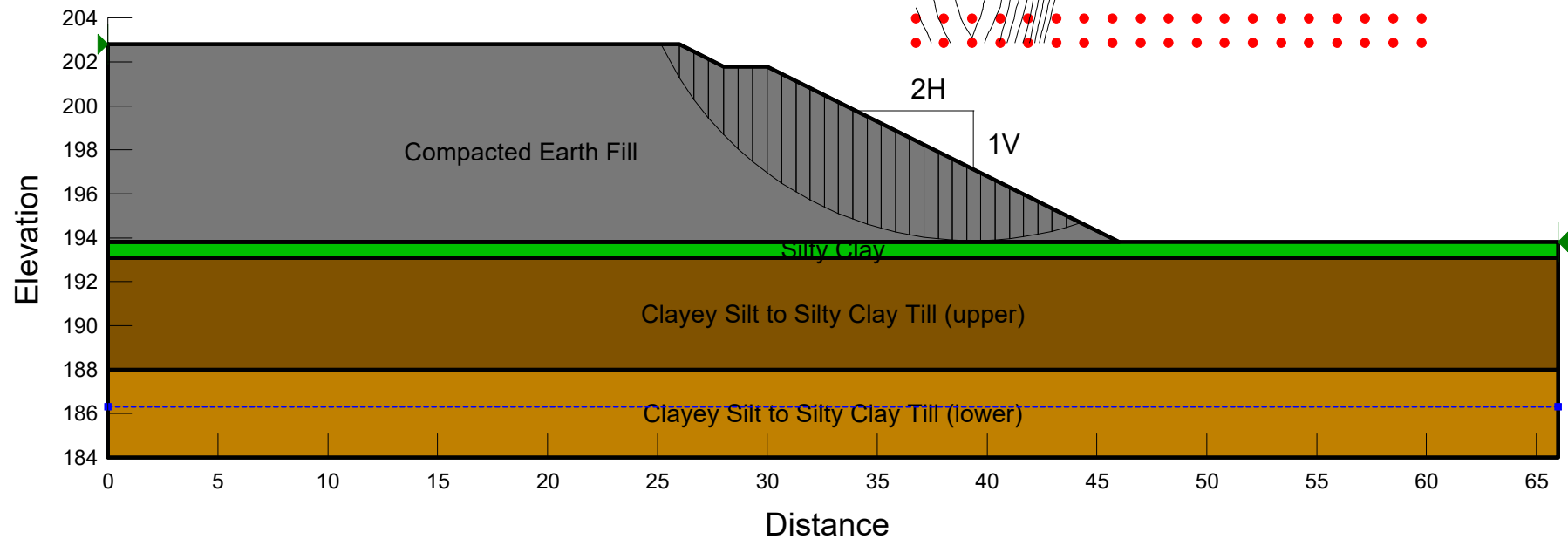
CRITICAL EMBANKMENT SECTION (STA. 14+080) LONG-TERM CONDITION



CRITICAL EMBANKMENT SECTION (STA. 14+080) **SEISMIC CONDITION**

Compacted Earth Fill	20 kN/m ³	0 kPa	30 °
Silty Clay	18 kN/m ³	75 kPa	0 °
Clayey Silt to Silty Clay Till (upper)	21 kN/m ³	100 kPa	0 °
Clayey Silt to Silty Clay Till (lower)	20 kN/m ³	75 kPa	0 °

Method: Morgenstern-Price, Half Sine
 Minimum Slip Surface Depth: 1 m
 Seismic: 0.055g



Appendix F

**West Robinson Creek Bridge North Approach Embankment
(Mainline Sta. 15+600 to 15+700)**

RECORD OF BOREHOLE No WR 17-01

1 OF 2

METRIC

W.P. _____ LOCATION N 4 852 916.1 E 292 436.3 ORIGINATED BY JZ
 HWY 427 BOREHOLE TYPE Solid Stem Augers COMPILED BY AN
 DATUM Geodetic DATE 2017.06.12 - 2017.06.12 CHECKED BY ME

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)					
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa										
199.8	GROUND SURFACE							20	40	60	80	100						
0.0	TOPSOIL: (125mm)							20	40	60	80	100						
0.1	Silty CLAY , trace sand, trace gravel, trace organics, rootlets Firm Dark Brown Moist		1	SS	7		199											
199.1																		
0.7	Silty CLAY , trace sand, trace gravel Stiff to Hard Brown to Grey Moist (TILL)		2	SS	21		198											
			3	SS	34		197											
			4	SS	24		196											
			5	SS	24		195											
			6	SS	22		194											
			7	SS	10		193											
			8	SS	13		192											
			9	SS	34		191											
190.0	END OF BOREHOLE AT 9.8m.																	
9.8																		

Continued Next Page

+³, ×³: Numbers refer to
Sensitivity

20
15
10
(%) STRAIN AT FAILURE

METRIC

[illegible]

METRIC

[illegible]

+³, ×³: Numbers refer to Sensitivity

RECORD OF BOREHOLE No WR 17-02

2 OF 5

METRIC

W.P. _____ LOCATION N 4 852 937.5 E 292 429.1 ORIGINATED BY JZ
 HWY 427 BOREHOLE TYPE Hollow Stem Augers/NQ Coring COMPILED BY AN
 DATUM Geodetic DATE 2017.07.10 - 2017.07.11 CHECKED BY ME

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa						
	Continued From Previous Page													
	Silty CLAY , trace to some sand, trace gravel Hard Grey Moist (TILL)		10	SS	162									
			11	SS	129									
			12	SS	85									
183.7														
14.8	SAND , some silt, trace gravel Very Dense Grey Wet		13	SS	117									0 79 16 5
	Hard augering													
			14	SS	54									

Continued Next Page

+³, ×³: Numbers refer to Sensitivity
 20
 15
 10
 (%) STRAIN AT FAILURE

RECORD OF BOREHOLE No WR 17-02

3 OF 5

METRIC

W.P. _____ LOCATION N 4 852 937.5 E 292 429.1 ORIGINATED BY JZ
 HWY 427 BOREHOLE TYPE Hollow Stem Augers/NQ Coring COMPILED BY AN
 DATUM Geodetic DATE 2017.07.10 - 2017.07.11 CHECKED BY ME

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa						
							20 40 60 80 100	20 40 60 80 100	20 40 60					
	Continued From Previous Page													
177.8							178							
20.7	Clayey SILT , trace to some sand Very Stiff to Hard Grey Moist (TILL)		15	SS	59		177			14			0 0 81 19	
							176							
							175							
			16	SS	50		174							
							173							
							172							
			17	SS	15		171							
							170							
							169							

Continued Next Page

+³, ×³: Numbers refer to Sensitivity 20 15 10 5 0 (%) STRAIN AT FAILURE

METRIC

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				PLASTIC LIMIT W _P	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL		
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa									WATER CONTENT (%)	
								○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE										
Continued From Previous Page																		
165.9	Clayey SILT , trace to some sand Hard Grey Moist (TILL)		18	SS	40		168											
32.6	SAND and SILT , some gravel, contains shale fragments Very Dense Grey Moist (TILL)		19	SS	100/		166									FI >10		
					0.125													
164.1	SHALE highly to slightly weathered, thinly bedded, horizontally laminated, grey 375mm clay interbed at 36.1m		1	RUN			165									RUN #1 TCR=12% SCR=0% RQD=0%		
			2	RUN			164									RUN #2 TCR=40% SCR=27% RQD=0%		
			3	RUN			163									RUN #3 TCR=15% SCR=10% RQD=10%		
			4	RUN			162									RUN #4 TCR=0% SCR=0% RQD=0%		
							161											
							160											
							159											

+³, ×³: Numbers refer to Sensitivity

RECORD OF BOREHOLE No WR 17-02

5 OF 5

METRIC

W.P. _____ LOCATION N 4 852 937.5 E 292 429.1 ORIGINATED BY JZ
 HWY 427 BOREHOLE TYPE Hollow Stem Augers/NQ Coring COMPILED BY AN
 DATUM Geodetic DATE 2017.07.10 - 2017.07.11 CHECKED BY ME

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa									
							20	40	60	80	100						
	Continued From Previous Page																
158.0																	
40.5	END OF BOREHOLE AT 40.5m. BOREHOLE BACKFILLED TO 18.3m TO INSTALL PIEZOMETER. Piezometer installation consists of 25mm diameter Schedule 40 PVC pipe with a 3.05m slotted screen. WATER LEVEL READINGS DATE DEPTH(m) ELEV.(m) 2017.08.08 18.1 180.4 NOTE: LOW RECOVERIES IN THE BEDROCK DUE TO CORING EQUIPMENT DEFICIENCIES.																

RECORD OF BOREHOLE No WR 17-03

1 OF 4

METRIC

W.P. _____ LOCATION N 4 852 992.5 E 292 415.0 ORIGINATED BY JZ
 HWY 427 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN
 DATUM Geodetic DATE 2017.07.12 - 2017.07.13 CHECKED BY ME

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				PLASTIC LIMIT w _P	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE									
193.7	GROUND SURFACE							20	40	60	80	100					
0.0	Silty CLAY , trace to some sand, trace gravel, trace organics, rootlets and topsoil Firm Brown Moist		1	SS	8									○			
			2	SS	6									○			
192.3																	
1.4	Silty CLAY , trace sand, trace gravel Very Stiff Brown Moist (TILL) Hard augering		3	SS	16									○			
			4	SS	20									○			
190.6																	
3.1	Clayey SILT , sandy, trace gravel Hard Grey Moist (TILL) Hard augering		5	SS	37									○			
			6	SS	79									○			
			7	SS	83									○			
			8	SS	82									○			
185.0																	
8.7	Silty SAND , trace clay Dense to Very Dense Grey Wet		9	SS	74									○			

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+³, ×³: Numbers refer to Sensitivity
 20
15
10
(%) STRAIN AT FAILURE

RECORD OF BOREHOLE No WR 17-03

2 OF 4

METRIC

W.P. _____ LOCATION N 4 852 992.5 E 292 415.0 ORIGINATED BY JZ
 HWY 427 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN
 DATUM Geodetic DATE 2017.07.12 - 2017.07.13 CHECKED BY ME

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa		W _p	W	W _L		
	Continued From Previous Page													
	Silty SAND , trace clay Dense to Very Dense Grey Wet		10	SS	48		183							0 72 22 6
							182							
			11	SS	33		181							
180.3														
13.4	Clayey SILT Hard Grey Moist to Wet (TILL) Hard augering		12	SS	49		180							
							179							
			13	SS	50		178							
							177							
							176							
			14	SS	68		175							0 0 79 21
							174							
174.0														
19.7	SILT , trace clay, trace sand Compact													

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+³, ×³: Numbers refer to Sensitivity 20 15 10 5 0 (%) STRAIN AT FAILURE

METRIC

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+³, ×³: Numbers refer to Sensitivity

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RECORD OF BOREHOLE No WR 17-03

4 OF 4

METRIC

W.P. _____ LOCATION N 4 852 992.5 E 292 415.0 ORIGINATED BY JZ
 HWY 427 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN
 DATUM Geodetic DATE 2017.07.12 - 2017.07.13 CHECKED BY ME

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa								
	Continued From Previous Page							20	40	60	80	100				
			18	SS	77		163									
162.0							162									
31.7	SHALE highly weathered, weak, grey															
161.3			19	SS	161/ 0.275											
32.4	END OF BOREHOLE AT 32.4m. Piezometer installation consists of 25mm (deep) and 50mm (shallow) diameter Schedule 40 PVC pipes with 1.52m slotted screens. DEEP WATER LEVEL READINGS: DATE DEPTH (m) ELEV. (m) 2017.08.08 4.3 189.4 SHALLOW WATER LEVEL READINGS: DATE DEPTH (m) ELEV. (m) 2017.08.08 1.3 192.4															

RECORD OF BOREHOLE No WR 17-04

1 OF 5

METRIC

W.P. _____ LOCATION N 4 853 081.4 E 292 428.4 ORIGINATED BY JZ
 HWY 427 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN
 DATUM Geodetic DATE 2017.06.26 - 2017.06.28 CHECKED BY ME

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa					
194.7	GROUND SURFACE												
0.0	TOPSOIL: (100mm)												
0.1	Clayey SILT , trace sand, trace gravel, trace organics, rootlets Soft Grey Moist		1	SS	3								
194.0													
0.7	Clayey SILT , trace sand, trace gravel Firm to Stiff Brown to Grey Moist (TILL) Hard augering		2	SS	6								
			3	SS	8								
			4	SS	14								
			5	SS	10								
								</					

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+³, ×³: Numbers refer to
Sensitivity

20
15
10
(%) STRAIN AT FAILURE

METRIC

[illegible]

+³, ×³: Numbers refer to Sensitivity

RECORD OF BOREHOLE No WR 17-04

3 OF 5

METRIC

W.P. _____ LOCATION N 4 853 081.4 E 292 428.4 ORIGINATED BY JZ
 HWY 427 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN
 DATUM Geodetic DATE 2017.06.26 - 2017.06.28 CHECKED BY ME

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL		
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa								
	Continued From Previous Page							20 40 60 80 100								
	SILT, trace clay to clayey, trace sand Dense to Compact Grey Wet		16	SS	39		174	○ UNCONFINED + FIELD VANE								
								● QUICK TRIAXIAL × LAB VANE								
			17	SS	16				20 40 60 80 100							
									PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT							
									W _p W W _L							
									WATER CONTENT (%)							
			18	SS	13					20 40 60						
										○						
			19	SS	13					○						
		20	SS	16				○								
		21	SS	22				○								
166.2	Sandy SILT, trace clay, trace gravel Compact to Dense Grey Wet (TILL)													0 26 67 7		
28.5																
			22	SS	46				○							
							165									

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+³, ×³: Numbers refer to Sensitivity
 20
 15 10 5 0
 (%) STRAIN AT FAILURE

RECORD OF BOREHOLE No WR 17-04

4 OF 5

METRIC

W.P. _____ LOCATION N 4 853 081.4 E 292 428.4 ORIGINATED BY JZ
 HWY 427 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN
 DATUM Geodetic DATE 2017.06.26 - 2017.06.28 CHECKED BY ME

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa						
	Continued From Previous Page													
			23	SS	24		164							
			24	SS	19		162							
			25	SS	20		161							
			26	SS	26		159							
159.4	Clayey SILT , with sand, trace gravel Very Stiff to Hard Grey Moist (TILL)		27	SS	144/ 0.275		158							
35.3	Shale fragments		28	SS	146/ 0.225		157							
			29	SS	100/ 0.025		155							

Continued Next Page

+³, ×³: Numbers refer to
Sensitivity

20
15
10
(%) STRAIN AT FAILURE

RECORD OF BOREHOLE No WR 17-04

5 OF 5

METRIC

W.P. _____ LOCATION N 4 853 081.4 E 292 428.4 ORIGINATED BY JZ
 HWY 427 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN
 DATUM Geodetic DATE 2017.06.26 - 2017.06.28 CHECKED BY ME

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa									
	Continued From Previous Page																
154.5																	
40.2	END OF BOREHOLE AT 40.2m ON REFUSAL. Piezometer installation consists of 25mm diameter Schedule 40 PVC pipe with a 1.52m slotted screen. WATER LEVEL READINGS DATE DEPTH(m) ELEV.(m) 2017.08.08 3.7 191.0																

METRIC

[illegible]

+³, ×³: Numbers refer to Sensitivity

METRIC

[illegible]

+³, ×³: Numbers refer to Sensitivity

RECORD OF BOREHOLE No WR 17-05

3 OF 5

METRIC

W.P. _____ LOCATION N 4 853 022.2 E 292 459.5 ORIGINATED BY JZ
 HWY 427 BOREHOLE TYPE Hollow Stem Augers/NQ Coring COMPILED BY AN
 DATUM Geodetic DATE 2017.06.16 - 2017.06.26 CHECKED BY ME

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa						
	Continued From Previous Page													
	Clayey SILT , trace to some sand, trace gravel Hard Grey Wet (TILL)		16	SS	31									
			17	SS	24									
			18	SS	25									0 0 76 24
			19	SS	14									
			20	SS	21									0 0 76 24
			21	SS	20									
			22	SS	36									

Continued Next Page

+³, ×³: Numbers refer to
Sensitivity

20
15 5
10 (%) STRAIN AT FAILURE

RECORD OF BOREHOLE No WR 17-05

4 OF 5

METRIC

W.P. _____ LOCATION N 4 853 022.2 E 292 459.5 ORIGINATED BY JZ
 HWY 427 BOREHOLE TYPE Hollow Stem Augers/NQ Coring COMPILED BY AN
 DATUM Geodetic DATE 2017.06.16 - 2017.06.26 CHECKED BY ME

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa		WATER CONTENT (%)				
							20 40 60 80 100	20 40 60 80 100	W _p W W _L	20 40 60				
	Continued From Previous Page													
	Clayey SILT , trace to some sand, trace gravel Very Stiff to Hard Grey Wet (TILL)		23	SS	23		163							
			24	SS	18		162							
			25	SS	19		160							
			26	SS	111		159							
			27	SS	186/ 0.275		157							
155.6	SHALE slightly weathered, thinly bedded, grey, medium strong		1	RUN			156					FI		
38.1	Limestone interbed (225mm) at 38.3m						155					>10	RUN #1 TCR=86% SCR=86% RQD=14%	
	Fossiliferous limestone (75mm) at 38.7m											6		
	Limestone interbed (150mm) at 39.5m											7		
	Vertical fracture (75mm) at 39.3m		2	RUN			154					3		
												>10	RUN #2 TCR=100% SCR=100% RQD=68%	
												5		

Continued Next Page

+³, ×³: Numbers refer to
Sensitivity

20
15
10

(%) STRAIN AT FAILURE

RECORD OF BOREHOLE No WR 17-05

5 OF 5

METRIC

W.P. _____ LOCATION N 4 853 022.2 E 292 459.5 ORIGINATED BY JZ
 HWY 427 BOREHOLE TYPE Hollow Stem Augers/NQ Coring COMPILED BY AN
 DATUM Geodetic DATE 2017.06.16 - 2017.06.26 CHECKED BY ME

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa									
						○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE					WATER CONTENT (%)						
						20	40	60	80	100	20	40	60				
	Continued From Previous Page																
	Fossiliferous limestone (25mm) at 40.1m and (50mm) at 10.2m																
	Limestone interbed (25mm) at 41.3m and 41.5m		3	RUN													
151.6																	
42.1	END OF BOREHOLE AT 42.1m. Well installation consists of 25mm (deep) and 50mm (shallow) diameter Schedule 40 PVC pipe with 3.05m and 1.52m slotted screen. DEEP WATER LEVEL READINGS: DATE DEPTH (m) ELEV. (m) 2017.06.29 11.0 182.7 SHALLOW WATER LEVEL READINGS: DATE DEPTH (m) ELEV. (m) 2017.06.29 1.6 192.1																

ONTMT4S MTO-19484.GPJ 2017TEMPLATE(MTO).GDT 17/8/9

RECORD OF BOREHOLE No WR 17-06

1 OF 4

METRIC

W.P. _____ LOCATION N 4 852 972.0 E 292 465.3 ORIGINATED BY JZ
 HWY 427 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN
 DATUM Geodetic DATE 2017.07.05 - 2017.07.07 CHECKED BY ME

