Foundation Investigation and Design Report

Highway 7 – Norwood to Havelock
Embankment Widening
Townships of Dummer and Belmont
W.P. 67-99-00

AECOM Canada Ltd.

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FOUNDATION INVESTIGATION REPORT

For

W.P. 67-99-00

Highway 7 - Norwood to Havelock

Embankment Widening
Townships of Dummer and Belmont

1.0 Introduction

This report was prepared as part of the Total Project Management (TPM) assignment for the Detailed Design of the pavement rehabilitation and widening to accommodate one eastbound passing lane and one westbound passing lane on Highway 7 between Norwood and Havelock, Ontario. The work is being carried out under MTO W.P. 67-99-00.

The work was carried out in general accordance with our Proposal No. 1041692 dated July 2008. Authorization to proceed was provided by the Ministry of Transportation of Ontario (MTO) under Agreement Number 4007-E-0024 with AECOM, the Detailed Design Consultant for this project. It is noted that during the course of this assignment Stantec Consulting Ltd. (Stantec) acquired Jacques Whitford Limited (JWL).

This report has been prepared specifically and solely for the construction project described herein. It contains factual information pertaining to the subsurface conditions which was obtained as part of this investigation.

2.0 Site Description and Geology

Site Location

The project limits are located within the Townships of Dummer and Belmont in Eastern Ontario and are shown on Drawing No. 1 in Appendix A. It is noted that for project orientation purposes, Highway 7 is assumed to run east-west with chainage increasing from west to east.

The project limits are defined as follows:

Start:	22+450 Dummer Township
Chainage Equation:	27+157.508 Dummer Township = 10+000 Belmont Township
End:	13+095 Belmont Township

Based on site observations and data from a Preliminary Pavement Design Investigation, three locations had been identified within the limits of the proposed passing lanes where buried organic material was suspected of being present beneath the existing highway embankment and where a Foundation Investigation was deemed to be warranted. The location of these three sections is shown on Drawing No. 1 in Appendix A.

General Site Description

Within the project limits, Highway 7 is classified as a two-lane Rural Collector Undivided (RCU) highway. The existing highway section typically includes two 3.35 m lanes with 2.0 m wide shoulders. The highway alignment passes through several muskeg sections. A Canadian Pacific Railway (CPR) line is approximately 20 m south of and runs parallel to the highway between Station 26+800 Dummer and 13+095 Belmont.

Physiographic Description

Based on the Physiography of Southern Ontario by Chapman and Putnam (1984) the embankment widening locations are situated in the physiographic region known as the Dummer Moraines. This is an area of rough stony land bordering the Canadian Shield. The soils in this region consist of a morainic mantle and drumlinized till plain.

Based on Geology Map No. 2544 published by the Ministry of Mines and Northern Development, the bedrock in the area consists of Middle Ordovician Limestone.

Embankment Sections

The lengths of the proposed eastbound (Station 25+041 to 26+900) and westbound (Station 11+025 to 12+900) passing lanes are both to be approximately 1.9 km for a total length of approximately 3.8 km. Approximately half of the passing lane widenings are to be constructed through muskeg sections. It is noted that the final lengths and locations of the proposed passing lanes were adjusted after completion of the Foundation Investigation field work.

The three embankment locations are described as follows:

Location 1 – 26+600 to 10+100

- Total length = 660 m, 300 m overlap with passing lane
- The eastbound passing lane will coincide with Location 1 between Station 26+600 and 26+500. The eastbound passing lane will generally be constructed on the south side, however, due to the proximity of the CPR tracks east of 26+700, the new centerline starts to shift toward the north at 26+528 so that the widening will be constructed to both the north and south sides of the existing embankment.
- The centerline of the existing highway is typically 1.2 m to 1.4 m above the existing grades in the adjacent muskeg.
- See Photo 1 in Appendix D.

Location 2 - 10+975 to 11+375

- Total length = 400 m, 350 m overlap with passing lane.
- A westbound passing lane will be added along the north side throughout most of this section (11+025 to 12+900).
- The centerline of the existing highway is typically 1.3 m to 2.0 m above the existing grades in the adjacent muskeg.
- See Photo 2 in Appendix D.

Location 3 – 11+850 to 12+900

- Total length = 1050 m, all within passing lane.
- A westbound passing lane will be added along the north side throughout this section.
- The centerline of the existing highway is typically 1.2 m to 1.8 m above the existing grades in the adjacent muskeg.
- See Photos 3 through 6 in Appendix D.

3.0 Method of Investigation

3.1 PREVIOUS INVESTIGATIONS

No previous Foundation Investigation Reports were available for this project area. A Preliminary Pavement Design Report for the proposed passing lane widening identified the presence of buried organic material beneath the existing highway embankment at several locations. In addition, a detailed pavement investigation has now been completed, which also identified the presence of organic peat.

3.2 DRILLING INVESTIGATION

The field investigation for the detailed design of the embankment widenings consisted of 51 boreholes. The locations of the boreholes are shown on the Borehole Location Plans, Drawings No. 2 through 4 in Appendix A.

Prior to carrying out the investigation, we contacted the public utility authorities to clear the borehole locations of both private and public utilities.

The field drilling program was carried out between May 28 and July 14, 2009.

The boreholes located off the existing roadway were advanced using portable drilling equipment which consisted of a tripod with both a one-third weight and full weight hammer for advancing the split spoon samplers and an electric core drill for advancing casing and coring bedrock. The portable drilling equipment was owned and operated by OGS Drilling Inc. of Almonte, Ontario. The Standard Penetration Test (SPT) N-values reported on the borehole records have been divided by three for those that were advanced using the one-third weight hammer.

The boreholes located within the roadway were advanced using a truck mounted CME 75 drill rig equipped for soil and bedrock sampling. The CME drilling equipment was owned and operated by George Downing Estate Drilling Ltd of Hawkesbury, Ontario.

The subsurface stratigraphy encountered in each borehole was recorded in the field by Mr. Zach Popper and Mr. Allan Brotton, experienced field technicians. Split spoon samples were collected on a continuous basis (every 760 mm). It is noted that sample recovery from the split spoon sampler was poor at some intervals due to the presence of large gravel, boulders and cobbles within the overburden. Relatively undisturbed samples of peat and marl were acquired by pushing thin-walled sample tubes. Portions of the overburden were cored with NQ equipment in order to penetrate through cobbles and boulders. All samples recovered were returned to our Ottawa laboratory for detailed classification and testing.

The boreholes were backfilled with cuttings and sealed with bentonite. For the boreholes advanced within the roadway the borehole was sealed at the surface with cold patch asphalt to match the existing asphalt thickness.

The groundwater level was measured in the boreholes at the time of drilling.

3.3 SURVEY

Borehole locations were established in the field by JWSL personnel relative to the centerline of the existing alignment. The location (northing and easting) and ground surface elevation at each borehole location was surveyed by Stantec Geomatics Limited personnel with reference to MTO Geodetic Benchmark 00819668559. The benchmark is located at approximate Station 13+000 Belmont Township and is reported to have a geodetic elevation of 213.801 m.

3.4 LABORATORY TESTING

All samples were taken to our Ottawa laboratory where they were subjected to a detailed visual examination by a Geotechnical Engineer. Selected soil samples underwent gradation analyses, Atterberg Limits testing and moisture content testing. Selected samples of the organic material were also subjected to organic content and consolidation testing. Samples of intact bedrock were tested to determine the unconfined compressive strength.

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

4.0 Subsurface Conditions

The subsurface conditions observed in the boreholes are presented in detail on the Borehole Records provided in Appendix B. An explanation of the symbols and terms used to describe the Borehole Records is also provided. Borehole location plans and stratigraphic sections of the soils encountered within the boreholes are provided on Drawings No. 2 through 4 in Appendix A.

The subsurface conditions within each of the three muskeg locations are summarized in the sections that follow.

4.1 LOCATION 1 – 26+600 TO 10+100

The borehole location plan and a stratigraphic cross-section through Location 1 are provided in Drawing No. 2 in Appendix A.

4.1.1 Pavement Structure / Embankment Fill

The existing pavement structure within Location 1 typically consists of approximately 238 mm of asphalt over 600 mm of granular base/subbase. Further details regarding the existing pavement structure are presented in the Pavement Design Report prepared for this project.

The pavement structure is underlain by granular embankment fill. The base of the embankment fill ranged from 1.4 m to 3.1m below the top of pavement (Elev. 218.1m to 220.2 m).

SPT ‘N’ values in the fill ranged from 6 to greater than 100 and averaged 33, indicating that the deposit varies from loose to very dense but is on average, dense. It is noted that the SPT ‘N’ values were typically lower at the base of the fill which was frequently below the water level and underlain by organic deposits.

Moisture content testing on eight samples yielded results ranging from 3% to 11% with an average of 8%. The results of eight grain size analyses performed in accordance with the procedures outlined in ASTM Specification D422-63 indicate that the embankment fill contained 6 to 28% gravel, 42 to 64% sand and 16 to 48% fines. The gradation results are provided on Figure 1 in Appendix C. This material is classified as silty sand to silty sand with gravel (SM) using the MTO Soil Classification System.

4.1.2 Organic Matter (PEAT)

A layer of dark brown to black organic matter (PEAT) was observed directly beneath the vegetation beside the existing highway embankment in Boreholes BH09-1 and BH09-18 as well as beneath the embankment fill in Boreholes BH 09-11, BH09-17, BH09-19 and BH09-20.

The peat ranged from coarse fibrous to amorphous in nature, however, it was most commonly fine fibrous. Woody material was encountered within the peat at some locations (see Photo 4 in Appendix C).

The thickness and properties of the peat beneath the existing highway embankment have been altered by the weight of the embankment fill above it. Where observed beneath the existing embankment fill, the thickness of the peat ranged from 800 mm to 2.1 m with an average of 1.5 m and the base of the peat ranged from elevation 216.1 m to 218.3 m. Adjacent to the existing highway embankment, the thickness of the peat ranged from 1.1 m to 3.3 m with an average of 2.2 m and the base of the peat ranged from elevation 216.7 m to 218.9 m.

SPT 'N' values within the peat were typically 3 beneath the existing highway embankment and 1 adjacent to the existing highway embankment.

The organic content was determined for four samples of the peat material from within Location 1. The organic content ranged from 48% to 79% with an average of 66%.

The moisture content of 11 samples of the peat including 7 from beneath the existing highway embankment and 4 within the adjacent muskeg are summarized in Table 4.1.

Table 4.1: Summary of Moisture Content of Peat Material

Parameter	Within Swamp			Beneath Existing Highway Embankment		
	Minimum	Maximum	Mean	Minimum	Maximum	Mean
Moisture Content (%)	340	695	503	138	512	253

One-dimensional consolidation tests were carried out on two samples of the peat material from within Location 1; one from beneath the existing highway embankment and one from the muskeg section adjacent to the embankment. The results of the consolidation testing are summarized in Table 4.2 below and are detailed on the Consolidation Summary sheets provided in Appendix C.

Table 4.2: Consolidation Test Results - Peat

Parameter	Within Swamp	Beneath Existing Highway Embankment
	BH09-18 ST-5	BH09-17 ST-6
Moisture Content	695 %	512%
In-situ Void Ratio	11.8	8.7
Specific Gravity	1.41	1.51
Unit Weight	8.59 kN/m^3	9.33 kN/m^3
Compression Index, Cc	5.13	4.54

The consolidation test results from both samples indicate that the peat is normally consolidated. Based on the depth to top of peat beneath the embankment relative to original top of peat elevation, it is estimated that the peat has compressed up to 44% of its original height under the current embankment loading.

4.1.3 MARL

A thin deposit of marl was encountered directly beneath the peat in Boreholes BH09-17, BH09-18 and BH09-20. The marl was generally whitish grey to cream colored and contained

occasional small shells. Photos of one sample of the marl from BH 09-18 are provided as Photo No 1 and Photo No. 2 in Appendix C.

The thickness of the marl, where encountered, ranged from 500 mm to 1.2 m. The base of the marl varied from elevation 215.3 m to 215.6 m (geodetic).

SPT 'N' values were 1, indicating very soft material.

The organic content of one sample of marl from within Location 1 was determined to be 10%.

The moisture content of three samples of the marl including two from beneath the existing highway embankment and one within the adjacent muskeg are summarized in Table 4.3.

Table 4.3: Summary of Moisture Content of Marl

Parameter	Within Swamp			Beneath Existing Highway Embankment		
	Minimum	Maximum	Mean	Minimum	Maximum	Mean
Moisture Content (%)	221	-	-	62	162	112

Atterberg Limits were measured for one sample of the marl from BH09-18. The test revealed a liquid limit in excess of 200, a plastic limit of 73 and a plasticity index in excess of 125.

4.1.4 Glacial Till

A glacial till layer was observed in all the boreholes advanced at this location. The thickness of the till layer ranged from 1.4 m to 7.6 m with an average thickness of approximately 3.1 m. The base of the unit varied from elevation 209.2 m to 217.9 m (geodetic).

SPT 'N' values ranged from 4 to 133 blows per 0.3 m, indicating that the deposit varies from a very loose to very dense state. N values in excess of 50 blows per 0.3 m are indicative of the presence of boulders and cobbles within the till material. Rock coring techniques were used to advance BH09-1 through cobbles and boulders within the till.

The moisture content of the 16 samples tested ranged from 7% to 25% with an average of 11%. Gradation analysis on 16 samples of the till material indicate that the till contained 3 to 51% gravel, 19 to 72% sand and 4 to 78% fines. The results are shown on Figures 2 to 4 in Appendix C.

Atterberg Limits were measured on the fines from one sample of the till material from BH09-20. The results indicated a low plastic clay material. The results of the Atterberg Limits testing are shown on Figure 5 in Appendix C.

The till material can generally be described as silty sand to silty sand with gravel (SM) but can vary to silty gravel with sand (GM) to silty clay (CL) with sand in accordance with the MTO Soil Classification System. Occasional to frequent cobbles and boulders were observed within the till strata with increased frequency with depth.

4.1.5 Bedrock

Two boreholes were advanced into the bedrock by coring. The rest of the boreholes were terminated at the bedrock surface as determined based on SPT refusal (>100 blows/0.3 m) and auger refusal.

The bedrock surface was encountered at elevation 216.3 m and 216.5 m in BH09-1 and BH09-11, respectively. The bedrock elevation was inferred to range from 3.6 m to 12.0 m below ground surface (elevation 217.9 m to 209.2 m) based on auger refusal in the other boreholes.

BH09-1 and BH09-11 were advanced 2.7 m and 3.2 m, respectively, into the bedrock by coring with NQ-size coring equipment. The core recovery was between 85% and 100% (average = 97%). The rock quality designation (RQD) ranged from 0 % to 61% (average = 28%), indicating very poor to fair rock mass quality.

The recovered rock core consists of grey limestone bedrock with shale partings. The rock ranged from slightly weathered to unweathered. Joint spacing ranged from very close to moderate with dipping orientation typically flat (0 to 20° from horizontal). Photographs of the recovered bedrock are provided in Appendix B. A detailed description of the rock cores is also provided in the Field Core Logs in Appendix B.

Unconfined compressive strength tests were carried out on two bedrock core samples; one taken from BH09-1 and one from BH09-11. The unconfined compressive strength of the two samples was 107 and 170 MPa. Based on the results of the unconfined compressive strength tests the rock strength was determined to range between strong and very strong.

4.1.6 Groundwater

Water was encountered approximately at ground surface within boreholes drilled in the muskeg section and at approximately the same elevation in boreholes advanced through the highway embankment adjacent to the muskeg. The water elevation was approximately 219.8 m at the time of the investigation.

4.2 LOCATION 2 – 10+975 TO 11+375

The borehole location plan and a stratigraphic cross-section through Location 2 are provided in Drawing No 3 in Appendix A.

4.2.1 Pavement Structure / Embankment Fill

The existing pavement structure within Location 2 typically consists of approximately 238 mm of asphalt over 600 mm of granular base/subbase. Further details regarding the existing pavement structure are presented in the Pavement Design Report prepared for this project.

The pavement structure is underlain by granular embankment fill. The base of the embankment fill ranged from 2.1 m to 3.4 m below the top of pavement (Elev. 214.6 m to 216.1 m).

SPT 'N' values ranged from 3 to 61 and averaged 25, indicating that the deposit varies from very loose to very dense but is on average, compact.

Moisture content testing on seven samples yielded results ranging from 3% to 10%, with an average of 6%. The results of seven grain size analyses performed in accordance with the procedures outlined in ASTM Specification D422-63 indicate that the embankment fill contained 15 to 47% gravel, 37 to 63% sand and 16 to 39% fines. The gradation results are provided on Figure 6 in Appendix C. This material is classified as silty sand with gravel (SM) using the MTO Soil Classification System.

4.2.2 Organic Matter (PEAT)

A layer of dark brown to black organic matter (PEAT) was observed directly beneath the vegetation beside the existing highway embankment in Boreholes BH09-2, BH09-3 and BH09-33 as well as beneath the embankment fill in Boreholes BH09-23 and BH09-31.

The peat ranged from coarse fibrous to amorphous in nature, however, it was most commonly fine fibrous (see Photo No. 3 in Appendix C). Woody material was encountered within the peat at some locations.

The thickness and properties of the peat beneath the existing highway embankment have been altered by the weight of the embankment fill above it. Where observed beneath the existing embankment fill, the thickness of the peat ranged from 600 mm to 1.5 m with an average of 1.0 m and the base of the peat ranged from elevation 214.4 m to 215.0 m. Adjacent to the existing highway embankment, the thickness of the peat ranged from 100 mm to 900 mm with an average of 600 mm and the base of the peat ranged from elevation 215.5 m to 216.5 m.

SPT 'N' values were 4 within the peat beneath the existing highway embankment and 2 within the peat in the adjacent muskeg section.

The moisture content of a sample of the peat from beneath the existing highway embankment was 283% while the moisture content of a sample from within the adjacent muskeg was 478%.

A one-dimensional consolidation test was carried out on a sample of the peat material taken from beneath the existing road embankment. The results of the consolidation testing are summarized in Table 4.4 below and are detailed on the Consolidation Summary sheets provided in Appendix C.

Table 4.4: Consolidation Test Results - Peat

Parameter	Beneath Existing Highway Embankment
	BH09-23 ST-4
Moisture Content	283%
In-situ Void Ratio	4.9
Specific Gravity	1.59
Unit Weight	10.19 kN/m^3
Compression Index, Cc	2.34

The consolidation test results indicate that the peat material is normally consolidated. Based on the depth to the top of peat beneath the embankment relative to the original top of peat elevation, it is estimated that the peat has compressed up to 43% of its original height under current embankment loading.

4.2.3 MARL

A thin deposit of marl was encountered in BH09-29 and BH09-33. The marl was generally whitish grey to cream colored and contained occasional small shells.

The thickness of the marl at these two borehole locations was 600 mm and 800 mm. The base of the marl ranged from elevation 214.8 m to 214.9 m (geodetic).

The SPT 'N' value within the marl was 2, indicating a very soft material.

The organic content of one sample of the marl (BH09-33, SS-2) was determined to be 39%.

The moisture content of a sample of marl from beneath the existing highway embankment was 43% and the moisture content of a sample of marl from the adjacent muskeg area was 244%.

A one-dimensional consolidation test was carried out on a sample of the marl taken from outside the existing roadway platform. The results of the consolidation testing are summarized in Table 4.5 below and are detailed on the Consolidation Summary sheets provided in Appendix C.

Table 4.5: Consolidation Test Results - Marl

Parameter	Beyond Existing Highway Embankment
	BH09-33 ST-2
Moisture Content	244%
In-situ Void Ratio	6.4
Specific Gravity	2.51
Unit Weight	11.44 kN/m^3
Compression Index, Cc	2.46

The consolidation test results indicate that the marl is normally consolidated.

4.2.4 Silt / Sandy Silt

A silt layer was observed in BH09-29, BH09-32 and BH09-34 beneath the embankment fill and marl. Where encountered, the thickness of the silt layer ranged from 800 mm to 1.6 m with an average thickness of approximately 1.1 m. The base of the unit varied from elevation 214.0 to 214.2 m (geodetic).

SPT 'N' values ranged from 3 to 23 blows per 0.3 m, indicating that the deposit varies from a very loose to compact state. In general the SPT 'N' values were 3 or 4, indicating a very loose state.

The moisture content of the three samples tested ranged from 33% to 36% with an average of 34%. Grain size analyses on three samples of the silt material indicate that it contained 2% to 6% gravel, 14% to 18% sand and 80% fines. The results are shown on Figure 10 in Appendix C.

Atterberg Limits were measured for three samples of the silt material. Two of the samples revealed a non-plastic fine material. The Atterberg Limits test for BH09-32 revealed a liquid limit of 35, a plastic limit of 29 and a plasticity index of 6. The results of the Atterberg Limit testing are shown of Figure 11 in Appendix C.

This material is silt with sand (ML) in accordance with the MTO Soils Classification System.

4.2.5 Glacial Till

A glacial till layer was observed in all the boreholes advanced at this location. The thickness of the till layer ranged from 600 mm to 2.3 m with an average thickness of approximately 1.4 m. The base of the unit varied from elevation 212.5 m to 215.3 m (geodetic).

SPT 'N' values ranged from 5 to 125 blows per 0.3 m, with an average of 37, indicating that the deposit varies from a loose to very dense state but is dense on average. N values in excess of 50 blows per 0.3 m are generally indicative of the boulders and cobbles present within the till material. Rock coring techniques were used to advance the holes through the boulders within the till at some locations.

The moisture content of the 16 samples tested ranged from 6% to 25% with an average of 15%. Gradation analysis on 16 samples of the till material indicate that the till contained 2 to 57% gravel, 25 to 66% sand and 11 to 71% fines. The results are shown on Figures 7 to 9 in Appendix C.

The till material can generally be described as silty sand to silty sand with gravel (SM) in accordance with the MTO Soil Classification System. Occasional cobbles and boulders were observed within the till.

4.2.6 Limestone Bedrock

Three boreholes were advanced into the bedrock by coring. The rest of the boreholes were terminated at the bedrock surface as determined based on SPT refusal (>100 blows/300 mm) and auger refusal.

The bedrock surface was confirmed by coring to be at elevation 215.2 m, 214.3 m and 215.3 m in BH09-2 BH09-3 and BH09-10, respectively. The bedrock elevation was inferred to range from 4.3 m to 5.2 m below ground surface (elevation 212.5 m to 213.7 m) based on auger refusal in the other boreholes.

BH09-2, BH09-3 and BH09-10 were advanced 2.7 m to 5.1 m into the bedrock by coring with NQ and BQ-size coring equipment. The core recovery was between 22% and 100% (average = 63%). The rock quality designation (RQD) ranged from 0 % to 67% (average = 14%), indicating very poor rock mass quality on average.

The recovered rock core consisted of grey limestone bedrock with shale partings. The rock ranged from slightly weathered to unweathered. Joint spacing ranged from very close to moderate with dipping orientation typically flat (0 to 20° from horizontal). Photographs of the recovered bedrock are provided in Appendix B. A detailed description of the rock cores is also provided in the Field Core Logs in Appendix B.

Unconfined compressive strength tests were carried out on two bedrock core samples; one taken from BH09-3 and one from BH09-10. The unconfined compressive strength of the two samples were 160 and 83 MPa. Based on the results of the unconfined compressive tests the rock strength was determined to range between strong and very strong.

4.2.7 Groundwater

Water was encountered approximately at ground surface within boreholes drilled in the muskeg section and at approximately the same elevation in boreholes advanced through the highway embankment adjacent to the muskeg. The water elevation was approximately 215.7 m to 216.6 m at the time of the investigation.

4.3 LOCATION 3 – 11+850 TO 12+900

The borehole location plan and a stratigraphic cross-section through Location 3 are provided in Drawing No 3 in Appendix A.

4.3.1 Pavement Structure / Embankment Fill

The existing pavement structure within Location 3 typically consists of approximately 238 mm of asphalt over 600 mm of granular base/subbase. Further details regarding the existing pavement structure are presented in the Pavement Design Report prepared for this project.

The pavement structure is underlain by granular embankment fill. The base of the embankment fill ranged from 1.5 m to 3.1 m below the top of pavement (Elev. 211.9 m to 213.5 m).

SPT ‘N’ values ranged from 2 to greater than 100 with an average of 22, indicating that the deposit varies from a very loose to very dense but is compact on average. It is noted that SPT refusal was encountered at a couple of locations, possibly indicating the presence of cobbles within the fill.

Moisture content testing on 14 samples yielded results ranging from 5% to 28% with an average of 10%. The results of thirteen grain size analyses performed in accordance with the procedures outlined in ASTM Specification D422-63 indicate that the embankment fill contained 9 to 52% gravel, 34 to 73% sand and 11 to 49% fines. The gradation results are provided on Figures 12 through 14 in Appendix C. This material ranges from silty sand to silty sand with gravel (SM) using the MTO Soil Classification System.

4.3.2 Organic Matter (PEAT)

A layer of dark brown to black organic matter (PEAT) was observed directly beneath the vegetation beside the existing highway embankment in Boreholes BH09-4, BH09-41, BH09-44,

BH09-47, BH09-5, BH09-6, BH09-51, BH09-54, BH09-57 and BH09-60 as well as beneath the embankment fill in Boreholes BH09-37, BH09-09, BH09-39, BH09-40, BH09-42, BH09-43, BH09-45, BH09-46, BH09-48, BH09-49, BH09-7, BH09-8, BH09-50 and BH09-52.

The peat ranged from coarse fibrous to amorphous in nature, however, it was most commonly fine fibrous. Woody material was encountered within the peat at some locations.

The thickness and properties of the peat beneath the existing highway embankment have been altered by the weight of the embankment fill above it. Where observed beneath the existing embankment fill, the thickness of the peat ranged from 0.6 m to 1.6 m with an average of 1.2 m and the base of the peat ranged from elevation 211.1 m to 212.0 m. Adjacent to the existing highway embankment, the thickness of the peat ranged from 0.4 m to 3.2 m with an average of 1.9 m and the base of the peat ranged from elevation 210.7 m to 212.7 m.

SPT 'N' values ranged from 1 to 7 but were on average, 3 in areas beneath the existing highway embankment and 2 in the adjacent muskeg sections.

The organic content was determined for five samples of the peat material encountered within Location 3. The organic content ranged from 26% to 79% with an average of 61%.

The moisture content of 26 samples of the peat including 12 from beneath the existing highway embankment and 14 within the adjacent muskeg are summarized in Table 4.6.

Table 4.6: Summary of Moisture Content of Peat

Parameter	Within Swamp			Beneath Existing Highway Embankment		
	Minimum	Maximum	Mean	Minimum	Maximum	Mean
Moisture Content (%)	211	623	429	90	489	265

One-dimensional consolidation tests were carried out on two samples of the peat material from within Location 3; one from beneath the existing highway embankment and one from adjacent to the embankment. The results of the consolidation testing are summarized in Table 4.7 below and are detailed on the Consolidation Summary sheets provided in Appendix C.

Table 4.7: Consolidation Test Results - Peat

Parameter	Within Swamp	Beneath Existing Highway Embankment
	BH09-41 ST-4	BH09-45 ST-5
Moisture Content	612 %	444%
In-situ Void Ratio	10.0	8.2
Specific Gravity	1.47	1.73
Unit Weight	9.29 kN/m^3	10.00 kN/m^3
Compression Index, Cc	4.31	2.85

The consolidation test results indicate that the peat material is normally consolidated. Based on the depth to top of peat beneath the embankment relative to the original top of peat elevation, it is estimated that the peat has compressed up to 45% of its original height under the current embankment loading.

4.3.3 MARL

A thin deposit of marl was encountered beneath the peat in six of the boreholes located between 12+300 and 12+400, and in one borehole adjacent to the existing highway embankment at 12+600. Marl was also observed as a discrete layer within the peat in one borehole adjacent to the highway at 11+963. The marl was generally whitish grey to cream colored and contained occasional small shells.

The thickness of the marl, where encountered, ranged from 300 mm to 1.2 m, with an average of 800 mm. The base of the marl varied from elevation 210.1 m to 211.3 m (geodetic).

SPT 'N' values within the marl were consistently 1, indicating a very soft material.

The organic content was determined for two samples of the marl from within Location 3. The organic contents were 5% and 9%.

The moisture content of 7 samples of the marl including 4 from beneath the existing highway embankment and 3 within the adjacent muskeg are summarized in Table 4.8.

Table 4.8: Summary of Moisture Content of Marl

Parameter	Within Swamp			Beneath Existing Highway Embankment		
	Minimum	Maximum	Mean	Minimum	Maximum	Mean
Moisture Content (%)	251	283	265	139	192	157

4.3.4 Silty Sand/Sand

A silty sand/sand layer was observed beneath the embankment fill and peat/marl in 18 boreholes within Location 3. The thickness of the silty sand layer ranged from 600 mm to 2.7 m with an average thickness of approximately 1.6 m. The base of the unit varied from elevation 208.5 m to 211.9 m (geodetic).

SPT 'N' values ranged from 1 to 51, with an average of 13, indicating that the deposit varies from a very loose to very dense state but is typically compact. Flowing sands were noted in Boreholes BH09-39 and BH09-40 during the drilling operation.

The moisture content of the 21 samples tested ranged from 14% to 24% with an average of 20%. Grain size analyses of twenty samples of the sandy deposit indicate that it contained 0 to 10% gravel, 35 to 96% sand and 4 to 65% fines. The gradation results are provided on Figures 15 through 18 in Appendix C. This material ranges is most commonly classified as silty sand (SM) using the MTO Soil Classification System with a few samples testing as well-graded or poorly graded sand and one sample as sandy silt (ML).

Atterberg Limits were assessed for one sample of the silty sand material and revealed a non-plastic fine material.

4.3.5 Glacial Till

A glacial till layer was observed in all the boreholes advanced at this location with the exception of BH09-39 and BH09-60. The thickness of the till layer ranged from 400 mm to 4.0 m with an average thickness of approximately 1.6 m. The base of the unit varied from elevation 207.3 m to 211.4 m (geodetic).

SPT 'N' values ranged from 6 to greater than 100 blows per 0.3 m, with an average of 48, indicating that the deposit varies from a loose to very dense state but is dense on average. N values in excess of 50 blows per 0.3 m are generally indicative of the boulders and cobbles present within the till material. Rock coring techniques were used to advance several of the holes through the cobbles and boulders within the till.

The moisture content of the 21 samples tested ranged from 5% to 16% with an average of 9%. Gradation analysis on 19 samples of the till material indicate that the till contained 21 to 58% gravel, 32 to 57% sand and 9 to 41% fines. The results are shown on Figures 19 through 21 in Appendix C.

The till material can generally be described as silty sand to silty sand with gravel (SM) in accordance with the MTO Soil Classification System. A few samples tested as silty gravel with sand (GM). Occasional cobbles and boulders were observed within the till.

4.3.6 Limestone Bedrock

The bedrock surface was inferred based on SPT refusal (>100 blows/0.3 m) and auger refusal in all boreholes. Bedrock was proven in six of these boreholes by advancing the boreholes a minimum of 3 m into the rock by coring. An additional six boreholes were advanced to a shallow depth (up to 600 mm) into bedrock by coring.

The bedrock surface was determined to range from 3.4 m to 7.5 m below the top of pavement or elevation 207.3 m to 211.4 m.

The core recovery was between 20% and 100% (average = 86%). The rock quality designation (RQD) ranged from 0 % to 85% (average = 24%), indicating very poor rock mass quality on average.

The recovered rock core consisted of grey limestone bedrock with shale partings. The rock ranged from slightly weathered to unweathered. Joint spacing ranged from very close to moderate with dipping orientation typically flat (0 to 20° from horizontal). Photographs of the recovered bedrock are provided in Appendix B. A detailed description of the rock cores is also provided in the Field Core Logs in Appendix B.

Unconfined compressive strength tests were carried out on six bedrock core samples. The unconfined compressive strength of the samples ranged from 96 to 198 MPa with an average of 160 MPa. Based on the results of the unconfined compressive tests the rock strength was determined to range between strong and very strong.

4.3.7 Groundwater

Water was encountered approximately at ground surface within boreholes drilled off road and at approximately the same elevation in boreholes advanced through the highway embankment adjacent to the muskeg. The water elevation ranged from Elev. 211.8 m to 214.0 m. Groundwater levels may vary seasonally.

5.0 Closure

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

This report has been prepared by Kenton Power, Paul Carnaffan and Fred Griffiths. Technical reviews were carried out by Arun Valsangkar and Raymond Haché.

Respectively Submitted;

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FOUNDATION DESIGN REPORT

For

W.P. 67-99-00

Highway 7 - Norwood to Havelock Embankment Widening

Township of Dummer and Belmont

6.0 Discussion

6.1 PROPOSED DEVELOPMENT

It is understood that the Ministry of Transportation of Ontario (MTO) is planning the construction of two passing lanes along Highway 7 as part of W.P. 67-99-00. The project is to include one passing lane in each direction (eastbound and westbound). The lengths of the eastbound and westbound passing lanes are to be approximately 1.9 km each for a total length of 3.8 km.

Three locations with a total length of 2110 m were identified as embankment fill locations within muskeg areas. The Pavement Design Report recommends that where present, swamp material in the embankment widening is to be removed by invoking OPSD 203.020.

The alignment of Highway 7 and a CPR railway line are approximately parallel from 26+800 (Dummer) to the east project limit at 13+095 (Belmont). Throughout the section from 26+800 to 13+095, the existing centreline of Highway 7 is typically 20 m north of the centreline of the rail line. As a result of the proximity to the railway, the widening to accommodate the end of the eastbound passing lane will be shifted northward, resulting in embankment widening to both the north and south sides along with a centreline crown shift.

After an initial assessment of the anticipated settlement associated with the proposed passing lane widenings, several iterations of revisions to the highway geometry were carried out in an effort to minimize adjustments that would impose new loads on sections of the existing highway embankment that are underlain by compressible organic deposits. The currently planned adjustments to the top of pavement throughout the three fill locations are shown in Table E-1 in Appendix E.

Table 6.1 summarizes the locations where grade increases are proposed in areas where buried organic deposits were identified beneath the existing highway embankment.

Table 6.1: Summary of Planned Grade Increases Where Buried Organics Were Identified

Station	Length (m)	Location of Grade Raise	Maximum Grade Raise (mm)
10+975 to 11+025	50	Right & Left Edge of Pavement & Shoulders	50
11+850 to 11+890	40	Full Width of EBL & WBL	150
12+275 to 12+350	75	EBL edge of pavement & shoulder only	75

It is noted that there are other areas where it is not proposed to raise the grades across the existing driving lanes and where muskeg removal will be carried out for the proposed passing

lane widening but where organic deposits buried beneath the existing shoulder or embankment side slopes will remain in place and will be subjected to new loads that will induce both primary consolidation and long term secondary settlement. A typical section showing this scenario is presented in Drawing No. 5 in Appendix E.

6.2 SOIL SUMMARY

The subsurface conditions observed in the boreholes are presented in detail on the Borehole Records provided in Appendix B. An explanation of the symbols and terms used to describe the Borehole Records is also provided.

In general, the subsurface stratigraphy within the muskeg sections consists of organic matter (both peat and marl), over a glacial till deposit, overlying limestone bedrock. Beneath the roadway the subsurface stratigraphy consists of pavement structure and granular embankment fill (typically silty sand) over organic matter (peat and/or marl), over glacial till, overlying limestone bedrock. Table 6.2 summarizes the thickness of organic deposits located within the three Foundation Investigation Locations.

Table 6.2: Summary of Organic Soil Deposits

Location	Station	Total Length (m)	Thickness of Organic Deposits (m)	
			Within Proposed Widening	Beneath Existing Highway Embankment
1	26+600 to 10+100	660	3.6	1.5 to 3.4
2	10+975 to 11+375	400	0.9 to 1.4	0.6 to 1.5
3	11+850 to 12+900	1050	0.4 to 3.5	0.6 to 2.6

Laboratory test results are presented in Appendix C.

The peat and marl deposits can be described as normally consolidated. The deposits within the muskeg sections adjacent to the existing highway embankment do not appear to have been subjected to any previous overburden loading. The peat and marl located beneath the existing highway embankment have undergone significant consolidation due to the weight of the existing embankment. This is evident by the reduction in moisture content and void ratio of the materials beneath the embankment compared to the materials adjacent to the embankment, as shown in Table 6.3. Based on the top of peat elevation beneath the embankment relative to the estimated original top of peat elevation, it is estimated that the peat has compressed up to approximately 45% of its original thickness under the current embankment load.

Table 6.3: Comparison of Peat Properties Beneath and Beside the Existing Embankment

Parameter	Design Values (based on averages)	
	Within Swamp	Beneath Existing Highway Embankment
Moisture Content	451%	275%
In-situ Void Ratio	10.9	7.3
Compression Index, Cc	4.7	3.2
Secondary Compression Index, Cα	0.28	0.19

The void ratio-log time curves from the laboratory consolidation tests did not provide a clear indication of the coefficient of secondary consolidation, therefore, secondary consolidation was estimated using the Cα/Cc concept of compressibility. A Cα/Cc value of 0.06 was assigned to the peat based on a literature review which suggests that Cα/Cc for peat is generally 0.06 ±0.01 (Mesri, Stark, Ajlouni & Chen, Secondary Compression of Peat with or without Surcharging, Journal of geotechnical and Geoenvironmental Engineering, May 1997).

The soil parameters used in the analysis are summarized in Table 6.4.

Table 6.4: Summary of Soil Parameters for Slope Stability Modeling

Soil Parameter	Soil Type				
	Granular Fill	Rock Fill	Peat	Marl	Till
Total Unit Weight (kN/m^3)	21	18	10.6	12.8	20.5
Cohesion (kPa)	0	0	27	12	0
Friction Angle	34º	48º	0º	0º	35º

The presence of a very weak layer of marl at localized areas presents a possible concern for stability of the existing highway embankment during the swamp removal. The high moisture content combined with a lack of fibrous content and low plasticity makes acquisition and testing of the very thin marl layers virtually impossible. Based on the observed SPT N values and the moisture contents, the undrained shear strength of the marl is estimated to be no greater than 12 kPa. Marl was identified intermittently at 15 Stations during the foundation and pavement investigations. The thickness ranged from 200 mm to 1.4 m with an average of 760 mm

6.3 DESIGN CONSIDERATIONS

The presence of the organic soil deposits both beneath the existing highway embankment and beneath the proposed widening for the passing lanes creates several potential issues that need to be considered during the design. These include:

Settlement considerations:

- Organic materials typically undergo substantial but relatively rapid primary consolidation after a load is applied, followed by secondary consolidation.
- Secondary consolidation is a time dependent process and is often the more critical component of settlement from a design perspective since the magnitude of settlement is often as great as the primary consolidation but the settlement occurs over a period of many years. The relationship between the magnitude of secondary consolidation is nearly linear with the log of time, which means that the magnitude of secondary consolidation decreases with each passing year.
- Any new loads applied to the top of the embankment will induce new primary and secondary consolidation.
- The peat and marl beneath the proposed widening are weak and highly compressible and if left in place would undergo initial settlement and secondary settlements that would continue for many years after completion of construction if conventional construction. Swamp excavation in accordance with OPSD 203.020 will alleviate this concern.

- The peat and marl beneath the existing highway embankment (where present) have not been subjected to any new loads since pavement rehabilitation in 1982. As a result, all primary settlement and secondary settlement from the current loading are essentially complete. In theory, some secondary settlement is still on-going, however, after 27 years the magnitude is insignificant and not likely perceptible on an annual basis. The addition of new loads will initiate new primary and secondary settlement. Experience at other sites has shown that the loading associated with as little as a single lift pavement overlay has been sufficient to initiate new settlement of buried organic layers. The existing information at the peat locations suggest that in order to achieve the current grades above the original peat level, placement of embankment fill approximately 2.2 times as thick as the current embankment height was required; this suggest that to achieve a final grade increase of 100 mm, a total of 200 mm of material may ultimately be required.
- Proposed geometric changes including profile adjustments, cross fall corrections and centreline shifts will have an impact on whether or not any new loads will be imposed on the organic materials buried beneath the existing embankment. Based on the settlement predictions presented in the Draft Foundation Investigation and Design Report, there were several design iterations by AECOM and Stantec in order to try to achieve zero stress increase across the existing embankment platform in areas underlain by compressible organic deposits while still meeting pavement, drainage and geometric design requirements. The results are that only the three limited areas listed in Table 6.1 remain where grade raises will be carried out across the existing driving lanes that are underlain by compressible organic matter.
- Self settlement of the backfill within the swamps will occur. Rock fill has been recommended as the backfill material in areas where muskeg material is removed. The rock fill will be placed in the wet without compaction. Self settlement of approximately 2 to 5% of the thickness of the rock fill should be expected. The majority of this self settlement is expected to occur within 6 months of completion of the fill placement.
- Where removal of the organic deposits is proposed beneath the proposed widenings, the stability of the existing embankment sections that are underlain by organic deposits must be maintained during construction. This is most critical where the existing embankment is underlain by marl which has very low strength.
- There is an existing CPR railway parallel to and in close proximity to the existing Highway 7 alignment throughout the eastern half of the project limits. Like Highway 7, the railway embankment passes through muskeg sections. It is not known if organic soils are present beneath the embankment that supports the railway. Any modifications to the Highway 7 embankment should be designed to ensure that they do not impact the adjacent railway embankment.
- The existing culverts within the proposed passing lanes will need to be extended or replaced. Differential settlement will need to be avoided to ensure integrity and functioning of the culverts. A separate Foundation Investigation and Design Report has been prepared for the culvert treatments.

6.4 SETTLEMENT ASSESSMENT

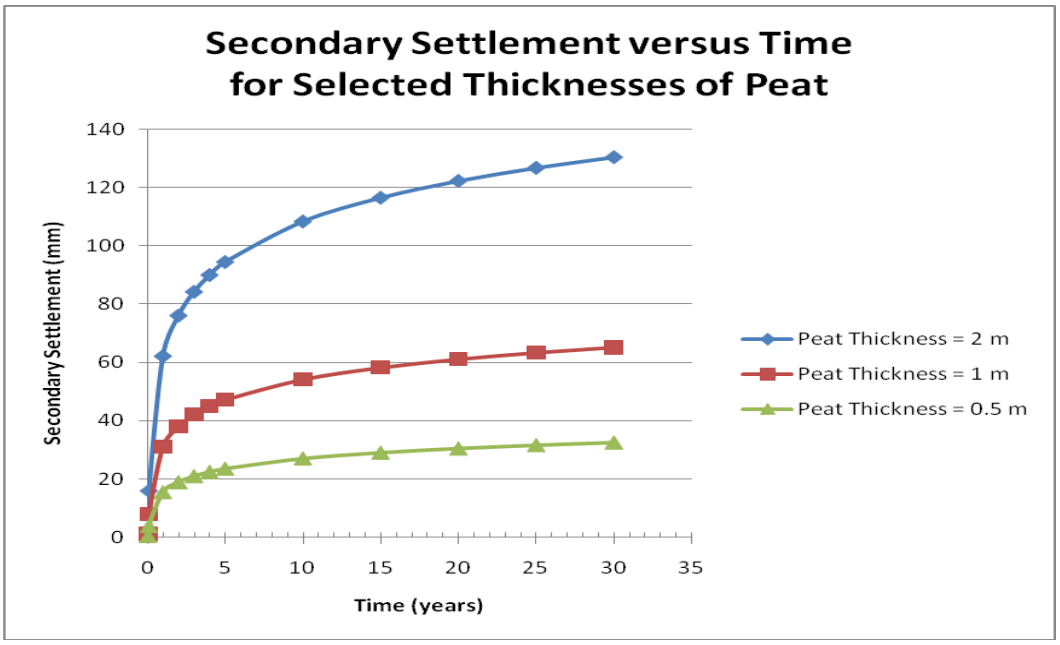
Self settlement of the rock fill backfill within the swamps will occur. Self settlement of approximately 2 to 5% of the thickness of the rock fill should be expected. The majority of this self settlement is expected to occur within 6 months of completion of the fill placement and can be dealt with by delaying the final grading and paving of the new passing lane by at least 6 months.

The settlement of embankments over organic soil deposits is dependent on several factors including:

1) Material properties – as indicated in the soil descriptions in Section 4, there is considerable variation in the properties of the organic materials. In addition, it is noted that the properties of peat change as it is compressed.

2) Thickness of the compressible layer – the thickness of the organic layer beneath the existing highway embankment varies both across the width of the embankment as well as along the length of the highway. The amount and duration of settlement are related to the thickness of the compressible materials. For illustration purposes, Figure 6.1 below shows an example of the predicted secondary settlement versus time for peat layers 500 mm, 1 m and 2 m thick, assuming all other conditions and properties are the same.

Figure 6-1 - Summary of Secondary Settlement vs. Time for Selected Thicknesses of Peat



3) Stress increase – the stress beneath an embankment varies both with depth and with lateral distance from the centerline of the embankment. In addition, the stress increase within the buried organic layers is affected by the magnitude of stress increase applied at surface. Even modest changes to the profile and centerline shifts can result in a stress increase within the buried organic layer.

Due to the variability in the factors listed above, the magnitude of settlement will vary across the width of the embankment and from station to station. For illustrative purposes, we have carried out a detailed assessment of the predicted settlements across the width of the embankment at a typical section where the organic materials will be removed from beneath the widening in accordance with OPSD 203.020, existing grades will be maintained across the existing driving lanes but grades will be raised across the existing shoulder and side slope beneath the proposed passing lane (left side). In this situation, only a limited portion of the buried organic

layers will be subjected to a stress increase. The additional stress will be restricted to new embankment fill placed above the 1H:1V excavation slope carried out above the swamp level as part of the swamp material excavation (as per OPSD 203.020) and a small grade increase due to cross fall adjustments over the existing shoulder.

The primary consolidation was estimated using one dimensional consolidation theory, the coefficients of consolidation (primary and secondary) and initial void ratio from the nearest laboratory consolidation testing, the thickness of the peat from the nearest borehole and the anticipated stress increase. The anticipated stress increase was calculated using a Boussinesq stress distribution to determine the stress profile beneath the embankment both before and after the widening.

Settlement Predictions – Typical Section near 12+000 Belmont

In the area of 12+000 Belmont, the proposed cross section includes a full lane width widening on the north side of the existing highway. Grades across the existing driving lanes will generally be lowered by up to 200 mm. Grades will be raised across the existing left shoulder and embankment side slope. The existing and proposed embankment geometry are shown on Figure 5 in Appendix E along with a schematic of the soil stratigraphy at this location based on the BH09-39, which was drilled at the right edge of pavement at 12+000.

Table 6.5 summarizes the primary settlement that is predicted to occur across the width of the embankment.

Table 6.5: Summary of Predicted Primary Settlement at 12+000

Parameter	Offset from Existing Centreline (m)							
	Left					C/L	Right	
	10	8	6	5	2		5	10
Primary Settlement (mm)	0[(1)]	55	10	5	0	0	0	0
Time for Primary Settlement	15 to 20 days							
Notes: 1) Primary settlement at 10 m left of C/L is shown as zero since all peat will be removed and replaced with rock fill.								

Table 6.6 summarizes the predicted magnitude of secondary settlement versus time for the section at 12+000.

Table 6.6: Summary of Predicted Secondary Settlement versus Time at 12+000

Time following Primary Consolidation	Secondary Settlement (mm)
6 months	30
12 months	40
18 months	45
24 months	50
5 years	60
10 years	65
15 years	70
20 years	75

It should be noted that the secondary consolidation will occur only in areas where primary consolidation occurs. Therefore, no secondary consolidation is expected at the left side of the embankment where all peat material is removed or across the right side of the existing embankment. Some redistribution of stresses will occur within the embankment as the consolidation occurs. As a result, the deformation of the pavement surface due to the secondary consolidation is expected to be a concave depression with maximum settlement (as shown in Table 6.4) occurring beneath the existing shoulder and side slope (approximately 6 m to 8 m left of existing C/L). The impact of this differential settlement on the pavement performance is the primary design issue for this project.

Settlement Predictions – Planned Grade Raise Sections

Three short sections were identified in Table 6.1 where the existing highway embankment is underlain by peat and it is planned to raise the profile across all or part of the existing platform. The most critical cross section within these three areas is at 11+850, where it is proposed to raise the grades by approximately 150 mm, 25 mm and 10 mm at the left edge of pavement, centreline and left edge of pavement, respectively. In addition, it is proposed to widen the platform on the left side. This section is underlain by approximately 1.2 m of peat.

The proposed grade increase across the left shoulder due to the widening is similar to what will occur at Station 12+200. Primary settlement across the left shoulder is expected to be similar to what is predicted for Station 12+200 (10 to 55 mm; see table 6.6 above). Near the centreline and across the right side of the embankment, the grade increases are significantly less (10 to 25 mm) and primary settlement is predicted to be less than 5 mm.

Table 6.7 summarizes the predicted magnitude of secondary settlement versus time for the section at 12+000.

Table 6.7: Summary of Predicted Secondary Settlement versus Time at 11+850

Time following Primary Consolidation	Secondary Settlement (mm)
6 months	25
12 months	30
18 months	35
24 months	40
5 years	45
10 years	50
15 years	55
20 years	60

Acceptable Levels of Embankment Settlement

The maximum acceptable post construction settlement for highway embankments is not specified by code. No structures are located within the embankment sections for this project, therefore, the primary concern is the impact of differential settlement on the pavement structure. Although not desirable, it is anticipated that up to 75 mm of settlement over a 15 year period could be tolerated. The effects of primary settlement can largely be ignored provided paving of the top lift of asphalt is delayed by at least 3 weeks after completion of the grading adjustments

and paving of the binder courses. Based on this approach, secondary settlement is the primary concern.

It is important to note that the values of settlement magnitude presented above in Tables 6.5 and 6.5 are only predictions. The methods for predicting the magnitude of consolidation of organic materials are not precise. Additional uncertainty is inherent in predicting the time rate of settlements. Further, the predicted values will vary due to factors such as variability in the initial material properties and the thickness of the peat deposit along the length and width of the highway.

It is also important to note that some level of regrading or asphalt padding should be anticipated during the life of the pavement structure. For instance in areas where 150 mm of grade raise is anticipated, initial settlements would be followed by future regrading, which in turn would induce further settlements. Based on observations from the investigation, it is anticipated that a final grade raise of 150 mm would require 300 mm of new material over the next 30 to 50 years; this estimate includes the new construction materials as well as future padding.

6.5 FOUNDATION DESIGN OPTIONS TO MINIMIZE IMPACT OF SETTLEMENT

The magnitude of the predicted settlements beneath the future driving lanes and passing lanes is large enough that it will have an impact on road geometry (cross-fall and profile), ride quality and possibly safety.

Nine possible treatment options were considered to either avoid or manage the settlement. A general description of the treatment options is provided below. The advantages, disadvantages, relative costs, risks and consequences of the options are provided in a Table in Appendix F.

Option 1 - Conventional Construction

- Construct widening using OPSD-203.020
- Carry out pavement rehabilitation of existing lanes as per remainder of project limits & pave widening to match
- Repair pavement as required in the future

Option 2 – Full Reconstruction with Complete Removal of Organic material

- Construct widening using OPSD-203.020, possibly to a greater width to allow for detour lanes
- Remove existing embankment and buried organic material
- Construct new embankment and pavement structure

Option 3 - Pre-load

- Construct widening using OPSD-203.020
- Build up grades within widening with granular. Delay paving widening and rehabilitation of existing pavement to allow for primary consolidation and portion of secondary consolidation. Pre-load periods are discussed in more detail in Section 7.2.
- Carry out pavement rehabilitation of existing lanes as per remainder of project limits & pave widening to match
- Repair pavement as required in the future

Option 4 - Surcharge
- Construct widening using OPSD-203.020
- Build up grades within widening with granular to higher than proposed final grades. Surcharge fill heights of 0.5 m to 2 m are typical for new embankments (as opposed to widenings)
- Delay paving to allow settlement to occur (assume 1 construction season)
- Remove surcharge material
- Carry out pavement rehabilitation of existing lanes as per remainder of project limits & pave widening to match

Option 5 - Lightweight Fill
- Construct Widening using OPSD-203.020
- Excavate existing roadway and replace fills with lightweight fill in order to achieve zero stress increase in organic layer beneath existing embankment. The type of lightweight fill required will depend on the loads to be offset. It is anticipated that zero stress increase could be achieved at some locations using a slag based lightweight fill, however, other areas would likely require the use of expanded polystyrene fill material.
- Construct new pavement structure full width

Option 6 - Soil Mixing
- Construct widening using OPSD-203.020
- Carry out soil mixing to stabilize the organic soils beneath the existing embankment (likely operation consists of auguring a series of large diameter holes on a tightly spaced grid; introducing cement and possibly some aggregate to blend with the organic soil resulting in a cemented composite block)
- Carry out pavement rehabilitation of existing lanes as per remainder of project limits & pave widening to match

Option 7 – GeoPiers
- Construct widening using OPSD-203.020
- Construct GeoPier reinforcement of existing embankment so that it is no longer susceptible to significant settlement due to small load increases. Operation consists of auguring a series of large diameter holes, backfilling with compacted lifts of granular material to form columns of aggregate; cement powder may be added)
- Carry out pavement rehabilitation of existing lanes as per remainder of project limits & pave widening to match

Option 8 - Geosynthetic Reinforcement
- Construct widening using OPSD-203.020
- Remove existing pavement structure full depth and full width
- Install geogrid at subgrade level across existing embankment and new passing lane.
- Construct new pavement structure full width.
- Repair pavement as required in the future

Option 9 - Do Nothing
- Do not construct widening
- Carry out pavement rehabilitation of existing lanes as per remainder of project limits

It is noted that following review of the Draft Foundation Investigation and Design Report, the limits of the proposed passing lanes and the proposed profile were adjusted to minimize settlement of the organic soil deposits. Option 3 (pre-loading) is the preferred option for managing the anticipated settlement associated with the revised highway geometry due to significantly lower initial cost and acceptable level of performance.

6.6 EMBANKMENT STABILITY

Stability of the embankment in its final configuration was analyzed using commercially available slope stability software (Slope/W).

A zonal acceleration ration of 0.05, as per Table A3.1.1 of the CHBDC for the town of Norwood was used to generate a pseudo-static acceleration coefficient of 0.05 for use in the seismic stability analysis.

The proposed final embankment geometry and materials were determined to be stable under long term conditions and under seismic loading conditions. Factors of safety of 2.5 and 2.2 were obtained under static and seismic loading conditions, respectively. A copy of the slope stability modeling results is provided in Appendix E.

Stability of the temporary excavation walls during removal of the muskeg and marl material as per OPSD 203.020 is discussed in Section 7.1.

6.7 IMPACT ON CPR RAILWAY EMBANKMENT

An existing CPR railway is located to the right (South side) of the Highway 7 alignment. From approximately 26+850 easterly, the centreline of the railway is located approximately 20 m right of the centreline of Highway 7.

It is not known whether or not the CPR railway embankment is underlain by organic material. For the purpose of this assessment, it has been assumed that the buried organic deposits beneath the Highway 7 embankment are also present beneath the existing CPR embankment.

