



THURBER ENGINEERING LTD.

**FOUNDATION INVESTIGATION AND DESIGN REPORT
STORMWATER MANAGEMENT POND #3
HIGHWAY 400 WIDENING
MAJOR MACKENZIE DRIVE TO KING ROAD
YORK REGION, ONTARIO
G.W.P. 2539-04-00**

GEOCRES No. 30M13-226

Report

to

SNC Lavalin Inc.

Date: March 9, 2018
File: 17265



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PART 1: FACTUAL INFORMATION

1. INTRODUCTION

This report presents the factual data obtained from a foundation investigation carried out by Thurber Engineering Ltd. (Thurber) for the proposed Stormwater Management Pond #3 (SWMP3) located on the west side of Highway 400 and just north of the south bound service centre, between Kirby Road and Teston Road. This pond is part of a Ministry of Transportation Ontario (MTO) Highway 400 widening project that includes accommodation of the ultimate 10-lane configuration including two HOV lanes in each direction, while the current MTO right-of-way is to be maintained.

The purpose of this investigation was to explore the subsurface conditions in the vicinity of the existing pond and the proposed SWMP3 with access road and, based on the data obtained, to provide a borehole locations and soil strata drawing, records of boreholes, laboratory test results and a written description of the subsurface conditions.

Thurber carried out this investigation as a sub-consultant to SNC-Lavalin Inc. (SLI) under MTO Assignment Nos. 2005-E-0036 and -0037.

2. SITE DESCRIPTION

The site is in the vicinity of an existing stormwater pond located at the northern edge of the Highway 400 southbound service centre, between Kirby Road and Teston Road. The existing pond occupies the area immediately to the west of the southbound off ramp and entrance to the service centre. The approximate footprint of the proposed SWMP3 and an access road covered in this report is shown on the Borehole Locations and Soil Strata drawing in Appendix C.

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The existing stormwater pond occupies the crest of a slope from the access ramp and parking lot of the service centre down towards a Purpleville Creek Tributary 'B' located just north of the pond. At the time of the field work, the banks and slopes surrounding the pond are moderately vegetated with shrubs and small trees. The vegetation becomes denser towards the tributary.

The project area is located within the physiographic region known as the South Slope, which comprised predominantly of Halton till. The Halton till is an interbedded complex of clayey silt to silt till and sand. This till comprises a slightly hummocky till plain, into which the surface watercourse have eroded 10 to 15 m deep gullies. Relatively recent fluvial sediments have been deposited in the gullies. The Halton till overlies bedrock at depths in the order of 100 m in the vicinity of the project area.

Drainage in the vicinity of the project area is largely controlled by the Humber River and its tributaries. Localized drainage is facilitated by the creeks flowing within the gullies.

The land use adjacent to this section of Highway 400 is largely rural and agricultural, although there is increasing residential and commercial development in recent years. Appendix D presents selected photographs of the observed site conditions for reference.

3. INVESTIGATION PROCEDURES

The field investigation for this project was carried out between February 27 and March 8, 2017, when seven boreholes denoted as Boreholes P17-01 to P17-07 were advanced within the area of the proposed SWMP #3 and pond access road. The approximate locations of the boreholes are shown on the Borehole Locations and Soil Strata Drawing provided in Appendix C.

Drilling was carried out using portable tri-pod equipment in conjunction with the wash boring technique. This portable equipment was supplied and operated by OGS Inc. Boreholes were advanced to depths of ranging from approximately 4.3 m to 9.5 m. In all boreholes, soil samples were obtained continuously at shallower depths and at selected intervals at deeper depths with a 50 mm outside diameter split spoon sampler driven in conjunction with the Standard Penetration Test (SPT).

The field investigation was supervised on a full time basis by a member of Thurber's staff who marked/staked the boreholes in the field, arranged for the clearance of subsurface utilities, directed the drilling, sampling and in-situ testing operations, logged the boreholes and processed the recovered soil samples for transport to Thurber's laboratory for further examination and testing.



Groundwater conditions were observed in the open boreholes throughout the drilling operations. Standpipe piezometers were installed in five of the boreholes (Boreholes P17-01, P17-03, P17-04, P17-05, and P17-07) to permit monitoring of the groundwater levels at the site. Each standpipe piezometer consisted of a 25 mm diameter PVC pipe, with a slotted screen sealed at selected depths within the boreholes. The boreholes, in which no standpipe piezometers were installed, were backfilled in general accordance with Ontario Regulation 903 (O.Reg. 903). After the final water level readings are taken, the piezometers will be decommissioned in general accordance with O.Reg. 903. Details of the piezometer installations are summarized as follows:

Borehole Number	Piezometer Installations			Completion Details
	Borehole Depth / Base Elevation (m)	Piezometer Tip Depth / Elevation (m)	Sand Filter Depth / Elevation (m)	
P17-01	7.0 / 239.9	6.8 / 240.1	4.6 – 7.0 / 242.3 – 239.9	Backfilled with filter sand from 7.0 m to 4.6 m, bentonite holeplug from 4.6m to surface.
P17-02	4.3 / 237.2	None installed		Backfilled with bentonite holeplug and soil cuttings to surface.
P17-03	5.0 / 239.1	4.6 / 239.5	2.4 – 4.6 / 241.7 – 239.5	Backfilled with filter sand from 4.6 m to 2.4 m, bentonite holeplug from 2.4m to surface.
P17-04	6.7 / 234.3	6.1 / 234.9	4.1 – 6.1 / 236.9 – 234.9	Backfilled with filter sand from 6.1 m to 4.1 m, bentonite holeplug from 4.1m to surface.
P17-05	9.5 / 239.0	9.2 / 239.3	7.2 – 9.5 / 241.3 – 239.0	Backfilled with filter sand from 9.5 m to 7.2 m, bentonite holeplug from 7.2m to surface.
P17-06	4.9 / 242.5	None installed		Backfilled with bentonite holeplug and soil cuttings to surface.
P17-07	6.4 / 239.4	6.1 / 239.7	4.1 – 6.1 / 241.7 – 239.7	Backfilled with filter sand from 6.1 m to 4.1 m, bentonite holeplug from 4.1m to surface.

4. LABORATORY TESTING

The recovered soil samples were subjected to Visual Identification (VI) and to natural moisture content determination. Selected samples were also subjected to grain size distribution analyses (hydrometer and/or sieve) and Atterberg Limits testing, where appropriate. Laboratory testing results are summarized on the Record of Borehole sheets included in Appendix A and are presented on the figures included in Appendix B.

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5. DESCRIPTION OF SUBSURFACE CONDITIONS

Details of the encountered soil stratigraphy are presented on the Record of Borehole sheets included in Appendix A. A general description of the stratigraphy, based on the conditions encountered in the boreholes, is given in the following paragraphs. However, the factual data presented on the Record of Borehole sheets takes precedence over this general description and must be used for interpretation of the site conditions. It should be recognized and expected that soil conditions may vary between and beyond borehole locations.

In general, the subsurface conditions encountered in the boreholes consisted of fill overlying sands and silts with clayey silt interlayers which are underlain by clayey silt till.

5.1 Topsoil and Organics

Topsoil or organics mixed with silty clay, roots and rootlets were encountered in all boreholes. These surficial deposits ranged in thickness from between approximately 50 mm to 600 mm. The thickness of these topsoil and organics may vary between and beyond borehole locations.

5.2 Silty Clay to Clayey Silt Fill

Fill was encountered in all boreholes with the exception of Borehole P17-03. The fill generally consisted of silty clay to clayey silt, and contained trace to some sand, trace gravel, and trace roots, rootlets and organics. The fill was generally observed beneath the surficial topsoil or organics and extended to depths ranging between approximately 1.1 m to 3.7 m below existing ground surface, or Elevations 246.4 to 239.8 .

SPT 'N' values within the silty clay to clayey silt fill ranged from 3 to 31 blows per 0.3 m penetration of the sampler, indicating a soft to hard consistency. Moisture contents between 13 percent and 34 percent were measured in the fill.

The results of grain size distribution analyses and Atterberg Limits testing carried out on selected samples of the silty clay to clayey silt fill are presented on the Record of Borehole sheets included in Appendix A and on Figure B1 of Appendix B. The results of the grain size distribution analyses are summarized below:



Soil Particle	Percentage (%)
Gravel	0
Sand	20 to 30
Silt	47 to 60
Clay	20 to 28

5.3 Clayey Silt Till

A glacial till deposit of clayey silt, with sand to some sand, and trace gravel was encountered in all boreholes with the exception of Borehole P17-04. The clayey silt till was encountered below the fill deposits in Boreholes P17-01, P16-06, and P16-07 at 2.4 to 3.7 m depths. In Boreholes P17-02 and P17-03, the clayey silt till was encountered at depths of 2.5 m and 1.8 m, respectively. In Borehole P17-05, the clayey silt till was encountered at a depth of approximately 8.5 m. Where fully penetrated in Boreholes P17-02, this cohesive till extended to a 3.7 m depth, or Elevation 237.8 m. Boreholes P17-01, P17-03, P17-05, P17-06 and P17-07 were terminated in this till at 4.9 m to 9.5 m depths, or Elevations 239.0 to 242.5.

SPT 'N' values within the clayey silt till deposit typically ranged from 9 blows to 100 blows per 0.3m of penetration indicating a stiff to hard consistency. Measured moisture contents within the clayey silt till deposit varied between 10 percent and 22 percent.

The results of grain size distribution analyses and Atterberg Limits testing carried out on selected samples of the clayey silt till are presented on the Record of Borehole sheets included in Appendix A and on Figures B2, B3 and B6 of Appendix B. The results of the grain size distribution analyses are summarized below:

Soil Particle	Percentage (%)
Gravel	0 to 5
Sand	18 to 40
Silt	40 to 64
Clay	16 to 25

The results of Atterberg Limits testing are summarized below:

Index Property	Percentage (%)
Plasticity Index	6 to 14
Liquid Limit	20 to 29



The results of the Atterberg Limits testing indicate that this till is of low plasticity with group symbol CL or ML.

Glacial tills inherently contain cobbles and boulders.

5.4 Silty Clay to Clayey Silt

Layers of silty clay to clayey silt, with sand to trace sand, and brown in colour was encountered in Boreholes P17-03, P17-04, and P17-05. In Borehole P17-03, the clayey silt was encountered immediately below the surficial silty clay with organics and extended to a depth of approximately 1.8 m, or Elevation 242.3. In Boreholes P17-04, the clayey silt was encountered below the fill and extended to a depth of approximately 2.6 m, or Elevation 238.4. A lower deposit of clayey silt was encountered at a depth of approximately 5.3 m in Borehole P17-04, which was terminated in these deposits at 6.7 m depth or Elevation 234.3. In Borehole P17-05, a 1.9 m thick layer of silty clay was encountered at 2.1 m depth with the base of the layer at 4.0 m, or Elevation 244.5.

Most of the SPT 'N' values ranged from 9 to 70 blows for 0.3 m penetration indicating that the silty clay to clayey silt was stiff to hard in consistency. Measured moisture contents in these cohesive soils were between 15 percent and 25 percent.

The results of grain size distribution analyses and Atterberg Limits testing carried out on selected samples of the silty clay to clayey silt are presented on the Record of Borehole sheets included in Appendix A and on Figures B4 and B6 of Appendix B. The results of the grain size distribution analyses are summarized below:

Soil Particle	Percentage (%)
Gravel	0
Sand	7 to 24
Silt	44 to 69
Clay	18 to 32

The results of Atterberg Limits testing are summarized below:

Index Property	Percentage (%)
Plastic Limit	9
Liquid Limit	24

The results of the Atterberg Limits testing indicate the clayey silt is of low plasticity with group symbol CL.



5.5 Sands and Silts

Cohesionless deposits consisting of varying proportions of sand, sand and silt, and sandy silt were encountered in Boreholes P17-02, P17-04, and P17-05. The base of these deposits were at 2.5 m to 8.5 m depths, or Elevations 240.0 to 235.7, where fully penetrated. Boreholes P17-02 was terminated within a lower sand at 4.3 m depth, or Elevation 237.2.

SPT 'N' values obtained in these deposits ranged between 11 and 100 blows per 0.3 m penetration indicate compact to very dense conditions. Measure moisture contents in the sands and silts were between 12 and 26 percent.

The results of grain size distribution analyses carried out on selected samples of the sandy silt to sand are presented on the Record of Borehole sheets included in Appendix A and on Figure B5 of Appendix B. The results of the grain size distribution analyses are summarized below:

Soil Particle	Percentage (%)
Gravel	0
Sand	30 to 86
Silt	43 to 57
Clay	6 to 13
Silt and Clay	14

5.6 Groundwater Conditions

Groundwater conditions were observed during drilling operations and groundwater levels were measured in the open boreholes upon completion of drilling. Standpipe piezometers were installed in Boreholes P17-01, P17-03, P17-04, P17-05, and P17-07 to monitor the groundwater level at the site. The groundwater levels measured in the standpipe piezometers are summarized below.



Borehole	Date	Water Level (m)		Remark
		Depth	Elevation	
P17-01	March 13, 2017	5.3	241.6	Standpipe piezometer
	April 10, 2017	5.2	241.7	
P17-03	March 6, 2017	Dry	-	Standpipe piezometer
	March 13, 2017	Dry	-	
	April 10, 2017	4.3	239.8	
P17-04	March 6, 2017	3.0	238.0	Standpipe piezometer
	March 13, 2017	3.1	237.9	
	April 10, 2017	3.2	237.8	
P17-05	March 13, 2017	4.5	244.0	Standpipe piezometer
	April 10, 2017	3.7	244.8	
P17-07	March 6, 2017	2.5	243.3	Standpipe piezometer
	March 13, 2017	2.6	243.2	
	April 10, 2017	2.2	243.6	

The groundwater levels above are short-term readings and seasonal fluctuations of the groundwater levels are to be expected. In particular, the groundwater levels may be at a higher elevation after periods of significant or prolonged precipitation.



6. MISCELLANEOUS

Thurber marked the borehole locations in the field and obtained subsurface utility clearances prior to drilling.

Ohlmann Geotechnical Services (OGS) Inc. of Almonte, Ontario supplied and operated the drilling, sampling and in-situ testing equipment for the field investigation. The field investigation was supervised on a full time basis by Ms. Cecile Ritchie of Thurber. Overall supervision of the field program was provided by Dr. Sydney Pang, P.Eng. of Thurber.

The coordinates and ground surface elevations at the borehole locations were established and provided by SLI.

Routine laboratory testing was carried out at Thurber's geotechnical laboratory. Interpretation of the field data and preparation of this report was carried out by Mr. Cory Zanatta, EIT and Dr. Sydney Pang, P.Eng. The report was reviewed by Dr. P.K. Chatterji, P.Eng., a Designated Principal Contact for MTO Foundations Projects.



Thurber Engineering Ltd.

Cory Zanatta, B.A.Sc.
Geotechnical Engineer-in-Training



Sydney Pang, P.Eng.
Associate, Senior Foundations Engineer



P.K. Chatterji, P.Eng.
Review Principal, Designated MTO Contact

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PART 2: ENGINEERING DISCUSSION AND RECOMMENDATIONS

7. GENERAL

This section of the report presents an interpretation of the geotechnical data in the factual report and provides foundation recommendations for the design and construction of Stormwater Management Pond #3 (SWMP3) and the associated pond access road.