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				PLASTIC LIMIT NATURAL LIMIT MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE				WATER CONTENT (%) W _P W W _L					
197.5	GROUND SURFACE							20	40	60	80	100					
0.0	TOPSOIL: (175mm)							20	40	60	80	100					
0.2	Silty CLAY , some sand, trace gravel, trace organics, trace rootlets Firm Brown		1	SS	7		197							○			
196.8	Moist																
0.7	Silty CLAY , trace to some sand, trace gravel Very Stiff Brown Moist (TILL)		2	SS	21		196							○			
			3	SS	25									○	—		
			4	SS	28		195							○			
			5	SS	29		194							○			
							193										
			6	SS	14									○			
							192										
			7	SS	16		191							○			
							190										
			8	SS	13									○	—		0 9 50 41
							189										
			9	SS	125		188							○			

Continued Next Page

+³, ×³: Numbers refer to
Sensitivity

20
15
10
(%) STRAIN AT FAILURE

RECORD OF BOREHOLE No WR 17-06

2 OF 4

METRIC

W.P. _____ LOCATION N 4 852 972.0 E 292 465.3 ORIGINATED BY JZ
 HWY 427 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN
 DATUM Geodetic DATE 2017.07.05 - 2017.07.07 CHECKED BY ME

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE									
	Continued From Previous Page																
	Silty CLAY , trace to some sand, trace gravel Hard Brown Moist (TILL)		10	SS	100/ 0.100		187										
			11	SS	100/ 0.125		186										
			12	SS	98		185									0 7 61 32	
183.4							184										
14.1	SAND , trace to some silt, trace clay, trace gravel, occasional cobbles Very Dense Grey Wet		13	SS	94		183										
			14	SS	61		182										
			15	SS	51		181										
							180										
							179										
							178										

Continued Next Page

+³, ×³: Numbers refer to Sensitivity
 20
15
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0 (%) STRAIN AT FAILURE

METRIC

[illegible]

+³, ×³: Numbers refer to Sensitivity

RECORD OF BOREHOLE No WR 17-06

4 OF 4

METRIC

W.P. _____ LOCATION N 4 852 972.0 E 292 465.3 ORIGINATED BY JZ
 HWY 427 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN
 DATUM Geodetic DATE 2017.07.05 - 2017.07.07 CHECKED BY ME

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				PLASTIC LIMIT W _P	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL			
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa									WATER CONTENT (%)		
								○ UNCONFINED		+ FIELD VANE									
	Continued From Previous Page							20	40	60	80	100							
	Clayey SILT , trace sand, trace gravel Hard to Very Stiff Grey Wet (TILL)		23	SS	36		167												
							166												
			24	SS	18		165												
164.4																			
33.1	SILT and SAND , trace gravel to gravelly, occasional shale fragments Very Dense Grey Moist (TILL)		25	SS	83		164									23 36 34 7			
							163												
			26	SS	176		162												
							161												
160.3			27	SS	142														
37.2	END OF BOREHOLE AT 37.2m. BOREHOLE BACKFILLED TO 18.3m TO INSTALL PIEZOMETER. Well installation consists of 50mm diameter Schedule 40 PVC pipe with a 3.05m slotted screen. WATER LEVEL READINGS DATE DEPTH(m) ELEV.(m) 2017.08.08 18.7 178.8																		

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FIGURE F1

CRITICAL EMBANKMENT SECTION (STA. 15+600) **SHORT-TERM CONDITION**

Compacted Earth Fill	20 kN/m ³	0 kPa	30 °
Soft to Stiff Silty Clay	18 kN/m ³	50 kPa	0 °
Firm to Stiff Clayey Silt to Silty Clay Till	20 kN/m ³	100 kPa	0 °
Very Stiff to Hard Clayey Silt to Silty Clay Till	21 kN/m ³	200 kPa	0 °

Method: Morgenstern-Price, Half Sine

Minimum Slip Surface Depth: 1 m

Seismic: 0

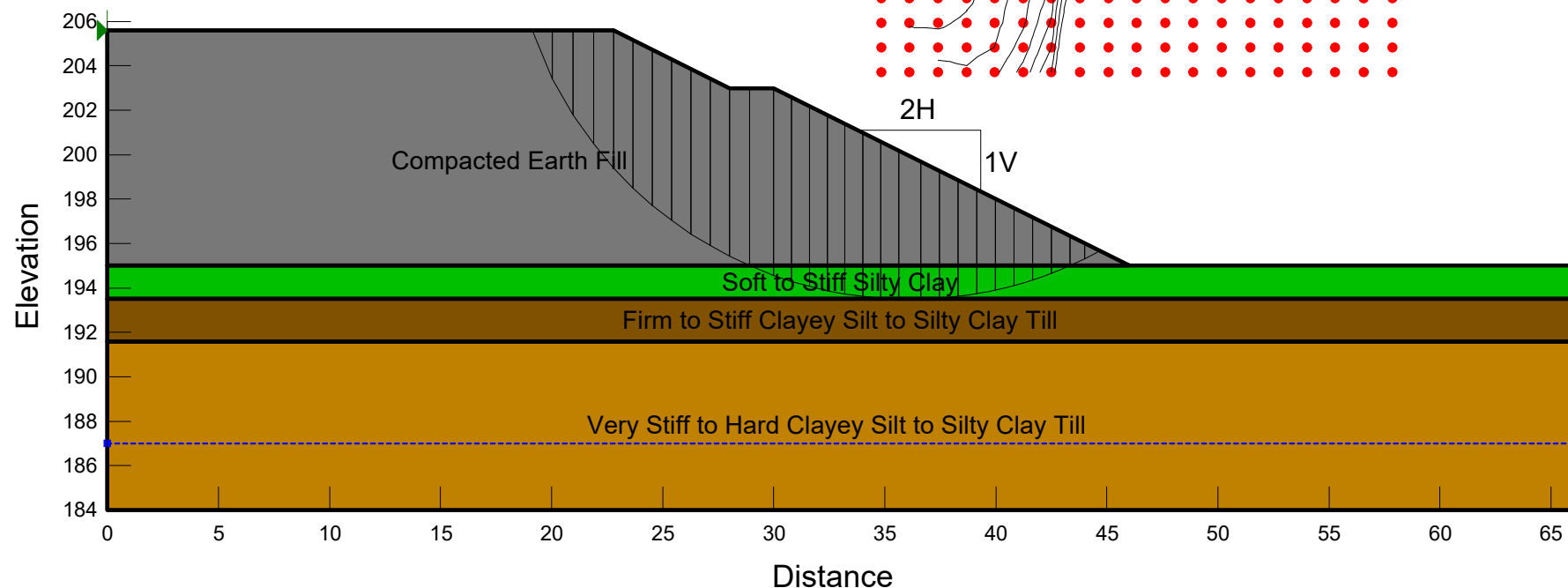
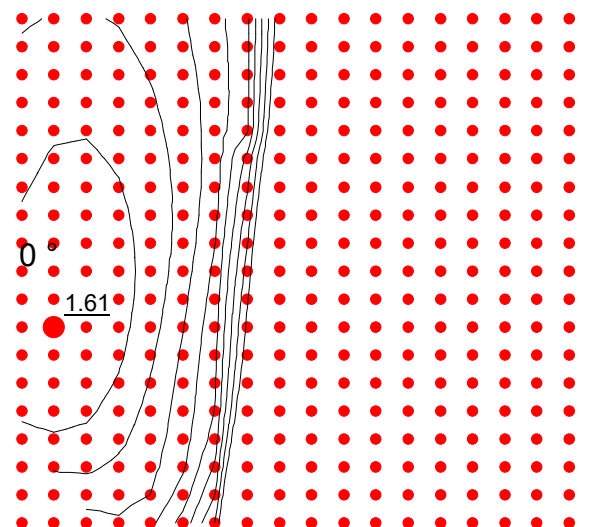


FIGURE F2

CRITICAL EMBANKMENT SECTION (STA. 15+600) **LONG-TERM CONDITION**

Compacted Earth Fill	20 kN/m ³	0 kPa	30 °
Soft to Stiff Silty Clay	18 kN/m ³	5 kPa	29 °
Firm to Stiff Clayey Silt to Silty Clay Till	20 kN/m ³	0 kPa	30 °
Very Stiff to Hard Clayey Silt to Silty Clay Till	21 kN/m ³	0 kPa	32 °

Method: Morgenstern-Price, Half Sine

Minimum Slip Surface Depth: 1 m

Seismic: 0

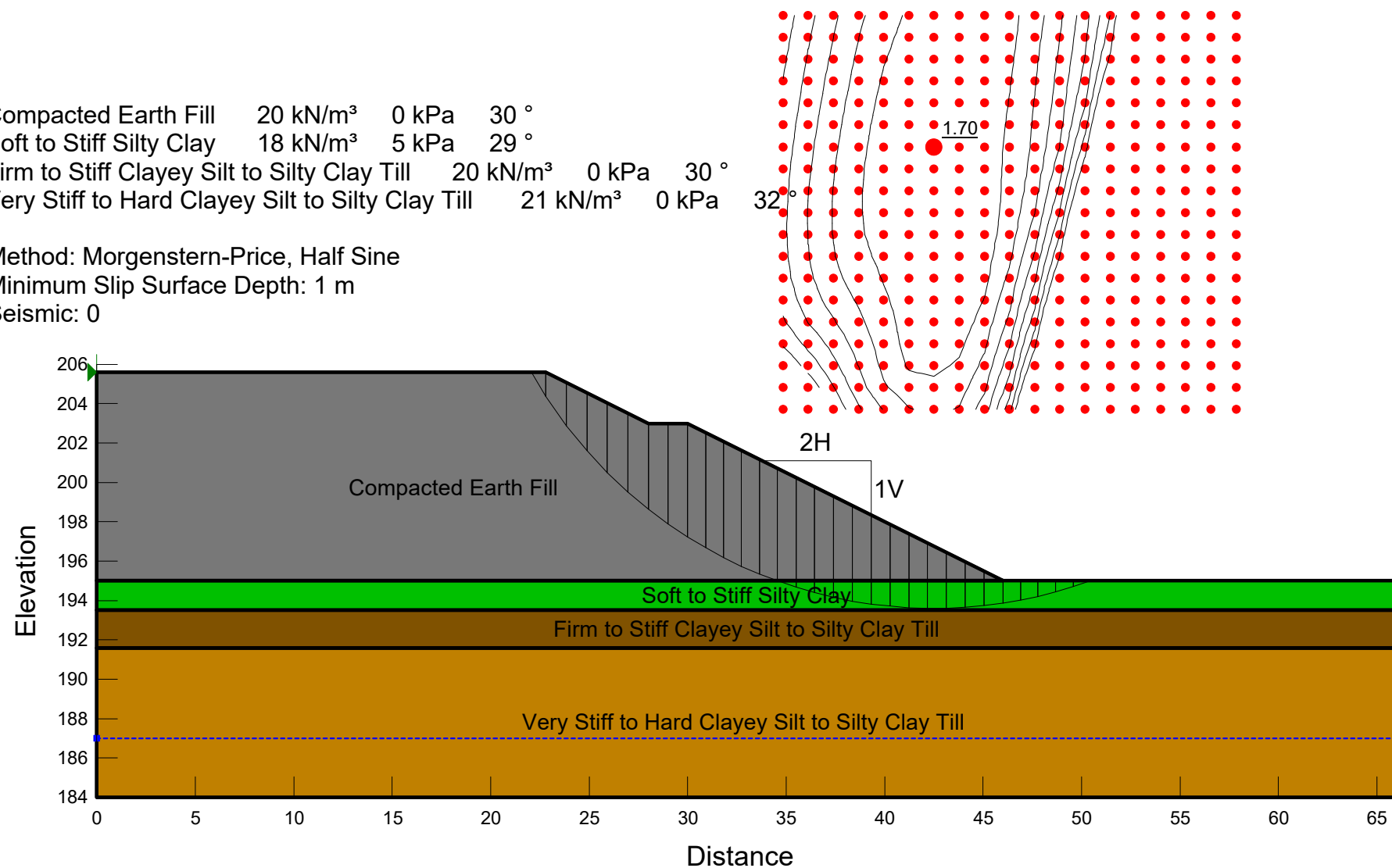
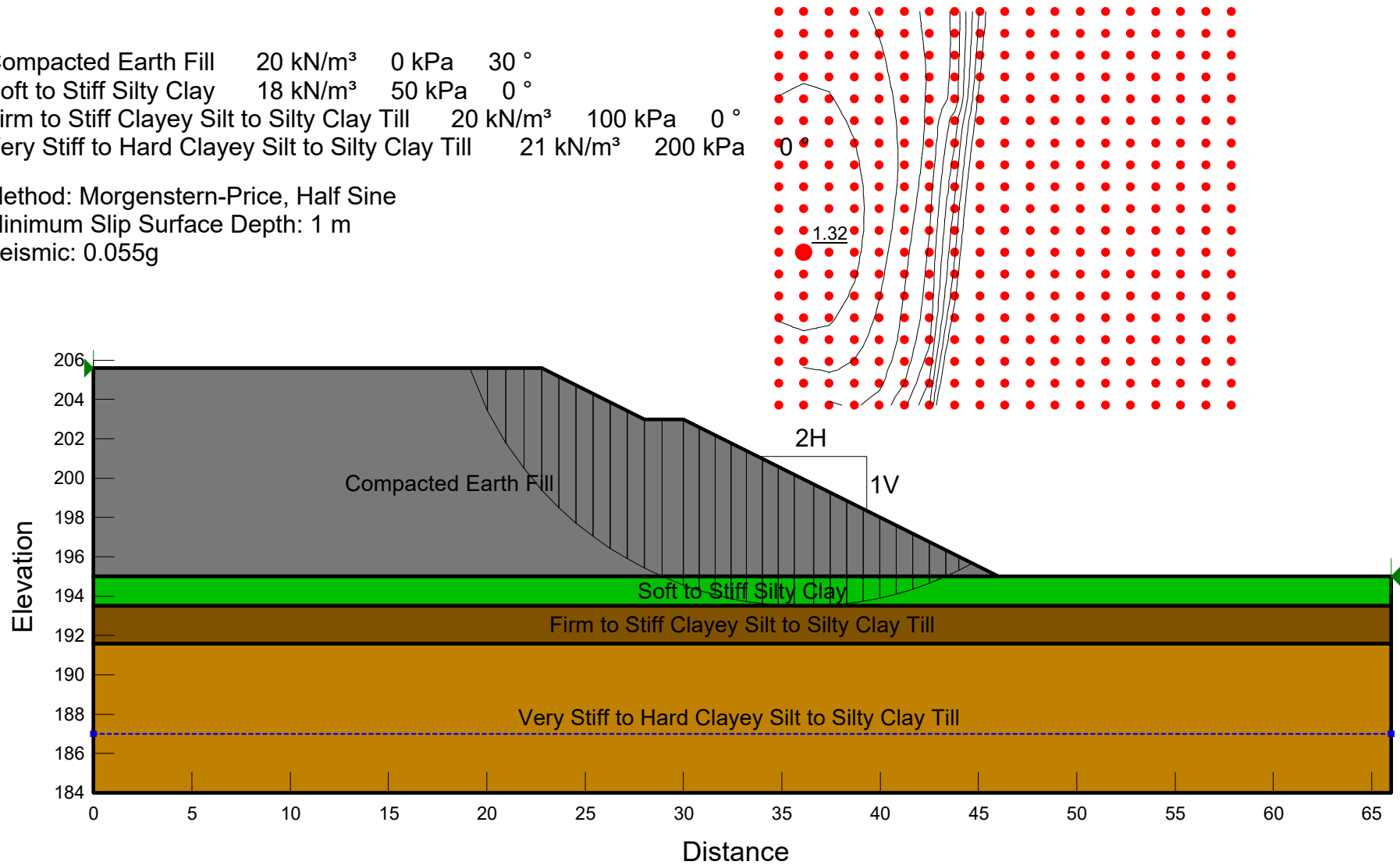


FIGURE F3

CRITICAL EMBANKMENT SECTION (STA. 15+600) SEISMIC CONDITION

Compacted Earth Fill	20 kN/m ³	0 kPa	30 °
Soft to Stiff Silty Clay	18 kN/m ³	50 kPa	0 °
Firm to Stiff Clayey Silt to Silty Clay Till	20 kN/m ³	100 kPa	0 °
Very Stiff to Hard Clayey Silt to Silty Clay Till	21 kN/m ³	200 kPa	0 °

Method: Morgenstern-Price, Half Sine
 Minimum Slip Surface Depth: 1 m
 Seismic: 0.055g



Appendix G

**CPR/McGillivray Road Overpass to Major Mackenzie Drive Overpass Embankment
(Mainline Sta. 15+700 to 16+800)**

RECORD OF BOREHOLE No FWR 17-01

1 OF 2

METRIC

W.P. _____ LOCATION N 4 853 132.4 E 292 383.2 ORIGINATED BY TM
 HWY 427 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN
 DATUM Geodetic DATE 2017.06.16 - 2017.06.15 CHECKED BY ME

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				PLASTIC LIMIT W _P	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa									
200.7	GROUND SURFACE							20	40	60	80	100					
0.0	TOPSOIL: (125mm)							20	40	60	80	100					
0.1	Silty CLAY , trace sand, trace gravel, trace organics, rootlets Firm Brown Moist		1	SS	8									○			
200.0							200										
0.7	Clayey SILT to Silty CLAY , trace sand, trace gravel Firm to Very Stiff Brown Moist (TILL)		2	SS	12									○			
			3	SS	21		199							○			
			4	SS	20		198							○			
			5	SS	22									○	—		
							197										
			6	SS	15		196							○			
							195										
			7	SS	8		194							○			
							193										
			8	SS	10									○			
							192										
			9	SS	14		191							○			

Continued Next Page

+³, ×³: Numbers refer to
Sensitivity

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(%) STRAIN AT FAILURE

METRIC

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT		UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20 40 60 80 100	20 40 60 80 100	W _P W W _L			
Continued From Previous Page													
189.1	Split spoon bouncing Becoming hard		10	SS	50/ 0.225		190						
11.6			Sandy SILT , some clay Very Dense Grey Wet (TILL)	11	SS		50/ 0.100	189					
188.4	Split spoon bouncing												0 30 47 23
12.3	END OF BOREHOLE AT 12.3m. BOREHOLE CAVED TO 11.6m AND DRY UPON COMPLETION. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG AND CUTTINGS TO SURFACE.												

