

**FOUNDATION INVESTIGATION REPORT  
PROPOSED RETAINING WALL AND  
NOISE BARRIER WALL REPLACEMENTS  
WIDENING OF HIGHWAY 401 EASTBOUND COLLECTORS  
FROM YONGE STREET TO BAYVIEW AVENUE  
TORONTO, ONTARIO  
G.W.P. 158-00-00**

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**FOUNDATION INVESTIGATION REPORT**  
**PROPOSED RETAINING WALL AND**  
**NOISE BARRIER WALL REPLACEMENTS**  
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## **1. INTRODUCTION**

Shaheen & Peaker Limited (S&P) was retained by Morrison Hershfield Limited (MHL) to conduct a foundation investigation for the proposed replacement of the existing retaining and noise barrier walls along the south side of Highway 401 Eastbound Collector from Yonge Street to Bayview Avenue. Retaining Wall Nos. 2, 3 and 5 are located in this area of the highway. It is proposed to widen the Highway 401 EB Collector by one lane and consequently, the existing Retaining Wall Nos. 2 and 3 are to be moved to the south. Retaining Wall No. 5 near Bayview Avenue will not be replaced since no widening is proposed in this area. In addition, the existing noise barrier walls in the project area will have to be moved to new locations near the property line of the highway. The purpose of this investigation was to obtain subsurface information at the site by means of exploratory boreholes.

The findings of the investigation are presented in this report. The work was performed in accordance with Consultant Agreement No. 2005-A-000498.

## **2. PHYSIOGRAPHY**

Two major river valleys, namely West Don River and East Don River, are located at the west and east sides of the project area. In general, starting from the west the grade along the Highway starts falling west of Avenue Road from about El. 183 m, towards the West Don River valley (Hogg's Hollow) to about El. 137 m, near the riverbank. It then rises towards Yonge Street to about El. 168 m, dropping again at east of Bayview Avenue to about El. 135 m, along the East Don River. At the site, between Yonge Street and Bayview Avenue, the grade is relatively flat and ranging, in general, from El. 175 to 167 m.

Within this general area, the overburden is comprised of Pleistocene or glacial deposits, which were laid down under a vast thickness of ice within the glacial rivers and lakes associated with them. Soils which were deposited by the ice itself form the glacial till deposits which are mainly unsorted by water action, while those formed by melt waters are stratified deposits. Near and within the present river valleys, these deposits were modified by rivers emptying into the glacial Lake Iroquois (fore-runner of the present Lake Ontario)



and sand, gravel, silt and minor amounts of clay were deposited. Finally, further modifications took place in modern times by the West Don and East Don Rivers.

In summary, below some man-made fill and/or modern post glacial deposits, the site is underlain by glacial tills with some sand and silt layers, except near the rivers where surficial sands and silts are more prevalent.

The depth of the overburden in the general area can be expected to be more than 50 m. The overburden which consists mainly of glacial and interglacial deposits are underlain at about El. 95 to 100 m by the Georgian Bay shale bedrock with limestone and siltstone interbeds. This formation belongs to the Upper Ordovician Period of the Paleozoic Era and is approximately 440 million years old.

### **3. INVESTIGATION PROCEDURES**

The fieldwork for this project was performed in two stages. The first stage was carried out to investigate the tilting of Panels 19, 73, 74, and 82 of Retaining Wall No. 2, and Panels 6, 19 and 20 of Retaining Wall No. 3 and Panel 3 of Retaining Wall No. 5 during the period of November 19 to December 17, 2003. The fieldwork at this stage consisted of drilling and sampling a total of 26 boreholes and carrying out 8 testpits.

The second stage was carried out between October 12 and 26, 2004 and was intended to investigate the proposed replacements of the existing Retaining Wall Nos. 2 and 3 and the construction of the new noise barrier walls. The fieldwork at this stage consisted of drilling and sampling a total of 36 boreholes. The boreholes were drilled at about 50 m spacing generally on the outside shoulder of Highway 401 Eastbound Collector lanes and along the south side of the existing retaining walls. Among these boreholes, Boreholes 2-1 to 2-26 were drilled for the replacements of Retaining Wall No. 2 and its adjacent noise barrier wall; Boreholes RW3-6A to 3-43 were drilled for the replacement of Retaining Wall No. 3 and its adjacent noise barrier wall. In addition, Boreholes 28, 31, 33, 35 and 37 were drilled for the new noise barrier wall between Retaining Wall Nos. 2 and 3.

The site location is indicated in the Key Plan on Drawing No 1, and the plan locations of the boreholes are shown on Drawing Nos. 2A, 2B and 2C.

Based on the drawing provided to us by MHL, the chainage alignment for this project is referenced along the crown of the N/S-E Ramp and Eastbound Collector (EBC) Lanes. There is one chainage equation on this project, as shown on Drawing No. 1:

$$10+279.514 \text{ N/S-E Ramp} = 32+049.185 \text{ EBC-Crown}$$

The majority of the boreholes were advanced using truck and track mounted drill rigs owned and operated by Eastern Soils Investigation Limited and Walker Drilling Limited. At Boreholes 3-39, RW3-6D, RW3-19A, RW3-20A, RW3-19/20E and RW5-3C locations, where steep slopes and difficult access were encountered, the boreholes were advanced using Dynamic Ram Sounder owned and operated by Sonic Soil Limited. All the boreholes were drilled under the full time supervision of Geotechnical Engineers from S&P.

The depth of the boreholes ranged from 1.2 m to 8.1 m, and in general, between 5.0 and 8.1 m. Sampling in the boreholes was conducted at frequent intervals of depth by the Standard Penetration Test (SPT) method, as specified in ASTM D1586. This consists of freely dropping a 63.5 kg hammer a vertical distance of 0.76 m to drive a 51 mm O.D. split-barrel (split-spoon) sampler into the ground. The number of blows of the hammer required to drive the sampler into the relatively undisturbed ground by a vertical distance of 0.30 m is recorded as the Standard Penetration Resistance or the N-value of the soil and this gives an indication of the consistency or the compactness condition of the soil deposit.

At the completion of drilling, the boreholes drilled on the paved shoulder of Highway 401 were grouted and sealed using a cement/bentonite mixture, and the upper portion was sealed with emulsified asphalt. The boreholes installed with piezometer were sealed with bentonite seal and grout above the slotted portion of the pipes and at ground surface. The rest of the boreholes drilled outside the paved shoulder and behind the existing retaining walls were grouted and sealed using a cement/bentonite mixture.

Water level observations in the open boreholes were made during drilling and at the completion of each borehole. In addition, piezometers were installed in 16 boreholes. These piezometers enabled us to monitor groundwater levels over a prolonged period of time without interference from surface water.

The borehole locations and elevations were determined by surveyors retained by MHL, who provided us with coordinates and geodetic elevations.

The results of drilling, in-situ testing and water level measurements are summarized on the Record of Borehole Sheets in Appendices A, C, E and G.

A laboratory testing programme, consisting of natural moisture content, bulk unit weight, Atterberg Limits tests and grain-size analyses, was performed on selected soil samples. The results of the laboratory tests are given on the appropriate Record of Borehole Sheets and also in Appendices B, D, F and H.

#### **4. SUBSURFACE CONDITIONS**

The soil conditions at the site are discussed in the following sections.

##### **4.1 PROPOSED REPLACEMENT OF RETAINING WALL NO. 2 (FROM N/S-E RAMP STATION 10+110 TO HWY 401 EB COLLECTOR STATION 32+600)**

In this section, a total of 37 boreholes (Boreholes 2-1 to 2-26, RW2-19A, RW2-19B, RW2-19C, RW2-73/74A, RW2-73/74B, RW2-73/74C, RW2-73/74D, RW2-82/83A, RW2-82/83B, RW2-82/83C and RW2-82/83D) was drilled on the paved right (outside) shoulders of Yonge St. to Hwy 401 N/S-E Ramp and Highway 401 Eastbound Collector, and on the south side of the existing retaining walls (Drawings 2A and 2B).

Details of the stratigraphy encountered in the boreholes are presented on the Record of Borehole Sheets in Appendix A. The following paragraphs are only meant to complement and amplify these data.

##### **4.1.1 PAVEMENT**

Boreholes 2-1, 2-3, 2-5, RW2-19A, 2-7, 2-9, 2-11, 2-13, 2-15, 2-17, 2-19, 2-21, 2-23, RW2-73/74A, 2-25 and RW2-82/83A were put down close to the edge of pavement of the highway. These boreholes encountered a 90 to 200 mm thick asphaltic concrete layer. In Boreholes 2-15 and 2-17, a concrete base of 170 to 180 mm in thickness was encountered below the asphalt.

##### **4.1.2 TOPSOIL**

Except for Boreholes RW2-19B and RW2-19C, the rest of the boreholes behind the retaining wall contacted topsoil at the ground surface. The thickness of topsoil in these boreholes ranges from 0.05 to 0.3 m. In Boreholes 2-1, 2-3, 2-13, 2-19, 2-21, and 2-23, which were drilled on the outside shoulder of Highway 401 Collector lanes, an old topsoil layer or somewhat organic clayey silt fill layer about 0.3 to 1.1 m in thickness was encountered underlying the clayey silt fill material at depths ranging from 1.2 to 3.2 m below the ground surface.

##### **4.1.3 GRANULAR FILL**

###### **4.1.3.1 Pavement Fill**

About half of the boreholes in this section encountered pavement granular fill materials. Among them, all the boreholes drilled on the highway and shoulder contacted pavement granular fill consisting of sand and gravel to sand with some gravel, extending to depths ranging from 0.5 to 0.9 m, below the surface of the asphalt pavement.

The grain-size distribution curves of 4 samples from this pavement fill material are given in Figures B-1A and B-1B in Appendix B. The results indicate the following grain-size distribution:

Gravel:	5 - 44%
Sand:	48 - 81%
Silt & Clay:	5 - 16%

#### 4.1.3.2 Retaining Wall Backfill

Behind the existing Retaining Wall No. 2 and below the pavement granular fill, Boreholes 2-5, RW2-19A, 2-7, 2-11, 2-13, 2-15, 2-17, 2-23, RW2-73/74A and RW2-82/83A encountered a sandy backfill material consisting of sand with some gravel to sand/silty sand, and extending to depths of 1.1 to 3.1 m below the existing grade. The grain-size distribution curves of six samples from this fill material are given in Figure B-1 in Appendix B. The results indicate the following grain-size distribution:

Gravel:	0 - 19%
Sand:	54 - 84%
Silt & Clay:	11 - 41%

The above results indicate that the granular backfill behind the retaining wall is relatively silty and sometimes contains traces to some clay. At some borehole locations, this sandy fill material was found to contain some clayey silt pockets.