This foundation investigation and design report with the interpretation and recommendations are intended for the use of the Ministry of Transportation, and shall not be used or relied upon for any other purposes or by any other parties including the construction contractor. The contractor must make their own interpretation based on the factual data in Part 1 of the report. Where comments are made on construction, they are provided only to highlight those aspects which could affect the design of the project. Contractors must make their own interpretation of the information provided as it may affect equipment selection, proposed construction methods and scheduling.

The general arrangements of the proposed pond, plans, and profiles related to the slopes adjacent to the pond have been provided by SLI. Based on this information, the essential features of the new pond are summarized as follows:

- The proposed pond is currently designed to have a permanent pond and a shallower extended detention pond, separated by a berm.
- The base of the permanent pond will be at Elevation 241.75 m, some 3.5 m below the existing pond base, and the base of the detention pond will be at Elevation 243.75 m. The highest design water level in the permanent pond is at Elevation 245.25.
- The current design uses a 2H : 1V finished slope within the permanent pond and 3H : 1V slopes within the extended detention pond. The berm separating the permanent pond and the detention pond will have 2H : 1V side slopes. The berm on the east side of the pond

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will have 3H : 1V slopes.

- At the design water level, the proposed pond is approximately 20 m wide in the north-south direction and 35 m in the east-west direction.

In addition, a new pond access road is proposed which would allow access from a location to the west of the pond. The access road would be constructed by placing new fill on the existing slopes. The completed road embankment will have a 5 m wide crest on the west side, gradually widening to the order of 15 m near the western edge of the detention pond. The embankment will have a consistent 2H : 1V slope down to the Purpleville Creek tributary valley.

It is understood that SWMP3 will function as a wet pond, i.e. a water level is to be continually maintained.

The discussions and recommendations presented in this report are based on project information provided by SLI and on the factual data obtained during the course of this investigation. Factual data obtained during previous investigations is also referenced where appropriate.

8. STORMWATER MANAGEMENT POND #3 DESIGN

8.1 Pond Design Criteria

Major foundation/geotechnical aspects of the pond design that are addressed herein include the following:

- Assessment of the stability of the creek valley slopes with the new access road embankment;
- Assessment of the stability of the proposed pond sideslopes including the effects of rapid drawdown;
- Assessment of the stability of the proposed pond access road;
- Estimation of the hydraulic conductivities of the soils in the pond area and their implication to water retention. A compacted clay liner may be required should the base of the pond coincide with relatively permeable soils such as sand.

Based on information provided by SLI, the design crest elevation along the outer perimeter of the pond is 246.25 m, which would be created by placing new fill at locations along the perimeter of the new pond footprint. The height of new fill to be placed to construct the new berms and dykes is typically in the order of 1 to 1.5 m, except for the west side where the fill height would be up to the order of 4 m. The majority of the pond will be constructed by excavating the ground in the vicinity of the existing pond. The design base elevations for the proposed permanent pond and



detention pond are 241.75 m and 243.75 m, respectively. The maximum depth of cut in the middle of the pond would be in the order of approximately 3.2 m. Near the west perimeter of the proposed pond, the access road would have a width of about 15 m and a maximum fill height of about 4 m. The proposed road would narrow to a width of 5 m towards the west, before it merges with the existing platform of the service centre.

8.2 Stability Analysis Methodology

For the purpose of embankment and slope stability analyses, the commercially available slope stability program GEO-SLOPE employing the Morgenstern-Price method of slices for limit equilibrium was used.

For global stability and based on consideration of the risks involved, past experience of slope and embankment performance and site specific conditions, a criterion of a minimum Factor of Safety (F.S.) of 1.3 against global slope instability has been used in this report.

9. SLOPE STABILITY ANALYSIS OF POND AND ACCESS ROAD

9.1 General

The borehole results indicate that the subsurface condition typically consists of firm to very stiff silty clay to clayey silt fill overlying compact to very dense sands and silts, and/or very stiff to hard clayey silt till. The groundwater level lowers from about Elevation 244 near the existing pond to about Elevation 238 near the toe of the valley slope.

The proposed SWMP#3 re-design will involving making cuts into the dense sands and silts and/or very stiff to hard clayey silt till.

9.2 Selected Cases for Stability Analysis

Representative cross-sections of the pond side slopes and the access road embankment have been selected for stability analyses. Soil parameters used for these analyses have been selected based primarily on correlations with SPT 'N' values, measured water contents and plasticity indices.

The F.S.'s obtained from stability analysis of the selected cases as outlined above are summarized in Table 9-1 below.

Table 9-1 Selected Stability Analysis Results

Location	Type of Analysis	Factor of Safety	Figure
Valley Slope with Pond Access Road (Section A-A')	Drained	1.5	E1
Valley Slope with Pond Access Road (Section A-A')	Undrained	1.5	E2
Valley Slope with Pond Access Road (Section B-B')	Drained	1.4	E3
Valley Slope with Pond Access Road (Section B-B')	Undrained	1.4	E4
Valley Slope with Saturated Lower Slope	Undrained	1.25	E5
Permanent Pond South Slope	Drained	> 2	E6
	UnDrained	> 2	E7
	Rapid Drawdown	1.15	E8
Permanent Pond North Slope	Drained	> 2	E9
	Undrained	> 2	E10
	Rapid Drawdown	1.15	E11
Permanent Pond East Slope	Drained	2.0	E12
	Undrained	> 2	E13
	Rapid Drawdown	1.2	E14

Figures E1 to E14 in Appendix E present selected stability analysis results of representative cases. The soil properties assumed in the analyses are shown on these figures.

Results of these analyses indicate that adequate factors of safety can be maintained for global stability in all the cases analysed.

9.2.1 Valley Slopes with New Access Road

Representative cases involving the new access road embankment yield factors of safety ranging between 1.4 and 1.5 which satisfy the global stability criterion.

For the unlikely case where the pond leaks to such an extent as to saturate the lower portion of the valley slope, the factor of safety is estimated to be about 1.25. The risk of pond leakage can be mitigated by installing an impermeable liner on the wet surfaces of the pond (see Section 9.3).

9.2.2 Slopes within the Pond

Several selected sections of the pond slopes have been analysed including rapid drawdown cases which refer to a low probability event where the water level in the pond drops abruptly (in a matter of hours) resulting in horizontal seepage gradients at the exposed slopes.



Representative cases involving the various pond slopes yield factors of safety of ≥ 2 which satisfy the global stability criterion.

The rapid drawdown cases yield factors of safety in the order of 1.15 to 1.2 which is deemed acceptable.

9.3 Pond Design and Construction

Based on the above and from a foundation/geotechnical engineering perspective, the design of the SWMP3 as currently considered by SLI should not have any adverse impact on the stability conditions of the nearby Purpleville Creek tributary valley slopes and the existing Highway 400 embankment.

Construction of the new pond will require excavation in the vicinity of the existing pond through the firm to hard clayey silt fill and clayey silt till, and compact to very dense sands and silts. Glacial tills inherently contain cobbles and boulders and, as such, the contractor should be equipped to handle and/or remove such obstructions.

Borehole information indicates that stiff to hard clayey silt and clayey silt till as well as compact to very dense sands and silts will be exposed across the sides and at the base of the pond. The clayey silt soils have relatively low hydraulic conductivity and the infiltration rate is therefore expected to be low. The sands and silts have higher hydraulic conductivity and, if encountered, will be causes of leakage. For design purposes, the following hydraulic conductivities may be assumed:

- Clayey silt till ($< 10^{-6}$ cm/s)
- Sands and silts (10^{-3} to 10^{-5} cm/s)

It is understood that SWMP#3 is designed to be a wet pond. Therefore, a head of water will need to be maintained in the pond at all times. It is probable that sands and silts are present at the pond base or on the sideslopes. These soils are not considered adequate for continuous water retention. It is therefore recommended that a compacted clay liner be placed on the anticipated wet surface inside the pond. A typical clay liner should be approximately 0.5 m in thickness. The excavated clayey silt and clayey silt till materials from construction of the pond may be used to form the liner. Alternatively, a geosynthetic clay liner may be used for the same purposes.

Construction of the SWMP#3 will require placement of fill for the proposed pond access road and the northern bank of the pond. Prior to placing new fill, the existing topsoil, organic soils, vegetation, soft soils, or otherwise unsuitable overburden materials, should be stripped. Any



existing slope surfaces should then be appropriately benched, as per OPSD 208.010, prior to placing new fill.

The excavated clayey silt and clayey silt till at this site are considered suitable from a geotechnical perspective for use as new fill. Provisions should be made, however, for the segregation and removal of any wet, unsuitable soils, organic materials, or cobbles and boulders which should not be used as embankment fill. The sands and silts have higher hydraulic conductivities, and are too wet for adequate compaction, and therefore should not be used as fill on site.

All new earth fill should be placed in regular lifts and be compacted in accordance with OPSS.PROV 501. Vegetation cover should be established on all exposed slopes to protect against surficial erosion in accordance with OPSS.PROV 804.

A concrete weir structure is to be founded at approximate Elevation 243.3 m near the north-east end of the pond. Based on Borehole P17-06, the weir would be founded on the native undisturbed stiff to very stiff clayey silt till. It is recommended that a factored geotechnical resistance at ULS of 300 kPa and a geotechnical resistance at SLS of 200 kPa be used for foundation design.

Excavation, grading and compaction should be carried out with reference to the requirements of OPSS.PROV 206 and OPSS.PROV 501.

It is important to note that water-bearing sands and silts could be exposed at some locations on the base and slopes of the pond. Granular sheeting or other measures may be required at these locations where persistent water seepage could result in surficial and basal instability. Any dewatering systems that may be required is the responsibility of the Contractor.

Erosion protection should be provided for selected surfaces of the sideslopes of the pond as required. Design of the erosion protection measures must consider hydrologic and hydraulic concerns. Typically, rip-rap should be provided in areas of high velocity or concentrated water flow. Other surfaces may be treated with vegetation, hydroseeding and/or erosion control blanket as required. Reference should be made to OPSS.PROV 804 for erosion protection requirements.

10. CONSTRUCTION CONCERNS

During construction, the Contract Administrator (CA) should employ experienced geotechnical staff to observe construction activities related to foundation construction. Potential construction concerns include, but are not necessarily limited to, the following:

- Groundwater control is essential for maintaining reasonably dry excavations.
- The pond base and sideslopes should be inspected periodically, or as required, to confirm stability.



- Should the water-bearing sands and silts be exposed at the pond base or on the sideslopes, dewatering, gravel sheeting or other treatment measures may be required to address surficial instability.

11. CLOSURE

Engineering analysis and preparation of this foundation design report was carried out by Mr. Cory Zanatta, EIT, and Dr. Sydney Pang, P.Eng. The report was reviewed by Dr. P. K. Chatteriji, P.Eng., a Designated Principal Contact for MTO Foundations Projects.



Thurber Engineering Ltd.

Cory Zanatta, B.A.Sc.
Geotechnical Engineering-In-Training



Sydney Pang, P.Eng.
Associate, Senior Foundations Engineer



P.K. Chatterji, P.Eng.
Review Principal, Designated MTO Contact

Client: SNC Lavalin Inc

File No.: 17265

E file: H:\17000-17999\17265 Highway 400 Widening - SWM Pond #3\Reports and Memos\SWMP3\FINAL\17265 Hwy 400
SWM Pond #3 FIDR FINAL Mar 18.docx

Date: March 9, 2018

Page: 18 of 18

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.

EXPLANATION OF ROCK LOGGING TERMS


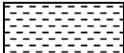



ROCK WEATHERING CLASSIFICATION

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

DISCONTINUITY SPACING

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

SYMBOLS

	CLAYSTONE
	SILTSTONE
	SANDSTONE
	COAL
	BEDROCK

STRENGTH CLASSIFICATION

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

TERMS

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

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			



Appendix A

Record of Borehole Sheets

RECORD OF BOREHOLE No P17-01

1 OF 1

METRIC

GWP# 2539-04-00 LOCATION Storm Water Management Pond #3 N 4 859 599.7 E 300 175.1 ORIGINATED BY CAR
 HWY 400 BOREHOLE TYPE Tripod COMPILED BY AN
 DATUM Geodetic DATE 2017.03.05 - 2017.03.06 CHECKED BY CZ

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						
246.9	GROUND SURFACE							20 40 60 80 100						
0.0	TOPSOIL , trace roots and rootlets: (125mm) Silty CLAY , trace gravel Firm to Very Stiff Brown Moist (FILL)		1	SS	3		246	20 40 60 80 100						0 24 48 28
0.1			2	SS	6									
			3	SS	6									
			4	SS	19		245							
			5	SS	14		244							
			6	SS	20									
243.2	Clayey SILT , with sand, trace gravel, trace roots and rootlets, topsoil stained Very Stiff to Hard Dark Brown Moist (TILL)		7	SS	22		243	20 40 60 80 100						2 27 46 25
3.7			8	SS	27									
			9	SS	21		242							
			10	SS	21		241							
			11	SS	43									
			12	SS	100/		240							
239.9	END OF BOREHOLE AT 7.0m. BOREHOLE OPEN TO 7.0m AND 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) 2017.03.13 5.3 241.6 2017.04.10 5.2 241.7		13	SS	0.225 100/ 0.050									
7.0														

ONTMT4S MTO-17265.GPJ 2015TEMPLATE(MTO).GDT 4/13/17

+³, ×³: Numbers refer to
Sensitivity

20
15
10
(%) STRAIN AT FAILURE

RECORD OF BOREHOLE No P17-02

1 OF 1

METRIC

GWP# 2539-04-00 LOCATION Storm Water Management Pond #3 N 4 859 610.1 E 300 164.2 ORIGINATED BY CAR
 HWY 400 BOREHOLE TYPE Tripod COMPILED BY AN
 DATUM Geodetic DATE 2017.03.02 - 2017.03.02 CHECKED BY CZ

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							
241.5	GROUND SURFACE														
0.0	ORGANICS mixed with silty clay, trace sand, roots and rootlets		1	SS	2	▽	241							0 30 57 13	
241.1	Soft														
0.4	Dark Brown Moist														
	Clayey SILT , some sand, with rootlets		2	SS	8										
240.4	Firm														
1.1	Brown Moist (FILL)		3	SS	20			240							
	Sandy SILT , trace to some clay														
	Compact		4	SS	11										
	Brown Moist														
239.0							239								
2.5	Clayey SILT , some sand, trace gravel, with cobbles from 2.7m to 2.8m depth		5	SS	42	238								1 18 64 17	
	Hard														
	Brown Moist (TILL)		6	SS	100										
237.8															
3.7	SAND , trace silt														
	Very Dense		7	SS	100										
237.2	Brown Moist													0 86 14	
4.3	END OF BOREHOLE AT 4.3m. WATER LEVEL AT 0.4m UPON COMPLETION. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG AND CUTTINGS TO SURFACE.													(SI+CL)	

+³, ×³: Numbers refer to
Sensitivity

20
15
10

(%) STRAIN AT FAILURE

RECORD OF BOREHOLE No P17-03

1 OF 1

METRIC

GWP# 2539-04-00 LOCATION Storm Water Management Pond #3 N 4 859 616.6 E 300 206.5 ORIGINATED BY CAR
 HWY 400 BOREHOLE TYPE Tripod COMPILED BY AN
 DATUM Geodetic DATE 2017.02.27 - 2017.02.27 CHECKED BY CZ