+³, ×³: Numbers refer to Sensitivity

RECORD OF BOREHOLE No FWR 17-02

1 OF 2

METRIC

W.P. _____ LOCATION N 4 853 212.8 E 292 378.6 ORIGINATED BY JZ
 HWY 427 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN
 DATUM Geodetic DATE 2017.06.14 - 2017.06.14 CHECKED BY ME

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)							
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa		WATER CONTENT (%)											
201.4	GROUND SURFACE							20	40	60	80	100	W _P	W	W _L	GR	SA	SI	CL		
0.0	TOPSOIL: (175mm)							20	40	60	80	100									
0.2	Silty CLAY , trace sand, trace gravel, trace organics, rootlets Soft		1	SS	4		201							○							
200.7	Brown Moist																				
0.7	Clayey SILT to Silty CLAY , trace sand Stiff to Very Stiff Brown Moist (TILL)		2	SS	16		200							○							
			3	SS	25									●	—						
			4	SS	22		199							○							
			5	SS	20		198							○							
							197														
			6	SS	10									●	—			0	0	39	61
							196														
			7	SS	10		195							○							
							194														
			8	SS	12									○							
							193														
			9	SS	11		192							●	—						

Continued Next Page

+³, ×³: Numbers refer to
Sensitivity

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(%) STRAIN AT FAILURE

RECORD OF BOREHOLE No FWR 17-02 2 OF 2 METRIC

W.P. _____ LOCATION N 4 853 212.8 E 292 378.6 ORIGINATED BY JZ
 HWY 427 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN
 DATUM Geodetic DATE 2017.06.14 - 2017.06.14 CHECKED BY ME

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE					W _p	W	W _L			
	Continued From Previous Page							20	40	60	80	100						
190.1	Hard		10	SS	49		191											
11.3	END OF BOREHOLE AT 11.3m. BOREHOLE DRY UPON COMPLETION. Piezometer installation consists of 25mm diameter Schedule 40 PVC pipe with a 1.52m slotted screen. WATER LEVEL READINGS DATE DEPTH(m) ELEV.(m) 2017.06.29 7.9 193.5																	

RECORD OF BOREHOLE No FCPR 17-01

1 OF 2

METRIC

W.P. _____ LOCATION N 4 853 567.2 E 292 178.4 ORIGINATED BY JZ
 HWY 427 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN
 DATUM Geodetic DATE 2017.05.11 - 2017.05.11 CHECKED BY ME

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																					
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																											
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202.4	GROUND SURFACE							20	40	60	80	100																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																							

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(%) STRAIN AT FAILURE

RECORD OF BOREHOLE No FCPR 17-01 2 OF 2 METRIC

W.P. _____ LOCATION N 4 853 567.2 E 292 178.4 ORIGINATED BY JZ
 HWY 427 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN
 DATUM Geodetic DATE 2017.05.11 - 2017.05.11 CHECKED BY ME

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa						
	Continued From Previous Page							20 40 60 80 100						
								○ UNCONFINED + FIELD VANE						
								● QUICK TRIAXIAL × LAB VANE						
								20 40 60 80 100						
								WATER CONTENT (%)						
								W _P W W _L						
								20 40 60						
190.8	Clayey SILT to Silty CLAY , some sand, trace gravel Very Stiff to Hard Brown to Grey Moist (TILL)		10	SS	26		192							
							191							
11.6	SAND and SILT , some clay, trace gravel Very Dense Grey Moist (TILL)		11	SS	100/ 0.275		190							
189.6														
12.8	END OF BOREHOLE AT 12.8m. BOREHOLE DRY UPON COMPLETION. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG AND CUTTINGS TO SURFACE.													

RECORD OF BOREHOLE No FCPR 17-02 1 OF 2 METRIC

W.P. _____ LOCATION N 4 853 644.8 E 292 143.0 ORIGINATED BY TF
 HWY 427 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN
 DATUM Geodetic DATE 2017.05.11 - 2017.05.11 CHECKED BY ME

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				PLASTIC LIMIT W _P	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE									WATER CONTENT (%)
203.2	GROUND SURFACE							20	40	60	80	100					
0.0	TOPSOIL: (150mm)																
0.2	ClayeySILT, trace sand, trace gravel Firm Brown		1	SS	7									○			
202.5	Brown																
0.7	Moist																
	ClayeySILT to Silty CLAY, trace sand, trace gravel, occasional cobbles Stiff to Very Stiff Brown to Grey Moist (TILL)		2	SS	21									○			
			3	SS	21									○			
			4	SS	20									○	├───┤		0 12 46 42
			5	SS	18									○			
			6	SS	20									○			
			7	SS	15									○			
			8	SS	10									○			
			9	SS	9									○			

Continued Next Page

+³, ×³: Numbers refer to Sensitivity 20 15 10 5 0 (%) STRAIN AT FAILURE

2 OF 2

CHECKED BY ME

+³, ×³: Numbers refer to Sensitivity

RECORD OF BOREHOLE No FCPR 17-03 1 OF 2 METRIC

W.P. _____ LOCATION N 4 853 613.1 E 292 068.8 ORIGINATED BY TF
 HWY 427 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN
 DATUM Geodetic DATE 2017.06.20 - 2017.06.20 CHECKED BY ME

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				UNIT WEIGHT kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa					
								20 40 60 80 100					
203.2	GROUND SURFACE												
0.0	TOPSOIL: (100mm)												
0.1	Silty CLAY , some sand, trace gravel, trace organics and rootlets Soft Brown Moist		1	SS	3		203						
202.5													
0.7	Clayey SILT to Silty CLAY , trace to some sand, trace gravel, occasional cobbles, with oxidized stains Stiff to Hard Brown to Grey Moist (TILL)		2	SS	21		202						
			3	SS	32		201						
			4	SS	20		200						
			5	SS	15		199						
			6	SS	9		198						
			7	SS	13		197						
			8	SS	14		196						
			9	SS	11		195						
							194						

Continued Next Page

+³, ×³: Numbers refer to Sensitivity 20 15 10 5 0 (%) STRAIN AT FAILURE

RECORD OF BOREHOLE No FCPR 17-03 2 OF 2 METRIC

W.P. _____ LOCATION N 4 853 613.1 E 292 068.8 ORIGINATED BY TF
 HWY 427 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN
 DATUM Geodetic DATE 2017.06.20 - 2017.06.20 CHECKED BY ME

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa									
						○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE					WATER CONTENT (%)						
						20	40	60	80	100	20	40	60				
193.1 10.1	Continued From Previous Page END OF BOREHOLE AT 10.1m. BOREHOLE DRY UPON COMPLETION. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG AND CUTTINGS TO SURFACE.																

ONTMT4S MTO-19484.GPJ 2017TEMPLATE(MTO).GDT 10/31/17

RECORD OF BOREHOLE No FMMO 17-01 1 OF 2 METRIC

W.P. _____ LOCATION N 4 853 899.5 E 291 680.0 ORIGINATED BY ES
 HWY 427 BOREHOLE TYPE Solid Stem Augers COMPILED BY AN
 DATUM Geodetic DATE 2017.06.27 - 2017.06.27 CHECKED BY ME

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				PLASTIC LIMIT W _P	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE									WATER CONTENT (%)
205.4	GROUND SURFACE							20	40	60	80	100					
0.0	ORGANICS: (125mm)							20	40	60	80	100					
0.1	ClayeySILT, some sand, trace gravel, trace organics Firm to Very Stiff Brown Moist		1	SS	5		205							○			
			2	SS	16									○			
							204										
203.8																	
1.6	ClayeySILT to Silty CLAY, some sand, trace gravel Very Stiff to Hard Brown to Grey Moist (TILL)		3	SS	37									○			
			4	SS	31		203							○			
			5	SS	30		202							○			
							201										
			6	SS	16									○			
							200										
							199							○			
							198										
			8	SS	10									○			
							197										
			9	SS	11		196							○			

Continued Next Page

+³, ×³: Numbers refer to Sensitivity
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 15
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 (%) STRAIN AT FAILURE

RECORD OF BOREHOLE No FMMO 17-01 2 OF 2 METRIC

W.P. _____ LOCATION N 4 853 899.5 E 291 680.0 ORIGINATED BY ES
 HWY 427 BOREHOLE TYPE Solid Stem Augers COMPILED BY AN
 DATUM Geodetic DATE 2017.06.27 - 2017.06.27 CHECKED BY ME

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

RECORD OF BOREHOLE No FMMO 17-02 1 OF 2 METRIC

W.P. _____ LOCATION N 4 853 911.5 E 291 748.4 ORIGINATED BY ES
 HWY 427 BOREHOLE TYPE Solid Stem Augers COMPILED BY AN
 DATUM Geodetic DATE 2017.06.27 - 2017.06.27 CHECKED BY ME

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa						
205.1	GROUND SURFACE													
0.0	ORGANICS: (125mm)													
0.1	Clayey SILT , some sand, trace gravel, some organics Soft to Stiff Dark Brown to Brown Moist		1	SS	4									
			2	SS	15									
203.4														
1.7	Clayey SILT to Silty CLAY , some sand, trace gravel Stiff to Very Stiff Brown to Grey Moist (TILL)		3	SS	19									
			4	SS	20									
			5	SS	17									
			6	SS	15									
			7	SS	12									
			8	SS	13									
			1	SH	TW									

Continued Next Page

+³, ×³: Numbers refer to Sensitivity
 20
 15
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 (%) STRAIN AT FAILURE

RECORD OF BOREHOLE No FMMO 17-02 2 OF 2 METRIC

W.P. _____ LOCATION N 4 853 911.5 E 291 748.4 ORIGINATED BY ES
 HWY 427 BOREHOLE TYPE Solid Stem Augers COMPILED BY AN
 DATUM Geodetic DATE 2017.06.27 - 2017.06.27 CHECKED BY ME

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE									
							20	40	60	80	100						
	Continued From Previous Page																
193.4			9	SS	24												
11.7	Sandy SILT, trace gravel Very Dense Grey Moist (TILL)																
192.5			10	SS	66												
12.6	END OF BOREHOLE AT 12.6m. Piezometer installation consists of 25mm diameter Schedule 40 PVC pipe with a 3.05m slotted screen. WATER LEVEL READINGS DATE DEPTH(m) ELEV.(m) 2017.06.29 11.9 193.2																

RECORD OF BOREHOLE No FMMO 17-03 1 OF 2 METRIC

W.P. _____ LOCATION N 4 853 897.4 E 291 797.8 ORIGINATED BY ES
 HWY 427 BOREHOLE TYPE Solid Stem Augers COMPILED BY AN
 DATUM Geodetic DATE 2017.06.27 - 2017.06.27 CHECKED BY ME

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)		
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa								
205.0	GROUND SURFACE							20	40	60	80	100	PLASTIC LIMIT w _P	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w _L	
0.0	ORGANICS: (150mm)							20	40	60	80	100	WATER CONTENT (%)			
0.2	Clayey SILT , some sand, trace gravel Soft to Very Stiff Brown to Grey Moist		1	SS	4		204									
			2	SS	16											
203.6	Occasional oxide stains															
1.4	Clayey SILT to Silty CLAY , some sand, trace gravel Very Stiff to Hard Brown to Grey Moist (TILL)		3	SS	22		203									
			4	SS	40		202									
			5	SS	21											
							201									
			6	SS	15		200									0 4 38 58
							199									
198.7																
6.3	Sandy SILT , trace clay, trace gravel Compact Grey Moist (TILL)		7	SS	28		198									
197.8																
7.2	Clayey SILT to Silty CLAY , some sand, trace gravel Stiff to Hard Grey Moist (TILL)		8	SS	32		197									
							196									
			9	SS	14											

Continued Next Page

+³, ×³: Numbers refer to
Sensitivity

20
15
10
(%) STRAIN AT FAILURE

RECORD OF BOREHOLE No FMMO 17-03 2 OF 2 METRIC

W.P. _____ LOCATION N 4 853 897.4 E 291 797.8 ORIGINATED BY ES
 HWY 427 BOREHOLE TYPE Solid Stem Augers COMPILED BY AN
 DATUM Geodetic DATE 2017.06.27 - 2017.06.27 CHECKED BY ME

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL			
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa				WATER CONTENT (%)							
								20 40 60 80 100				W _P W W _L							
	Continued From Previous Page							○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE											
			10	SS	19		194												
							193												
192.2			11	SS	36														
12.8	END OF BOREHOLE AT 12.8m. BOREHOLE DRY UPON COMPLETION. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG AND CUTTINGS TO SURFACE.																		

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RECORD OF BOREHOLE No FMMO 17-04 1 OF 2 METRIC

W.P. _____ LOCATION N 4 853 726.4 E 292 024.4 ORIGINATED BY TF
 HWY 427 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN
 DATUM Geodetic DATE 2017.06.22 - 2017.06.22 CHECKED BY ME

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)					
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE		WATER CONTENT (%) W _P W W _L				GR	SA	SI	CL		
203.8	GROUND SURFACE							20	40	60	80	100							
0.0	TOPSOIL: (125mm)							20	40	60	80	100							
0.1	Clayey SILT , trace sand, trace gravel, occasional oxide stains Firm to Stiff Brown Moist		1	SS	7									○					
			2	SS	12									○					
202.3																			
1.5	Clayey SILT to Silty CLAY , trace to some sand, trace gravel Stiff to Very Stiff Brown to Grey Moist (TILL)		3	SS	19									○					
			4	SS	26									○					
			5	SS	15									○					
			6	SS	9									○					
			7	SS	12									○					
			8	SS	10									○					
			1	TW										●	●				0 16 42 42
			9	SS	14									○					

Continued Next Page

+³, ×³: Numbers refer to
Sensitivity

20
15
10
(%) STRAIN AT FAILURE

RECORD OF BOREHOLE No FMMO 17-04 2 OF 2 METRIC

W.P. _____ LOCATION N 4 853 726.4 E 292 024.4 ORIGINATED BY TF
 HWY 427 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN
 DATUM Geodetic DATE 2017.06.22 - 2017.06.22 CHECKED BY ME

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC NATURAL LIQUID LIMIT MOISTURE LIMIT CONTENT			UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa 20 40 60 80 100 ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE					WATER CONTENT (%) 20 40 60 W _p W W _L				
	Continued From Previous Page																
			10	SS	11		193										
							192										
191.0	Hard		11	SS	40												
12.8	END OF BOREHOLE AT 12.8m. BOREHOLE DRY UPON COMPLETION. Well installation consists of 25mm diameter Schedule 40 PVC pipe with a 1.52m slotted screen. WATER LEVEL READINGS DATE DEPTH(m) ELEV.(m) 2017.06.29 Dry -						191										

RECORD OF BOREHOLE No FMMO 17-05 1 OF 2 METRIC

W.P. _____ LOCATION N 4 853 679.8 E 292 063.9 ORIGINATED BY TF
 HWY 427 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN
 DATUM Geodetic DATE 2017.05.12 - 2017.05.12 CHECKED BY ME

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)						
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa												
								○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE												
203.5	GROUND SURFACE							20	40	60	80	100								
0.0	TOPSOIL: (100mm)																			
0.1	Clayey SILT, trace gravel, organics Firm Brown Moist		1	SS	5		203													
202.8																				
0.7	Clayey SILT to Silty CLAY, trace to some sand, trace gravel, occasional cobbles and boulders Firm to Very Stiff Brown to Grey Moist (TILL)		2	SS	11		202													
			3	SS	9															
			4	SS	8		201													
			5	SS	6		200													
			6	SS	9		199													
			7	SS	9		198													
			8	SS	8		197													
			9	SS	8		196													
							195													
							194													

Continued Next Page

+³, ×³: Numbers refer to
Sensitivity

20
15
10
(%) STRAIN AT FAILURE

RECORD OF BOREHOLE No FMMO 17-05 2 OF 2 METRIC

W.P. _____ LOCATION N 4 853 679.8 E 292 063.9 ORIGINATED BY TF
 HWY 427 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN
 DATUM Geodetic DATE 2017.05.12 - 2017.05.12 CHECKED BY ME

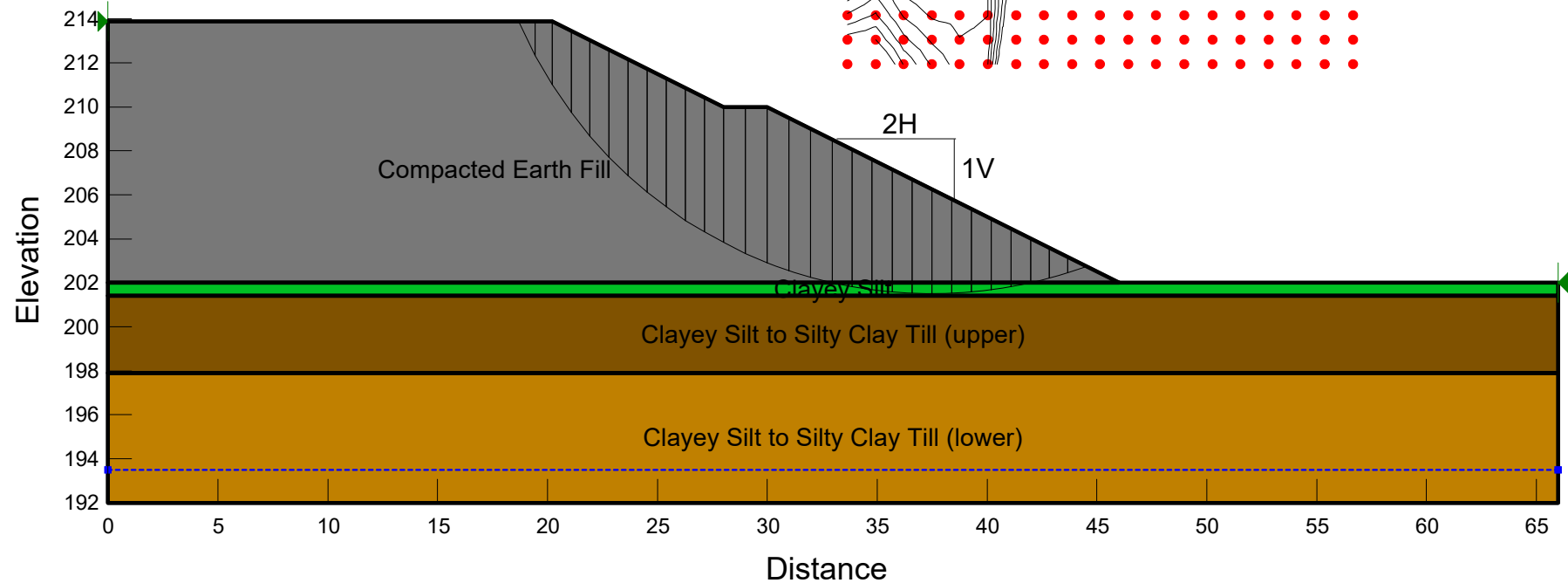
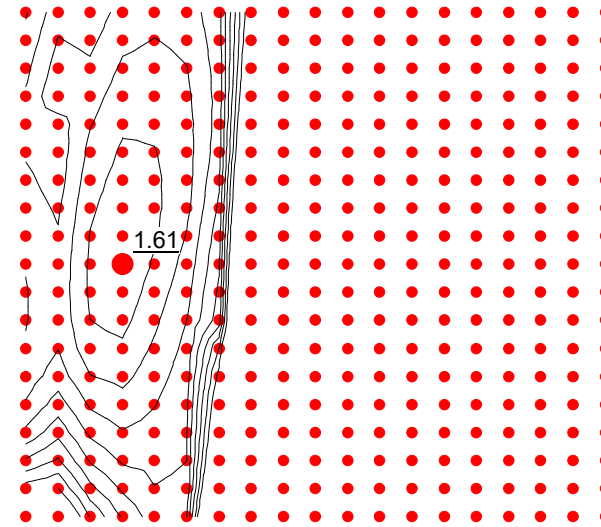
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE									
	Continued From Previous Page																
			10	SS	20		193										
							192										
			11	SS	5		191										
190.7 12.8	END OF BOREHOLE AT 12.8m. WATER LEVEL AT 5.8m UPON COMPLETION. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG AND CUTTINGS TO SURFACE.																