Standard Penetration Tests performed in this fill material yielded N-values between 4 and in excess of 50 blows/0.3 m, but generally between 8 and 19 blows/0.3 m, indicating that this material was not uniformly compacted.

#### 4.1.4 EARTHFILL

Except for Boreholes 2-7, 2-10, 2-12, 2-22 and RW2-82/83A, the majority of the boreholes drilled for Retaining Wall No.2 contacted earthfill below the pavement structure/topsoil and granular backfill at depths ranging from 0.05 to 2.6 m below the ground surface. In Borehole RW2-19B, the earthfill was encountered from the ground surface, and in Boreholes 2-13 and 2-23, fill material was found interbedded in the sandy fill material at a depth of 0.7 m below the ground surface. In general, the earthfill material consists of clayey silt to sandy silt with traces of clay, sand and gravel, and is basically a cohesive material. Traces of topsoil pockets were also noted in some of the boreholes. The thickness of the fill material varies between 0.3 and 2.4 m and extends to depths ranging from 0.7 to 4.4 m below the ground surface.

The results of grain-size distribution analyses of two samples from Boreholes 2-4 and RW2-73/74A are given in Figure B-2 in Appendix B, and are presented as follows:

Gravel:	1%
Sand:	33-39%
Silt:	36-57%
Clay:	9-24%

Atterberg Limits tests performed in the laboratory on three samples from Boreholes RW2-73/74A, 2-9 and 2-17 gave the following index values as shown in Figure B-3, Appendix B.

Liquid Limit	18-24%
Plastic Limit:	9-15%
Plasticity Index:	7-15%
Natural Moisture Content:	2-13%

These values are characteristic of clayey soils of low plasticity.

N-values recorded in this fill material range from 0 to 30 blows/0.3 m, but in general, 6 to 15 blows/0.3 m, indicating a very soft to hard but generally firm to stiff consistency.

#### 4.1.5 CLAYEY SILT

In Borehole 2-12, a layer of clayey silt was contacted below the topsoil layer, extending to 0.7 m depth below the ground surface. In Boreholes 2-1 and 2-23, this clayey silt layer was encountered underlying the buried topsoil layer at 1.5 and 2.6 m depth and extended to 2.9 and 4.7 m below the ground surface, respectively.

The grain-size distribution of a sample from Borehole 2-23 is given in Figure B-4 in Appendix B, and the results are as follows:

Gravel:	0%
Sand:	14%
Silt:	66%
Clay:	20%

Atterberg Limits test performed in the laboratory on a sample from Borehole 2-1 gave the following index values as shown in Figure B-5, Appendix B.

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Liquid Limit	29%
Plastic Limit:	13%
Plasticity Index:	16%
Natural Moisture Content:	21%

These values are characteristic of clayey soils of low plasticity.

Standard Penetration Tests conducted in this unit gave N-values ranging from 7 to 20 blows/0.3 m indicating a firm to very stiff consistency.

#### 4.1.6 CLAYEY SILT TILL

With the exception of Borehole 2-9, where sandy silt to silt till with sand layer was contacted below the clayey silt fill, a major deposit of clayey silt till was encountered in the rest of the boreholes in this section. In general, the clayey silt till deposit was found underlying the fill materials and the surficial clayey silt layer at depths ranging from 0.7 to 4.7 m below the existing grade. In Boreholes 2-7 and 2-10, this deposit was contacted underlying the sandy silt till at depths of 5.5 and 5.4 m, respectively. In Borehole 2-22, the clayey silt till was contacted below the topsoil layer at 0.3 m depth. This glacial till deposit was found extending to depths varying from 1.8 m to in excess of 8.1 m below the existing grade (from El. 169.2 m in Borehole 2-4 to at below El. 159.6 m in Borehole 2-26). The majority (27 boreholes) drilled in this section were terminated in this deposit.

This clayey silt till consists of a heterogeneous mixture of clayey silt with sand and some gravel. The presence of cobbles and boulders can always be expected in the glacial till deposits, owing to their mode of deposition.

The results of grain-size distribution analyses of ten samples from this deposit are given in an envelope form in Figure B-6 in Appendix B and are shown as follows:

Gravel:	0-17%
Sand:	16-48%
Silt:	31-63%
Clay:	15-30%

Atterberg Limits Tests results of 16 samples from this deposit gave the following index values as shown in Figure B-7, Appendix B.

Liquid Limit	18-27%
Plastic Limit:	12-16%
Plasticity Index:	5-14%
Natural Moisture Content:	11-19%

These values are characteristic of clayey soils of low plasticity and from the fact that, in general, the measured natural moisture contents are at or lower than the measured plastic limit indicates that the deposit is probably pre-consolidated (i.e. carried higher overburden pressures in the past in comparison with present conditions).

N-values recorded in this till deposit range from 7 to in excess of 50 blows/0.3 m, but in general, 22 to in excess of 50 blows/0.3 m indicating a firm to hard but generally very stiff to hard consistency.

#### 4.1.7 SILTY SAND TO SANDY SILT TILL

Boreholes 2-7, 2-9 and 2-10 contacted a sandy silt to silt till deposit below the fill materials and topsoil at depths ranging from 0.1 to 2.3 m below the existing grade. In Boreholes 2-7 and 2-10, the sandy silt till deposit was found overlying the clayey silt till at depths of about 5.5 m, while in Borehole 2-9, this glacial deposit, with an interbedded sand layer, was encountered to the full depth of the borehole. At Boreholes 2-4, 2-5, 2-6, 2-8 and 2-24 locations, a sandy silt to silt till/silty sand to sandy silt till was encountered underlying the clayey silt till at depths ranging from 2.1 to 7.0 m and extended to depths from 7.0 to at least 7.9 m below the ground surface.

The results of grain-size distribution analysis of two samples from the sandy silt till deposit in Boreholes 2-7 and 2-9 are given in Figure B-8 in Appendix B. The following grain-size distribution is indicated.

Gravel:	0%
Sand:	20-32%
Silt:	60-72%
Clay:	8%

At Boreholes 2-5 and 2-6 locations, increased sand content was observed and the glacial till attained a silty sand to sandy silt till texture. The grain-size distribution of a sample from this silty sand to sandy silt till in Borehole 2-6 is given in Figure B-9 in Appendix B.

Gravel:	5%
Sand:	44%
Silt:	37%
Clay:	14%

The presence of cobbles and boulders can always be expected in the glacial till deposits, owing to their mode of deposition.

In addition, in Borehole 2-10, a 1.5 m thick sandy silt layer with some clay was found to be interbedded at depths between 2 and 3.5 m below the ground surface. The grain-size distribution of a sample from this sandy silt layer is given in Figure B-10 in Appendix B, as presented below:

Gravel:	0%
Sand:	18%
Silt:	64%
Clay:	18%

N-values recorded in this till deposit range from 7 to more than 84 blows/0.3 m, but in general, in excess of 50 blows/0.3 m indicating a very dense relative density.

#### 4.1.8 SILTY CLAY

Underlying the clayey silt till in Boreholes 2-14 and 2-16, a silty clay deposit was encountered at 1.8 and 4.4 m below the ground surface, respectively. In Borehole 2-14, this clayey deposit, which extends to the full depth of the borehole (8.1 m), was found to contain a sand interbed at 4.4 m below the ground surface, while in Borehole 2-16, the silty clay was underlain by a sand deposit at 7.3 m. Also in Borehole 2-18, about 1.0 m thick silty clay layer was contacted in the clayey silt till as an interbed at 4.4 m depth. The grain-size distribution of a sample from this deposit in Borehole 2-14 is given in Figure B-11 in Appendix B. The following grain-size distribution is indicated.

Gravel:	0%
Sand:	4%
Silt:	35%
Clay:	61%

Atterberg Limits Test performed in the laboratory for a sample from Borehole 2-14 gave the following index values as shown in Figure B-12, Appendix B.

Liquid Limit	43%
Plastic Limit:	20%
Plasticity Index:	23%
Natural Moisture Content:	21%

These values are characteristic of clayey soils of intermediate plasticity.

N-values recorded in this deposit range from 18 to in excess of 75 blows/0.3 m indicating a very stiff to hard consistency.



#### 4.1.9 SAND

Underlying the clayey silt till, sandy silt till and the silty clay deposits in Boreholes 2-1, 2-2, 2-4, 2-6, 2-13 and 2-16, a sand deposit was contacted at depths ranging from 6.2 to 7.3 m or at elevations from El. 162.3 to 169.0 m, extending to the full depths of the boreholes (7.8 to 8.1 m). In Boreholes 2-9 and 2-14, a sand layer about 1.0 to 1.5 m thick was encountered interbedded in the sandy silt till and silty clay deposit at depths of 5.5 m (El. 168.9 m) and 4.4 m (El. 166.3 m), respectively.

The sand deposit was found to contain some gravel. The grain-size distribution analysis on a sample from Borehole 2-14 gave the following results (also see Figure B-13 in Appendix B).

Gravel:	15%
Sand:	82%
Silt & Clay:	3%

N-values recorded in this deposit range from 19 to more than 86 blows/0.3 m, but in general, in excess of 50 blows/0.3 m, indicating a compact to very dense but generally very dense relative density.

#### 4.1.10 GROUNDWATER CONDITIONS

Groundwater conditions in the open boreholes were observed while drilling and at the completion of each borehole. In addition, 13 piezometers were installed in the boreholes drilled behind the existing retaining walls to enable prolonged groundwater level measurements, without interference from surface water. The observations and recorded values are shown on the individual Record of Borehole sheets.

Water levels in the piezometers were measured about one month after the installation in Boreholes 2-2, 2-4, 2-10, 2-12, 2-14, 2-16, 2-20 and 2-22, and eleven months after the installation in Boreholes RW2-19B, RW2-19C, RW2-73/74B, RW2-73/74D and RW2-82/83C. The stabilized piezometer readings in this section are presented in Table 4.1.