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												
244.1	GROUND SURFACE							20	40	60	80	100								
0.0	Silty CLAY , organic inclusions, trace sand, with roots and rootlets		1	SS	3		244													
243.7	Soft Brown Moist																			
0.4	Clayey SILT , with sand, roots and rootlets, topsoil stained		2	SS	11		243													
	Stiff Dark Brown Moist		3	SS	9															
242.3	Clayey SILT , with sand, trace gravel		4	SS	10		242													
1.8	Hard Brown Wet (TILL)		5	SS	35															
			6	SS	47		241													
			7	SS	100															
							240													
239.1			8	SS	100															
5.0	END OF BOREHOLE AT 5.0m. Piezometer installation consists of 25mm diameter Schedule 40 PVC pipe with a 1.52m slotted screen. WATER LEVEL READINGS DATE DEPTH(m) ELEV.(m) 2017.03.06 Dry - 2017.03.13 Dry - 2017.04.10 4.3 239.8																			

ONTMT4S MTO-17265.GPJ 2015TEMPLATE(MTO).GDT 4/13/17

RECORD OF BOREHOLE No P17-04

1 OF 1

METRIC

GWP# 2539-04-00 LOCATION Storm Water Management Pond #3 N 4 859 637.1 E 300 206.8 ORIGINATED BY CAR
 HWY 400 BOREHOLE TYPE Tripod COMPILED BY AN
 DATUM Geodetic DATE 2017.02.28 - 2017.02.28 CHECKED BY CZ

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						
241.0	GROUND SURFACE							<div>20406080100</div> <div>○ UNCONFINED + FIELD VANE</div> <div>● QUICK TRIAXIAL × LAB VANE</div>						
0.0	ORGANICS mixed with silty clay, roots and rootlets Very Soft Dark Brown Moist		1	SS	1									
240.4														
0.6	Clayey SILT , trace sand, with roots and rootlets Firm Light Brown Moist (FILL)		2	SS	5		240							
239.8														
1.2	Clayey SILT , trace sand Very Stiff Brown Moist		3	SS	15		239							
			4	SS	23									0 7 68 25
238.4														
2.6	SAND and SILT , trace clay Very Dense to Dense Brown Moist		5	SS	57		238							
			6	SS	61									
							237							
			7	SS	35		236							0 49 43 8
235.7														
5.3	Clayey SILT , some sand Hard Grey Wet						235							
			8	SS	44									0 13 69 18
234.3														
6.7	END OF BOREHOLE AT 6.7m. Piezometer installation consists of 25mm diameter Schedule 40 PVC pipe with a 1.52m slotted screen. WATER LEVEL READINGS DATE DEPTH(m) ELEV.(m) 2017.03.06 3.0 238.0 2017.03.13 3.1 237.9 2017.04.10 3.2 237.8													



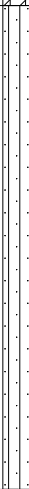
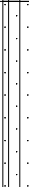
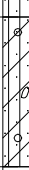
ONTMT4S MTO-17265.GPJ 2015TEMPLATE(MTO).GDT 4/13/17

RECORD OF BOREHOLE No P17-05

1 OF 2

METRIC

GWP# 2539-04-00 LOCATION Storm Water Management Pond #3 N 4 859 596.5 E 300 219.5 ORIGINATED BY CAR
 HWY 400 BOREHOLE TYPE Tripod COMPILED BY AN
 DATUM Geodetic DATE 2017.03.08 - 2017.03.08 CHECKED BY CZ

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						
248.5	GROUND SURFACE													
0.0	TOPSOIL , with roots and rootlets Clayey SILT , trace gravel, trace rootlets Firm to Hard Brown Moist (FILL)		1	SS	4									
0.1														
			2	SS	10									
			3	SS	31									
246.4			4	SS	53									
2.1	Silty CLAY , with sand, trace gravel Hard Brown Moist													
			5	SS	60									
			6	SS	70									
244.5														
4.0	Sandy SILT , trace gravel Very Dense Brown Moist													
			7	SS	54									
			8	SS	68									
			9	SS	99									
241.3														
7.2	SAND and SILT , trace clay Dense Brown Moist													
			10	SS	46									
240.0														
8.5	Clayey SILT , with sand, trace gravel, with silty sand seams Hard Brown Moist (TILL)													
			11	SS	100/ 0.075									
239.0														
9.5	END OF BOREHOLE AT 9.5m. Piezometer installation consists of 25mm diameter Schedule 40 PVC													

Continued Next Page

+³, ×³: Numbers refer to
Sensitivity

20
15
10

(%) STRAIN AT FAILURE

ONTMT4S MTO-17265.GPJ 2015TEMPLATE(MTO).GDT 4/13/17

METRIC




[illegible][illegible]

RECORD OF BOREHOLE No P17-06

1 OF 1

METRIC

GWP# 2539-04-00 LOCATION Storm Water Management Pond #3 N 4 859 614.6 E 300 257.4 ORIGINATED BY CAR
 HWY 400 BOREHOLE TYPE Tripod COMPILED BY AN
 DATUM Geodetic DATE 2017.03.01 - 2017.03.01 CHECKED BY CZ

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
247.4	GROUND SURFACE							20	40	60	80	100							
0.0	TOPSOIL , with roots and rootlets: (50mm) Clayey SILT , trace to some sand, topsoil stained Firm to Stiff Dark Brown Moist (FILL)		1	SS	6		247							○					
			2	SS	6									○					
			3	SS	13		246							○					
			4	SS	6									○					0 20 60 20
245.0							245							○					
2.4	Clayey SILT , with sand, trace gravel Stiff to Hard Brown Wet (TILL)		5	SS	9									○					
			6	SS	17		244							○					0 36 48 16
														○					
			7	SS	72		243												
242.5																			
4.9	END OF BOREHOLE AT 4.9m. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG AND CUTTINGS TO SURFACE.																		

+³, ×³: Numbers refer to
Sensitivity

20
15
10

(%) STRAIN AT FAILURE

RECORD OF BOREHOLE No P17-07

1 OF 1

METRIC

GWP# 2539-04-00 LOCATION Storm Water Management Pond #3 N 4 859 625.3 E 300 239.3 ORIGINATED BY CAR
 HWY 400 BOREHOLE TYPE Tripod COMPILED BY AN
 DATUM Geodetic DATE 2017.02.28 - 2017.03.01 CHECKED BY CZ

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	
245.8	GROUND SURFACE																			
0.0 0.1	TOPSOIL with roots and rootlets: (75mm) Clayey SILT , with sand, trace gravel, with roots and rootlets Stiff to Firm Brown Moist (FILL)		1	SS	9								○							
			2	SS	11		245						○							
			3	SS	12		244						○							
			4	SS	5								○				0	30	47	23
			5	SS	6		243						○							
242.8			6	SS	20		242						○				0	34	43	23
3.0	Clayey SILT , with sand, trace gravel Very Stiff to Hard Brown Moist (TILL)																			
			7	SS	76		241						○							
							240													
239.4			8	SS	100								○							
6.4	END OF BOREHOLE AT 6.4m. Piezometer installation consists of 25mm diameter Schedule 40 PVC pipe with a 1.52m slotted screen. WATER LEVEL READINGS DATE DEPTH(m) ELEV.(m) 2017.03.06 2.5 243.3 2017.03.13 2.6 243.2 2017.04.10 2.2 243.6																			

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



Appendix B

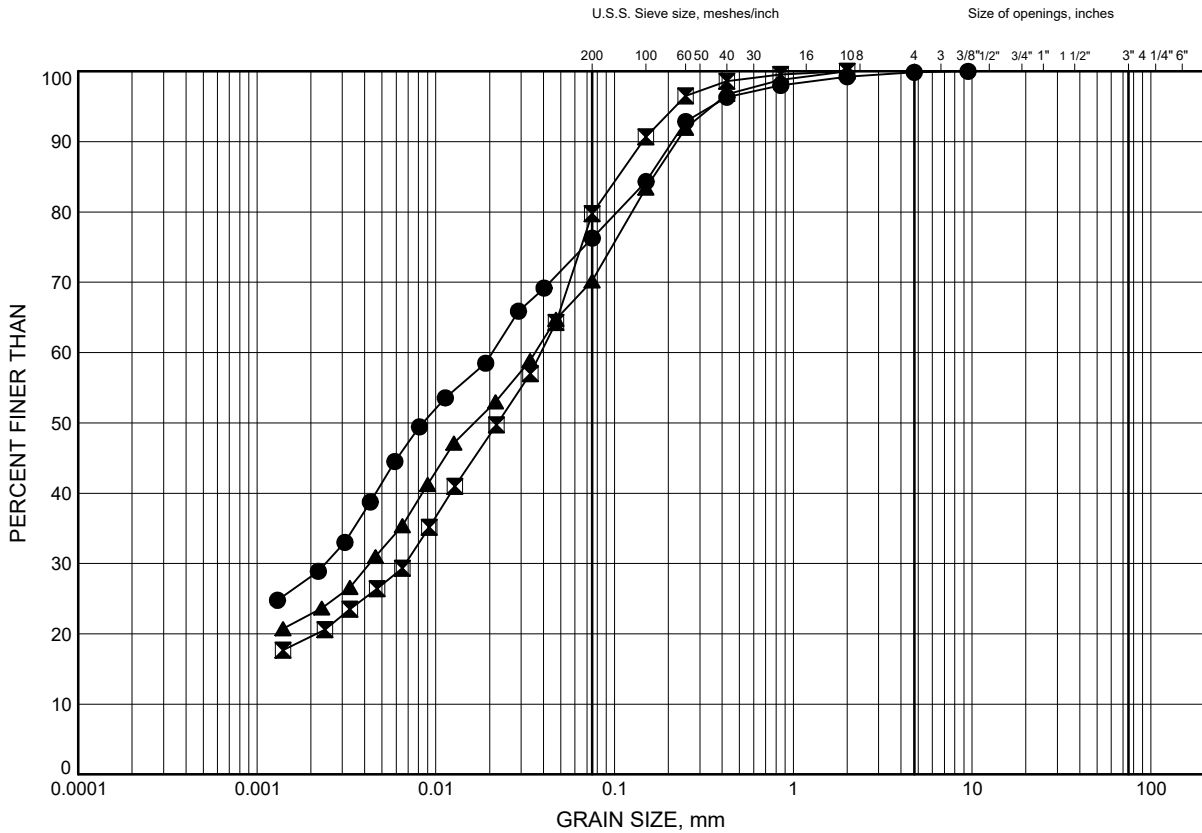
Laboratory Test Results

Storm Water Management Pond #3

GRAIN SIZE DISTRIBUTION

FIGURE B1

Silty CLAY to Clayey SILT FILL



SILT and CLAY	FINE	MEDIUM	COARSE	FINE	COARSE	COBBLE SIZE
FINE GRAINED	SAND			GRAVEL		

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	P17-01	2.13	244.77
⊠	P17-06	2.13	245.27
▲	P17-07	2.13	243.67

Date April 2017
GWP# 2539-04-00



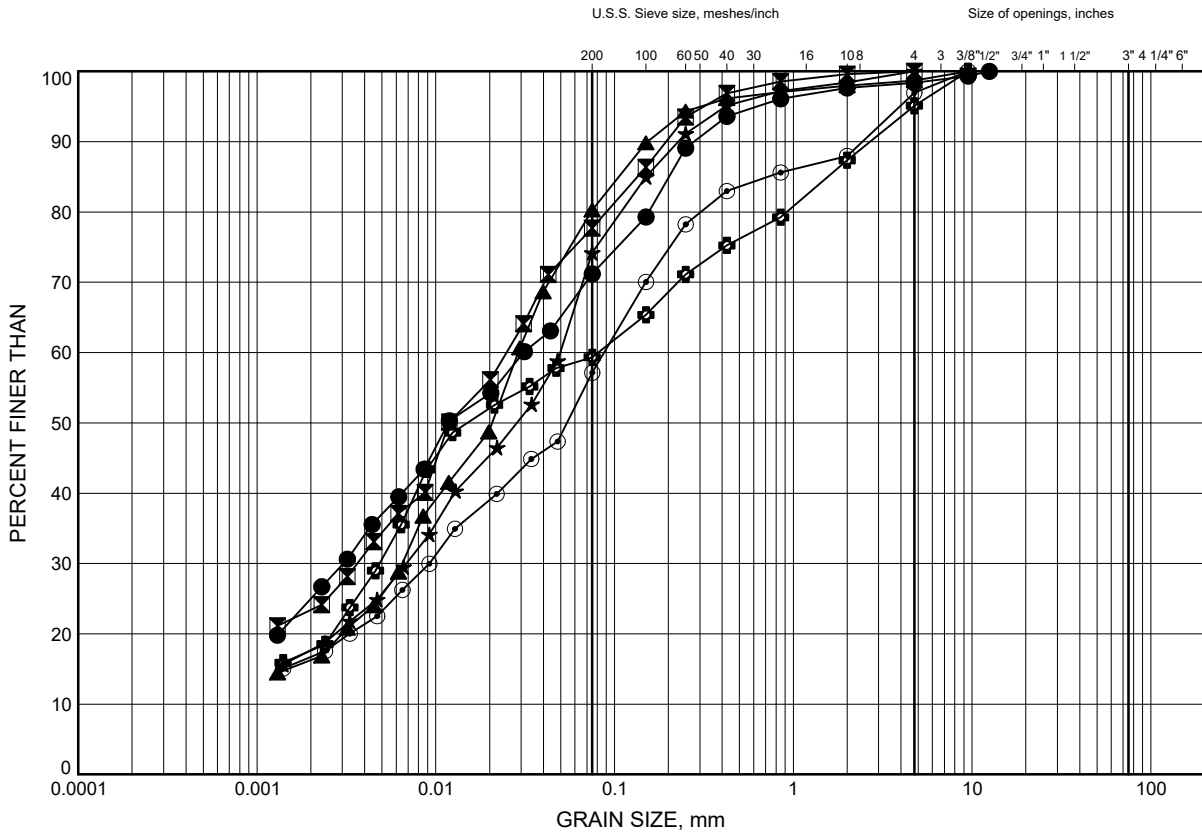
Prep'd AN
Chkd. SKP

Storm Water Management Pond #3

GRAIN SIZE DISTRIBUTION

FIGURE B2

Clayey SILT TILL



SILT and CLAY	FINE	MEDIUM	COARSE	FINE	COARSE	COBBLE SIZE
FINE GRAINED	SAND			GRAVEL		

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	P17-01	3.96	242.94
⊠	P17-01	6.40	240.50
▲	P17-02	2.74	238.76
★	P17-03	2.13	241.97
⊙	P17-03	3.96	240.14
⊕	P17-05	9.27	239.23