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CRITICAL EMBANKMENT SECTION (STA. 16+080) SHORT-TERM CONDITION

Compacted Earth Fill	20 kN/m ³	0 kPa	30 °
Clayey Silt	18 kN/m ³	50 kPa	0 °
Clayey Silt to Silty Clay Till (upper)	21 kN/m ³	100 kPa	0 °
Clayey Silt to Silty Clay Till (lower)	20 kN/m ³	75 kPa	0 °

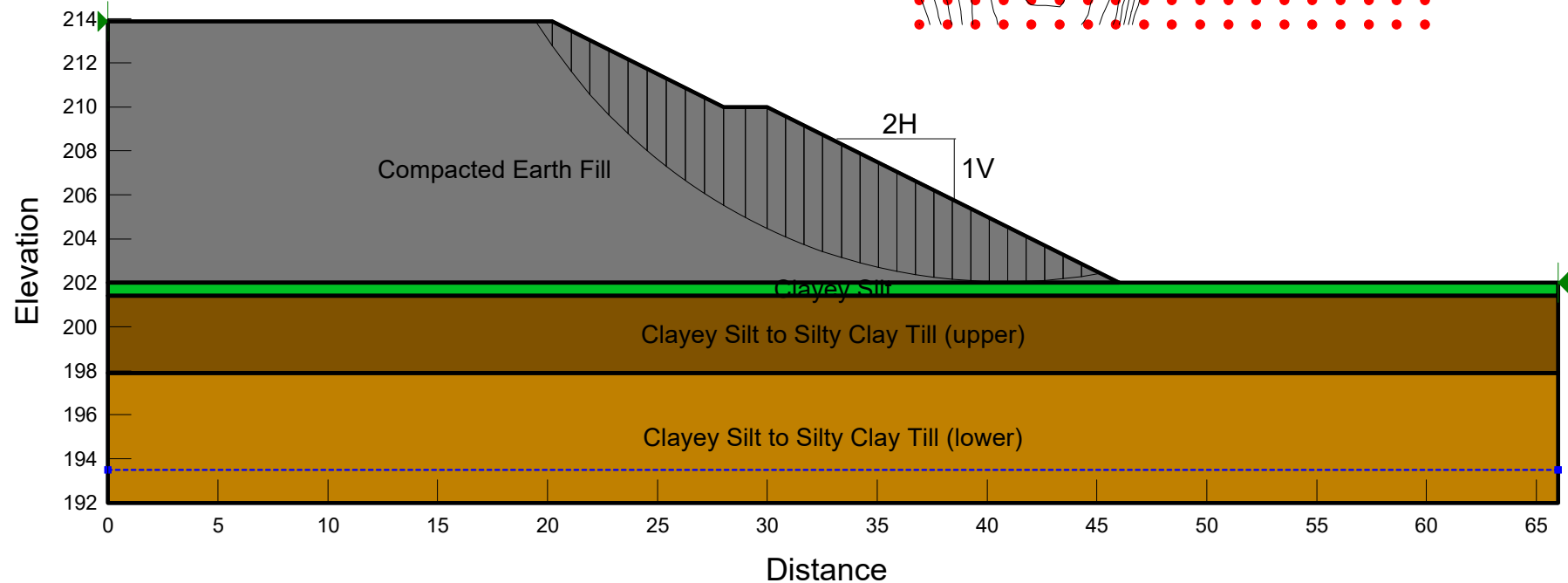
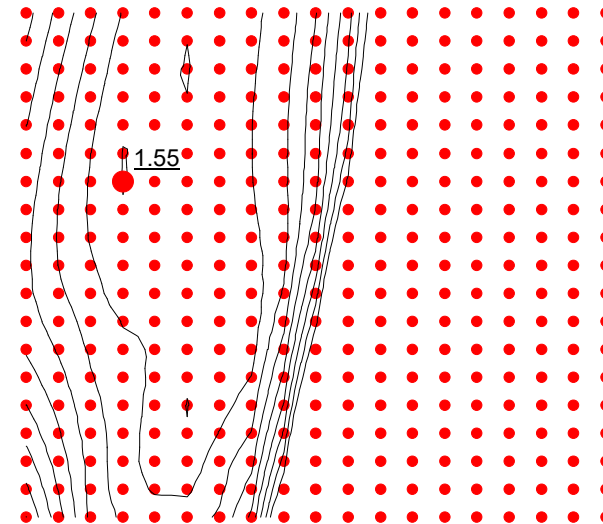
Method: Morgenstern-Price, Half Sine
Minimum Slip Surface Depth: 1 m
Seismic: 0



CRITICAL EMBANKMENT SECTION (STA. 16+080) **LONG-TERM CONDITION**

Compacted Earth Fill	20 kN/m ³	0 kPa	30 °
Clayey Silt	18 kN/m ³	5 kPa	30 °
Clayey Silt to Silty Clay Till (upper)	21 kN/m ³	0 kPa	32 °
Clayey Silt to Silty Clay Till (lower)	20 kN/m ³	0 kPa	31 °

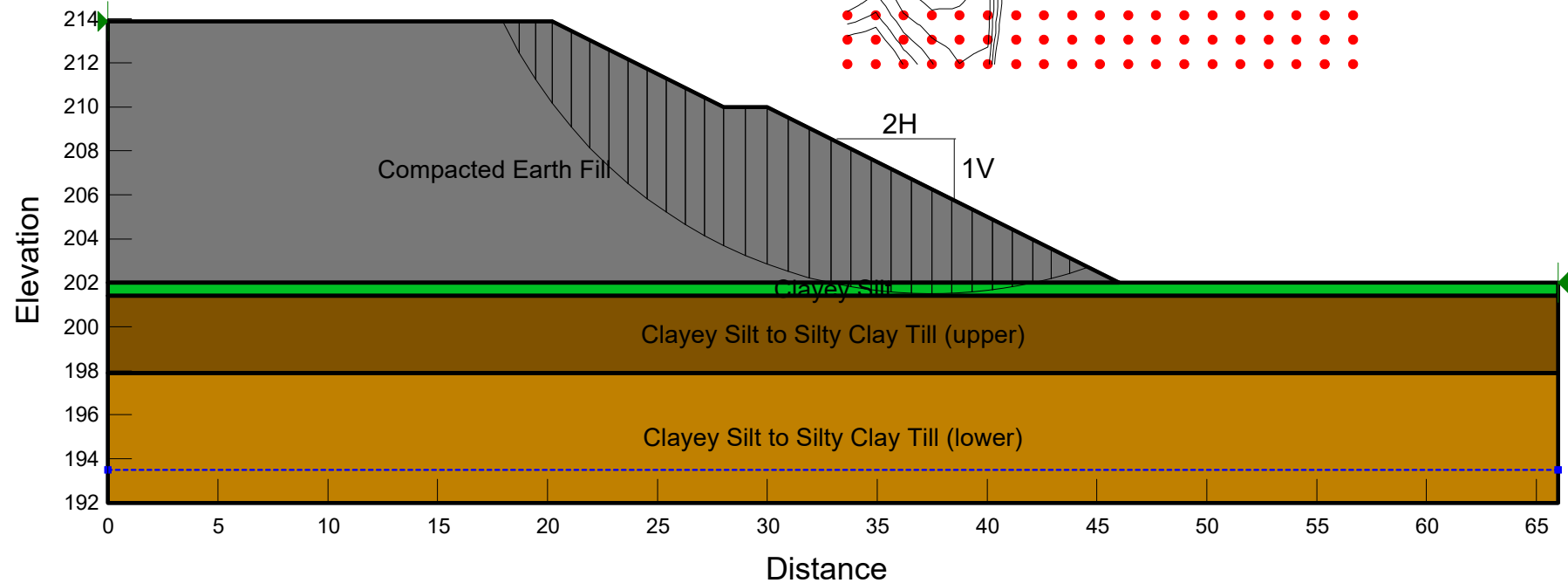
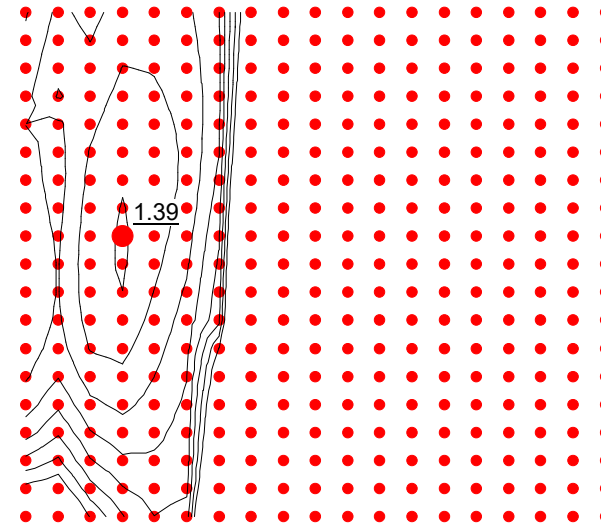
Method: Morgenstern-Price, Half Sine
 Minimum Slip Surface Depth: 1 m
 Seismic: 0



CRITICAL EMBANKMENT SECTION (STA. 16+080) **SEISMIC CONDITION**

Compacted Earth Fill	20 kN/m ³	0 kPa	30 °
Clayey Silt	18 kN/m ³	50 kPa	0 °
Clayey Silt to Silty Clay Till (upper)	21 kN/m ³	100 kPa	0 °
Clayey Silt to Silty Clay Till (lower)	20 kN/m ³	75 kPa	0 °

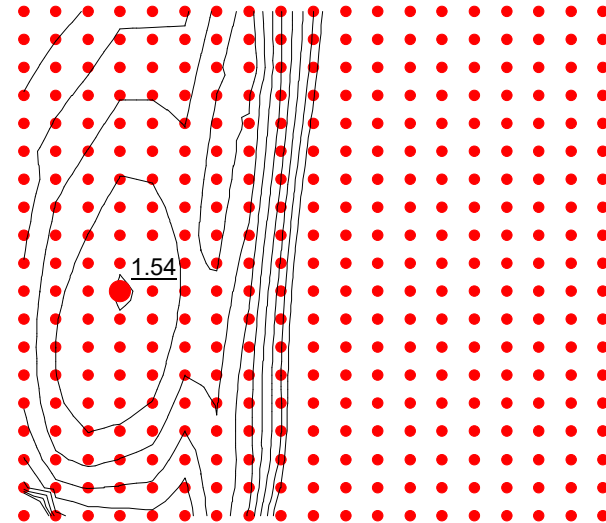
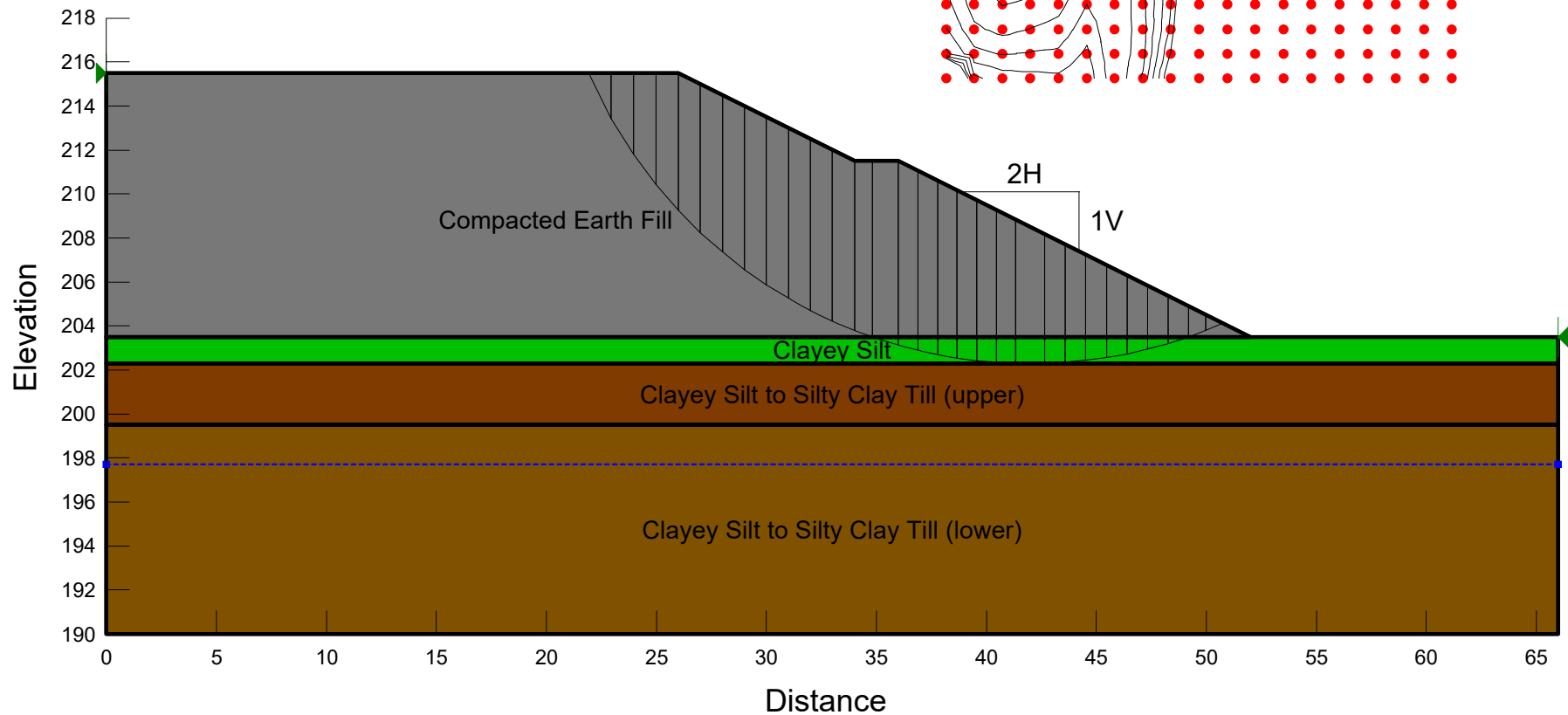
Method: Morgenstern-Price, Half Sine
 Minimum Slip Surface Depth: 1 m
 Seismic: 0.055g



CRITICAL EMBANKMENT SECTION (STA. 16+300) **SHORT-TERM CONDITION**

Compacted Earth Fill	20 kN/m ³	0 kPa	30 °
Clayey Silt	18 kN/m ³	50 kPa	0 °
Clayey Silt to Silty Clay Till (upper)	21 kN/m ³	100 kPa	0 °
Clayey Silt to Silty Clay Till (lower)	20 kN/m ³	75 kPa	0 °

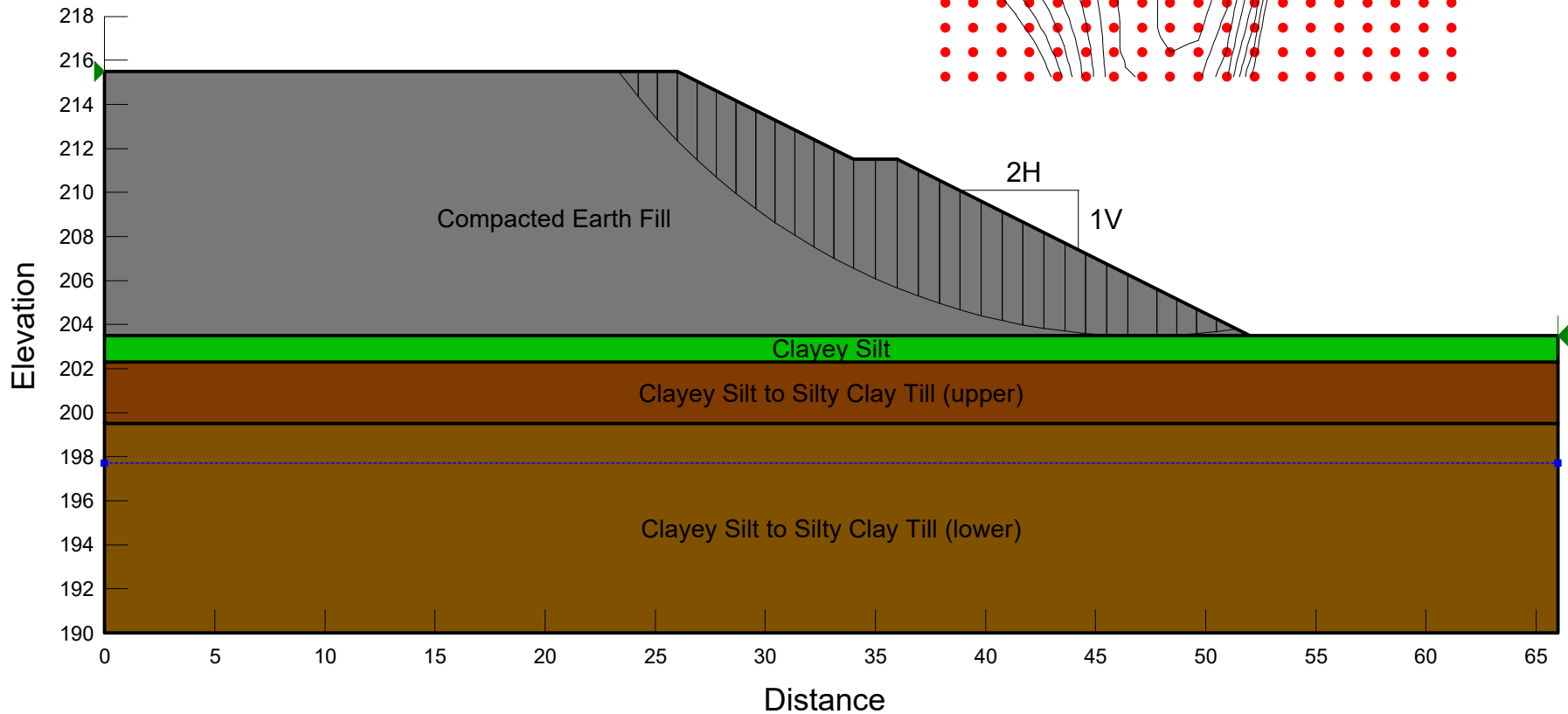
Method: Morgenstern-Price, Half Sine
 Minimum Slip Surface Depth: 1 m
 Seismic: 0



CRITICAL EMBANKMENT SECTION (STA. 16+300) **LONG-TERM CONDITION**

Compacted Earth Fill	20 kN/m ³	0 kPa	30 °
Clayey Silt	18 kN/m ³	5 kPa	30 °
Clayey Silt to Silty Clay Till (upper)	21 kN/m ³	0 kPa	32 °
Clayey Silt to Silty Clay Till (lower)	20 kN/m ³	0 kPa	31 °