Table 4.1 Stabilized Piezometer Readings Behind Retaining Wall No. 2

BH No.	Existing Ground Elevation at BH Location (m)	Piezometer Readings Depth (m)	Piezometer Readings Elevation (m)
2-2	175.2	7.3	167.9
2-4	174.2	6.0	168.2
RW2-19B	173.6	1.9	171.7
RW2-19C	173.9	2.0	171.9

BH No.	Existing Ground Elevation at BH Location (m)	Piezometer Readings Depth (m)	Piezometer Readings Elevation (m)
2-10	173.5	1.6	171.9
2-12	171.9	dry	—
2-14	170.7	2.4	168.3
2-16	169.6	1.5	168.1
2-20	168.7	5.2	163.5
2-22	168.4	3.7	164.7
RW2-73/74B	167.9	2.7	165.2
RW2-73/74D	167.9	2.8	165.1
RW2-82/83C	168.0	2.5	165.5

Based on the piezometer readings and the change of the soil colour from brown to grey, the permanent groundwater table at the site can be expected to be at El. 168.0 to 172.0 m at the west portion of the Retaining Wall No. 2 and at El. 163.0 to 166.0 m in the east portion of the retaining wall. In addition, a perched water condition is likely occurring at the tilted retaining wall panels locations, due to the accumulation of surface water in the relatively pervious fill materials overlying the relatively impervious clayey silt till.

It should also be pointed out that the groundwater is subject to seasonal fluctuations and fluctuations in response to major weather events.

#### 4.2 PROPOSED REPLACEMENT OF RETAINING WALL NO. 3 (FROM HWY 401 EB COLLECTOR STATION 32+889 TO STATION 33+115)

In this section, a total of 14 boreholes was drilled (Drawing No. 2C). Boreholes RW3-6B, RW3-6C, 3-38, RW3-19/20B, RW3-19/20D and 3-40 were drilled on the paved shoulder of Highway 401, while Boreholes RW3-6A, RW3-6D, 3-39, RW3-19A, RW3-20A, RW3-19/20E, 3-41 and 3-43 were put down on the top and behind the retaining wall.

Details of the stratigraphy encountered in the boreholes are presented on the Record of Borehole Sheets in Appendix C. The following paragraphs are only meant to complement and amplify these data.

##### 4.2.1 PAVEMENT

Boreholes RW3-6B, RW3-6C, 3-38, RW3-19/20B, RW3-19/20D and 3-40 were drilled on the paved shoulder of Highway 401 and these encountered 110 mm to 160 mm thick asphaltic concrete layer.

#### 4.2.2 TOPSOIL

Boreholes RW3-6A, RW3-6D, 3-39, RW3-19A, RW3-20A, RW3-19/20E, 3-41 and 3-43, which were drilled at the south side of the existing retaining wall, encountered topsoil at the ground surface. The thickness of topsoil in these boreholes ranges from 0.075 to 0.2 m.

#### 4.2.3 GRANULAR FILL

##### 4.2.3.1 Pavement Fill

Below the asphalt, the boreholes drilled on the shoulder of the highway contacted about 0.45 to 1.0 m thick granular base consisting of crushed gravel and sand which extends to about 0.6 to 1.1 m below the ground surface.

Based on the recorded N-values, which range from 15 to 44 blows/0.3 m, the pavement granular fill is believed to have received systematic compaction when first placed and that it is in a compact to dense state.

##### 4.2.3.2 Retaining Wall Backfill

Behind the fill retaining wall and below the pavement granular fill, Borehole 3-40 contacted granular fill materials consisting of sand with some clayey silt layers or zones, extending to a depth of 2.1 m below the existing grade. This sandy fill material was found to contain traces to some gravel.

Behind the cut retaining wall and underneath the topsoil, Borehole RW3-6A encountered silty sand backfill extending to a depth of 1.7 m below the existing grade (from the top of the cut retaining wall). The silty sand contains traces of gravel and organics.

Standard Penetration Tests performed in this granular fill material yielded N-values between 9 and 22 blows/0.3 m indicating loose to compact but generally compact relative density.

#### 4.2.4 EARTHFILL

Further back of the existing cut retaining wall and below the topsoil in Boreholes RW3-6D, 3-39, RW3-19A, RW3-20A and RW3-19/20E, earthfill was encountered extending to depths ranging from 0.8 to 1.5 m below the existing grade.

This earthfill consists mainly of clayey silt and is basically a cohesive material. N-values recorded in this fill material range from 1 to 28 blows/0.3 m, but in general, 3 to 10 blows/0.3 m. These values indicate that this fill material probably did not receive a systematic compaction when it was first placed.

#### 4.2.5 CLAYEY SILT TILL

With the exception of Borehole 3-41, a major deposit of clayey silt till was contacted in most of the boreholes in this section. In Boreholes RW3-6A, RW3-6B, RW3-6C, RW3-6D, 3-39, RW3-19A, RW3-20A and RW3-19/20E, this glacial till was contacted underlying the fill materials to the full depths of the boreholes (2.3 to 4.9 m below the existing grade). In Boreholes 3-38, RW3-19/20B, RW3-19/20D and 3-43, this deposit was underlain by silt or sandy silt/till at depths ranging from 2.9 to 5.8 m (or from El. 160.7 to 163.4 m), while in Borehole 3-40, a 2.1 m thick clayey silt till layer was found interbedded in the silty sand deposit from 3.7 m (El. 162.6 m) to 5.8 m (El. 160.5 m) below the existing grade.

This glacial till deposit consists of a heterogeneous mixture of clayey silt with sand and traces of gravel, and is basically a cohesive material. As was mentioned before, the presence of cobbles and boulders can also be expected in glacial till deposits. The results of grain-size distribution analyses of four samples from this deposit are given in Figure D-1 in Appendix D. The grain-size distribution is as follows:

Gravel:	2-8%
Sand:	27-42%
Silt:	34-50%
Clay:	10-23%

Atterberg Limits tests results of five samples from this deposit gave the following index values as shown in Figure D-2, Appendix D.

Liquid Limit	17-24%
Plastic Limit:	11-13%
Plasticity Index:	4-11%
Natural Moisture Content:	4-12%

The above values are characteristic of clayey soils of low plasticity and from the fact that the measured natural moisture contents are lower than the measured plastic limits indicates that the deposit is probably pre-consolidated (i.e. carried higher overburden pressures in the past in comparison with present conditions).

Recorded N-values in the glacial till deposit range from 6 to in excess of 50 blows/0.3 m, but in general, 20 to in excess of 50 blows/0.3 m indicating a firm to hard but generally a very stiff to hard consistency.

#### 4.2.6 SAND

Below fill materials, Boreholes 3-40 and 3-41 in the vicinity of the Wilket Creek contacted a  $1.5 \pm$  m thick sand deposit at 2.1 m depth below the ground surface or at elevations 164.2 m and 161.4 m, respectively.

Grain-size distribution test was performed on a sample from this deposit in Borehole 3-41. The results are given in Figure D-3 in Appendix D, as follows:

Gravel:	0%
Sand:	93%
Silt & Clay:	7%

In Borehole 3-40, the samples from this sandy deposit showed increased gravel and silt contents. Grain-size distribution of one sample from this deposit in Borehole 3-40 is given in Figure D-4 in Appendix D.

Gravel:	17%
Sand:	59%
Silt & Clay:	24%

The silty sand deposit in this borehole was also found to contain a clayey silt till interbed between depths of 3.7 and 5.8 m. The silty sand deposit was contacted to the full depth of the borehole (6.6 m below the ground surface).

N-values recorded in this sandy deposit range from 14 to 28 blows/0.3 m indicating a compact relative density.

#### 4.2.7 SANDY SILT TO SILTY SAND TILL

A sandy silt to silty sand till deposit was encountered below the clayey silt till at 5.8 m depth (El. 160.7 m) in Borehole 3-38, below the sand deposit at 3.6 m depth (El. 159.9 m) in Borehole 3-41, and below the silt deposit at 4.8 m depth (El. 161.8 m) in Borehole 3-43. This glacial till deposit was found to extend at least to the full depths of the boreholes (6.6 to 8.1 m below the ground surface).

This glacial till deposit consists of a heterogeneous mixture of sandy silt to silty sand with traces of gravel, and is basically a non-cohesive material. As was mentioned before, due to their mode of deposition, the presence of cobbles and boulders can also be expected in glacial till deposits. Grain-size distribution of one sample from this deposit in Borehole 3-41 is given in Figure D-5 in Appendix D. The following grain-size distribution is presented.

Gravel:	3%
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Sand:	46%
Silt:	40%
Clay:	11%

N-values recorded in this sandy deposit range from 20 to 53 blows/0.3 m indicating a compact to very dense relative density.

#### 4.2.8 SILT TO SANDY SILT

In Boreholes RW3-19/20B and RW3-19/20D, a silt to sandy silt deposit was contacted below the clayey silt till deposit at 2.9 m (El. 163.4 m) below the existing grade, extending to the full depth of the boreholes at 5.0 m below the ground surface. In Borehole 3-43, at 4.0 m depth, a 0.8 m thick silt layer with traces of gravel and clay was encountered between the clayey silt till and silty sand till.

N-values recorded in this sandy deposit range from 16 to in excess of 50 blows/0.3 m indicating a compact to very dense relative density.

#### 4.2.9 GROUNDWATER CONDITIONS

Groundwater conditions in the open boreholes were observed while drilling and at the completion of each borehole. In addition, one piezometer was installed in Borehole 3-41 drilled behind the existing retaining wall to enable prolonged groundwater level measurements, without interference from surface water. The observations and recorded values are shown on the individual Record of Borehole sheets.

Water level in the piezometer in Borehole 3-41 was measured at Elevation 161.2 m or 2.3 m below the ground surface, about one month after the installation. Based on the piezometer readings and the change of the soil colour from brown to grey, the permanent groundwater table at the site can be expected to be between El. 162.0 to 164.0 m, while in the vicinity of the Wilket Creek Culvert (Station 33+100) the permanent groundwater table is approximately at El. 161.2 m.

It should also be pointed out that the groundwater is subject to seasonal fluctuations and fluctuations in response to major weather events. In addition, a perched water condition is likely occurring at the tilted retaining wall panels locations, due to the accumulation of surface water in the relatively pervious fill materials overlying the relatively impervious clayey silt till. This perched water condition could also occur somewhere else at the site with similar subsurface conditions.

#### 4.3 PROPOSED REPLACEMENT OF NOISE BARRIER WALL (FROM N/S-E RAMP STATION 10+024 TO HWY 401 EB COLLECTOR STATION 33+168)

Boreholes drilled for the retaining wall (Retaining Wall Nos. 2 and 3) replacements described in Sections 4.1 and 4.2 will also be utilized for the proposed noise barrier wall replacement.