Where a widening is constructed along the left (north) side of the existing highway and the grades are maintained across the right side, no settlement is expected at the CPR embankment due to the offset distance and limited depth and thickness of the organic deposit. The CPR embankment is outside of the zone where the proposed widening will generate new loads. No embankment widening is proposed along the right (south) side of the existing embankment in areas immediately adjacent to the CPR embankment, therefore there will be no impact on the CPR embankment due to widening for the passing lanes for Highway 7.

The three sections where the grades are being raised across the right side of the existing embankment (Table 6.1) were reviewed and no settlement is expected at the CPR embankment due to the offset distance and limited depth and thickness of the organic deposit.

7.0 Recommendations

7.1 EMBANKMENT WIDENING WITHIN SWAMPS

Widening of the existing embankments to accommodate the passing lanes through swamp sections should be constructed in accordance with OPSS 209 using the excavation method (OPSS 209.07.03) and in accordance with OPSD 203.020 Embankments over Swamp – Existing Slope Excavated to 1H:1V.

7.1.1 Excavation

OPSD 203.020 allows for a 1H:1V slope down from the existing edge of granular to the top of the adjacent swamp and a vertical excavation below this level. Due to the fibrous nature of the material, the peat is expected to stand approximately vertically for the short time duration required to excavate and backfill short sections. A slope stability analysis of a typical section with the excavation geometry as per OPSD 203.020 using the same soil parameters as shown in Table 6.5, indicated a factor of safety of approximately 1.5 under temporary (undrained) conditions. A copy of the analysis results is included in Appendix E.

It is noted that at many locations, the existing embankment fill, generally consists of silty sand extending beneath the water level. Therefore, some sloughing of the existing embankment fill may occur. Due to the limited depth of this fill beneath the water level (less than 1.5 m and most commonly less than 1 m) the extent of the sloughing is expected to be restricted to the area of the existing side slopes and shoulder rounding and is not expected to have a negative effect on the paved driving lanes of Highway 7.

A slope stability analysis was carried out based on the following assumptions:

- A typical section where the existing embankment is underlain by 1.0 m of peat over 1.0 m of marl
- Excavation geometry is carried out as per OPSD 203.020
- The soil parameters as shown in Section 6.2

The results of the analysis indicate a factor of safety of approximately 1.0 under temporary (undrained) conditions. A copy of the analysis results is included in Appendix E. A factor of safety of at least 1.3 is typically required for temporary excavation slopes. It is anticipated that the peat above the marl will act as a mat and will bridge across short sections, particularly over short longitudinal sections and where the marl is of limited thickness. Therefore, it is recommended to impose an operational constraint limiting the width of the base of the excavation to no more than 3 m at any time. A draft copy of a special provision invoking this requirement is included in Appendix G.

7.1.2 Backfill

The observed water level was frequently near the top of the swamp material during the investigation. It is therefore expected that much of the backfill will be placed in wet conditions. As per OPSS 209.07.03.01, backfill material other than rock may be placed up to 600 mm above the water without compaction. In order to limit post construction settlement due to the lack of compaction and to provide a stronger base for the overlying pavement structure, a coarse, angular material such as rock fill is recommended.

Since no compaction is likely to be provided for most of the backfill, it is recommended that the backfill be placed a minimum of one construction season prior to placing the asphalt layers above it in order to allow for self settlement of the uncompacted embankment fill. This requirement will be achieved by the preloading requirement of the peat and not impose a new specific project restriction.

7.2 PRE-LOADING OF EMBANKMENT WIDENING

7.2.1 Methodology

It is recommended that the pre-loading option, as discussed in Section 6.5, be carried out to manage the settlement associated with the passing lane widenings and profile adjustments. Specifically this option would include the following steps:

- Removal of swamp material from within the proposed widening as per OPSD 203.020
- Backfill of the swamp section
- Construction of the embankment fill and pavement structure subbase and base granular layers as per the Pavement Design Report.
- Placement of additional granular fill (OPSS Granular A) up to the top of asphalt design grades throughout the proposed widening.
- Allowing time for settlement to occur. Settlement is to be monitored during this time period. Further discussion regarding the time duration for the pre-load and monitoring of settlement is provided below in Sections 7.2.2 and 7.2.3, respectively.
- Blade off excess granular to the outside slopes upon completion of the pre-load period. Recompact surface. Place the hot mix paving across the widened embankment.

7.2.2 Pre-load Time Period

In general, primary settlement of the organic deposits is expected to be complete within 15 to 20 days of application of the new loads. The majority of the self settlement of the uncompacted backfill is expected to occur within the first 6 months.

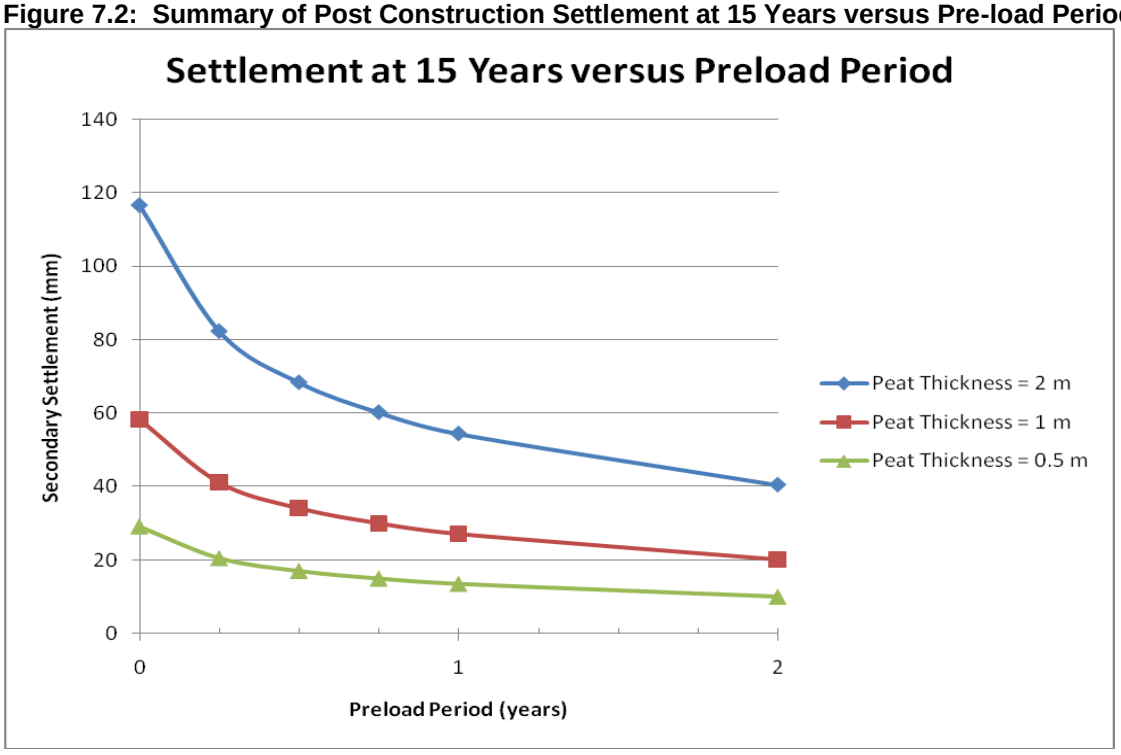
Table 7.1 provides an assessment of the secondary settlement that is predicted to occur by 10, 15 and 20 years post construction and following pre-load periods ranging from 0 to 2 years.

Table 7.1: Summary of Predicted Post Construction Settlement versus Pre-load Time for Selected Peat Thicknesses

Preload Time (years)	Peat Thickness = 500 mm Post Construction Settlement (mm)			Peat Thickness = 1 m Post Construction Settlement (mm)			Peat Thickness = 2 m Post Construction Settlement (mm)		
	10 years	15 years	20 years	10 years	15 years	20 years	10 years	15 years	20 years
0	27	29	31	54	58	61	108	117	122
0.25	19	21	22	37	41	44	74	82	88
0.5	15	17	19	30	34	37	60	68	74
0.75	13	15	16	26	30	33	52	60	66
1	12	14	15	23	27	30	46	54	60
2	8	10	12	16	20	23	32	40	46

Based on the data presented in Table 7.2, approximately 50% of the total secondary settlement that is expected to occur within the 20 years post construction is likely to be complete by the end of the first 12 months and 66% of the secondary settlement is likely to be complete by the end of 2 years. Beyond 2 years, the incremental benefit of waiting additional time is greatly diminished. This diminishing benefit of prolonging the pre-load time period is shown graphically in Figure 7.2.

Figure 7.2: Summary of Post Construction Settlement at 15 Years versus Pre-load Period



The actual amount of secondary settlement remaining after the pre-load period will depend not only on the length of the pre-load period but also on variability in the thickness and properties of the buried organic layers.

Selection of the appropriate pre-load time period requires balancing the technical goal of minimizing post construction settlement with the potential implications to cost and schedule of extending the pre-load period. A maximum tolerable post construction settlement of 75 mm over the design life of the pavement structure (15 years) has been proposed based on pavement performance. It is noted that this amount of settlement would occur over the 15 year time period and that some maintenance, including localized patching may be carried out during that time period. A minimum of pre-load period of 6 months is recommended in order to limit post construction settlement to less than 75 mm over 15 years. Based on the curves presented in Figure 7.2, all areas with less than 2 m thickness of buried peat would meet this objective and areas with 1 m or less of buried peat would likely experience less than 40 mm of settlement.

A 12 month pre-load period would be beneficial from a technical perspective in further reducing post construction settlement and thereby future pavement maintenance costs, however, the prolonged delay may have contractual implications including increased project costs. A possible construction schedule might be the following:

Summer or Fall of Year 1 - construct widening

Summer of Fall of Year 2 - pave the widening

7.2.3 Pre-load Treatment – Monitoring Requirements

Settlement monitoring should be carried out throughout the construction and pre-load period. A structured settlement monitoring program that includes plans, details and specifications will need to be developed.

The monitoring program is likely to include surveying of the surface elevation along the edge of existing pavement as well as the middle of the new passing lane at regularly spaced intervals (e.g. 50 m). The frequency of monitoring will be greater during the initial stages of construction and pre-loading since the expected rate of settlement is greatest during the initial stages. Sufficient data is required to develop a settlement versus time curve.

7.3 CONSTRUCTION CONSIDERATIONS

No dewatering is anticipated to be required for the proposed embankment construction. It is anticipated that the rock fill placed as backfill following muskeg removal will be placed in the wet.

Excavations for the muskeg removal have been discussed in Section 7.1. No other excavation work is anticipated as part of the embankment construction.

8.0 Closure

The recommendations made in this report are in accordance with our present understanding of the project. We request that we be permitted to review our recommendations when the drawings and specifications are complete.

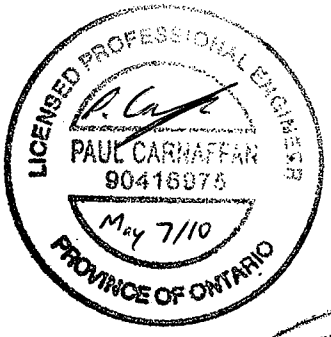
A soil investigation is a limited sampling of a site. The conclusions given herein are based on information gathered at the specific borehole locations. Should any conditions at the site be encountered which differ from those at the borehole locations, we request that we be notified immediately in order to assess the additional information and its effects on the above recommendations.

We trust the information presented herein meets your present requirements. Should you have any questions or require additional information, please do not hesitate to contact us.

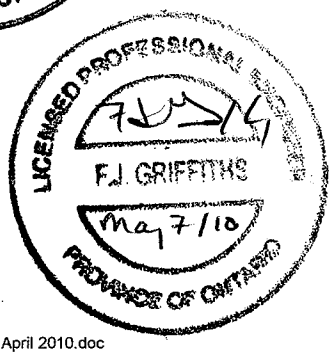
This report has been prepared by Paul Carnaffan and Fred Griffiths. Technical reviews were carried out by Arun Valsangkar and Raymond Haché.

Respectfully submitted,

STANTEC CONSULTING LTD



Paul Carnaffan, M.Eng., P.Eng.
Associate



Fred J. Griffiths, Ph.D., P.Eng.
Designated Principal MTO Foundation Contact

P:\2010\122410158 - 1047243 Hwy 7 Norwood to Havelock\Foundations\Embankments\FINAL April 2010.doc

APPENDIX A

Drawing No. 1 – Fill Section Location Plan
Drawing No. 2 to 4 – Borehole Location Plan and Stratigraphic Sections

T:\Autocad\Drawings\Project Drawings\2010\122410158 (1047243)\Foundation\Fill Location\1047243-1 FF_May3.dwg PRINTED: May 03, 2010

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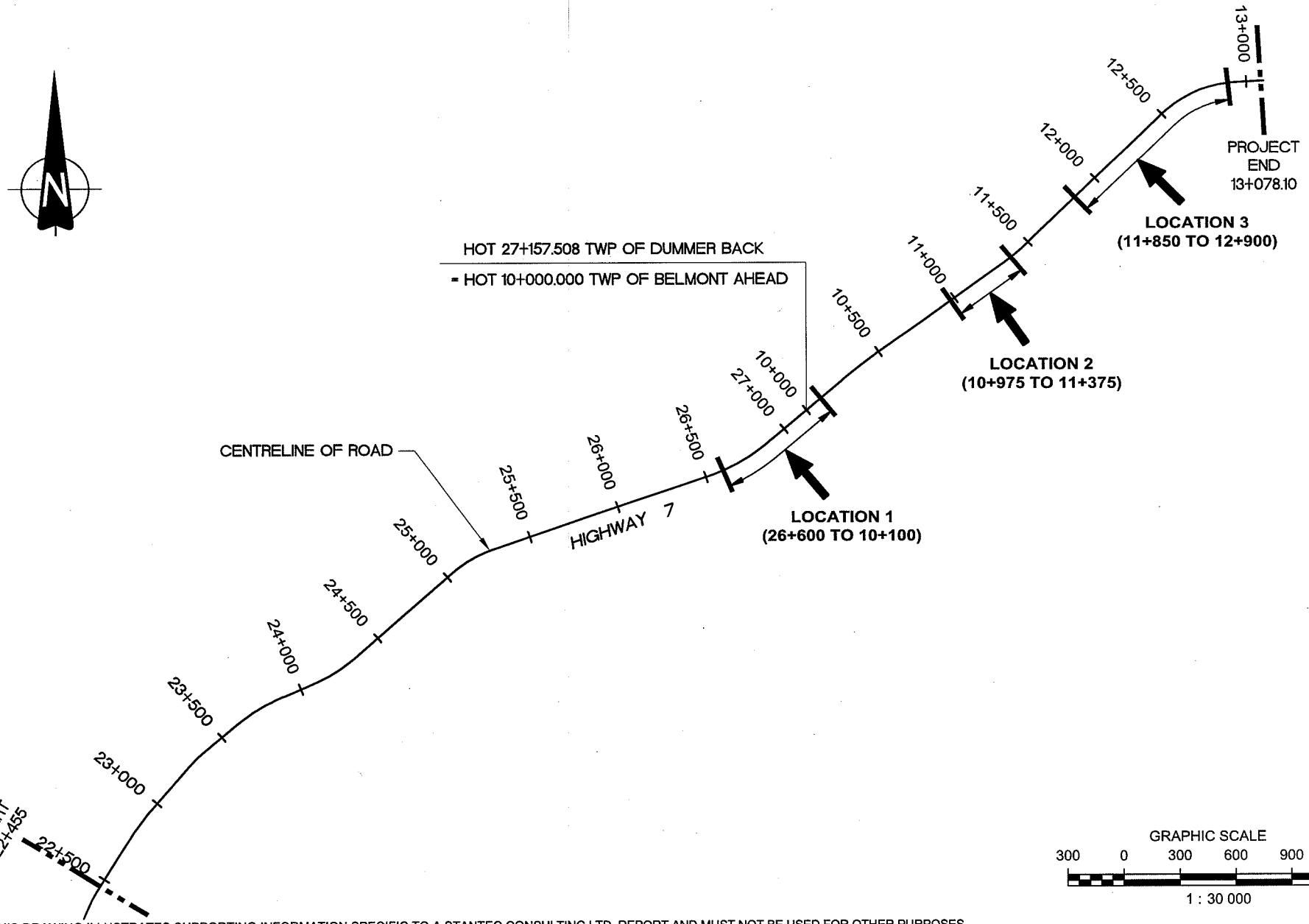

NOTE: THIS DRAWING ILLUSTRATES SUPPORTING INFORMATION SPECIFIC TO A STANTEC CONSULTING LTD. REPORT AND MUST NOT BE USED FOR OTHER PURPOSES.

CULVERT LOCATION PLAN

FOUNDATION INVESTIGATION - WP 67-99-00
HIGHWAY 7, NORWOOD TO HAVELOCK, ONTARIO

Client: AECOM CANADA LTD.

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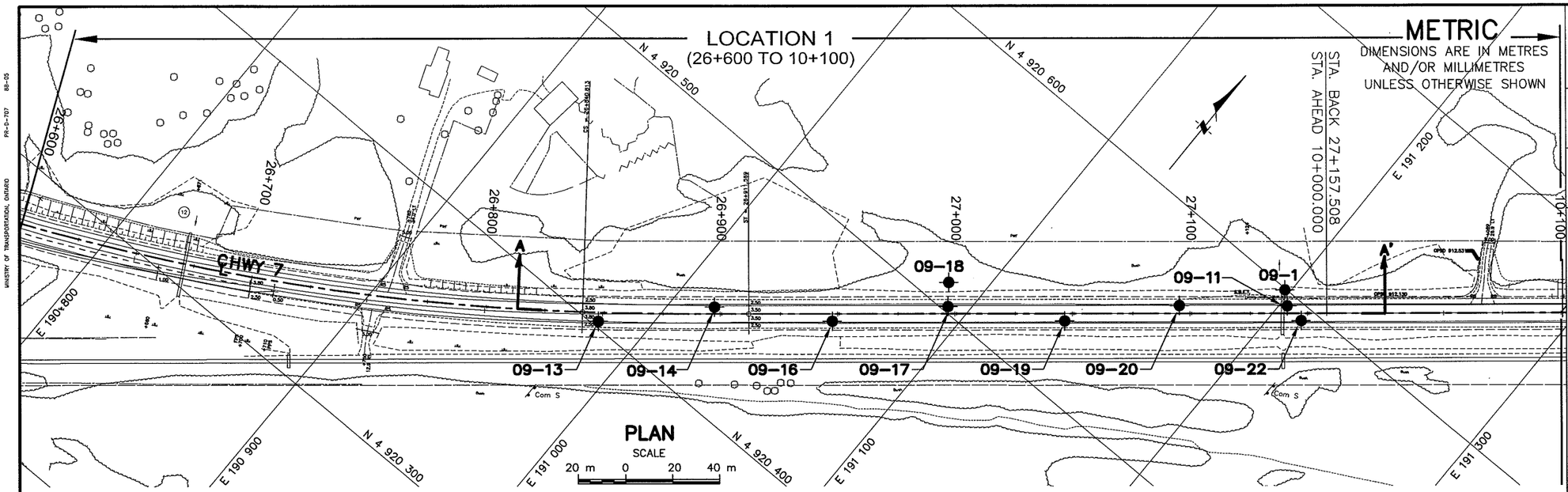
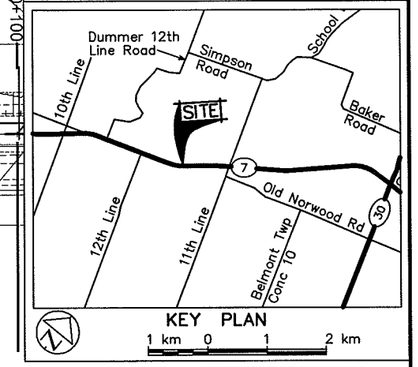
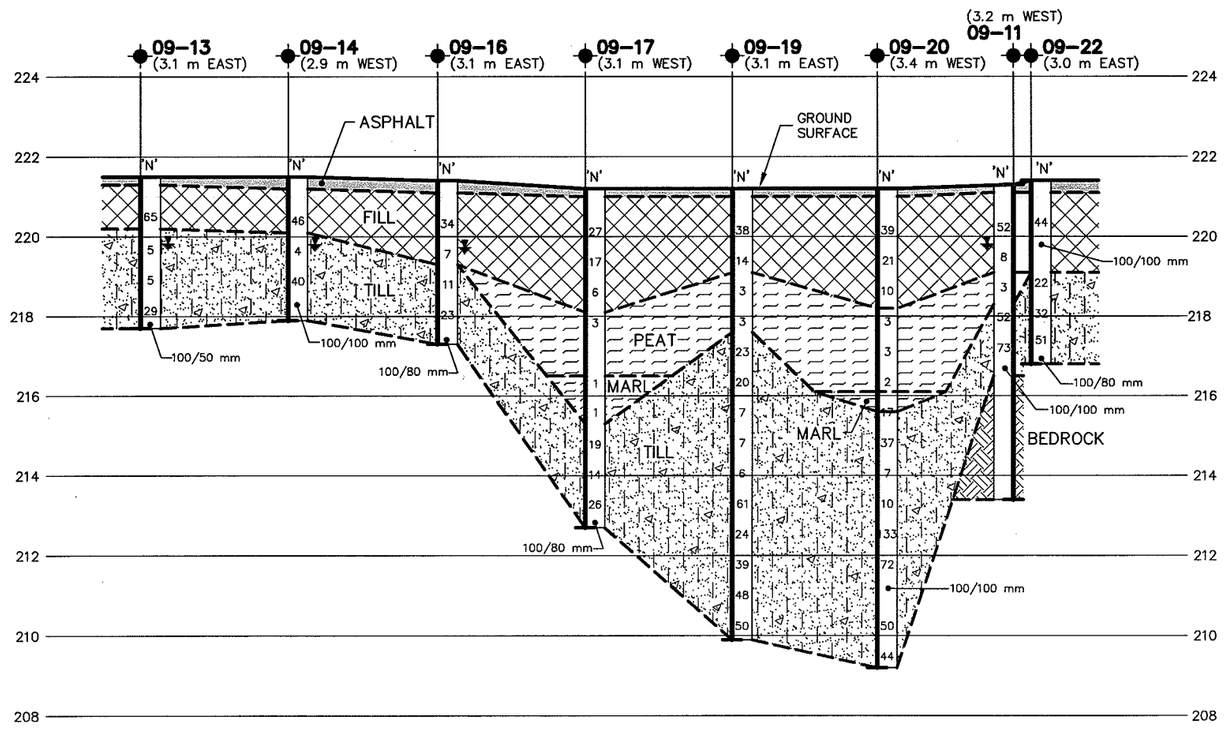
Scale:	1 : 30 000
Date:	10/05/03
Dwn. By:	GBB
App'd By:	

Dwg. No.: 1

Stantec







CROSS–SECTION A–A'

SCALE

20 m 0 20 40 m HORIZONTAL

1.5 m 0 1.5 3.0 m VERTICAL

PLATE No
CONT
WP 67–99–00

SHEET

HWY 7, LOCATION 1
STA 26+600 TO STA 10+100
BOREHOLE LOCATIONS & SOIL STRATA

Stantec

LEGEND

- Bore Hole
- N Blows/0.3m (Std Pen Test, 475 J/blow)
- WL at Time of Investigation June/July 2009
- (m EAST) Offset From Cross–Section Line

No	ELEVATION	MTM ZONE 9 NORTH	COORDINATES EAST
09–1	220.0	4 920 599.5	191 197.8
09–11	221.3	4 920 595.0	191 202.8
09–13	221.5	4 920 402.3	190 981.7
09–14	221.5	4 920 438.6	191 015.8
09–16	221.4	4 920 466.1	191 058.2
09–17	221.2	4 920 502.4	191 092.1
09–18	220.0	4 920 510.4	191 085.9
09–19	221.2	4 920 529.5	191 134.2
09–20	221.2	4 920 565.7	191 167.4
09–22	221.4	4 920 594.0	191 211.4

NOTE
The boundaries between soil strata have been established only at Bore Hole locations. Between Bore holes the boundaries are assumed from geological evidence.

NOTE: The complete foundation investigation and design report for this project and other related documents may be examined at the Engineering Materials Office, Downsview. Information contained in this report and related documents is specifically excluded in accordance with the conditions of Section 102–2 of Form 100.

REVISIONS			
	DATE	BY	DESCRIPTION

GEOCRES No 31C–195

HWY No 7			DIST
SUBM'D	CHECKED	DATE 2010–04–30	SITE
DRAWN GBB	CHECKED	APPROVED	DWG 2

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CREATED: GBB
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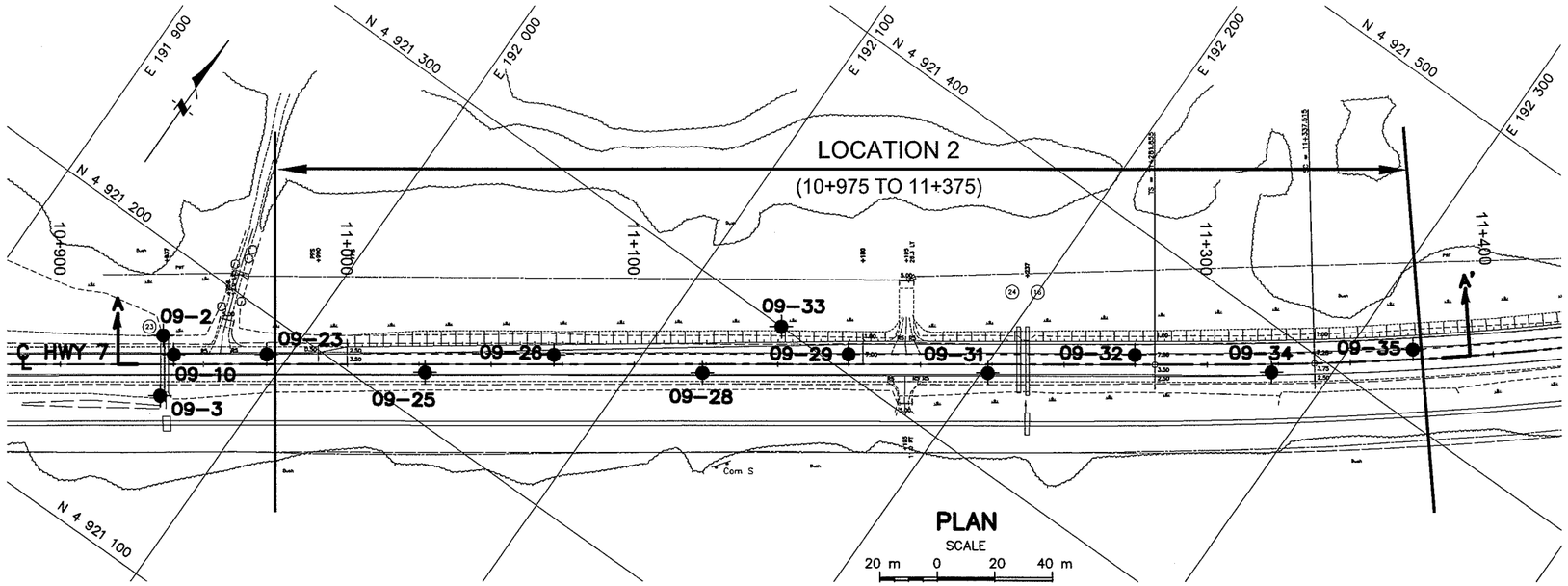
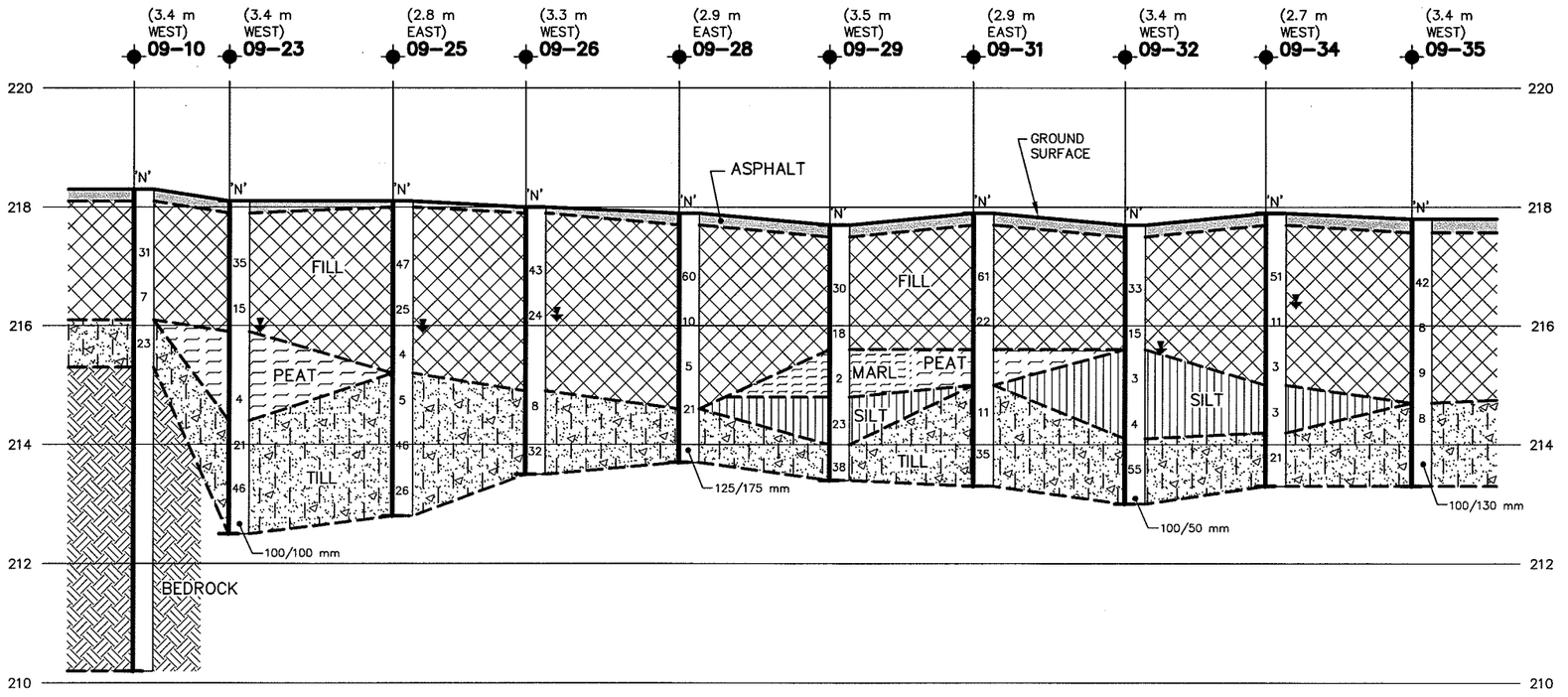
MINISTRY OF TRANSPORTATION, ONTARIO 88–05 PR–D–707





METRIC

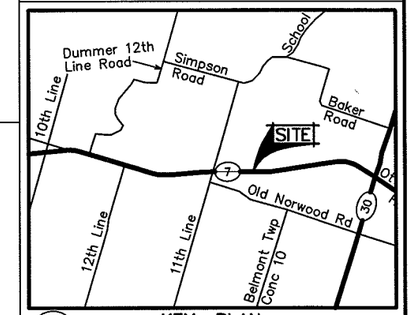
DIMENSIONS ARE IN METRES AND/OR MILLIMETRES UNLESS OTHERWISE SHOWN

PLATE No
CONT WP 67–99–00

SHEET

HWY 7, LOCATION 2
STA 10+975 TO STA 11+375
BOREHOLE LOCATIONS & SOIL STRATA

Stantec



LEGEND

- Bore Hole
- N — Blows/0.3m (Std Pen Test, 475 J/blow)
- WL at Time of Investigation June/July 2009
- (m EAST) — Offset From Cross–Section Line

No	ELEVATION	MTM ZONE 9 COORDINATES NORTH	EAST
09–2	216.6	4 921 172.9	191 960.0
09–3	216.9	4 921 155.2	191 971.2
09–10	218.3	4 921 169.6	191 966.9
09–23	218.1	4 921 188.4	191 993.4
09–25	218.1	4 921 215.2	192 041.8
09–26	218.0	4 921 246.1	192 074.9
09–28	217.9	4 921 271.0	192 120.7
09–29	217.7	4 921 305.8	192 158.7
09–31	217.9	4 921 328.7	192 202.0
09–32	217.7	4 921 363.5	192 240.3
09–33	216.3	4 921 300.0	192 133.9
09–34	217.9	4 921 386.2	192 282.6
09–35	217.8	4 921 421.1	192 318.3

NOTE
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REVISIONS	DATE	BY	DESCRIPTION

GEOCRES No 31C–195

HWY No 7			DIST
SUBM'D	CHECKED	DATE 2010–04–30	SITE
DRAWN GBB	CHECKED	APPROVED	DWG 3

MINISTRY OF TRANSPORTATION, ONTARIO PR–D–707 88–05

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MINISTRY OF TRANSPORTATION, ONTARIO FR-D-707 88-05

METRIC

DIMENSIONS ARE IN METRES AND/OR MILLIMETRES UNLESS OTHERWISE SHOWN

PLATE No
CONT
WP 67-99-00

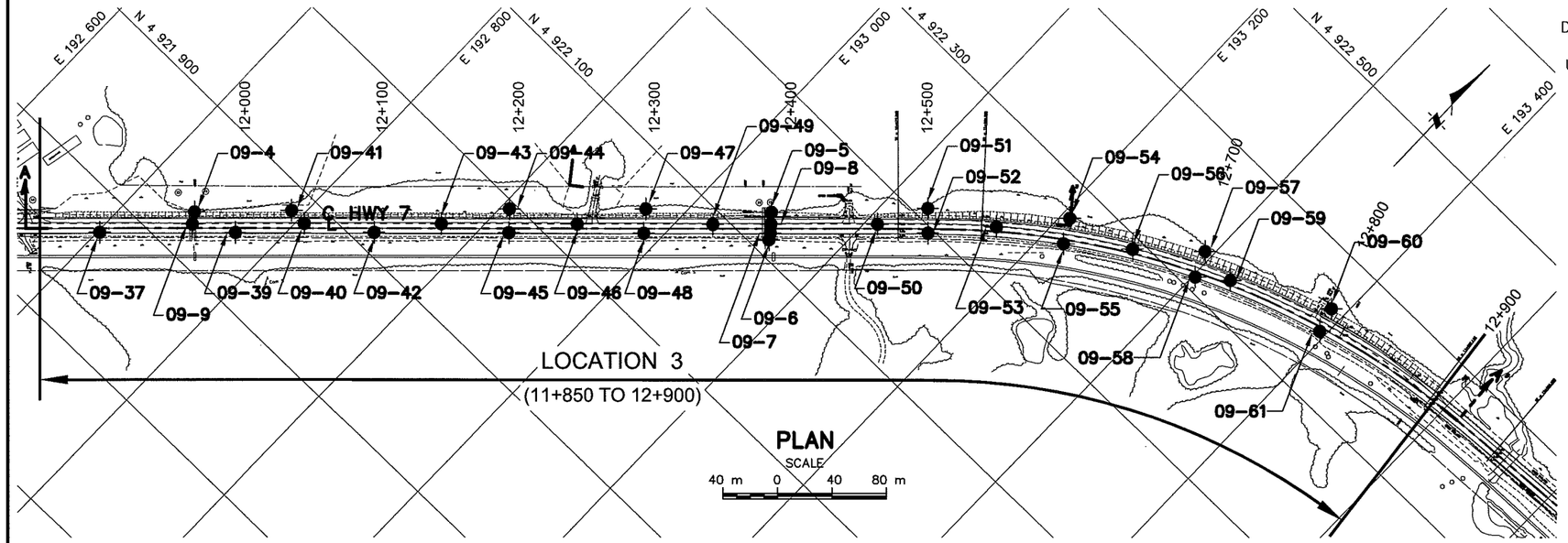
HWY 7, LOCATION 3

STA 11+850 TO STA 12+900

BOREHOLE LOCATIONS & SOIL STRATA

SHEET

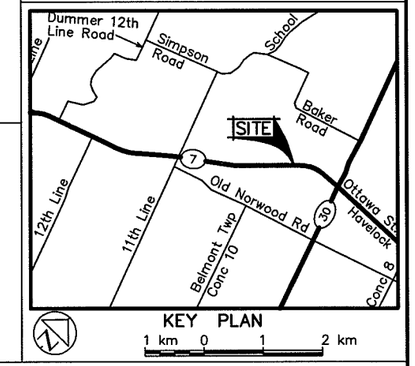
Stantec



PLAN

SCALE

40 m 0 40 80 m



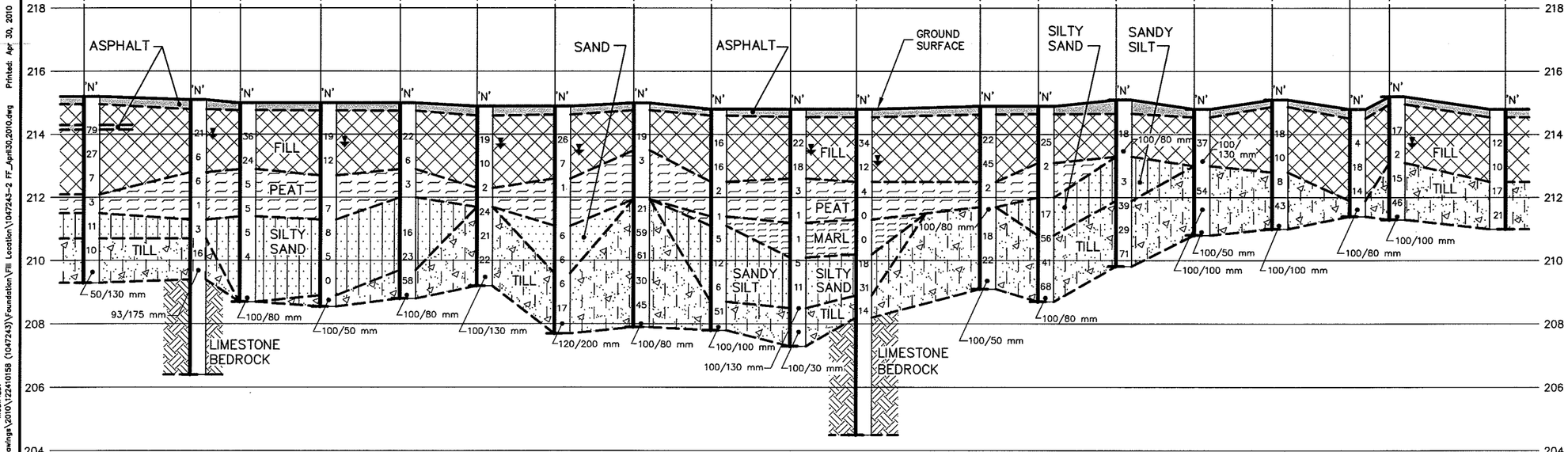
KEY PLAN

1 km 0 1 2 km

LEGEND

- Bore Hole
- N Blows/0.3m (Std Pen Test, 475 J/blow)
- WL at Time of Investigation June/July 2009
- (m EAST) Offset From Cross-Section Line

No	ELEVATION	MTM ZONE 9 NORTH	COORDINATES EAST
09-4	213.9	4 921 833.1	192 741.2
09-5	213.8	4 922 126.8	193 045.6
09-6	213.1	4 922 111.3	193 058.0
09-7	214.8	4 922 115.3	193 056.4
09-8	214.9	4 922 120.1	193 051.2
09-9	215.1	4 921 825.7	192 746.1
09-37	215.2	4 921 774.3	192 701.5
09-39	215.0	4 921 843.3	192 773.3
09-40	215.0	4 921 883.3	192 805.1
09-41	213.9	4 921 883.6	192 791.9
09-42	215.0	4 921 913.6	192 846.0
09-43	214.9	4 921 952.3	192 876.9
09-44	213.8	4 921 994.9	192 905.4
09-45	214.9	4 921 982.2	192 917.1
09-46	215.0	4 922 021.6	192 948.8
09-47	213.8	1 922 064.6	192 977.7
09-48	214.8	4 922 050.8	192 988.8
09-49	214.8	4 922 090.7	193 020.8
09-50	214.9	4 922 174.8	193 107.5
09-51	213.7	4 922 208.8	193 126.2
09-52	214.9	4 922 195.9	193 138.7
09-53	215.1	4 922 234.2	193 171.7
09-54	213.4	4 922 276.0	193 206.1
09-55	214.8	4 922 259.6	193 215.5
09-56	215.1	4 922 291.9	193 254.6
09-57	213.2	4 922 327.9	193 294.2
09-58	214.8	4 922 309.4	193 301.8
09-59	215.2	4 922 325.7	193 322.3
09-60	213.1	4 922 326.5	193 390.1
09-61	214.8	4 922 344.7	193 395.3



CROSS-SECTION A-A'

SCALE

40 m 0 40 80 m HORIZONTAL

1.5 m 0 1.5 3.0 m VERTICAL

NOTES

The boundaries between soil strata have been established only at Bore Hole locations. Between Bore holes the boundaries are assumed from geological evidence.

The complete foundation investigation and design report for this project and other related documents may be examined at the Engineering Materials Office, Downsview. Information contained in this report and related documents is specifically excluded in accordance with the conditions of Section 102-2 of Form 100.

REVISIONS		
DATE	BY	DESCRIPTION

GEOCRES No 31C-195

HWY No 7			DIST
SUBM'D	CHECKED	DATE 2010-04-30	SITE
DRAWN GBB	CHECKED	APPROVED	DWG 4

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Printed: Apr 30, 2010

APPENDIX B

Symbols and Terms Used on Borehole and Test Pit Records
Borehole Records
Bedrock Core Records
Bedrock Core Photographs

SYMBOLS AND TERMS USED ON BOREHOLE AND TEST PIT RECORDS

SOIL DESCRIPTION

Terminology describing common soil genesis:

Topsoil	- mixture of soil and humus capable of supporting vegetative growth
Peat	- mixture of visible and invisible fragments of decayed organic matter
Till	- unstratified glacial deposit which may range from clay to boulders
Fill	- material below the surface identified as placed by humans (excluding buried services)

Terminology describing soil structure:

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

Terminology describing soil types:
The classification of soil types are made on the basis of grain size and plasticity in accordance with the Unified Soil Classification System (USCS) (ASTM D 2487 or D 2488). The classification excludes particles larger than 76 mm (3 inches). The USCS provides a group symbol (e.g. SM) and group name (e.g. silty sand) for identification.

Terminology describing cobbles, boulders, and non-matrix materials (organic matter or debris):
Terminology describing materials outside the USCS, (e.g. particles larger than 76 mm, visible organic matter, construction debris) is based upon the proportion of these materials present:

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

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

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

Terminology describing consistency of cohesive soils:
The standard terminology to describe cohesive soils includes the consistency, which is based on undrained shear strength as measured by *in situ* vane tests, penetrometer tests, or unconfined compression tests.

Consistency	Undrained Shear Strength	
	kips/sq.ft.	kPa
Very Soft	<0.25	<12.5
Soft	0.25 - 0.5	12.5 - 25
Firm	0.5 - 1.0	25 - 50
Stiff	1.0 - 2.0	50 – 100
Very Stiff	2.0 - 4.0	100 - 200
Hard	>4.0	>200

ROCK DESCRIPTION

Terminology describing rock quality:

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

Rock quality classification is based on a modified core recovery percentage (RQD) in which all pieces of sound core over 100 mm long are counted as recovery. The smaller pieces are considered to be due to close shearing, jointing, faulting, or weathering in the rock mass and are not counted. RQD was originally intended to be done on NW core; however, it can be used on different core sizes if the bulk of the fractures caused by drilling stresses are easily distinguishable from *in situ* fractures. The terminology describing rock mass quality based on RQD is subjective and is underlain by the presumption that sound strong rock is of higher engineering value than fractured weak rock.

Terminology describing rock mass:

Spacing (mm)	Joint Classification	Bedding, Laminations, Bands
> 6000	*Extremely Wide*	-
2000-6000	*Very Wide*	*Very Thick*
600-2000	*Wide*	*Thick*
200-600	*Moderate*	*Medium*
60-200	*Close*	*Thin*
20-60	*Very Close*	*Very Thin*
<20	*Extremely Close*	*Laminated*
<6	-	*Thinly Laminated*

Terminology describing rock strength:

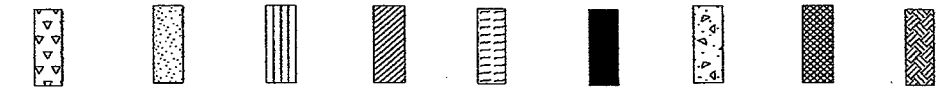
Strength Classification	Unconfined Compressive Strength (MPa)
Extremely Weak	< 1
Very Weak	1 – 5
Weak	5 – 25
Medium Strong	25 – 50
Strong	50 – 100
Very Strong	100 – 250
Extremely Strong	> 250

Terminology describing rock weathering:

Term	Description
Fresh	No visible signs of rock weathering. Slight discolouration along major discontinuities
Slightly Weathered	Discolouration indicates weathering of rock on discontinuity surfaces. All the rock material may be discoloured.
Moderately Weathered	Less than half the rock is decomposed and/or disintegrated into soil.
Highly Weathered	More than half the rock is decomposed and/or disintegrated into soil.
Completely Weathered	All the rock material is decomposed and/or disintegrated into soil. The original mass structure is still largely intact.

STRATA PLOT

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



Boulders, Cobbles, Gravel | Sand | Silt | Clay | Organics | Asphalt | Concrete | Fill | Bedrock

SAMPLE TYPE

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

WATER LEVEL MEASUREMENT

measured in standpipe, piezometer, or well

inferred

RECOVERY

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

N-VALUE

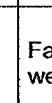
Numbers in this column are the field results of the Standard Penetration Test: the number of blows of a 140 pound (64 kg) hammer falling 30 inches (760 mm), required to drive a 2 inch (50.8 mm) O.D. split spoon sampler one foot (305 mm) into the soil. For split spoon samples where insufficient penetration was achieved and N-values cannot be presented, the number of blows are reported over sampler penetration in millimetres (e.g. 50/75). Some design methods make use of N value corrected for various factors such as overburden pressure, energy ratio, borehole diameter, etc. No corrections have been applied to the N-values presented on the log.

DYNAMIC CONE PENETRATION TEST (DCPT)

Dynamic cone penetration tests are performed using a standard 60 degree apex cone connected to A size drill rods with the same standard fall height and weight as the Standard Penetration Test. The DCPT value is the number of blows of the hammer required to drive the cone one foot (305 mm) into the soil. The DCPT is used as a probe to assess soil variability.

OTHER TESTS

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

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

Stantec

RECORD OF BOREHOLE No BH09-01 1 OF 1 METRIC

W.P. 67-99-00 LOCATION 27+139 O/S CL 13.8 LT N: 4 920 599 E: 191 198 ORIGINATED BY ZP

DIST HWY 7 BOREHOLE TYPE Portable Drilling Equipment, 1/3 Weight Hammer, Splitspoons, NQ Coring Equipment COMPILED BY ZP

DATUM Geodetic DATE 5.27.09 - 5.27.09 CHECKED BY

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa: O UNCONFINED, ● QUICK TRIAXIAL, ✖ FIELD VANE, × LAB VANE (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) 10 20 30	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
220.0											
0.0	Fine fibrous organic matter, soft, dark brown to black, (PEAT)		1	SS	1	▽					
218.9			2	SS	9		219				
1.1	Silty gravel (GM) with sand dense to very dense, grey, TILL - frequent cobbles and boulders - boulder frequency increasing with depth		3	SS	50				o		49 29 (22)
							218				
			4	NQ							
			5	NQ			217				
			6	NQ							
216.3			7	NQ							
3.7	Grey LIMESTONE bedrock with shale partings - poor to fair quality - slightly weathered - flat orientation (0 - 20°) - very close to close joint spacing - rough planar		8	NQ			216				REC=100 RQD=33
			9	NQ							REC=98 RQD=41
			10	NQ			215				REC=95 RQD=21
			11	NQ			214				REC=99 RQD=61
213.5											
6.4	End of Borehole										

✖3, ×3: Numbers refer to Sensitivity O3%: STRAIN AT FAILURE

ONTARIO MTO STANTEC 1047243. HWY 7.GPJ ONTARIO MOT.GDT 10/29/09

Stantec

RECORD OF BOREHOLE No BH09-02 1 OF 1 METRIC

W.P. 67-99-00 LOCATION 10+938 O/S CL 11.8 LT N: 4 921 173 E: 191 960 ORIGINATED BY ZP

DIST HWY 7 BOREHOLE TYPE Portable Drilling Equipment, Splitspoons, NQ and BQ Coring Equipment COMPILED BY ZP

DATUM Geodetic DATE 5.28.09 - 5.28.09 CHECKED BY

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (O UNCONFINED, ● QUICK TRIAXIAL, ✖ FIELD VANE, × LAB VANE) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
216.6											
216.6 / 0.1	Fine fibrous organic matter, soft, dark brown to black, (PEAT)										
	Silty sand (SM) with gravel, compact, brown TILL		1	SS	10						
			2	SS	24		216		o		34 54 (12)
215.2			3	SS	50/150mm						
1.4	Grey LIMESTONE bedrock with shale partings - very poor to poor quality - slightly to moderately weathered - flat orientation (0 - 20°) - very close joint spacing - rough planar		4	NQ			215				REC=33 RQD=21
			5	NQ							REC=33 RQD=0
			6	NQ							REC=58 RQD=0
			7	NQ			214				REC=88 RQD=28
			8	NQ							REC=64 RQD=28
			9	NQ							REC=81 RQD=0
			10	BQ			213				REC=30 RQD=0
212.3			11	BQ							REC=22 RQD=0
4.3	End of Borehole										

✖³, ×³: Numbers refer to Sensitivity O³% STRAIN AT FAILURE

ONTARIO MTO STANTEC_1047243_HWY 7.GPJ ONTARIO MOT.GDT 10/29/09

Stantec

RECORD OF BOREHOLE No BH09-03 1 OF 1 METRIC

W.P. 67-99-00 LOCATION 10+938 O/S CL 12.5 RT N: 4 921 155 E: 191 971 ORIGINATED BY ZP

DIST HWY 7 BOREHOLE TYPE Portable Drilling Equipment, Splitspoons, NQ and BQ Coring Equipment COMPILED BY ZP

DATUM Geodetic DATE 5.29.09 - 6.1.09 CHECKED BY

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa: O UNCONFINED, ● QUICK TRIAXIAL, ✖ FIELD VANE, × LAB VANE; 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L; WATER CONTENT (%) 10 20 30	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
216.9										
0.0	Coarse fibrous organic matter, soft, dark brown to black, (PEAT) - with wood and roots		1	SS	2	▽				
216.0			2	SS	9		216			5 58 (37)
0.9	Silty sand (SM), compact, brown, TILL -with occasional cobbles		3	SS	16					2 66 (32)
215.0										
1.8	Sandy silt (ML), compact, brown, TILL - frequent cobbles and boulders - boulder frequency increasing with depth		4	SS	60/ 200mm		215			4 25 (71)
214.3										
2.6	Grey LIMESTONE bedrock with shale partings - very poor to poor quality - slightly weathered - flat orientation (0 - 20°) - very close to close joint spacing - rough planar		5	NQ			214			REC=71 RQD=35
			6	NQ						REC=75 RQD=0
			7	BQ						REC=86 RQD=0
			8	BQ			213			REC=79 RQD=0
			9	BQ			212			REC=95 RQD=20
211.6										
5.3	End of Borehole									

✖³, ×³: Numbers refer to Sensitivity O³% STRAIN AT FAILURE

ONTARIO MTO STANTEC 1047243. HWY 7.GPJ ONTARIO MOT.GDT 10/29/09

Stantec

RECORD OF BOREHOLE No BH09-04 1 OF 1 METRIC

W.P. 67-99-00 LOCATION 11+963 O/S CL 13.8 LT N: 4 921 833 E: 192 741 ORIGINATED BY ZP

DIST HWY 7 BOREHOLE TYPE Portable Drilling Equipment, Splitspoons, Sheby Tubes, BQ Coring Equipment COMPILED BY ZP

DATUM Geodetic DATE 6.3.09 - 6.4.09 CHECKED BY KD

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH kPa (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
213.9											
0.0	Fine fibrous organic matter, soft, dark brown to black, (PEAT)		1	BS	-				44		
			2	ST	-		213				
			3	ST	-						
211.6			4	BS	-		212		50		
2.3	MARL, soft, whitish grey										
211.3											
2.6	Fine fibrous organic matter, soft, dark brown to black, (PEAT)		5	SS	15		211		38		
210.7											
3.2	Silty sand (SM) with gravel, compact, grey, TILL - frequent cobbles and boulders - boulder frequency increasing with depth - mud seem at 5.59 m - 15 mm void at 5.94 m		6	SS	12						
			7	SS	22		210				
209.3			8	SS	100/150mm				o		40 45 (15)
4.6	Grey LIMESTONE bedrock with shale partings - poor quality - slightly weathered - flat orientation (0 - 20°) - very close to close joint spacing - rough planar		9	BQ			209				REC=100 RQD=0
			10	BQ							REC=100 RQD=0
			11	BQ							REC=100 RQD=0
			12	BQ			208				REC=100 RQD=45
			13	BQ							REC=100 RQD=25
			14	BQ			207				
206.0							206				REC=100 RQD=43
8.0	End of Borehole										

$\times^3$, $\times^3$: Numbers refer to Sensitivity $o^{3\%}$ STRAIN AT FAILURE

ONTARIO MTO STANTEC 1047243. HWY 7.GPJ ONTARIO MOT.GDT 10/29/09

Stantec

RECORD OF BOREHOLE No 09-5 1 OF 1 METRIC

W.P. 67-99-00 LOCATION 12+387 O/S CL 13.6 LT N: 4 922 127 E: 193 046 ORIGINATED BY ZP

DIST HWY 7 BOREHOLE TYPE Portable Drilling Equipment, 1/3 Weight Hammer, Splitspoons, BQ Coring Equipment COMPILED BY ZP

DATUM Geodetic DATE 6.1.09 - 6.2.09 CHECKED BY

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE
213.8							
0.0	Amorphous organic matter, soft, brown to black (PEAT)		1	SS	0	▽	
			2	SS	1		213
212.5							
1.2	Fine fibrous organic matter, soft, dark brown to black, (PEAT)		3	SS	3		
			4	SS	2		212
211.5							
2.3	MARL, soft, whitish grey		5	SS	0		
			6	SS	1		211
210.3							
3.5	Silty sand (SM), loose, grey to brown		7	SS	8		
							210
209.5							
4.3	Silty sand (SM), dense, grey to brown, TILL - frequent cobbles and boulders - boulder frequency increasing with depth		8	SS	50/150mm		
			9	BQ			
			10	BQ			209
208.2							
5.5	Grey LIMESTONE bedrock with shale partings - very poor to poor quality - slightly weathered - flat orientation (0 - 20°) - very close joint spacing - rough planar		11	BQ			
			12	BQ			208
			13	BQ			
			14	BQ			
			15	BQ			207
			16	BQ			
			17	BQ			
			18	BQ			
			19	BQ			
206.0							
7.7	End of Borehole						

DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100

SHEAR STRENGTH kPa
O UNCONFINED ● QUICK TRIAXIAL ✖ FIELD VANE × LAB VANE
20 40 60 80 100

PLASTIC LIMIT w_P NATURAL MOISTURE CONTENT w LIQUID LIMIT w_L
WATER CONTENT (%)
10 20 30

UNIT WEIGHT γ kN/m³

211 387 283 261

REMARKS & GRAIN SIZE DISTRIBUTION (%)
GR SA SI CL

0 78 (22)

$✖^{3}$, $×^{3}$: Numbers refer to Sensitivity $O^{3\%}$ STRAIN AT FAILURE

ONTARIO MTO STANTEC 1047243. HWY 7.GPJ ONTARIO MOT.GDT 4/8/10

Stantec

RECORD OF BOREHOLE No 09-6 1 OF 1 METRIC

W.P. 67-99-00 LOCATION 12+387 O/S CL 10.2 RT N: 4 922 112 E: 193 060 ORIGINATED BY ZP

DIST HWY 7 BOREHOLE TYPE Portable Drilling Equipment, Splitspoons, NQ Coring Equipment COMPILED BY ZP

DATUM Geodetic DATE 6.2.09 - 6.3.09 CHECKED BY

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL ✖ FIELD VANE × LAB VANE) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
213.7	610mm WATER										
0.0	610 mm WATER										
213.1							213				
0.6	Coarse fibrous organic matter, soft, dark brown to black, (PEAT) - trace wood		1	SS	1						
			2	SS	0		212				
211.4			3	SS	2				242		
2.3	MARL, soft, whitish grey		4	SS	1/ 450mm		211		251		
210.8											
2.9	Silty sand (SM), loose to compact, brown		5	SS	10				○		0 79 (21)
			6	SS	9		210				
209.4											
4.3	Silty sand (SM) with gravel, dense, brown, TILL		7	SS	33		209				
			8	SS	34				○		21 51 (28)
207.9											
5.8	Grey LIMESTONE bedrock with shale partings - poor to excellent quality - slightly weathered - flat orientation (0 - 20°) - very close to moderate joint spacing - rough planar		9	NQ			208				
			10	NQ							
			11	NQ			207				
			12	NQ							
			13	NQ			206				
204.7							205				
9.0	End of Borehole										

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

ONTARIO MTO STANTEC 1047243. HWY 7.GPJ ONTARIO MOT.GDT 4/8/10

Stantec

RECORD OF BOREHOLE No 09-7 1 OF 1 METRIC

W.P. 67-99-00 LOCATION 12+392 O/S CL 3.2 RT N: 4 922 115 E: 193 055 ORIGINATED BY AB

DIST HWY 7 BOREHOLE TYPE Splitspoons, Hollow Stem Augers, NQ Coring Equipment COMPILED BY ZP

DATUM Geodetic DATE 6.22.09 - 6.22.09 CHECKED BY

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED ● QUICK TRIAXIAL ✖ FIELD VANE × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 10 20 30	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
214.8											
0.0 / 214.6	250 mm ASPHALT										
0.3	Silty sand with gravel, grey, FILL		1	BS	-						
			2	SS	34		214				
			3	SS	12	▽	213		○		34 52 (14)
212.5											
2.3	Fine fibrous organic matter, soft, dark brown to black, (PEAT)		4	SS	4		212			350	
			5	SS	1/ 600mm						
211.3											
3.5	MARL, soft, whitish grey		6	SS	1/ 450mm		211			135	
210.2											
4.6	Silty sand (SM), compact to dense, greyish brown		7	SS	18		210				
			8	SS	31				○		0 84 (16)
208.9							209				
5.9	Silty sand (SM), compact, brown, TILL		9	SS	14						
208.2											
6.6	Grey LIMESTONE bedrock with shale partings - very poor to poor quality - slightly weathered - flat orientation (0 - 20°) - very close to close joint spacing - rough planar		10	NQ			208				
			11	NQ			207				
			12	NQ			206				
204.5							205				
10.3	End of Borehole										

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

ONTARIO MTO STANTEC 1047243. HWY 7.GPJ ONTARIO MOT.GDT 4/14/10

Stantec

RECORD OF BOREHOLE No 09-8 1 OF 1 METRIC

W.P. 67-99-00 LOCATION 12+393 O/S CL 3.2 LT N: 4 922 120 E: 193 051 ORIGINATED BY AB

DIST HWY 7 BOREHOLE TYPE Splitspoons, Hollow Stem Augers, NQ Coring Equipment COMPILED BY ZP

DATUM Geodetic DATE 6.22.09 - 6.22.09 CHECKED BY

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (O UNCONFINED, ● QUICK TRIAXIAL, ✖ FIELD VANE, X LAB VANE)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
214.9											
0.0 / 214.7	230 mm ASPHALT										
0.2	Silty sand with gravel, grey, FILL		1	BS	-						
			2	SS	24	▽	214				
			3	SS	6		213				
212.7											
2.3	Fine fibrous organic matter, soft, dark brown to black, (PEAT)		4	SS	2				97		
			5	SS	1		212		239		
211.5											
3.5	MARL, soft, whitish grey		6	SS	1		211				
210.4											
4.6	Silty sand (SM), very loose to loose, brown		7	SS	1		210				
			8	SS	7				o		2 81 (17)
208.6							209				
6.3	Silty sand (SM), dense, brown, TILL		9	SS	75/ 130mm				o		7 83 (10)
	- frequent cobbles and boulders										
	- boulder frequency increasing with depth		10	SS	75/ 80mm		208				
207.6			11	NQ							
7.3	Grey LIMESTONE bedrock with shale partings		12	NQ							
	- poor quality						207				
	- slightly weathered		13	NQ							
	- flat orientation (0 - 20°)										
	- very close to close joint spacing						206				
	- rough planar		14	NQ							
204.6							205				
10.4	End of Borehole										

✖³, X³: Numbers refer to Sensitivity O³% STRAIN AT FAILURE

ONTARIO MTO STANTEC 1047243. HWY 7.GPJ ONTARIO MOT.GDT 4/8/10

Stantec

RECORD OF BOREHOLE No 09-9 1 OF 1 METRIC

W.P. 67-99-00 LOCATION 11+967 O/S CL 3.2 LT N: 4 921 826 E: 192 746 ORIGINATED BY AB

DIST HWY 7 BOREHOLE TYPE Splitspoons, Hollow Stem Augers, NQ Coring Equipment COMPILED BY ZP

DATUM Geodetic DATE 6.23.09 - 6.23.09 CHECKED BY

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa: O UNCONFINED, ● QUICK TRIAXIAL, × FIELD VANE, × LAB VANE (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
215.1											
0.0 / 214.8	300 mm ASPHALT						215				
0.3	Silty sand with gravel, brown, FILL		1	BS	-						
			2	SS	21	▽	214		o		
			3	SS	6						
212.8							213				
2.3	Fine fibrous organic matter, soft, dark brown, (PEAT)		4	SS	6						
			5	SS	1		212				
211.3											
3.8	Silty sand (SM), very loose, grey		6	SS	3		211				
210.7											
4.4	Silty sand (SM) with gravel, compact to dense, grey, TILL - frequent cobbles and boulders		7	SS	16				o		
			8	SS	93/175mm		210				
209.4											
5.7	Grey LIMESTONE bedrock with shale partings - very poor to good quality - slightly weathered - flat orientation (0 - 20°) - very close to moderate joint spacing - rough planar		9	NQ			209				
			10	NQ			208				
206.4							207				
8.8	End of Borehole										

$\times^3, \times^3$: Numbers refer to Sensitivity $O^{3\%}$ STRAIN AT FAILURE

ONTARIO MTO STANTEC 1047243. HWY 7.GPJ ONTARIO MOT.GDT 4/30/10

Stantec

RECORD OF BOREHOLE No BH09-10 1 OF 1 METRIC

W.P. 67-99-00 LOCATION 10+941 O/S CL 3.2 LT N: 4 921 170 E: 191 967 ORIGINATED BY AB

DIST HWY 7 BOREHOLE TYPE Splitspoons, Hollow Stem Augers, NQ Coring Equipment COMPILED BY ZP

DATUM Geodetic DATE 6.23.09 - 6.23.09 CHECKED BY

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa: O UNCONFINED, ● QUICK TRIAXIAL, ✖ FIELD VANE, × LAB VANE, 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) 10 20 30	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
218.3											
0.0 / 218.1	270 mm ASPHALT										
0.3	Silty sand with gravel, brown, FILL		1	BS	-		218		O		27 56 (17)
			2	SS	31						
							217				
			3	SS	7						
216.1											
2.3	Silty sand (SM) with gravel, compact, brown TILL - frequent cobbles and boulders - boulder frequency increasing with depth		4	SS	23		216		O		20 64 (16)
215.3											
3.0	Grey LIMESTONE bedrock with shale partings - very poor to poor quality - moderate to slightly weathered - flat orientation (0 - 20°) - close to moderate joint spacing - rough planar		5	NQ			215				
							214				
			6	NQ							
			7	NQ			213				REC=100 RQD=0
			8	NQ			212				REC=78 RQD=20
							211				
			9	NQ							REC=100 RQD=67
210.2											
8.1	End of Borehole										

✖³, ×³: Numbers refer to Sensitivity O³% STRAIN AT FAILURE

ONTARIO MTO STANTEC 1047243. HWY 7.GPJ ONTARIO MOT.GDT 10/29/09

Stantec

RECORD OF BOREHOLE No BH09-11 1 OF 1 METRIC

W.P. 67-99-00 LOCATION 27+140 O/s CL 3.2 LT N: 4 920 595 E: 191 203 ORIGINATED BY AB

DIST HWY 7 BOREHOLE TYPE Splitspoons, Hollow Stem Augers, NQ Coring Equipment COMPILED BY ZP

DATUM Geodetic DATE 6.24.09 - 6.24.09 CHECKED BY

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa: O UNCONFINED, ● QUICK TRIAXIAL, ✖ FIELD VANE, × LAB VANE (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
221.3											
0.0 / 221.1	250 mm ASPHALT						221				
0.3	Silty sand with gravel, brown, FILL		1	BS	-						
			2	SS	52						
						▽	220				
			3	SS	8				o		28 56 (16)
219.1											
2.3	Amorphous to fine fibrous organic matter, soft, dark brown, (PEAT)		4	SS	3		219				
218.3											
3.1	Silty gravel (GM) with sand, very dense, grey, TILL - frequent cobbles and boulders between 4.8 m and 5.0 m		5	SS	52		218				
			6	SS	73				o		49 37 (14)
			7	SS	100/100mm		217				
216.5											
4.8	Grey LIMESTONE bedrock with shale partings - very poor to fair quality - slightly weathered - flat orientation (0 - 20°) - very close to close joint spacing - rough planar		8	NQ							
			9	NQ			216				
			10	NQ			215				
			11	NQ			214				
213.4											
8.0	End of Borehole										

✖³, ×³: Numbers refer to Sensitivity O³% STRAIN AT FAILURE

ONTARIO MTO STANTEC 1047243 HWY 7.GPJ ONTARIO MOT.GDT 4/8/10

Stantec

RECORD OF BOREHOLE No BH09-13 1 OF 1 METRIC

W.P. 67-99-00 LOCATION 26+850 O/S CL 3.2 RT N: 4 920 402 E: 190 982 ORIGINATED BY AB

DIST HWY 7 BOREHOLE TYPE Splitspoons, Hollow Stem Augers COMPILED BY ZP

DATUM Geodetic DATE 7.8.09 - 7.8.09 CHECKED BY

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (O UNCONFINED, ● QUICK TRIAXIAL, ✖ FIELD VANE, × LAB VANE) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
221.5											
0.0 / 221.3	270 mm ASPHALT										
0.3	Silty sand with gravel, brown, FILL		1	BS	-		221				
			2	SS	65						
220.2											
1.4	Silty sand (SM), loose, dark brown, TILL -trace organics		3	SS	5	▽	220		o		8 50 (42)
			4	SS	5		219				
218.6											
2.9	Silty sand (SM) with gravel, compact, grey, TILL		5	SS	29		218		o		39 42 (19)
217.7											
3.9	End of Borehole Auger Refusal on Inferred Bedrock		6	SS	100/50mm						

$\times^3$, $\times^3$: Numbers refer to Sensitivity $O^{3\%}$ STRAIN AT FAILURE

ONTARIO MTO STANTEC 1047243. HWY 7.GPJ ONTARIO MOT.GDT 10/29/09

Stantec

RECORD OF BOREHOLE No BH09-14 1 OF 1 METRIC

W.P. 67-99-00 LOCATION 26+900 O/S CL 3.2 LT N: 4 920 439 E: 191 016 ORIGINATED BY AB

DIST HWY 7 BOREHOLE TYPE Splitspoons, Hollow Stem Augers COMPILED BY ZP

DATUM Geodetic DATE 7.8.09 - 7.8.09 CHECKED BY

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (O UNCONFINED, ● QUICK TRIAXIAL, ✖ FIELD VANE, X LAB VANE) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
221.5											
0.0 / 221.2	260 mm ASPHALT										
0.3	Silty sand with gravel, grey, FILL		1	BS	-		221		o		14 64 (22)
220.1			2	SS	46						
1.4	Silty gravel (GM) with sand, loose to dense brown to grey, TILL		3	SS	4	▽	220				
			4	SS	40		219		o		46 37 (17)
			5	SS	100/ 100mm						
217.9							218				
3.6	End of Borehole Auger Refusal on Inferred Bedrock										

$✖^{3}, X^{3}$: Numbers refer to Sensitivity $O^{3\%}$ STRAIN AT FAILURE

ONTARIO MTO STANTEC 1047243. HWY 7.GPJ ONTARIO MOT.GDT 10/29/09

Stantec

RECORD OF BOREHOLE No BH09-16 1 OF 1 METRIC

W.P. 67-99-00 LOCATION 26+950 O/S CL 3.2 RT N: 4 920 466 E: 191 058 ORIGINATED BY AB

DIST HWY 7 BOREHOLE TYPE Splitspoons, Hollow Stem Augers COMPILED BY ZP

DATUM Geodetic DATE 7.8.09 - 7.8.09 CHECKED BY

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa: O UNCONFINED, ● QUICK TRIAXIAL, ✖ FIELD VANE, × LAB VANE (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) 10 20 30	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
221.4											
0.0	300 mm ASPHALT										
221.1											
0.3	Silty sand with gravel, brown to grey, FILL		1	BS	-		221				
			2	SS	34				o		11 49 (40)
							220				
			3	SS	7	▽					
219.3											
2.1	Silty gravel (GM) with sand, compact to dense brown, TILL										
			4	SS	11		219				
			5	SS	23		218		o		51 36 (13)
			6	SS	100/ 80mm						
217.3											
4.1	End of Borehole										
	Auger Refusal on Inferred Bedrock										

✖³, ×³: Numbers refer to Sensitivity O³% STRAIN AT FAILURE

ONTARIO MTO STANTEC 1047243. HWY 7.GPJ ONTARIO MOT.GDT 10/29/09

Stantec

RECORD OF BOREHOLE No BH09-17 1 OF 1 METRIC

W.P. 67-99-00 LOCATION 27+000 O/S CL 3.2 LT N: 4 920 502 E: 191 092 ORIGINATED BY AB

DIST HWY 7 BOREHOLE TYPE Splitspoons, Shelby Tubes, Hollow Stem Augers COMPILED BY ZP

DATUM Geodetic DATE 7.8.09 - 7.8.09 CHECKED BY

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL ✖ FIELD VANE × LAB VANE) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
221.2											
0.0 / 221.0	260 mm ASPHALT										
0.2	Silty sand with gravel, brown to grey, FILL		1	BS	-		221				
			2	SS	27						
							220				
			3	SS	17				○		18 48 (34)
							219				
			4	SS	6				○		6 46 (48)
218.1											
3.1	Dark brown fine fibrous organic matter (PEAT) - Organic Content = 66.4%		5	SS	3		218			267	
			6	ST	-		217			513	9.3
216.5											
4.7	MARL, soft, whitish grey - Organic Content = 10.1%		7	SS	1					162	
			8	SS	1		216				
215.3											
5.9	Silty gravel (GM) with sand, compact to dense grey, TILL		9	SS	19		215				
			10	SS	14		214				
			11	SS	26				○		45 30 (25)
212.7							213				
8.5	End of Borehole Auger Refusal on Inferred Bedrock		12	SS	100/ 80mm						

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

ONTARIO MTO STANTEC 1047243. HWY 7.GPJ ONTARIO MOT.GDT 10/29/09

Stantec

RECORD OF BOREHOLE No BH09-18 1 OF 1 METRIC

W.P. 67-99-00 LOCATION 27+000 O/S CL 12.8 LT N: 4 920 510 E: 191 086 ORIGINATED BY ZP

DIST HWY 7 BOREHOLE TYPE Portable Drilling Equipment, Splitspoons, Shelby Tubes COMPILED BY ZP

DATUM Geodetic DATE 7.14.09 - 7.14.09 CHECKED BY

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa: O UNCONFINED, ● QUICK TRIAXIAL, ✖ FIELD VANE, × LAB VANE (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) 10 20 30	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
220.0	Cattails										
0.0	Dark brown to black fine fibrous organic matter (PEAT)		1	SS	1						
	- Organic Content = 78.7%		2	BS	-		219		536		
			3	ST	-						
			4	SS	1		218				
			5	ST	-		217		695	8.6	
216.7											
3.3	MARL, soft, whitish grey		6	ST	-				221 227		
			7	SS	1		216				
215.6											
4.4	Clayey silty sand (SC-SM), dense, grey, TILL		8	SS	35		215				10 40 (50)
	- occassional cobbles										
214.8											
5.2	Sand (SP-SM) with silt and gravel, dense, grey, TILL		9	SS	34						43 48 (9)
214.2											
5.8	End of Borehole										
	Auger Refusal at 5.8 m										

✖³, ×³: Numbers refer to Sensitivity O³% STRAIN AT FAILURE

ONTARIO MTO STANTEC 1047243. HWY 7.GPJ ONTARIO MOT.GDT 10/29/09

Stantec

RECORD OF BOREHOLE No BH09-19 1 OF 2 METRIC

W.P. 67-99-00 LOCATION 27+050 O/S CL 3.2 RT N: 4 920 530 E: 191 134 ORIGINATED BY AB

DIST HWY 7 BOREHOLE TYPE Splitspoons, Hollow Stem Augers COMPILED BY ZP

DATUM Geodetic DATE 7.8.09 - 7.8.09 CHECKED BY MP

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa: O UNCONFINED, ● QUICK TRIAXIAL, ✖ FIELD VANE, × LAB VANE, 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) 10 20 30	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
221.2											
0.0 / 221.0	260 mm ASPHALT						221				
0.3	Silty sand with gravel, brown to grey, FILL		1	BS	-						
			2	SS	38		220				
219.7											
1.5	Sandy Silt with gravel, brown to grey, FILL		3	SS	14				o		12 42 (46)
219.1							219				
2.1	Fine fibrous organic matter, soft, dark brown to black, (PEAT)		4	SS	3					202	
			5	SS	3		218			213	
217.6											
3.7	Silty sand (SM) with gravel to sandy silt (ML), loose to very dense, grey, TILL		6	SS	23		217				
			7	SS	20						
			8	SS	7		216				
			9	SS	7		215		o		25 44 (31)
			10	SS	6		214				
			11	SS	61						
			12	SS	24		213				
			13	SS	39		212		o		15 43 (42)

Continued Next Page

✖³, ×³: Numbers refer to Sensitivity O 3% STRAIN AT FAILURE

Stantec

RECORD OF BOREHOLE No BH09-19 2 OF 2 METRIC

W.P. 67-99-00 LOCATION 27+050 O/S CL 3.2 RT N: 4 920 530 E: 191 134 ORIGINATED BY AB

DIST HWY 7 BOREHOLE TYPE Splitspoons, Hollow Stem Augers COMPILED BY ZP

DATUM Geodetic DATE 7.8.09 - 7.8.09 CHECKED BY

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL ✖ FIELD VANE × LAB VANE) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES					kN/m³	GR SA SI CL
	Silty sand (SM) with gravel to sandy silt (ML), loose to very dense, grey, TILL *(continued)*		14	SS	48		211				
			15	SS	50				○		3 43 (54)
209.9							210				
11.3	End of Borehole Auger Refusal on Inferred Bedrock										

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

Stantec

RECORD OF BOREHOLE No BH09-20 1 OF 2 METRIC

W.P. 67-99-00 LOCATION 27+098 O/S CL 3.2 LT N: 4 920 566 E: 191 167 ORIGINATED BY AB

DIST HWY 7 BOREHOLE TYPE Splitspoons, Hollow Stem Augers COMPILED BY ZP

DATUM Geodetic DATE 7.8.09 - 7.8.09 CHECKED BY

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100	SHEAR STRENGTH kPa ○ UNCONFINED ● QUICK TRIAXIAL ✖ FIELD VANE × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w_L	WATER CONTENT (%) 10 20 30	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
221.2															
0.0 / 221.0	210 mm ASPHALT						221								
0.2	Silty sand with gravel, brown, FILL		1	BS	-										
			2	SS	39		220								
219.7															
1.5	Silty sand with gravel, brown to grey, FILL		3	SS	21					○					15 48 (37)
			4	SS	10		219								
218.2															
3.0	Fine fibrous organic matter, soft, dark brown to black, (PEAT)		5	SS	3		218						212		
	- Organic Content = 48.0%		6	SS	3		217						225		
216.1			7	SS	2								138		
5.1	MARL, soft, whitish grey						216								
	- trace seashells		8	SS	17								62		
215.6															
5.6	Silty lean clay (CL) with sand, firm, grey, TILL		9	SS	37		215								
			10	SS	7		214				●○	●			3 19 (78)
			11	SS	10										
213.1							213								
8.2	Silty sand (SM) with gravel to sand with gravel, dense to very dense brown, TILL		12	SS	133										
			13	SS	72		212			○					42 46 (12)

Continued Next Page

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

ONTARIO MTO STANTEC 1047243. HWY 7.GPJ ONTARIO MOT.GDT 10/29/09

Stantec

RECORD OF BOREHOLE No BH09-20 2 OF 2 METRIC

W.P. 67-99-00 LOCATION 27+098 O/S CL 3.2 LT N: 4 920 566 E: 191 167 ORIGINATED BY AB

DIST HWY 7 BOREHOLE TYPE Splitspoons, Hollow Stem Augers COMPILED BY ZP

DATUM Geodetic DATE 7.8.09 - 7.8.09 CHECKED BY

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (20 40 60 80 100): O UNCONFINED, ● QUICK TRIAXIAL, ✖ FIELD VANE, × LAB VANE	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	Silty sand (SM) with gravel to sand with gravel, dense to very dense brown, TILL *(continued)*		14	SS	100/ 100mm		211				
			15	SS	50		210				
209.2			16	SS	44				o		24 72 (4)
12.0	End of Borehole Auger Refusal on Inferred Bedrock										

✖³, ×³: Numbers refer to Sensitivity O³% STRAIN AT FAILURE

ONTARIO MTO STANTEC 1047243. HWY 7.GPJ ONTARIO MOT.GDT 10/29/09

Stantec

RECORD OF BOREHOLE No BH09-22 1 OF 1 METRIC

W.P. 67-99-00 LOCATION 27+150 O/S CL 3.2 RT N: 4 920 594 E: 191 211 ORIGINATED BY AB

DIST HWY 7 BOREHOLE TYPE Splitspoons COMPILED BY ZP

DATUM Geodetic DATE 7.9.09 - 7.9.09 CHECKED BY

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa: ○ UNCONFINED ✖ FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) 10 20 30	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						
221.4											
0.0 / 221.1	300 mm ASPHALT										
0.3	Silty sand with gravel, brown, FILL		1	BS	-		221				
			2	SS	44				○		23 48 (29)
			3	SS	100/100mm		220				
219.1											
2.3	Silty sand (SM) with gravel, dense to very dense, grey, TILL		4	SS	22		219				
			5	SS	32				○		30 50 (20)
			6	SS	51		218				
216.8			7	SS	100/80mm		217				
4.7	End of Borehole Auger Refusal on Inferred Bedrock										

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

ONTARIO MTO STANTEC 1047243. HWY 7.GPJ ONTARIO MOT.GDT 10/29/09

Stantec

RECORD OF BOREHOLE No BH09-23 1 OF 1 METRIC

W.P. 67-99-00 LOCATION 10+975 O/S CL 3.2 LT N: 4 921 188 E: 191 993 ORIGINATED BY AB

DIST HWY 7 BOREHOLE TYPE Splitspoons, Shelby Tubes, Hollow Stem Augers COMPILED BY ZP

DATUM Geodetic DATE 7.7.09 - 7.7.09 CHECKED BY

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa: O UNCONFINED, ● QUICK TRIAXIAL, ✖ FIELD VANE, × LAB VANE (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
218.1											
218.0	160 mm ASPHALT										
0.2	Silty sand with gravel, brown, FILL		1	BS	-		218				
			2	SS	35						
							217				
			3	SS	15	▽			o		16 47 (37)
215.9							216				
2.3	Fine fibrous organic matter, soft, dark brown to black, (PEAT)		4	ST	-				283 ●	10.2	
							215				
			5	SS	4						
214.4											
3.8	Silty gravel (GM) with sand, compact to very dense, grey, TILL		6	SS	21		214				
			7	SS	46				o		48 41 (11)
							213				
212.5			8	SS	100/100mm						
5.6	End of Borehole Auger Refusal on Inferred Bedrock										

✖3, ×3: Numbers refer to Sensitivity O3% STRAIN AT FAILURE

ONTARIO MTO STANTEC 1047243. HWY 7.GPJ ONTARIO MOT.GDT 10/29/09

Stantec

RECORD OF BOREHOLE No BH09-25 1 OF 1 METRIC

W.P. 67-99-00 LOCATION 11+025 O/S CL 3.2 RT N: 4 921 215 E: 192 042 ORIGINATED BY AB

DIST HWY 7 BOREHOLE TYPE Splitspoons, Hollow Stem Augers COMPILED BY ZP

DATUM Geodetic DATE 7.7.09 - 7.7.09 CHECKED BY NP

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa: O UNCONFINED, ● QUICK TRIAXIAL, ✖ FIELD VANE, × LAB VANE, 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 10 20 30	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
218.1							218				
218.0	140 mm ASPHALT										
0.1	Silty sand with gravel, brown, FILL		1	BS	-				O		15 63 (22)
			2	SS	47		217				
			3	SS	25	▽	216				
215.2			4	SS	4						
2.9	Silt sand (SM) with gravel, loose, grey, TILL		5	SS	5		215		O		16 36 (48)
214.3											
3.8	Silty gravel (GM) with sand, compact to dense, grey, TILL		6	SS	46		214				
			7	SS	26				O		44 42 (14)
212.8							213				
5.2	End of Borehole Auger Refusal on Inferred Bedrock										

✖3, ×3: Numbers refer to Sensitivity O3% STRAIN AT FAILURE

ONTARIO MTO STANTEC 1047243. HWY 7.GPJ ONTARIO MOT.GDT 10/29/09

Stantec

RECORD OF BOREHOLE No BH09-26 1 OF 1 METRIC

W.P. 67-99-00 LOCATION 11+075 O/S CL 3.2 LT N: 4 921 246 E: 192 075 ORIGINATED BY AB

DIST HWY 7 BOREHOLE TYPE Splitspoons, Shelby Tubes, Hollow Stem Augers COMPILED BY ZP

DATUM Geodetic DATE 7.7.09 - 7.7.09 CHECKED BY

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa: O UNCONFINED, ● QUICK TRIAXIAL, ✖ FIELD VANE, × LAB VANE, 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%) 10 20 30	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
218.0											
217.8	130 mm ASPHALT										
0.1	Silty sand with gravel, brown, FILL		1	BS	-						
			2	SS	43		217				
			3	SS	24	▽	216		o		22 39 (39)
			4	SS	-						
214.9							215				
3.1	Silty sand (SM) with gravel, loose to dense, grey, TILL - trace of organic material		5	SS	8				o		34 40 (26)
			6	SS	32		214				
213.5											
4.5	End of Borehole Auger Refusal on Inferred Bedrock										

✖³, ×³: Numbers refer to Sensitivity O³% STRAIN AT FAILURE

ONTARIO MTO STANTEC 1047243 HWY 7.GPJ ONTARIO MOT.GDT 10/29/09

Stantec

RECORD OF BOREHOLE No BH09-28 1 OF 1 METRIC

W.P. 67-99-00 LOCATION 11+125 O/S CL 3.2 RT N: 4 921 271 E: 192 121 ORIGINATED BY AB

DIST HWY 7 BOREHOLE TYPE Splitspoons, Hollow Stem Augers COMPILED BY ZP

DATUM Geodetic DATE 7.7.09 - 7.7.09 CHECKED BY

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH kPa (O UNCONFINED, ● QUICK TRIAXIAL, ✖ FIELD VANE, × LAB VANE) 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 10 20 30	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
217.9											
0.0 / 217.8	170 mm ASPHALT										
0.2	Silty gravel with sand, brown, FILL - trace organic material		1	BS	-						
			2	SS	60		217				
			3	SS	10		216		●		47 37 (16)
			4	SS	5		215				
214.6											
3.4	Silty sand (SM) with gravel, compact to dense, grey, TILL		5	SS	21						
			6	SS	125/175mm		214		●		25 46 (29)
213.7											
4.3	End of Borehole Auger Refusal on Inferred Bedrock										

✖[3], ×[3]: Numbers refer to Sensitivity O[3%] STRAIN AT FAILURE

ONTARIO MTO STANTEC 1047243. HWY 7.GPJ ONTARIO MOT.GDT 10/29/09

Stantec

RECORD OF BOREHOLE No BH09-29 1 OF 1 METRIC

W.P. 67-99-00 LOCATION 11+175 O/S CL 3.2 LT N: 4 921 306 E: 192 159 ORIGINATED BY AB

DIST HWY 7 BOREHOLE TYPE Splitspoons, Hollow Stem Augers COMPILED BY ZP

DATUM Geodetic DATE 7.7.09 - 7.7.09 CHECKED BY

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100	SHEAR STRENGTH kPa: O UNCONFINED, ● QUICK TRIAXIAL, ✖ FIELD VANE, × LAB VANE; 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L; WATER CONTENT (%) 10 20 30	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
217.7												
219.8	155 mm ASPHALT											
0.2	Silty sand with gravel, brown, FILL		1	BS	-							
			2	SS	30		217					
			3	SS	18		216					
215.6												
2.1	MARL, soft, whitish grey		4	SS	2		215				43	
214.8												
2.9	Silt (ML) with sand, compact, grey											
	- trace seashells		5	SS	23						o	6 14 (80)
214.0							214					
3.7	Silty gravel (GM) with sand, compact, grey, TILL		6	SS	38					o		31 29 (40)
213.4												
4.3	End of Borehole											
	Auger Refusal on Inferred Bedrock											

✖³, ×³: Numbers refer to Sensitivity O³% STRAIN AT FAILURE

ONTARIO MTO STANTEC 1047243 HWY 7.GPJ ONTARIO MOT.GDT 10/29/09

Stantec

RECORD OF BOREHOLE No BH09-31 1 OF 1 METRIC

W.P. 67-99-00 LOCATION 11+225 O/S CL 3.2 RT N: 4 921 329 E: 192 202 ORIGINATED BY AB

DIST HWY 7 BOREHOLE TYPE Splitspoons, Shelby Tubes, Hollow Stem Augers COMPILED BY ZP

DATUM Geodetic DATE 7.7.09 - 7.7.09 CHECKED BY

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa: O UNCONFINED, ● QUICK TRIAXIAL, ✖ FIELD VANE, × LAB VANE, 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) 10 20 30	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
217.9											
0.0 / 217.7	200 mm ASPHALT										
0.2	Silty sand with gravel, brown, FILL		1	BS	-						
			2	SS	61		217		O		23 56 (21)
			3	SS	22		216				
215.6											
2.3 / 215.0	Fine fibrous organic matter, soft, dark brown to black, (PEAT)		4	ST	-		215				
2.9	Silt sand (SM) with gravel, compact to dense, grey, TILL		5	SS	11						
			6	SS	35		214		O		22 28 (50)
213.3											
4.6	End of Borehole Auger Refusal on Inferred Bedrock										

✖³, ×³: Numbers refer to Sensitivity O³% STRAIN AT FAILURE

ONTARIO MTO STANTEC 1047243 HWY 7.GPJ ONTARIO MOT.GDT 10/29/09

Stantec

RECORD OF BOREHOLE No BH09-32 1 OF 1 METRIC

W.P. 67-99-00 LOCATION 11+275 O/S CL 3.2 LT N: 4 921 364 E: 192 240 ORIGINATED BY AB

DIST HWY 7 BOREHOLE TYPE Splitspoons, Hollow Stem Augers COMPILED BY ZP

DATUM Geodetic DATE 7.7.09 - 7.7.09 CHECKED BY

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa: O UNCONFINED, ● QUICK TRIAXIAL, ✖ FIELD VANE, × LAB VANE (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) 10 20 30	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
217.7											
217.6	150 mm ASPHALT										
0.2	Silty sand with gravel, brown, FILL		1	BS	-						
			2	SS	33		217				
			3	SS	15		216				
215.6						▽					
2.1	Silt (ML) with sand, loose, grey		4	SS	3		215				
			5	SS	4				●-O-●		5 15 (80)
214.1							214				
3.7	Silty gravel (GM) with sand, very dense, grey, TILL		6	SS	55				O		43 38 (19)
213.0			7	SS	100/50mm		213				
4.8	End of Borehole										
	Auger Refusal on Inferred Bedrock										

✖3, ×3: Numbers refer to Sensitivity O3% STRAIN AT FAILURE

Stantec

RECORD OF BOREHOLE No BH09-33A 1 OF 1 METRIC

W.P. 67-99-00 LOCATION 11+151 O/S CL 12.1 LT N: 4 921 300 E: 192 134 ORIGINATED BY ZP

DIST HWY 7 BOREHOLE TYPE Portable Drilling Equipment, Splitspoons, Shelby Tubes, BQ Coring Equipment COMPILED BY ZP

DATUM Geodetic DATE 7.13.09 - 7.14.09 CHECKED BY

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH kPa (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
216.3	Cattails										
0.0	Fine fibrous organic matter, soft, dark brown to black, (PEAT)		1	BS	-		216		47%		
215.5											
0.8	MARL, soft, whitish grey		2	SS	-		215				
214.9	- Organic Content = 38.5%										
1.4	Silt sand (SM) with gravel, compact, grey, TILL		3	SS	15						
	- occasional cobbles and boulders		4	SS	16		214				22 28 (50)
	- boulder (limestone)		5	SS	100/ 100 mm						
213.0	- boulder		6	BQ	-						
3.3	End of Borehole		7	BQ	-						

ONTARIO MTO STANTEC 1047243 HWY 7.GPJ ONTARIO MOT.GDT 10/29/09

✖3, ×3: Numbers refer to Sensitivity O3% STRAIN AT FAILURE

Stantec

RECORD OF BOREHOLE No BH09-33B 1 OF 1 METRIC

W.P. 67-99-00 LOCATION 11+151 O/S CL 12.1 LT N: 4 921 300 E: 192 134 ORIGINATED BY ZP

DIST HWY 7 BOREHOLE TYPE Portable Drilling Equipment, Splitspoons, Shelby Tubes, BQ Coring Equipment COMPILED BY ZP

DATUM Geodetic DATE 7.13.09 - 7.14.09 CHECKED BY

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH kPa (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
216.3	Cattails										
0.0	Fine fibrous organic matter, soft, dark brown to black, (PEAT)		1	BS	-		216				
215.5											
0.8	MARL, soft, whitish grey		2	ST	-				244	11.4	
214.9							215				
1.4											

SHEAR STRENGTH kPa: O UNCONFINED ● QUICK TRIAXIAL ✖ FIELD VANE × LAB VANE

✖³, ×³: Numbers refer to Sensitivity O^3% STRAIN AT FAILURE

ONTARIO MTO STANTEC 1047243_HWY 7.GPJ ONTARIO MOT.GDT 10/29/09

Stantec

RECORD OF BOREHOLE No BH09-34 1 OF 1 METRIC

W.P. 67-99-00 LOCATION 11+325 O/S CL 3.2 RT N: 4 921 386 E: 192 283 ORIGINATED BY AB

DIST HWY 7 BOREHOLE TYPE Splitspoons, Hollow Stem Augers COMPILED BY ZP

DATUM Geodetic DATE 7.7.09 - 7.7.09 CHECKED BY VCP

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH kPa (20 40 60 80 100) O UNCONFINED ● QUICK TRIAXIAL ✖ FIELD VANE × LAB VANE	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
217.9											
0.0 / 217.7	230 mm ASPHALT										
0.2	Silty sand with gravel, brown, FILL		1	BS	-						
	- trace orgainic material		2	SS	51	▽	217				
			3	SS	11		216				
215.0			4	SS	3						
2.9	Silt (ML) with sand, loose, grey		5	SS	3		215		o		2 18 (80)
214.2											
3.7	Sandy gravel (GP) with silt, compact, grey, TILL		6	SS	21		214		o		57 30 (13)
213.3											
4.6	End of Borehole										
	Auger Refusal on Inferred Bedrock										

✖³, ×³: Numbers refer to Sensitivity O³% STRAIN AT FAILURE

ONTARIO MTO STANTEC 1047243. HWY 7.GPJ ONTARIO MOT.GDT 10/29/09

Stantec

RECORD OF BOREHOLE No BH09-35 1 OF 1 METRIC

W.P. 67-99-00 LOCATION 11+375 O/S CL 3.2 LT N: 4 921 421 E: 192 318 ORIGINATED BY AB

DIST HWY 7 BOREHOLE TYPE Splitspoons, Hollow Stem Augers COMPILED BY ZP

DATUM Geodetic DATE 7.7.09 - 7.7.09 CHECKED BY

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (20 40 60 80 100): O UNCONFINED, ● QUICK TRIAXIAL, ✖ FIELD VANE, × LAB VANE	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
217.8											
0.0 / 217.6	230 mm ASPHALT										
0.2	Silty sand with gravel, brown to grey, FILL		1	BS	-						
			2	SS	42		217		o		26 49 (25)
			3	SS	8		216				
			4	SS	9		215				
214.7											
3.1	Silt sandy (SM) with gravel, loose to dense, brown, TILL		5	SS	8				o		24 31 (45)
			6	SS	100/ 130mm		214				
213.3											
4.5	End of Borehole Auger Refusal on Inferred Bedrock										

✖[3], ×[3]: Numbers refer to Sensitivity O[3%] STRAIN AT FAILURE

ONTARIO MTO STANTEC 1047243_HWY 7.GPJ ONTARIO MOT.GDT 10/29/09

Stantec

RECORD OF BOREHOLE No BH09-37 1 OF 1 METRIC

W.P. 67-99-00 LOCATION 11+900 O/S CL 3.2 RT N: 4 921 774 E: 192 702 ORIGINATED BY AB

DIST HWY 7 BOREHOLE TYPE Splitspoons, Hollow Stem Augers COMPILED BY ZP

DATUM Geodetic DATE 6.25.09 - 6.25.09 CHECKED BY MK

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (O UNCONFINED, ● QUICK TRIAXIAL, ✖ FIELD VANE, × LAB VANE) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
215.2											
0.0 / 214.9	240 mm ASPHALT						215				
0.2 / 214.3	Silty sand with gravel, brown, FILL		1	BS	-						
214.9	150 mm ASPHALT										
1.0 / 212.1	Silty sand with gravel, brown to grey, FILL		2	SS	79		214				
			3	SS	27				o		28 54 (18)
			4	SS	7		213				
3.1 / 211.5	Fine fibrous organic matter, soft, dark brown to black, (PEAT)		5	SS	3		212			219	
3.7 / 210.7	Silty sand (SM), compact, grey - trace organics		6	SS	11		211				
4.4 / 209.3	Silty gravel (GM) with sand, compact to dense, brown, TILL		7	SS	10		210				
			8	SS	50/ 130mm				o		45 39 (16)
5.9	End of Borehole Auger Refusal on Inferred Bedrock										

✖³, ×³: Numbers refer to Sensitivity O³% STRAIN AT FAILURE

ONTARIO MTO STANTEC 1047243. HWY 7.GPJ ONTARIO MOT.GDT 10/29/09

Stantec

RECORD OF BOREHOLE No BH09-39 1 OF 1 METRIC

W.P. 67-99-00 LOCATION 12+000 O/S CL 3.2 RT N: 4 921 843 E: 192 773 ORIGINATED BY AB

DIST HWY 7 BOREHOLE TYPE Splitspoons, Hollow Stem Augers COMPILED BY ZP

DATUM Geodetic DATE 6.26.09 - 6.26.09 CHECKED BY

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED ● QUICK TRIAXIAL ✖ FIELD VANE × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 10 20 30	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
215.0											
0.0 / 214.8	230 mm ASPHALT										
0.2	Silty sand with gravel, brownish grey, FILL		1	BS	-						
			2	SS	36		214				
			3	SS	24				○		24 49 (27)
212.9							213				
2.1	Dark brown amorphous organic matter (PEAT)		4	SS	5					233	
			5	SS	4		212				
211.4											
3.7	Silty sand (SM), loose, grey										
	- flowing sands encountered		6	SS	5		211		○		1 73 (26)
			7	SS	4						
			8	SS	-		210				
			9	SS	100/80mm		209				
208.7											
6.3	End of Borehole										
	Auger Refusal on Inferred Bedrock										

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

ONTARIO MTO STANTEC 1047243. HWY 7.GPJ ONTARIO MOT.GDT 10/29/09

Stantec

RECORD OF BOREHOLE No BH09-40 1 OF 1 METRIC

W.P. 67-99-00 LOCATION 12+050 O/S CL 3.2 LT N: 4 921 883 E: 192 805 ORIGINATED BY AB

DIST HWY 7 BOREHOLE TYPE Splitspoons, Shelby Tubes, Hollow Stem Augers COMPILED BY ZP

DATUM Geodetic DATE 6.25.09 - 6.25.09 CHECKED BY

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH kPa (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
215.0											
0.0 / 214.7	240 mm ASPHALT										
0.2 / 213.6	Silty sand with gravel, brown, FILL		1	BS	-						
			2	SS	19	▽	214				
1.4 / 212.7	Silty gravel with sand, grey, FILL		3	SS	12		213		o		52 37 (11)
2.3 / 211.3	Fine fibrous organic matter, soft, dark brown to black, (PEAT)		4	ST	-						
			5	SS	7		212				
3.7 / 208.9	Silty sand (SM), loose, grey - flowing sands encountered		6	SS	8		211				
			7	SS	5		210		o		0 89 (11)
			8	SS	-		209				
6.1 / 208.5	Sand (SP) with silt and gravel, dense, grey, TILL		9	SS	100/ 50mm				o		43 48 (9)
6.5	End of Borehole Auger Refusal on Inferred Bedrock										

$\times^3$, $\times^3$: Numbers refer to Sensitivity $o^{3\%}$ STRAIN AT FAILURE

ONTARIO MTO STANTEC 1047243_HWY 7.GPJ ONTARIO MOT.GDT 10/29/09

Stantec

RECORD OF BOREHOLE No BH09-41 1 OF 1 METRIC

W.P. 67-99-00 LOCATION 12+040 O/S CL 12.1 LT N: 4 921 884 E: 192 792 ORIGINATED BY ZP

DIST HWY 7 BOREHOLE TYPE Portable Drilling Equipment: Splitspoons, Shelby Tubes, NQ and BQ Coring Equipment COMPILED BY ZP

DATUM Geodetic DATE 7.13.09 - 7.13.09 CHECKED BY KP

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL ✖ FIELD VANE × LAB VANE) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
213.9	Cattails										
0.0	Fine fibrous organic matter, soft, dark brown to black, (PEAT) - Organic Content = 72.1%		1	SS	1						
			2	BS	-		213		476		
			3	ST	-		212				
211.2			4	ST	-				612	9.3	
2.7	Silty sand (SM), loose to compact, greyish brown		5	SS	9		211				0 78 (22)
			6	SS	17						
							210				
209.5			7	SS	100/130mm						0 77 (23)
4.4	Silty sand (GM), dense, grey, TILL - frequent cobbles and boulders - boulder frequency increasing with depth		8	NQ	-						
208.9			9	BQ	-		209				
5.0	End of Borehole										

ONTARIO MTO STANTEC 1047243_HWY 7.GPJ ONTARIO MOT.GDT 10/29/09

✖3, ×3: Numbers refer to Sensitivity O3%: STRAIN AT FAILURE

Stantec

RECORD OF BOREHOLE No BH09-42 1 OF 1 METRIC

W.P. 67-99-00 LOCATION 12+100 O/S CL 3.2 RT N: 4 921 914 E: 192 846 ORIGINATED BY AB

DIST HWY 7 BOREHOLE TYPE Splitspoons, Hollow Stem Augers COMPILED BY ZP

DATUM Geodetic DATE 6.26.09 - 6.26.09 CHECKED BY KK

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa O UNCONFINED ● QUICK TRIAXIAL ✖ FIELD VANE × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 10 20 30	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
215.0											
0.0 / 214.8	250 mm ASPHALT										
0.3 / 214.3	Silty sand with gravel, brown, FILL		1	BS	-						
0.8	Silty sand with gravel, grey, FILL		2	SS	22		214				
212.9			3	SS	6		213				
2.1	Fine fibrous organic matter, soft, dark brown to black, (PEAT) - Organic Content = 48.3%		4	SS	3				206		
212.0							212				
3.1	Silty sand (SM), compact, brown to grey -trace gravel		5	BS	-						
			6	SS	16		211				
			7	SS	23		210				9 80 (11)
209.7											
5.3	Silty sand (SM), very dense, grey, TILL		8	SS	58						
208.8			9	SS	100/80mm		209				
6.2	End of Borehole Auger Refusal on Inferred Bedrock										

✖³, ×³: Numbers refer to Sensitivity O³% STRAIN AT FAILURE

ONTARIO MTO STANTEC 1047243. HWY 7.GPJ ONTARIO MOT.GDT 10/29/09

Stantec

RECORD OF BOREHOLE No BH09-43 1 OF 1 METRIC

W.P. 67-99-00 LOCATION 12+149 O/S CL 3.2 LT N: 4 921 952 E: 192 877 ORIGINATED BY AB

DIST HWY 7 BOREHOLE TYPE Splitspoons, Hollow Stem Augers COMPILED BY ZP

DATUM Geodetic DATE 6.25.09 - 6.25.09 CHECKED BY

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (O UNCONFINED, ● QUICK TRIAXIAL, ✖ FIELD VANE, × LAB VANE) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
214.9											
0.0 / 214.6	300 mm ASPHALT										
0.3	Silty sand with gravel, brownish grey, FILL		1	BS	-						
			2	SS	19	▽	214		o		16 70 (14)
			3	SS	10		213				
212.3			4	SS	2						
2.6 / 211.7	Fine fibrous organic matter, soft, dark brown to black, (PEAT)						212				
3.2	Silty sand (SM) with gravel compact to dense, grey, TILL		5	SS	24						
			6	SS	21		211		o		37 49 (14)
			7	SS	22		210				
209.2			8	SS	100/130mm						
5.7	End of Borehole Auger Refusal on Inferred Bedrock										

✖³, ×³: Numbers refer to Sensitivity O³% STRAIN AT FAILURE

ONTARIO MTO STANTEC 1047243. HWY 7.GPJ ONTARIO MOT.GDT 10/29/09

Stantec

RECORD OF BOREHOLE No BH09-44 1 OF 1 METRIC

W.P. 67-99-00 LOCATION 12+200 O/S CL 13.8 LT N: 4 921 995 E: 192 905 ORIGINATED BY ZP

DIST HWY 7 BOREHOLE TYPE Splitspoons, Hollow Stem Augers, NQ and BQ Coring Equipment COMPILED BY ZP

DATUM Geodetic DATE 6.25.09 - 6.26.09 CHECKED BY

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa: O UNCONFINED, ● QUICK TRIAXIAL, ✖ FIELD VANE, × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) 10 20 30	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
213.7	Cattails										
0.0	Dark brown to black amorphous organic matter (PEAT)		1	BS	-		213				
			2	SS	1				623		
			3	SS	0		212				
211.6			4	SS	8						
2.1	Silty sand (SM), loose to compact, grey		5	SS	13		211				3 77 (20)
210.6											
3.1	Sand (SP), compact to very dense, brown - trace silt and gravel		6	SS	26		210				
			7	SS	51						2 93 (5)
208.9							209				
4.8	Silty sand (SM) with gravel, dense, brown, TILL -with frequent cobbles and boulders		8	SS	31						
			9	SS	100/ 80mm						
			10	NQ			208				REC=100 RQD=55
207.5			11	NQ							REC=100 RQD=16
6.2	Grey LIMESTONE bedrock with shale partings - poor to fair quality - slightly weathered - flat orientation (0 - 20°) - very close to close joint spacing - rough planar		12	NQ			207				
206.9											
6.8	End of Borehole										

✖³, ×³: Numbers refer to Sensitivity O³% STRAIN AT FAILURE

ONTARIO MTO STANTEC 1047243. HWY 7.GPJ ONTARIO MOT.GDT 10/29/09

Stantec

RECORD OF BOREHOLE No BH09-45 1 OF 1 METRIC

W.P. 67-99-00 LOCATION 12+200 O/S CL 3.2 RT N: 4 921 982 E: 192 917 ORIGINATED BY AB

DIST HWY 7 BOREHOLE TYPE Splitspoons, Shelby Tubes, Hollow Stem Augers COMPILED BY ZP

DATUM Geodetic DATE 6.6.09 - 6.6.09 CHECKED BY

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa: O UNCONFINED, ● QUICK TRIAXIAL, ✖ FIELD VANE, × LAB VANE (20 40 60 80 100)	PLASTIC LIMIT W_P / NATURAL MOISTURE CONTENT W / LIQUID LIMIT W_L — WATER CONTENT (%) 10 20 30	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
214.9											
0.0 / 214.7	270 mm ASPHALT										
0.3 / 214.2	Silty sand with gravel, brown, FILL		1	BS	-						
0.8 / 212.6	Silty sand with gravel, grey, FILL		2	SS	26	▽	214				
			3	SS	7		213				
2.3 / 211.1	Fine fibrous organic matter, soft, dark brown to black, (PEAT)		4	SS	1		212				
			5	ST	-				44	10.0	
3.8 / 209.6	SAND (SP), loose, brown		6	SS	6		211				
			7	SS	6		210		o		10 85 (5)
5.3 / 207.7	Silty sand (SM) with gravel, loose to dense, grey, TILL		8	SS	6		209				
			9	SS	17				o		32 49 (19)
			10	SS	120/200mm		208				
7.2	End of Borehole Auger Refusal on Inferred Bedrock										

✖[3], ×[3]: Numbers refer to Sensitivity O[3%] STRAIN AT FAILURE

ONTARIO MTO STANTEC 1047243 HWY 7.GPJ ONTARIO MOT.GDT 10/29/09

Stantec

RECORD OF BOREHOLE No BH09-46 1 OF 1 METRIC

W.P. 67-99-00 LOCATION 12+249 O/S CL 3.2 LT N: 4 922 022 E: 192 949 ORIGINATED BY AB

DIST HWY 7 BOREHOLE TYPE Splitspoons, Shelby Tubes, Hollow Stem Augers COMPILED BY ZP

DATUM Geodetic DATE 6.25.09 - 6.25.09 CHECKED BY

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH kPa (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
215.0											
0.0 / 214.7	230 mm ASPHALT										
0.2	Silty sand with gravel, brown, FILL		1	BS	-						
			2	SS	19		214				20 62 (18)
213.5											
1.5	Fine fibrous organic matter, soft, dark brown to black, (PEAT)		3	SS	3				208		
			4	ST	-		213				
211.9											
3.1	Silty sand (SM) with gravel, compact to very dense, grey, TILL		5	SS	21		212				
			6	SS	59		211				
			7	SS	61						
			8	SS	30		210				38 48 (14)
			9	SS	45		209				
207.9			10	SS	100/80mm		208				
7.1	End of Borehole Auger Refusal on Inferred Bedrock										

$\times^3$, $\times^3$: Numbers refer to Sensitivity $\circ^{3\%}$ STRAIN AT FAILURE

ONTARIO MTO STANTEC 1047243, HWY 7.GPJ ONTARIO MOT.GDT 10/29/09

Stantec

RECORD OF BOREHOLE No BH09-47 1 OF 1 METRIC

W.P. 67-99-00 LOCATION 12+300 O/S CL 14.0 LT N: 4 922 065 E: 192 978 ORIGINATED BY ZP

DIST HWY 7 BOREHOLE TYPE Portable Drilling Equipment, Splitspoons, NQ and BQ Coring Equipment COMPILED BY ZP

DATUM Geodetic DATE 6.25.09 - 6.25.09 CHECKED BY

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa: O UNCONFINED, ● QUICK TRIAXIAL, ✖ FIELD VANE, × LAB VANE, 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) 10 20 30	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
213.8	Cattails										
0.0	Fine fibrous organic matter, soft, dark brown to black, (PEAT)		1	SS	1						
			2	SS	1		213				
			3	ST	-						
							212				
			4	ST	-						
210.8			5	SS	5		211		607		
3.0	Sand (SP) to silty sand, compact, brown		6	SS	26						0 96 (4)
209.8			7	SS	100/ 0mm		210				2 86 (12)
4.0	Silty sand (SM), compact, brown, TILL - frequent cobbles and boulders - boulder frequency increasing with depth		8	BQ			209				
208.1			9	BQ							REC=100 RQD=0
5.7	Grey LIMESTONE bedrock with shale partings - very poor quality		10	BQ			208				REC=100 RQD=0
207.5											
6.2	End of borehole										

ONTARIO MTO STANTEC 1047243. HWY 7.GPJ ONTARIO MOT.GDT 10/29/09

✖³, ×³: Numbers refer to Sensitivity O³% STRAIN AT FAILURE

Stantec

RECORD OF BOREHOLE No BH09-48 1 OF 1 METRIC

W.P. 67-99-00 LOCATION 12+299 O/S CL 3.2 LT N: 4 922 051 E: 192 989 ORIGINATED BY AB

DIST HWY 7 BOREHOLE TYPE Splitspoons, Hollow Stem Augers COMPILED BY ZP

DATUM Geodetic DATE 7.6.09 - 7.6.09 CHECKED BY

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED ● QUICK TRIAXIAL ✖ FIELD VANE × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 10 20 30	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
214.8											
0.0 / 214.6	200 mm ASPHALT										
0.2	Silty sand with gravel, brown, FILL		1	BS	-						
			2	SS	16						
			3	SS	16						17 53 (30)
212.5											
2.3	Fine fibrous organic matter, soft, dark brown to black, (PEAT)		4	SS	2						
211.4			5	SS	1						
3.4 / 211.1	MARL, soft, whitish grey - trace seashells										
3.7	Sandy silt (ML), loose to compact brown		6	SS	5						
			7	SS	12						0 35 (65)
			8	SS	6						
208.7											
6.1	Silty sand (SM) with gravel, very dense, grey, TILL		9	SS	51						41 44 (15)
207.8			10	SS	100/100mm						
7.0	End of Borehole Auger Refusal on Inferred Bedrock										