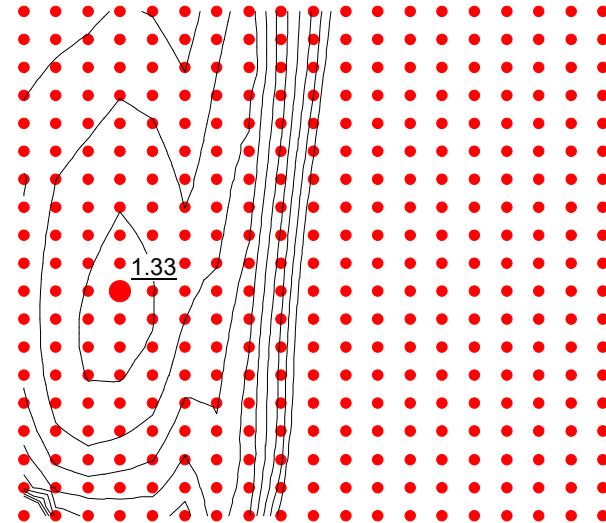
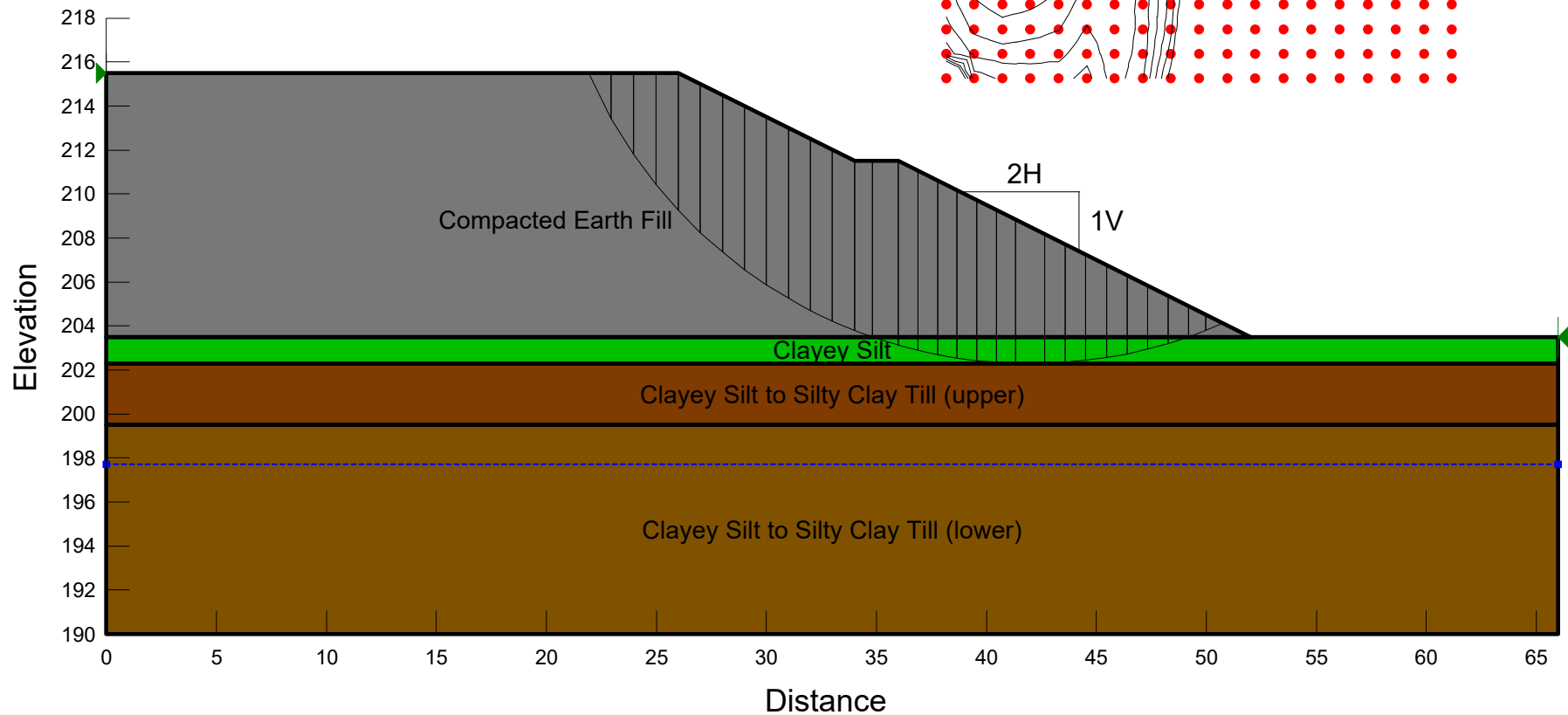
Method: Morgenstern-Price, Half Sine
 Minimum Slip Surface Depth: 1 m
 Seismic: 0



CRITICAL EMBANKMENT SECTION (STA. 16+300) **SEISMIC CONDITION**

Compacted Earth Fill	20 kN/m ³	0 kPa	30 °
Clayey Silt	18 kN/m ³	50 kPa	0 °
Clayey Silt to Silty Clay Till (upper)	21 kN/m ³	100 kPa	0 °
Clayey Silt to Silty Clay Till (lower)	20 kN/m ³	75 kPa	0 °

Method: Morgenstern-Price, Half Sine
 Minimum Slip Surface Depth: 1 m
 Seismic: 0.055g



CRITICAL EMBANKMENT SECTION (STA. 16+520) **SHORT-TERM CONDITION**

Compacted Earth Fill	20 kN/m ³	0 kPa	30 °
Clayey Silt	18 kN/m ³	50 kPa	0 °
Clayey Silt Till (upper)	21 kN/m ³	100 kPa	0 °
Clayey Silt Till (lower)	20 kN/m ³	75 kPa	0 °

Method: Morgenstern-Price, Half Sine
 Minimum Slip Surface Depth: 1 m
 Seismic: 0

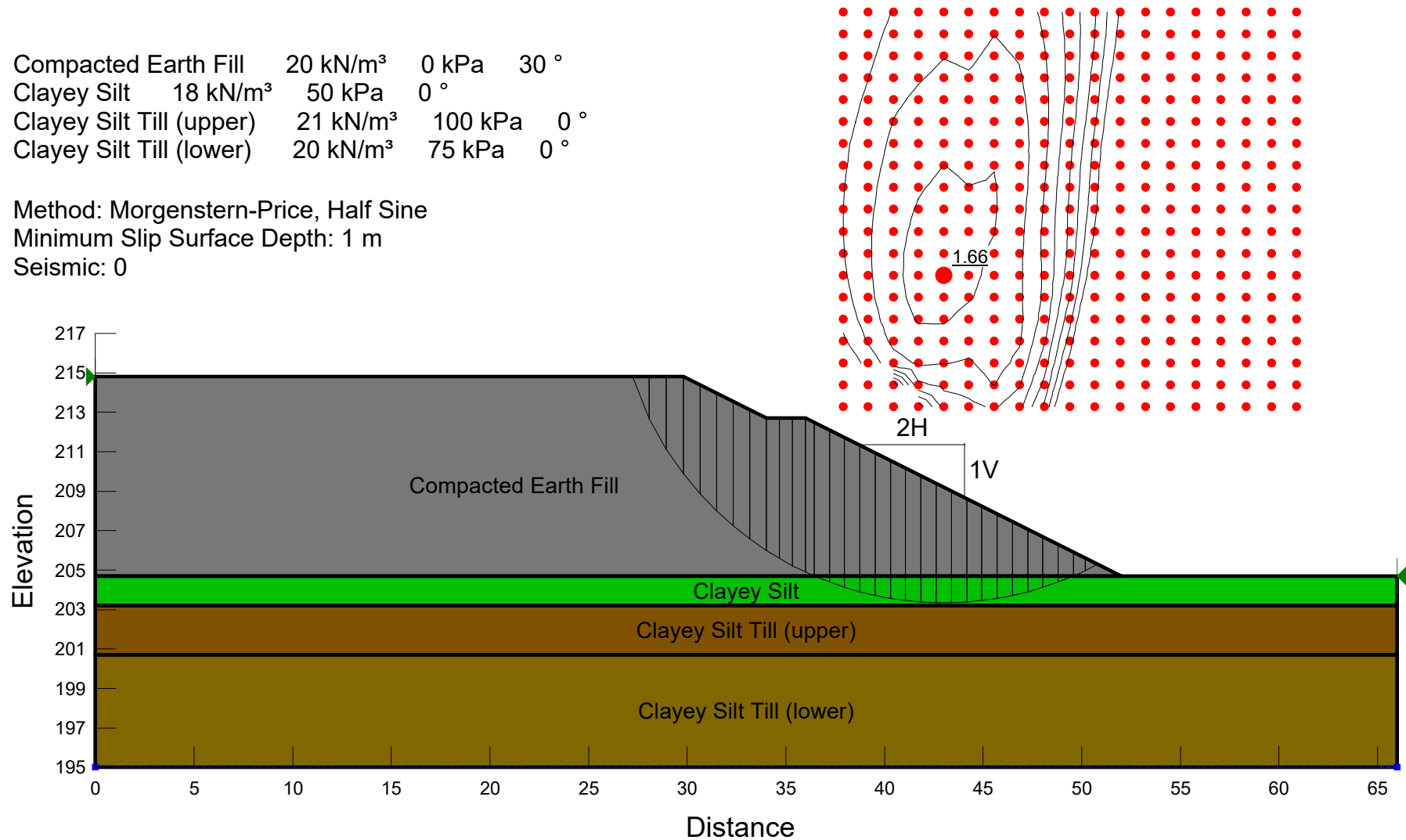
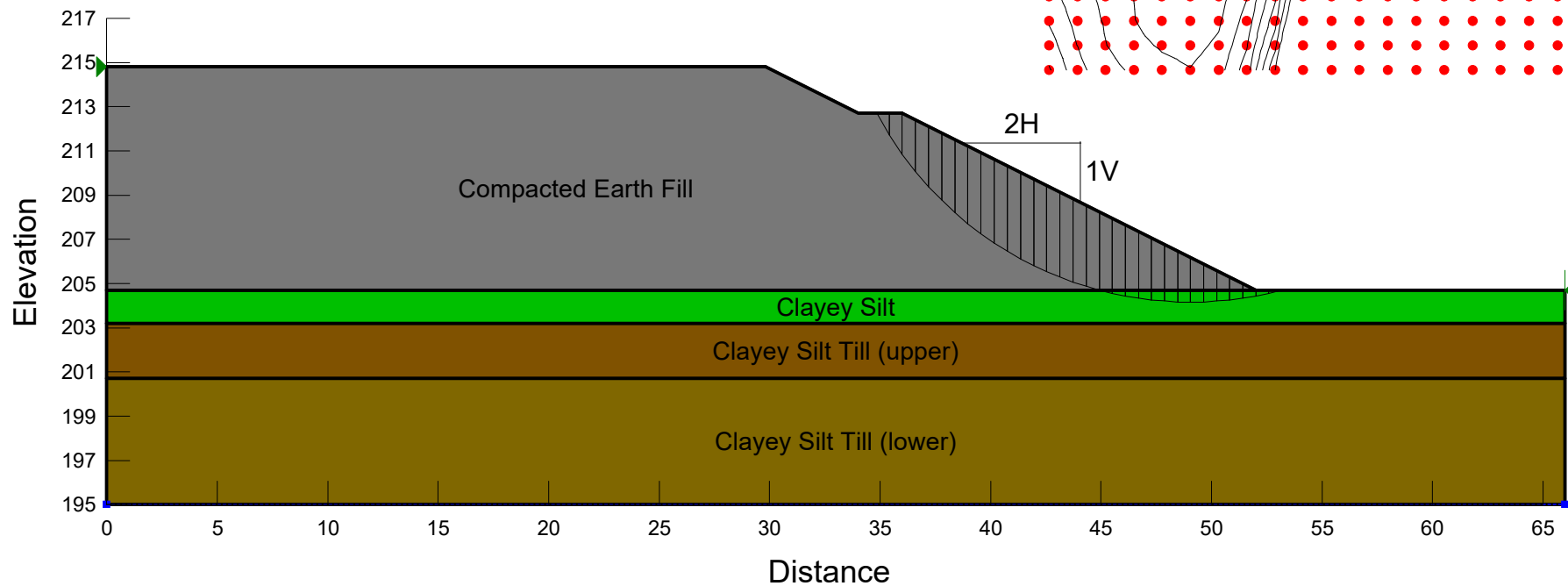
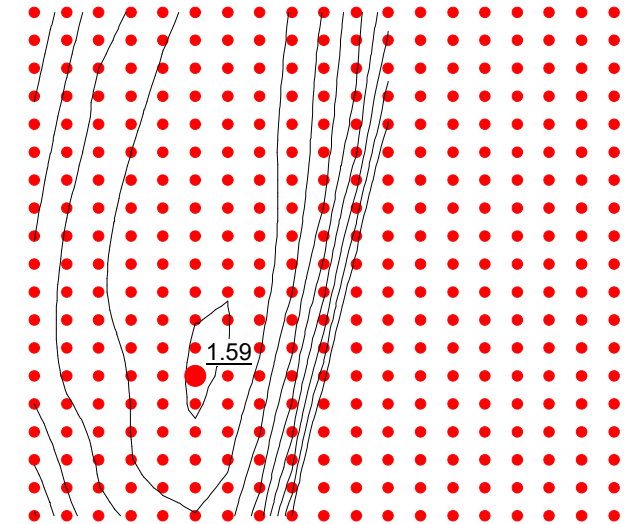


FIGURE G8

CRITICAL EMBANKMENT SECTION (STA. 16+520) LONG-TERM CONDITION

Compacted Earth Fill	20 kN/m ³	0 kPa	30 °
Clayey Silt	18 kN/m ³	5 kPa	30 °
Clayey Silt Till (upper)	21 kN/m ³	0 kPa	32 °
Clayey Silt Till (lower)	20 kN/m ³	0 kPa	31 °

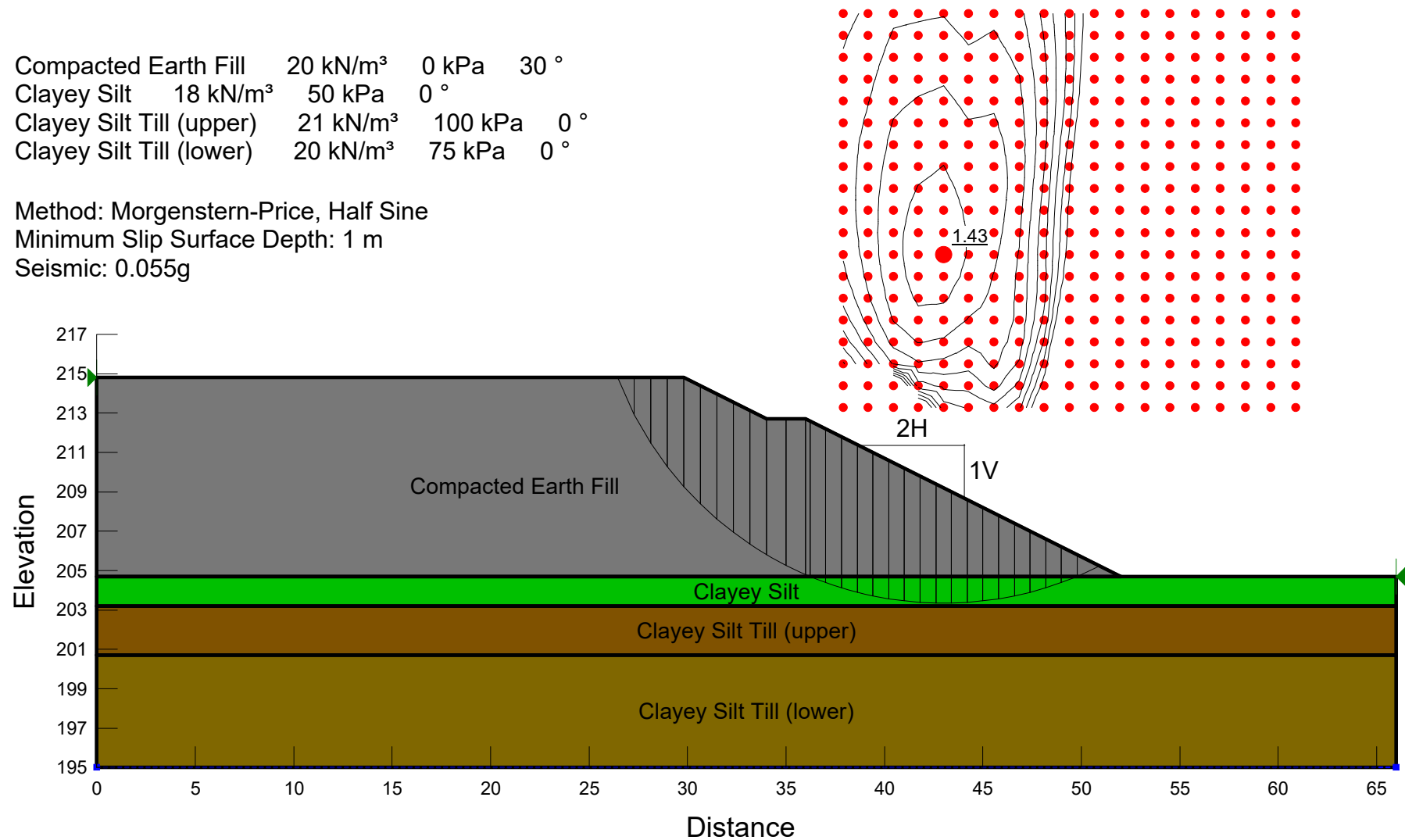
Method: Morgenstern-Price, Half Sine
Minimum Slip Surface Depth: 1 m
Seismic: 0



CRITICAL EMBANKMENT SECTION (STA. 16+520) **SEISMIC CONDITION**

Compacted Earth Fill	20 kN/m ³	0 kPa	30 °
Clayey Silt	18 kN/m ³	50 kPa	0 °
Clayey Silt Till (upper)	21 kN/m ³	100 kPa	0 °
Clayey Silt Till (lower)	20 kN/m ³	75 kPa	0 °

Method: Morgenstern-Price, Half Sine
 Minimum Slip Surface Depth: 1 m
 Seismic: 0.055g



Appendix H
Major Mackenzie Drive at West Robinson Creek Bridge
West Approach Embankment
(Sta. 9+300 to 9+400)

RECORD OF BOREHOLE No MMW 17-01 1 OF 2 METRIC

W.P. _____ LOCATION N 4 853 547.5 E 291 323.8 ORIGINATED BY ES
 HWY 427 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN
 DATUM Geodetic DATE 2017.07.06 - 2017.07.06 CHECKED BY ME

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa						
200.8	GROUND SURFACE							20	40	60	80	100		
0.8	ASPHALT: (25mm)													
	SAND, some to trace gravel Compact Brown Moist (FILL)		1	GS			200							
			1	SS	16									
199.3														
1.5	ClayeySILT, some sand, trace gravel Soft to Stiff Dark Brown Moist		2	SS	5		199							
			3	SS	4		198							
			4	SS	9									
							197							
196.8	75mm sand seam at 3.5m													
4.0	SILT AND SAND, trace clay Very Dense Grey Moist (TILL)		5	SS	50/ 0.100		196							
							195							
			6	SS	91		194							
							193							
			7	SS	88									
							192							
191.5	Cobbles		8	SS	86/									
9.3	END OF BOREHOLE AT 9.3m. BOREHOLE OPEN AND WATER LEVEL AT 8.2m. BOREHOLE BACKFILLED WITH				0.175									

Continued Next Page

+³, ×³: Numbers refer to
Sensitivity

20
15
10

(%) STRAIN AT FAILURE

2 OF 2

W.P.	LOCATION	N 4 853 547.5 E 291 323.8	ORIGINATED BY	ES
HWY 427	BOREHOLE TYPE	Hollow Stem Augers	COMPILED BY	AN
DATUM Geodetic	DATE	2017.07.06 - 2017.07.06	CHECKED BY	ME

[illegible]

RECORD OF BOREHOLE No MMW 17-02 1 OF 2 METRIC

W.P. _____ LOCATION N 4 853 577.0 E 291 399.6 ORIGINATED BY ES
 HWY 427 BOREHOLE TYPE Solid Stem Augers COMPILED BY AN
 DATUM Geodetic DATE 2017.07.28 - 2017.07.28 CHECKED BY ME

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL			
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa									
								○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE									
202.8	GROUND SURFACE							20	40	60	80	100					
0.0	TOPSOIL: (100mm)																
0.1	ClayeySILT, some sand, trace gravel Firm Brown Moist		1	SS	6												
201.9							202										
0.9	ClayeySILT, some sand, trace gravel Very Stiff to Hard Brown to Grey Moist (TILL)		2	SS	22												
			3	SS	32		201										
	Occasional oxide stains		4	SS	37		200										
			5	SS	26												
							199										
			6	SS	19		198										
	Occasional sand seam																
197.2																	
5.6	SILT AND SAND, trace clay, trace gravel Compact to Very Dense Grey Moist (TILL)		7	SS	24		197										
							196										
			8	SS	88		195										
							194										
			9	SS	40												
193.0																	
9.8	END OF BOREHOLE AT 9.8m.																