Between Retaining Wall Nos. 2 and 3, an additional 5 boreholes (Boreholes 28, 31, 33, 35 and 37) were drilled south of the paved shoulder of the Highway 401 Eastbound Collectors for the existing noise barrier wall replacement in this section (Drawing No. 2B).

Details of the stratigraphy encountered in the five boreholes put down between Retaining Wall Nos. 2 and 3 (presented on the Record of Borehole Sheets in Appendix E) are briefly described below.

##### 4.3.1 TOPSOIL

A 0.1 to 0.2 m thick topsoil layer was contacted at all five borehole locations, followed by clayey silt fill or clayey silt layers.

##### 4.3.2 CLAYEY SILT FILL

All five boreholes contacted a fill/possible fill layer consisting of clayey silt with traces of rootlets and topsoil inclusions was contacted underlying the topsoil layer and extending to 0.6 to 1.4 m below the existing grade or to El. 167.6 to 166.0 m. The grain-size distribution of a sample from this deposit is given in Figure F-1 in Appendix F, which yielded 0% gravel, 40% sand, 38% silt and 22% clay size particles.

Standard Penetration Test performed in this fill material yielded N-values of 8 to 21 blows/0.3 m, indicating a stiff to very stiff consistency.

##### 4.3.3 CLAYEY SILT

A clayey silt deposit was contacted below the fill material at Borehole 33. This surficial clayey silt layer was found to be about 0.7 m thick and extended to 1.4 m below the ground surface or to El. 166.7 m. This clayey silt deposit is basically a cohesive material. One Atterberg limits test performed on a representative sample from this deposit in Borehole 33 is presented in Figure F-2 in Appendix F, which gave 24% liquid limit, 11% plastic limit and 13% plasticity index indicating a low plasticity.

An N-value of 24 blows/0.3 m recorded in this deposit indicating a very stiff consistency.

#### 4.3.4 CLAYEY SILT TILL

All five boreholes drilled in this section encountered clayey silt till below the surficial clayey silt deposit or clayey silt fill at elevations ranging from El. 166.0 to 167.6 m. All boreholes, except Borehole 37, were terminated in this glacial till deposit at depths between 6.2 m and 6.4 m below the ground surface or at elevations between 161.2 and 162.2 m. In Borehole 37, the clayey silt till is underlain by silty sand till at 2.1 m depth below the existing grade. In Boreholes 33 and 35, 1.8 and 2.6 m thick silt interbeds were contacted within the clayey silt till.

Grain-size distribution of one sample from this deposit in Borehole 28 is given in Figure F-3 in Appendix F. The following grain-size distribution is presented.

Gravel:	0%
Sand:	35%
Silt:	45%
Clay:	20%

Atterberg Limits tests results of three samples from this deposit gave the following index values as shown in Figure F-4, Appendix F.

Liquid Limit	19-23%
Plastic Limit:	11%
Plasticity Index:	8-12%
Natural Moisture Content:	8-11%

The above values are characteristic of clayey soils of low plasticity and from the fact that the measured natural moisture contents are lower than the measured plastic limits indicates that the deposit is probably pre-consolidated (i.e. carried higher overburden pressures in the past in comparison with present conditions).

The presence of cobbles and boulders can always be expected in the glacial till deposits, owing to their mode of deposition.

N-values recorded in this till deposit range from 14 to in excess of 50 blows/0.3 m. These values indicate stiff to hard consistency but in general, the recorded values are in excess of 30 blows/0.3 m indicating a typically hard consistency.

#### 4.3.5 SILT

I Boreholes 33, 35 and 37 contacted a silt deposit below or within the clayey silt till deposit at depths of 2.1 to 4.4 m below the ground surface or at El. 166.0 to 163.5 m. As mentioned in the previous section, the thickness of this silt deposit was found to be about



1.8 to 2.6 m at Boreholes 33 and 35, while Borehole 37 was terminated in this deposit at 6.6 m depth below the ground surface or at El. 161.3 m. The grain-size distribution of a sample from this deposit is given in Figure F-5 in Appendix F, which yielded 0% gravel, 16% sand, 72% silt and 12% clay size particles. As previously stated, the presence of cobbles and boulders can always be expected in the glacial till deposits, owing to their mode of deposition.

N-values recorded in this till deposit range from 46 to in excess of 50 blows/0.3 m, but in general, in excess of 50 blows/0.3 m indicating a very dense relative density.

#### 4.3.6 SILTY SAND TILL

In Borehole 37, underlying the clayey silt till at a depth of 2.1 m (El. 165.8 m), a silty sand till layer was contacted. The silty sand till was found to overlain the silt deposit at a depth of 4.4 m (El. 163.5 m). The grain-size distribution of a sample from this deposit is given in Figure F-6 in Appendix F, which yielded 13% gravel, 62% sand, 19% silt and 6% clay size particles. As previously stated, the presence of cobbles and boulders can always be expected in the glacial till deposits, owing to their mode of deposition.

N-values recorded in this till deposit were in excess of 50 blows/0.3 m, indicating a very dense relative density.

#### 4.3.7 GROUNDWATER CONDITIONS

Groundwater conditions in the open boreholes were observed while drilling and at the completion of each borehole. In addition, piezometers were installed in Boreholes 31 and 35 to enable prolonged groundwater level measurements, without interference from surface water. The observations and recorded values are shown on the individual Record of Borehole sheets.

Water level in the piezometer in Borehole 35 was measured at Elevation 163.3 m or 4.1 m below the ground surface, while no water was observed in the piezometer in Borehole 31, about one month after the installation. Based on the piezometer readings and the change of the soil colour from brown to grey, the permanent groundwater table at the site can be expected to be between El. 162.0 to 164.0 m.

It should also be pointed out that the groundwater is subject to seasonal fluctuations and fluctuations in response to major weather events.

#### 4.4 PANEL NO. 3 OF RETAINING WALL NO. 5 (FROM HWY 401 EB COLLECTOR STATION 33+250 TO STATION 33+300)

Three boreholes were drilled to investigate the tilted Panel # 3 of the existing Retaining Wall No. 5. Of these three boreholes, one (Borehole RW5-3A) was drilled on the paved shoulder of Highway 401 close to the toe of the retaining wall, while the remaining two (Boreholes RW5-3B and RW5-3C) were drilled behind the existing noise barrier wall, due to drill inaccessibility and presence of underground utilities. The locations of these boreholes are shown on Drawing No. 2C.

Details of the subsurface conditions encountered in the boreholes are given on the Records of Borehole Sheets, in Appendix G. The individual strata are briefly described in the following paragraphs.

##### 4.4.1 PAVEMENT FILL

Beneath a 150 mm thick asphaltic concrete layer, Borehole RW5-3A contacted a 0.55 m thick granular base consisting of crushed gravel and sand extending to 0.7 m below the ground surface.

##### 4.4.2 TOPSOIL

Boreholes RW5-3B and RW5-3C encountered an about 0.15 m thick topsoil at the ground surface.

##### 4.4.3 EARTHFILL

Further back of the cut retaining wall (behind the noise barrier wall) and underlying the topsoil layer, earthfill consisting of clayey silt fill was contacted in Boreholes RW5-3B and RW5-3C. In Borehole RW5-3C, this fill was underlain by a silty sand fill at 0.8 m below the ground surface or at El. 167.2 m, while in Borehole RW5-3B, the clayey silt fill was contacted to the full depth of the borehole at 1.2 m below the ground surface or at El. 166.6 m.

This clayey silt fill was found to contain some sand and occasional gravel. Standard Penetration Tests performed in this fill material yielded N-values between 3 and 55 blows/0.3 m indicating that this material was not uniformly compacted.

##### 4.4.4 GRANULAR BACKFILL

Below the pavement fill in Borehole RW5-3A (at the toe of cut retaining wall) and the clayey silt fill in Borehole RW5-3C (at the top of the cut retaining wall), fill material consisting of

silty sand with occasional gravel was contacted at 0.7 to 0.8 m below the ground surface. Borehole RW5-3C was terminated in this fill material at 2.3 m below the ground surface or at El. 165.7 m. In Borehole RW5-3A, this sandy fill material was found extending to a depth of 2.2 m below the ground surface or to El. 165.7 m.

Grain-size distribution of one sample from this deposit in Borehole RW5-3A is given in Figure H-1 in Appendix H. The following grain-size distribution is presented.

Gravel:	13%
Sand:	56%
Silt:	20%
Clay:	11%

Standard Penetration Tests performed in this fill material yielded N-values between 14 and 66 blows/0.3 m indicating that this material probably received some systematic compaction when first placed.

#### 4.4.5 SILTY SAND TO SANDY SILT

In Borehole RW5-3A, a silty sand to sandy silt deposit was contacted underlying the fill materials at a depth of 2.2 m and extending to a depth of 4.0 m below the ground surface. This deposit is basically a non-cohesive deposit, and N-values obtained in this deposit are in excess of 50 blows/0.3 m indicating a very dense relative density.

#### 4.4.6 SILTY SAND TILL

Below the silty sand to sandy silt deposit, Borehole RW5-3A contacted a silty sand till deposit extending to the full depth of the borehole (5.0 m below the ground surface or El. 162.9 m).

As was discussed before, this is a basically non-cohesive deposit consisting of a heterogeneous mixture of silty sand with traces of gravel and clay.

Standard Penetration Test performed in this till deposit yielded an N-value of in excess of 50 blows/0.3 m indicating a very dense relative density.

#### 4.4.7 GROUNDWATER CONDITIONS

The boreholes were dry upon their completion; but this is unlikely to represent a stabilized condition. Based on the colour of the soil and moisture contents of the samples, however, it is our opinion that the groundwater table at time of our investigation was between El. 163.0 and 164.0 m.

It should, however, be pointed out that the groundwater table is subject to seasonal fluctuations and in response to major weather events. In addition, a perched water condition is likely to occur, especially during wet periods, due to the accumulation of surface water in the relatively pervious granular fill overlying the relatively impervious clayey silt till.

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Yuxin Lang, P.Eng.