Date April 2017
GWP# 2539-04-00



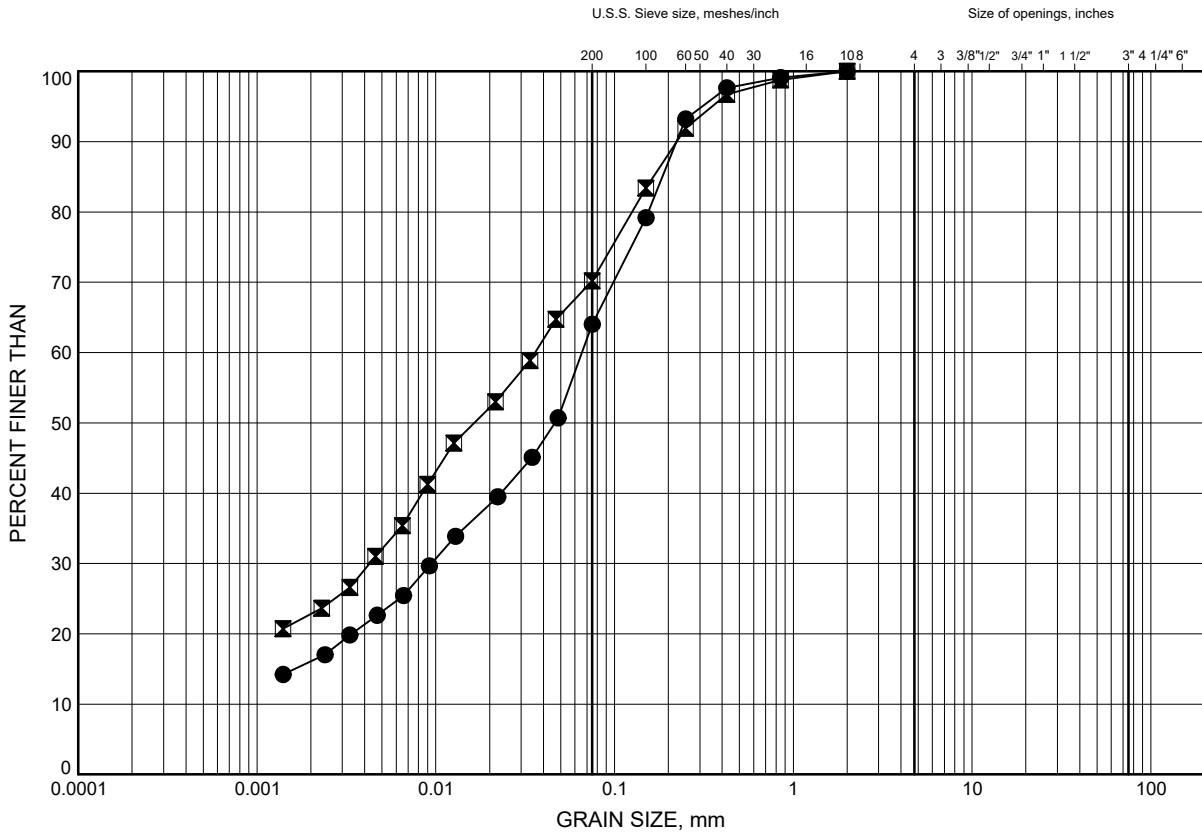
Prep'd an
Chkd. skp

Storm Water Management Pond #3

GRAIN SIZE DISTRIBUTION

FIGURE B3

Clayey SILT TILL



SILT and CLAY	FINE	MEDIUM	COARSE	FINE	COARSE	COBBLE SIZE
FINE GRAINED	SAND			GRAVEL		

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	P17-06	3.35	244.05
⊠	P17-07	2.13	243.67

Date April 2017
GWP# 2539-04-00



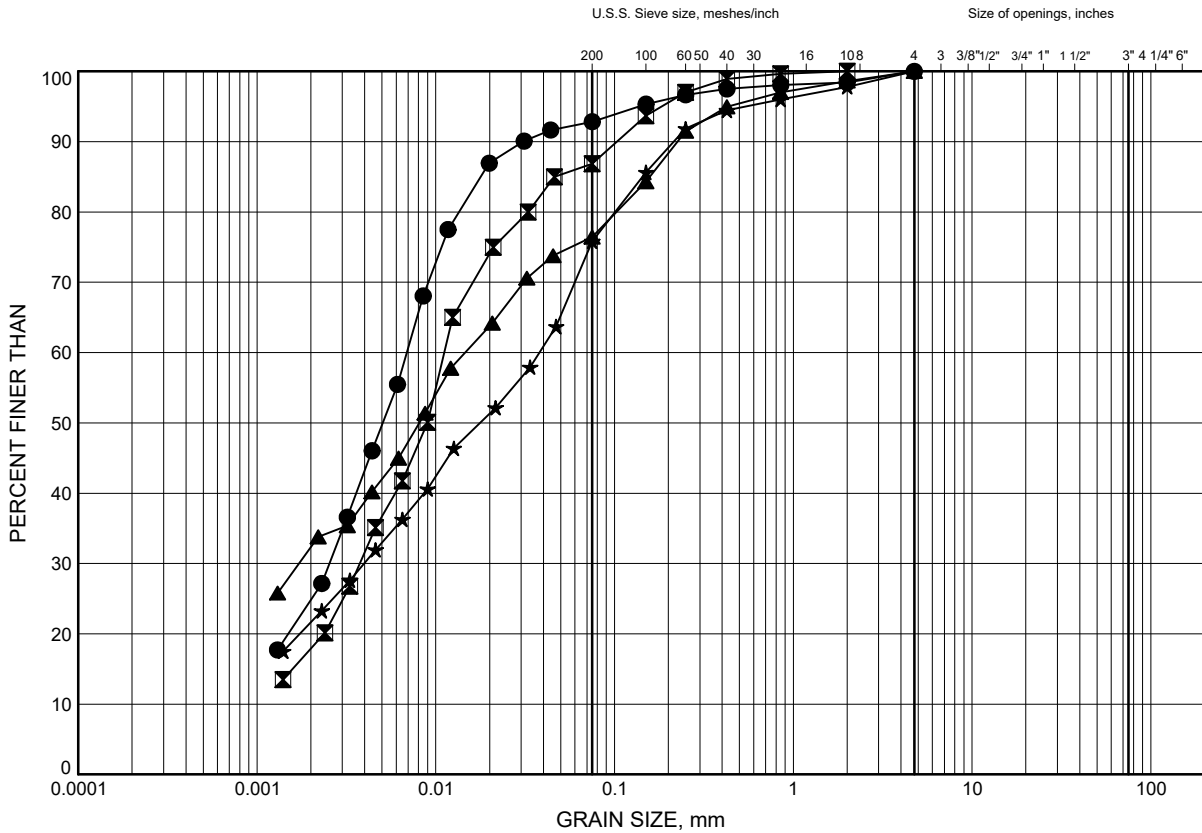
Prep'd an
Chkd. skp

Storm Water Management Pond #3

GRAIN SIZE DISTRIBUTION

FIGURE B4

Silty CLAY to Clayey SILT



SILT and CLAY	FINE	MEDIUM	COARSE	FINE	COARSE	COBBLE SIZE
FINE GRAINED	SAND			GRAVEL		

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	P17-04	2.13	238.87
⊠	P17-04	6.40	234.60
▲	P17-05	2.13	246.37
★	P17-05	3.35	245.15

Date April 2017
GWP# 2539-04-00



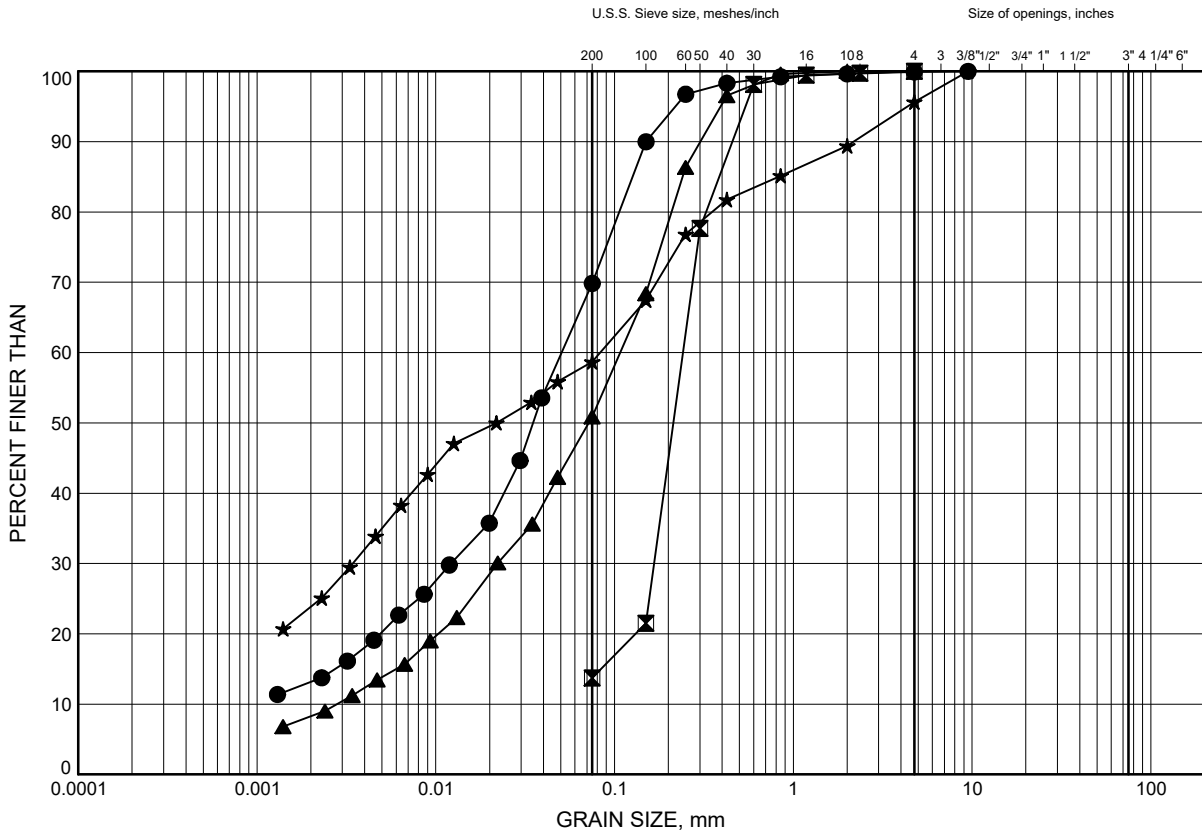
Prep'd AN
Chkd. SKP

Storm Water Management Pond #3

GRAIN SIZE DISTRIBUTION

FIGURE B5

Sandy SILT to SAND



SILT and CLAY	FINE	MEDIUM	COARSE	FINE	COARSE	COBBLE SIZE
FINE GRAINED	SAND			GRAVEL		

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	P17-02	1.52	239.98
⊠	P17-02	4.22	237.28
▲	P17-04	4.88	236.12
★	P17-05	7.70	240.80