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

ONTARIO MTO STANTEC 1047243. HWY 7.GPJ ONTARIO MOT.GDT 10/29/09

Stantec

RECORD OF BOREHOLE No BH09-49 1 OF 1 METRIC

W.P. 67-99-00 LOCATION 12+349 O/S CL 3.2 LT N: 4 922 091 E: 193 021 ORIGINATED BY AB

DIST HWY 7 BOREHOLE TYPE Splitspoons, Hollow Stem Augers COMPILED BY ZP

DATUM Geodetic DATE 6.25.09 - 6.25.09 CHECKED BY

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa: O UNCONFINED, ● QUICK TRIAXIAL, ✖ FIELD VANE, × LAB VANE (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) 10 20 30	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
214.8											
0.0 / 214.5	240 mm ASPHALT										
0.2	Silty sand with gravel, greyish brown, FILL		1	BS	-						
			2	SS	22	▽	214				
			3	SS	18		213				
212.6											
2.1	Dark brown amorphous organic matter (PEAT)		4	SS	3				485		
			5	SS	1		212				
211.2											
3.6	MARL, soft, whitish grey		6	SS	1		211		144		
210.1									152		
4.7	Silty sand (SM), loose to compact, grey		7	SS	5		210				
			8	SS	11		209				
208.5	- Organic Content = 8.6%		9	SS	100/ 130mm				o		0 73 (27)
6.3	Silty sand (SM) with gravel, dense brownish grey, TILL - frequent cobbles and boulders		10	SS	100/ 30mm		208		o		41 42 (17)
207.3											
7.5	End of Borehole Auger Refusal on Inferred Bedrock										

$\times^3, \times^3$: Numbers refer to Sensitivity $O^{3\%}$ STRAIN AT FAILURE

ONTARIO MTO STANTEC 1047243. HWY 7.GPJ ONTARIO MOT.GDT 10/29/09

Stantec

RECORD OF BOREHOLE No BH09-50 1 OF 1 METRIC

W.P. 67-99-00 LOCATION 12+462 O/S CL 3.2 LT N: 4 922 175 E: 193 108 ORIGINATED BY AB

DIST HWY 7 BOREHOLE TYPE Splitspoons, Hollow Stem Augers COMPILED BY ZP

DATUM Geodetic DATE 6.25.09 - 6.25.09 CHECKED BY

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED ● QUICK TRIAXIAL ✖ FIELD VANE × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 10 20 30	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
214.9											
0.0 / 214.7	260 mm ASPHALT										
0.3	Silty sand with gravel, brown, FILL		1	BS	-						
			2	SS	22		214				
			3	SS	45		213		○		38 47 (15)
212.5											
2.4	Fine fibrous organic matter, soft, dark brown to black, (PEAT) - Organic Content = 73.2%		4	SS	2		212			357	
211.7											
3.2	Silty gravel (GM) with sand, compact to dense, brown, TILL		5	SS	100/ 80mm					90	
			6	SS	18		211				
			7	SS	22		210		○		47 39 (14)
			8	SS	100/ 50mm						
209.1											
5.8	End of Borehole Auger Refusal on Inferred Bedrock										

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

ONTARIO MTO STANTEC 1047243. HWY 7.GPJ ONTARIO MOT.GDT 10/29/09

Stantec

RECORD OF BOREHOLE No BH09-51 1 OF 1 METRIC

W.P. 67-99-00 LOCATION 12+500 O/S CL 15.1 LT N: 4 922 209 E: 193 126 ORIGINATED BY ZP

DIST HWY 7 BOREHOLE TYPE Portable Drilling Equipment, Splitspoons, NQ and BQ Coring Equipment COMPILED BY ZP

DATUM Geodetic DATE 6.24.09 - 6.24.09 CHECKED BY

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH kPa (O UNCONFINED, ● QUICK TRIAXIAL, ✖ FIELD VANE, × LAB VANE)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
213.7	Cattails							20 40 60 80 100	10 20 30		
0.0 / 213.1	Dark brown to black amorphous organic matter (PEAT)		1	BS	-		213				
0.6 / 212.0	Fine fibrous organic matter, soft, dark brown to black, (PEAT)		2	BS	-				526		
			3	SS	5		212				
1.7	Silty sand (SM) with gravel, very dense, grey, TILL - frequent cobbles and boulders - boulder frequency increasing with depth		4	SS	53						
			5	SS	64		211				33 57 (10)
			6	BQ							
			7	BQ							
			8	BQ			210				
			9	BQ							
208.9			10	BQ			209				
4.8 / 208.6	Grey LIMESTONE bedrock with shale partings - fair quality		11	BQ							REC=73 RQD=50
5.1	End of Borehole										

✖³, ×³: Numbers refer to Sensitivity O³% STRAIN AT FAILURE

ONTARIO MTO STANTEC 1047243. HWY 7.GPJ ONTARIO MOT.GDT 10/29/09

Stantec

RECORD OF BOREHOLE No BH09-52 1 OF 1 METRIC

W.P. 67-99-00 LOCATION 12+500 O/S CL 3.2 RT N: 4 922 196 E: 193 139 ORIGINATED BY AB

DIST HWY 7 BOREHOLE TYPE Splitspoons, Shelby Tubes, Hollow Stem Augers COMPILED BY ZP

DATUM Geodetic DATE 7.6.09 - 7.6.09 CHECKED BY

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa: O UNCONFINED, ● QUICK TRIAXIAL, ✖ FIELD VANE, × LAB VANE (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) 10 20 30	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
214.9											
0.0 / 214.6	250 mm ASPHALT										
0.3 / 213.1	Silty sand with gravel, greyish brown, FILL		1	BS	-		214				
			2	SS	25						
1.8 / 212.0	Fine fibrous organic matter, soft, dark brown to black, (PEAT)		3	SS	2		213				
			4	ST	-						
2.9 / 210.8	Silty sand (SM), compact, brown		5	SS	17		212				2 54 (44)
			6	SS	56		211				
4.1 / 208.7	Sand silt (ML), with gravel, dense to very dense, light brown, TILL		7	SS	41		210				
			8	SS	68						23 36 (41)
			9	SS	100/80mm		209				
6.2	End of Borehole Auger Refusal on Inferred Bedrock										

✖³, ×³: Numbers refer to Sensitivity O³% STRAIN AT FAILURE

ONTARIO MTO STANTEC 1047243. HWY 7.GPJ ONTARIO MOT.GDT 10/29/09

Stantec

RECORD OF BOREHOLE No BH09-53 1 OF 1 METRIC

W.P. 67-99-00 LOCATION 12+550 O/S CL 3.2 LT N: 4 922 234 E: 193 172 ORIGINATED BY AB

DIST HWY 7 BOREHOLE TYPE Splitspoons, Hollow Stem Augers COMPILED BY ZP

DATUM Geodetic DATE 6.25.09 - 6.25.09 CHECKED BY

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (O UNCONFINED, ● QUICK TRIAXIAL, ✖ FIELD VANE, × LAB VANE) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
215.1											
0.0	440 mm ASPHALT						215				
214.7											
0.4	Silty sand with gravel, brown, FILL		1	BS	-						
			2	SS	18		214		o		9 66 (25)
			3	SS	100/ 80mm						
213.3											
1.8	Sandy silt (ML) with gravel, very soft, dark brown - frequent organic material						213				
			4	SS	3						
211.9							212				
3.3	Silty sand (SM) with gravel, compact to very dense, light brown, TILL		5	SS	39						
			6	SS	29		211				
			7	SS	71				o		40 43 (17)
209.8							210				
5.3	End of Borehole Auger Refusal on Inferred Bedrock										

✖[3], ×[3]: Numbers refer to Sensitivity O[3%] STRAIN AT FAILURE

ONTARIO MTO STANTEC 1047243. HWY 7.GPJ ONTARIO MOT.GDT 10/29/09

Stantec

RECORD OF BOREHOLE No BH09-54 1 OF 1 METRIC

W.P. 67-99-00 LOCATION 12+600 O/S CL 15.5 LT N: 4 922 276 E: 193 206 ORIGINATED BY ZP

DIST HWY 7 BOREHOLE TYPE Portable Drilling Equipment, Splitspoons, NQ and BQ Coring Equipment COMPILED BY ZP

DATUM Geodetic DATE 6.23.09 - 6.24.09 CHECKED BY VP

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (O UNCONFINED, ● QUICK TRIAXIAL, ✖ FIELD VANE, × LAB VANE) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
213.4	Cattails										
0.0	Fine fibrous organic matter, soft, dark brown to black, (PEAT)		1	SS	1		213				
			2	SS	1				386		
211.7			3	SS	0		212		285		
1.7	MARL, soft, whitish grey - with frequent shell fragments		4	SS	16						
211.1							211				
2.3	Gravel (GM) with sand and silt, dense, brown, TILL - frequent cobbles and boulders - boulder frequency increasing with depth		5	SS	100/150mm				o		58 32 (10)
			6	NQ							
			7	NQ			210				
209.4			8	NQ							
4.0	Grey LIMESTONE bedrock with shale partings - very poor quality		9	BQ			209				REC=100 RQD=23
208.7											
4.7	End of Borehole										

✖³, ×³: Numbers refer to Sensitivity O³% STRAIN AT FAILURE

ONTARIO MTO STANTEC 1047243. HWY 7.GPJ ONTARIO MOT.GDT 10/29/09

Stantec

RECORD OF BOREHOLE No BH09-55 1 OF 1 METRIC

W.P. 67-99-00 LOCATION 12+600 O/S CL 3.2 RT N: 4 922 260 E: 193 216 ORIGINATED BY AB

DIST HWY 7 BOREHOLE TYPE Splitspoons, Hollow Stem Augers COMPILED BY ZP

DATUM Geodetic DATE 7.6.09 - 7.6.09 CHECKED BY KP

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (O UNCONFINED, ● QUICK TRIAXIAL, ✖ FIELD VANE, × LAB VANE) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
214.8											
0.0 / 214.6	250 mm ASPHALT										
0.3	Silty sand with gravel, brown, FILL		1	BS	-						
			2	SS	37		214		o		11 73 (16)
213.0			3	SS	100/130mm						
1.8	Silty sand (SM) with gravel, very dense, brown, TILL - frequent cobbles and boulders - boulder frequency increasing with depth		4	SS	54		213		o		23 50 (27)
			5	SS	100/100mm		212				
210.8			6	SS	100/50mm		211				
4.0	End of Borehole Auger Refusal on Inferred Bedrock										

$\times^3$, $\times^3$: Numbers refer to Sensitivity $O^{3\%}$ STRAIN AT FAILURE

ONTARIO MTO STANTEC 1047243. HWY 7.GPJ ONTARIO MOT.GDT 10/29/09

Stantec

RECORD OF BOREHOLE No BH09-56 1 OF 1 METRIC

W.P. 67-99-00 LOCATION 12+649 O/S CL 3.2 LT N: 4 922 292 E: 193 255 ORIGINATED BY AB

DIST HWY 7 BOREHOLE TYPE Splitspoons, Hollow Stem Augers COMPILED BY ZP

DATUM Geodetic DATE 6.24.09 - 6.24.09 CHECKED BY

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED ✖ FIELD VANE ● QUICK TRIAXIAL × LAB VANE) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
215.1											
0.0 / 214.9	220 mm ASPHALT						215				
0.2 / 213.7	Silty sand with gravel, brown, FILL		1	BS	-						
			2	SS	18		214				
1.4 / 212.8	Silty sand with gravel, brown to grey, FILL		3	SS	10		213		○		22 64 (14)
2.3 / 211.0	Silty sand (SM) with gravel, loose to dense, brown, TILL		4	SS	8						
			5	SS	43		212				
			6	SS	100/100mm				○		42 46 (12)
4.1	End of Borehole Auger Refusal on Inferred Bedrock										

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

ONTARIO MTO STANTEC 1047243. HWY 7.GPJ ONTARIO MOT.GDT 10/29/09

Stantec

RECORD OF BOREHOLE No BH09-57 1 OF 1 METRIC

W.P. 67-99-00 LOCATION 12+700 O/S CL 16.2 LT N: 4 922 328 E: 193 294 ORIGINATED BY ZP

DIST HWY 7 BOREHOLE TYPE Portable Drilling Equipment, Splitspoons, NQ Coring Equipment COMPILED BY ZP

DATUM Geodetic DATE 6.23.09 - 6.23.09 CHECKED BY

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH kPa (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
213.2	Cattails										
0.0	Fine fibrous organic matter, soft, dark brown to black, (PEAT)		1	SS	1		213				
212.4											
0.8	Silty sand (SM) with gravel, compact, grey, TILL		2	SS	10						
	-with occasional cobbles						212				
			3	SS	27						
211.3			4	SS	100/50mm						
1.9	Grey LIMESTONE bedrock with shale partings - very poor quality		5	NQ			211				REC=100 RQD=0
210.7											
2.5	End of Borehole										

ONTARIO MTO STANTEC 1047243. HWY 7.GPJ ONTARIO MOT.GDT 10/29/09

✖³, ×³: Numbers refer to Sensitivity O³% STRAIN AT FAILURE

Stantec

RECORD OF BOREHOLE No BH09-58 1 OF 1 METRIC

W.P. 67-99-00 LOCATION 12+700 O/S CL 3.2 RT N: 4 922 309 E: 193 302 ORIGINATED BY AB

DIST HWY 7 BOREHOLE TYPE Splitspoons, Hollow Stem Augers COMPILED BY ZP

DATUM Geodetic DATE 7.6.09 - 7.6.09 CHECKED BY

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa: O UNCONFINED, ● QUICK TRIAXIAL, ✖ FIELD VANE, × LAB VANE (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) 10 20 30	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
214.8											
0.0 / 214.5	290 mm ASPHALT										
0.3	Silty sand with gravel, brown, FILL		1	BS	-		214		o		25 57 (18)
			2	SS	4						
			3	SS	18		213				
			4	SS	14				o		17 34 (49)
211.9							212				
2.9	Silty gravel (GM) with sand, dense, brown, TILL		5	SS	100/ 80mm						
211.4	-with frequent cobbles and boulders										
3.4	End of Borehole										
	Auger Refusal on Inferred Bedrock										

✖3, ×3: Numbers refer to Sensitivity O3% STRAIN AT FAILURE

ONTARIO MTO STANTEC 1047243. HWY 7.GPJ ONTARIO MOT.GDT 10/29/09

Stantec

RECORD OF BOREHOLE No BH09-59 1 OF 1 METRIC

W.P. 67-99-00 LOCATION 12+750 O/S CL 3.2 LT N: 4 922 326 E: 193 322 ORIGINATED BY AB

DIST HWY 7 BOREHOLE TYPE Splitspoons, Hollow Stem Augers COMPILED BY ZP

DATUM Geodetic DATE 6.24.09 - 6.24.09 CHECKED BY

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (O UNCONFINED, ● QUICK TRIAXIAL, ✖ FIELD VANE, × LAB VANE) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
215.2											
0.0 / 215.0	240 mm ASPHALT						215				
0.2	Silty sand with gravel, brown, FILL		1	BS	-						
			2	SS	17	▽	214				
213.1			3	SS	2						
2.1	Silty sand (SM) with gravel, compact to dense, brown, TILL		4	SS	15		213		o		24 42 (34)
			5	SS	46		212				
211.3			6	SS	100/100mm				o		25 45 (30)
3.9	End of Borehole										
	Auger Refusal on Inferred Bedrock										

✖³, ×³: Numbers refer to Sensitivity O³% STRAIN AT FAILURE

ONTARIO MTO STANTEC 1047243. HWY 7.GPJ ONTARIO MOT.GDT 10/29/09

Stantec

RECORD OF BOREHOLE No BH09-60 1 OF 1 METRIC

W.P. 67-99-00 LOCATION 12+800 O/S CL 14.9 LT N: 4 922 362 E: 193 390 ORIGINATED BY ZP

DIST _____ HWY 7 BOREHOLE TYPE Portable Drilling Equipment, Splitspoons, NQ Coring Equipment COMPILED BY ZP

DATUM Geodetic DATE 6.23.09 - 6.23.09 CHECKED BY

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED ● QUICK TRIAXIAL ✖ FIELD VANE × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 10 20 30	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
213.1	Tall grass						213				
0.0 / 212.7	Fine fibrous organic matter, soft, dark brown to black, (PEAT)		1	SS	2						
0.4	Silty SAND (SM), compact to dense, brown		2	SS	15	▽	212		○		2 69 (29)
			3	SS	13						
210.9			4	SS	100/ 50mm		211		○		0 69 (31)
2.2 / 210.1	Grey LIMESTONE bedrock with shale partings - very poor quality		5	NQ							REC=100 RQD=0
2.9	End of Borehole										

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

ONTARIO MTO STANTEC 1047243. HWY 7.GPJ ONTARIO MOT.GDT 10/29/09

Stantec

RECORD OF BOREHOLE No BH09-61 1 OF 1 METRIC

W.P. 67-99-00 LOCATION 12+800 O/S CL 3.2 RT N: 4 922 345 E: 193 395 ORIGINATED BY AB

DIST HWY 7 BOREHOLE TYPE Splitspoons, Hollow Stem Augers COMPILED BY ZP

DATUM Geodetic DATE 7.6.09 - 7.6.09 CHECKED BY

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa: O UNCONFINED, ● QUICK TRIAXIAL, ✖ FIELD VANE, × LAB VANE, 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) 10 20 30	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
214.8											
0.0 / 214.5	250 mm ASPHALT										
0.3	Silty sand with gravel, brown, FILL - trace organic material		1	BS	-		214				
			2	SS	12				o		
			3	SS	10		213				
212.5											
2.3	Silty sand (SM) with gravel, compact brown to grey, TILL		4	SS	17		212		o		22 43 (35)
			5	SS	21						
211.0											
3.8	End of Borehole Auger Refusal on Inferred Bedrock										

$✖^{3}$, $×^{3}$: Numbers refer to Sensitivity $O^{3\%}$ STRAIN AT FAILURE

Field Core Log

Stantec

Client: AECOM Canada Ltd.
Project: Highway 7 - Norwood to Havelock, W.P. 67-99-00
Contractor: George Downing Estate Drilling Ltd. - (CME75)

Project No.: 122410158
Date: June 5, 2009
Borehole No.: 09-1
Logger: Kenton C. Power

DEPTH FROM	RUN NO.	% CORE RECOVERY	% RQD	DEPTH TO	GENERAL DESCRIPTION (Rock Type/s, %, Colour, Texture, etc.)	STRENGTH	WEATHERING	DISCONTINUITIES							OCCASIONAL FEATURES	DRILLING OBSERVATIONS
								NO. OF SETS	TYPE/S	ORIENTATION	SPACING	ROUGHNESS	APERTURE	FILLING		
3.08	6 and 7	-	-	3.69	Boulders											
3.69	8	100	33	4.45	Grey LIMESTONE bedrock with shale partings	VS	S		B	F	VC/C	RP		T		
4.45	9	98	41	4.98	Grey LIMESTONE bedrock with shale partings	VS	U		B	F	C	RP		T		
4.98	10	95	21	4.54	Grey LIMESTONE bedrock with shale partings	VS	U		B	F	C	RP		T		

STRENGTH (MPa)
EH = Extremely Strong = > 250
VS = Very Strong = 100-250
S = Strong = 50-100
MS = Medium Strong = 25-50
W = Weak = 5 - 25
VW = Very Weak = 1-5
EW = Extremely Weak = < 1

WEATHERING
U = Unweathered = No Signs
S = Slightly = Oxidized
M = Moderately = Discoloured
H = Highly = Friable
C = Completely = Soil-like

DISCONTINUITY TYPE
B = Bedding Joint
J = Cross Joint
F = Fault
S = Shear Plane

SPACING
VW = Very Wide = >3m
W = Wide = 1-3 m
M = Moderate = 0.3-1 m
C = Close = 5-30 cm
VC = Very Close = <5 cm

ORIENTATION
F = Flat = 0-20^0
D = Dipping = 20-50^0
V = n-Vertical = >50^0

ROUGHNESS
RU = Rough Undulating
RP = Rough Planar
SU = Smooth Undulating
SP = Smooth Planar
LU = Slickensided Undulating
LP = Slickensided Planar

FILLING
T = Tight, Hard
O = Oxidized
SA = Slightly Altered, Clay Free
S = Sandy, Clay Free
Si = Sandy, Silty, Minor Clay
NC = Non-softening Clay
SC = Swelling, Soft Clay

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Field Core Log

Stantec

Client: AECOM Canada Ltd.
Project: Highway 7 - Norwood to Havelock, W.P. 67-99-00
Contractor: George Downing Estate Drilling Ltd. - (CME75)

Project No.: 122410158
Date: June 5, 2009
Borehole No.: 09-1
Logger: Kenton C. Power

DEPTH FROM	RUN NO.	% CORE RECOVERY	% RQD	DEPTH TO	GENERAL DESCRIPTION (Rock Type/s, %, Colour, Texture, etc.)	STRENGTH	WEATHERING	DISCONTINUITIES							OCCASIONAL FEATURES	DRILLING OBSERVATIONS
								NO. OF SETS	TYPE/S	ORIENTATION	SPACING	ROUGHNESS	APERTURE	FILLING		
5.54	11	99	61	6.43	Grey LIMESTONE bedrock with shale partings	VS	U		B	F	C	RP		T		

STRENGTH (MPa)
EH = Extremely Strong = > 250
VS = Very Strong = 100-250
S = Strong = 50-100
MS = Medium Strong = 25-50
W = Weak = 5 - 25
VW = Very Weak = 1-5
EW = Extremely Weak = < 1

WEATHERING
U = Unweathered = No Signs
S = Slightly = Oxidized
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H = Highly = Friable
C = Completely = Soil-like

DISCONTINUITY TYPE
B = Bedding Joint
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F = Fault
S = Shear Plane

SPACING
VW = Very Wide = >3m
W = Wide = 1-3 m
M = Moderate = 0.3-1 m
C = Close = 5-30 cm
VC = Very Close = <5 cm

ORIENTATION
F = Flat = 0-20^0
D = Dipping = 20-50^0
V = n-Vertical = >50^0

ROUGHNESS
RU = Rough Undulating
RP = Rough Planar
SU = Smooth Undulating
SP = Smooth Planar
LU = Slickensided Undulating
LP = Slickensided Planar

FILLING
T = Tight, Hard
O = Oxidized
SA = Slightly Altered, Clay Free
S = Sandy, Clay Free
Si = Sandy, Silty, Minor Clay
NC = Non-softening Clay
SC = Swelling, Soft Clay

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Field Core Log

Stantec

Client: AECOM Canada Ltd.
Project: Highway 7 - Norwood to Havelock, W.P. 67-99-00
Contractor: OGS Drilling Inc. (portable drilling equipment)

Project No.: 122410158
Date: June 5, 2009
Borehole No.: 09-2
Logger: Kenton C. Power

DEPTH FROM	RUN NO.	% CORE RECOVERY	% RQD	DEPTH TO	GENERAL DESCRIPTION (Rock Type/s, %, Colour, Texture, etc.)	STRENGTH	WEATHERING	DISCONTINUITIES							OCCASIONAL FEATURES	DRILLING OBSERVATIONS
								NO. OF SETS	TYPE/S	ORIENTATION	SPACING	ROUGHNESS	APERTURE	FILLING		
1.37	4	33	21	1.83	Grey LIMESTONE bedrock with shale partings	S	S		B	F	VC	PR		T		
1.83	5 and 6	33 and 58	0 and 0	2.13	Grey LIMESTONE bedrock with shale partings	S	S		B	F	VC	PR		T		
2.44	7 and 8	88 and 64	28 and 28	3.13	Grey LIMESTONE bedrock with shale partings	S	S		B	F	VC	PR		T		
3.13	9 and 10	81 and 30	0 and 0	4.04	Grey LIMESTONE bedrock with shale partings	S	S		B	F	VC	PR		T		

STRENGTH (MPa)

EH = Extremely Strong = > 250
VS = Very Strong = 100-250
S = Strong = 50-100
MS = Medium Strong = 25-50
W = Weak = 5 - 25
VW = Very Weak = 1-5
EW = Extremely Weak = < 1

WEATHERING

U = Unweathered = No Signs
S = Slightly = Oxidized
M = Moderately = Discoloured
H = Highly = Friable
C = Completely = Soil-like

DISCONTINUITY TYPE

B = Bedding Joint
J = Cross Joint
F = Fault
S = Shear Plane

SPACING

VW = Very Wide = >3m
W = Wide = 1-3 m
M = Moderate = 0.3-1 m
C = Close = 5-30 cm
VC = Very Close = <5 cm

ORIENTATION

F = Flat = 0-20^0
D = Dipping = 20-50^0
V = n-Vertical = >50^0

ROUGHNESS

RU = Rough Undulating
RP = Rough Planar
SU = Smooth Undulating
SP = Smooth Planar
LU = Slickensided Undulating
LP = Slickensided Planar

FILLING

T = Tight, Hard
O = Oxidized
SA = Slightly Altered, Clay Free
S = Sandy, Clay Free
Si = Sandy, Silty, Minor Clay
NC = Non-softening Clay
SC = Swelling, Soft Clay

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Field Core Log

Stantec

Client: AECOM Canada Ltd.
Project: Highway 7 - Norwood to Havelock, W.P. 67-99-00
Contractor: OGS Drilling Inc. (portable drilling equipment)

Project No.: 122410158
Date: June 5, 2009
Borehole No.: 09-2
Logger: Kenton C. Power

DEPTH FROM	RUN NO.	% CORE RECOVERY	% RQD	DEPTH TO	GENERAL DESCRIPTION (Rock Type/s, %, Colour, Texture, etc.)	STRENGTH	WEATHERING	DISCONTINUITIES							OCCASIONAL FEATURES	DRILLING OBSERVATIONS
								NO. OF SETS	TYPE/S	ORIENTATION	SPACING	ROUGHNESS	APERTURE	FILLING		
4.04	11	22	0	4.42	Grey LIMESTONE bedrock with shale partings	RENG	S		B	F	VC	PR		T		

STRENGTH (MPa)
EH = Extremely Strong = > 250
VS = Very Strong = 100-250
S = Strong = 50-100
MS = Medium Strong = 25-50
W = Weak = 5 - 25
VW = Very Weak = 1-5
EW = Extremely Weak = < 1

WEATHERING
U = Unweathered = No Signs
S = Slightly = Oxidized
M = Moderately = Discoloured
H = Highly = Friable
C = Completely = Soil-like

DISCONTINUITY TYPE
B = Bedding Joint
J = Cross Joint
F = Fault
S = Shear Plane

SPACING
VW = Very Wide = >3m
W = Wide = 1-3 m
M = Moderate = 0.3-1 m
C = Close = 5-30 cm
VC = Very Close = <5 cm

ORIENTATION
F = Flat = 0-20^0
D = Dipping = 20-50^0
V = n-Vertical = >50^0

ROUGHNESS
RU = Rough Undulating
RP = Rough Planar
SU = Smooth Undulating
SP = Smooth Planar
LU = Slickensided Undulating
LP = Slickensided Planar

FILLING
T = Tight, Hard
O = Oxidized
SA = Slightly Altered, Clay Free
S = Sandy, Clay Free
Si = Sandy, Silty, Minor Clay
NC = Non-softening Clay
SC = Swelling, Soft Clay

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Field Core Log

Stantec

Client: AECOM Canada Ltd.
Project: Highway 7 - Norwood to Havelock, W.P. 67-99-00
Contractor: OGS Drilling Inc.

Project No.: 122410158
Date: June 5, 2009
Borehole No.: 09-3
Logger: Kenton C. Power

DEPTH FROM	RUN NO.	% CORE RECOVERY	% RQD	DEPTH TO	GENERAL DESCRIPTION (Rock Type/s, %, Colour, Texture, etc.)	STRENGTH	WEATHERING	DISCONTINUITIES							OCCASIONAL FEATURES	DRILLING OBSERVATIONS
								NO. OF SETS	TYPE/S	ORIENTATION	SPACING	ROUGHNESS	APERTURE	FILLING		
2.59	5	71	35	3.2	Grey LIMESTONE bedrock with shale partings	VS	S		B	F	VC	RP		T		
3.2	6	75	0	3.4	Grey LIMESTONE bedrock with shale partings	VS	S		B	F	VC	RP		T		
3.4	7	86	0	3.76	Grey LIMESTONE bedrock with shale partings	VS	U		B	F	VC	RP		T		
3.76	8	79	0	4.16	Grey LIMESTONE bedrock with shale partings	VS	U		B	F	C	RP		T		

STRENGTH (MPa)

EH = Extremely Strong = > 250
VS = Very Strong = 100-250
S = Strong = 50-100
MS = Medium Strong = 25-50
W = Weak = 5 - 25
VW = Very Weak = 1-5
EW = Extremely Weak = < 1

WEATHERING

U = Unweathered = No Signs
S = Slightly = Oxidized
M = Moderately = Discoloured
H = Highly = Friable
C = Completely = Soil-like

DISCONTINUITY TYPE

B = Bedding Joint
J = Cross Joint
F = Fault
S = Shear Plane

SPACING

VW = Very Wide = >3m
W = Wide = 1-3 m
M = Moderate = 0.3-1 m
C = Close = 5-30 cm
VC = Very Close = <5 cm

ORIENTATION

F = Flat = 0-20^0
D = Dipping = 20-50^0
V = n-Vertical = >50^0

ROUGHNESS

RU = Rough Undulating
RP = Rough Planar
SU = Smooth Undulating
SP = Smooth Planar
LU = Slickensided Undulating
LP = Slickensided Planar

FILLING

T = Tight, Hard
O = Oxidized
SA = Slightly Altered, Clay Free
S = Sandy, Clay Free
Si = Sandy, Silty, Minor Clay
NC = Non-softening Clay
SC = Swelling, Soft Clay

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Field Core Log

Stantec

Client: AECOM Canada Ltd.
Project: Highway 7 - Norwood to Havelock, W.P. 67-99-00
Contractor: OGS Drilling Inc.

Project No.: 122410158
Date: June 5, 2009
Borehole No.: 09-3
Logger: Kenton C. Power

DEPTH FROM	RUN NO.	% CORE RECOVERY	% RQD	DEPTH TO	GENERAL DESCRIPTION (Rock Type/s, %, Colour, Texture, etc.)	STRENGTH	WEATHERING	DISCONTINUITIES							OCCASIONAL FEATURES	DRILLING OBSERVATIONS
								NO. OF SETS	TYPE/S	ORIENTATION	SPACING	ROUGHNESS	APERTURE	FILLING		
4.16	9	95	21	5.26	Grey LIMESTONE bedrock with shale partings	VS	U		B	F	C	RP		T		

STRENGTH (MPa)
EH = Extremely Strong = > 250
VS = Very Strong = 100-250
S = Strong = 50-100
MS = Medium Strong = 25-50
W = Weak = 5 - 25
VW = Very Weak = 1-5
EW = Extremely Weak = < 1

WEATHERING
U = Unweathered = No Signs
S = Slightly = Oxidized
M = Moderately = Discoloured
H = Highly = Friable
C = Completely = Soil-like

DISCONTINUITY TYPE
B = Bedding Joint
J = Cross Joint
F = Fault
S = Shear Plane

SPACING
VW = Very Wide = >3m
W = Wide = 1-3 m
M = Moderate = 0.3-1 m
C = Close = 5-30 cm
VC = Very Close = <5 cm

ORIENTATION
F = Flat = 0-20^0
D = Dipping = 20-50^0
V = n-Vertical = >50^0

ROUGHNESS
RU = Rough Undulating
RP = Rough Planar
SU = Smooth Undulating
SP = Smooth Planar
LU = Slickensided Undulating
LP = Slickensided Planar

FILLING
T = Tight, Hard
O = Oxidized
SA = Slightly Altered, Clay Free
S = Sandy, Clay Free
Si = Sandy, Silty, Minor Clay
NC = Non-softening Clay
SC = Swelling, Soft Clay

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Field Core Log

Stantec

Client: AECOM Canada Ltd.
Project: Highway 7 - Norwood to Havelock, W.P. 67-99-00
Contractor: OGS Drilling Inc.

Project No.: 122410158
Date: June 5, 2009
Borehole No.: 09-4
Logger: Kenton C. Power

DEPTH FROM	RUN NO.	% CORE RECOVERY	% RQD	DEPTH TO	GENERAL DESCRIPTION (Rock Type/s, %, Colour, Texture, etc.)	STRENGTH	WEATHERING	DISCONTINUITIES							OCCASIONAL FEATURES	DRILLING OBSERVATIONS
								NO. OF SETS	TYPE/S	ORIENTATION	SPACING	ROUGHNESS	APERTURE	FILLING		
4.62	9 and 10	100 and 100	0 and 0	5.59	Grey LIMESTONE bedrock with shale partings	VS	S		B	F	VC/C	RP		T		
5.59	11 and 12	100 and 100	100 and 45	6.04	Grey LIMESTONE bedrock with shale partings	VS	S		B	F	VC/C	RP		T		
6.04	13	100	25	7.37	Grey LIMESTONE bedrock with shale partings	VS	S		B	F	VC/C	RP		T		
7.37	14	100	43	7.97	Grey LIMESTONE bedrock with shale partings	VS	U		B	F	C	RP		T		

STRENGTH (MPa)
EH = Extremely Strong = > 250
VS = Very Strong = 100-250
S = Strong = 50-100
MS = Medium Strong = 25-50
W = Weak = 5 - 25
VW = Very Weak = 1-5
EW = Extremely Weak = < 1

WEATHERING
U = Unweathered = No Signs
S = Slightly = Oxidized
M = Moderately = Discoloured
H = Highly = Friable
C = Completely = Soil-like

DISCONTINUITY TYPE
B = Bedding Joint
J = Cross Joint
F = Fault
S = Shear Plane

SPACING
VW = Very Wide = >3m
W = Wide = 1-3 m
M = Moderate = 0.3-1 m
C = Close = 5-30 cm
VC = Very Close = <5 cm

ORIENTATION
F = Flat = 0-20^0
D = Dipping = 20-50^0
V = n-Vertical = >50^0

ROUGHNESS
RU = Rough Undulating
RP = Rough Planar
SU = Smooth Undulating
SP = Smooth Planar
LU = Slickensided Undulating
LP = Slickensided Planar

FILLING
T = Tight, Hard
O = Oxidized
SA = Slightly Altered, Clay Free
S = Sandy, Clay Free
Si = Sandy, Silty, Minor Clay
NC = Non-softening Clay
SC = Swelling, Soft Clay

Field Core Log

Stantec

Client: AECOM Canada Ltd.
Project: Highway 7 - Norwood to Havelock, W.P. 67-99-00
Contractor: OGS Drilling Inc.

Project No.: 122410158
Date: June 5, 2009
Borehole No.: 09-5
Logger: Kenton C. Power

DEPTH FROM	RUN NO.	% CORE RECOVERY	% RQD	DEPTH TO	GENERAL DESCRIPTION (Rock Type/s, %, Colour, Texture, etc.)	STRENGTH	WEATHERING	DISCONTINUITIES							OCCASIONAL FEATURES	DRILLING OBSERVATIONS
								NO. OF SETS	TYPE/S	ORIENTATION	SPACING	ROUGHNESS	APERTURE	FILLING		
5.54	11	100	47	5.94	Grey LIMESTONE bedrock with shale partings	VS	S		B	F	C	RP		T		
5.94	12 and 13	54 and 60	0	6.38	Grey LIMESTONE bedrock with shale partings	VS	S		B	F	VC	RP		T		
6.38	14 and 15	20 and 100	0	6.94	Grey LIMESTONE bedrock with shale partings	VS	U		B	F	VC	RP		T		
6.94	16 and 17	50 and 75	0	7.19	Grey LIMESTONE bedrock with shale partings	VS	U		B	F	VC	RP		T		

STRENGTH (MPa)
EH = Extremely Strong = > 250
VS = Very Strong = 100-250
S = Strong = 50-100
MS = Medium Strong = 25-50
W = Weak = 5 - 25
VW = Very Weak = 1-5
EW = Extremely Weak = < 1

WEATHERING
U = Unweathered = No Signs
S = Slightly = Oxidized
M = Moderately = Discoloured
H = Highly = Friable
C = Completely = Soil-like

DISCONTINUITY TYPE
B = Bedding Joint
J = Cross Joint
F = Fault
S = Shear Plane

SPACING
VW = Very Wide = >3m
W = Wide = 1-3 m
M = Moderate = 0.3-1 m
C = Close = 5-30 cm
VC = Very Close = <5 cm

ORIENTATION
F = Flat = 0-20^0
D = Dipping = 20-50^0
V = n-Vertical = >50^0

ROUGHNESS
RU = Rough Undulating
RP = Rough Planar
SU = Smooth Undulating
SP = Smooth Planar
LU = Slickensided Undulating
LP = Slickensided Planar

FILLING
T = Tight, Hard
O = Oxidized
SA = Slightly Altered, Clay Free
S = Sandy, Clay Free
Si = Sandy, Silty, Minor Clay
NC = Non-softening Clay
SC = Swelling, Soft Clay

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Field Core Log

Stantec

Client: AECOM Canada Ltd.
Project: Highway 7 - Norwood to Havelock, W.P. 67-99-00
Contractor: OGS Drilling Inc.

Project No.: 122410158
Date: June 5, 2009
Borehole No.: 09-5
Logger: Kenton C. Power

DEPTH FROM	RUN NO.	% CORE RECOVERY	% RQD	DEPTH TO	GENERAL DESCRIPTION (Rock Type/s, %, Colour, Texture, etc.)	STRENGTH	WEATHERING	DISCONTINUITIES							OCCASIONAL FEATURES	DRILLING OBSERVATIONS
								NO. OF SETS	TYPE/S	ORIENTATION	SPACING	ROUGHNESS	APERTURE	FILLING		
7.19	18	50	0	7.35	Grey LIMESTONE bedrock with shale partings	VS	U		B	F	VC/C	RP		T		
7.35	19	100	27	7.75	Grey LIMESTONE bedrock with shale partings	VS	U		B	F	C	RP		T		

STRENGTH (MPa)
EH = Extremely Strong = > 250
VS = Very Strong = 100-250
S = Strong = 50-100
MS = Medium Strong = 25-50
W = Weak = 5 - 25
VW = Very Weak = 1-5
EW = Extremely Weak = < 1

WEATHERING
U = Unweathered = No Signs
S = Slightly = Oxidized
M = Moderately = Discoloured
H = Highly = Friable
C = Completely = Soil-like

DISCONTINUITY TYPE
B = Bedding Joint
J = Cross Joint
F = Fault
S = Shear Plane

SPACING
VW = Very Wide = >3m
W = Wide = 1-3 m
M = Moderate = 0.3-1 m
C = Close = 5-30 cm
VC = Very Close = <5 cm

ORIENTATION
F = Flat = 0-20^0
D = Dipping = 20-50^0
V = n-Vertical = >50^0

ROUGHNESS
RU = Rough Undulating
RP = Rough Planar
SU = Smooth Undulating
SP = Smooth Planar
LU = Slickensided Undulating
LP = Slickensided Planar

FILLING
T = Tight, Hard
O = Oxidized
SA = Slightly Altered, Clay Free
S = Sandy, Clay Free
Si = Sandy, Silty, Minor Clay
NC = Non-softening Clay
SC = Swelling, Soft Clay

P:\2009\122410158 - 1047243- Hwy 7 Havelock\Foundation\Bedrock Cores\1047243 Bedrock Core Logs.xlsx

Field Core Log

Stantec

Client: AECOM Canada Ltd.
Project: Highway 7 - Norwood to Havelock, W.P. 67-99-00
Contractor: OGS Drilling Inc.

Project No.: 122410158
Date: June 5, 2009
Borehole No.: 09-6
Logger: Kenton C. Power

DEPTH FROM	RUN NO.	% CORE RECOVERY	% RQD	DEPTH TO	GENERAL DESCRIPTION (Rock Type/s, %, Colour, Texture, etc.)	STRENGTH	WEATHERING	DISCONTINUITIES							OCCASIONAL FEATURES	DRILLING OBSERVATIONS
								NO. OF SETS	TYPE/S	ORIENTATION	SPACING	ROUGHNESS	APERTURE	FILLING		
5.77	9	67	100	5.92	Grey LIMESTONE bedrock with shale partings	VS	S		B	F	VC/C	RP		T		
5.92	10	96	48	6.53	Grey LIMESTONE bedrock with shale partings	VS	U		B	F	C	RP		T		
6.53	11	96	43	7.14	Grey LIMESTONE bedrock with shale partings	VS	S		B	F	VC/C	RP		T		
7.14	12	92	54	7.8	Grey LIMESTONE bedrock with shale partings	VS	U		B	F	C	RP		T		

STRENGTH (MPa)
EH = Extremely Strong = > 250
VS = Very Strong = 100-250
S = Strong = 50-100
MS = Medium Strong = 25-50
W = Weak = 5 - 25
VW = Very Weak = 1-5
EW = Extremely Weak = < 1

WEATHERING
U = Unweathered = No Signs
S = Slightly = Oxidized
M = Moderately = Discoloured
H = Highly = Friable
C = Completely = Soil-like

DISCONTINUITY TYPE
B = Bedding Joint
J = Cross Joint
F = Fault
S = Shear Plane

SPACING
VW = Very Wide = >3m
W = Wide = 1-3 m
M = Moderate = 0.3-1 m
C = Close = 5-30 cm
VC = Very Close = <5 cm

ORIENTATION
F = Flat = 0-20^0
D = Dipping = 20-50^0
V = n-Vertical = >50^0

ROUGHNESS
RU = Rough Undulating
RP = Rough Planar
SU = Smooth Undulating
SP = Smooth Planar
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FILLING
T = Tight, Hard
O = Oxidized
SA = Slightly Altered, Clay Free
S = Sandy, Clay Free
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NC = Non-softening Clay
SC = Swelling, Soft Clay

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Field Core Log

Stantec

Client: AECOM Canada Ltd.
Project: Highway 7 - Norwood to Havelock, W.P. 67-99-00
Contractor: OGS Drilling Inc.

Project No.: 122410158
Date: June 5, 2009
Borehole No.: 09-6
Logger: Kenton C. Power

DEPTH FROM	RUN NO.	% CORE RECOVERY	% RQD	DEPTH TO	GENERAL DESCRIPTION (Rock Type/s, %, Colour, Texture, etc.)	STRENGTH	WEATHERING	DISCONTINUITIES							OCCASIONAL FEATURES	DRILLING OBSERVATIONS
								NO. OF SETS	TYPE/S	ORIENTATION	SPACING	ROUGHNESS	APERTURE	FILLING		
7.8	13	94	86	8.99	Grey LIMESTONE bedrock with shale partings	VS	S		B	F	VC/C	RP		T		

STRENGTH (MPa)
EH = Extremely Strong = > 250
VS = Very Strong = 100-250
S = Strong = 50-100
MS = Medium Strong = 25-50
W = Weak = 5 - 25
VW = Very Weak = 1-5
EW = Extremely Weak = < 1

WEATHERING
U = Unweathered = No Signs
S = Slightly = Oxidized
M = Moderately = Discoloured
H = Highly = Friable
C = Completely = Soil-like

DISCONTINUITY TYPE
B = Bedding Joint
J = Cross Joint
F = Fault
S = Shear Plane

SPACING
VW = Very Wide = >3m
W = Wide = 1-3 m
M = Moderate = 0.3-1 m
C = Close = 5-30 cm
VC = Very Close = <5 cm

ORIENTATION
F = Flat = 0-20^0
D = Dipping = 20-50^0
V = n-Vertical = >50^0

ROUGHNESS
RU = Rough Undulating
RP = Rough Planar
SU = Smooth Undulating
SP = Smooth Planar
LU = Slickensided Undulating
LP = Slickensided Planar

FILLING
T = Tight, Hard
O = Oxidized
SA = Slightly Altered, Clay Free
S = Sandy, Clay Free
Si = Sandy, Silty, Minor Clay
NC = Non-softening Clay
SC = Swelling, Soft Clay

Field Core Log

Stantec

Client: AECOM Canada Ltd.
Project: Highway 7 - Norwood to Havelock, W.P. 67-99-00
Contractor: George Downing Estate Drilling Ltd. - (CME75)

Project No.: 122410158
Date: June 5, 2009
Borehole No.: 09-7
Logger: Kenton C. Power

DEPTH FROM	RUN NO.	% CORE RECOVERY	% RQD	DEPTH TO	GENERAL DESCRIPTION (Rock Type/s, %, Colour, Texture, etc.)	STRENGTH	WEATHERING	DISCONTINUITIES							OCCASIONAL FEATURES	DRILLING OBSERVATIONS
								NO. OF SETS	TYPE/S	ORIENTATION	SPACING	ROUGHNESS	APERTURE	FILLING		
6.64	10	83	0	7.23	Grey LIMESTONE bedrock with shale partings	VS	S		B	F	VC/C	RP		T		
7.23	11	96	48	8.75	Grey LIMESTONE bedrock with shale partings	VS	U		B	F	VC/C	RP		T		
8.75	12	93	36	10.27	Grey LIMESTONE bedrock with shale partings	VS	U		B	F	VC/C	RP		T		

STRENGTH (MPa)
EH = Extremely Strong = > 250
VS = Very Strong = 100-250
S = Strong = 50-100
MS = Medium Strong = 25-50
W = Weak = 5 - 25
VW = Very Weak = 1-5
EW = Extremely Weak = < 1

WEATHERING
U = Unweathered = No Signs
S = Slightly = Oxidized
M = Moderately = Discoloured
H = Highly = Friable
C = Completely = Soil-like

DISCONTINUITY TYPE
B = Bedding Joint
J = Cross Joint
F = Fault
S = Shear Plane

SPACING
VW = Very Wide = >3m
W = Wide = 1-3 m
M = Moderate = 0.3-1 m
C = Close = 5-30 cm
VC = Very Close = <5 cm

ORIENTATION
F = Flat = 0-20^0
D = Dipping = 20-50^0
V = n-Vertical = >50^0

ROUGHNESS
RU = Rough Undulating
RP = Rough Planar
SU = Smooth Undulating
SP = Smooth Planar
LU = Slickensided Undulating
LP = Slickensided Planar

FILLING
T = Tight, Hard
O = Oxidized
SA = Slightly Altered, Clay Free
S = Sandy, Clay Free
Si = Sandy, Silty, Minor Clay
NC = Non-softening Clay
SC = Swelling, Soft Clay

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Field Core Log

Stantec

Client: AECOM Canada Ltd.
Project: Highway 7 - Norwood to Havelock, W.P. 67-99-00
Contractor: George Downing Estate Drilling Ltd. - (CME75)

Project No.: 122410158
Date: June 5, 2009
Borehole No.: 09-8
Logger: Kenton C. Power

DEPTH FROM	RUN NO.	% CORE RECOVERY	% RQD	DEPTH TO	GENERAL DESCRIPTION (Rock Type/s, %, Colour, Texture, etc.)	STRENGTH	WEATHERING	DISCONTINUITIES							OCCASIONAL FEATURES	DRILLING OBSERVATIONS
								NO. OF SETS	TYPE/S	ORIENTATION	SPACING	ROUGHNESS	APERTURE	FILLING		
6.91	11	-	-	7.32	Boulders											
7.32	12	48	0	8.0	Grey LIMESTONE bedrock with shale partings	S	S		B	F	VC	RP		T		
8.0	13	93	31	8.84	Grey LIMESTONE bedrock with shale partings	S	U		B	F	VC/C	RP		T		
8.84	14	100	26	10.36	Grey LIMESTONE bedrock with shale partings	S	U		B	F	VC/C	RP		T		

STRENGTH (MPa)
EH = Extremely Strong = > 250
VS = Very Strong = 100-250
S = Strong = 50-100
MS = Medium Strong = 25-50
W = Weak = 5 - 25
VW = Very Weak = 1-5
EW = Extremely Weak = < 1

WEATHERING
U = Unweathered = No Signs
S = Slightly = Oxidized
M = Moderately = Discoloured
H = Highly = Friable
C = Completely = Soil-like

DISCONTINUITY TYPE
B = Bedding Joint
J = Cross Joint
F = Fault
S = Shear Plane

SPACING
VW = Very Wide = >3m
W = Wide = 1-3 m
M = Moderate = 0.3-1 m
C = Close = 5-30 cm
VC = Very Close = <5 cm

ORIENTATION
F = Flat = 0-20^0
D = Dipping = 20-50^0
V = n-Vertical = >50^0

ROUGHNESS
RU = Rough Undulating
RP = Rough Planar
SU = Smooth Undulating
SP = Smooth Planar
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LP = Slickensided Planar

FILLING
T = Tight, Hard
O = Oxidized
SA = Slightly Altered, Clay Free
S = Sandy, Clay Free
Si = Sandy, Silty, Minor Clay
NC = Non-softening Clay
SC = Swelling, Soft Clay

Field Core Log

Stantec

Client: AECOM Canada Ltd.
Project: Highway 7 - Norwood to Havelock, W.P. 67-99-00
Contractor: George Downing Estate Drilling Ltd. - (CME75)

Project No.: 122410158
Date: June 5, 2009
Borehole No.: 09-9
Logger: Kenton C. Power

DEPTH FROM	RUN NO.	% CORE RECOVERY	% RQD	DEPTH TO	GENERAL DESCRIPTION (Rock Type/s, %, Colour, Texture, etc.)	STRENGTH	WEATHERING	DISCONTINUITIES							OCCASIONAL FEATURES	DRILLING OBSERVATIONS
								NO. OF SETS	TYPE/S	ORIENTATION	SPACING	ROUGHNESS	APERTURE	FILLING		
5.74	9	70	15	7.26	Grey LIMESTONE bedrock with shale partings	VS	S		B	F	VC/C	RP		T		
7.26	10	100	85	8.78	Grey LIMESTONE bedrock with shale partings	VS	U		B	F	C/M	RP		T		

STRENGTH (MPa)
EH = Extremely Strong = > 250
VS = Very Strong = 100-250
S = Strong = 50-100
MS = Medium Strong = 25-50
W = Weak = 5 - 25
VW = Very Weak = 1-5
EW = Extremely Weak = < 1

WEATHERING
U = Unweathered = No Signs
S = Slightly = Oxidized
M = Moderately = Discoloured
H = Highly = Friable
C = Completely = Soil-like

DISCONTINUITY TYPE
B = Bedding Joint
J = Cross Joint
F = Fault
S = Shear Plane

SPACING
VW = Very Wide = >3m
W = Wide = 1-3 m
M = Moderate = 0.3-1 m
C = Close = 5-30 cm
VC = Very Close = <5 cm

ORIENTATION
F = Flat = 0-20^0
D = Dipping = 20-50^0
V = n-Vertical = >50^0

ROUGHNESS
RU = Rough Undulating
RP = Rough Planar
SU = Smooth Undulating
SP = Smooth Planar
LU = Slickensided Undulating
LP = Slickensided Planar

FILLING
T = Tight, Hard
O = Oxidized
SA = Slightly Altered, Clay Free
S = Sandy, Clay Free
Si = Sandy, Silty, Minor Clay
NC = Non-softening Clay
SC = Swelling, Soft Clay

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Field Core Log

Stantec

Client: AECOM Canada Ltd.
Project: Highway 7 - Norwood to Havelock, W.P. 67-99-00
Contractor: George Downing Estate Drilling Ltd. - (CME75)

Project No.: 122410158
Date: June 5, 2009
Borehole No.: 09-10
Logger: Kenton C. Power

DEPTH FROM	RUN NO.	% CORE RECOVERY	% RQD	DEPTH TO	GENERAL DESCRIPTION (Rock Type/s, %, Colour, Texture, etc.)	STRENGTH	WEATHERING	DISCONTINUITIES							OCCASIONAL FEATURES	DRILLING OBSERVATIONS
								NO. OF SETS	TYPE/S	ORIENTATION	SPACING	ROUGHNESS	APERTURE	FILLING		
2.99	5 and 6	-	-	5.21	Grey LIMESTONE bedrock with shale partings	S	S		B	F	VC	RP		T		
5.21	7	100	0	5.57	Grey LIMESTONE bedrock with shale partings	S	S		B	F	VC	RP		T		
5.57	8	78	20	7.09	Grey LIMESTONE bedrock with shale partings	S	U		B	F	VC/C	RP		T		
7.09	9	100	67	8.09	Grey LIMESTONE bedrock with shale partings	S	U		B	F	C/M	RP		T		

STRENGTH (MPa)
EH = Extremely Strong = > 250
VS = Very Strong = 100-250
S = Strong = 50-100
MS = Medium Strong = 25-50
W = Weak = 5 - 25
VW = Very Weak = 1-5
EW = Extremely Weak = < 1

WEATHERING
U = Unweathered = No Signs
S = Slightly = Oxidized
M = Moderately = Discoloured
H = Highly = Friable
C = Completely = Soil-like

DISCONTINUITY TYPE
B = Bedding Joint
J = Cross Joint
F = Fault
S = Shear Plane

SPACING
VW = Very Wide = >3m
W = Wide = 1-3 m
M = Moderate = 0.3-1 m
C = Close = 5-30 cm
VC = Very Close = <5 cm

ORIENTATION
F = Flat = 0-20^0
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ROUGHNESS
RU = Rough Undulating
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FILLING
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SC = Swelling, Soft Clay

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Field Core Log

Stantec

Client: AECOM Canada Ltd.
Project: Highway 7 - Norwood to Havelock, W.P. 67-99-00
Contractor: George Downing Estate Drilling Ltd. - (CME75)

Project No.: 122410158
Date: June 5, 2009
Borehole No.: 09-11
Logger: Kenton C. Power

DEPTH FROM	RUN NO.	% CORE RECOVERY	% RQD	DEPTH TO	GENERAL DESCRIPTION (Rock Type/s, %, Colour, Texture, etc.)	STRENGTH	WEATHERING	DISCONTINUITIES							OCCASIONAL FEATURES	DRILLING OBSERVATIONS
								NO. OF SETS	TYPE/S	ORIENTATION	SPACING	ROUGHNESS	APERTURE	FILLING		
4.82	8	85	0	5.13	Grey LIMESTONE bedrock with shale partings	VS	S		B	F	VC	RP		T		
5.13	9	100	0	5.71	Grey LIMESTONE bedrock with shale partings	VS	S		B	F	VC	RP		T		
5.71	10	95	10	6.94	Grey LIMESTONE bedrock with shale partings	VS	S		B	F	VC	RP		T		
9.64	11	100	55	7.94	Grey LIMESTONE bedrock with shale partings	VS	S		B	F	VC/C	RP		T		

STRENGTH (MPa)
EH = Extremely Strong = > 250
VS = Very Strong = 100-250
S = Strong = 50-100
MS = Medium Strong = 25-50
W = Weak = 5 - 25
VW = Very Weak = 1-5
EW = Extremely Weak = < 1

WEATHERING
U = Unweathered = No Signs
S = Slightly = Oxidized
M = Moderately = Discoloured
H = Highly = Friable
C = Completely = Soil-like

DISCONTINUITY TYPE
B = Bedding Joint
J = Cross Joint
F = Fault
S = Shear Plane

SPACING
VW = Very Wide = >3m
W = Wide = 1-3 m
M = Moderate = 0.3-1 m
C = Close = 5-30 cm
VC = Very Close = <5 cm

ORIENTATION
F = Flat = 0-20^0
D = Dipping = 20-50^0
V = n-Vertical = >50^0

ROUGHNESS
RU = Rough Undulating
RP = Rough Planar
SU = Smooth Undulating
SP = Smooth Planar
LU = Slickensided Undulating
LP = Slickensided Planar