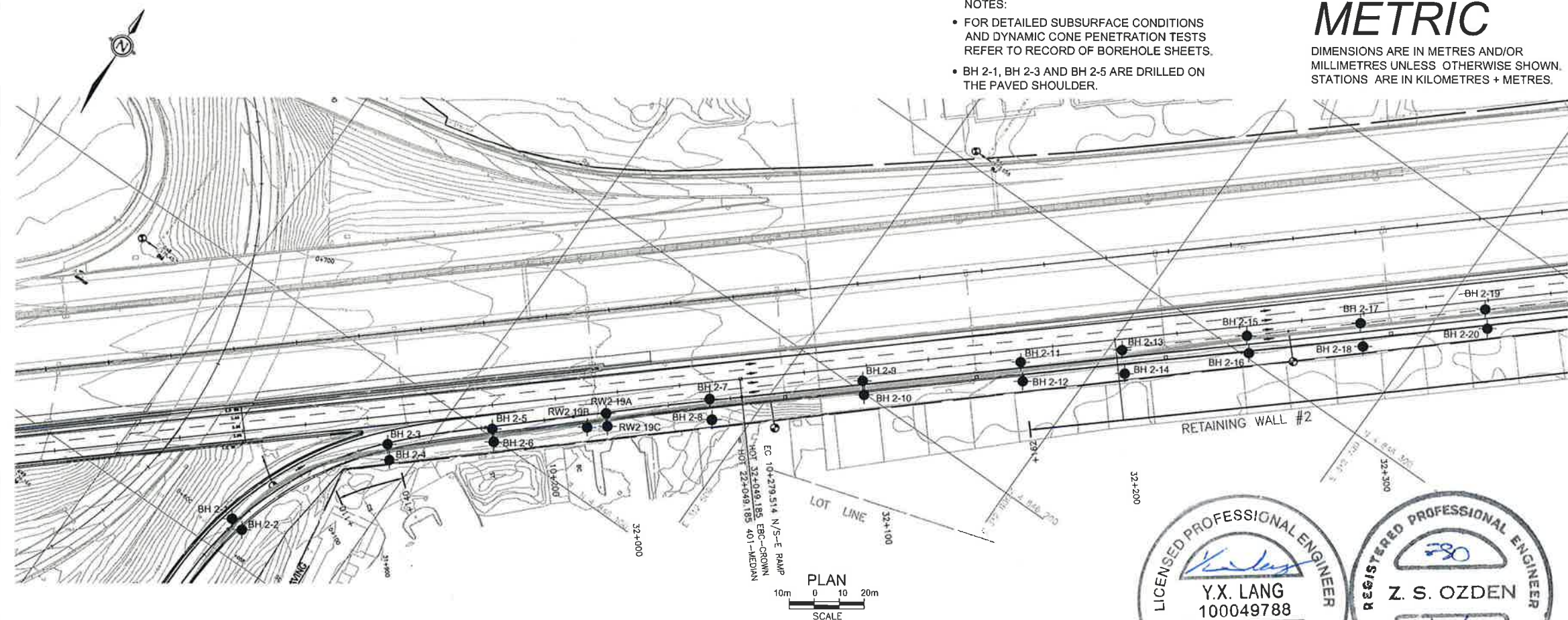
  
R. Miranda, P.Eng.

  
Z. S. Ozden, M.A.Sc., P.Eng.



# Drawings

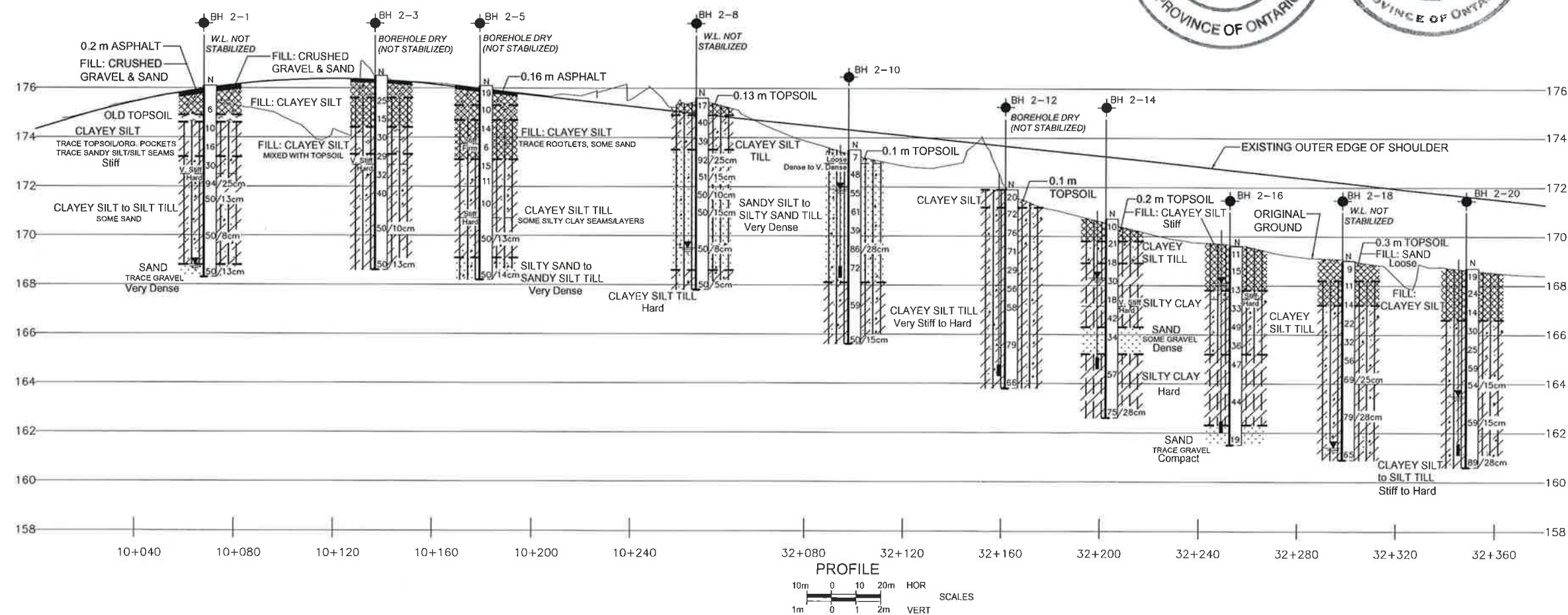




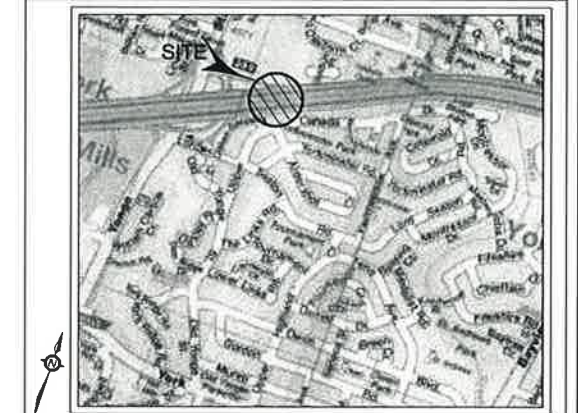
- NOTES:
- FOR DETAILED SUBSURFACE CONDITIONS AND DYNAMIC CONE PENETRATION TESTS REFER TO RECORD OF BOREHOLE SHEETS.
  - BH 2-1, BH 2-3 AND BH 2-5 ARE DRILLED ON THE PAVED SHOULDER.

**METRIC**

DIMENSIONS ARE IN METRES AND/OR MILLIMETRES UNLESS OTHERWISE SHOWN. STATIONS ARE IN KILOMETRES + METRES.



**SHAHEEN & PEAKER LIMITED**



KEY PLAN N.T.S.

**LEGEND**

- Bore Hole
- N Blows/0.3m (Std. Pen. Test, 475 J/blow)
- Water Level at Time of Investigation Oct., 2004
- Water Level in Piezometer
- Piezometer

No.	ELEV.	STATION	OFFSET
BH 2-1	176.1	10+068.0	1.9m Lt EP
BH 2-2	175.2	10+068.0	4.0m Rt EP
BH 2-3	176.5	10+137.0	0.4m Rt EP
BH 2-4	174.2	10+136.2	6.8m Rt EP
BH 2-5	176.1	10+179.2	0.9m Rt EP
BH 2-6	173.8	10+179.1	6.2m Rt EP
RW2 19A	175.6	10+225.0	0.3m Rt EP
RW2 19B	173.6	10+216.6	5.0m Rt EP
RW2 19C	173.9	10+225.0	5.6m Rt EP
BH 2-7	175.1	10+266.7	0.7m Lt EP
BH 2-8	175.6	10+266.7	7.7m Rt EP
BH 2-9	174.4	32+097.9	5.8m Rt EP
BH 2-10	173.5	32+097.9	11.5m Rt EBC C/L
BH 2-11	174.2	32+161.7	4.9m Rt EBC C/L
BH 2-12	171.9	32+161.7	12.7m Rt EBC C/L
BH 2-13	173.7	32+202.4	4.3m Rt EBC C/L
BH 2-14	170.7	32+202.4	13.9m Rt EBC C/L
BH 2-15	173.2	32+252.6	3.8m Rt EBC C/L
BH 2-16	169.6	32+252.6	10.8m Rt EBC C/L
BH 2-17	172.7	32+298.3	3.6m Rt EBC C/L
BH 2-18	169.0	32+298.3	13.1m Rt EBC C/L
BH 2-19	171.9	32+348.4	3.5m Rt EBC C/L
BH 2-20	168.7	32+348.4	11.4m Rt EBC C/L

**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 Materials Engineering and Research Office, Downsview. Information contained in this report and related documents are specifically excluded in accordance with the conditions of Section GC 2.01 of OPS Gen. Cond.