Date April 2017
GWP# 2539-04-00

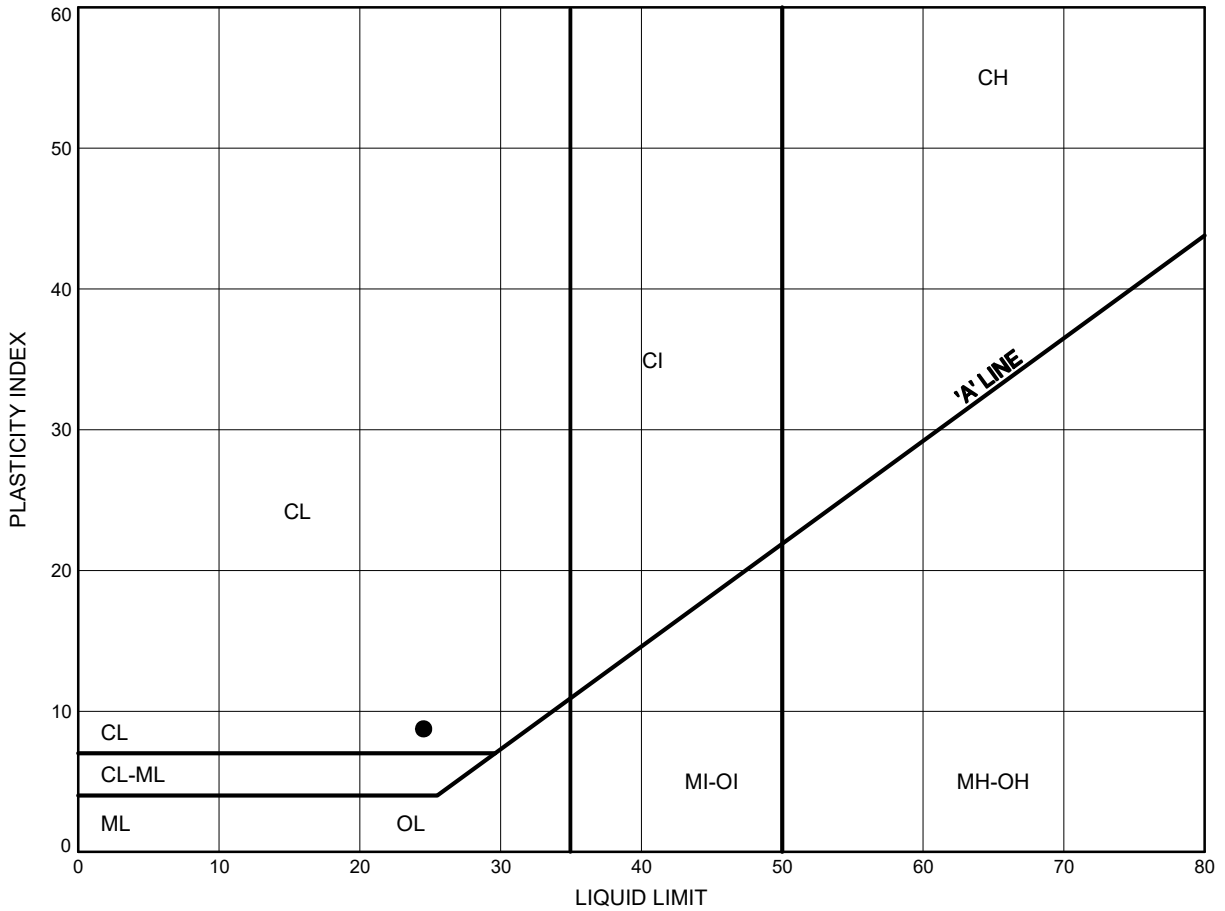


Prep'd AN
Chkd. SKP

Storm Water Management Pond #3
ATTERBERG LIMITS TEST RESULTS

FIGURE B6

Clayey SILT



LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	P17-04	6.40	234.60

Date April 2017
 GWP# 2539-04-00

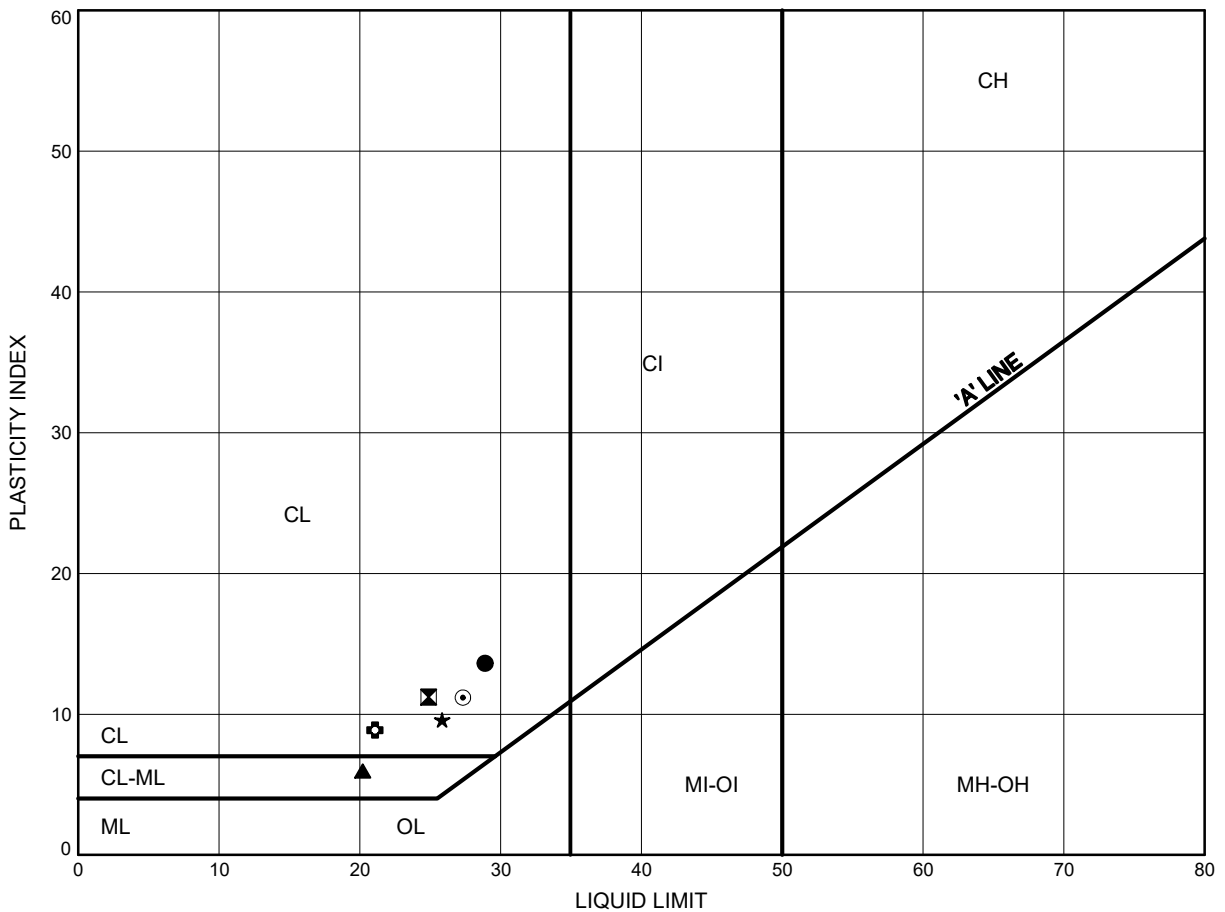


Prep'd AN
 Chkd. SKP

Storm Water Management Pond #3
ATTERBERG LIMITS TEST RESULTS

FIGURE B7

Clayey SILT TILL



LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	P17-01	3.96	242.94
⊠	P17-01	6.40	240.50
▲	P17-02	2.74	238.76
★	P17-03	2.13	241.97
⊙	P17-05	9.27	239.23
⊕	P17-07	3.35	242.45

Date April 2017
 GWP# 2539-04-00

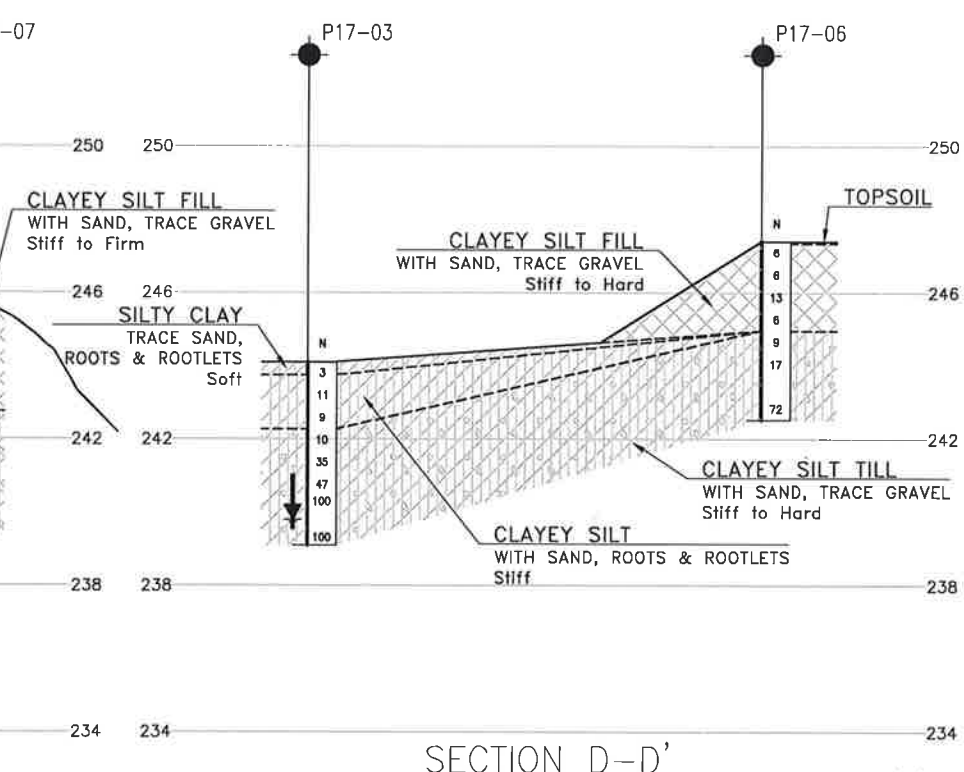
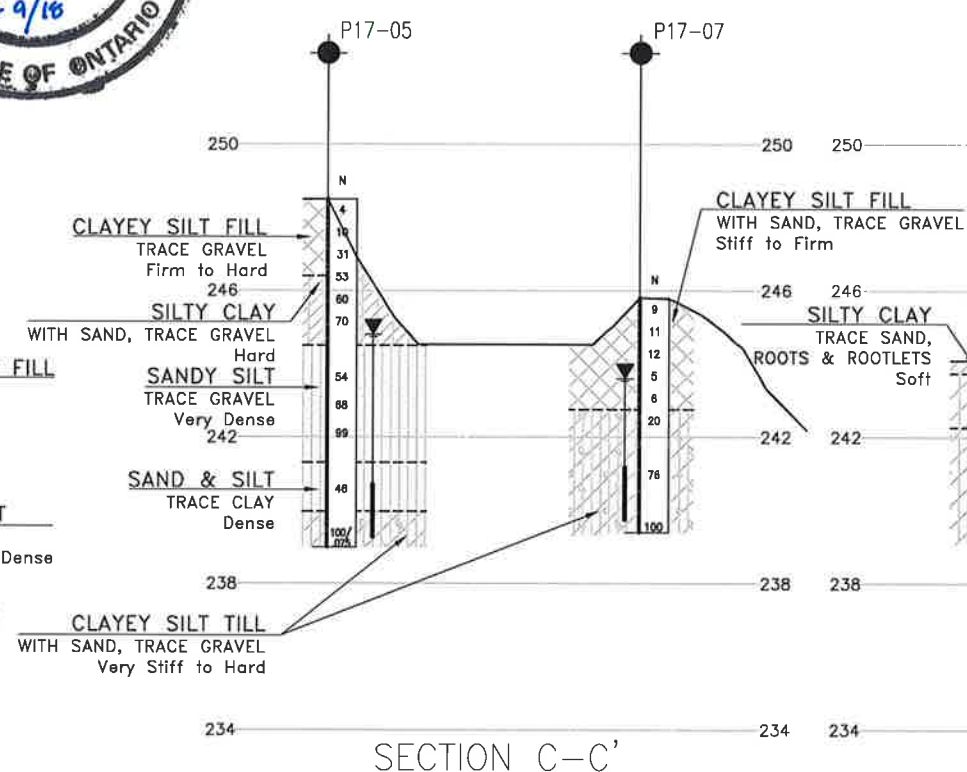
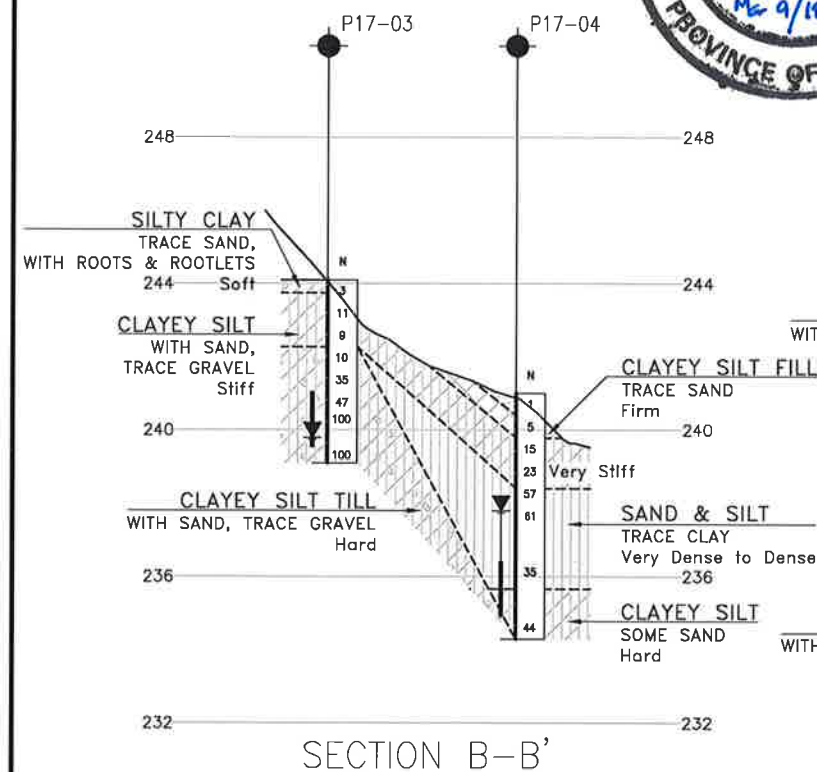
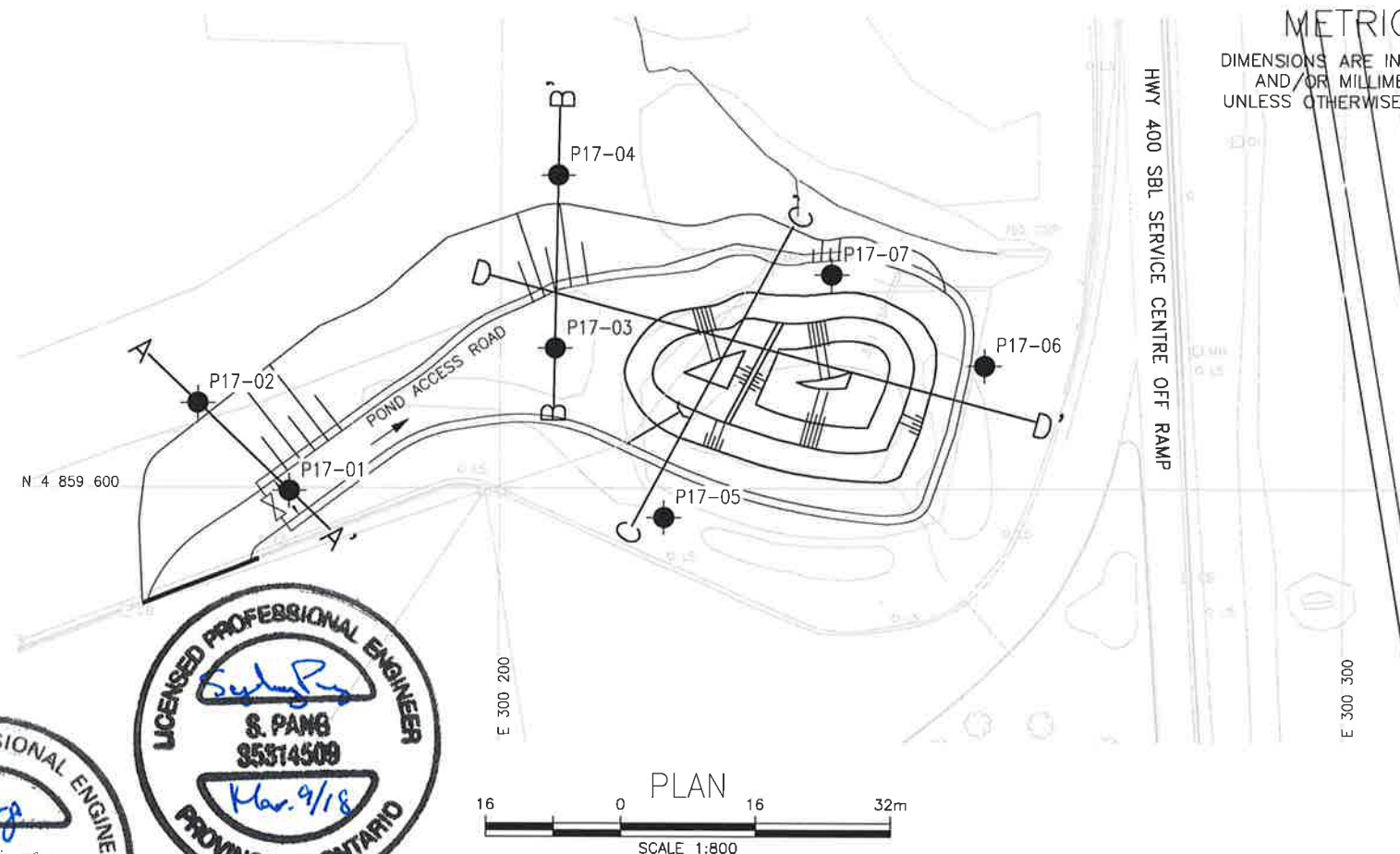
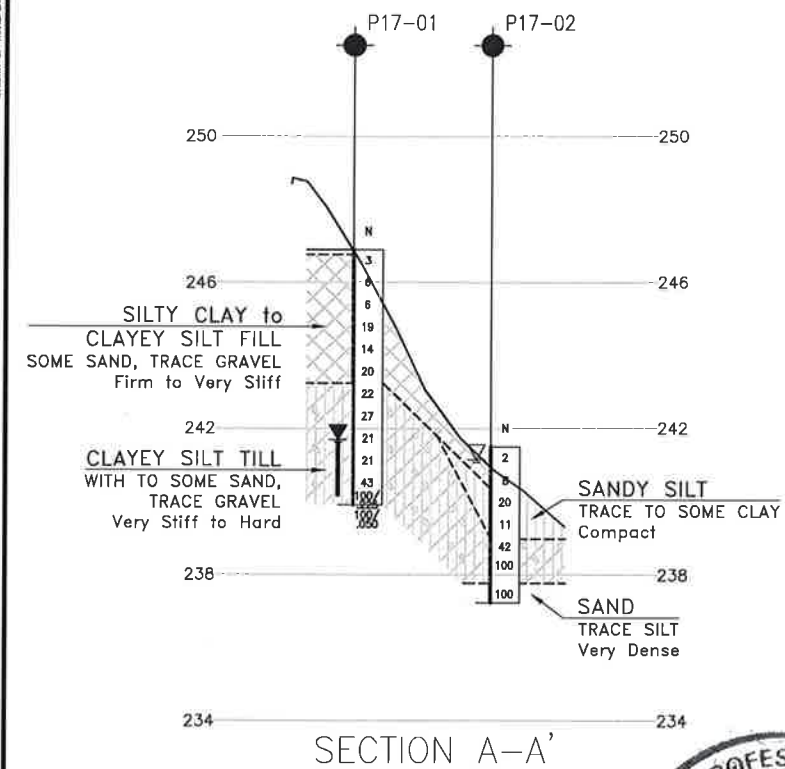


Prep'd AN
 Chkd. SKP

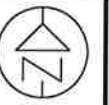


Appendix C

Borehole Locations and Soil Strata Drawing



CONT No
GWP No 2539-04-00








HIGHWAY 400
STORMWATER MANAGEMENT
POND #3
BOREHOLE LOCATIONS AND SOIL STRATA



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
P17-01	246.9	4 859 599.7	300 175.1
P17-02	241.5	4 859 610.1	300 164.2
P17-03	244.1	4 859 616.6	300 206.5
P17-04	241.0	4 859 637.1	300 206.8
P17-05	248.5	4 859 596.5	300 219.5
P17-06	247.4	4 859 614.6	300 257.4
P17-07	245.8	4 859 625.3	300 239.3

-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.