FILLING
T = Tight, Hard
O = Oxidized
SA = Slightly Altered, Clay Free
S = Sandy, Clay Free
Si = Sandy, Silty, Minor Clay
NC = Non-softening Clay
SC = Swelling, Soft Clay

Photo No. 1: 10+938 BH09-2

Photo No. 2: 10+938 BH09-3

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Photo No. 3: 10+941 BH09-10

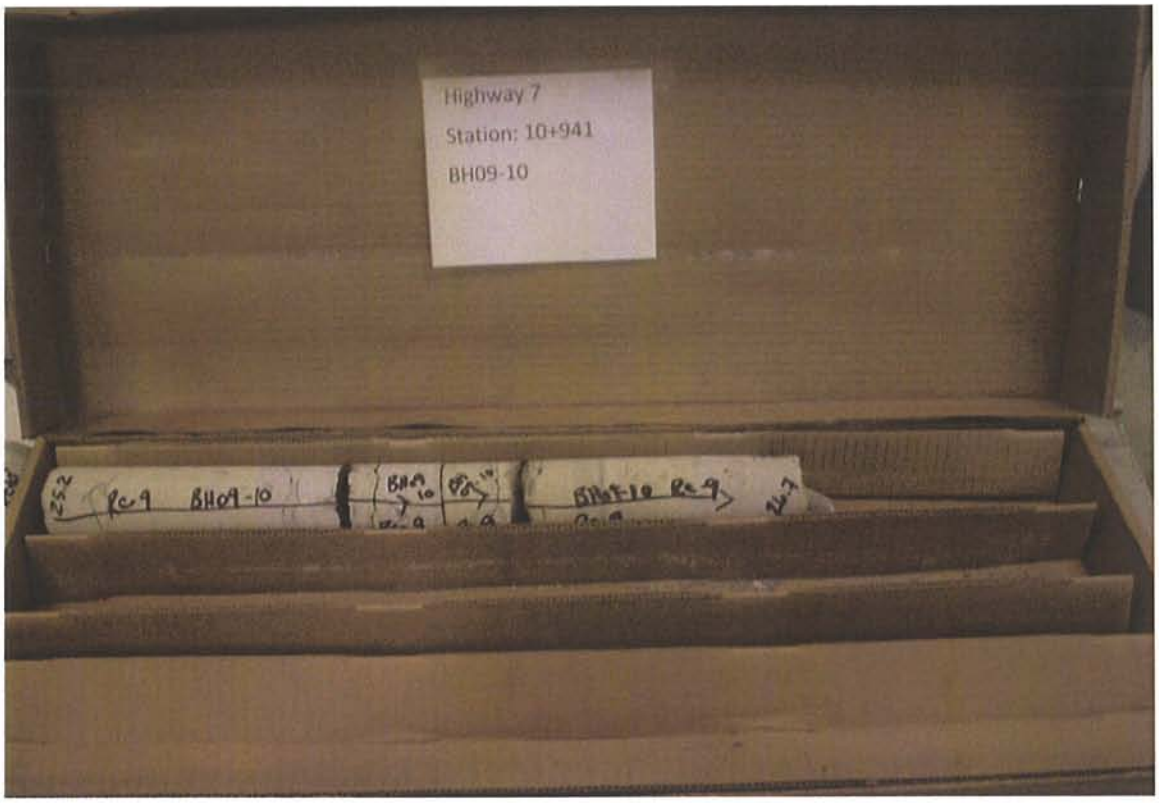

Photo No. 4: 10+941 BH09-10 Bottom

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Photo No. 5: 11+963 BH09-4

Photo No. 6: 11+967 BH09-9 Top

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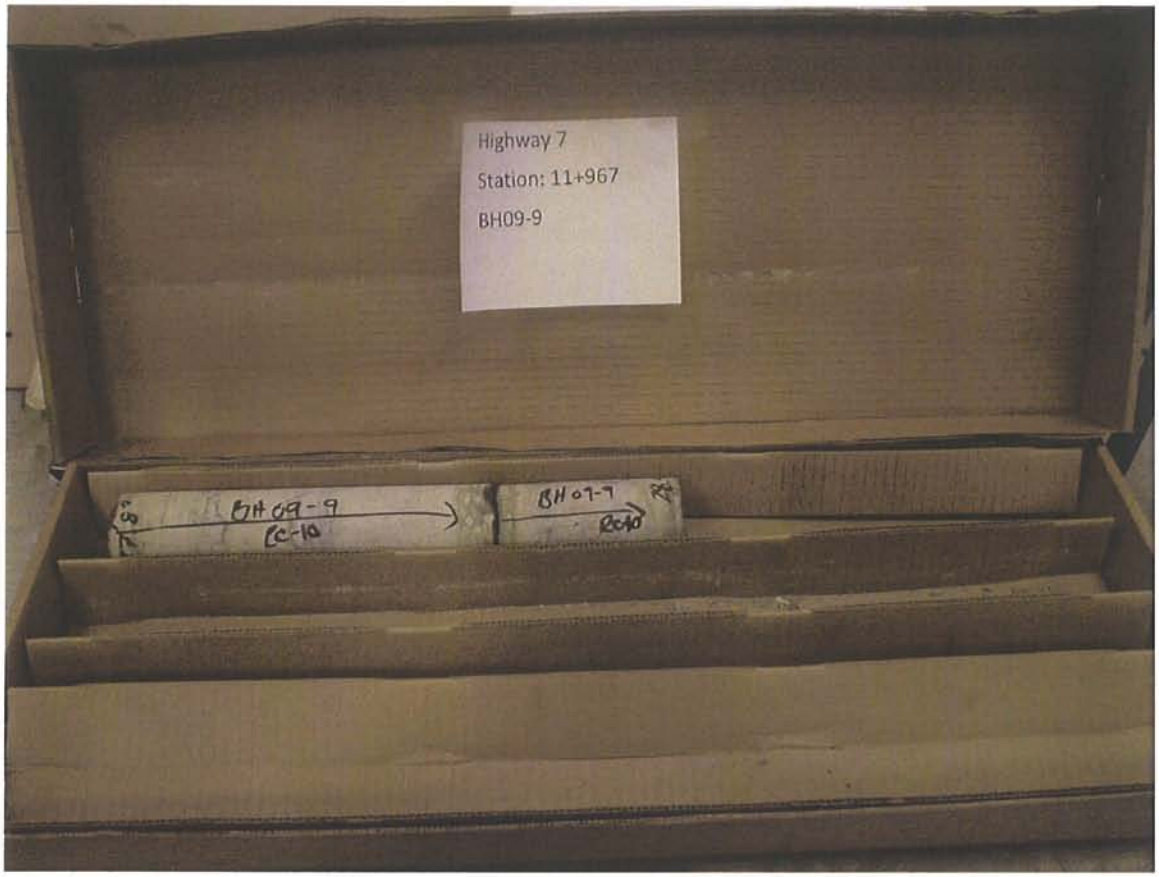

Photo No. 7: 11+967 BH09-9 Bottom

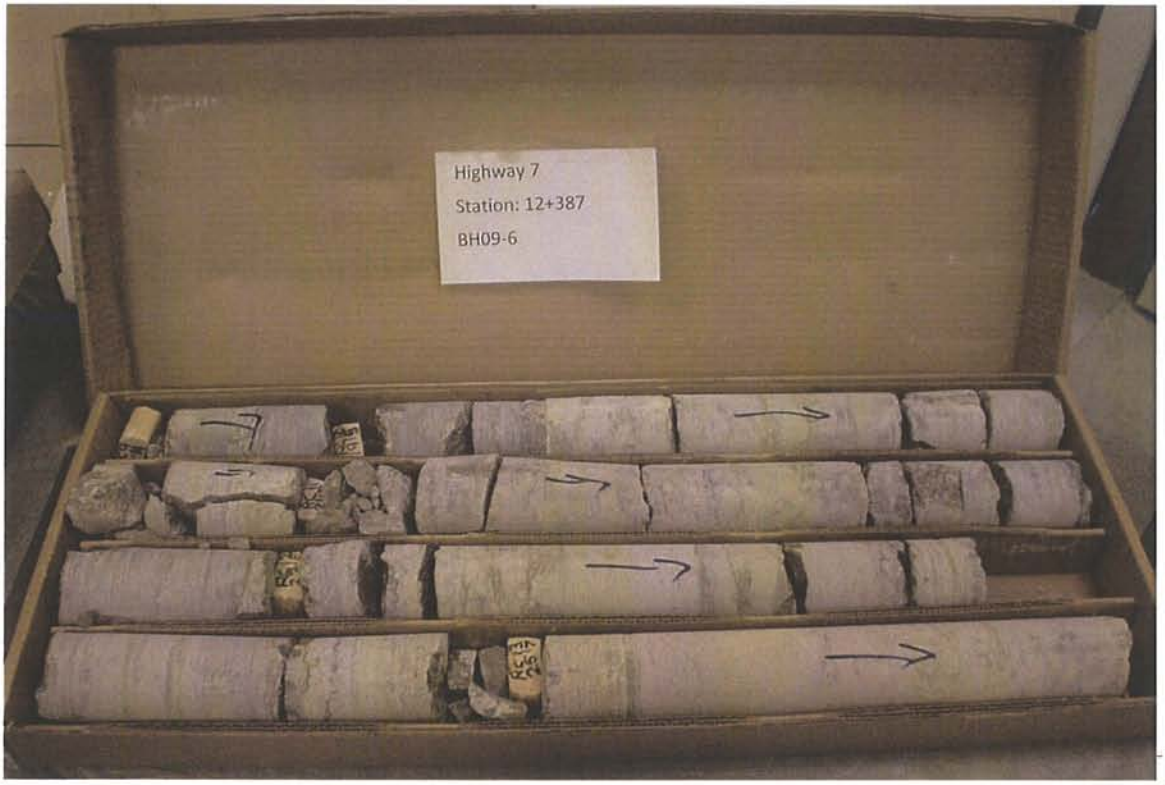

Photo No. 8: 12+387 BH09-6 Top

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Photo No. 9: 12+387 BH09-6 Bottom

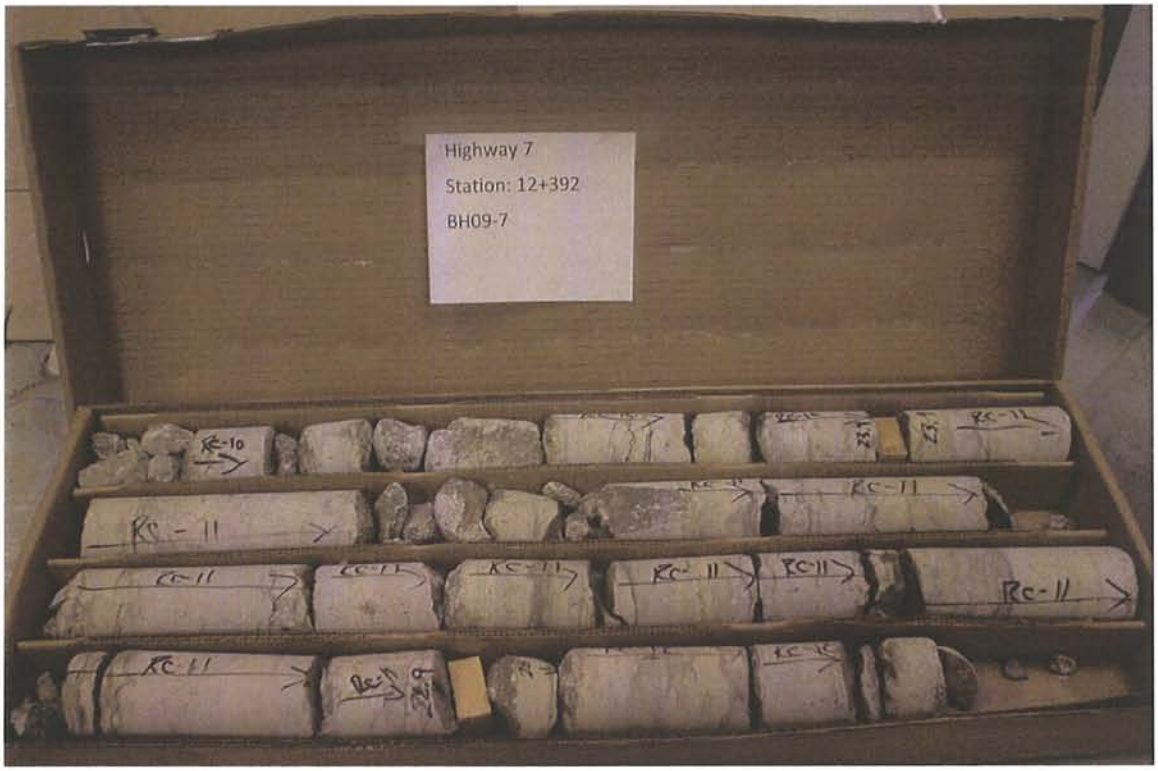

Photo No. 10: 12+392 BH09-7 Top

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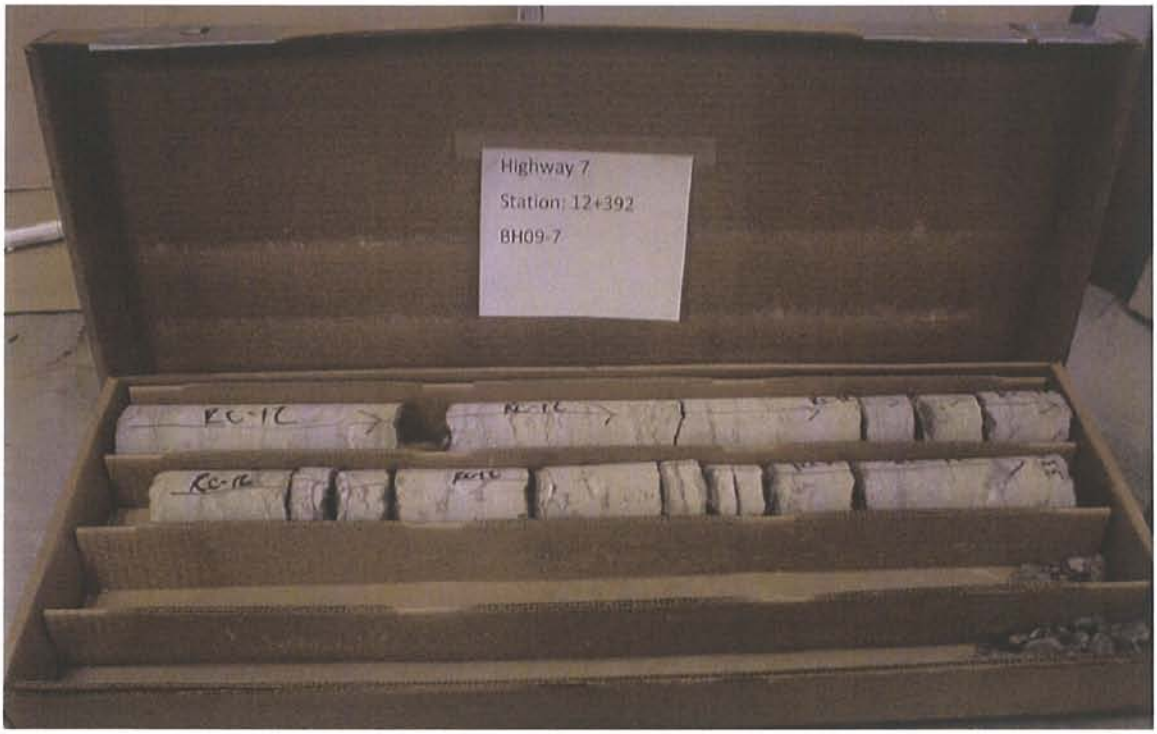

Photo No. 11: 12+392 BH09-7 Bottom

Photo No. 12: 12+393 BH09-8 Top

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Photo No. 13: 12+393 BH09-8 Bottom

Photo No. 14: 27+139 BH09-1 Top

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Photo No. 15: 27+139 BH09-1 Bottom

Photo No. 16: 27+140 BH09-11 Top

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Photo No. 17: 27+140 BH09-11 Bottom

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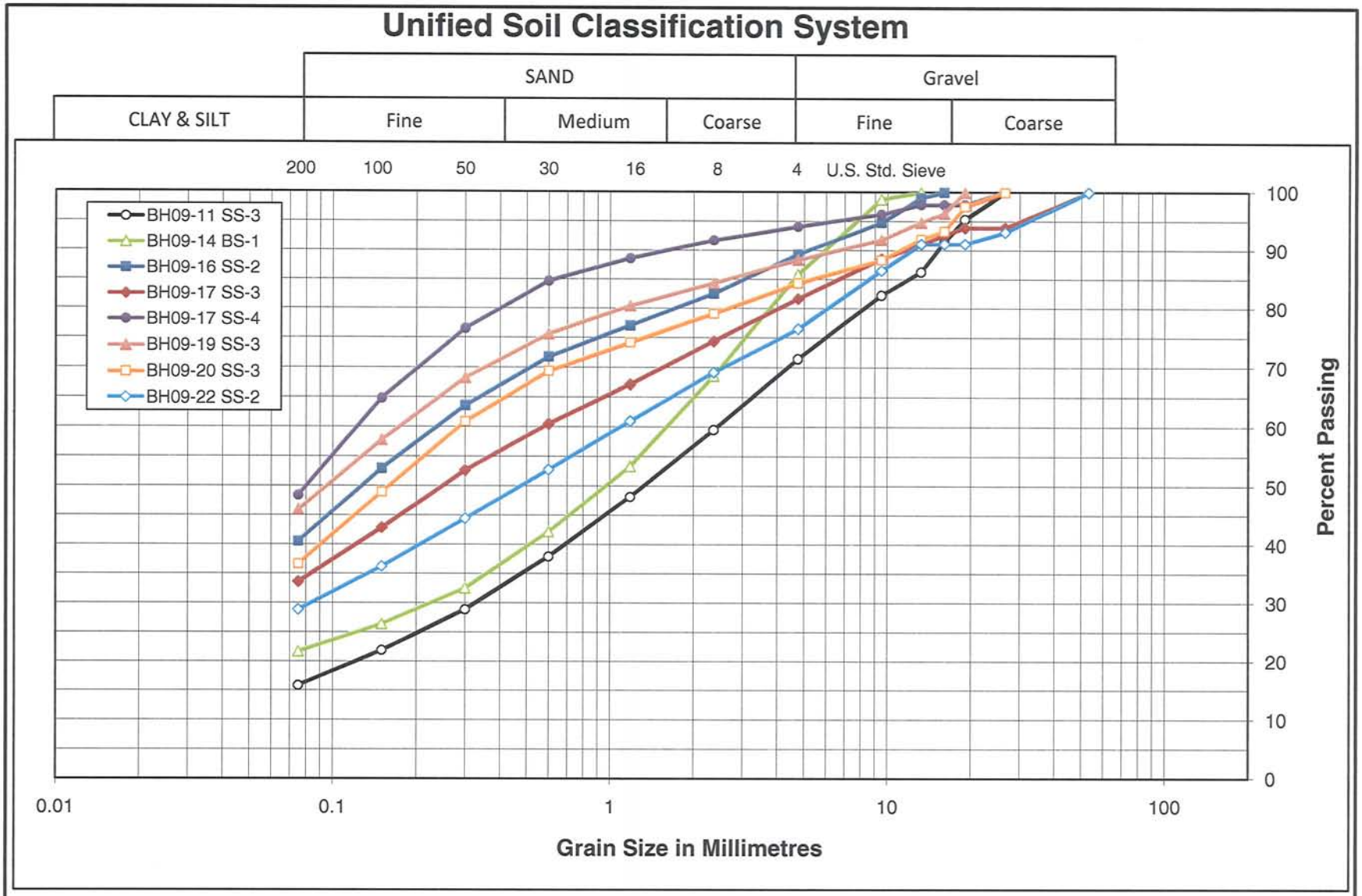
APPENDIX C

Laboratory Test Results
Peat/Marl Sample Photographs



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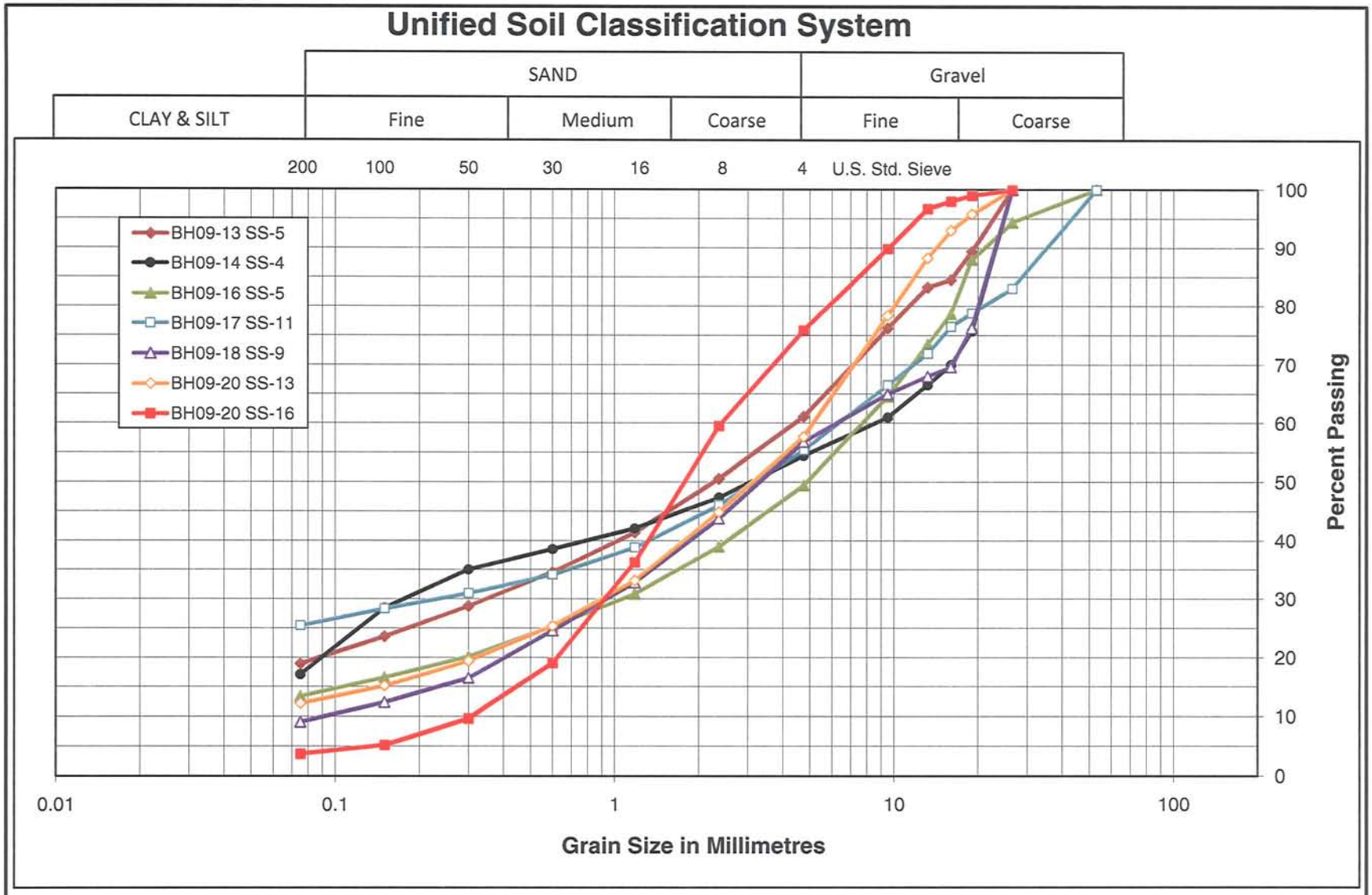
GRAIN SIZE DISTRIBUTION

FILL: Silty Sand to Silty Sand with Gravel

Location 1: 26+600 to 10+100

Figure No. 1

Project No. 1047243



Stantec

GRAIN SIZE DISTRIBUTION

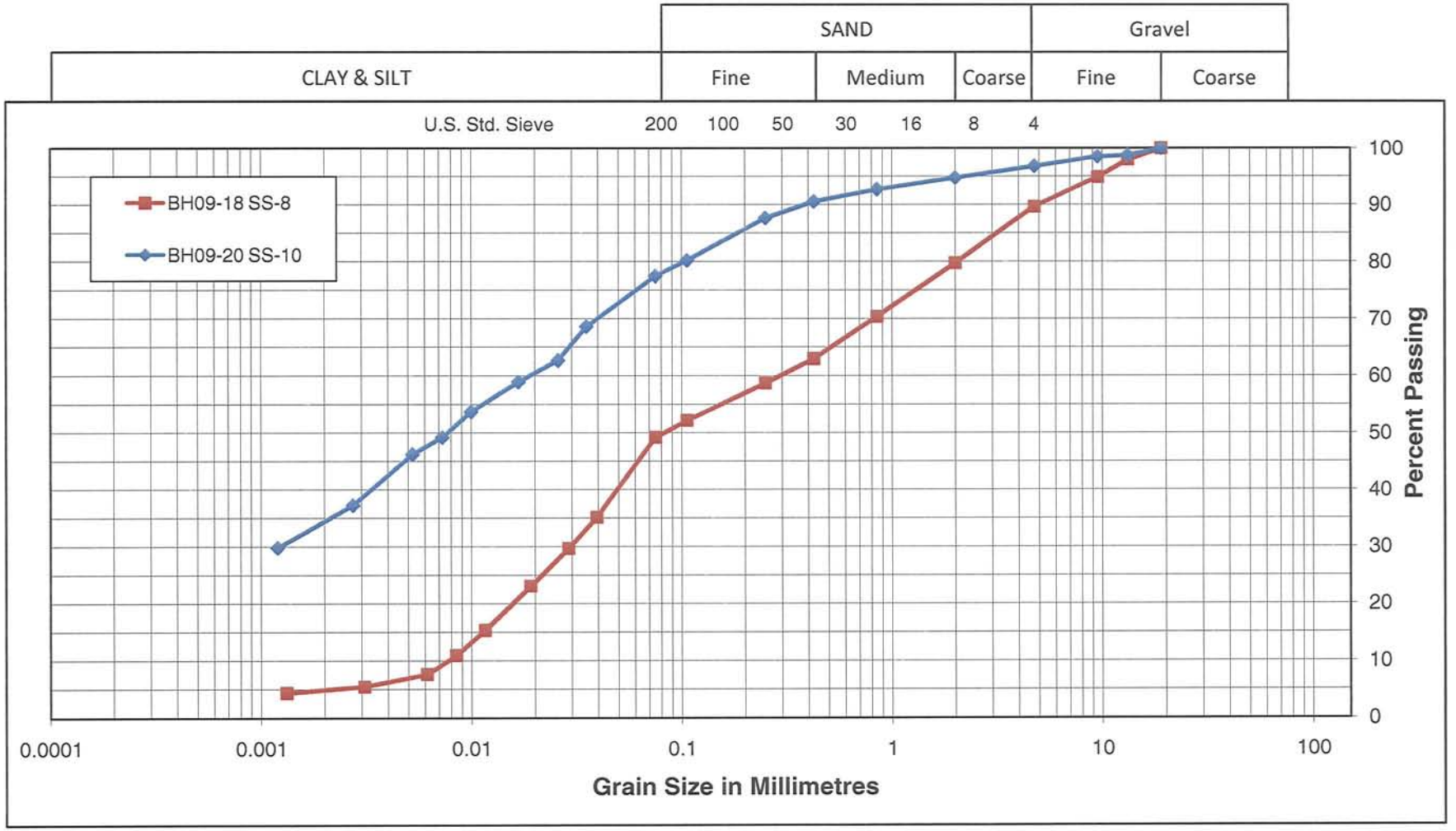
TILL: Silty Sand with Gravel to Sand with Gravel

Location 1: 26+600 to 10+100

Figure No. 2

Project No. 1047243

Unified Soil Classification System



Stantec

GRAIN SIZE DISTRIBUTION

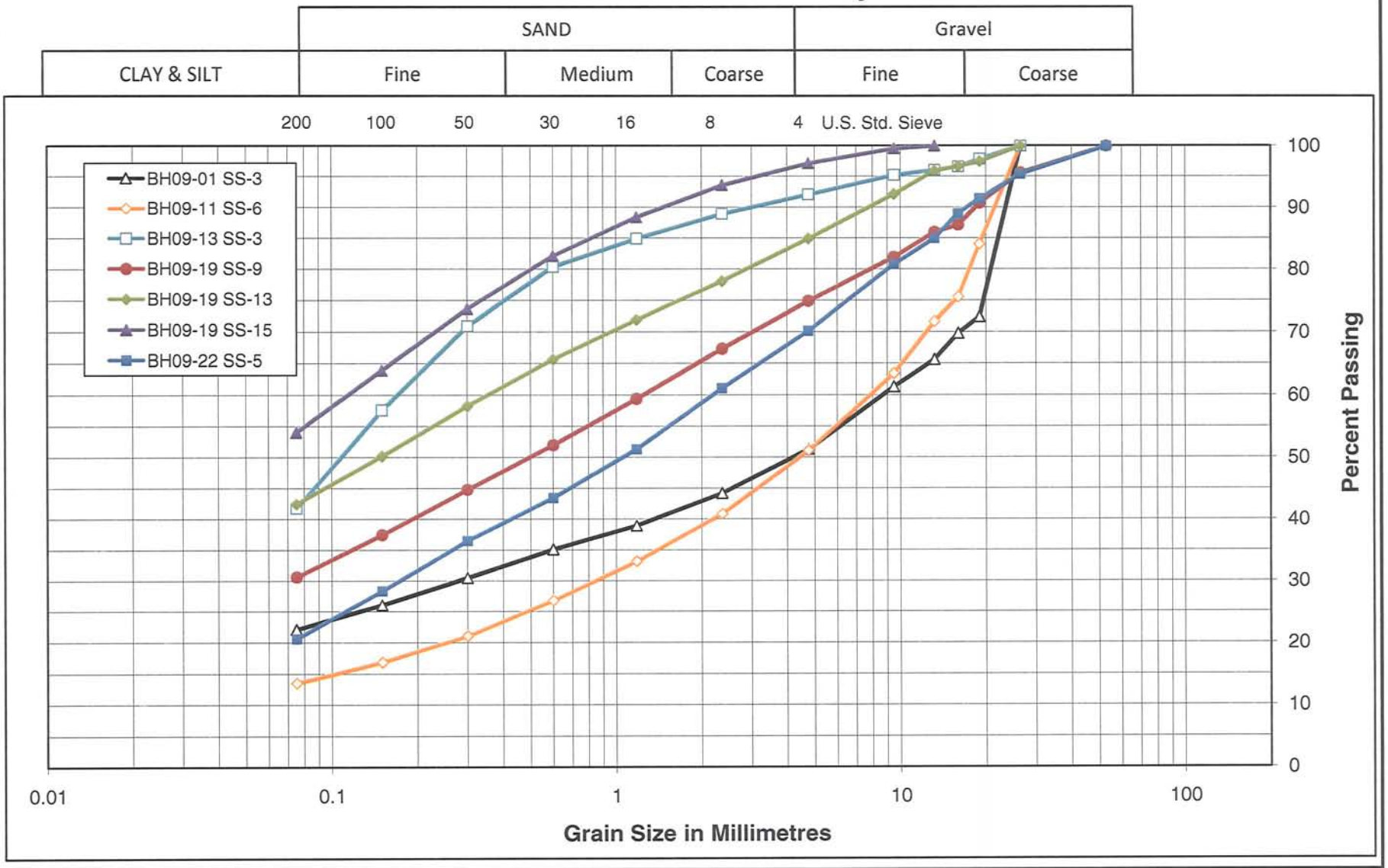
TILL: Sandy Silt to Clay with Sand

Location 1: 26+600 to 10+100

Figure No. 3

Project No. 1047243

Unified Soil Classification System



Stantec

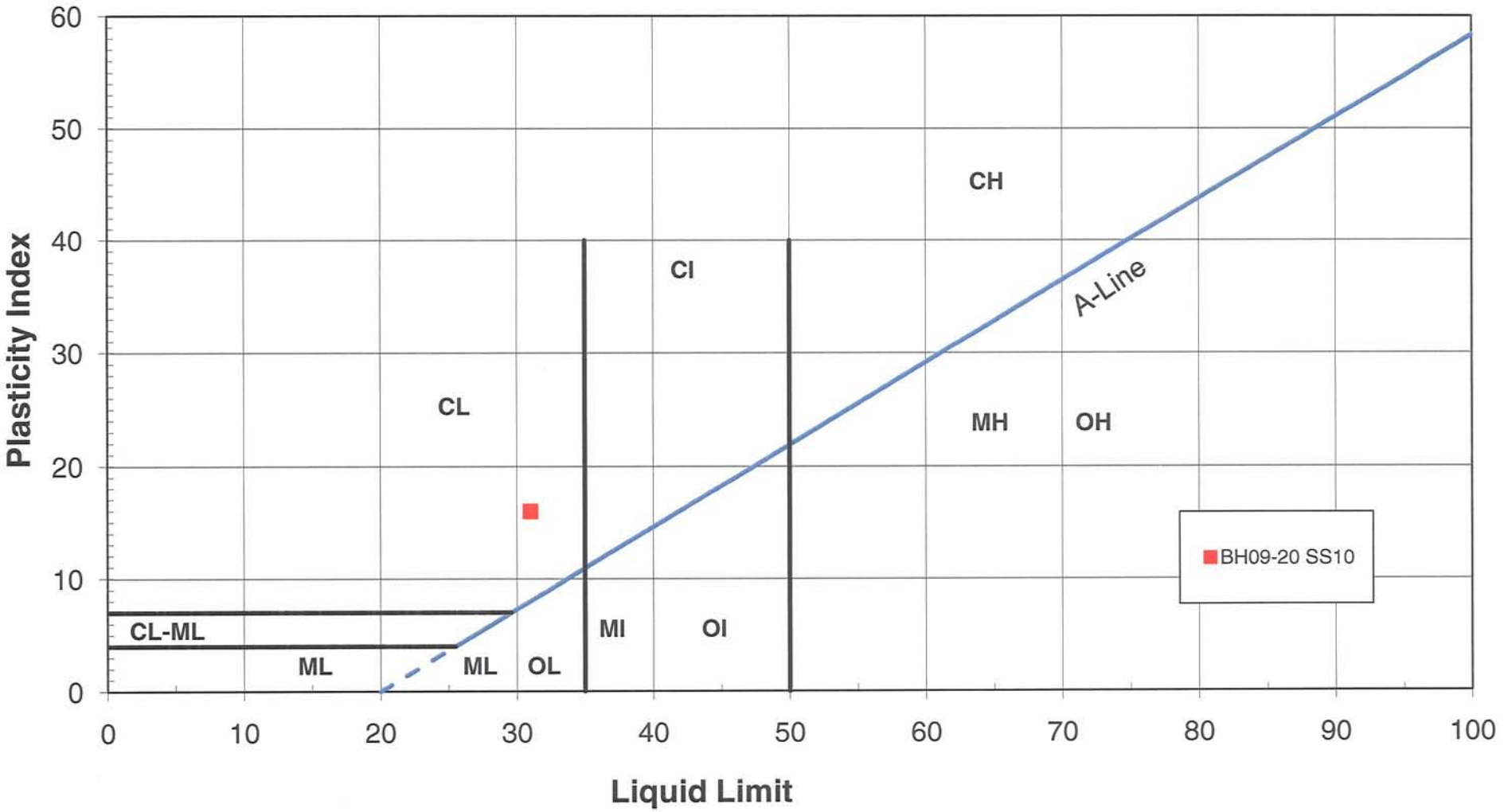
GRAIN SIZE DISTRIBUTION

TILL: Silty Sand to Silty Sand with Gravel

Location 1: 26+600 to 10+100

Figure No. 4

Project No. 1047243



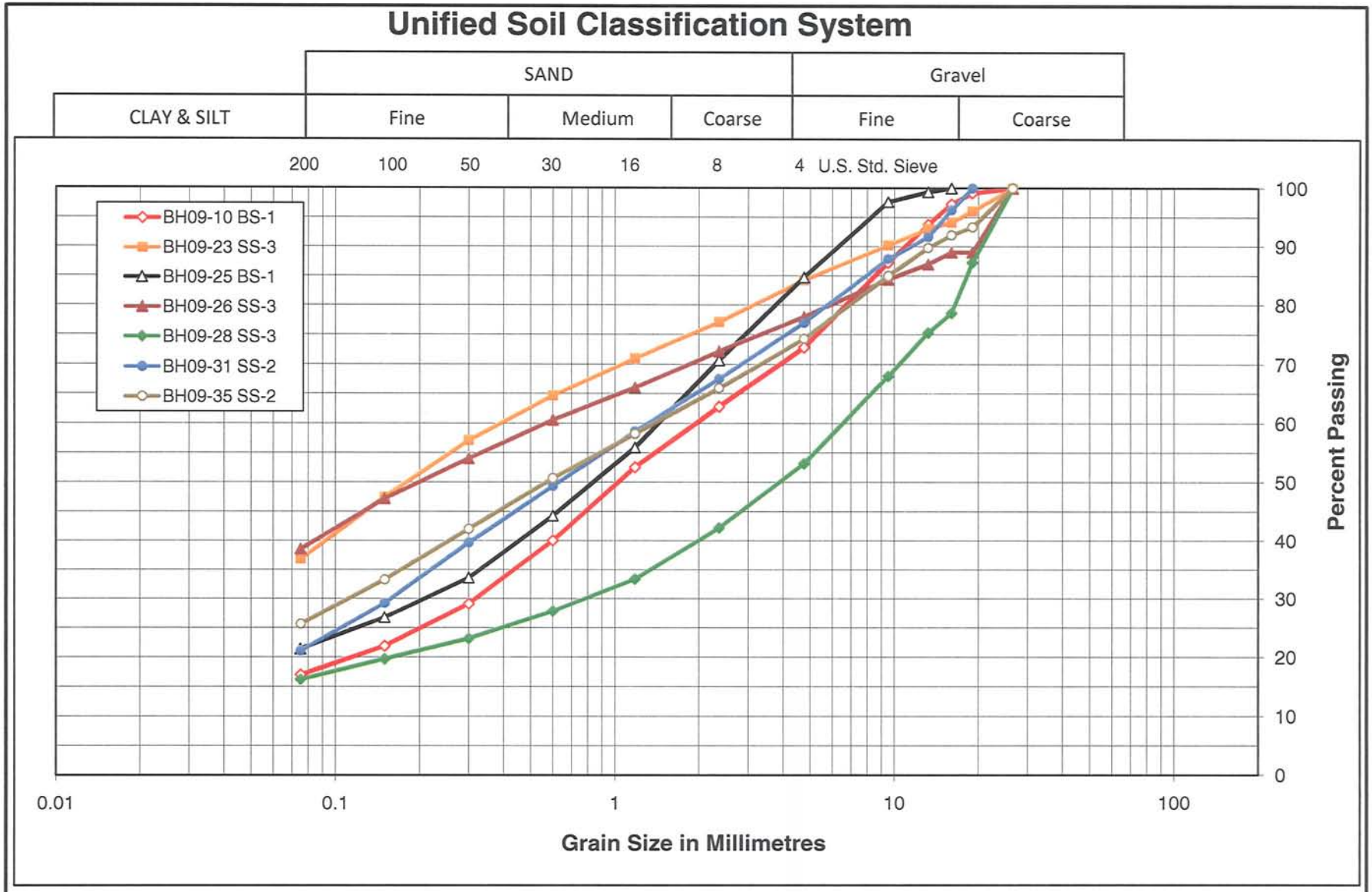
Stantec

PLASTICITY CHART

Location 1: 26+600 to 10+100

Figure 5

Project No. 1047243



Stantec

GRAIN SIZE DISTRIBUTION

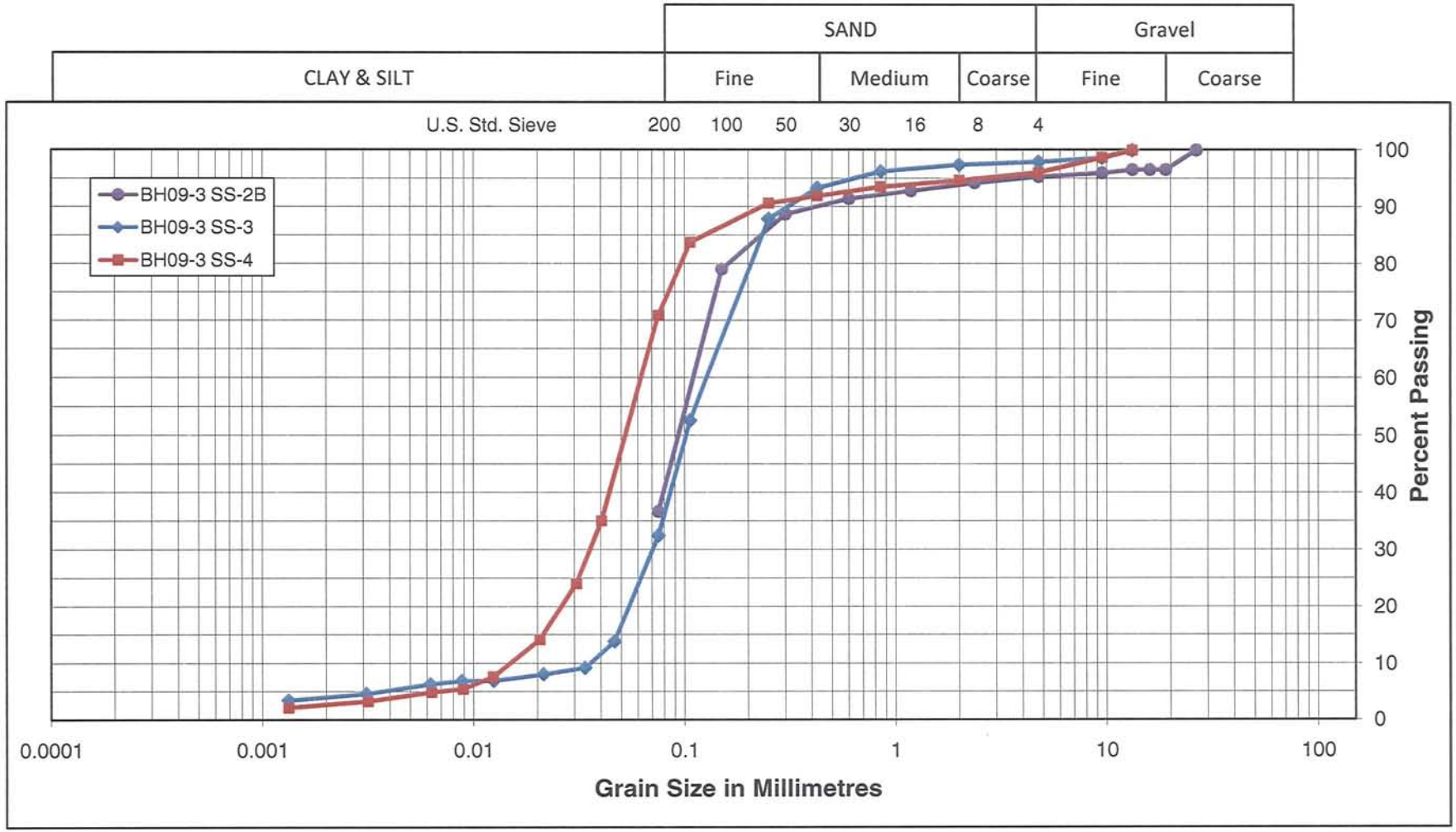
FILL: Silty Sand with Gravel to Silty Gravel with Sand