REV.	DATE	BY	DESCRIPTION

Geocres No.			
HWY No. 401			DIST 6
SUBM'D ZO	CHECKED RM	DATE Mar., 2005	SITE
DRAWN JZ	CHECKED YL	APPROVED	DWG 2A

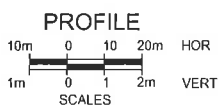
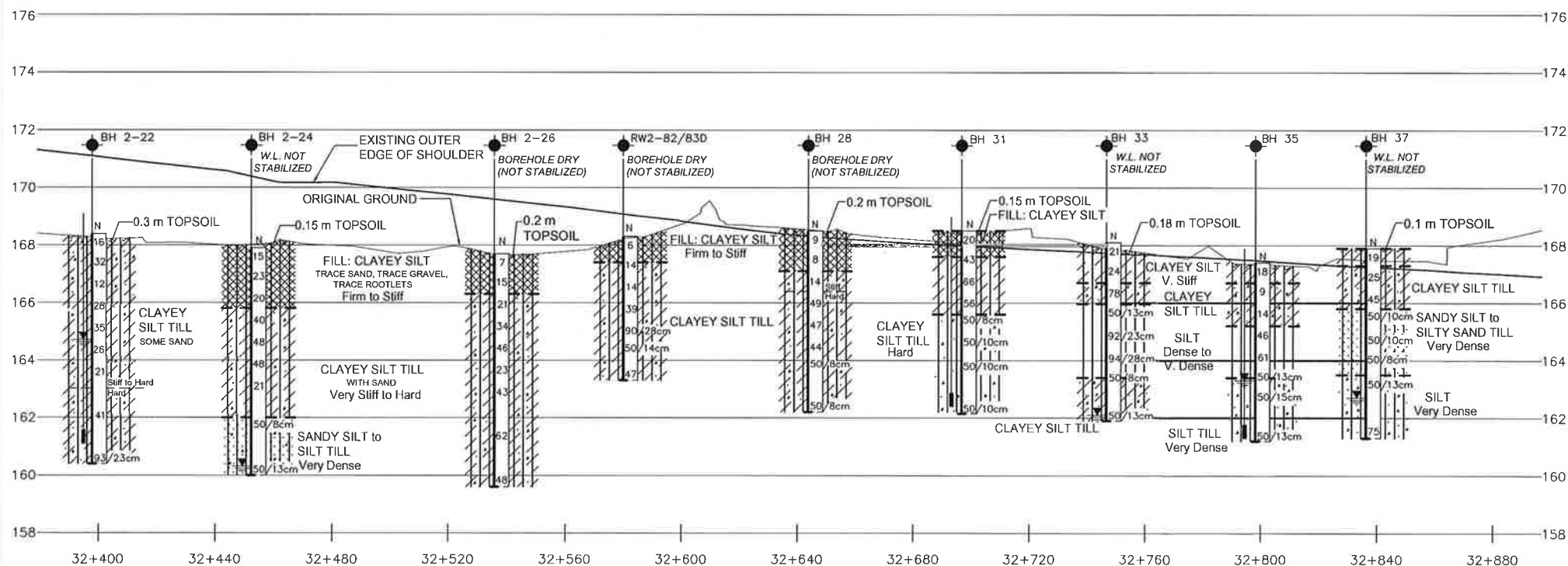
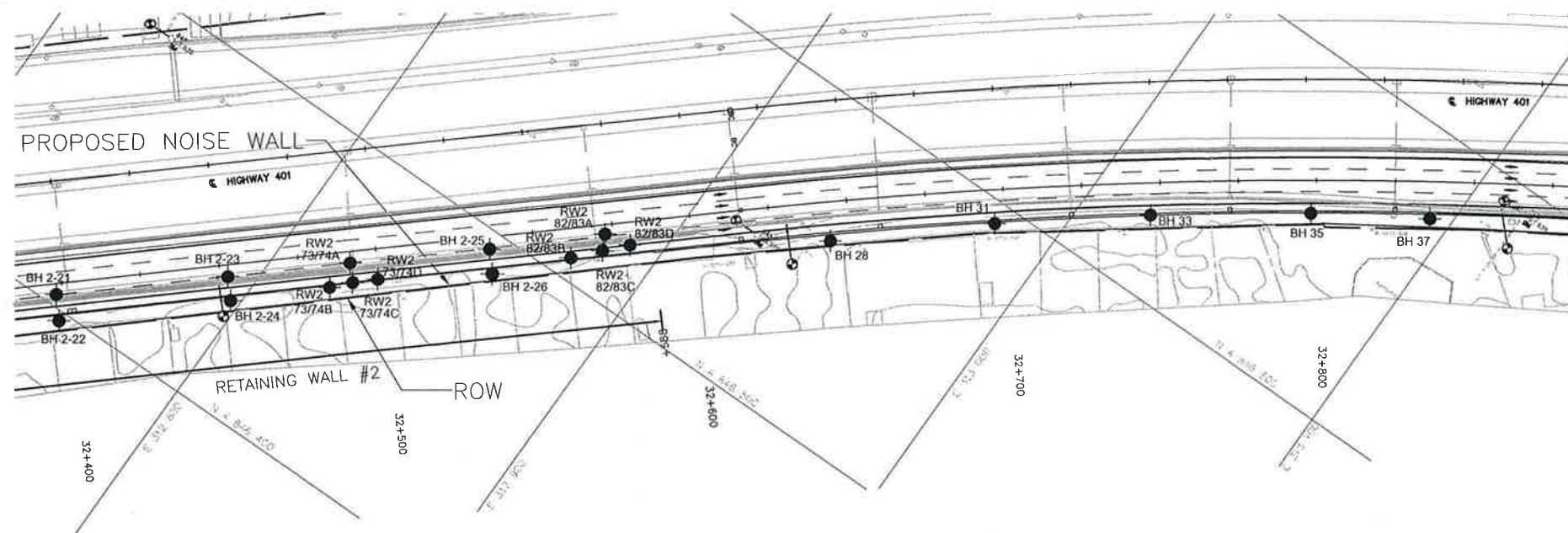




NOTE:  
FOR DETAILED SUBSURFACE CONDITIONS  
AND DYNAMIC CONE PENETRATION TESTS  
REFER TO RECORD OF BOREHOLE SHEETS.

**METRIC**

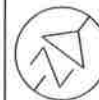
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MILLIMETRES UNLESS OTHERWISE SHOWN.  
STATIONS ARE IN KILOMETRES + METRES.



CONT No.

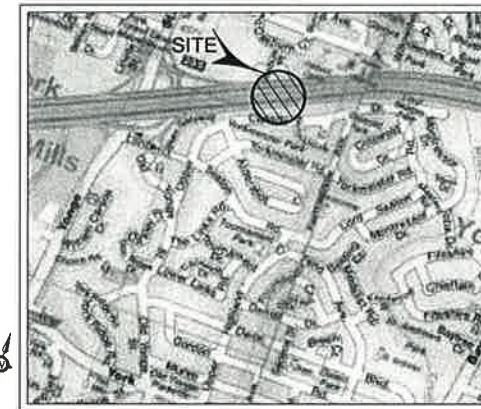
GWP 158-00-00

HWY 401 EBL COLLECTOR  
YONGE ST. TO BAYVIEW AVE.  
BORE HOLE LOCATIONS & SOIL STRATA



SHEET  
482

**SHAHEEN & PEAKER LIMITED**



KEY PLAN N.T.S.

**LEGEND**

- Bore Hole
- Blows/0.3m (Std. Pen. Test, 475 J/blow)
- Water Level at Time of Investigation  
Oct., 2004
- Water Level in Piezometer
- Piezometer

No.	ELEV.	STATION	OFFSET
BH 2-21	171.3	32+397.9	3.5m Rt EBC C/L
BH 2-22	168.4	32+397.8	12m Rt EBC C/L
BH 2-23	170.8	32+452.4	3.8m Rt EBC C/L
BH 2-24	167.9	32+452.3	11.6m Rt EBC C/L
RW2 73/74A	168.0	32+491.4	3.6m Rt EBC C/L
RW2 73/74B	167.9	32+484.0	10.8m Rt EBC C/L
RW2 73/74C	167.9	32+491.5	10.0m Rt EBC C/L
RW2 73/74D	167.9	32+499.6	9.8m Rt EBC C/L
BH 2-25	169.9	32+535.9	3.9m Rt EBC C/L
BH 2-26	167.7	32+535.9	11.9m Rt EBC C/L
RW2 82/83A	169.3	32+572.5	3.0m Rt EBC C/L
RW2 82/83B	167.7	32+561.0	9.5m Rt EBC C/L
RW2 82/83C	168.0	32+571.3	7.2m Rt EBC C/L
RW2 82/83D	168.3	32+580.0	7.3m Rt EBC C/L
BH 28	168.5	32+643.8	12.6m Rt EBC C/L
BH 31	168.5	32+696.7	10.9m Rt EBC C/L
BH 33	168.1	32+746.6	10.4m Rt EBC C/L
BH 35	167.4	32+798.2	10.6m Rt EBC C/L
BH 37	167.9	32+836.3	11.9m Rt EBC C/L

**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 Materials Engineering and Research Office, Downsview.  
Information contained in this report and related documents are  
specifically excluded in accordance with the conditions of Section  
GC 2.01 of OPS Gen. Cond.

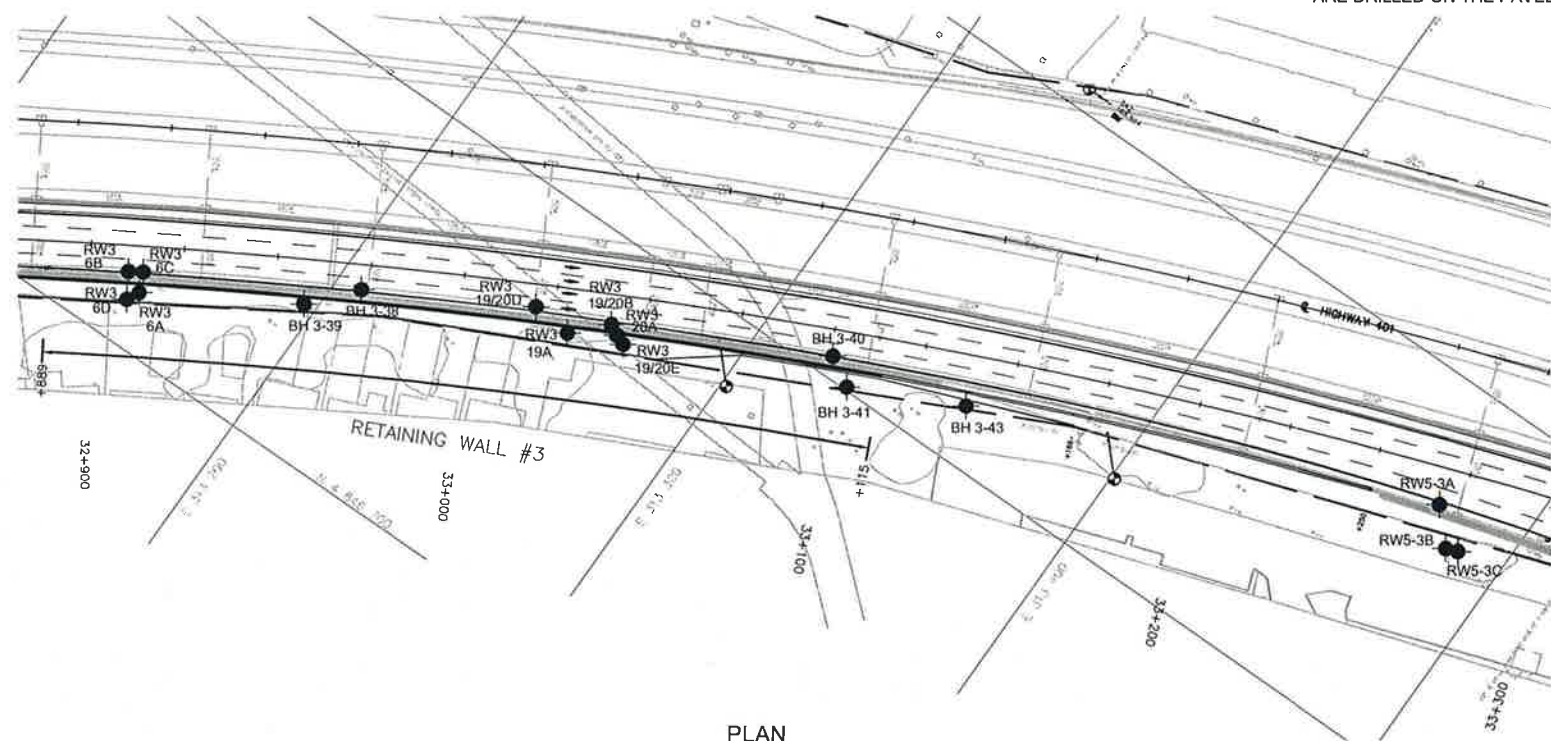
REV.	DATE	BY	DESCRIPTION

Geocres No.