Continued Next Page

+³, ×³: Numbers refer to
Sensitivity

20
15
10
(%) STRAIN AT FAILURE

2 OF 2

W.P.	LOCATION	N 4 853 577.0 E 291 399.6	ORIGINATED BY	ES
HWY 427	BOREHOLE TYPE	Solid Stem Augers	COMPILED BY	AN
DATUM Geodetic	DATE	2017.07.28 - 2017.07.28	CHECKED BY	ME

[illegible]

RECORD OF BOREHOLE No MMW 17-03

1 OF 2

METRIC

W.P. _____ LOCATION N 4 853 568.0 E 291 337.7 ORIGINATED BY KK
 HWY 427 BOREHOLE TYPE Hollow Stem Augers/Tricone COMPILED BY AN
 DATUM Geodetic DATE 2017.07.10 - 2017.07.10 CHECKED BY ME

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE									
199.4	GROUND SURFACE						20	40	60	80	100	20	40	60			
0.0	TOPSOIL: (225mm)																
0.2	Clayey SILT , trace sand, trace gravel Soft to Stiff Brown Moist		1	SS	2								○				
			2	SS	4								○				
			3	SS	10								○				
197.1																	
2.3	SILT AND SAND , some clay Dense to Very Dense Grey Moist (TILL)		4	SS	34								○				
			5	SS	59								○				
			6	SS	100/ 0.250								⊕				
			7	SS	70								○				
			8	SS	81								○				
			9	SS	102/ 0.275								○				

Continued Next Page

+³, ×³: Numbers refer to Sensitivity
 20
 15
 10
 (%) STRAIN AT FAILURE

RECORD OF BOREHOLE No MMW 17-03 2 OF 2 METRIC

W.P. _____ LOCATION N 4 853 568.0 E 291 337.7 ORIGINATED BY KK
 HWY 427 BOREHOLE TYPE Hollow Stem Augers/Tricone COMPILED BY AN
 DATUM Geodetic DATE 2017.07.10 - 2017.07.10 CHECKED BY ME

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				PLASTIC LIMIT W _P	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)							
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa								WATER CONTENT (%)				GR	SA	SI	CL
								20	40	60	80					100	20	40	60				
	Continued From Previous Page																						
189.2																							
10.2	SAND and GRAVEL , trace silt, trace clay Very Dense Grey Moist		10	SS	87		189								o			35	49	16 (SI+CL)			
							188																
			11	SS	51		187								o								
							186																
			12	SS	12		185								o								
							184																
183.6			13	SS	16										o								
15.8	END OF BOREHOLE AT 15.8m. Piezometer installation consists of 25mm diameter Schedule 40 PVC pipe with a 1.52m slotted screen.																						

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RECORD OF BOREHOLE No MMW 17-04 1 OF 4 METRIC

W.P. _____ LOCATION N 4 853 582.0 E 291 376.7 ORIGINATED BY KK
 HWY 427 BOREHOLE TYPE Hollow Stem Augers/Tricone COMPILED BY AN
 DATUM Geodetic DATE 2017.07.05 - 2017.07.06 CHECKED BY ME

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa						
202.7	GROUND SURFACE							20	40	60	80	100		
0.0	TOPSOIL: (100mm)							20	40	60	80	100		
0.1	ClayeySILT, trace gravel, organics Firm Brown Moist		1	SS	5		202							
201.9														
0.8	ClayeySILT, trace sand, trace gravel Very Stiff to Hard Brown to Grey Moist (TILL)		2	SS	17		201							
			3	SS	17		200							
			4	SS	51		199							
			5	SS	30		198							
			6	SS	32		197							
197.1														
5.6	SILT AND SAND, trace gravel, some clay Dense to Very Dense Grey Moist (TILL)		7	SS	40		196							
			8	SS	88		195							
			9	SS	101/ 0.250		194							
							193							

Continued Next Page

+³, ×³: Numbers refer to
Sensitivity

20
15
10
(%) STRAIN AT FAILURE

RECORD OF BOREHOLE No MMW 17-04 2 OF 4 METRIC

W.P. _____ LOCATION N 4 853 582.0 E 291 376.7 ORIGINATED BY KK
 HWY 427 BOREHOLE TYPE Hollow Stem Augers/Tricone COMPILED BY AN
 DATUM Geodetic DATE 2017.07.05 - 2017.07.06 CHECKED BY ME

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa						
	Continued From Previous Page													
	SILT AND SAND, some gravel, some clay Very Dense Grey Moist (TILL)		10	SS	100/ 0.275		192							
							191							
			11	SS	68		190							
							189							
			12	SS	53		188							
							187							
			13	SS	38		186							
							185							
			14	SS	100/ 0.275		184							
							183							
			15	SS	100/ 0.275									

Continued Next Page

+³, ×³: Numbers refer to Sensitivity 20 15 10 5 0 (%) STRAIN AT FAILURE

3 OF 4

ORIGINATED BY KK

COMPILED BY AN

CHECKED BY ME

Continued Next Page

+³, ×³: Numbers refer to Sensitivity

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RECORD OF BOREHOLE No MMW 17-04 4 OF 4 METRIC

W.P. _____ LOCATION N 4 853 582.0 E 291 376.7 ORIGINATED BY KK
 HWY 427 BOREHOLE TYPE Hollow Stem Augers/Tricone COMPILED BY AN
 DATUM Geodetic DATE 2017.07.05 - 2017.07.06 CHECKED BY ME

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				PLASTIC LIMIT W _P	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa								
	Continued From Previous Page															
172.2																
30.5	SHALE moderately weathered to fresh, thinly bedded, horizontal laminated, weak to medium strong with strong to very strong limestone interbeds, grey: (Georgian Bay Formation)		20	SS	100/0.075											
171.2																
171.2				21	SS	100/0.075										
31.5	Highly fractured (100mm) at 31.5m															
	Sub-vertical fracture (175mm) at 31.7m and (50mm) at 32.0m		1	RUN												
	Vertical fracture (75mm) at 32.2m															
	Limestone interbed (175mm) at 32.2m and (150mm) at 32.7m		2	RUN												
	Limestone interbed (350mm) at 33.9m and (225mm) at 34.3m															
	Vertical fracture (150mm) at 33.8m		3	RUN												
167.4																
35.3	END OF BOREHOLE AT 32.3m. Piezometer installation consists of two 25mm and 50mm diameter Schedule 40 PVC pipe with a 3.05m and 1.52m slotted screen. DEEP WATER LEVEL READINGS: DATE DEPTH (m) ELEV. (m) 2017.08.09 1.9 200.8 SHALLOW WATER LEVEL READINGS: DATE DEPTH (m) ELEV. (m) 2017.08.08 Dry - 2017.08.09 Dry -															

RECORD OF BOREHOLE No MMW 17-05 1 OF 4 METRIC

W.P. _____ LOCATION N 4 853 547.5 E 291 344.6 ORIGINATED BY KK
 HWY 427 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN
 DATUM Geodetic DATE 2017.07.04 - 2017.07.11 CHECKED BY ME

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa							
201.0	GROUND SURFACE							<div><div>20406080100</div><div>○ UNCONFINED + FIELD VANE</div><div>● QUICK TRIAXIAL × LAB VANE</div></div>							
0.0	ASPHALT: (125mm)							<div><div>20406080100</div><div>○ UNCONFINED + FIELD VANE</div><div>● QUICK TRIAXIAL × LAB VANE</div></div>							
0.1	SAND, some gravel, trace silt Compact Brown Moist (FILL)		1	SS	28		200								
			2	SS	13										
			3	SS	14		199								
198.8															
2.2	Silty CLAY, some sand, trace gravel Stiff Brown Moist		4	SS	9		198								
			5	SS	9										
							197								
196.9															
4.1	SILT AND SAND, clayey Very Dense Grey Moist (TILL)		6	SS	62		196								
			7	SS	70		195								
			8	SS	75		193								
			9	SS	80		192								

Continued Next Page

+³, ×³: Numbers refer to Sensitivity 20 15 10 5 0 (%) STRAIN AT FAILURE

RECORD OF BOREHOLE No MMW 17-05 2 OF 4 METRIC

W.P. _____ LOCATION N 4 853 547.5 E 291 344.6 ORIGINATED BY KK
 HWY 427 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN
 DATUM Geodetic DATE 2017.07.04 - 2017.07.11 CHECKED BY ME

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE									
	Continued From Previous Page																
	SILT AND SAND , clayey Very Dense Grey Moist (TILL)		10	SS	47/ 0.075		190										
							189										
			11	SS	101/ 0.250											0 31 46 23	
187.7							188										
13.3	SAND , gravelly to trace gravel, trace silt Very Dense Grey Moist		12	SS	101/ 0.275		187										
							186										
			13	SS	100/ 0.275											0 91 9 (SI+CL)	
							185										
			14	SS	100/ 0.225		184										
							183										
			15	SS	100/ 0.275		182										
			16	SS	100/ 0.275												

Continued Next Page

+³, ×³: Numbers refer to Sensitivity
 20
 15
 10
 (%) STRAIN AT FAILURE

RECORD OF BOREHOLE No MMW 17-05 3 OF 4 METRIC

W.P. _____ LOCATION N 4 853 547.5 E 291 344.6 ORIGINATED BY KK
 HWY 427 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN
 DATUM Geodetic DATE 2017.07.04 - 2017.07.11 CHECKED BY ME

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa					
	Continued From Previous Page				0.275								
180.1	SAND , gravelly to trace gravel, trace silt Very Dense Grey Moist												0 3 85 12
20.9	SILT , some clay, trace sand Dense Grey Moist		17	SS	44								
177.2													
23.8	SAND and GRAVEL , trace silt Very Dense Grey Wet		18	SS	100/ 0.225								

Continued Next Page

+³, ×³: Numbers refer to Sensitivity 20 15 10 5 (%) STRAIN AT FAILURE

4 OF 4

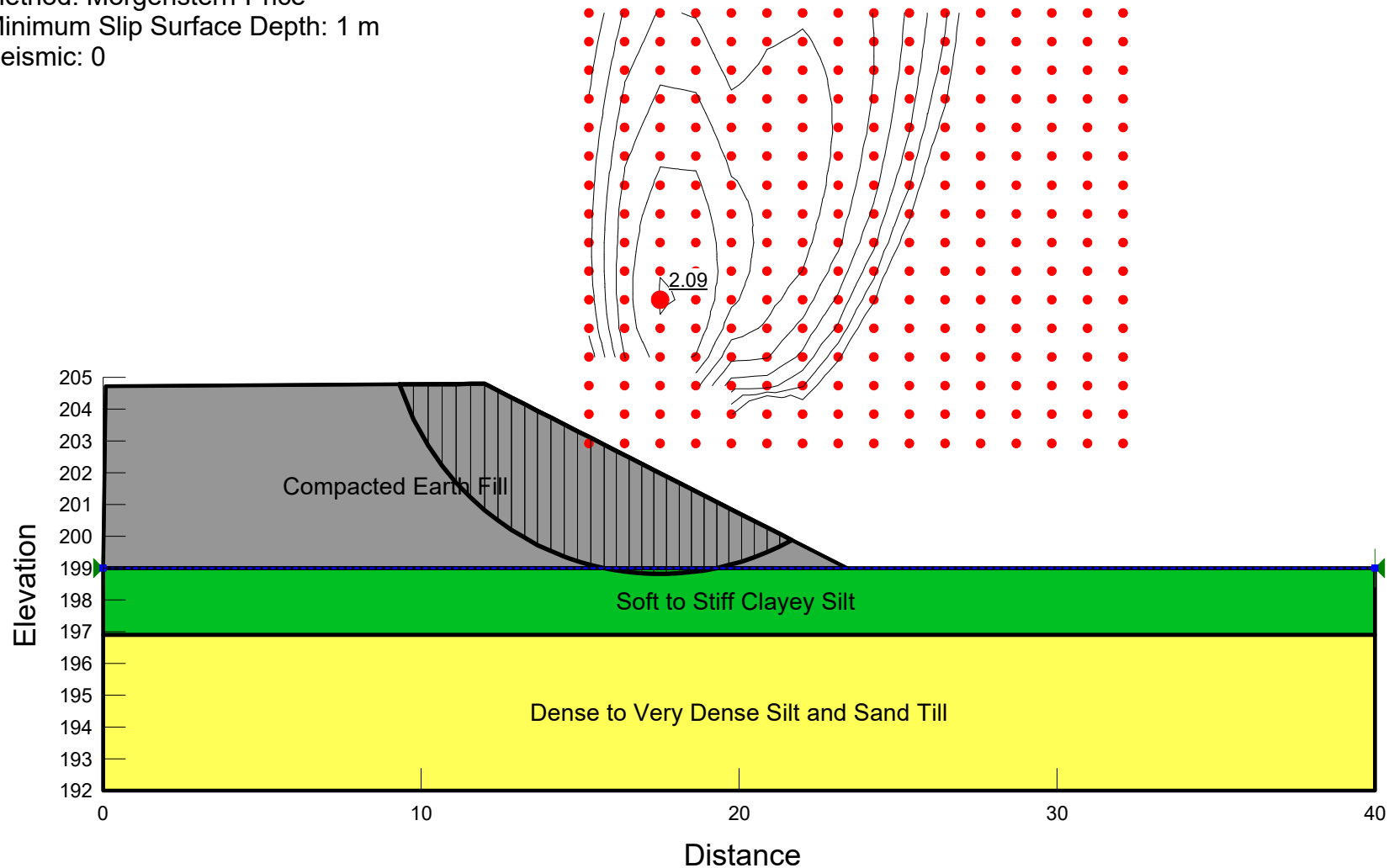
W.P.	LOCATION	N 4 853 547.5 E 291 344.6	ORIGINATED BY	KK	
HWY	427	BOREHOLE TYPE	Hollow Stem Augers	COMPILED BY	AN
DATUM	Geodetic	DATE	2017.07.04 - 2017.07.11	CHECKED BY	ME

[illegible]

CRITICAL EMBANKMENT SECTION (STA. 9+390) **SHORT-TERM CONDITION**

File Name: MM over WRC West Embankment TSA Stability.gsz
 Last Edited By: Geoff Lay
 Date: 11/30/2017
 Method: Morgenstern-Price
 Minimum Slip Surface Depth: 1 m
 Seismic: 0

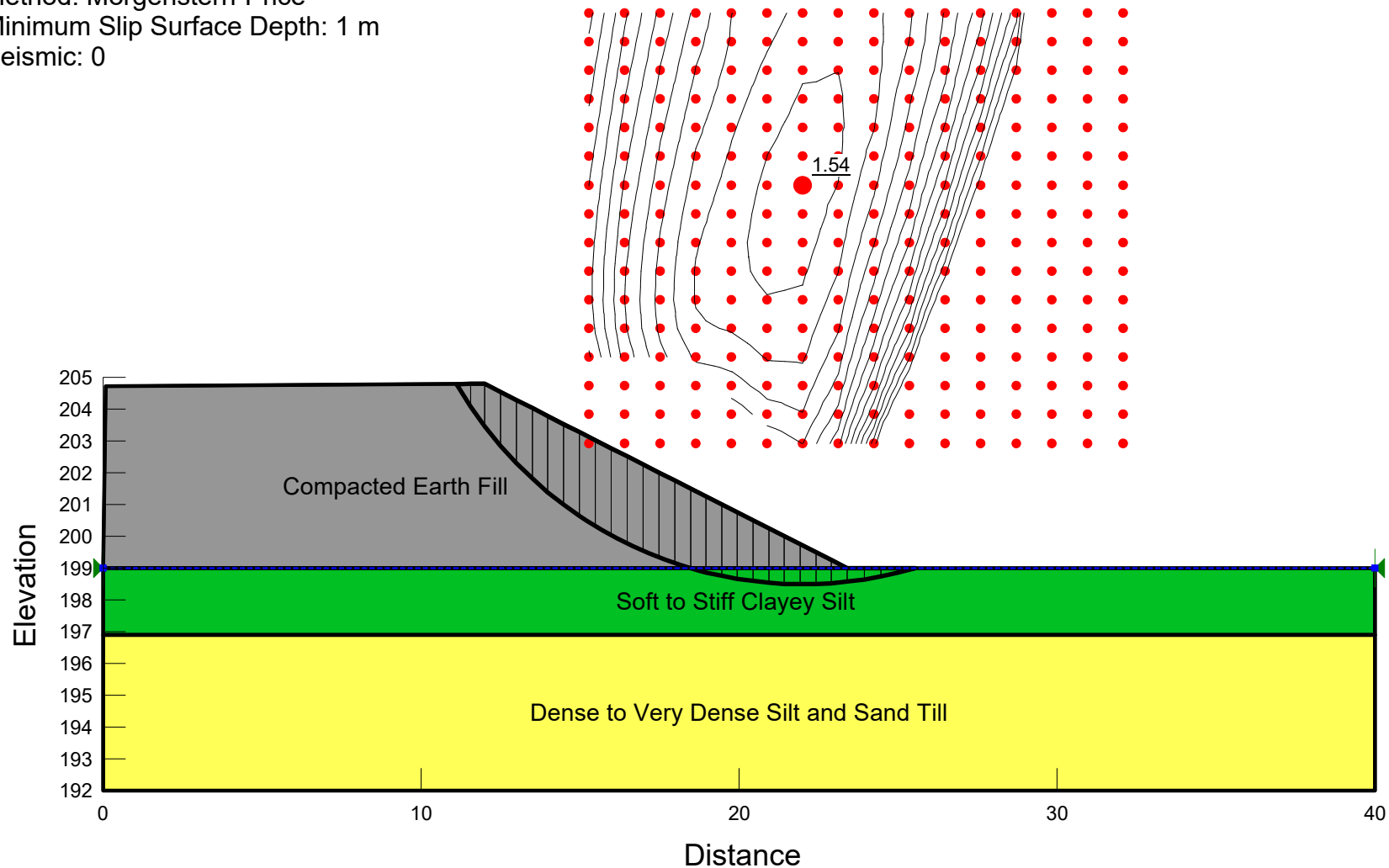
Soft to Stiff Clayey Silt	18 kN/m ³	50 kPa	0 °
Dense to Very Dense Silt and Sand Till	20 kN/m ³	0 kPa	36 °
Compacted Earth Fill	20 kN/m ³	0 kPa	30 °



CRITICAL EMBANKMENT SECTION (STA. 9+390) LONG-TERM CONDITION

File Name: MM over WRC West Embankment ESA Stability.gsz
 Last Edited By: Geoff Lay
 Date: 11/16/2017
 Method: Morgenstern-Price
 Minimum Slip Surface Depth: 1 m
 Seismic: 0