GEOCRES No. 30M13-226

REVISIONS								
	DATE	BY				DESCRIPTION		
	DESIGN CZ	CHK SKP	CODE		LOAD		DATE	MAR 2018
	DRAWN AN	CHK CZ	SITE		STRUCT	DWG 1		



Appendix D

Site Photographs



Photo 1: Looking east at location of Borehole P17-01



Photo 2: Looking south across the existing stormwater pond



Photo 3: Looking north east across the existing stormwater pond



Photo 4: Looking west across the existing stormwater pond



Photo 5: Looking east at south end of pond at location of Borehole P17-07

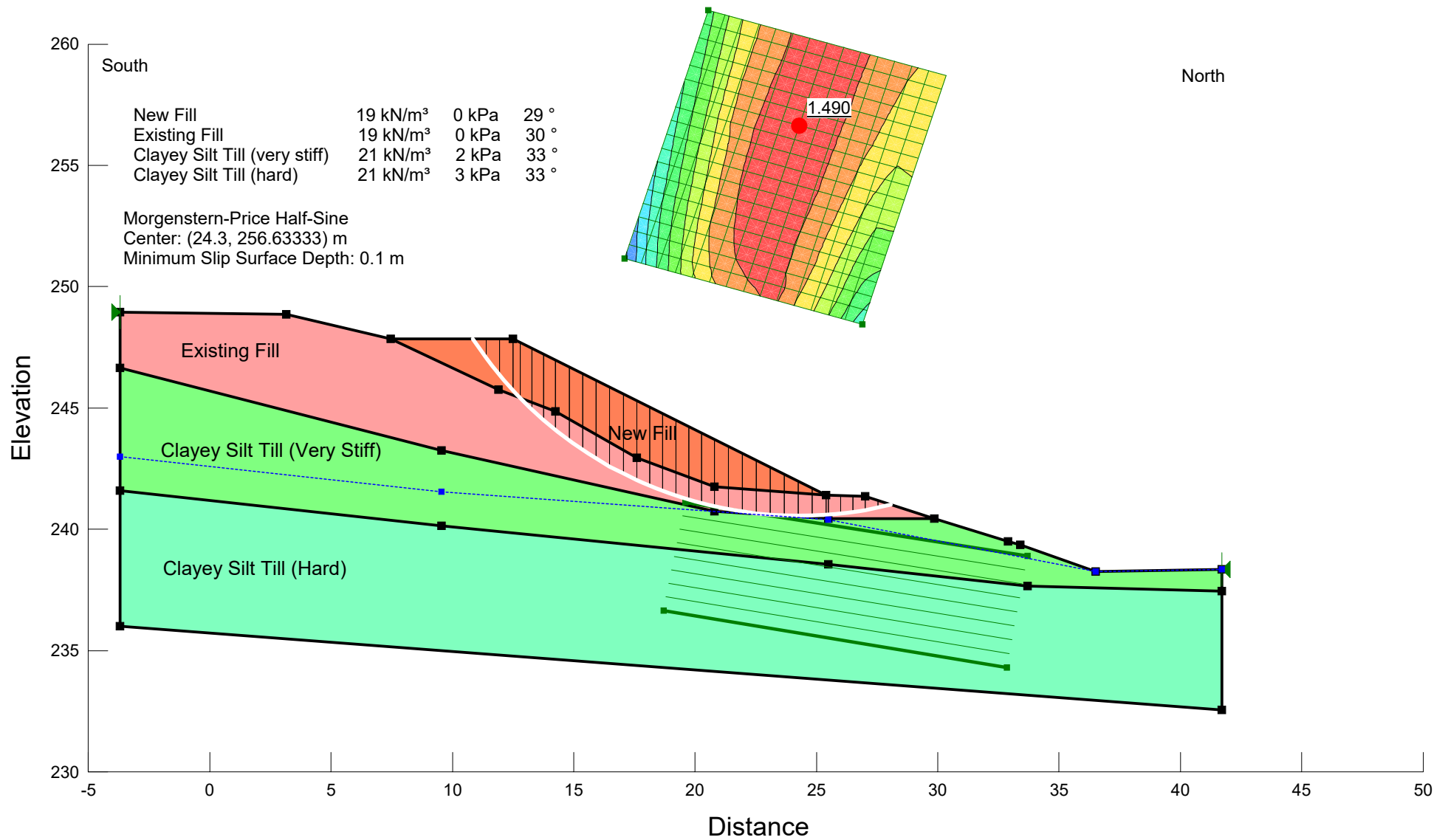


Appendix E

Selected Results of Slope Stability Analyses

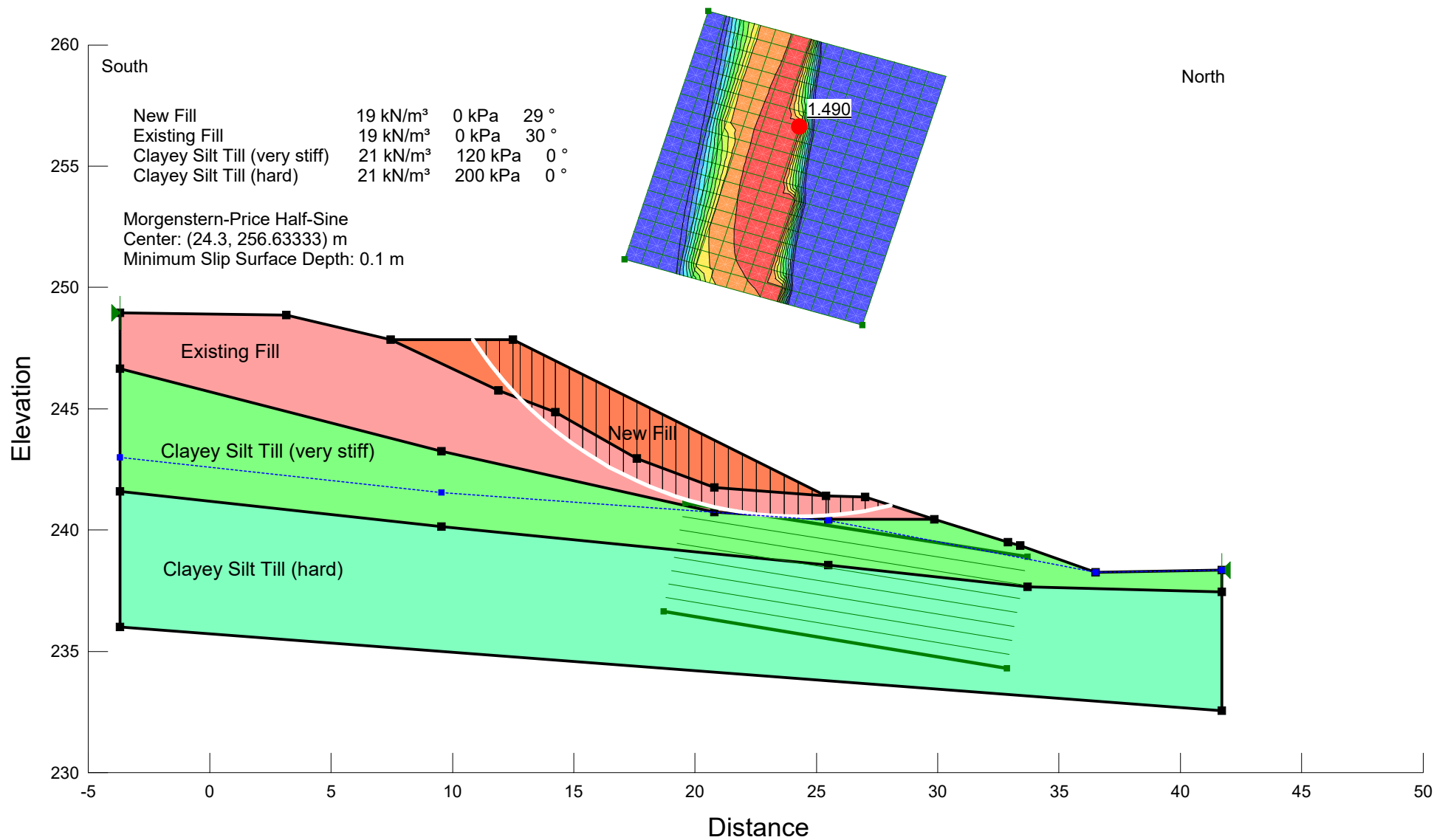
**STORMWATER MANAGEMENT POND #3
HIGHWAY 400 WIDENING
VALLEY SLOPE WITH POND ACCESS ROAD (SECTION A-A') -DRAINED**

FIGURE E1



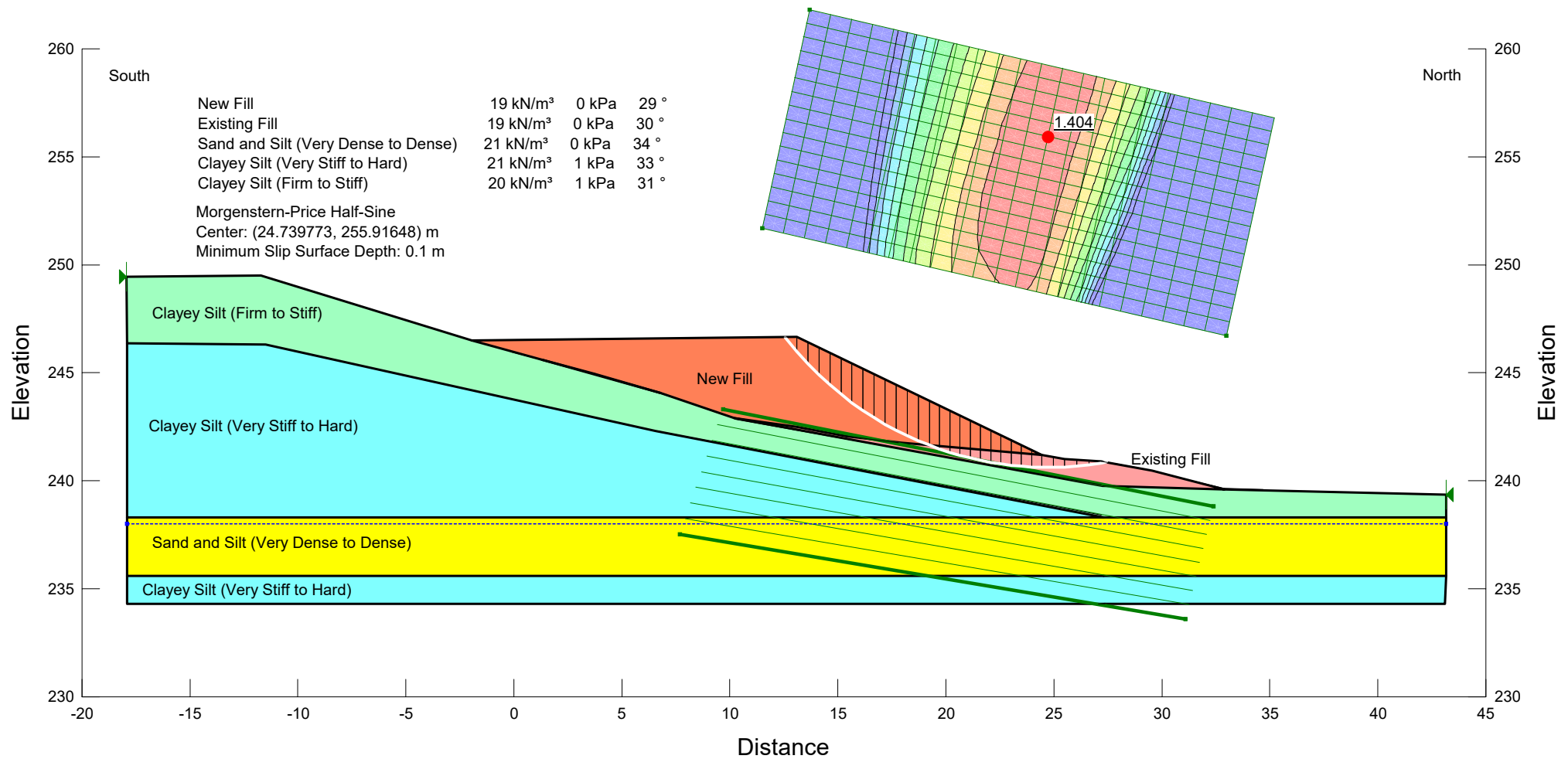
**STORMWATER MANAGEMENT POND #3
HIGHWAY 400 WIDENING
VALLEY SLOPE WITH POND ACCESS ROAD (SECTION A-A') - UNDRAINED**

FIGURE E2



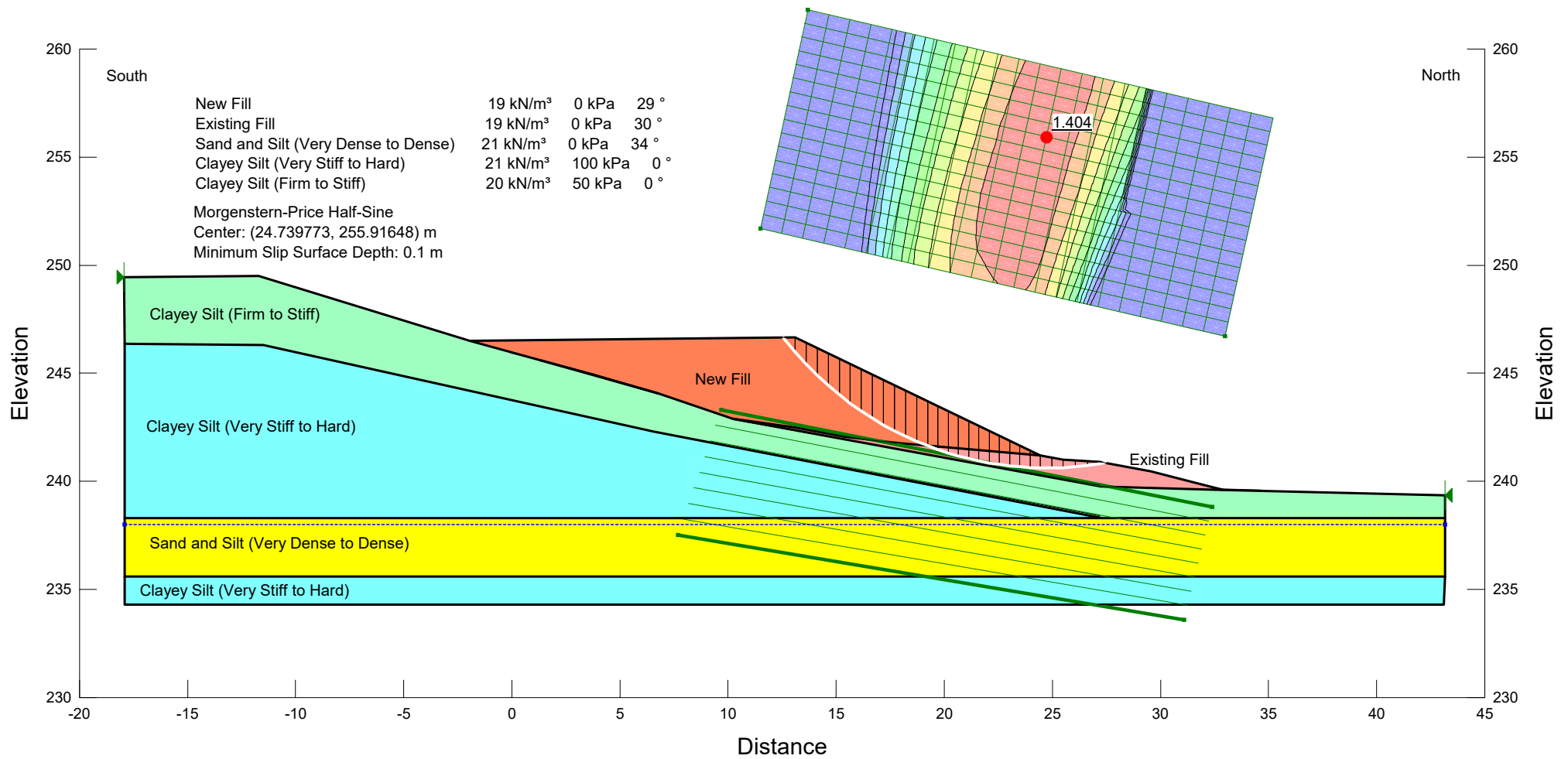
**STORMWATER MANAGEMENT POND #3
HIGHWAY 400 WIDENING
VALLEY SLOPE WITH POND ACCESS ROAD (SECTION B-B') -DRAINED**