HWY No. 401			DIST 6
SUBM'D ZO	CHECKED RM	DATE Mar., 2005	SITE
DRAWN JZ	CHECKED YL	APPROVED	DWG 2B











- FOR DETAILED SUBSURFACE CONDITIONS AND DYNAMIC CONE PENETRATION TESTS REFER TO RECORD OF BOREHOLE SHEETS.
- RW 3-6B, BH 3-38, RW 3-19/20D AND BH 3-40 ARE DRILLED ON THE PAVED SHOULDER.

DIMENSIONS ARE IN METRES AND/OR  
MILLIMETRES UNLESS OTHERWISE SHOWN.  
STATIONS ARE IN KILOMETRES + METRES.

SHEET  
483

### LEGEND

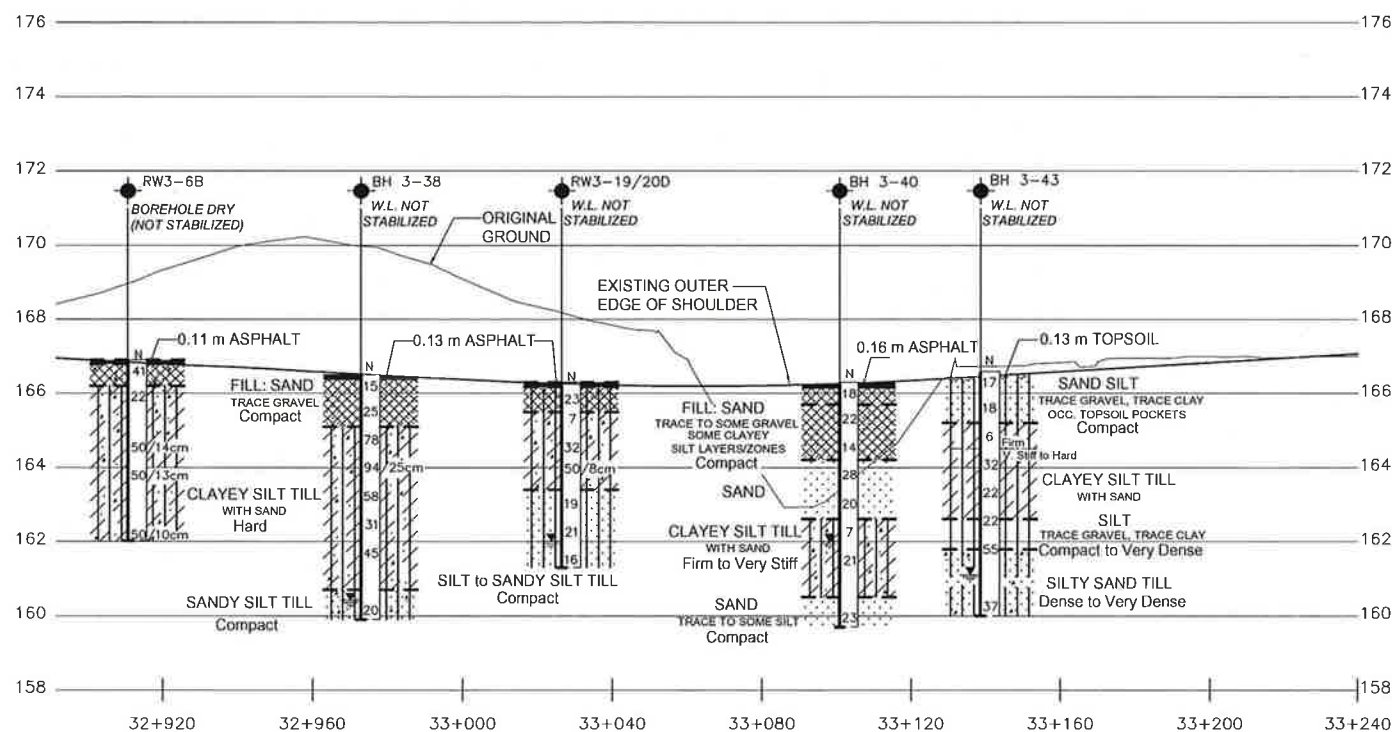
- 
-  Bore Hole  
 Water Level at Time of Investigation  
 Water Level in Piezometer  
 Piezometer

No.	ELEV.	STATION	OFFSET
RW3 6A	170.1	32+913.5	12.7m Rt EBC C/U
RW3 6B	166.9	32+910.4	7.0m Rt EBC C/U
RW3 6C	166.9	32+914.3	6.9m Rt EBC C/U
RW3 6D	170.6	32+912.1	14.5m Rt EBC C/U
BH 3-38	166.5	32+972.9	6.8m Rt EBC C/U
BH 3-39	170.9	32+958.0	12.2m Rt EBC C/U
RW3 19A	168.7	33+030.0	12.0m Rt EBC C/U
RW3 19/20B	166.3	33+040.6	8.1m Rt EBC C/U
RW3 19/20D	166.3	33+021.0	6.0m Rt EBC C/U
RW3 19/20E	168.9	33+044.5	13.0m Rt EBC C/U
RW3 20A	167.9	33+042.5	10.8m Rt EBC C/U
BH 3-40	166.3	33+100.7	7.2m Rt EBC C/U
BH 3-41	163.5	33+105.8	14.8m Rt EBC C/U
BH 3-43	166.6	33+138.6	13.8m Rt EBC C/U
RW5 3A	167.1	33+269.2	10.0m Rt EBC C/U
RW5 3B	167.8	33+274.1	21.0m Rt EBC C/U
RW5 3C	168.0	33+277.4	20.9m Rt EBC C/U

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 Materials Engineering and Research Office, Downsview. Information contained in this report and related documents are specifically excluded in accordance with the conditions of Section GC 2.01 of OPS Gen. Cond.

REV.			
	DATE	BY	DESCRIPTION
Geocres No.			
HWY No. 401			DIST 6
SUBM'D ZO	CHECKED RM	DATE Mar., 2005	SITE
DRAWN JZ	CHECKED YL	APPROVED	DWG 2C



**PROFILE**

10m 0 10 20m HOR

1m 0 1 2m VERT

**SCALES**





# Appendix A

## Records of Boreholes for Retaining Wall 2

SPT 1103

# RECORD OF BOREHOLE No 2-1

1 OF 1

METRIC

GWP 158-00-00

LOCATION Hwy 401 EBL Collector Yonge St. to Bayview Ave., Sta.: 10+068.0; Offset: 1.8m Lt EP

ORIGINATED BY Y.L.

DIST 6 HWY 401

BOREHOLE TYPE Solid Stem Augers

COMPILED BY J.Z.

DATUM Geodetic

DATE 10/12/2004

CHECKED BY R.M.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT $\gamma$ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20 40 60 80 100	20 40 60 80 100	20 40 60 80 100	20 40 60 80 100	20 40 60 80 100		
176.1 0.0	Ground Surface						176							
	200 mm ASPHALT FILL: CRUSHED GRAVEL & SAND brown, damp		1	AS										
174.9 1.2	clayey silt fill layer		2	SS	6		175							
174.6 1.5	OLD TOPSOIL		3	SS	10		174							
	CLAYEY SILT trace topsoil/organic pockets trace sandy silt/silt seams grey to brown, moist, stiff		4	SS	16		173							
173.2 2.9			5	SS	30		172							
			6	SS	94/25		171							
	CLAYEY SILT to SILT TILL some sand		7	SS	50/13		170							
			8	SS	50/8		169							
168.8 7.3	SAND trace gravel, grey, wet, very dense		9	SS	50/13									
168.3 7.8	End of Borehole.													
	*Water level at 7.3 m (not stabilized) and hole open to full depth on completion.													