Location 2: 10+975 to 11+375

Figure No. 6

Project No. 1047243

Unified Soil Classification System



Stantec

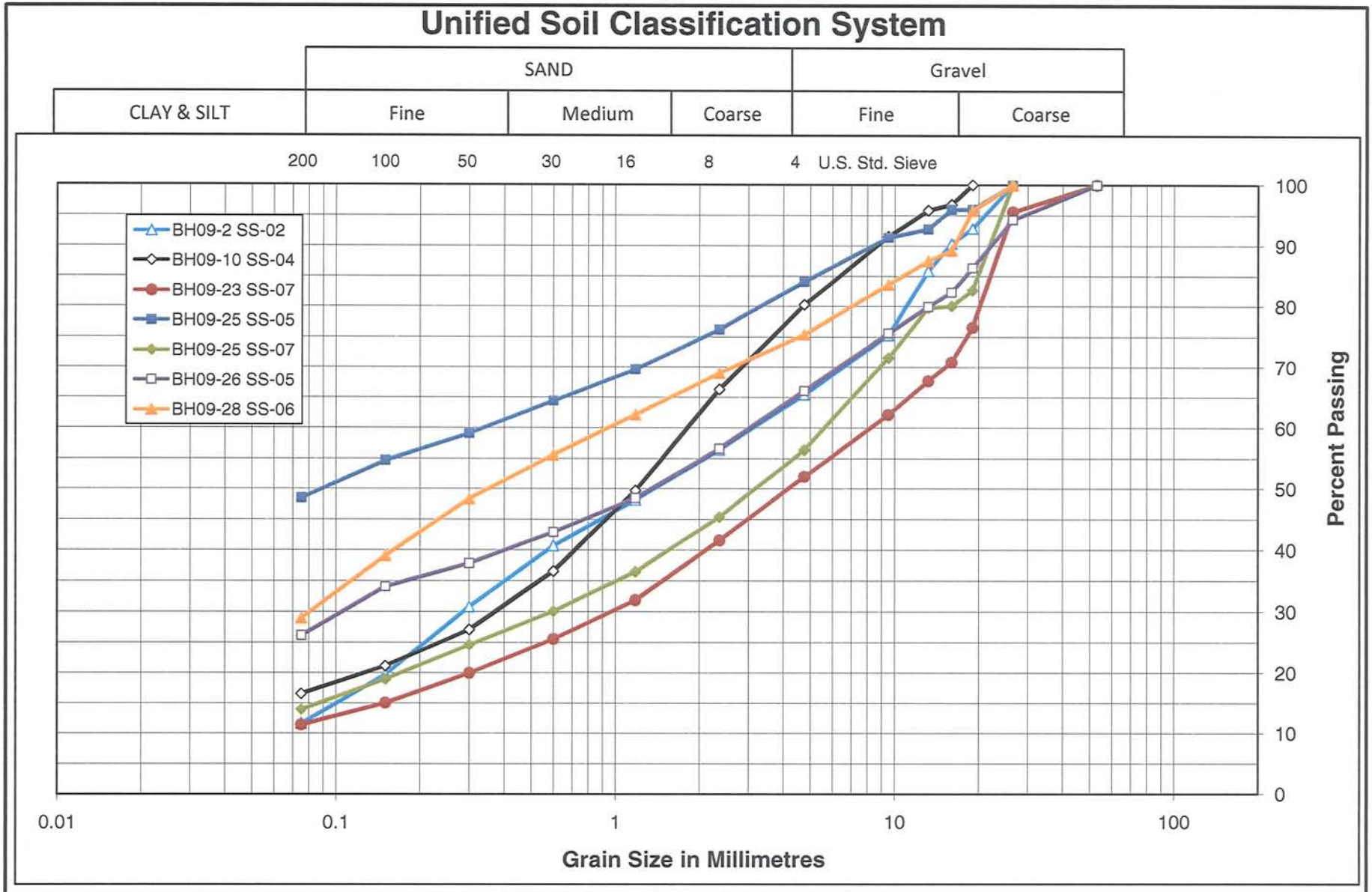
GRAIN SIZE DISTRIBUTION

TILL: Silty Sand

Location 2: 10+975 to 11+375

Figure No. 7

Project No. 1047243



Stantec

GRAIN SIZE DISTRIBUTION

TILL: Silty Sand with Gravel

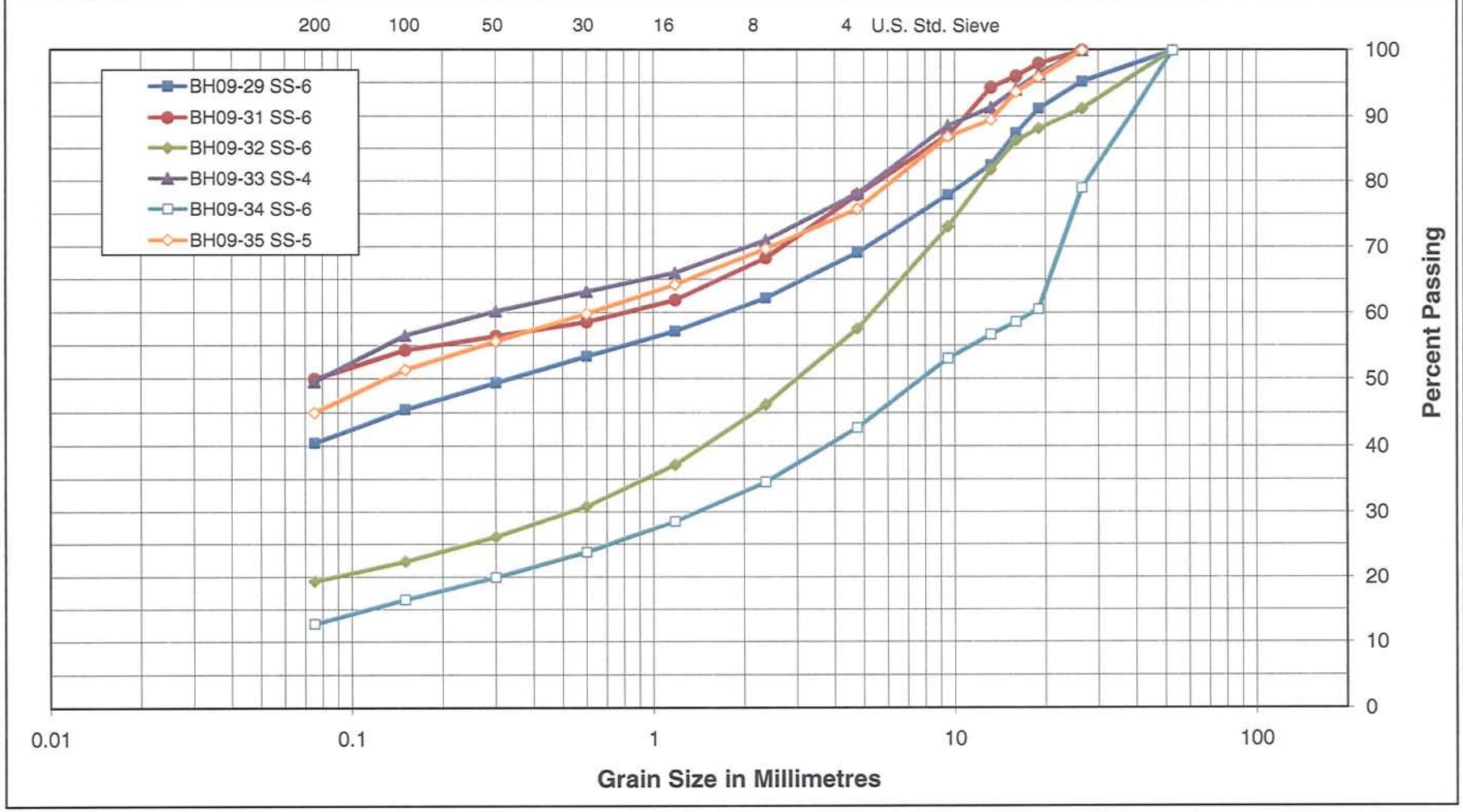
Location 2: 10+975 to 11+375

Figure No. 8

Project No. 1047243

Unified Soil Classification System

CLAY & SILT	SAND			Gravel	
	Fine	Medium	Coarse	Fine	Coarse



GRAIN SIZE DISTRIBUTION

TILL: Silty Sand with Gravel

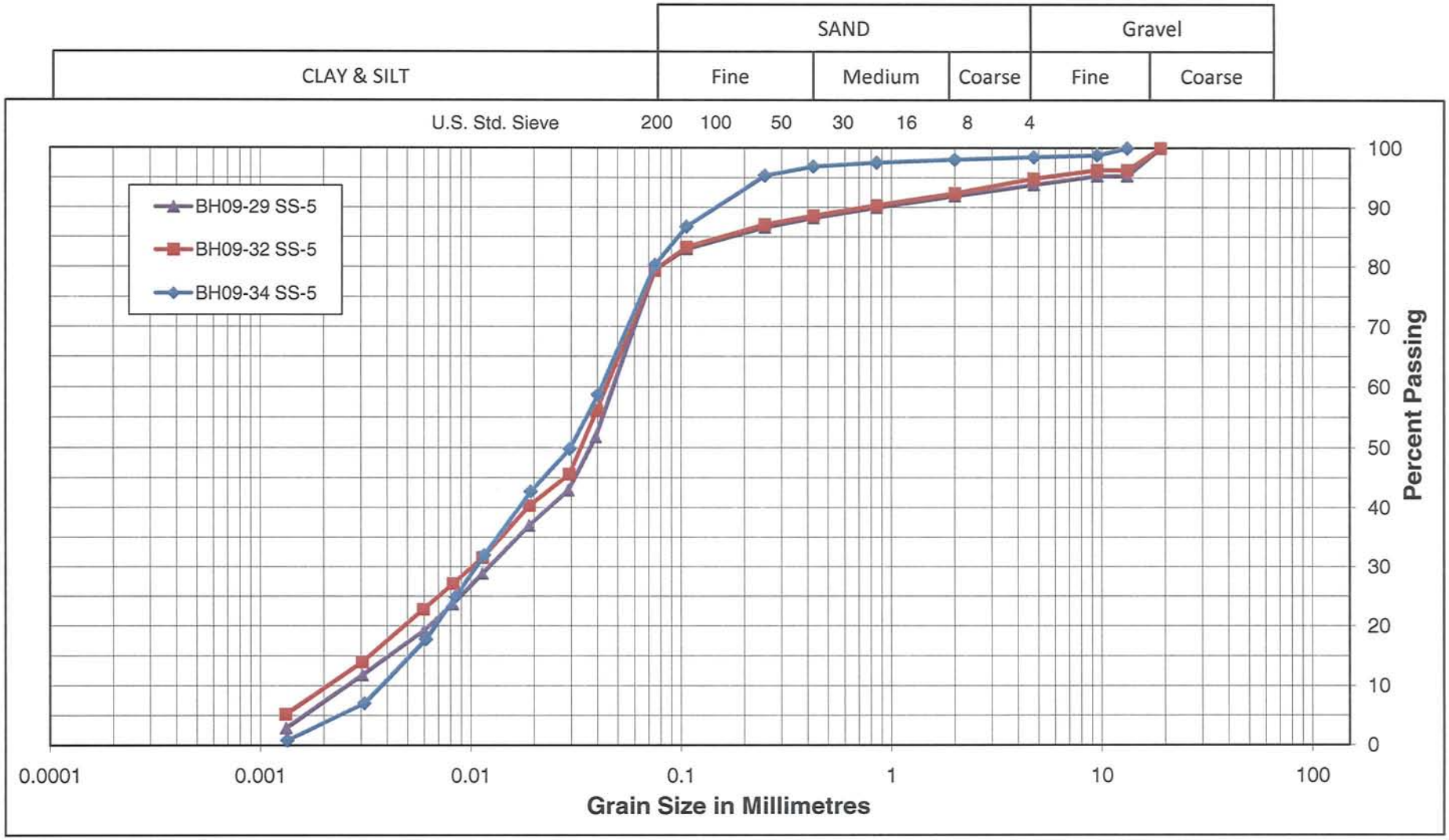
Location 2: 10+975 to 11+375

Figure No. 9

Project No. 1047243

Stantec

Unified Soil Classification System



Stantec

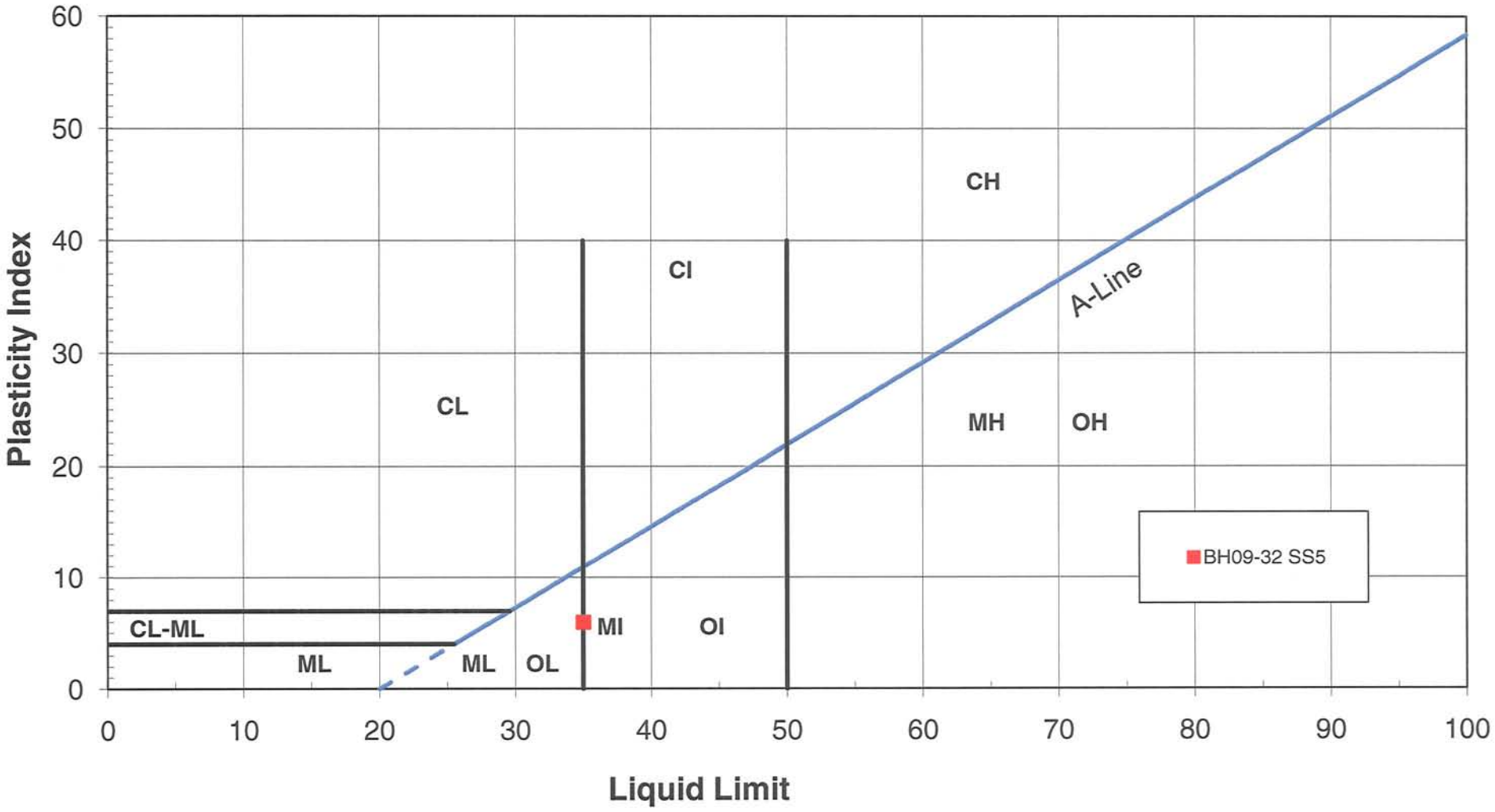
GRAIN SIZE DISTRIBUTION

SILT with Sand

Location 2: 10+975 to 11+375

Figure No. 10

Project No. 1047243



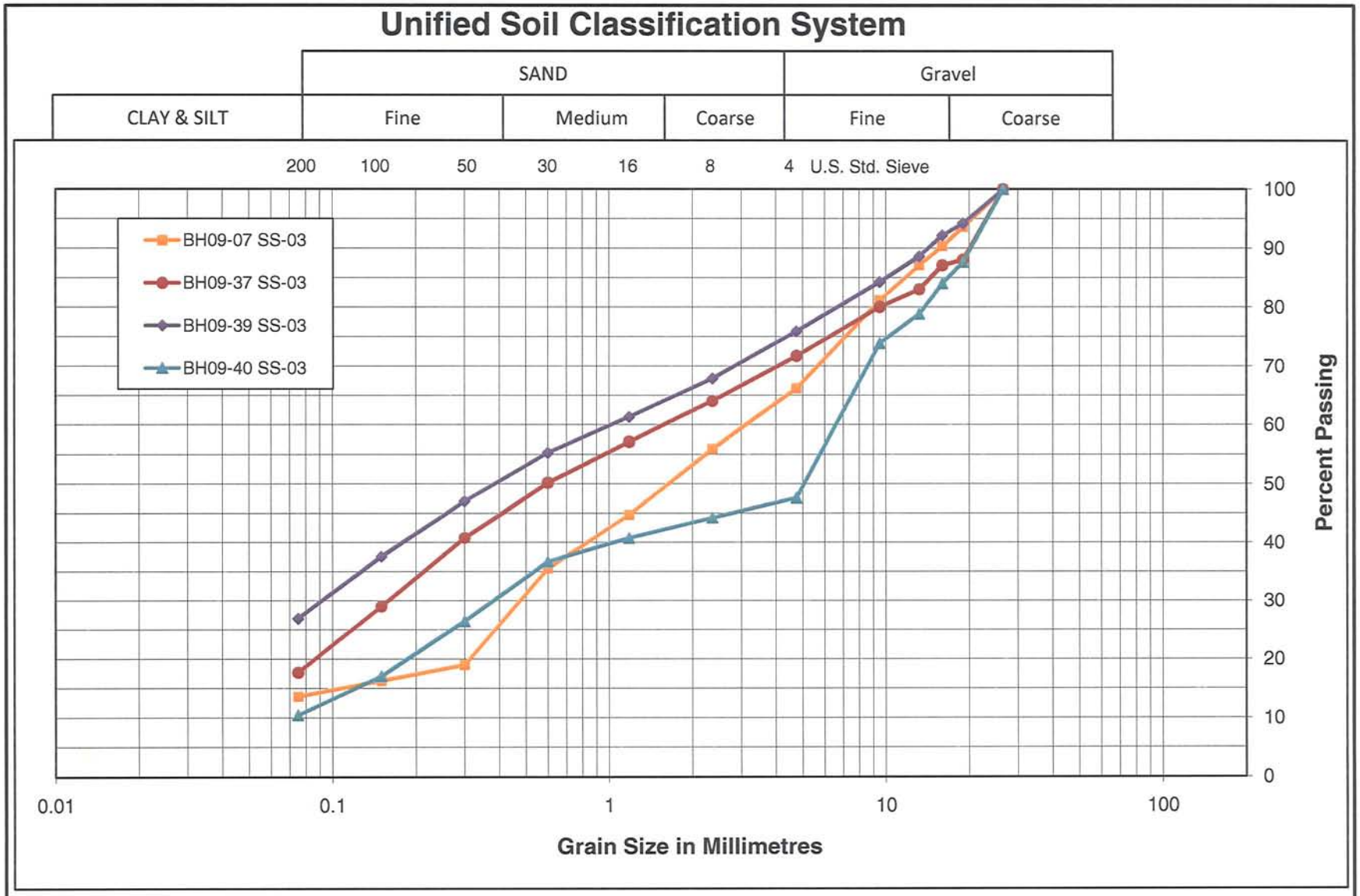
Stantec

PLASTICITY CHART

Location 2: 10+975 to 11+375

Figure 11

Project No. 1047243



Stantec

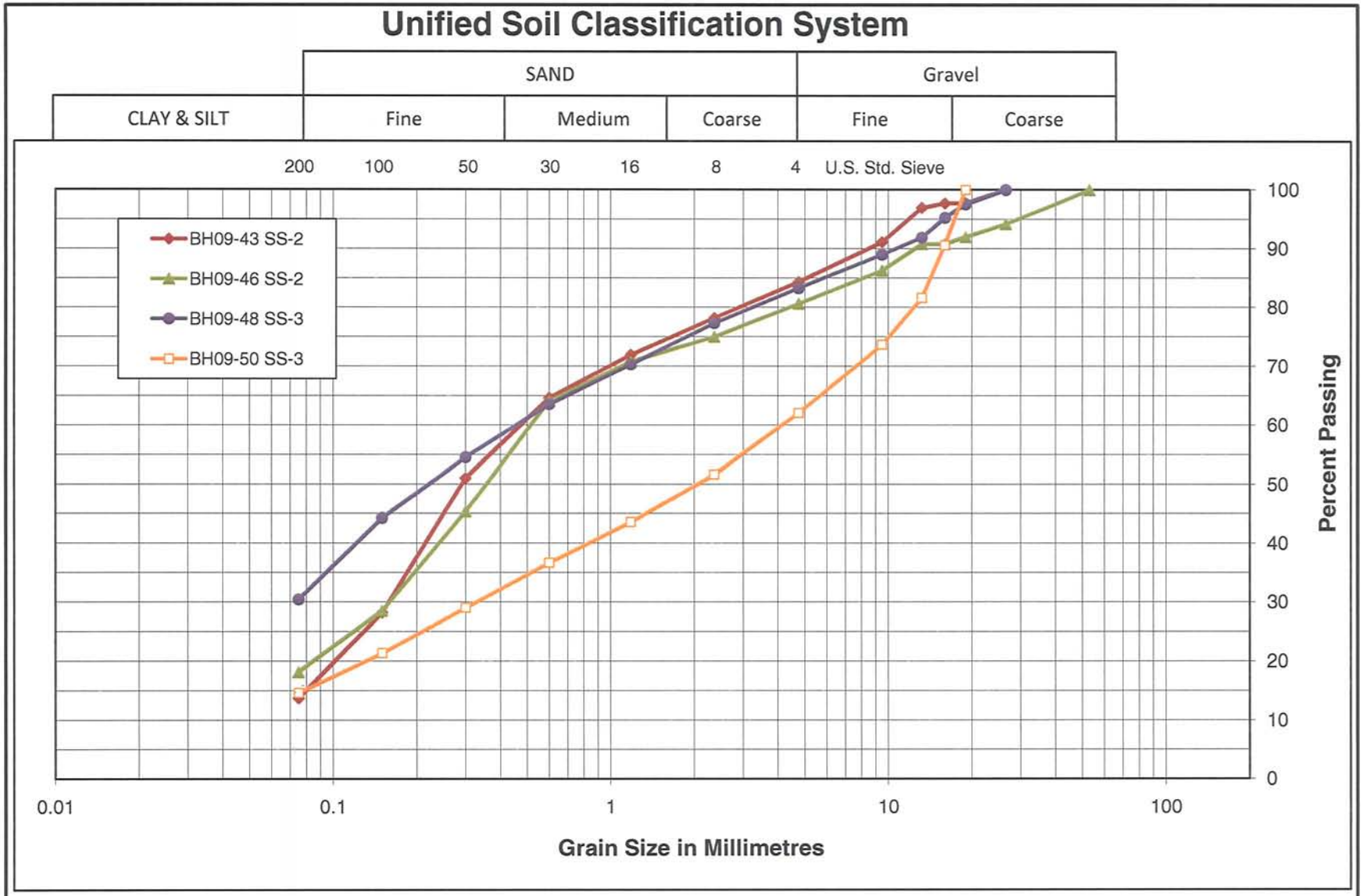
GRAIN SIZE DISTRIBUTION

FILL: Silty Sand with Gravel

Location 3: 11+850 to 12+900

Figure No. 12

Project No. 1047243



Stantec

GRAIN SIZE DISTRIBUTION

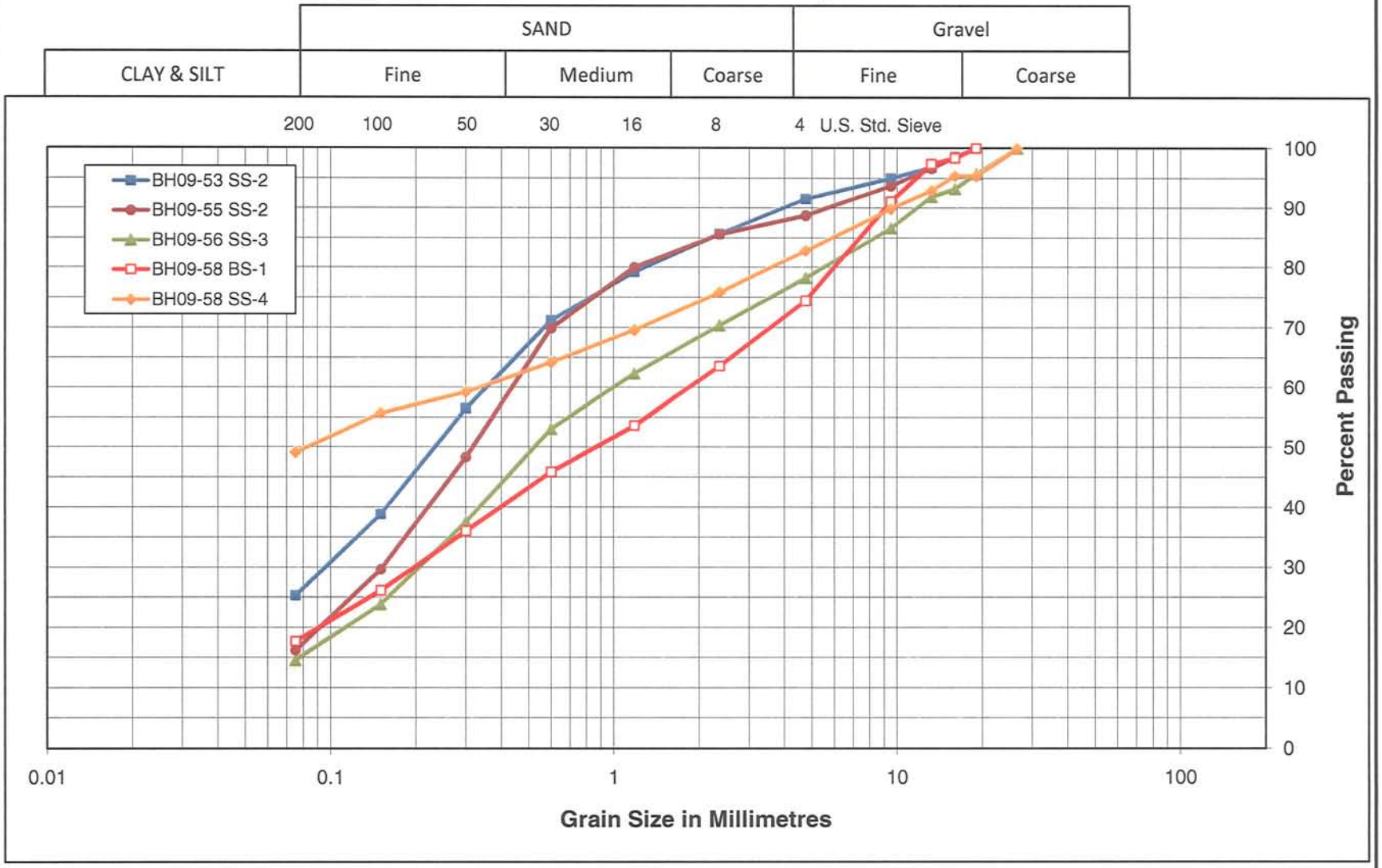
FILL: Silty Sand with Gravel

Location 3: 11+850 to 12+900

Figure No. 13

Project No. 1047243

Unified Soil Classification System



Stantec

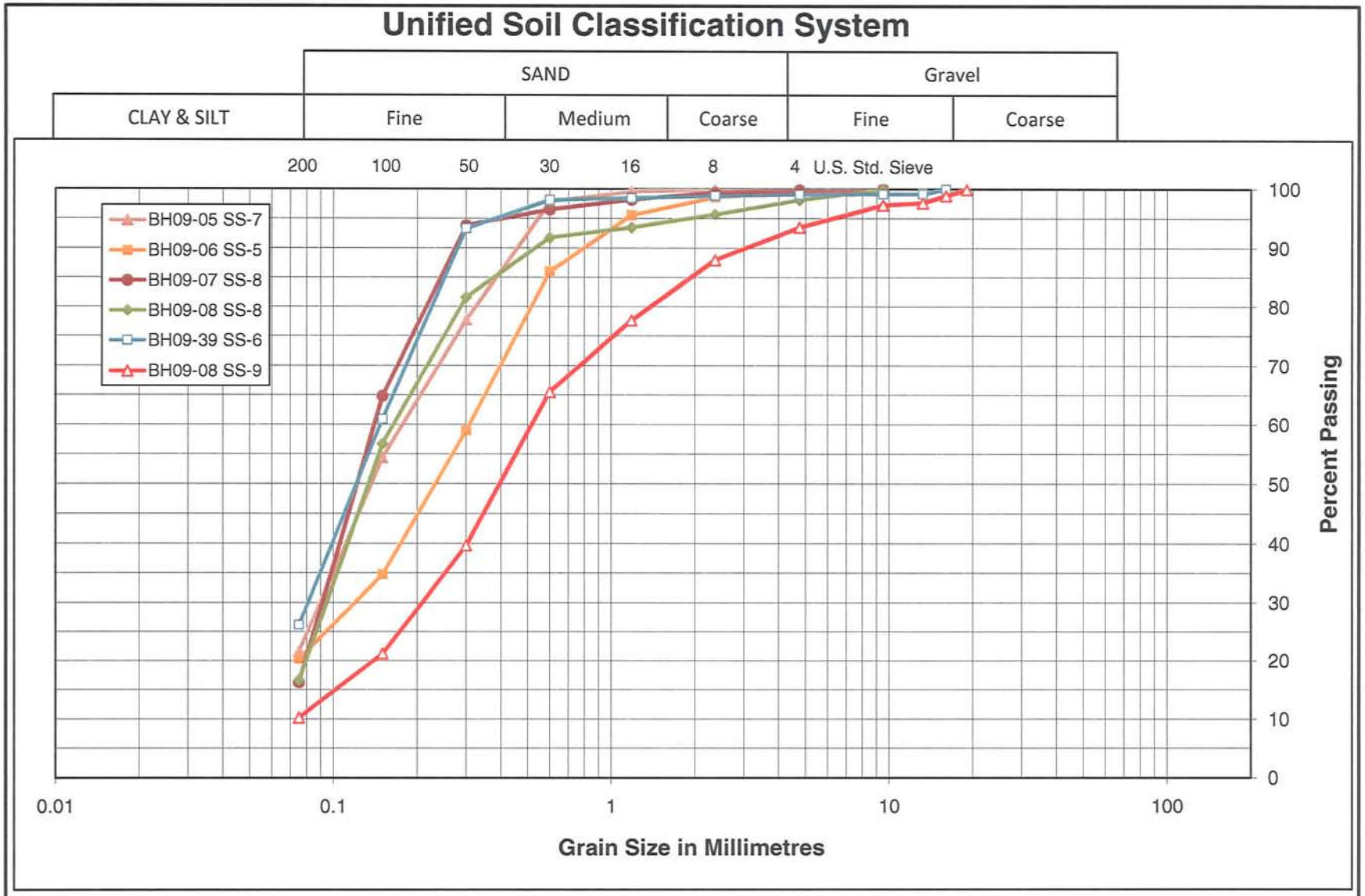
GRAIN SIZE DISTRIBUTION

FILL: Silty Sand to Silty Sand with Gravel

Location 3: 11+850 to 12+900

Figure No. 14

Project No. 1047243



Stantec

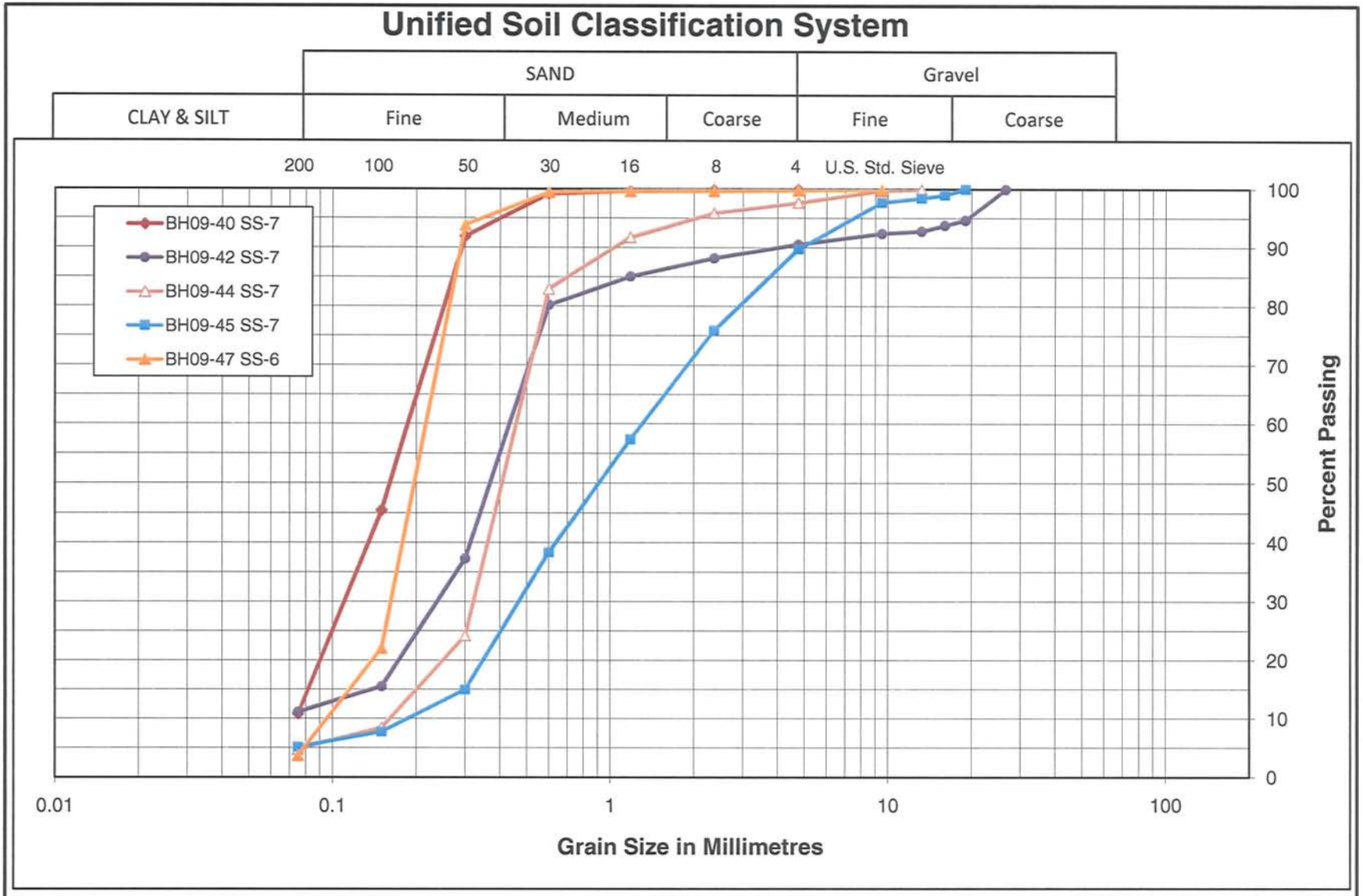
GRAIN SIZE DISTRIBUTION

SILTY SAND

Location 3: 11+850 to 12+900

Figure No. 15

Project No. 1047243



Stantec

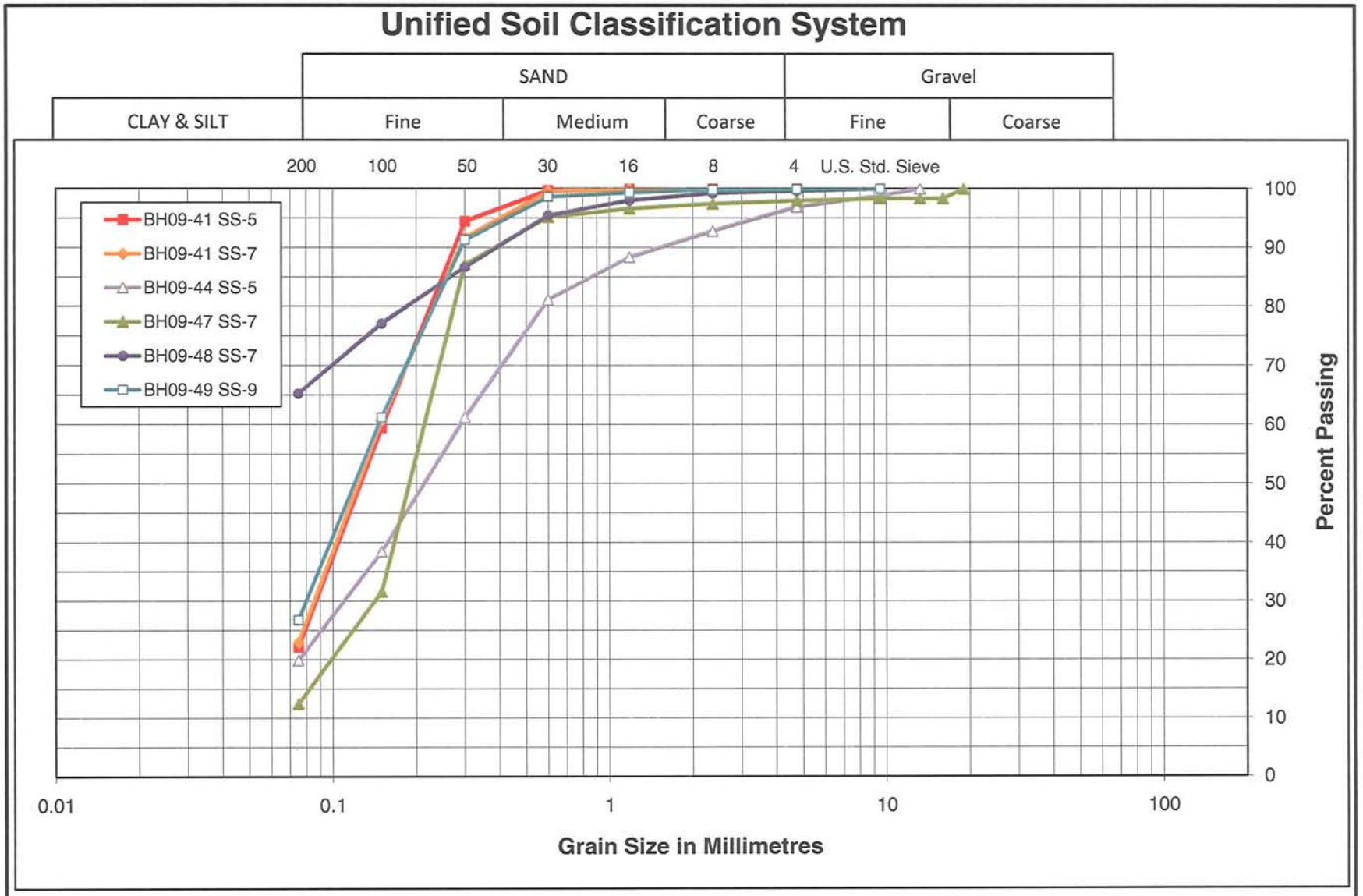
GRAIN SIZE DISTRIBUTION

SAND: Well-graded to poorly-graded

Location 3: 11+850 to 12+900

Figure No. 16

Project No. 1047243



Stantec

GRAIN SIZE DISTRIBUTION

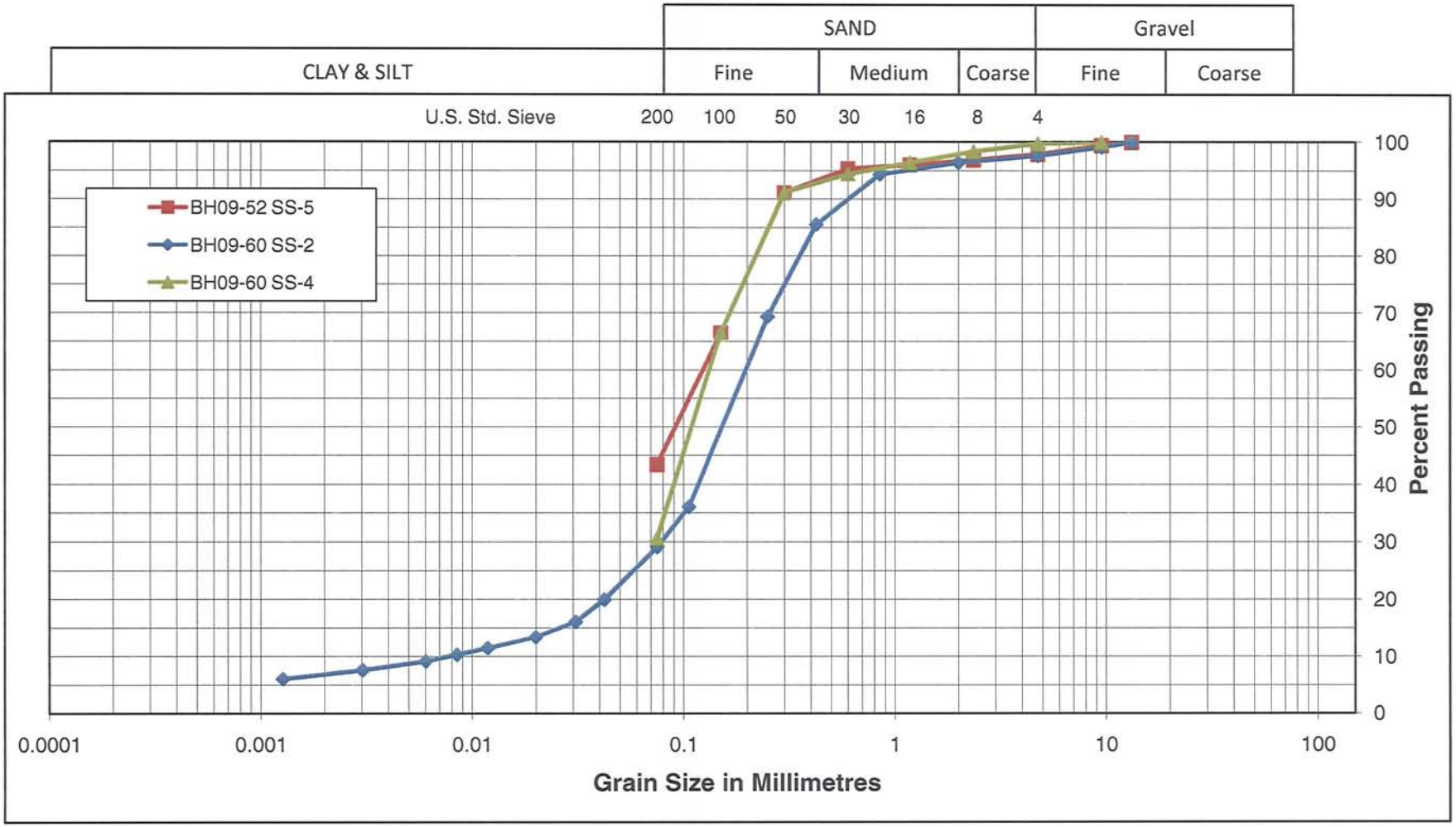
SILTY SAND

Location 3: 11+850 to 12+900

Figure No. 17

Project No. 1047243

Unified Soil Classification System



Stantec

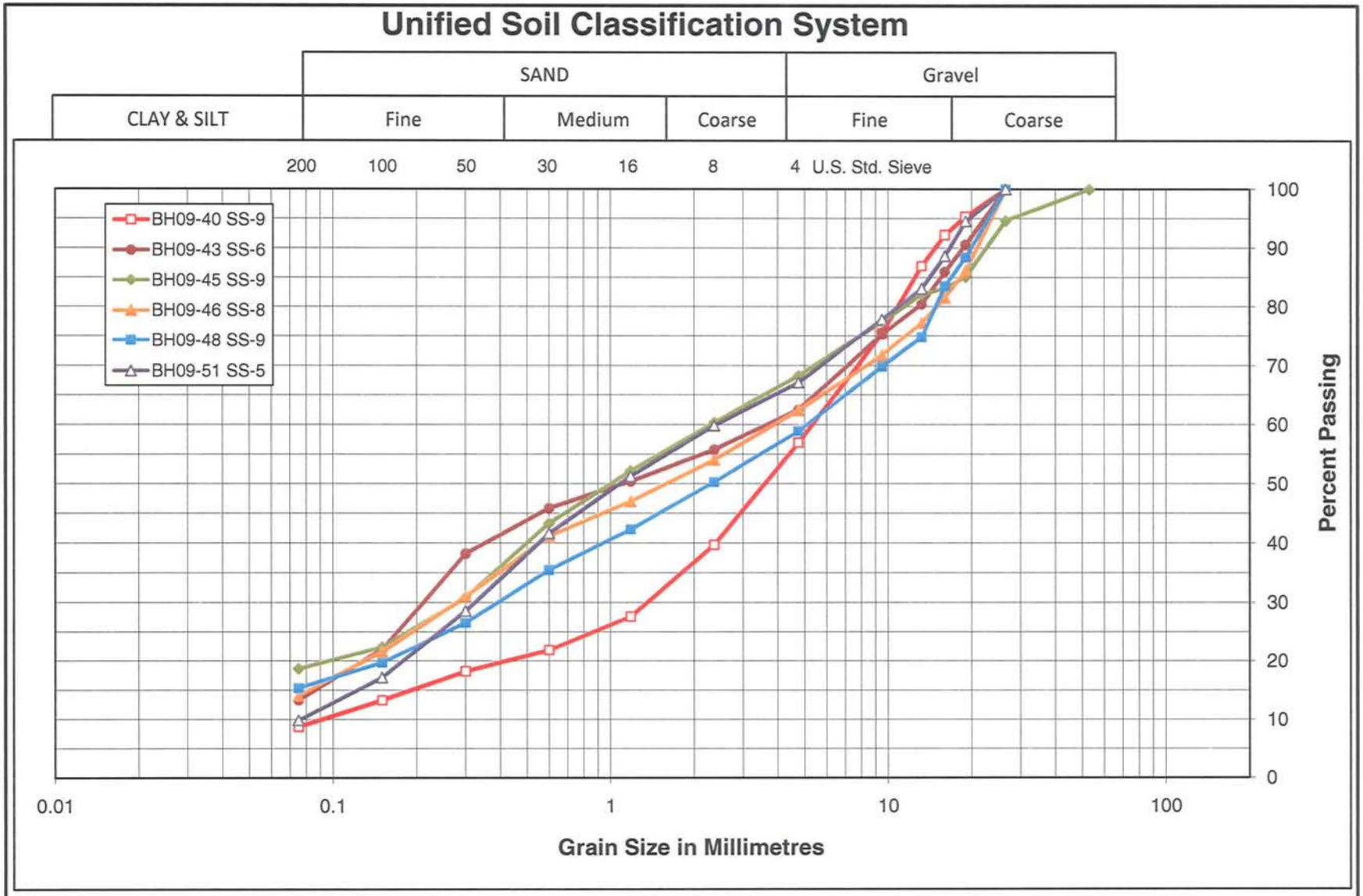
GRAIN SIZE DISTRIBUTION

SILTY SAND

Location 3: 11+850 to 12+900

Figure No. 18

Project No. 1047243



Stantec

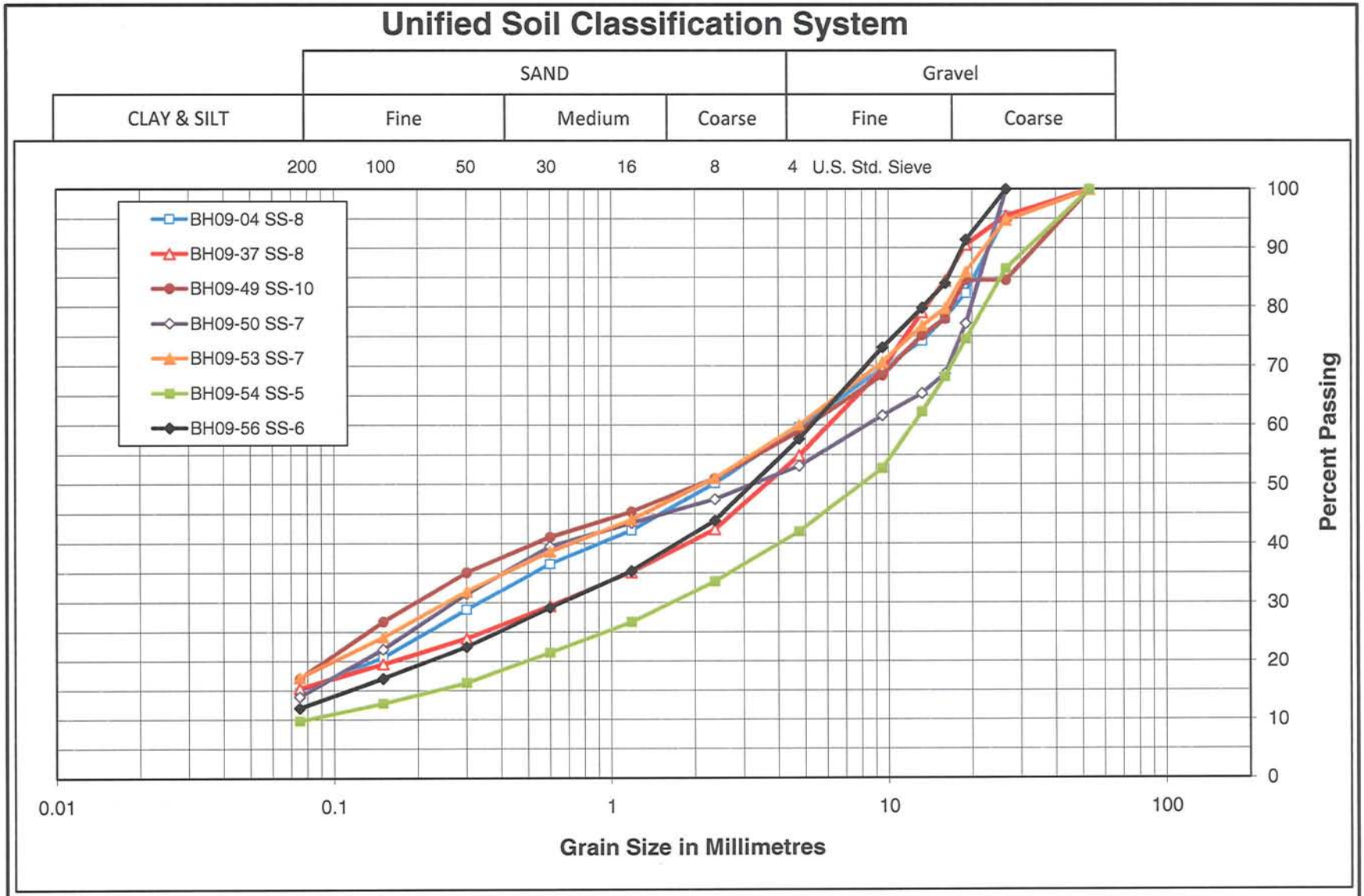
GRAIN SIZE DISTRIBUTION

TILL: Silty Sand with Gravel

Location 3: 11+850 to 12+900

Figure No. 19

Project No. 1047243



Stantec

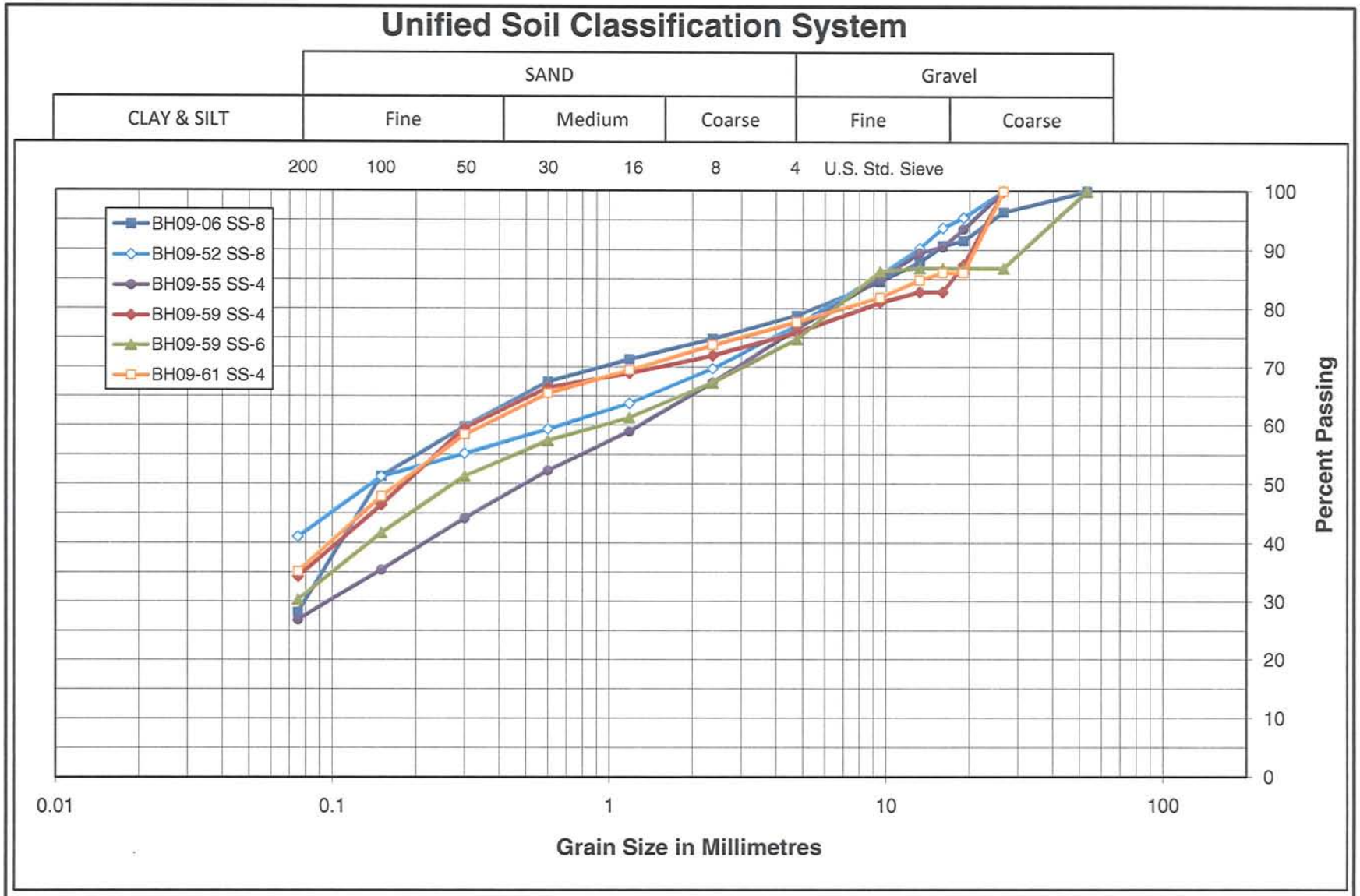
GRAIN SIZE DISTRIBUTION

TILL: Silty Sand with Gravel

Location 3: 11+850 to 12+900

Figure No. 20

Project No. 1047243



Stantec

GRAIN SIZE DISTRIBUTION

TILL: Silty Sand with Gravel

Location 3: 11+850 to 12+900

Figure No. 21

Project No. 1047243

Golder Associates

August 25, 2009 Project No. 09-1116-0030

Mr. Paul Carnaffan
Jacques Whitford Stantec Limited
2781 Lancaster Road
Suite 200
Ottawa, Ontario
K1B 1A7

RE: GEOTECHNICAL LABORATORY TESTING

Dear Sir

This letter reports the results of laboratory testing carried out on the samples received at our office in Mississauga. The results of the tests are summarized in the following table and figures.

We trust that the results are sufficient for your current requirements. If you have any questions, please do not hesitate to call us.

GOLDER ASSOCIATES LTD.

Marijana Manojlovic
Laboratory Manager

MM/lg

n:\admin\lab\2009\09-1116-0030\letter.docx

50 BEST EMPLOYERS IN CANADA 2009 REPORT ON BUSINESS

50 BEST MANAGED COMPANIES

Golder Associates Ltd.
2390 Argentia Road, Mississauga, Ontario, Canada L5N 5Z7
Tel: +1 (905) 567 4444 Fax: +1 (905) 567 6561 www.golder.com
Golder Associates: Operations in Africa, Asia, Australasia, Europe, North America and South America

OEDOMETER CONSOLIDATION SUMMARY

SAMPLE IDENTIFICATION

Project Number	09-1116-0030	Sample Number	ST-6
Borehole Number	09-17	Sample Depth, m	3.8-4.4

TEST CONDITIONS

Test Type	Standard	Load Duration, hr	24
Oedometer Number	2		
Date Started	07/17/2009		
Date Completed	08/06/2009		

SAMPLE DIMENSIONS AND PROPERTIES - INITIAL

Sample Height, cm	2.54	Unit Weight, kN/m^3	9.33
Sample Diameter, cm	6.34	Dry Unit Weight, kN/m^3	1.53
Area, cm^2	31.57	Specific Gravity, measured	1.51
Volume, cm^3	80.28	Solids Height, cm	0.262
Water Content, %	511.61	Volume of Solids, cm^3	8.27
Wet Mass, g	76.39	Volume of Voids, cm^3	72.01
Dry Mass, g	12.49	Degree of Saturation, %	88.7

TEST COMPUTATIONS

Pressure kPa	Corr. Height cm	Void Ratio	Average Height cm	t_{90} sec	cv. cm^2/s	mv m^2/kN	k cm/s
0.00	2.543	8.706	2.543				
4.71	2.500	8.542	2.522	5	2.70E-01	3.59E-03	9.48E-05
9.48	2.469	8.422	2.484	4	3.27E-01	2.59E-03	8.30E-05
19.31	2.394	8.135	2.431	17	7.37E-02	3.00E-03	2.17E-05
38.90	2.240	7.548	2.317	15	7.58E-02	3.09E-03	2.29E-05
77.62	1.935	6.383	2.087	14	6.60E-02	3.10E-03	2.00E-05
155.17	1.525	4.820	1.730	17	3.73E-02	2.08E-03	7.59E-06
310.37	1.189	3.536	1.357	60	6.50E-03	8.53E-04	5.43E-07
620.50	0.924	2.528	1.056	60	3.94E-03	3.35E-04	1.29E-07
1241.19	0.736	1.807	0.830	50	2.92E-03	1.20E-04	3.43E-08
2481.76	0.589	1.249	0.662	46	2.02E-03	4.63E-05	9.18E-09
1241.19	0.613	1.338	0.601				
310.37	0.715	1.727	0.664				
77.62	0.810	2.093	0.762				
19.31	0.880	2.358	0.845				
4.71	0.923	2.523	0.902				

Note:
k calculated using cv based on t_{90} values.

SAMPLE DIMENSIONS AND PROPERTIES - FINAL

Sample Height, cm	0.92	Unit Weight, kN/m^3	11.90
Sample Diameter, cm	6.34	Dry Unit Weight, kN/m^3	4.20
Area, cm^2	31.57	Specific Gravity, measured	1.51
Volume, cm^3	29.14	Solids Height, cm	0.262
Water Content, %	183.11	Volume of Solids, cm^3	8.27
Wet Mass, g	35.36	Volume of Voids, cm^3	20.87
Dry Mass, g	12.49		

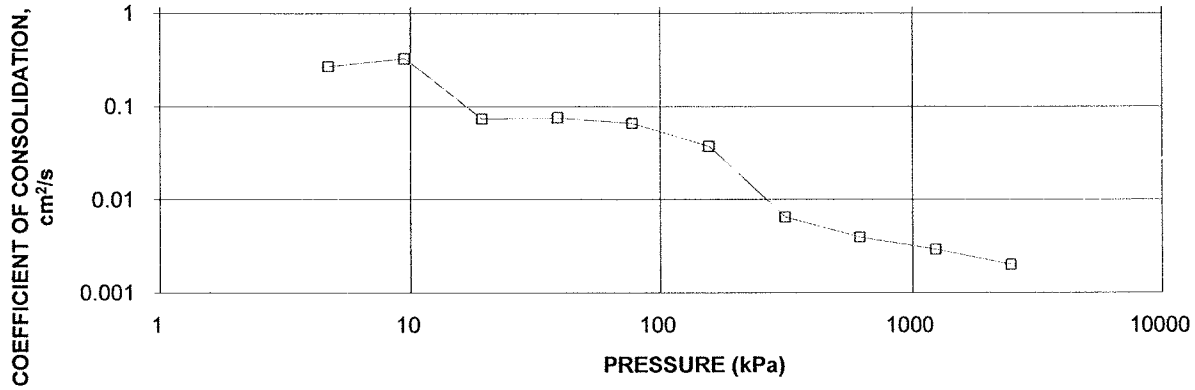
Prepared By: LH

Golder Associates

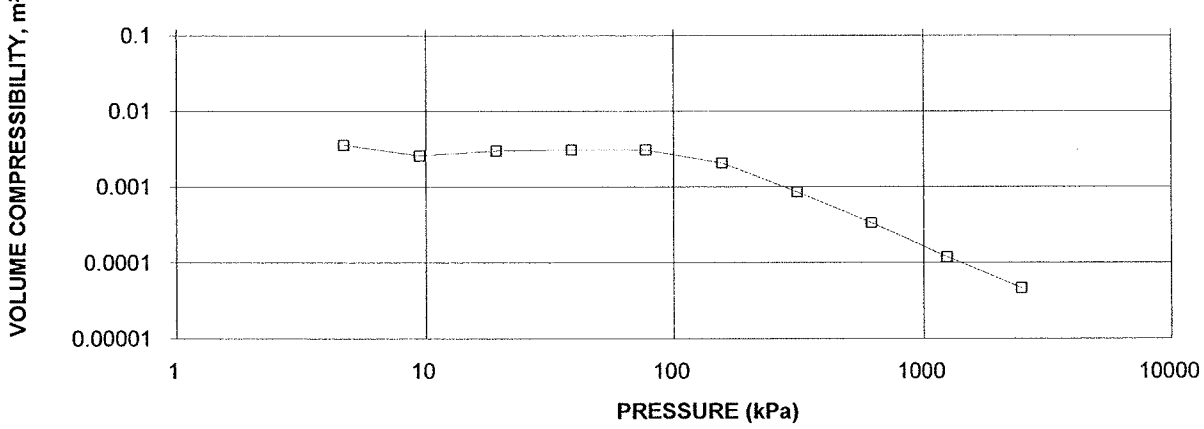
Checked By: MM

OEDOMETER CONSOLIDATION SUMMARY

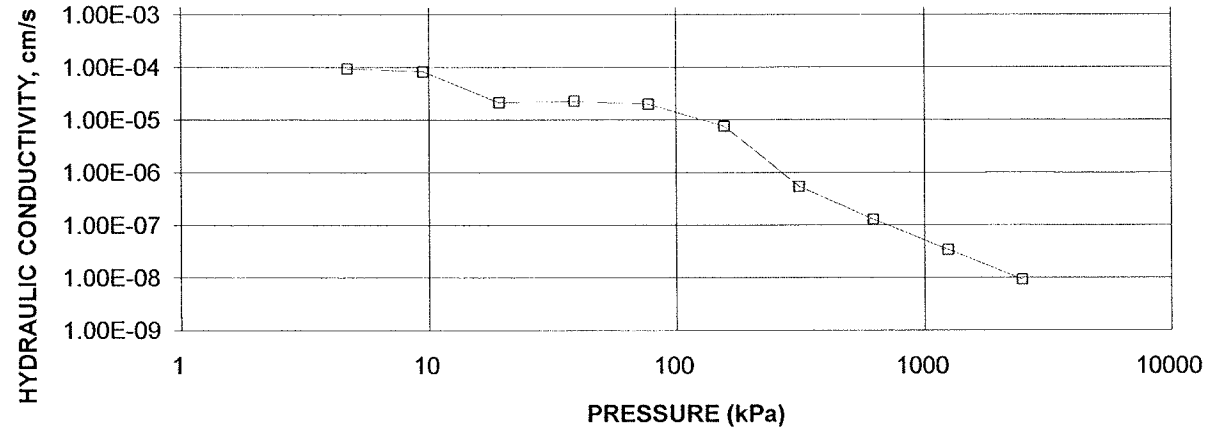
CONSOLIDATION TEST
CV cm^2/s VS PRESSURE (kPa)
BH 09-17 SA ST-6



CONSOLIDATION TEST
MV m^2/kN vs PRESSURE (kPa)
BH 09-17 SA ST-6

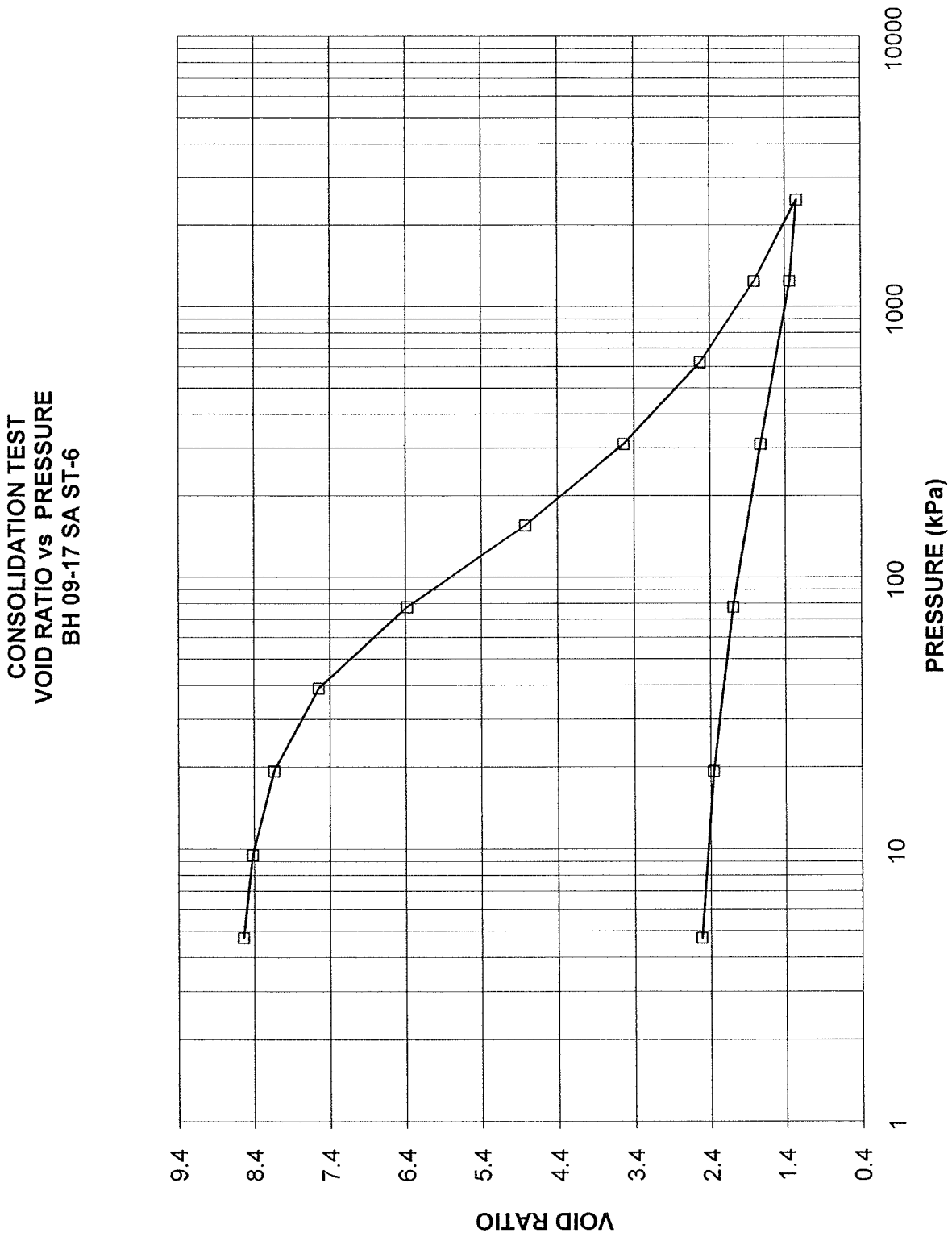


CONSOLIDATION TEST
HYDRAULIC CONDUCTIVITY vs PRESSURE
BH 09-17 SA ST-6



Project No. 09-1116-0030
Prepared By: LH
Golder Associates
Checked By: MM

CONSOLIDATION TEST VOID RATIO VS. LOG PRESSURE	FIGURE



Project No. 09-1116-0030

Prepared By: LH

Golder Associates

Checked By: MM

OEDOMETER CONSOLIDATION SUMMARY

SAMPLE IDENTIFICATION

Project Number	09-1116-0030	Sample Number	ST-5
Borehole Number	09-18	Sample Depth, m	2.7-3.3

TEST CONDITIONS

Test Type	Standard	Load Duration, hr	24
Oedometer Number	11		
Date Started	07/23/2009		
Date Completed	08/11/2009		

SAMPLE DIMENSIONS AND PROPERTIES - INITIAL

Sample Height, cm	2.54	Unit Weight, kN/m^3	8.59
Sample Diameter, cm	6.34	Dry Unit Weight, kN/m^3	1.08
Area, cm^2	31.57	Specific Gravity, measured	1.41
Volume, cm^3	80.16	Solids Height, cm	0.198
Water Content, %	694.90	Volume of Solids, cm^3	6.26
Wet Mass, g	70.19	Volume of Voids, cm^3	73.89
Dry Mass, g	8.83	Degree of Saturation, %	83.0

TEST COMPUTATIONS

Pressure kPa	Corr. Height cm	Void Ratio	Average Height cm	t_{90} sec	cv. cm^2/s	mv m^2/kN	k cm/s
0.00	2.539	11.799	2.539				
4.71	2.405	11.123	2.472	5	2.59E-01	1.12E-02	2.85E-04
9.48	2.243	10.307	2.324	6	1.91E-01	1.34E-02	2.50E-04
19.55	1.978	8.971	2.110	5	1.89E-01	1.04E-02	1.92E-04
39.01	1.618	7.156	1.798	22	3.11E-02	7.29E-03	2.22E-05
78.01	1.290	5.502	1.454	49	9.14E-03	3.31E-03	2.97E-06
156.03	0.989	3.984	1.139	131	2.10E-03	1.52E-03	3.13E-07
310.65	0.775	2.906	0.882	462	3.57E-04	5.45E-04	1.90E-08
78.01	0.839	3.228	0.807				
19.47	0.922	3.648	0.880				
4.71	0.985	3.966	0.954				

Note:
k calculated using cv based on t_{90} values.