FIGURE E3



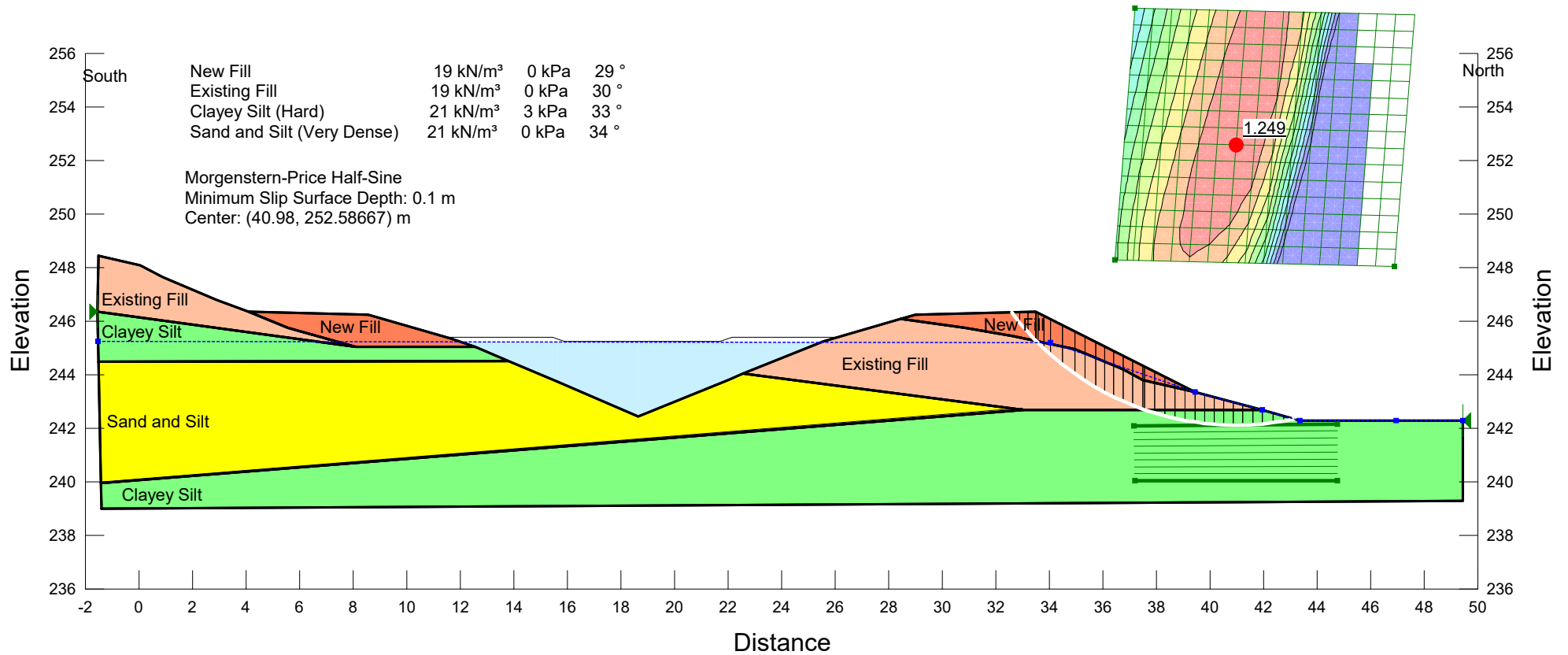
**STORMWATER MANAGEMENT POND #3
HIGHWAY 400 WIDENING
VALLEY SLOPE WITH POND ACCESS ROAD (SECTION B-B') -UNDRAINED**

FIGURE E4



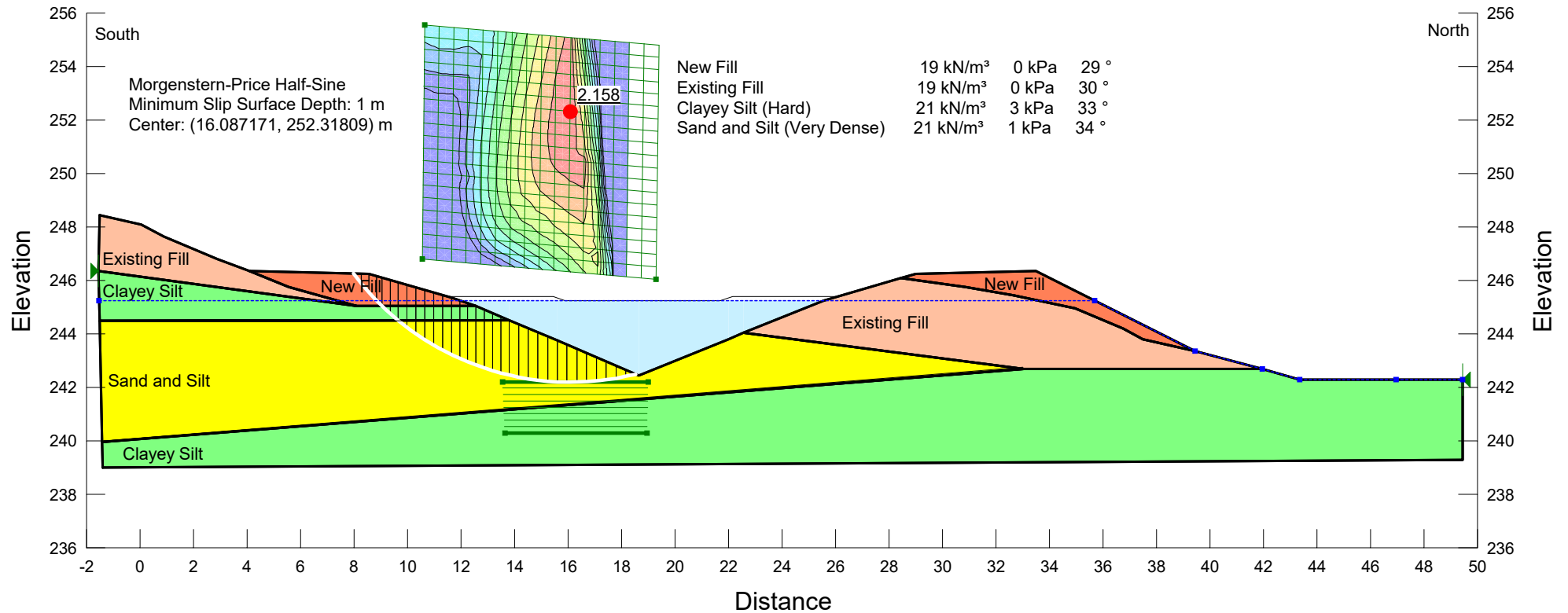
**STORMWATER MANAGEMENT POND #3
HIGHWAY 400 WIDENING
VALLEY SLOPE WITH SATURATED LOWER SLOPE -DRAINED**

FIGURE E5



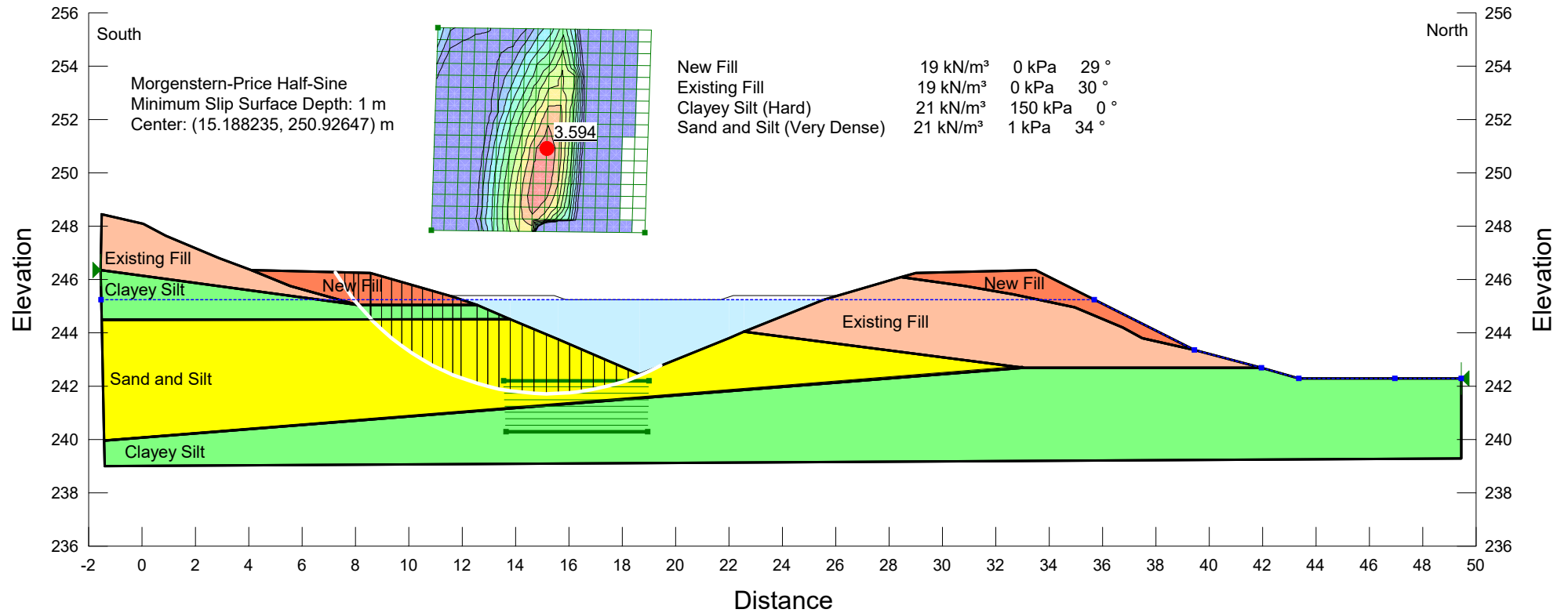
**STORMWATER MANAGEMENT POND #3
HIGHWAY 400 WIDENING
PERMANENT POND SOUTH SLOPE -DRAINED**

FIGURE E6



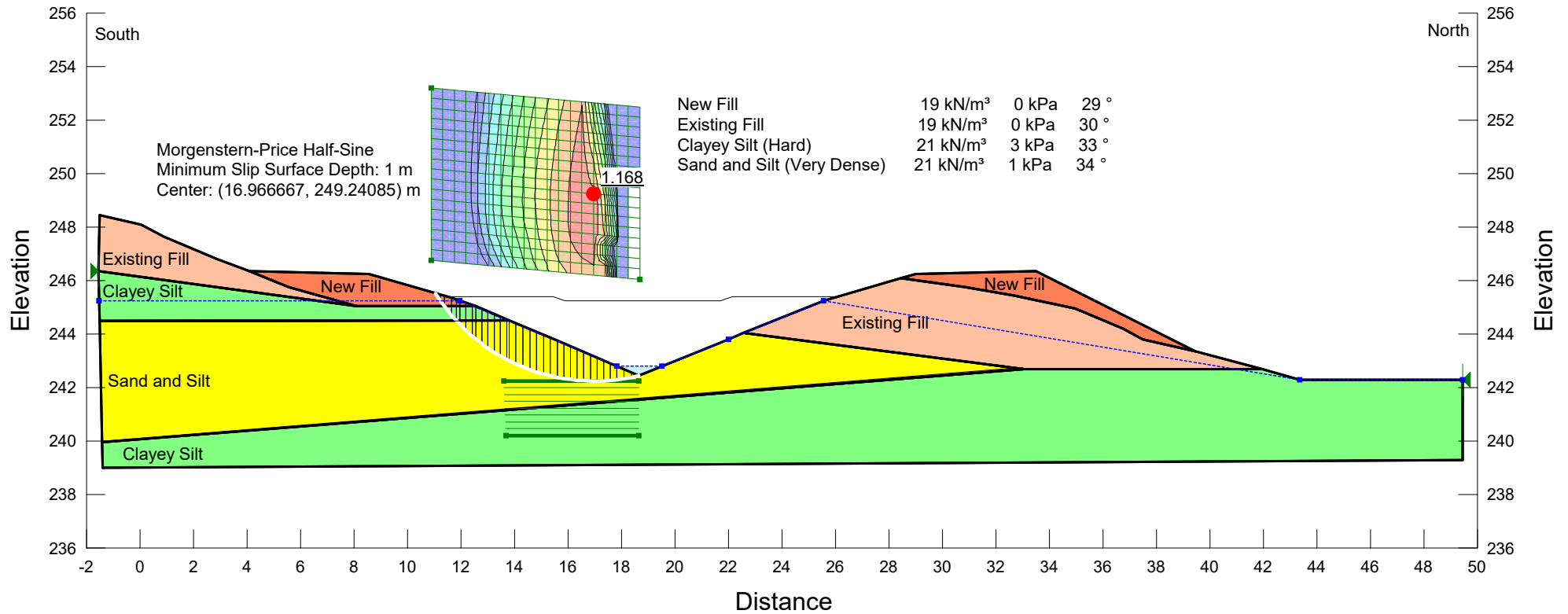
**STORMWATER MANAGEMENT POND #3
HIGHWAY 400 WIDENING
PERMANENT POND SOUTH SLOPE - UNDRAINED**