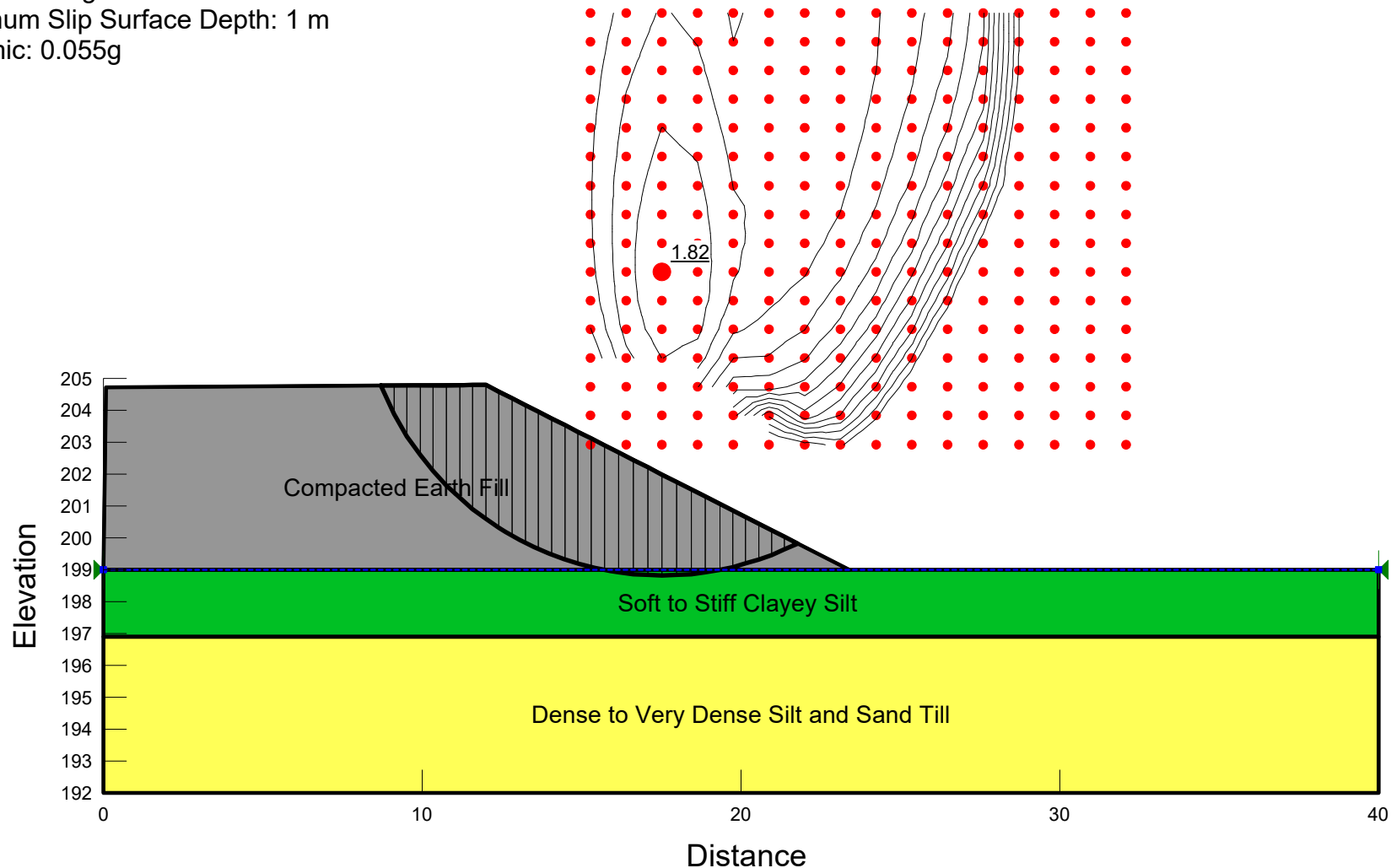
Soft to Stiff Clayey Silt	18 kN/m ³	5 kPa	29 °
Dense to Very Dense Silt and Sand Till	20 kN/m ³	0 kPa	36 °
Compacted Earth Fill	20 kN/m ³	0 kPa	30 °



CRITICAL EMBANKMENT SECTION (STA. 9+390) **SEISMIC CONDITION**

File Name: MM over WRC West Embankment Seismic Stability.gsz
 Last Edited By: Geoff Lay
 Date: 11/30/2017
 Method: Morgenstern-Price
 Minimum Slip Surface Depth: 1 m
 Seismic: 0.055g

Soft to Stiff Clayey Silt	18 kN/m ³	50 kPa	0 °
Dense to Very Dense Silt and Sand Till	20 kN/m ³	0 kPa	36 °
Compacted Earth Fill	20 kN/m ³	0 kPa	30 °



Appendix I
Cut Section North of Zenway Boulevard
(Sta. 10+750 to 11+000)

RECORD OF BOREHOLE No TS 17-26

1 OF 1

METRIC

W.P. _____ LOCATION N 4 848 666.6 E 293 873.1 ORIGINATED BY KK
 HWY 427 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN
 DATUM Geodetic DATE 2017.06.14 - 2017.06.14 CHECKED BY ME

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT w _p	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL			
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa												
								○ UNCONFINED	+	FIELD VANE										
								● QUICK TRIAXIAL	×	LAB VANE										
186.5	GROUND SURFACE						20	40	60	80	100									
0.0	TOPSOIL: (150mm)						20	40	60	80	100									
0.2	Silty CLAY , trace sand, trace gravel, trace organics (rootlets) Stiff to Very Stiff Dark Brown Moist		1	SS	19								○							
			2	SS	8								○							
185.0																				
1.5	Silty CLAY , some sand, trace gravel, occasional cobbles Firm to Very Stiff Brown Moist (TILL)		3	SS	8								○	—			0 14 34 52			
			4	SS	4								○							
			5	SS	6								○							
			6	SS	6								○	—						
			7	SS	18								○							
179.8																				
6.7	END OF BOREHOLE AT 6.7m. BOREHOLE DRY UPON COMPLETION.																			

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RECORD OF BOREHOLE No TS 17-27

1 OF 1

METRIC

W.P. _____ LOCATION N 4 848 671.7 E 293 901.6 ORIGINATED BY KK
 HWY 427 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN
 DATUM Geodetic DATE 2017.06.14 - 2017.06.14 CHECKED BY ME

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT W _P	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL		
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE								WATER CONTENT (%)	
185.3	GROUND SURFACE							20	40	60	80	100					
0.0	TOPSOIL: (150mm)							20	40	60	80	100					
0.2	Silty CLAY , some sand, trace gravel, trace organics (rootlets) Firm Dark Brown Moist		1	SS	18		185						○				
			2	SS	6		184						○				
183.6																	
1.7	Silty CLAY , some sand, trace gravel, occasional cobbles Stiff to Very Stiff Brown Moist (TILL)		3	SS	18		183						○	○			
			4	SS	18								○				
			5	SS	25		182						○				
			6	SS	21		181						○				
							180										
			7	SS	9		179						○				
178.6																	
6.7	END OF BOREHOLE AT 6.7m. BOREHOLE DRY UPON COMPLETION. Piezometer installation consists of 25mm diameter Schedule 40 PVC pipe with a 1.52m slotted screen. WATER LEVEL READINGS DATE DEPTH(m) ELEV.(m) 2017.07.07 0.8 184.5																

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METRIC

[illegible]

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+³, ×³: Numbers refer to Sensitivity

FIGURE I1

CRITICAL DEEP CUT SECTION (STA. 10+900) SHORT-TERM CONDITION

File Name: 19484 Critical Deep Cut Section 10+900 TSA 4 m bench.gsz
Last Solved Date: 11/15/2017
Last Edited By: Geoff Lay
Method: Morgenstern-Price
Minimum Slip Surface Depth: 1 m
Seismic: 0

Firm Silty Clay Till	19 kN/m ³	65 kPa	0 °
Firm Silty Clay	18 kN/m ³	50 kPa	0 °
Very Stiff Silty Clay Till	21 kN/m ³	100 kPa	0 °

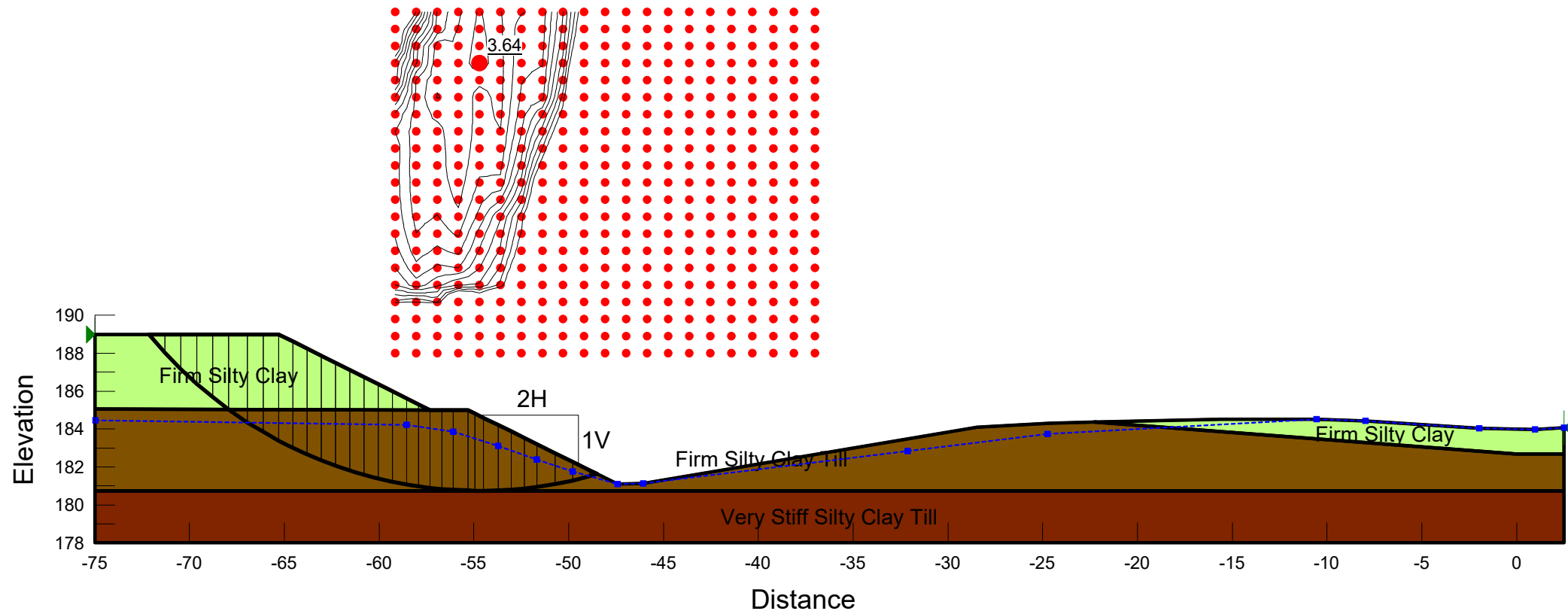


FIGURE I2

CRITICAL DEEP CUT SECTION (STA. 10+900) LONG-TERM CONDITION

File Name: 19484 Critical Deep Cut Section 10+900 ESA 4m bench.gsz
Last Solved Date: 11/15/2017
Last Edited By: Geoff Lay
Method: Morgenstern-Price
Minimum Slip Surface Depth: 1 m
Seismic: 0

Firm Silty Clay Till	19 kN/m ³	5 kPa	28 °
Firm Silty Clay	18 kN/m ³	5 kPa	27 °
Very Stiff Silty Clay Till	21 kN/m ³	3 kPa	31 °

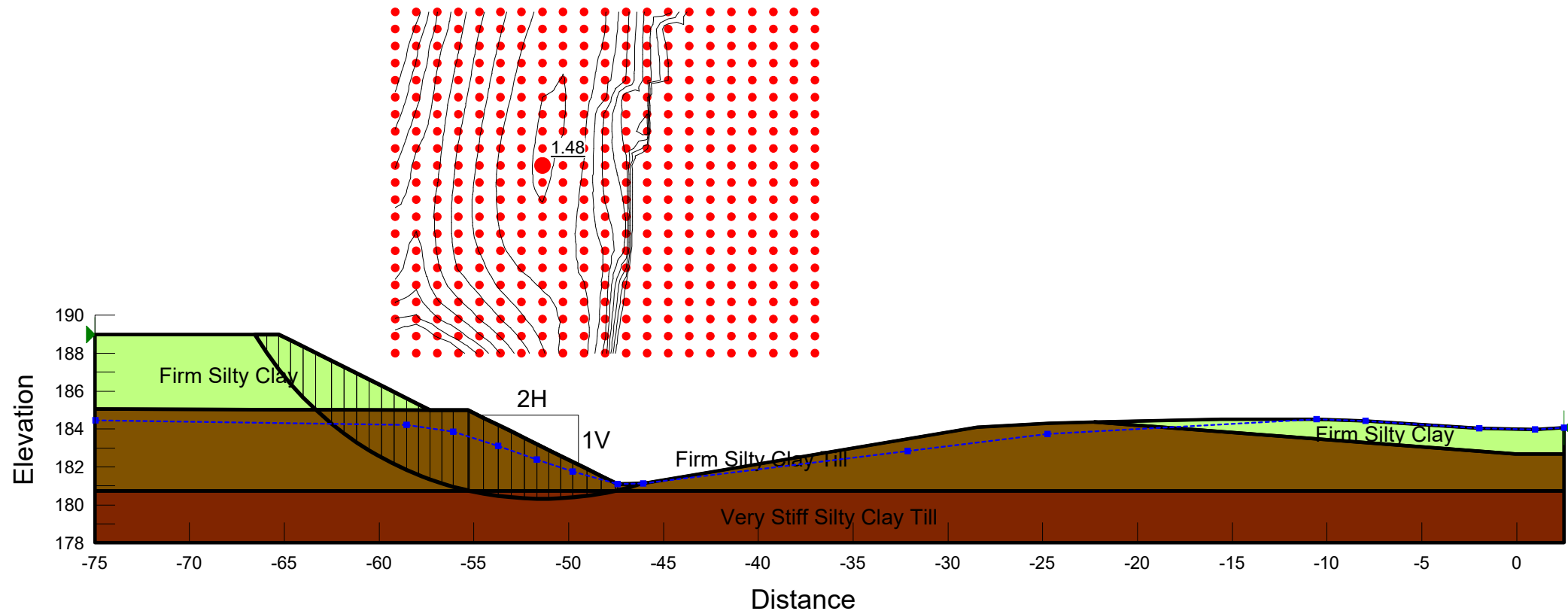
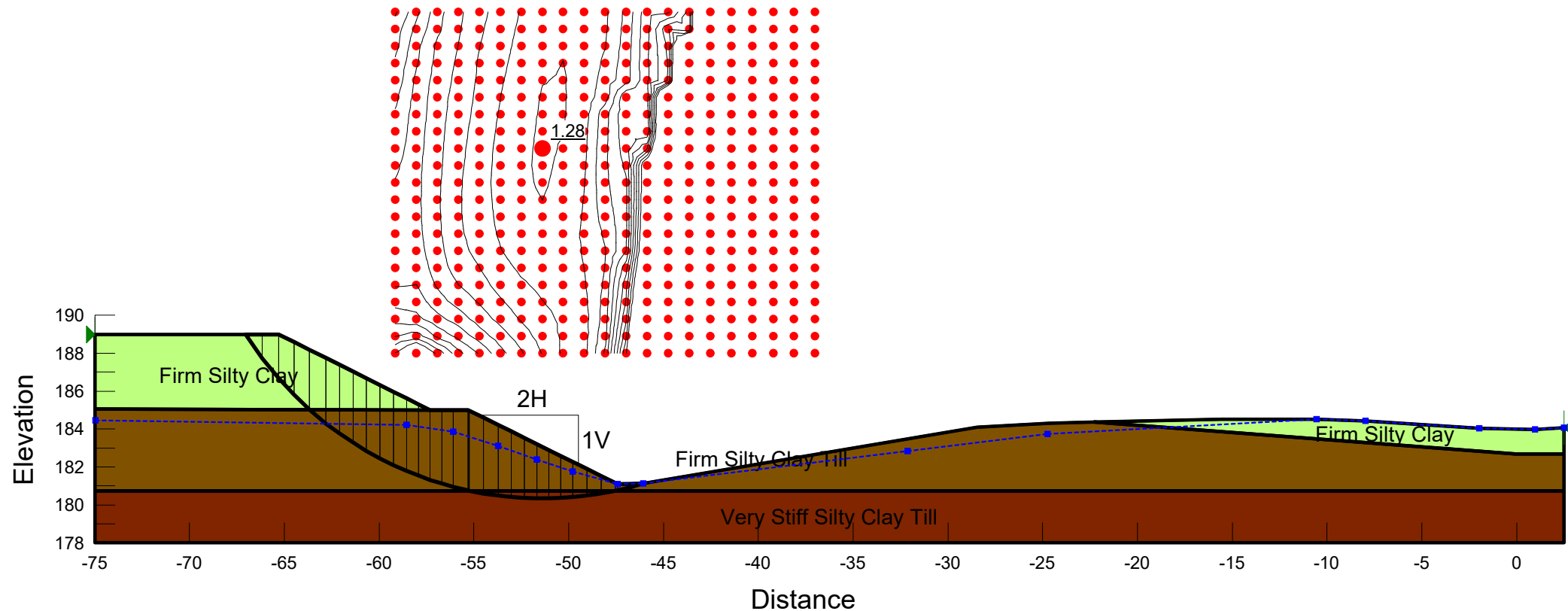


FIGURE I3

CRITICAL DEEP CUT SECTION (STA. 10+900) SEISMIC CONDITION

File Name: 19484 Critical Deep Cut Section 10+900 ESA 4m bench Seismic.gsz
Last Solved Date: 11/15/2017
Last Edited By: Geoff Lay
Method: Morgenstern-Price
Minimum Slip Surface Depth: 1 m
Seismic: 0.055g

Firm Silty Clay Till	19 kN/m ³	5 kPa	28 °
Firm Silty Clay	18 kN/m ³	5 kPa	27 °
Very Stiff Silty Clay Till	21 kN/m ³	3 kPa	31 °



Appendix J
Fill Section South of Rainbow Creek
(Sta. 11+380 to 11+410)


PROJECT <u>06-1111-012</u>		RECORD OF BOREHOLE No E6		1 OF 1 METRIC	
W.O. <u>05-20012</u>		LOCATION <u>N 4849219.0 :E 293803.8</u>		ORIGINATED BY <u>DD</u>	
DIST <u>Central</u> HWY <u>427</u>		BOREHOLE TYPE <u>200 mm Outside Diameter Hollow Stem Augers</u>		COMPILED BY <u>VA</u>	
DATUM <u>Geodetic</u>		DATE <u>February 27, 2009</u>		CHECKED BY <u>SMM</u>	

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20 40 60 80 100	20 40 60 80 100					
SHEAR STRENGTH kPa								WATER CONTENT (%)						
							○ UNCONFINED + FIELD VANE							
							● QUICK TRIAXIAL × REMOULDED							
179.1	GROUND SURFACE													
0.0	TOPSOIL													
	CLAYEY SILT, some sand, trace gravel (TILL), containing oxidation zones Stiff to hard Brown to grey Moist		1	SS	8									
			2	SS	27									
			3	SS	31									
176.9														
2.2	SILTY CLAY, trace gravel, trace sand (TILL) Hard Brown to grey Moist		4	SS	53									
			5	SS	49									
175.3														
3.8	CLAYEY SILT, trace to some sand, trace gravel (TILL) Very stiff to hard Grey Moist		6	SS	25									
			7	SS	46									
173.9														
5.2	END OF BOREHOLE													
	NOTES: 1. Open borehole dry upon completion of drilling. 2. Borehole backfilled with bentonite.													