SAMPLE DIMENSIONS AND PROPERTIES - FINAL

Sample Height, cm	0.99	Unit Weight, kN/m^3	11.05
Sample Diameter, cm	6.34	Dry Unit Weight, kN/m^3	2.78
Area, cm^2	31.57	Specific Gravity, measured	1.41
Volume, cm^3	31.10	Solids Height, cm	0.198
Water Content, %	296.94	Volume of Solids, cm^3	6.26
Wet Mass, g	35.05	Volume of Voids, cm^3	24.83
Dry Mass, g	8.83		

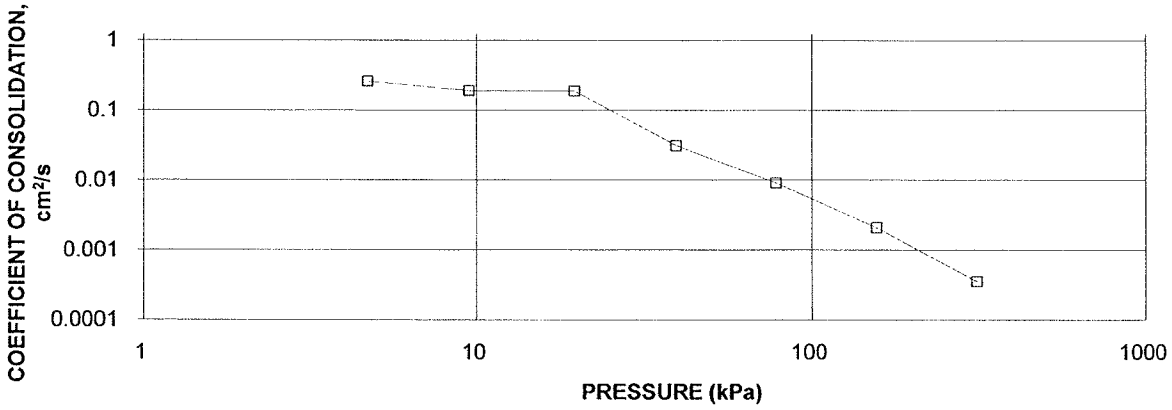
Prepared By: LH

Golder Associates

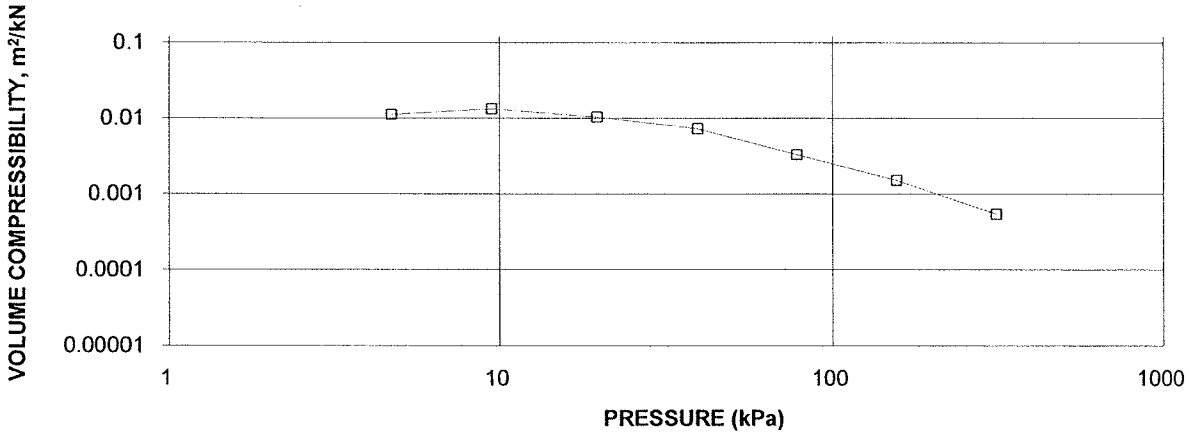
Checked By: MM

OEDOMETER CONSOLIDATION SUMMARY

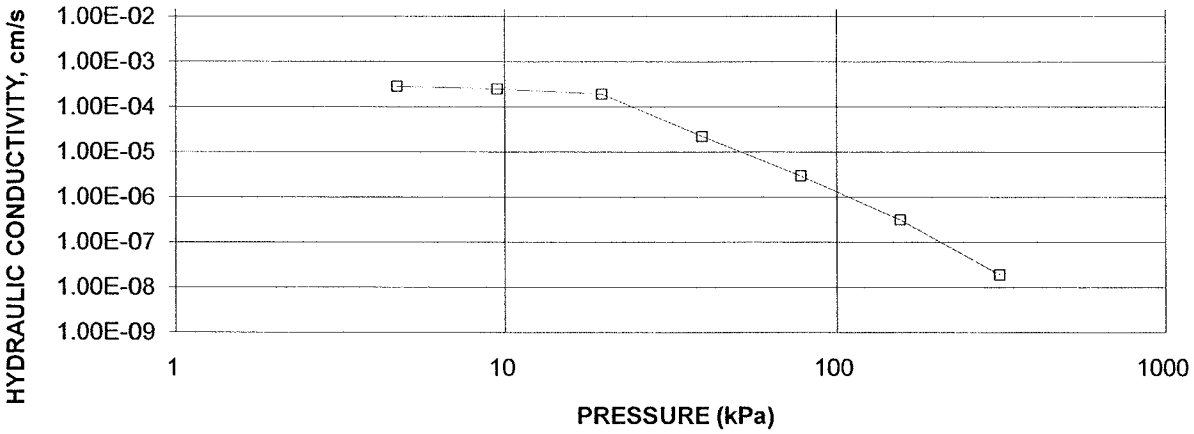
CONSOLIDATION TEST
CV cm^2/s VS PRESSURE (kPa)
BH 09-18 SA ST-5



CONSOLIDATION TEST
MV m^2/kN vs PRESSURE (kPa)
BH 09-18 SA ST-5



CONSOLIDATION TEST
HYDRAULIC CONDUCTIVITY vs PRESSURE
BH 09-18 SA ST-5

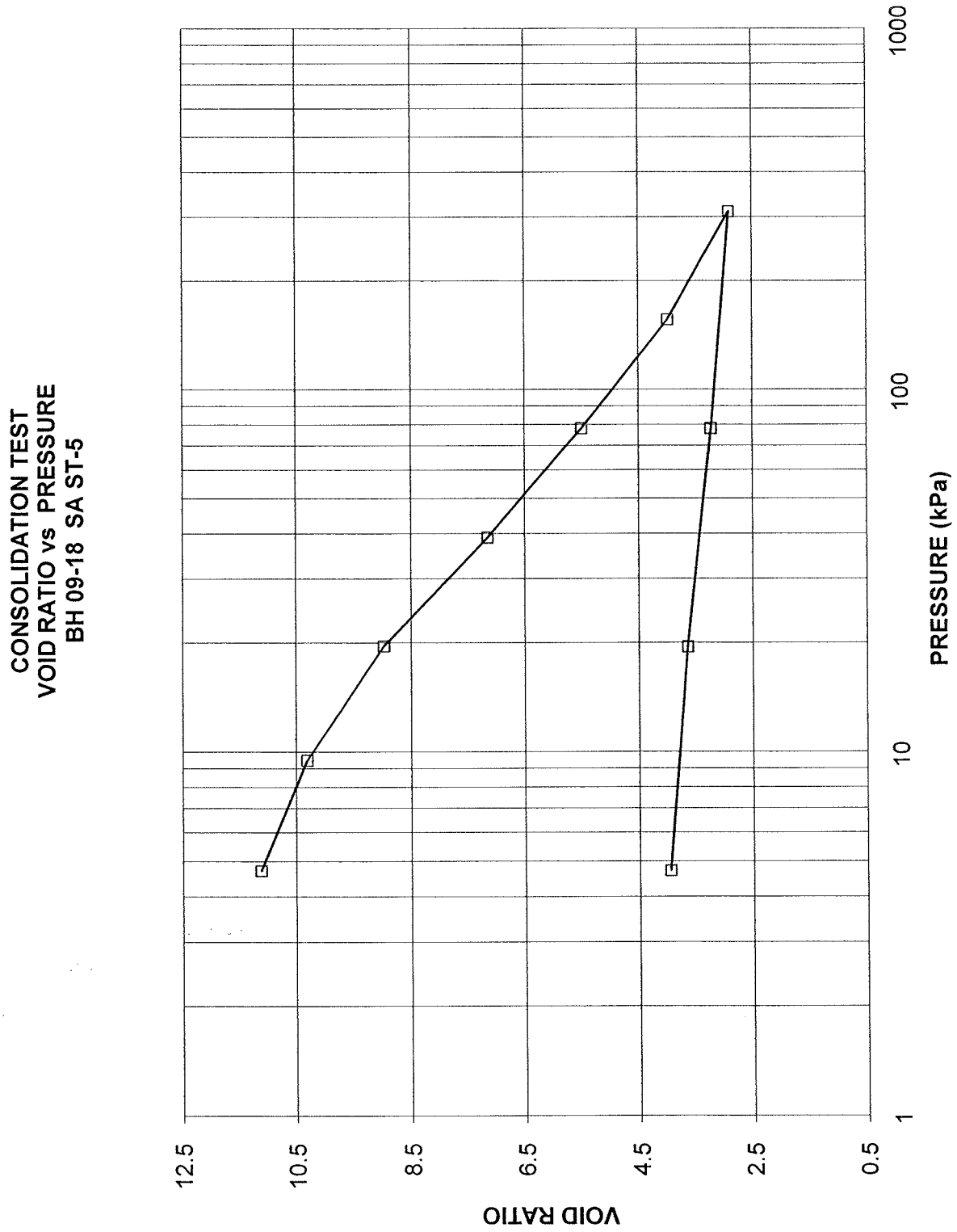


Project No. 09-1116-0030
Prepared By: LH

Golder Associates

Checked By: MM

CONSOLIDATION TEST VOID RATIO VS. LOG PRESSURE	FIGURE



Project No. 09-1116-0030

Prepared By: LH

Golder Associates

Checked By: MM

OEDOMETER CONSOLIDATION SUMMARY

SAMPLE IDENTIFICATION

Project Number	09-1116-0030	Sample Number	ST-4
Borehole Number	09-23	Sample Depth, m	2.3-2.9

TEST CONDITIONS

Test Type	Standard	Load Duration, hr	24
Oedometer Number	3		
Date Started	07/17/2009		
Date Completed	08/06/2009		

SAMPLE DIMENSIONS AND PROPERTIES - INITIAL

Sample Height, cm	2.54	Unit Weight, kN/m^3	10.19
Sample Diameter, cm	6.35	Dry Unit Weight, kN/m^3	2.66
Area, cm^2	31.62	Specific Gravity, measured	1.59
Volume, cm^3	80.28	Solids Height, cm	0.433
Water Content, %	283.23	Volume of Solids, cm^3	13.69
Wet Mass, g	83.39	Volume of Voids, cm^3	66.60
Dry Mass, g	21.76	Degree of Saturation, %	92.5

TEST COMPUTATIONS

Pressure kPa	Corr. Height cm	Void Ratio	Average Height cm	t_{90} sec	cv. cm^2/s	mv m^2/kN	k cm/s
0.00	2.539	4.866	2.539				
4.74	2.539	4.865	2.539	7	1.95E-01	4.15E-05	7.95E-07
9.56	2.530	4.844	2.534	3	4.54E-01	7.35E-04	3.27E-05
19.08	2.509	4.796	2.519	8	1.68E-01	8.69E-04	1.43E-05
40.46	2.456	4.674	2.482	8	1.63E-01	9.69E-04	1.55E-05
77.55	2.356	4.443	2.406	8	1.53E-01	1.06E-03	1.59E-05
154.90	2.094	3.838	2.225	25	4.20E-02	1.33E-03	5.49E-06
309.83	1.748	3.038	1.921	82	9.54E-03	8.80E-04	8.23E-07
619.24	1.422	2.285	1.585	100	5.32E-03	4.15E-04	2.16E-07
1241.34	1.167	1.695	1.294	75	4.73E-03	1.62E-04	7.50E-08
2480.73	0.968	1.235	1.067	41	5.89E-03	6.33E-05	3.65E-08
1241.34	0.990	1.286	0.979				
309.83	1.088	1.514	1.039				
77.55	1.173	1.709	1.130				
19.08	1.248	1.884	1.211				
4.74	1.296	1.995	1.272				

Note:
k calculated using cv based on t_{90} values.

SAMPLE DIMENSIONS AND PROPERTIES - FINAL

Sample Height, cm	1.30	Unit Weight, kN/m^3	12.27
Sample Diameter, cm	6.35	Dry Unit Weight, kN/m^3	5.21
Area, cm^2	31.62	Specific Gravity, measured	1.59
Volume, cm^3	40.99	Solids Height, cm	0.433
Water Content, %	135.66	Volume of Solids, cm^3	13.69
Wet Mass, g	51.28	Volume of Voids, cm^3	27.31
Dry Mass, g	21.76		

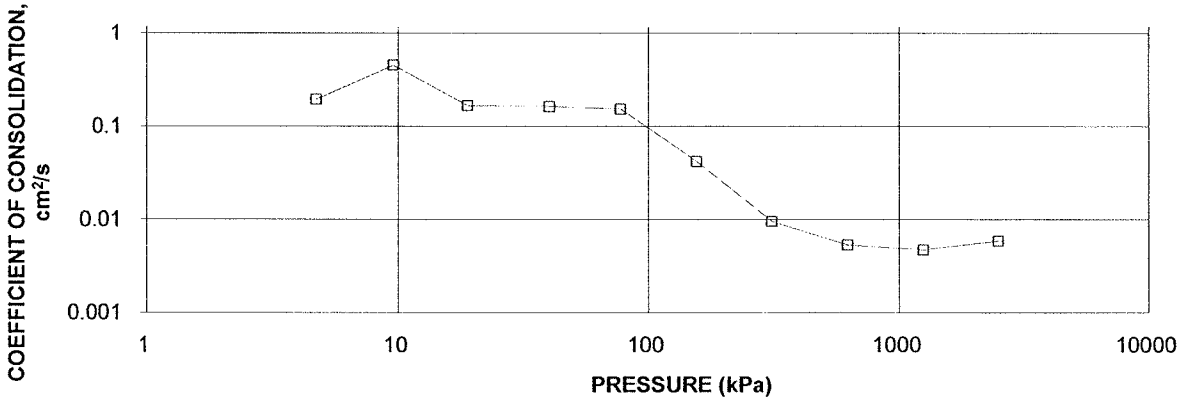
Prepared By: LH

Golder Associates

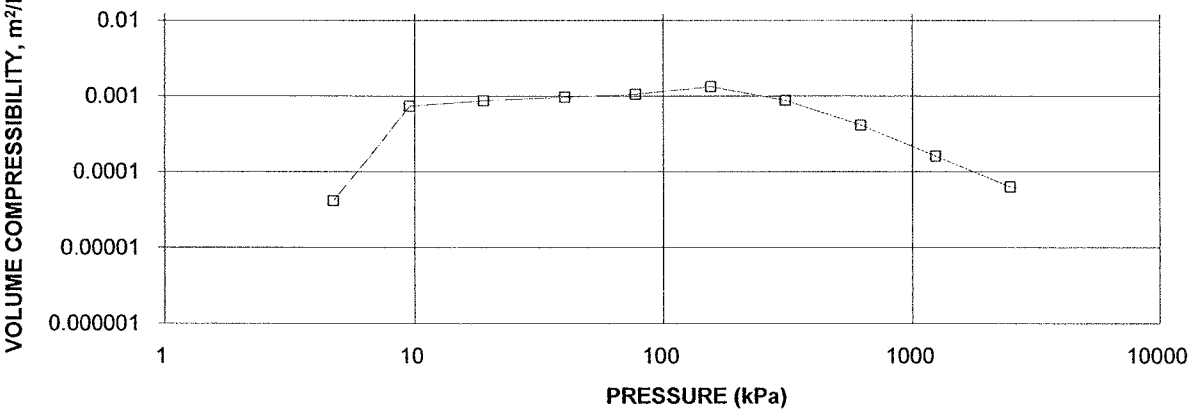
Checked By: MM

OEDOMETER CONSOLIDATION SUMMARY

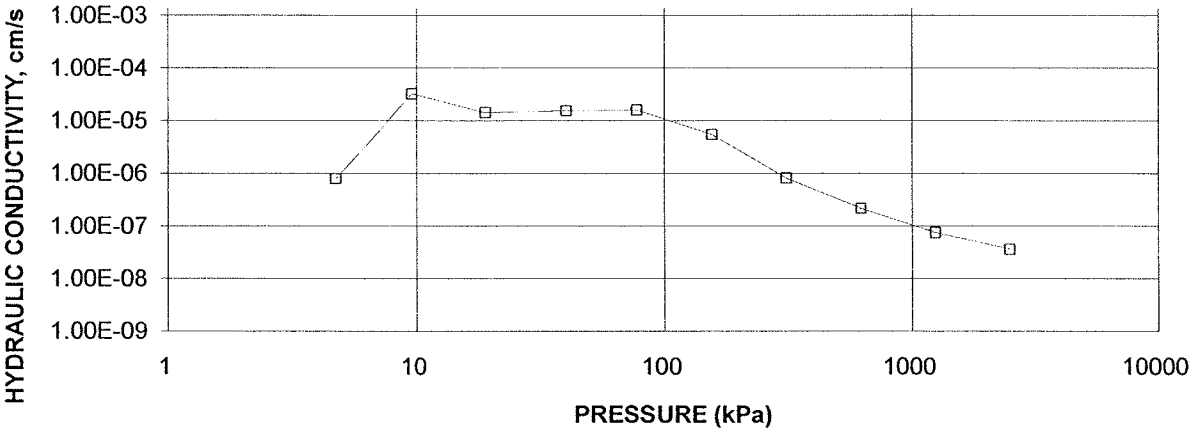
CONSOLIDATION TEST
CV cm^2/s VS PRESSURE (kPa)
BH 09-23 SA ST-4



CONSOLIDATION TEST
MV m^2/kN vs PRESSURE (kPa)
BH 09-23 SA ST-4

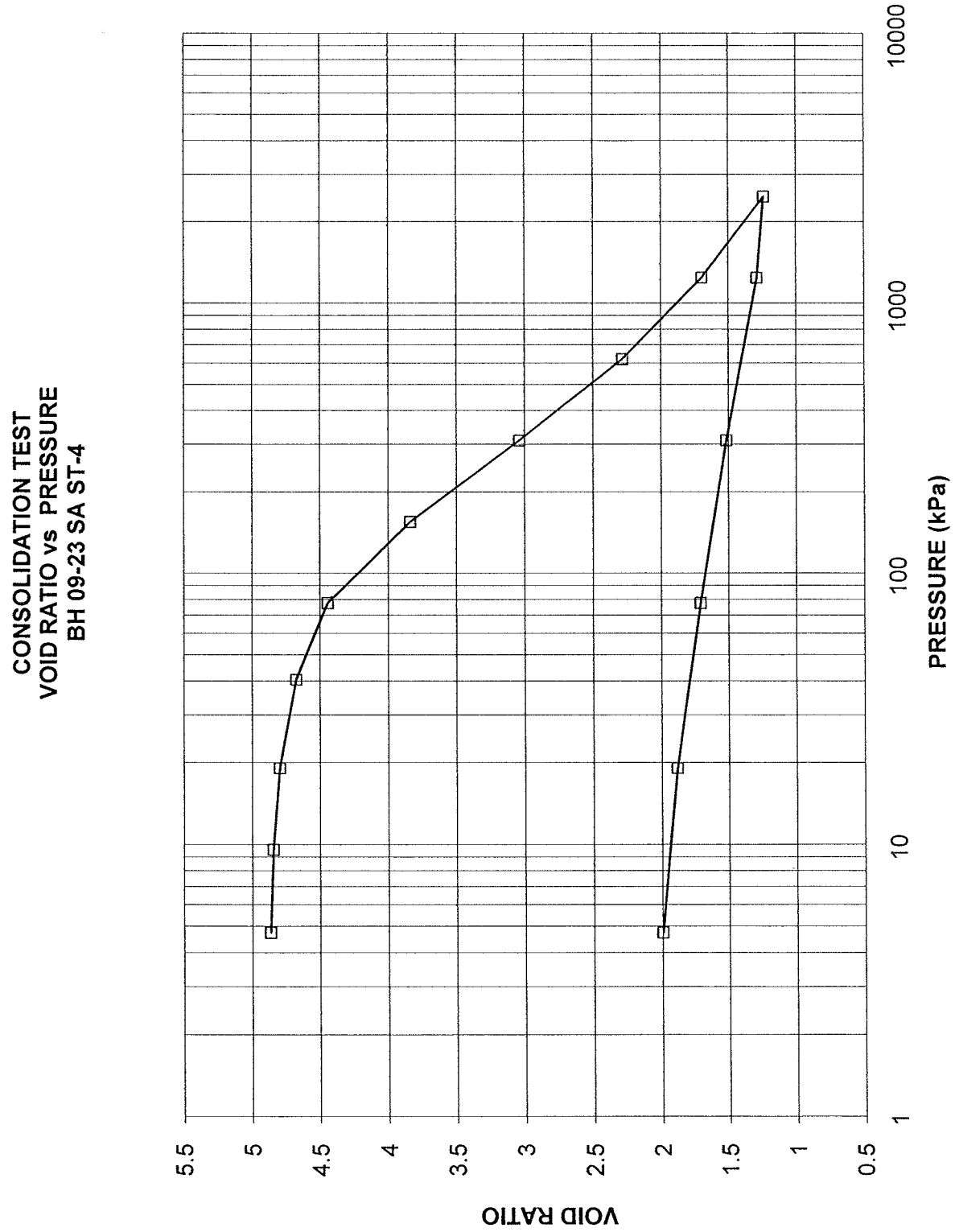


CONSOLIDATION TEST
HYDRAULIC CONDUCTIVITY vs PRESSURE
BH 09-23 SA ST-4



Project No. 09-1116-0030
Prepared By: LH
Golder Associates
Checked By: MM

CONSOLIDATION TEST VOID RATIO VS. LOG PRESSURE	FIGURE



Project No. 09-1116-0030

Prepared By: LH

Golder Associates

Checked By: MM

OEDOMETER CONSOLIDATION SUMMARY

SAMPLE IDENTIFICATION

Project Number	09-1116-0030	Sample Number	ST-1
Borehole Number	09-33	Sample Depth, m	0.8-1.4

TEST CONDITIONS

Test Type	Standard	Load Duration, hr	24
Oedometer Number	5		
Date Started	07/17/2009		
Date Completed	08/06/2009		

SAMPLE DIMENSIONS AND PROPERTIES - INITIAL

Sample Height, cm	1.91	Unit Weight, kN/m^3	11.44
Sample Diameter, cm	6.34	Dry Unit Weight, kN/m^3	3.32
Area, cm^2	31.53	Specific Gravity, measured	2.51
Volume, cm^3	60.10	Solids Height, cm	0.257
Water Content, %	244.40	Volume of Solids, cm^3	8.11
Wet Mass, g	70.12	Volume of Voids, cm^3	51.98
Dry Mass, g	20.36	Degree of Saturation, %	95.7

TEST COMPUTATIONS

Pressure kPa	Corr. Height cm	Void Ratio	Average Height cm	t_{90} sec	cv. cm^2/s	mv m^2/kN	k cm/s
0.00	1.906	6.409	1.906				
4.65	1.796	5.981	1.851	18	4.04E-02	1.24E-02	4.91E-05
9.58	1.714	5.662	1.755	317	2.06E-03	8.73E-03	1.76E-06
19.50	1.590	5.180	1.652	382	1.51E-03	6.56E-03	9.74E-07
38.83	1.412	4.488	1.501	222	2.15E-03	4.83E-03	1.02E-06
77.79	1.210	3.702	1.311	346	1.05E-03	2.72E-03	2.81E-07
155.56	1.031	3.007	1.120	518	5.14E-04	1.21E-03	6.07E-08
314.40	0.881	2.423	0.956	614	3.15E-04	4.96E-04	1.53E-08
625.87	0.759	1.949	0.820	398	3.58E-04	2.05E-04	7.20E-09
1246.42	0.666	1.588	0.712	60	1.79E-03	7.87E-05	1.38E-08
2488.44	0.578	1.246	0.622	50	1.64E-03	3.72E-05	5.97E-09
1246.42	0.590	1.295	0.584				
314.40	0.621	1.413	0.606				
77.79	0.664	1.582	0.642				
19.50	0.722	1.804	0.693				
4.65	0.767	1.981	0.744				

Note:

k calculated using cv based on t_{90} values.

Sample looks like marl

SAMPLE DIMENSIONS AND PROPERTIES - FINAL

Sample Height, cm	0.77	Unit Weight, kN/m^3	14.98
Sample Diameter, cm	6.34	Dry Unit Weight, kN/m^3	8.26
Area, cm^2	31.53	Specific Gravity, measured	2.51
Volume, cm^3	24.18	Solids Height, cm	0.257
Water Content, %	81.43	Volume of Solids, cm^3	8.11
Wet Mass, g	36.94	Volume of Voids, cm^3	16.07
Dry Mass, g	20.36		

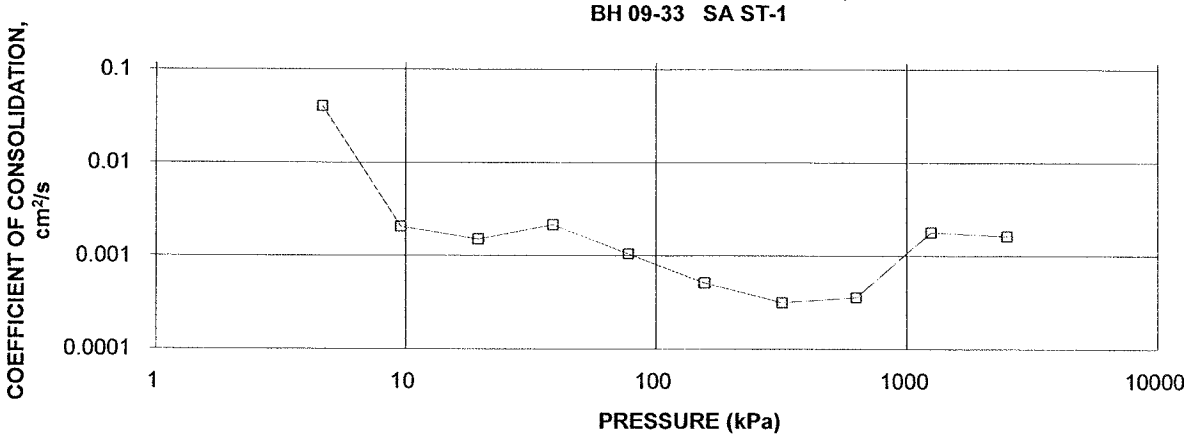
Prepared By: LH

Golder Associates

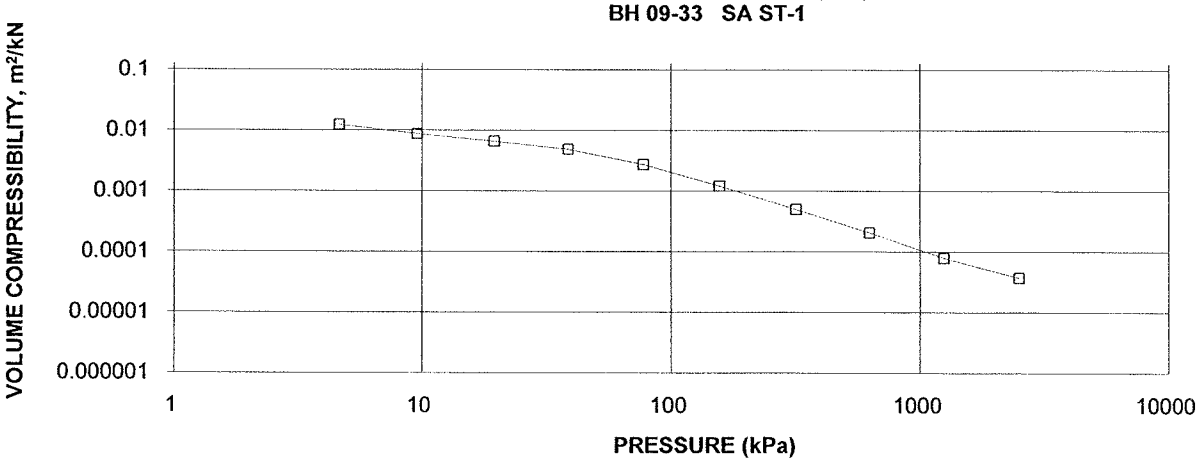
Checked By: MM

OEDOMETER CONSOLIDATION SUMMARY

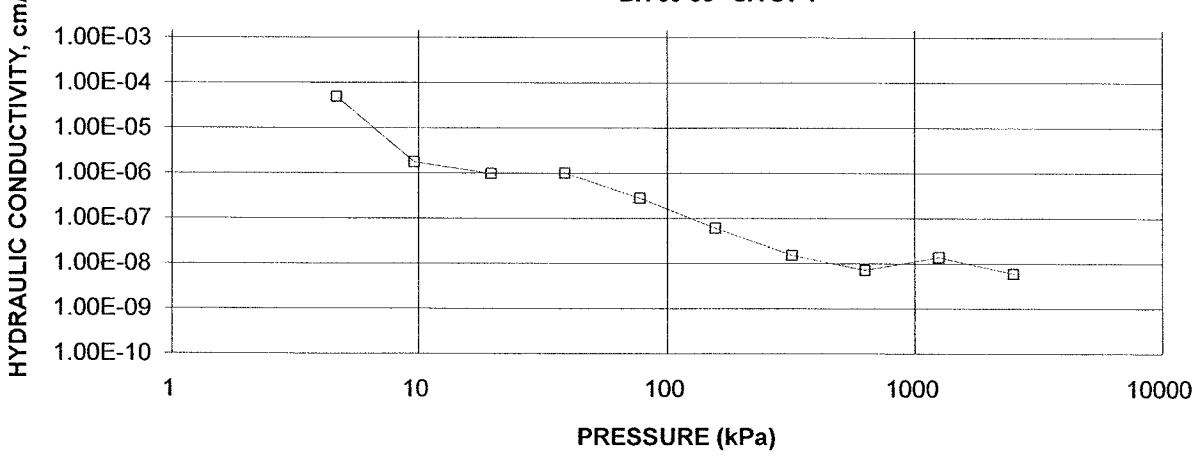
CONSOLIDATION TEST
CV cm^2/s VS PRESSURE (kPa)
BH 09-33 SA ST-1



CONSOLIDATION TEST
MV m^2/kN vs PRESSURE (kPa)
BH 09-33 SA ST-1



CONSOLIDATION TEST
HYDRAULIC CONDUCTIVITY vs PRESSURE
BH 09-33 SA ST-1

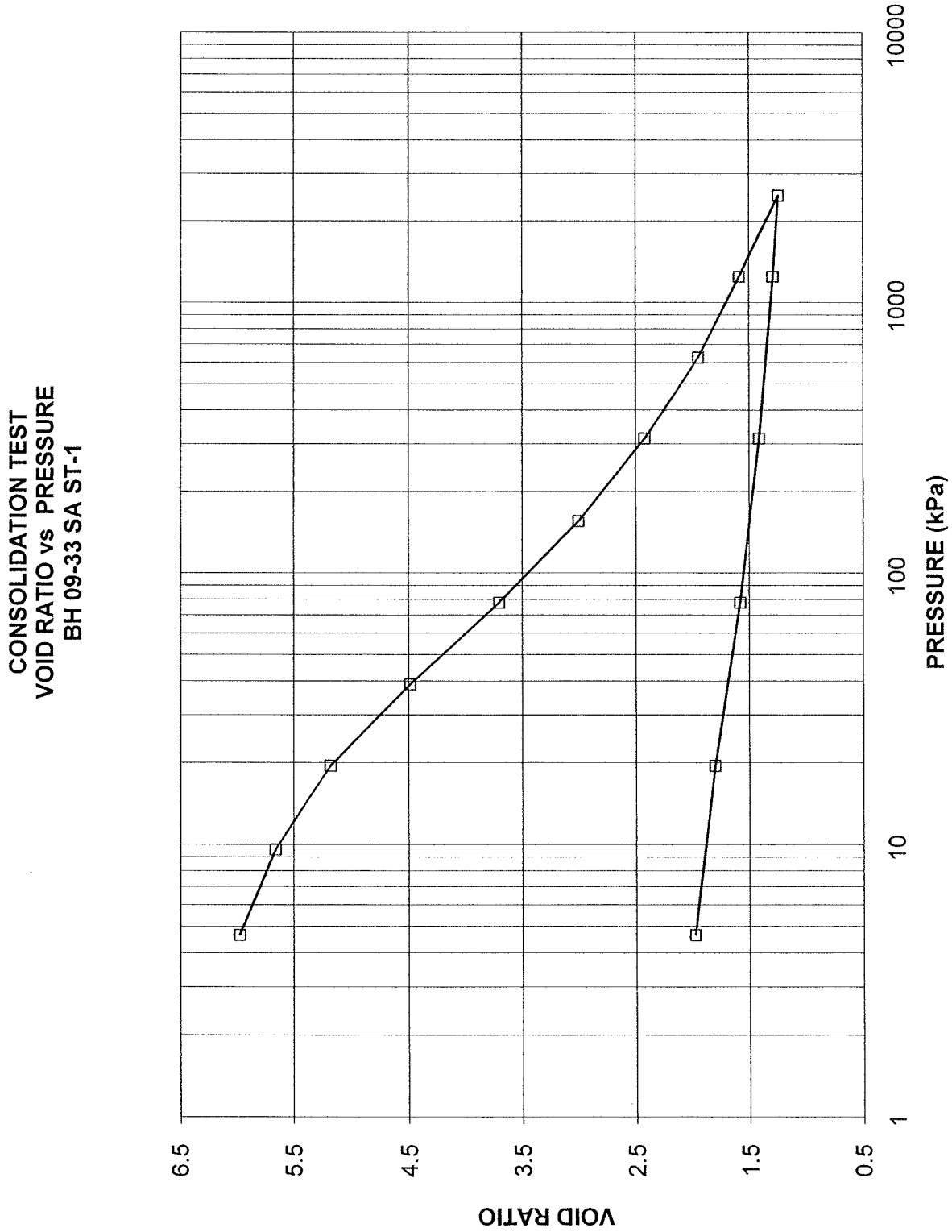


Project No. 09-1116-0030
Prepared By: LH

Golder Associates

Checked By: MM

CONSOLIDATION TEST VOID RATIO VS. LOG PRESSURE	FIGURE



Project No. 09-1116-0030

Prepared By: LH

Golder Associates

Checked By: MM

OEDOMETER CONSOLIDATION SUMMARY

SAMPLE IDENTIFICATION

Project Number	09-1116-0030	Sample Number	ST-4
Borehole Number	09-41	Sample Depth, m	2.1-2.7

TEST CONDITIONS

Test Type	Standard	Load Duration, hr	24
Oedometer Number	9		
Date Started	07/17/2009		
Date Completed	08/05/2009		

SAMPLE DIMENSIONS AND PROPERTIES - INITIAL

Sample Height, cm	1.90	Unit Weight, kN/m^3	9.29
Sample Diameter, cm	6.33	Dry Unit Weight, kN/m^3	1.31
Area, cm^2	31.47	Specific Gravity, measured	1.47
Volume, cm^3	59.89	Solids Height, cm	0.172
Water Content, %	612.05	Volume of Solids, cm^3	5.42
Wet Mass, g	56.75	Volume of Voids, cm^3	54.47
Dry Mass, g	7.97	Degree of Saturation, %	89.6

TEST COMPUTATIONS

Pressure kPa	Corr. Height cm	Void Ratio	Average Height cm	t_{90} sec	cv. cm^2/s	mv m^2/kN	k cm/s
0.00	1.903	10.046	1.903				
4.48	1.839	9.674	1.871	6	1.24E-01	7.51E-03	9.10E-05
9.38	1.753	9.175	1.796	5	1.37E-01	9.22E-03	1.24E-04
18.97	1.632	8.473	1.693	5	1.21E-01	6.63E-03	7.89E-05
40.77	1.389	7.062	1.511	7	6.91E-02	5.86E-03	3.97E-05
77.38	1.175	5.820	1.282	5	6.97E-02	3.07E-03	2.10E-05
155.62	0.954	4.537	1.065	20	1.20E-02	1.48E-03	1.75E-06
311.33	0.772	3.480	0.863	51	3.10E-03	6.15E-04	1.86E-07
622.29	0.625	2.628	0.698	94	1.10E-03	2.48E-04	2.68E-08
1244.34	0.509	1.954	0.567	89	7.66E-04	9.80E-05	7.35E-09
2490.46	0.414	1.402	0.461	43	1.05E-03	4.01E-05	4.13E-09
1244.34	0.436	1.528	0.425				
311.83	0.503	1.921	0.469				
77.38	0.566	2.287	0.535				
18.97	0.626	2.632	0.596				
4.48	0.669	2.883	0.647				

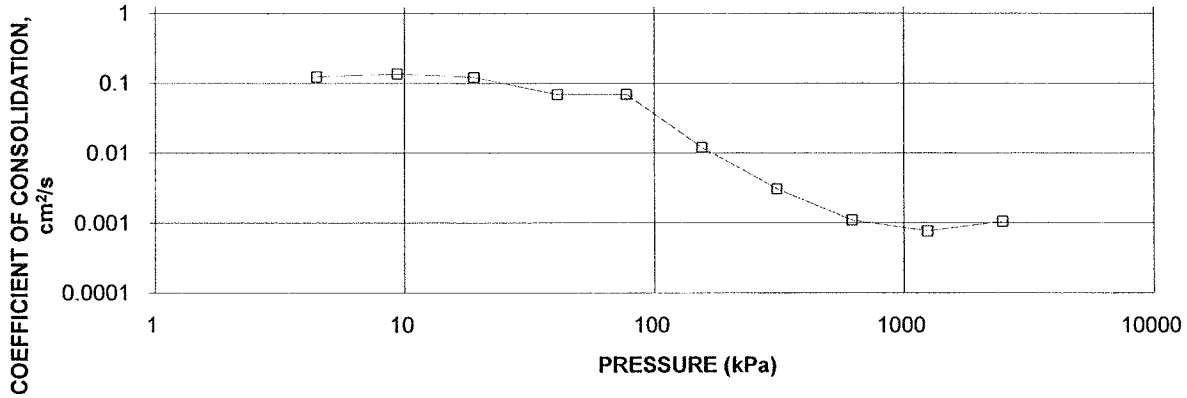
Note:
k calculated using cv based on t_{90} values.

SAMPLE DIMENSIONS AND PROPERTIES - FINAL

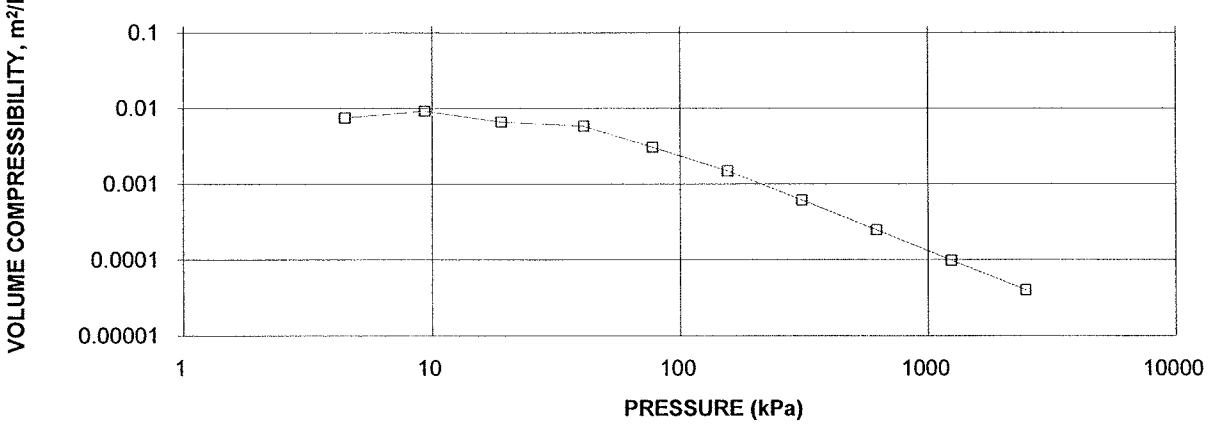
Sample Height, cm	0.67	Unit Weight, kN/m^3	11.02
Sample Diameter, cm	6.33	Dry Unit Weight, kN/m^3	3.71
Area, cm^2	31.47	Specific Gravity, measured	1.47
Volume, cm^3	21.05	Solids Height, cm	0.172
Water Content, %	196.74	Volume of Solids, cm^3	5.42
Wet Mass, g	23.65	Volume of Voids, cm^3	15.63
Dry Mass, g	7.97		

OEDOMETER CONSOLIDATION SUMMARY

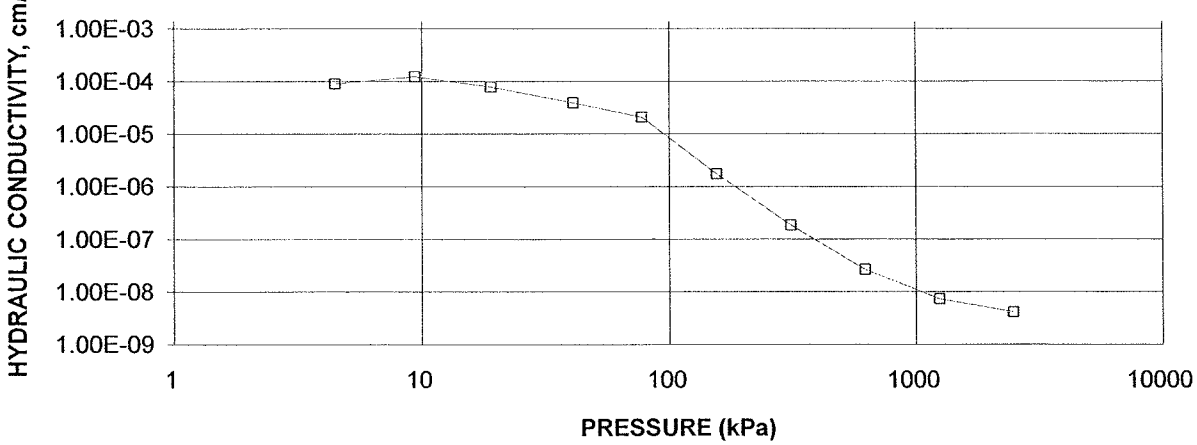
CONSOLIDATION TEST
CV cm²/s VS PRESSURE (kPa)
BH 09-41 SA ST-4



CONSOLIDATION TEST
MV m²/kN vs PRESSURE (kPa)
BH 09-41 SA ST-4

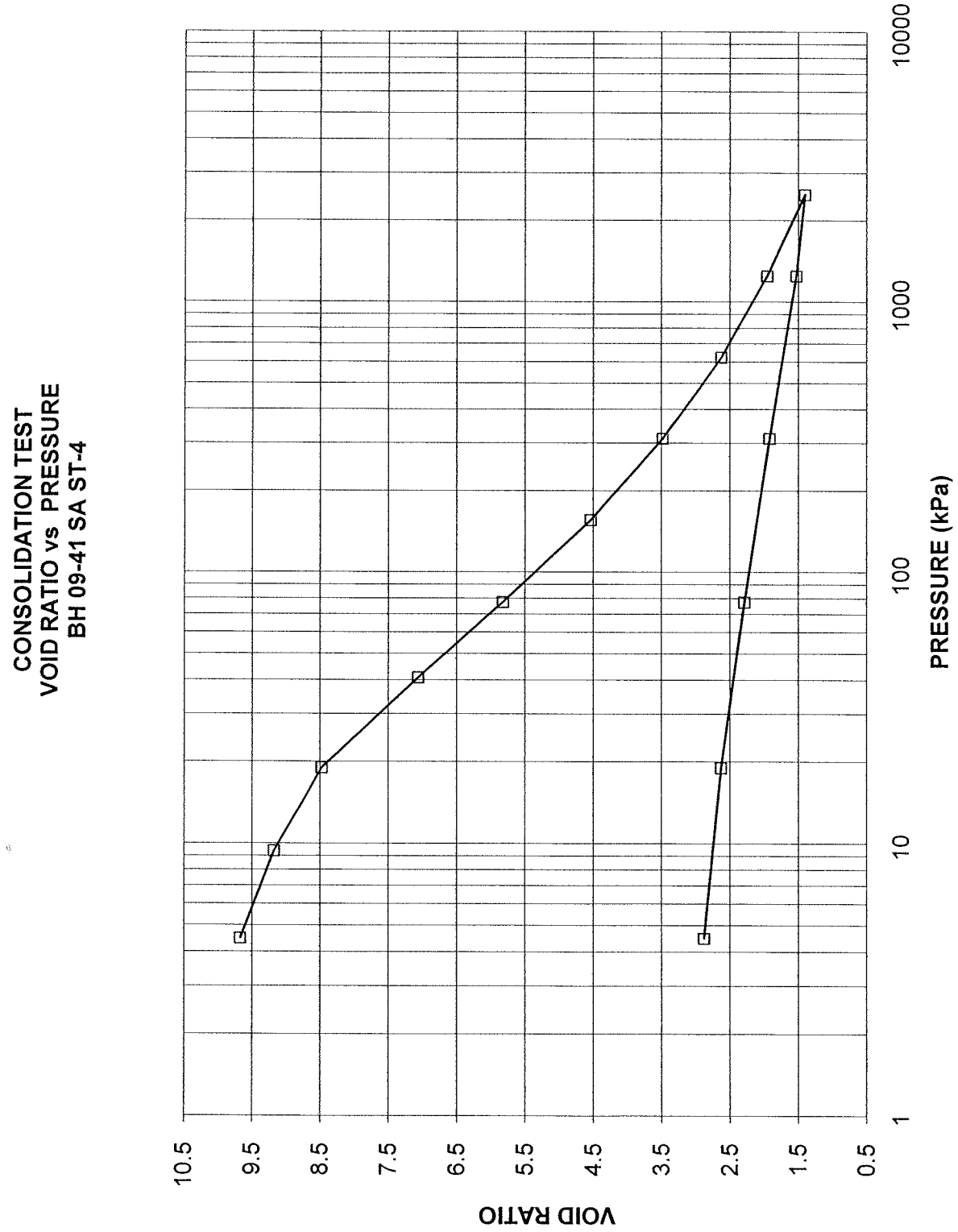


CONSOLIDATION TEST
HYDRAULIC CONDUCTIVITY vs PRESSURE
BH 09-41 SA ST-4



Project No. 09-1116-0030
Prepared By: LH
Golder Associates
Checked By: MM

CONSOLIDATION TEST VOID RATIO VS. LOG PRESSURE	FIGURE



Project No. 09-1116-0030

Prepared By: LH

Golder Associates

Checked By: MM

OEDOMETER CONSOLIDATION SUMMARY

SAMPLE IDENTIFICATION

Project Number	09-1116-0030	Sample Number	ST-5
Borehole Number	09-45	Sample Depth, m	3.0-3.6

TEST CONDITIONS

Test Type	Standard	Load Duration, hr	24
Oedometer Number	10		
Date Started	07/23/2009		
Date Completed	08/11/2009		

SAMPLE DIMENSIONS AND PROPERTIES - INITIAL

Sample Height, cm	2.54	Unit Weight, kN/m^3	10.00
Sample Diameter, cm	6.35	Dry Unit Weight, kN/m^3	1.84
Area, cm^2	31.62	Specific Gravity, measured	1.73
Volume, cm^3	80.34	Solids Height, cm	0.275
Water Content, %	443.80	Volume of Solids, cm^3	8.71
Wet Mass, g	81.95	Volume of Voids, cm^3	71.63
Dry Mass, g	15.07	Degree of Saturation, %	93.4

TEST COMPUTATIONS

Pressure kPa	Corr. Height cm	Void Ratio	Average Height cm	t_{90} sec	cv. cm^2/s	mv m^2/kN	k cm/s
0.00	2.541	8.223	2.541				
4.76	2.500	8.075	2.521	8	1.68E-01	3.37E-03	5.57E-05
9.55	2.440	7.858	2.470	29	4.46E-02	4.93E-03	2.15E-05
19.44	2.306	7.371	2.373	37	3.23E-02	5.33E-03	1.69E-05
38.70	2.095	6.603	2.200	57	1.80E-02	4.33E-03	7.64E-06
77.43	1.836	5.663	1.965	66	1.24E-02	2.63E-03	3.20E-06
154.91	1.534	4.569	1.685	90	6.69E-03	1.53E-03	1.00E-06
309.79	1.264	3.586	1.399	69	6.01E-03	6.88E-04	4.05E-07
77.43	1.374	3.987	1.319				
19.52	1.520	4.518	1.447				
4.76	1.633	4.928	1.577				

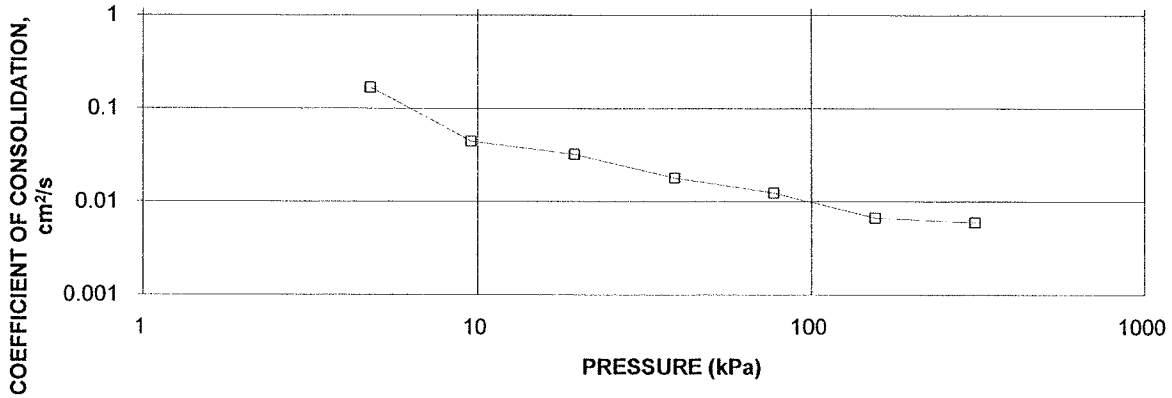
Note:
k calculated using cv based on t_{90} values.