FIGURE E7



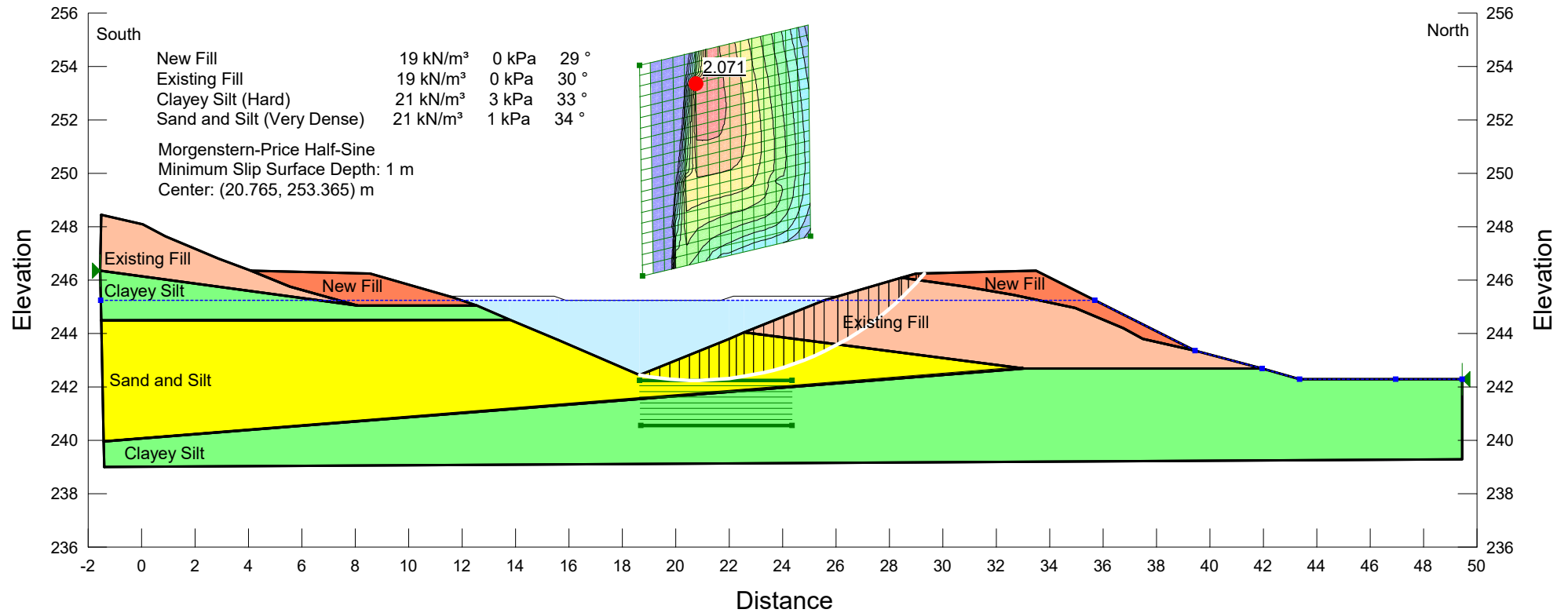
**STORMWATER MANAGEMENT POND #3
HIGHWAY 400 WIDENING
PERMANENT POND SOUTH SLOPE - RAPID DRAWDOWN**

FIGURE E8



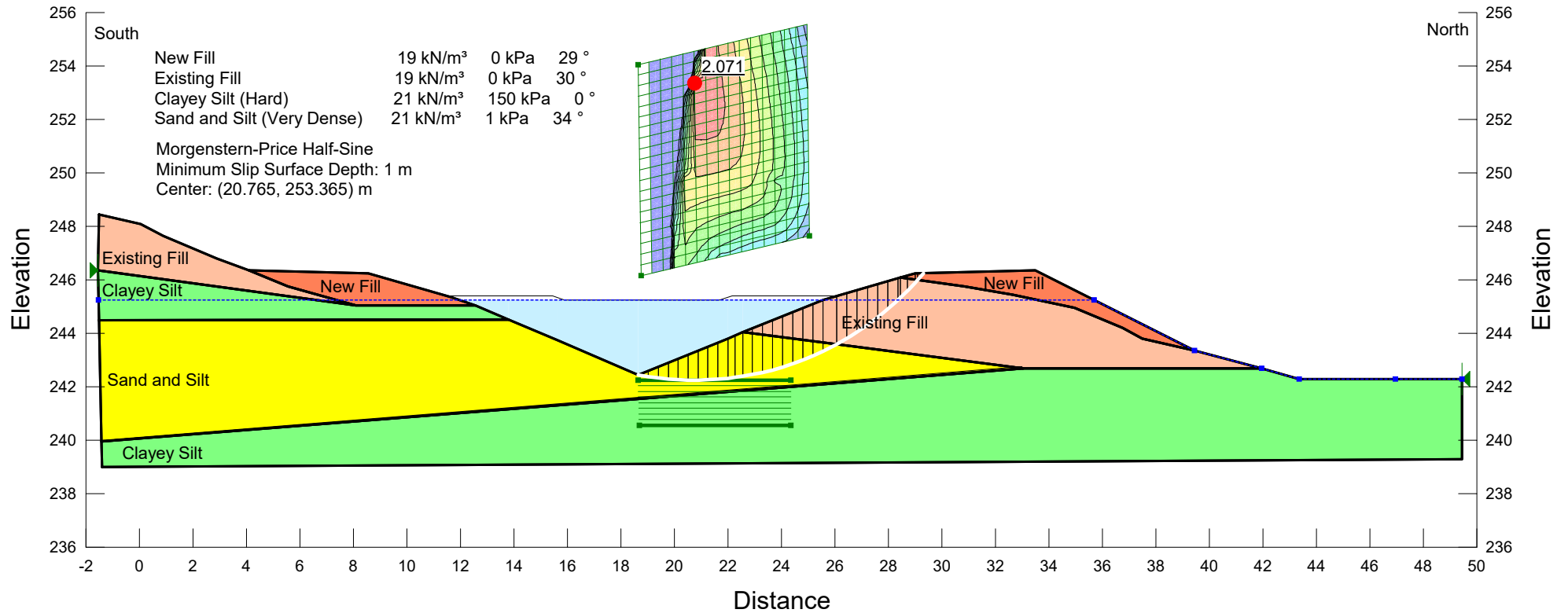
**STORMWATER MANAGEMENT POND #3
HIGHWAY 400 WIDENING
PERMANENT POND NORTH SLOPE - DRAINED**

FIGURE E9



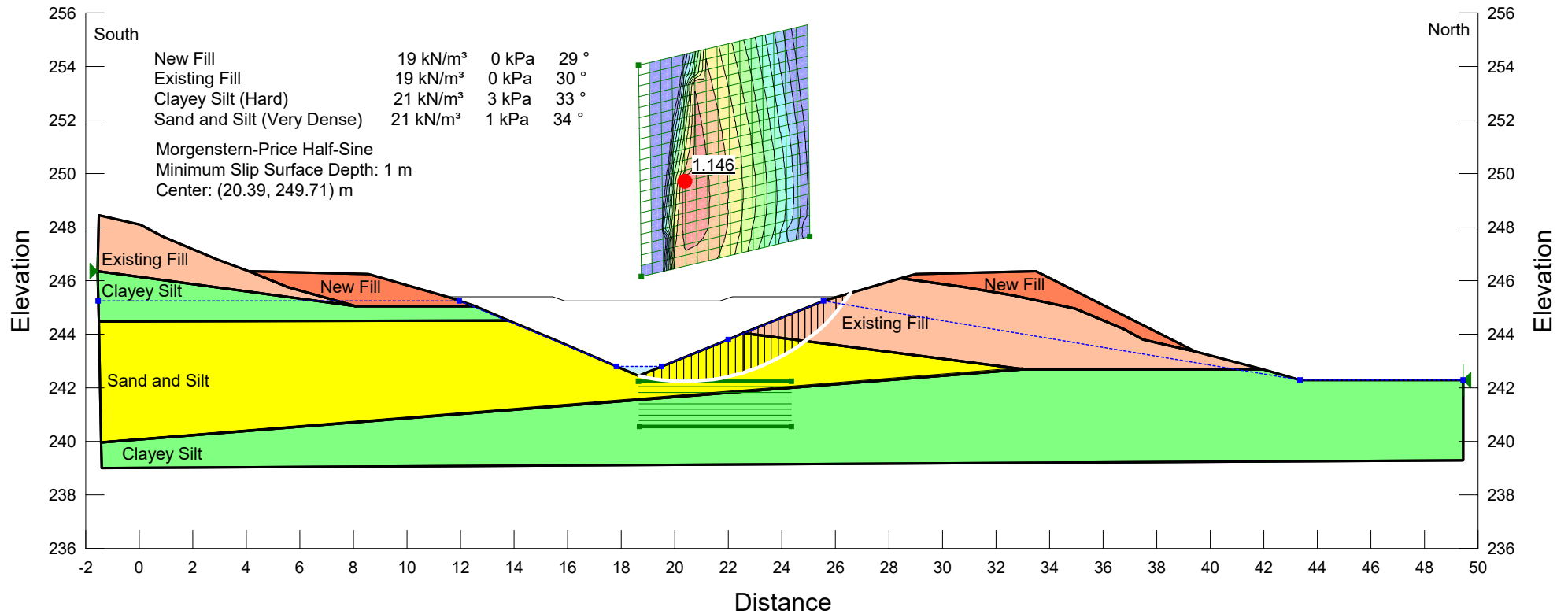
**STORMWATER MANAGEMENT POND #3
HIGHWAY 400 WIDENING
PERMANENT POND NORTH SLOPE - UNDRAINED**

FIGURE E10



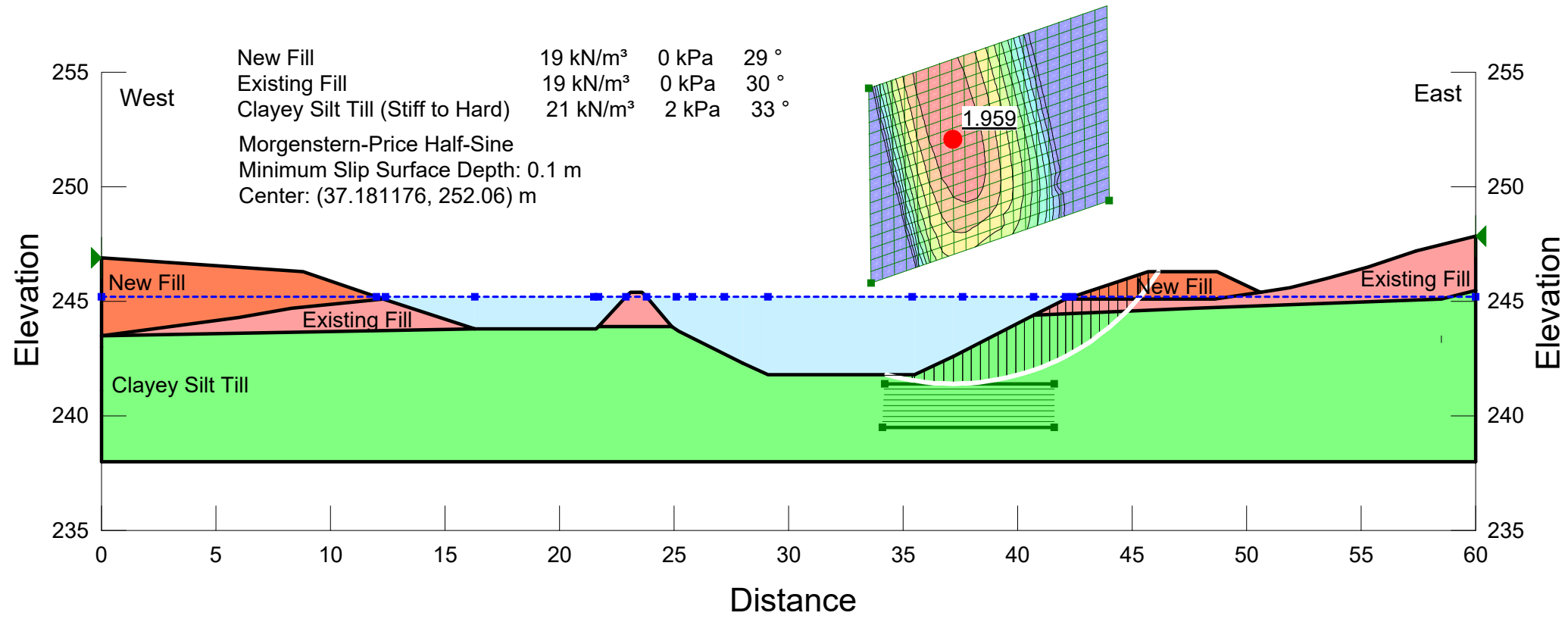
**STORMWATER MANAGEMENT POND #3
HIGHWAY 400 WIDENING
PERMANENT POND NORTH SLOPE - RAPID DRAWDOWN**

FIGURE E11



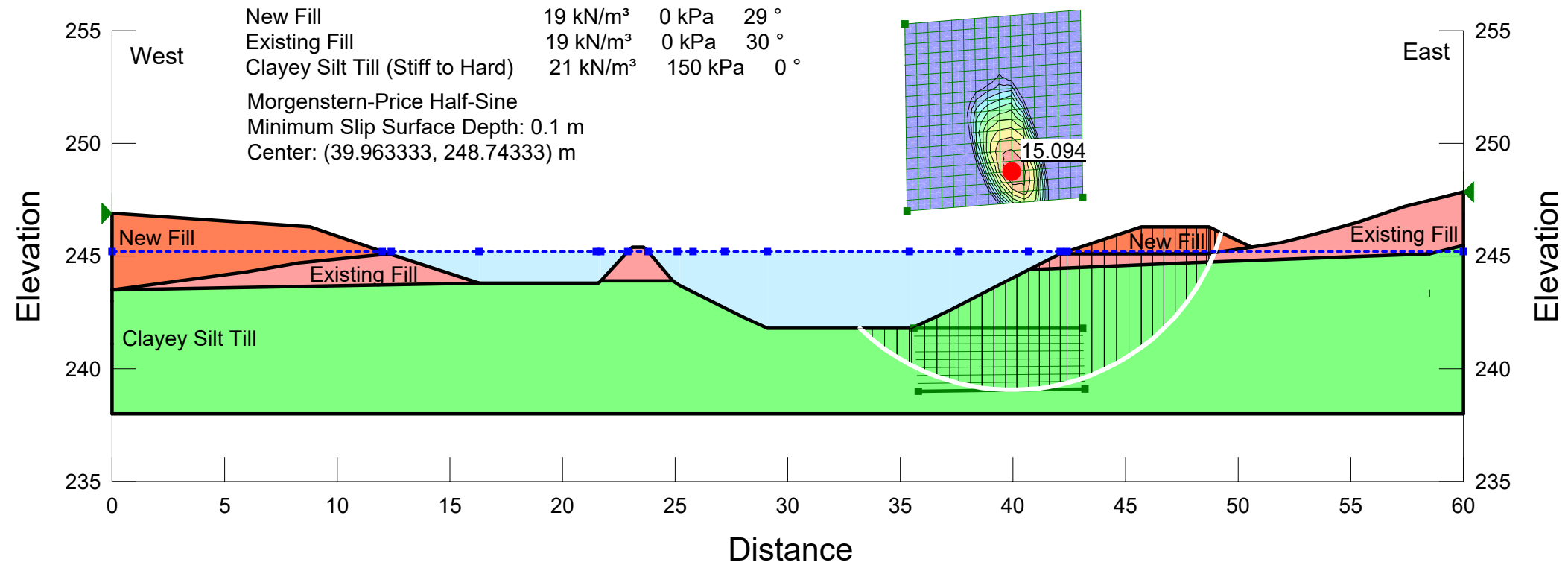
STORMWATER MANAGEMENT POND #3
HIGHWAY 400 WIDENING
PERMANENT POND EAST SLOPE -DRAINED

FIGURE E12



**STORMWATER MANAGEMENT POND #3
HIGHWAY 400 WIDENING
PERMANENT POND EAST SLOPE - UNDRAINED**

FIGURE E13



**STORMWATER MANAGEMENT POND #3
HIGHWAY 400 WIDENING
PERMANENT POND EAST SLOPE - RAPID DRAWDOWN**

FIGURE E14