MIS-MTO 001 06-1111-012.GPJ GAL-MISS.GDT 8/5/09 SAC/DD

PROJECT <u>06-1111-012</u>		RECORD OF BOREHOLE No E7		1 OF 1 METRIC	
W.O. <u>05-20012</u>		LOCATION <u>N 4849217.1 ; E 293850.2</u>		ORIGINATED BY <u>DD</u>	
DIST <u>Central</u> HWY <u>427</u>		BOREHOLE TYPE <u>200 mm Outside Diameter Hollow Stem Augers</u>		COMPILED BY <u>VA</u>	
DATUM <u>Geodetic</u>		DATE <u>March 2, 2009</u>		CHECKED BY <u>SM</u>	

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

178.3	GROUND SURFACE													
0.0	TOPSOIL													
	CLAYEY SILT, trace sand, trace gravel (TILL), containing rootlets to a depth of 0.6 m Firm to hard Brown to grey Moist		1	SS	4									
			2	SS	19									
			3	SS	43									
			4	SS	40									
	Becoming grey below a depth of 3.0 m		5	SS	14									
			6	SS	11									
			7	SS	16									
173.2	Containing thin sand layer at a depth of 5.1 m													
5.2	END OF BOREHOLE													
	NOTES: 1. Open borehole dry upon completion of drilling. 2. Borehole backfilled with bentonite hole plug.													

MIS-MTO 001 06-1111-012.GPJ GAL-MISS.GDT 8/5/09 SAC/DD

FIGURE J1

**CRITICAL EMBANKMENT SECTION (STA. 11+380)
SHORT-TERM CONDITION - NO SEEPAGE**

Compacted Earth Fill 20 kN/m³ 0 kPa 30 °
Clayey Silt 18 kN/m³ 50 kPa 0 °
Clayey Silt to Silty Clay Till 20 kN/m³ 0 kPa 100 °

Method: Morgenstern-Price
Minimum Slip Surface Depth: 1 m
Seismic: 0

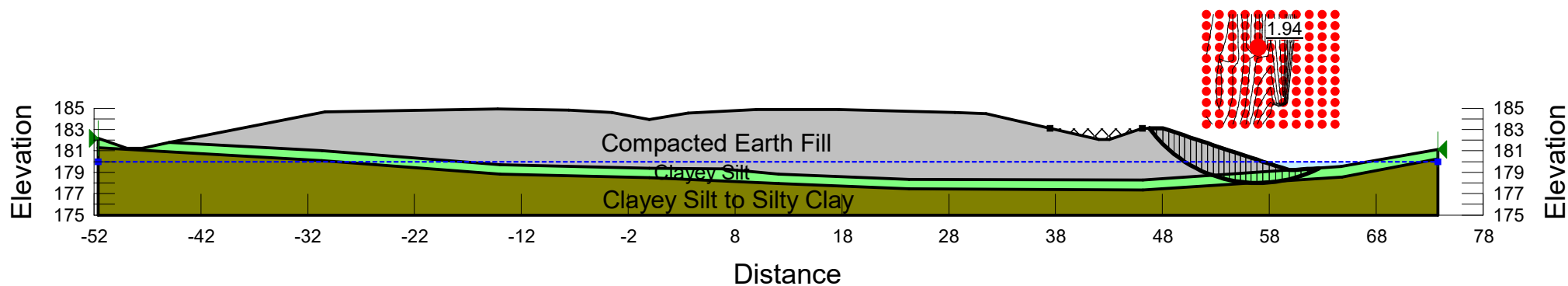


FIGURE J2

CRITICAL EMBANKMENT SECTION (STA. 11+380) **SHORT-TERM CONDITION - WITH SEEPAGE**

Compacted Earth Fill 20 kN/m³ 0 kPa 30 °
 Clayey Silt 18 kN/m³ 50 kPa 0 °
 Clayey Silt to Silty Clay Till 20 kN/m³ 0 kPa 100 °

Method: Morgenstern-Price
 Minimum Slip Surface Depth: 1 m
 Seismic: 0

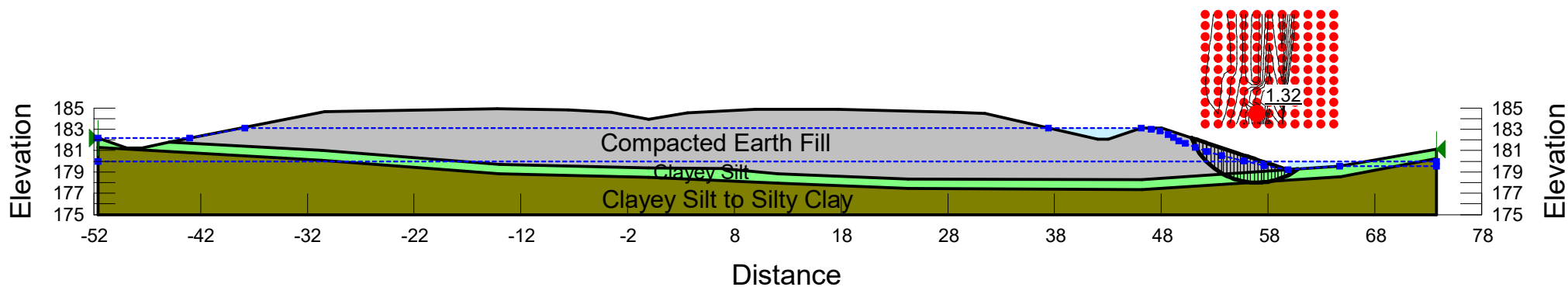


FIGURE J3

**CRITICAL EMBANKMENT SECTION (STA. 11+380)
LONG-TERM CONDITION**

Compacted Earth Fill 20 kN/m³ 0 kPa 30 °
Clayey Silt 18 kN/m³ 5 kPa 29 °
Clayey Silt to Silty Clay Till 20 kN/m³ 0 kPa 32 °

Method: Morgenstern-Price
Minimum Slip Surface Depth: 1 m
Seismic: 0

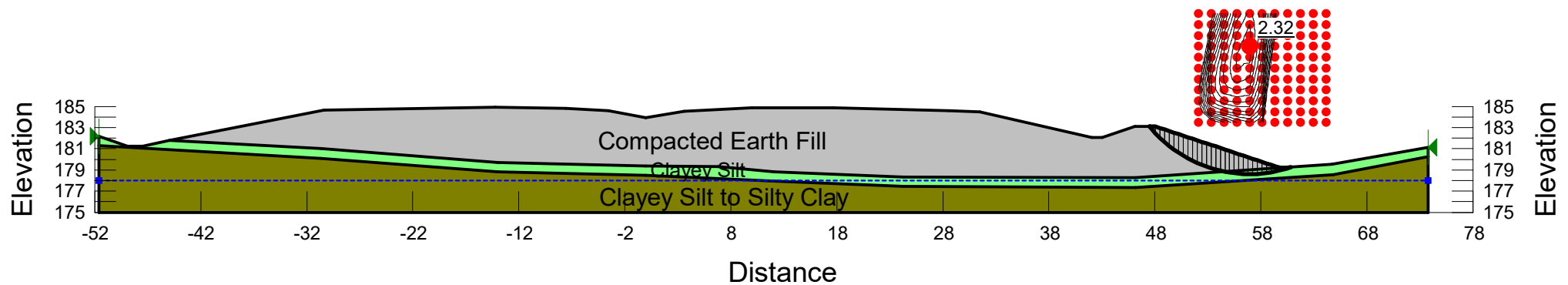
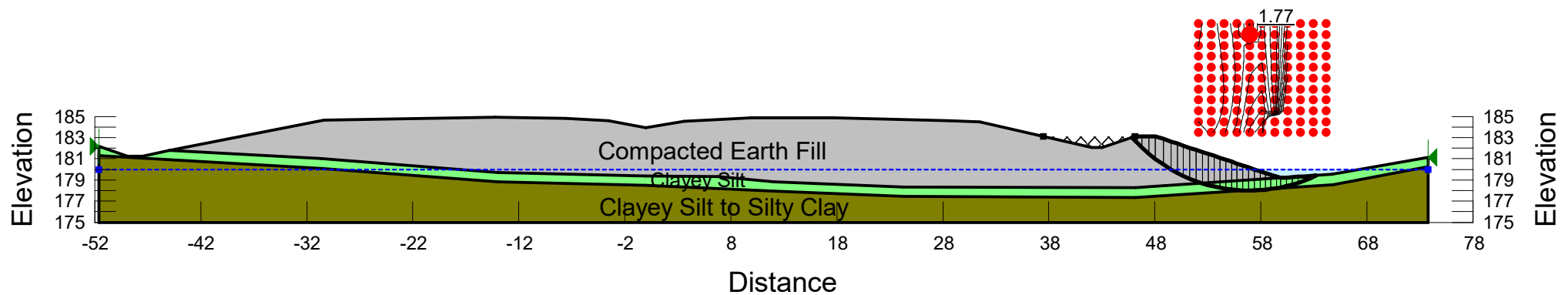


FIGURE J4

**CRITICAL EMBANKMENT SECTION (STA. 11+380)
SEISMIC CONDITION - NO SEEPAGE**

Compacted Earth Fill 20 kN/m³ 0 kPa 30 °
Clayey Silt 18 kN/m³ 50 kPa 0 °
Clayey Silt to Silty Clay Till 20 kN/m³ 0 kPa 100 °

Method: Morgenstern-Price
Minimum Slip Surface Depth: 1 m
Seismic: 0.055g



Appendix K

Supply and Installation of Embankment Monitoring Equipment

SUPPLY AND INSTALLATION OF EMBANKMENT MONITORING EQUIPMENT

1.1 GENERAL

1.1.1 Scope

This special provision contains the requirements for the supply and installation of the following geotechnical instruments:

- Settlement Rods (SR)

1.1.2 Purpose

The purpose of these instruments is to monitor settlements in the foundation soils and embankment fill during construction of the high fill embankments at the following locations:

- Highway 427 over Rutherford Road
- Highway 427 over CPR / McGillivray Road
- Major Mackenzie Drive Overpass
- Zenway Boulevard Underpass

1.1.3 Or equal

The term, “*or equal*”, shall be understood to indicate that the equal product is the same or better than the specified product in function, performance, reliability, quality and general configuration.

1.1.4 Notification

The Foundation Consultant shall be notified a minimum of 15 days in advance of commencing the installation of instruments.

1.1.5 Submission Requirements

The Contractor shall submit details of proposed installation methods, including survey benchmarks, and installation schedule to the Foundation Consultant, a minimum of 5 days before the start of instrument installation.

1.1.6 Drawings

Reference shall be made to the following drawings:

- Hwy 427 Expansion – Miscellaneous Details Preloading/Access Route, H427-D-N-9B-HWY-000-DWG-0068-A
- Hwy 427 Expansion – Preloading Areas – Rutherford Road Overpass, H427-D-N-9B-HWY-000-DWG-0069-A

- Hwy 427 Expansion – Preloading Areas – CPR/McGillivray Road, H427-D-N-9B-HWY-000-DWG-0070-A
- Hwy 427 Expansion – Preloading Areas – Major Mackenzie Drive Overpass, H427-D-N-9B-HWY-000-DWG-0069-A
- Hwy 427 Expansion – Hwy 427 at Zenway Boulevard Underpass – Retained Soil Systems Wall Layout I, H427-D-N-1-STR-B10-DWG-504-B, Note 4

1.1.7 Equipment Operation and Weather Conditions

All installation and monitoring equipment and associated materials shall be capable of withstanding the range of temperatures possible for their locations within the ground or on the surface.

1.2 **Installation**

1.2.1 Instrument Location

Prior to the installation of instruments, the Contractor shall accurately survey and stake the location of each instrument and obtain a ground elevation and northing/easting coordinates at each instrument location.

The quantities and locations of instruments are shown on the following Drawings:

- Rutherford Road – H427-D-H-9B-HWY-000-DWG-0069
- CPR/McGillivray Road – H427-D-H-9B-HWY-000-DWG-0070
- Major Mackenzie Drive – H427-D-H-9B-HWY-000-DWG-0071
- Miscellaneous Details – H427-D-H-9B-HWY-000-DWG-0068
- Zenway Boulevard – H427-D-H-1-HWY-000-DWG-0044 & DWG-0045

In addition to the above-mentioned drawings, an additional two (2) SRs are required behind each of the proposed abutment walls.

1.2.2 Survey Benchmarks (BM)

The Contractor shall provide a minimum of two non-yielding temporary survey benchmarks (BM) at each site.

The number and locations of benchmarks shall be such that direct sighting is possible from all settlement rods (SR) to at least one benchmark.

1.2.3 Accuracy of Surveying for Elevations

Elevations shall be surveyed to an accuracy of ± 2 mm or better.

1.2.4 Materials and Equipment

The Contractor shall supply all materials and equipment required for the installation of instrumentation unless noted otherwise.

1.2.5 Underground Utilities

The Contractor shall be responsible for locating and protecting all underground utilities prior to drilling boreholes, if required, for installing instruments. Any damage to underground utilities caused by the Contractor's work shall be repaired by the Contractor.

1.2.6 Marking and Labelling

The location of any above ground monitoring fixture shall be made clearly visible to nearby traffic before, during and after embankment construction. Marking shall be of sufficient size to be visible from a reversing vehicle and after heavy snowfalls.

Instruments shall be clearly labelled in the field, each instrument having a unique identifier. The labelling shall remain legible for the duration of the monitoring program.

1.2.7 Protection of Instruments

All instruments shall be adequately protected by the Contractor such that they are not damaged during construction. Any damaged instrument shall be immediately repaired or replaced at the Contractor's cost.

1.2.8 Installation Program

Instrument installation shall commence before any embankment fill placement. No material stockpiling shall be allowed within the embankment construction area during instrument installation. The following Table 1 gives a summary of the installation schedule requirements.

Table 1 – Installation Program

TYPE	START INSTALLATION	FINISH INSTALLATION
SR	Following organic stripping and before any fill placement	At completion of preload embankment construction

2.0 **SETTLEMENT RODS (SR) – SUPPLY & INSTALLATION**

2.1 **GENERAL**

2.1.1 Scope

This Section contains the requirements for the supply and installation of settlement rods.

The purpose of the settlement rods is to monitor settlements of the embankment base. The settlement readings shall help establish the timing for construction of pavement structure.

Settlement is measured by survey of the top of the rod with reference to stable, non-settling benchmarks.

2.1.2 General Procedure

The settlement rods shall be attached to a plate at the existing ground surface. As embankment construction proceeds the rods shall be extended above the new top of embankment.

Sleeves around the rods shall be installed to reduce friction and allow uninhibited movement of the rod with the plate.

A protective surround shall be extended with the rods as embankment construction proceeds.

2.1.3 Location

The locations of the settlement rods are shown on the attached drawings and indicated in Section 1.2.1.

2.2 MATERIALS

2.2.1 General

The Contractor shall supply all materials and equipment required for the installation of the settlement rods.

2.2.2 Plate

The Contractor shall supply a steel plate with thickness of at least 6.35 mm. The plate shall be at least 0.5 m by 0.5 m.

2.2.3 Rod

The Contractor shall supply a steel pipe Schedule 40 with an outside diameter not less than 25.4mm (1"), supplied in lengths as required to complete the installation.

The top end of each length of rod shall be threaded to receive a cap. A rounded cap shall be installed at the top of the rod in such a way that a single survey point can be clearly identified and returned to.

2.2.4 Friction Reducing Sleeve

The Contractor shall supply a friction reducing sleeve consisting of Schedule 40 - 50.8mm (2") O.D. PVC pipe cut perpendicular to the axis of the pipe.

2.2.5 Protective Surround

The Contractor shall supply a protective surround for the portion of the rod within the embankment.

The surround shall consist of 300 mm diameter corrugated steel pipe (CSP - OPSS 1801) with the ends cut perpendicular to the axis of the pipe and free of burrs and sharp edges. The space between the CSP and the Friction Reducing Sleeve (PVC pipe) shall be filled with medium to coarse sand.

2.3 INSTALLATION

2.3.1 General

The Contractor shall install settlement rods as per the contract drawings provided in addition to what is stated or emphasized below.

2.3.2 Settlement Plate

The settlement plate shall be installed horizontally on undisturbed native soil just below the existing ground surface.

The elevation of the base of the plate shall be surveyed before backfilling.

2.3.3 Rod

The rod shall be fixed to the centre of the plate and perpendicular to the plate.

The coupling of the rods shall be such that all sections have the same axis and no separation or contraction will occur at the couplings.

2.3.4 Friction Reducing Sleeve

The friction reducing sleeve shall be over the entire length of the rod that is below ground and within the embankment fill except that the cap on top of the settlement rod shall extend 25 mm above the top of the friction sleeve at all times.

2.3.5 Extension of Rod

The settlement rods shall be extended upwards as the embankment is constructed so that the top of the rod is always at least 0.3 m but no more than 2 m above the surrounding fill. The top of the rod shall be surveyed before and after each rod extension is added.

2.3.6 Protective Surround

The CSP, Friction Reducing Sleeve and sand protective surround shall be extended with the rods.

The settlement rod shall be centred in the CSP and friction reducing sleeve.

The annulus between the CSP and the friction-reducing sleeve shall be filled with sand to a level not higher than the top of the sleeve.

2.3.7 Installation Details

The elevation, easting and northing of the centre of the base of the plate shall be surveyed.

The elevation, easting and northing of the top of the rod shall be surveyed before and after each rod extension is added.

The total distance from the base of the plate to the top of the rod shall be measured to an accuracy of ± 2 mm or better.

2.4 **COORDINATION WITH MONITORING**

2.4.1 Notification

The Contractor shall notify the Foundation Consultant no later than 7 days after installing a settlement rod. At this time the Contractor shall also supply the following information to the Foundation Consultant:

- Elevations of plate and top of rod;
- Dates of installation;
- Description of settlement rods, sleeve and plate;
- Installation photos.

During the embankment construction, the Contractor shall extend all settlement rods, friction protective sleeves and CSP protective surrounds simultaneously prior to the placement of the next lift of fill (i.e. every 1.5m lift). The Contractor shall notify the Foundation Consultant no less than 3 days prior to extending any settlement rod. Adjustments in the length of any settlement rod shall be coordinated with the Foundation Consultant to allow surveying by Contractor of the elevation of the top of rod immediately before and immediately after installation of extension rod. This surveying is necessary to accurately track the settlement data.

2.4.2 Monitoring

Monitoring of the settlement rods shall be done by Contractor. Monitoring shall be conducted prior to, during the embankment construction. The Contractor shall provide installation information as specified above and provide access to the settlement rods for monitoring including, but not limited to a scaffolding platform and ladder if required and snow clearing in the winter. The Contractor shall provide electric power and general area lighting as needed for reading the instruments.

Three (3) baseline readings shall be conducted on 3 consecutive days prior the placement of embankment fills. Subsequent readings shall be conducted for every 1.5 m of placed and compacted fills, or weekly, whichever occurs first.

2.5 REPORTING

The Contractor shall record and report relevant installation details to the Foundation Consultant. These include, but are not limited to:

- Settlement rod easting, northing;
- Elevations of the plate and the top of the rod;
- Distance between the base of plate and top of rod;
- Dates of installation;
- Installation notes, sketches and photographs.

3.0 DECOMMISSIONING OF INSTRUMENTS

The Contractor shall decommission all the Settlement Rods (SR) at the end of the monitoring program (i.e. time of paving) unless advised otherwise by the Foundation Consultant.