SAMPLE DIMENSIONS AND PROPERTIES - FINAL

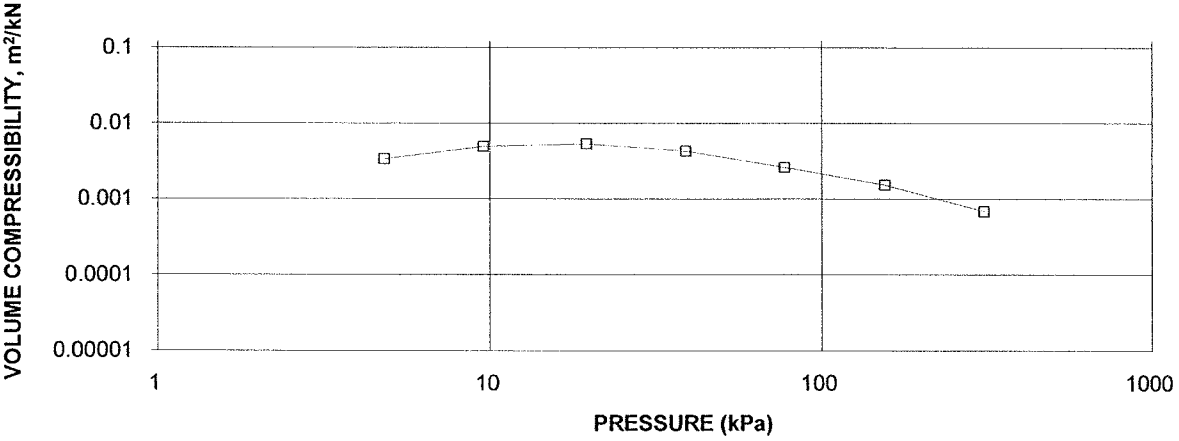
Sample Height, cm	1.63	Unit Weight, kN/m^3	10.93
Sample Diameter, cm	6.35	Dry Unit Weight, kN/m^3	2.86
Area, cm^2	31.62	Specific Gravity, measured	1.73
Volume, cm^3	51.64	Solids Height, cm	0.275
Water Content, %	281.82	Volume of Solids, cm^3	8.71
Wet Mass, g	57.54	Volume of Voids, cm^3	42.93
Dry Mass, g	15.07		

OEDOMETER CONSOLIDATION SUMMARY

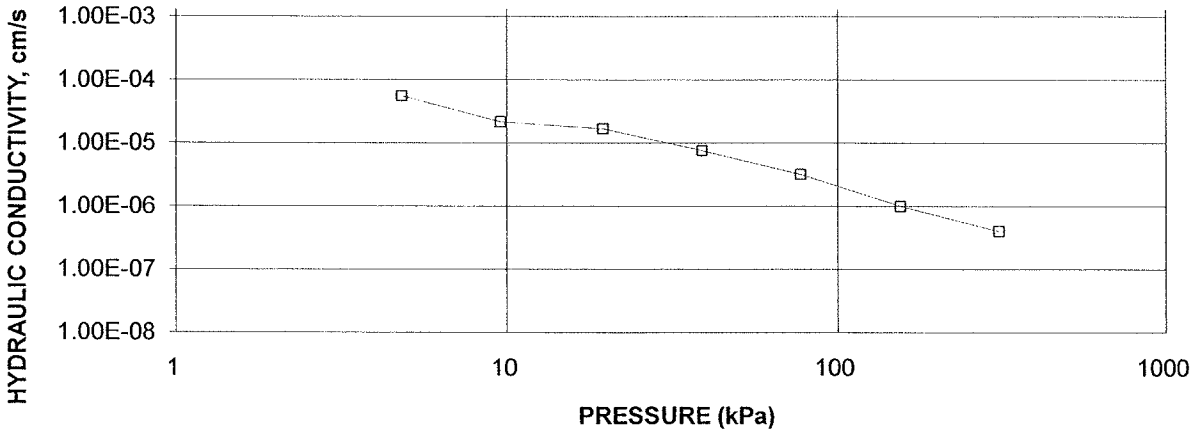
CONSOLIDATION TEST
CV cm^2/s VS PRESSURE (kPa)
BH 09-45 SA ST-5



CONSOLIDATION TEST
MV m^2/kN vs PRESSURE (kPa)
BH 09-45 SA ST-5



CONSOLIDATION TEST
HYDRAULIC CONDUCTIVITY vs PRESSURE
BH 09-45 SA ST-5



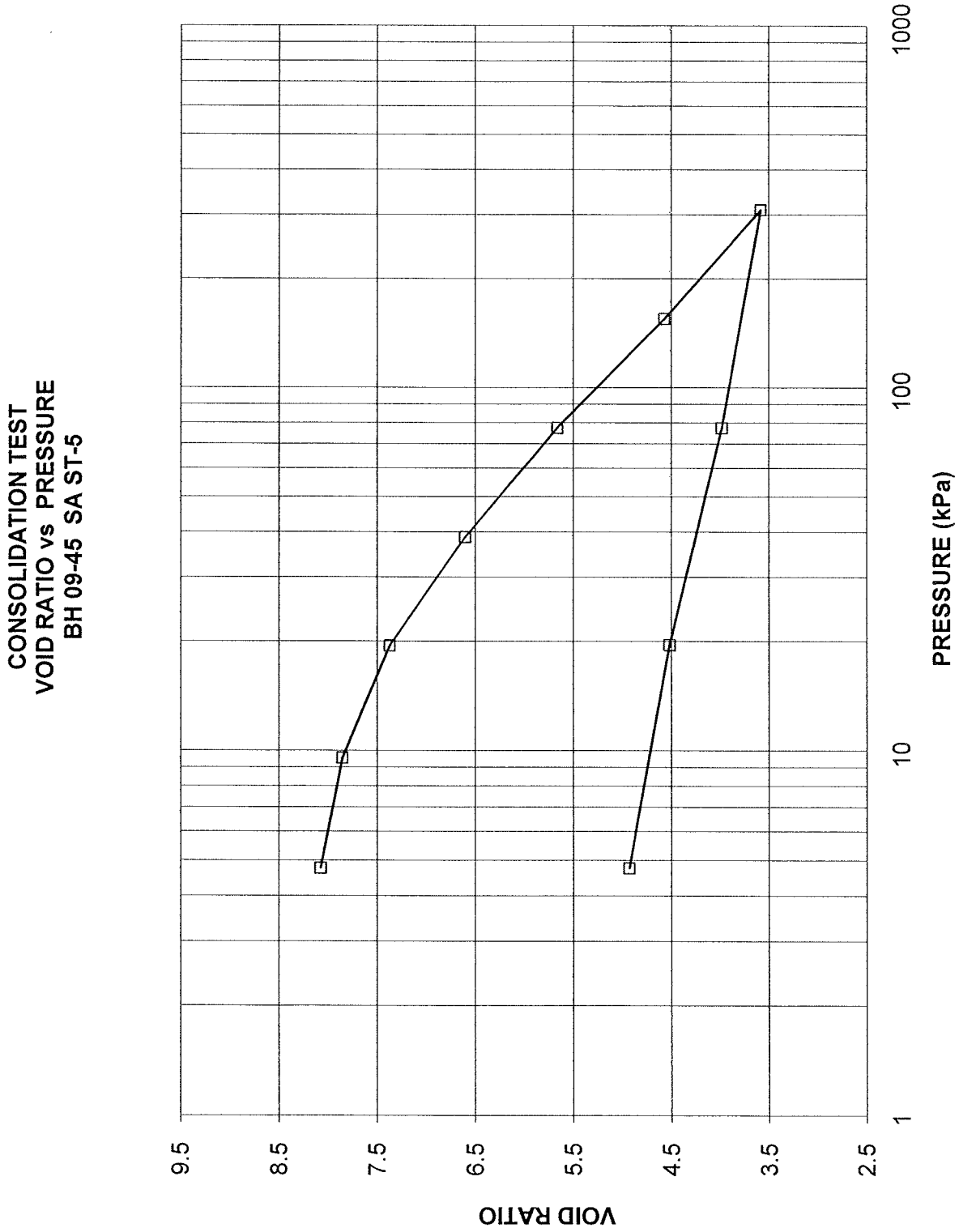
Project No. 09-1116-0030

Prepared By: LH

Golder Associates

Checked By: MM

CONSOLIDATION TEST VOID RATIO VS. LOG PRESSURE	FIGURE



Project No. 09-1116-0030

Prepared By: LH

Golder Associates

Checked By: MM

SPECIFIC GRAVITY TEST RESULTS

ASTM D 854-98 TEST METHOD A

PROJECT NUMBER	09-1116-0030
PROJECT NAME	Jacques Whitford / Lab Testing / 1047243
DATE TESTED	July, 2009

Borehole No.	Sample No.	Depth (m)	Measured Specific Gravity
09-17	ST-6	3.8-4.4	1.51
09-18	ST-5	2.7-3.3	1.41
09-23	ST-4	2.3-2.9	1.59
09-33	ST-1	2.3-2.9	2.51
09-41	ST-4	2.1-2.7	1.47
09-45	ST-5	3.0-3.6	1.73

Note: Test carried out on soil particles <4.75mm using kerosene.

Checked By:

Golder Associates

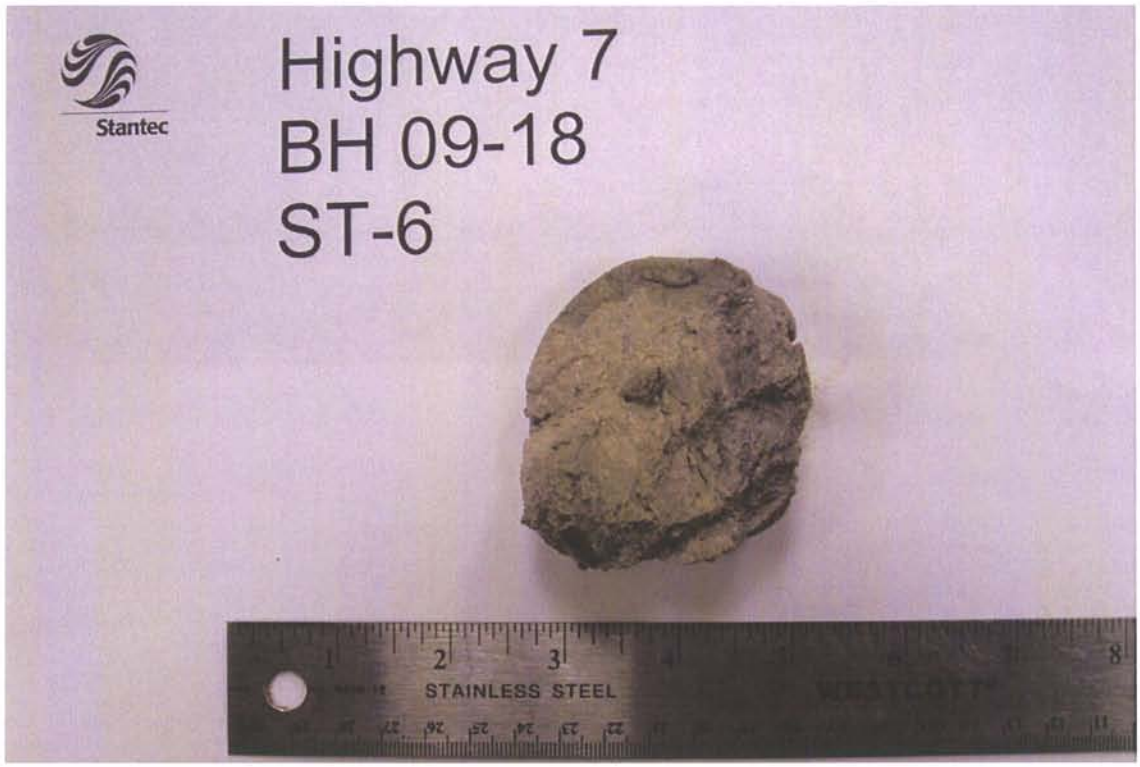


Photo No. 1: 27+000 BH 09-18, ST-6 – Marl

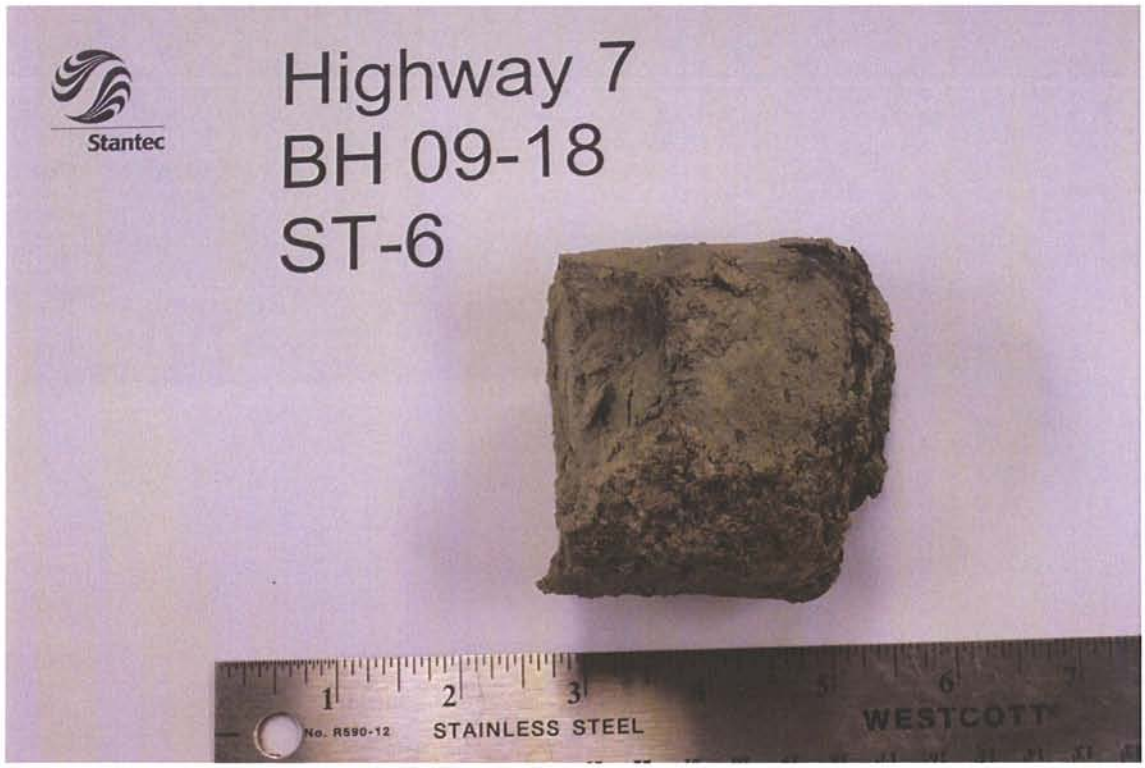


Photo No. 2: 27+000 BH 09-18, ST-6 – Marl

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Photo No. 3: BH 09-33, ST-1 - Fine Fibrous Peat

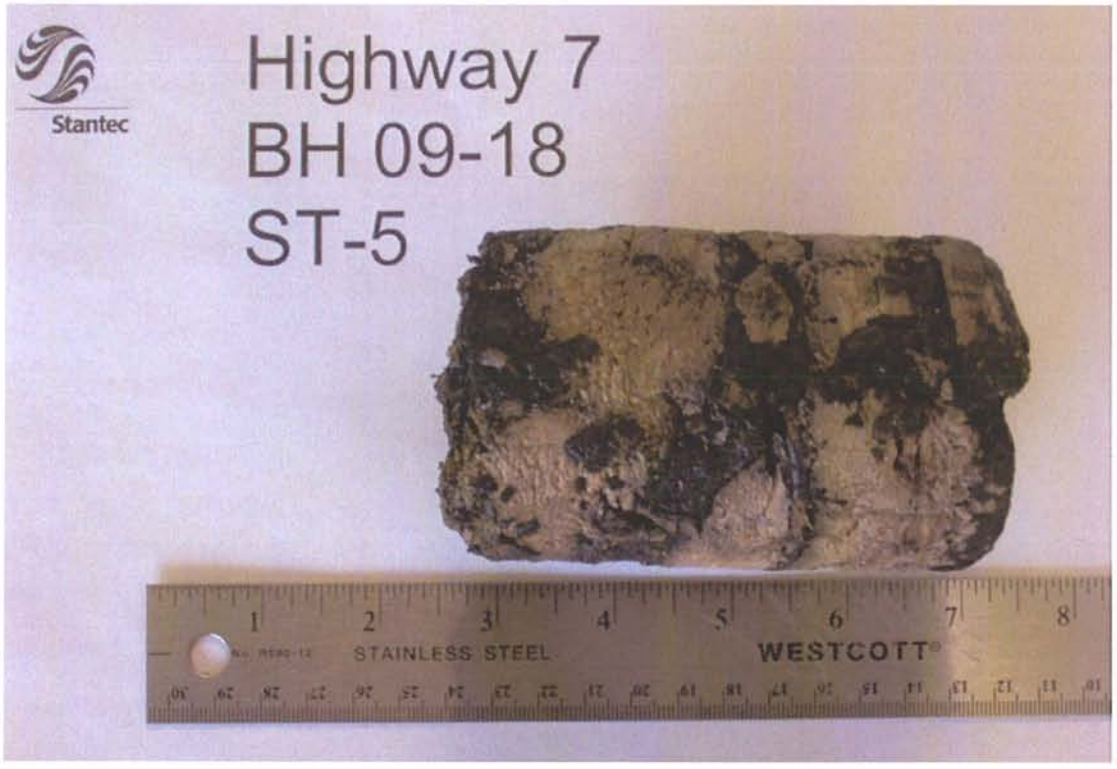

Photo No. 4: 27+000 BH 09-18, ST-5 - Fine Fibrous Peat with Hard Woody Pieces

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APPENDIX D

Site Photographs

Photo No. 1: Looking East at approximate Station 26+600

Photo No. 2: Looking East at approximate Station 11+250

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Photo No. 3: Looking West at approximate Station 11+950

Photo No. 4: Looking East at approximate Station 12+000

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Photo No. 5: Looking East at approximate Station 12+050

Photo No. 6: Looking East at approximate Station 12+500

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APPENDIX E

Table E-1: Planned Pavement Grade Adjustments
Typical Cross Section (Drawing No. 5)
Slope Stability Results

Table E-1
Hwy 7 Norwood to Havelock - W.P. 67-99-00
Proposed Vertical Grade Adjustments

Station	Proposed Vertical Adjustment (mm)		
	Existing Left Edge of Pavement	Existing C/L	Existing Right Edge of Pavement
Fill Location 1			
26+600	-30	-48	20
26+625	-40	-60	40
26+650	-50	-110	-25
26+675	-140	-200	-170
26+700	-120	-290	-260
26+725	-220	-315	-410
26+750	-200	-315	-450
26+775	-220	-300	-310
26+800	-270	-290	-300
26+825	-280	-335	-315
26+850	-370	-350	-250
26+875	-300	-300	-140
26+900	-200	-180	-50
26+925	-120	-140	-40
26+950	-190	-180	-120
26+975	-150	-160	-80
27+000	-160	-200	-160
27+025	-180	-230	-170
27+050	-200	-230	-130
27+075	-100	-140	-80
27+100	-10	-70	40
27+125	0	-70	-10
27+150	0	-50	-20
10+000	103	82	-68
10+025	61	53	-28
10+050	0	-1	-73
10+075	0	-11	-62
10+100	26	25	-18
Fill Location 2			
10+975	50	-10	30
11+000	49	-38	-5
11+025	18	-74	-34
11+050	-26	-100	-81
11+075	-32	-113	-87
11+100	-23	-122	-103

Hwy 7 Norwood to Havelock - W.P. 67-99-00
Proposed Vertical Grade Adjustments

Station	Proposed Vertical Adjustment (mm)		
	Existing Left Edge of Pavement	Existing C/L	Existing Right Edge of Pavement
11+125	-8	-111	-115
11+150	-2	-99	-109
11+175	-55	-98	-127
11+200	-87	-178	-194
11+225	-153	-236	-253
11+250	-132	-218	-237
11+275	-55	-120	-129
11+300	56	7	47
11+325	62	-4	82
11+350	49	4	99
11+375	47	18	124
Fill Location 3			
11+850	156	26	11
11+875	143	37	3
11+900	81	-34	-43
11+925	30	-73	-72
11+950	-26	-81	-96
11+975	9	-68	-79
12+000	43	-86	-104
12+025	11	-102	-100
12+050	-6	-137	-109
12+075	-32	-155	-130
12+100	-68	-163	-153
12+125	-82	-180	-168
12+150	-83	-189	-160
12+175	-64	-149	-110
12+200	-29	-89	-53
12+225	-64	-82	-27
12+250	-70	-98	-16
12+275	-61	-85	16
12+300	-22	-36	77
12+325	7	-26	66
12+350	-38	-86	14
12+375	-146	-164	-49
12+400	-183	-222	-119
12+425	-167	-233	-169
12+450	-114	-223	-201
12+475	-175	-231	-170

Hwy 7 Norwood to Havelock - W.P. 67-99-00

Proposed Vertical Grade Adjustments

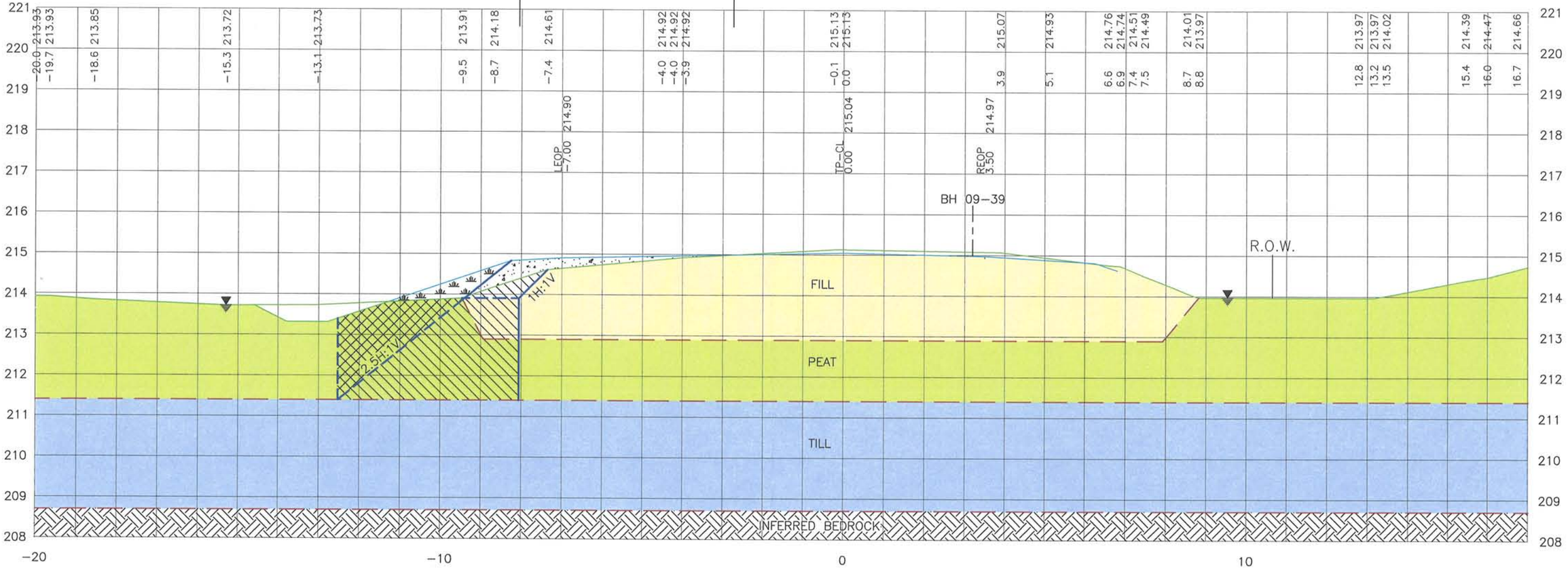
Station	Proposed Vertical Adjustment (mm)		
	Existing Left Edge of Pavement	Existing C/L	Existing Right Edge of Pavement
12+500	-117	-159	-53
12+525	2	-53	46
12+550	145	25	103
12+575	235	118	175
12+600	201	139	181
12+625	217	151	247
12+650	210	159	249
12+675	111	89	188
12+700	3	15	134
12+725	4	-13	104
12+750	6	-43	73
12+775	-61	-124	-38
12+800	-4	-163	-104
12+825	-18	-91	-18
12+850	64	-13	88
12+875	78	26	115
12+900	60	22	71

P:\2010\122410158 - 1047243 Hwy 7 Norwood to Havelock\Foundations\Embankments\Fill Amounts.xls

FULL MUSKEG REMOVAL
BENEATH EMBANKMENT WIDENING
AS PER OPSD 203.020

GRADE RAISE
ABOVE BURIED PEAT

NO GRADE RAISE ABOVE
EXISTING EMBANKMENT
UNDERLAIN BY PEAT



12+000.000

LEGEND:

- EXCAVATE AND BACKFILL
- EMBANKMENT MATERIAL
- SLOPE FLATTENING MATERIAL
- EXCAVATE AND BACKFILL WITH SWAMP MATERIAL
- WATER LEVEL

Ministry of Transportation
Ontario

Stantec

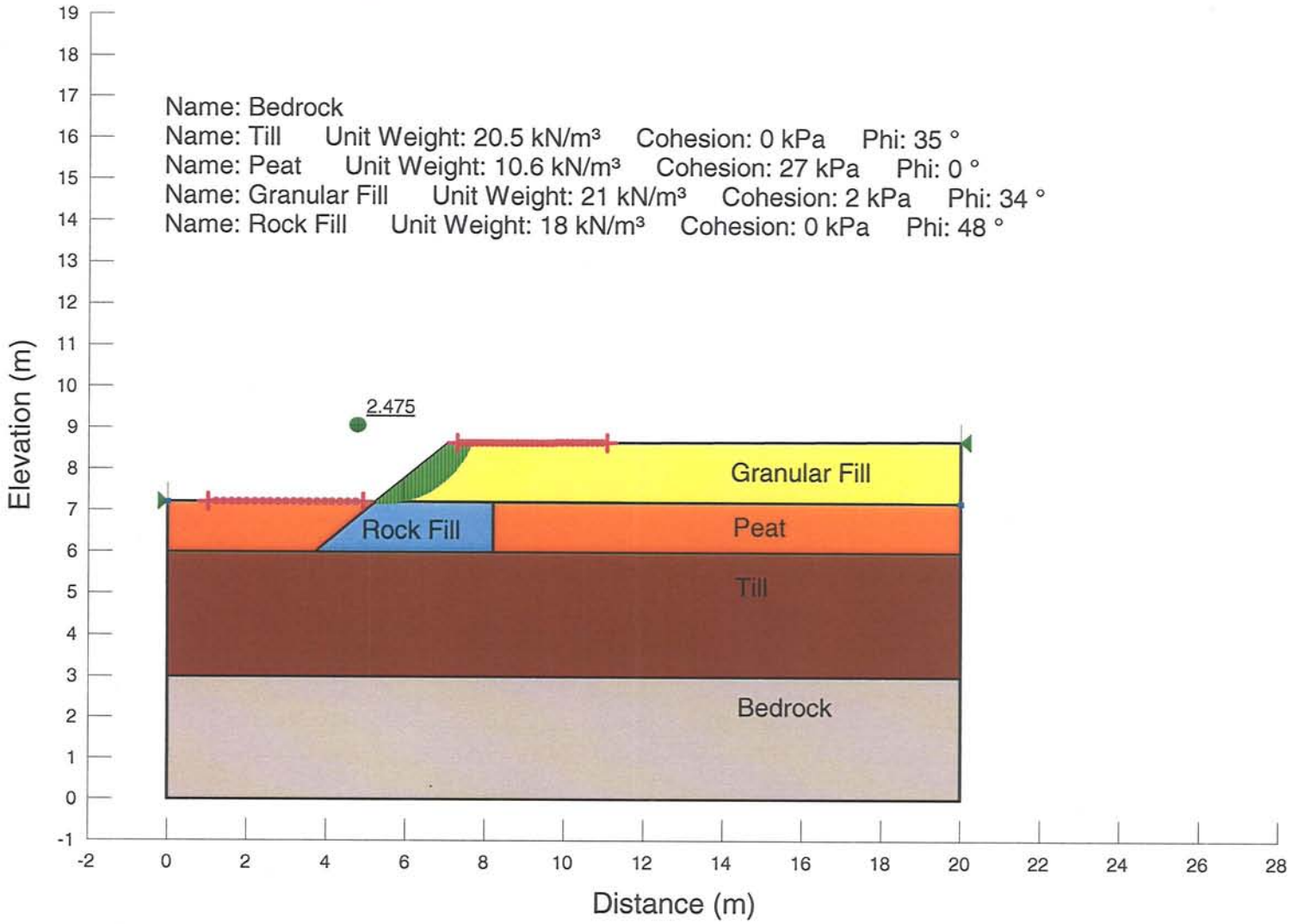
SCALE
1 m 0 2 m
1 : 100

HIGHWAY 7
DETAILED DESIGN STUDY
NORWOOD (EAST LIMIT) TO HAVELOCK (WEST LIMIT)
W.P. 67−99−00

HIGHWAY 7
CROSS−SECTION
STA. 12+000.000

DWG. No.
5

T:\Autocad\Drawings\Project Drawings\2010\122410158 (1047243)\Cross-Sections\1047243_xsections.dwg PRINTED: Apr 30, 2010



Stantec

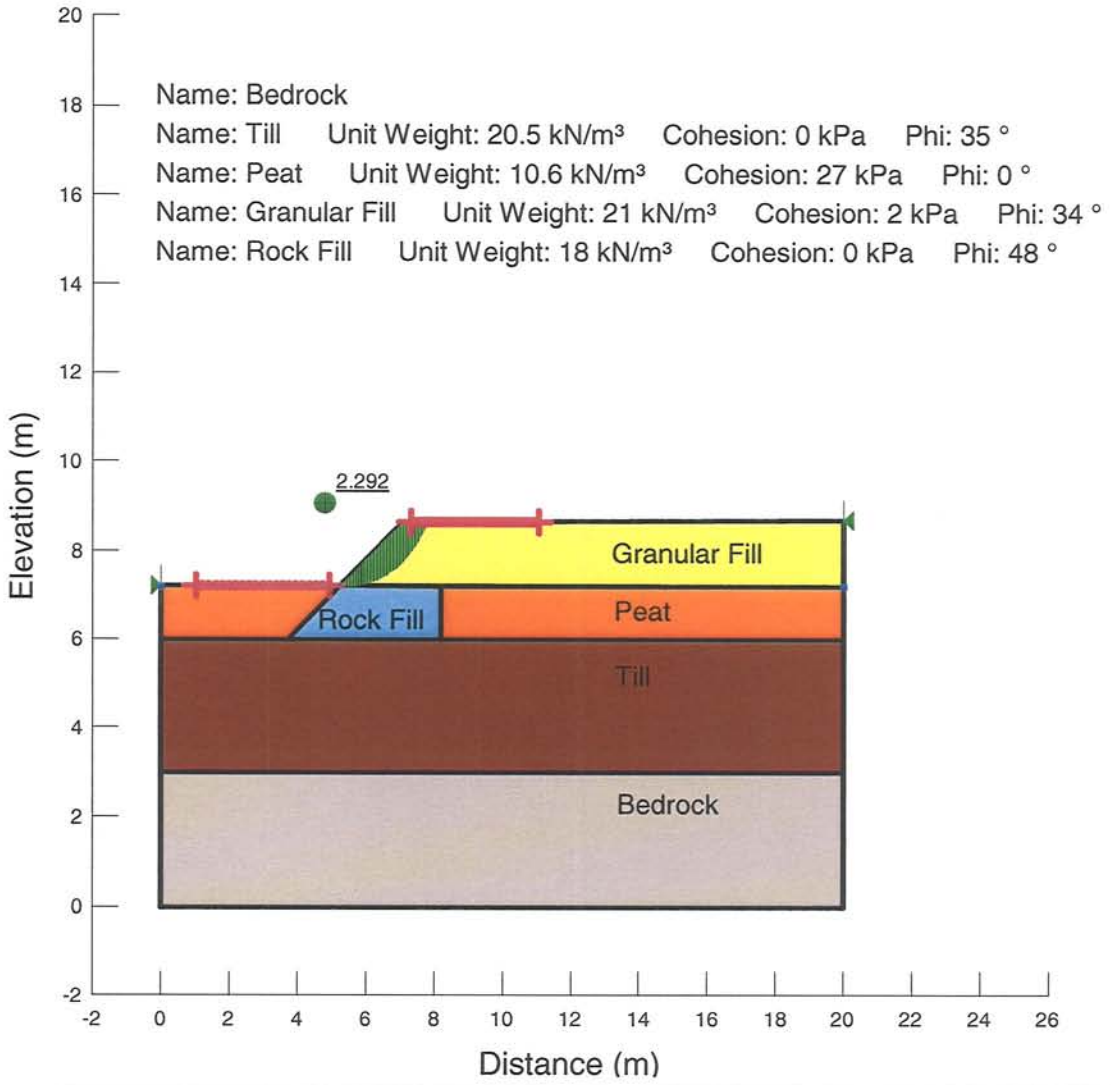
Slope Stability Analysis

Final Slope Configuration - Static Conditions

Highway 7 - W.P. 67-99-00
Norwood to Havelock

Figure No. 1

P:\2010\122410158 - 1047243 Hwy 7 Norwood to Havelock\Foundations\Embankments\SlopeW\Embankment SlopeW Figures.xls



Stantec

Slope Stability Analysis

Final Slope Configuration - Seismic Conditions (a =0.05)

Highway 7 - W.P. 67-99-00
Norwood to Havelock

Figure No. 2

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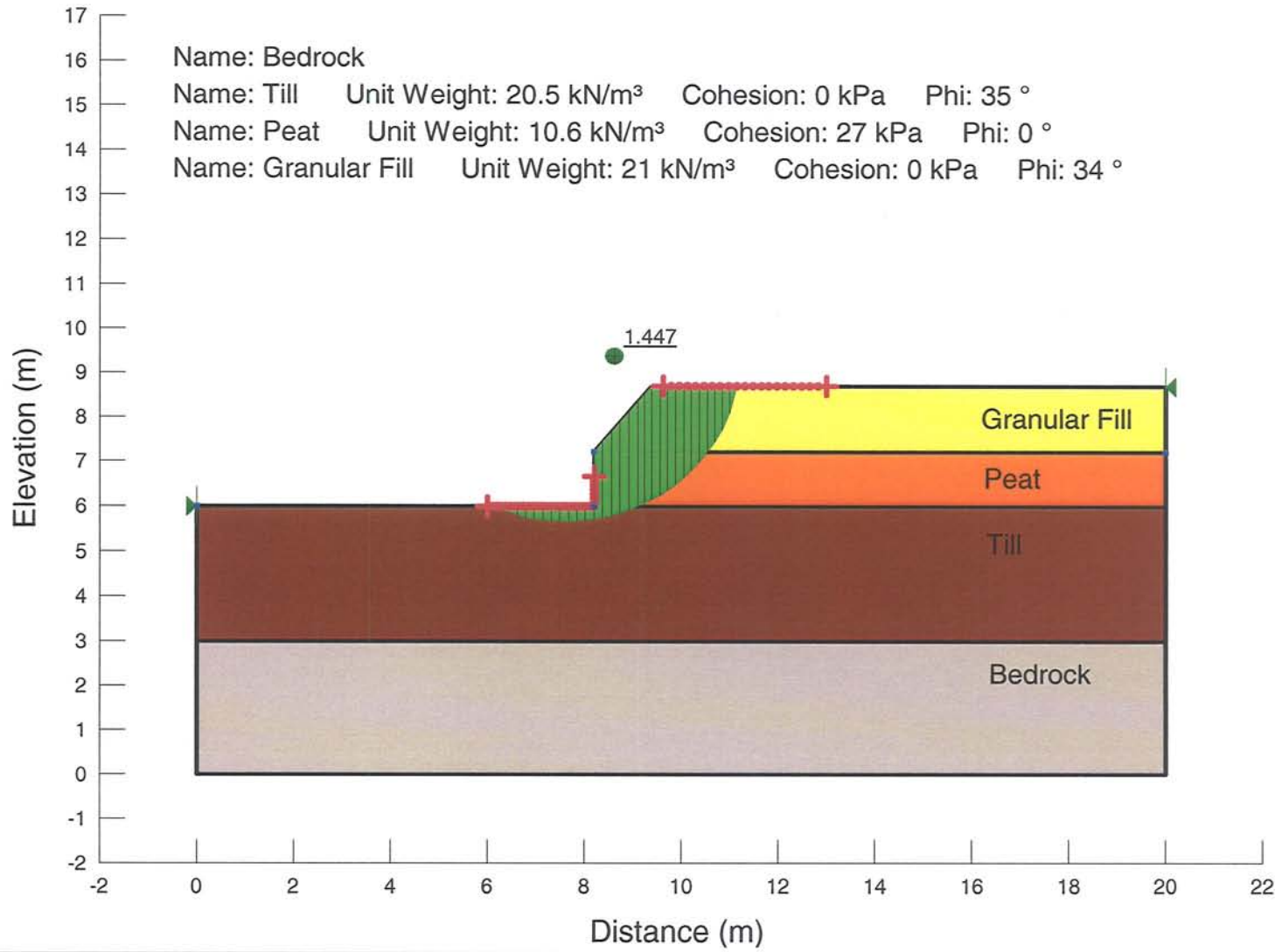

Stantec

Slope Stability Analysis

Temporary Excavation for Muskeg Removal as per OPSD 203.020

Highway 7 - W.P. 67-99-00
Norwood to Havelock

Figure No. 3

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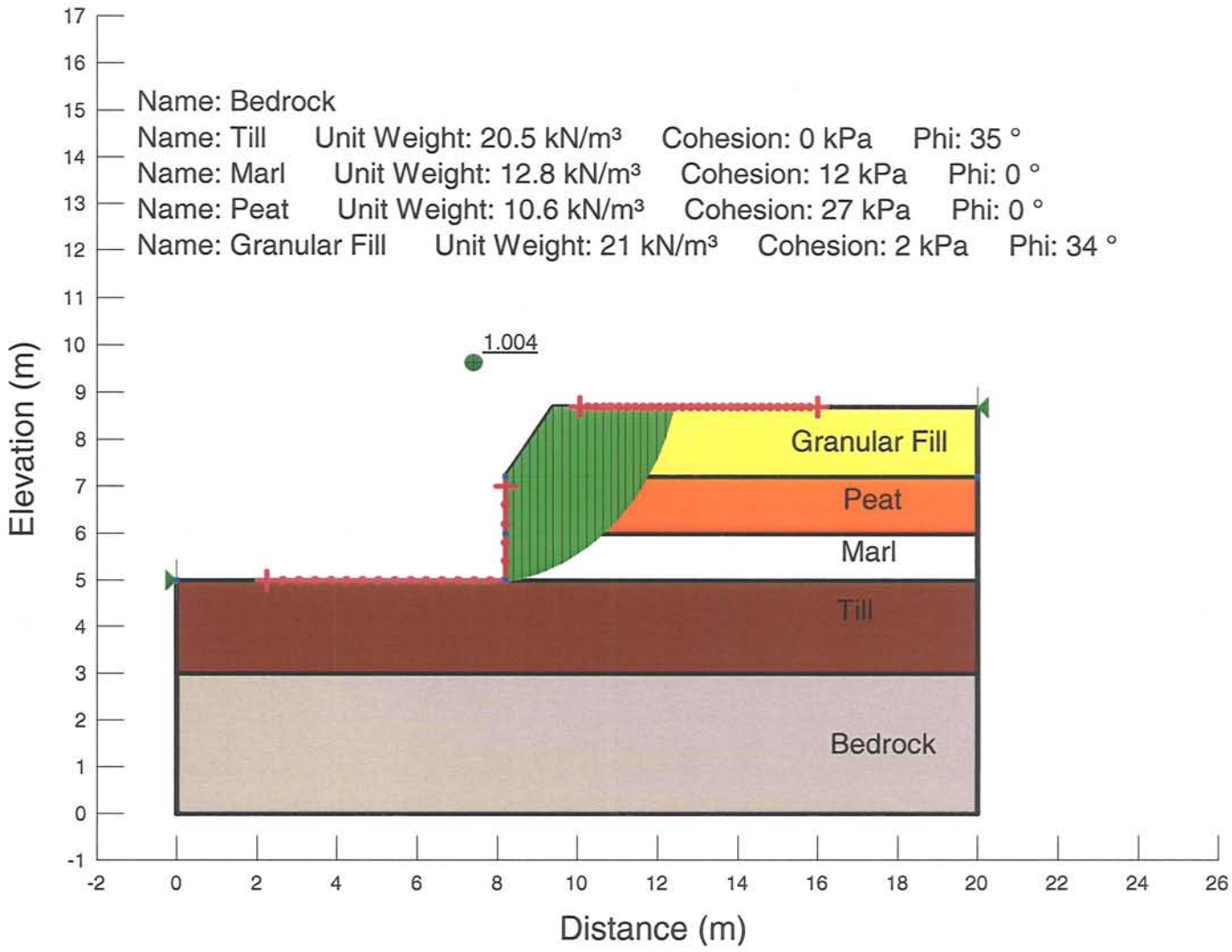

Stantec

Slope Stability Analysis

Temporary Excavation for Muskeg Removal as per OPSD 203.020

Highway 7 - W.P. 67-99-00
Norwood to Havelock

Figure No. 4

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APPENDIX F

Highway Cross Sections

Highway 7 – W.P. 67-99-00
Norwood (east Limit) to Havelock (west limit)
Comparison of Options for Treatment of Settlement Associated with Proposed Passing Lane Widenings

Option #	Description	Advantages	Disadvantages	Relative Cost	Risk/Consequences
1	Conventional Construction - Construct widening using OPSD-203.020 - Carry out pavement rehabilitation of existing lanes as per remainder of project limits & pave widening to match - Repair pavement as required in the future	- Short initial construction period - Conventional construction equipment and techniques	- Expect significant differential settlement within first year. This could present unacceptable ride quality, cracking and possibly a safety concern - Repairs in the form of padding and possibly an overlay could be required within 1 year. - Several rounds of repairs likely required within pavement design life - Future pavement rehabilitation work may initiate a new round of consolidation of the buried organic layer	Low	Risk: Repairs required more frequently than expected due to differential settlement Consequence: Additional costs, traffic impacts, poor ride quality and poor public perception. If repairs not carried out in time it could result in safety issue.
2	Full Reconstruction with Complete Removal of Organic Material - Remove existing embankment and buried organic material - Construct new embankment and pavement structure	- Eliminates settlement concerns for now and for future rehabilitation projects. - Lower future maintenance requirements.	- Would require construction of detour alignment and/or extensive roadway protection. - Highly intrusive – would likely require longer construction period and greater overall impact to drivers. - Difficult to segregate and stockpile materials onsite, therefore likely to generate large volume of surplus material during removal of existing embankment fill and underlying organic materials.	High	Risk: Variability in thickness of buried organic layer makes quantity estimation difficult Consequence: High cost
3	Pre-load - Construct widening using OPSD-203.020 - Build up grades within widening with granular. - Delay paving widening and rehabilitation of existing pavement to allow for primary consolidation and portion of secondary consolidation. Delay of 6 months to 1 year likely. - Carry out pavement rehabilitation of existing lanes as per remainder of project limits & pave widening to match - Repair pavement as required in the future	- 1 year pre-load allows primary consolidation and approximately 50% of the secondary consolidation expected within the first 20 years to occur prior to final paving. A minimum pre-load period of 6 months would be required. - Conventional construction equipment and techniques - Does not intrude on existing driving lanes and therefore allows for standard pavement rehabilitation treatment	- Delays pavement rehabilitation by 6 months to 1 year - Some differential settlement due to secondary consolidation still expected to occur. Some padding likely requires within pavement design life - Future pavement rehabilitation work may initiate a new round of consolidation of the buried organic layer	Low	Risk: Settlement is less than expected Consequence: Blade off additional material and use as slope flattening (in effect it became a small surcharge). Beneficial to performance but will have resulted in small additional material cost

Highway 7 – W.P. 67-99-00
Norwood (east Limit) to Havelock (west limit)
Comparison of Options for Treatment of Settlement Associated with Proposed Passing Lane Widenings

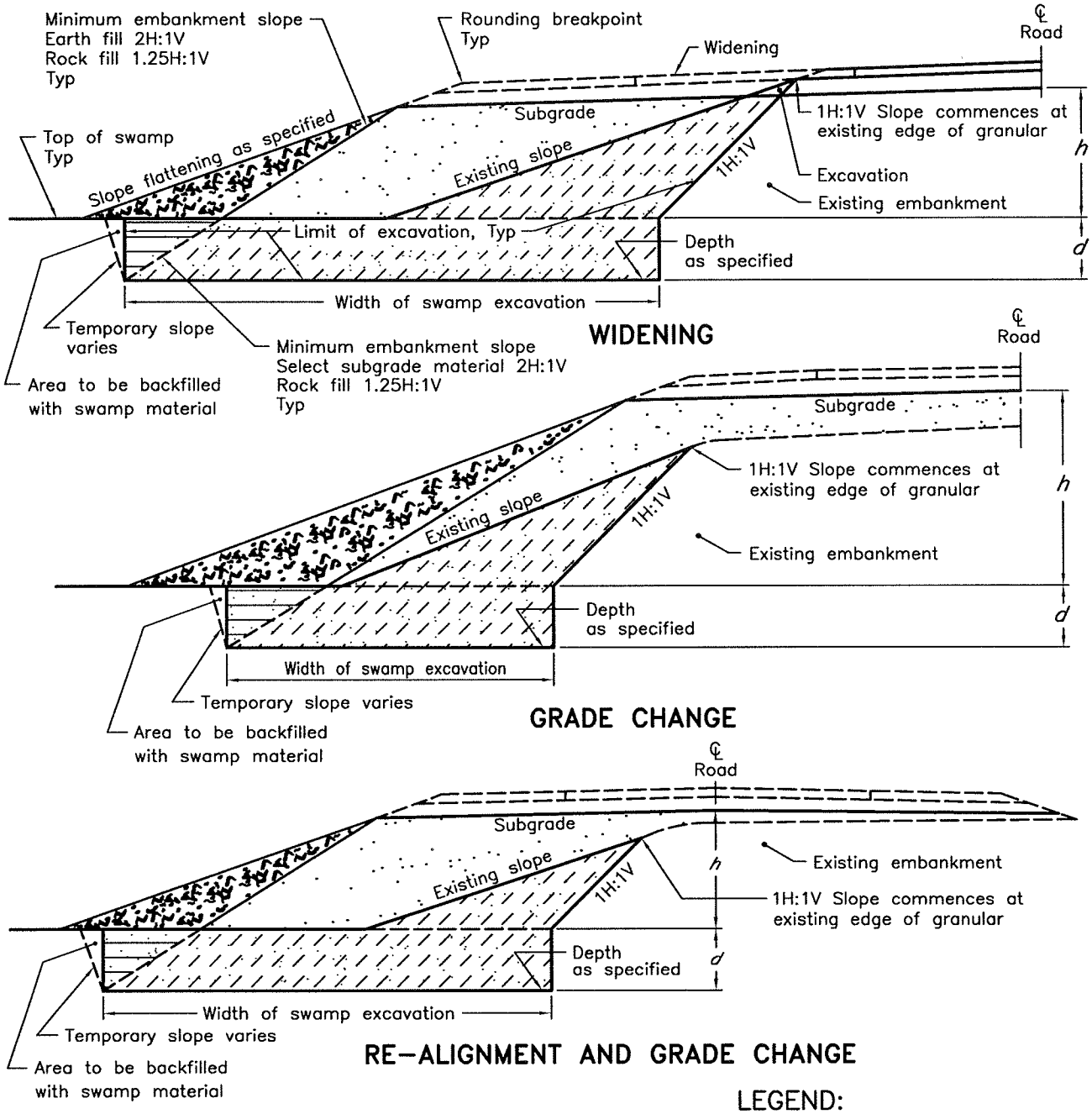
Option #	Description	Advantages	Disadvantages	Relative Cost	Risk/Consequences
4	Surcharge - Construct widening using OPSD-203.020 - Build up grades within widening with granular to higher than proposed final grades. - Delay paving to allow settlement to occur (assume leaving 1 construction season) - Remove surcharge material - Carry out pavement rehabilitation of existing lanes as per remainder of project limits & pave widening to match	- 1 year surcharge could allow for negligible post-paving settlement during the design life of the pavement. - Conventional construction equipment and techniques - Does not intrude on existing driving lanes and therefore allows for standard rehabilitation treatment	- Delays pavement rehabilitation by 1 year - Surcharge material would need to be removed and wasted or used as additional slope flattening material – additional material cost - Building up the surcharge material adjacent to the existing driving lanes may pose operational issues (e.g. snow clearing, safety concerns, etc.). Concrete barriers could be required to separate traffic from the surcharge material - Future pavement rehabilitation work may initiate a new round of consolidation of the buried organic layer	Low	Risk: Surcharge removed too soon due to reliability in predicting settlement of peat & secondary consolidation starts to occur prior to end of design life Consequence: Some settlement late in design life, possibly requiring some pavement repairs prior to next schedule major pavement rehabilitation
5	Lightweight Fill - Construct Widening using OPSD-203.020, however, use lightweight fill in order to achieve zero stress increase in organic layer beneath existing embankment - Carry out pavement rehabilitation of existing lanes as per remainder of project limits & pave widening to match	- If a zero stress increase can be achieved, settlement problems can be avoided. - Avoids time delays associated with pre-load or surcharging.	- Placement of lightweight fill material below water level may be difficult (buoyancy concern) and may be subject to environmental constraints with some lightweight fill materials. - Future pavement rehabilitation work may initiate a new round of consolidation of the buried organic layer. - To achieve zero stress increase, it may require intrusion into existing driving lanes - Need to ensure that detailing of treatment does not impede pavement structure drainage	High	Risk: Problems placing lightweight fill beneath water Consequence: Claims from contractor and/or sub-standard end product Risk: Differential frost performance Consequence: Differential frost heaves requiring future repair
6	Soil Mixing - Construct widening using OPSD-203.020 - Carry out soil mixing to stabilize the organic soils beneath the existing embankment (likely operation consists of auguring a series of large diameter holes on a tightly spaced grid; introducing cement and possibly some aggregate to blend with the organic soil resulting in a cemented composite block) - Carry out pavement rehabilitation of existing lanes as per remainder of project limits & pave widening to match	- Eliminates settlement concerns for now and for future rehabilitation projects. - Lower future maintenance requirements.	- Treatment of existing driving lane beside widening could have significant traffic impacts - Highly intrusive – requires reconstruction of pavement structure in existing driving lanes.	High	Risk: Variability in thickness of buried organic layer makes quantity estimation difficult Consequence: High cost

Highway 7 – W.P. 67-99-00
Norwood (east Limit) to Havelock (west limit)
Comparison of Options for Treatment of Settlement Associated with Proposed Passing Lane Widenings

Option #	Description	Advantages	Disadvantages	Relative Cost	Risk/Consequences
7	GeoPiers - Construct widening using OPSD-203.020 - Construct GeoPier reinforcement of existing embankment so that it is no longer susceptible to significant settlement due to small load increases. Operation consists of auguring a series of large diameter holes, backfilling with compacted lifts of granular material to form columns of aggregate; cement powder may be added) - Carry out pavement rehabilitation of existing lanes as per remainder of project limits & pave widening to match	- Eliminates settlement concerns for now and for future rehabilitation projects. - Lower future maintenance requirements.	- Treatment of existing driving lane beside widening could have significant traffic impacts - Highly intrusive – requires reconstruction of pavement structure in existing driving lanes.	High	Risk: Variability in thickness of buried organic layer makes quantity estimation difficult Consequence: High cost
8	Geosynthetic Reinforcement - Construct widening using OPSD-203.020 - Remove existing pavement structure full depth and full width - Install geogrid at subgrade level across existing embankment and new passing lane. - Construct new pavement structure full width. - Repair pavement as required in the future	- Helps minimize distortion of pavement surface due to differential settlement of underlying compressible material - Eliminates reflective cracking since full new pavement structure is required.	- Treatment of existing driving lane beside widening could have significant traffic impacts - Highly intrusive – requires reconstruction of pavement structure in existing driving lanes. - Does not eliminate settlement of buried organic materials –only helps decrease impact of settlement on pavement surface. - Although settlement across the pavement surface may be less irregular, settlement will still occur and will require padding to correct cross-fall deficiencies in the future. - Re-use of excavated pavement granular is problematic - Consider as pavement structure reinforcement in conjunction with other options.	Medium	Risk: Geogrid does not redistribute stress/strain sufficiently and unacceptable differential settlement is manifested at surface. Consequence: Significant pavement repairs required prior to next scheduled rehabilitation treatment.
9	Do Nothing - Do not construct widening - Carry out pavement rehabilitation of existing lanes as per remainder of project limits	- Avoids issue of differential settlement across the width of the highway - Shortest construction period - Conventional pavement rehabilitation contract	- Does not achieve objective of providing passing lanes	Low	Not Applicable

APPENDIX G

OPSD 203.020
Draft Special Provision



NOTES:

A For this OPSD to apply, h must be $\leq$4.5m and d must be $\leq$6.0m.

B Height of fill is the vertical difference between top of subgrade and top of swamp elevation measured at new road centreline.

C Widening of existing earth embankments shall be benched according to OPSD–208.010.

D All dimensions are in millimetres unless otherwise shown.

LEGEND:

h – Height of fill

d – Depth of sub–excavation

Embankment materials as specified

Excavated swamp material

Excavate and backfill as specified

Excavate and backfill with swamp material

ONTARIO PROVINCIAL STANDARD DRAWING

Nov 2005 | Rev 2

EMBANKMENTS OVER SWAMP

EXISTING SLOPE EXCAVATED TO 1H:1V

OPSD – 203.020

Amendment to OPSS 209, April 2009

Special Provision No. ***

Construction Specification for Embankments over Swamps and compressible Soils

General

This special provision outlines the procedure to be used for the excavation of the unsuitable muskeg deposits from beneath embankment widenings within muskeg sections. The work of embankment construction shall be carried out using the excavation method as outlined in OPSS 209 and this Special Provision.

A minimum of 10 working days prior to commencing with any work at these excavation areas, the contractor shall submit a work plan and traffic management plan to the contract administrator detailing their proposed strategy to complete the work. The work plan shall detail the proposed excavation equipment, method of excavation and sequence of excavation.

When work commences with the excavations, the contractor shall complete a trial section at each of the swamp excavation areas. The trial section will be restricted to a short section perpendicular to the highway alignment with the base of the excavation trench not wider than 3 m at any time.

The contractor shall retain the services of a RAQS certified Professional Foundation Engineer to review the work plan, be present on site during the construction of the trial sections, and be available throughout the duration of the contract.

209.07.03 Excavation Method

Clause 209.07.03 of OPSS 209 is amended by the addition of the following:

Excavation of the unsuitable muskeg material shall be started from one end of the muskeg section and proceed to the opposite end.

The excavation of the unsuitable muskeg materials shall be carried out in short sections perpendicular to the highway alignment with the base of the excavation trench not wider than 3 m at any time.

209.07.03.01 Embankment Construction and Backfill

Clause 209.07.03.01 of OPSS 209 is amended by the addition of the following:

As per OPSD 203.020, excavation through the existing embankment shall be cut to 1:1 prior to vertical excavation within the underlying muskeg material. This vertical excavation slope shall be immediately flattened to 1.25:1 using 200 mm (maximum size) graded rock fill prior to placing the adjacent rock fill.

The rock fill shall not be end-dumped but rather the rock fill shall be pushed into the excavation.