SPT 1103

# RECORD OF BOREHOLE No 2-2

1 OF 1

METRIC

GWP 158-00-00 LOCATION Hwy 401 EBL Collector Yonge St. to Bayview Ave., Sta.:10+068; Offset:4.0m Rt EP ORIGINATED BY M.L.  
 DIST 6 HWY 401 BOREHOLE TYPE Solid Stem Augers COMPILED BY J.Z.  
 DATUM Geodetic DATE 10/25/2004 CHECKED BY R.M.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT $\gamma$ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20	40	60	80	100		
175.2	Ground Surface													
0.0	0.1 m TOPSOIL		1	SS	16		175							
	very stiff													
	firm		2	SS	6		174							
173.7	FILL: CLAYEY SILT trace sand, trace gravel brown, damp to moist													
1.5			3	SS	7		173							
	firm													
	hard to very stiff		4	SS	32		172							
			5	SS	17		171							
	hard		6	SS	51		170							
	CLAYEY SILT TILL with sand grey, damp to moist		7	SS	70/25		169							
169.0														
6.2	SAND some gravel brown, wet, very dense		8	SS	50/13		168							
167.1			9	SS	66/23									
8.1	End of Borehole.  *Water level at 7.3 m (not stabilized) and hole open to full depth on completion.  Piezometer installed at 7.3 m.  *Water level on: Oct. 28, 2004 - 7.2 m (El. 168.0 m) Nov. 26, 2004 - 7.3 m (El. 167.9 m)													wet spoon

+ 3 . X 3 : Numbers refer to  
Sensitivity

20  
15 5  
10 (%) STRAIN AT FAILURE

SPT 1103

# RECORD OF BOREHOLE No 2-3

1 OF 1

METRIC

GWP 158-00-00 LOCATION Hwy 401 EBL Collector Yonge St. to Bayview Ave., Sta.: 10+137.0; Offset: 0.4m Rt EP ORIGINATED BY Y.L.  
DIST 6 HWY 401 BOREHOLE TYPE Solid Stem Augers COMPILED BY J.Z.  
DATUM Geodetic DATE 10/12/2004 CHECKED BY R.M.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT $\gamma$ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20	40	60	80	100		
176.5	Ground Surface													
0.0	130 mm ASPHALT		1	AS	-	*	176							
175.8	270 mm CRUSHED GRAVEL & SAND		2	SS	25		175							
0.9	FILL: CLAYEY SILT		3	SS	15		174							
174.4	trace gravel, trace rootlets		4	SS	30		173							
2.1	trace sand seams/zones		5	SS	29		172							
173.3	FILL: CLAYEY SILT		6	SS	32		171							
3.2	mixed with topsoil		7	SS	40		170							
	dark brown, moist		8	SS	50/10		169							
	CLAYEY SILT to SILT TILL		9	SS	50/13									
	some sand													
	damp to moist													
	very stiff													
	hard													
	brown													
	grey													
168.6	End of Borehole.													
7.9	*Borehole dry (not stabilized) and hole open to full depth on completion.													

+<sup>3</sup>, ×<sup>3</sup>: Numbers refer to  
Sensitivity

20  
15  
10  
(%) STRAIN AT FAILURE

SPT 1103

# RECORD OF BOREHOLE No 2-4

1 OF 1

METRIC

GWP 158-00-00 LOCATION Hwy 401 EBL Collector Yonge St. to Bayview Ave., Sta.: 10+136.2; Offset: 6.8m Rt EP ORIGINATED BY M.L.  
DIST 8 HWY 401 BOREHOLE TYPE Solid Stem Augers COMPILED BY J.Z.  
DATUM Geodetic DATE 10/28/2004 CHECKED BY R.M.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT W <sub>P</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)		
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa									
								○ UNCONFINED		+ FIELD VANE						● POCKET PENETR. X LAB VANE	
174.2	Ground Surface						20	40	60	80	100						
0.0	0.2 m TOPSOIL		1	SS	5												
	FILL: CLAYEY SILT with SAND some gravel, trace topsoil pockets brown, moist		2	SS	7												
	firm																
	stiff																
172.1	some sand seams/pockets		3	SS	13												
2.1	CLAYEY SILT TILL trace sand seams brown, moist		4	SS	28												
	very stiff																
	hard		5	SS	30												
			6	SS	47												
169.2	grey silt layer		7	SS	51												
5.0	SANDY SILT TILL grey, moist, very dense		8	SS	84/28												
167.2																	
7.0	SAND trace silt, occasional gravel grey, wet, very dense		9	SS	50/13												
166.3																	
7.9	End of Borehole.																
	*Water level at 5.6 m (not stabilized) and hole open to full depth on completion.																
	Piezometer installed at 7.6 m.																
	*Water level on: Oct. 28, 2004 - 5.6 m (El. 168.6 m) Nov. 26, 2004 - 6.0 m (El. 168.2 m)																

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

SPT 1103

# RECORD OF BOREHOLE No 2-5

1 OF 1

METRIC

GWP 158-00-00

LOCATION Hwy 401 EBL Collector Yonge St. to Bayview Ave., -Sta.: 10+179.2; Offset: 0.9m R/E

ORIGINATED BY S.A.

DIST 6 HWY 401

BOREHOLE TYPE Solid Stem Augers

COMPILED BY J.Z.

DATUM Geodetic

DATE 10/12/2004

CHECKED BY R.M.

## SOIL PROFILE

## SAMPLES

## GROUND WATER CONDITIONS

## DYNAMIC CONE PENETRATION RESISTANCE PLOT

20 40 60 80 100

SHEAR STRENGTH kPa

○ UNCONFINED + FIELD VANE

● POCKET PENETR. X LAB VANE

20 40 60 80 100

PLASTIC  
LIMIT

W<sub>P</sub>

NATURAL  
MOISTURE  
CONTENT

W

LIQUID  
LIMIT

W<sub>L</sub>

WATER CONTENT (%)

20 40 60

UNIT  
WEIGHT

γ

kN/m<sup>3</sup>

19.4

REMARKS  
&  
GRAIN SIZE  
DISTRIBUTION  
(%)

GR SA SI CL

ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	20 40 60 80 100	PLASTIC LIMIT W <sub>P</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
176.1	Ground Surface						176						
0.0	160 mm ASPHALT		1	SS	19	*	176						
175.3	FILL: CRUSHED GRAVEL & SAND brown, moist, compact		2	SS	10		176						
0.8	FILL: SAND some gravel brown, moist, loose		3	SS	14		176						19 70 (11)
174.7	FILL: CLAYEY SILT trace rootlets, some sand grey, moist		4	SS	6		174						
1.4			5	SS	15		173						
173.1	some organic, organic stained		6	SS	11		172						
3.0	CLAYEY SILT TILL some silty clay seams/layers grey, moist		7	SS	10		171						
			8	SS	50/13		170						
169.1	SILTY SAND to SANDY SILT TILL brown, moist, very dense		9	SS	50/14		169						
7.0													
168.2	End of Borehole.												
7.9	*Borehole dry (not stabilized) and hole open to full depth on completion.												

+<sup>3</sup>, X<sup>3</sup>: Numbers refer to  
Sensitivity

20  
15-5  
10 (%) STRAIN AT FAILURE

SPT 1103

# RECORD OF BOREHOLE No 2-6

1 OF 1

METRIC

GWP 158-00-00 LOCATION Hwy 401 EBL Collector Yonge St. to Bayview Ave., Sta.: 10+179.1; Offset: 6.2m Rt EP ORIGINATED BY Y.L.  
 DIST 6 HWY 401 BOREHOLE TYPE Solid Stem Augers COMPILED BY J.Z.  
 DATUM Geodetic DATE 10/28/2004 CHECKED BY R.M.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT $\gamma$ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20	40	60	80	100		
173.8 0.0	Ground Surface													
	0.25 m TOPSOIL		1	SS	23									
	FILL: CLAYEY SILT some sand, some topsoil pockets, trace gravel brown to dark brown, damp, very stiff		2	SS	16									
172.4 1.4														
	FILL: SAND some gravel, trace cobbles brown, moist, very dense		3	SS	50/15									
171.7 2.1														
	CLAYEY SILT TILL some sand brown, moist		4	SS	22									
	very stiff		5	SS	31									
	hard		6	SS	50/8									
168.9 4.9			7	SS	99/25									
	SILTY SAND to SANDY SILT TILL grey, moist, very dense		8	SS	50/10									
166.5 7.3														
	SAND some gravel, trace silt grey, wet, very dense		9	SS	50/10									
165.9 7.9														
	End of Borehole.													
	*Water level at 3.1 m (not stabilized) and hole open to 7.3 m on completion.													

+<sup>3</sup>, X<sup>3</sup>: Numbers refer to  
Sensitivity

20  
15 5  
10 (%) STRAIN AT FAILURE

SPT 1103

# RECORD OF BOREHOLE No RW2-19B

1 OF 1

METRIC

GWP 158-00-00 LOCATION Hwy 401 EBL Collector Yonge St. to Bayview Ave., Sta.:10+216.6; Offset:5m Rt EP ORIGINATED BY R.A.  
DIST 6 HWY 401 BOREHOLE TYPE Solid Stem Augers COMPILED BY J.Z.  
DATUM Geodetic DATE 12/5/2003 CHECKED BY R.M.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			UNIT WEIGHT  γ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa					
173.6	Ground Surface						20	40	60	80	100		
0.0	FILL: CLAYEY SILT occasional gravel brown, moist, very soft		1	SS	2								
172.9			2	SS	6								
0.7		firm											
		very stiff	3	SS	19								
		hard	4	SS	80/28								
	CLAYEY SILT TILL damp to moist		5	SS	50/8								
		brown											
		grey	6	SS	40								
168.6			7	SS	38								
5.0	End of Borehole.												
	Borehole open to full depth on completion.												
	Piezometer installed to 4.6 m.												
	* Water level on: Dec. 05, 2003 - Dry Dec. 17, 2003 - 1.5 m (El. 172.1 m) Oct. 28, 2004 - 1.9 m (El. 171.7 m)												



SPT 1103

# RECORD OF BOREHOLE No RW2-19A

1 OF 1

METRIC

GWP 158-00-00 LOCATION Hwy 401 EBL Collector Yonge St. to Bayview Ave., Sta.:10+225; Offset:0.3m Rt EP ORIGINATED BY G.I.  
DIST 6 HWY 401 BOREHOLE TYPE Solid Stem Augers COMPILED BY J.Z.  
DATUM Geodetic DATE 11/19/2003 CHECKED BY R.M.

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT $\gamma$ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)
FLEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES		20	40	60	80	100		
175.6 0.0	Ground Surface												
	200 mm ASPHALT 250 mm CRUSHED STONE		1	SS	28								
174.5 1.1	FILL: SILTY SAND trace gravel brown, moist, compact		2	SS	6								
	FILL: CLAYEY SILT trace to some sand, occasional gravel brown, moist, loose		3	SS	6								
173.3 2.3	CLAYEY SILT TILL with sand, damp to moist		4	SS	12								
	stiff		5	SS	17								
	very stiff		6	SS	28								
	hard		7	SS	79								
	brown		8	SS	50/13								
	grey		9	SS	50/13								
167.5 8.1	End of Borehole. *Borehole dry (not stabilized) and hole open to full depth on completion.		10	SS	89								

SPT 1103

# RECORD OF BOREHOLE No RW2-19C

1 OF 1

METRIC

GWP 158-00-00 LOCATION Hwy 401 EBL Collector Yonge St. to Bayview Ave., Sta. 10+225, Offset: 5.8m Rt EP ORIGINATED BY R.A.  
 DIST 8 HWY 401 BOREHOLE TYPE Solid Stem Augers COMPILED BY J.Z.  
 DATUM Geodetic DATE 12/5/2003 CHECKED BY R.M.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT $\gamma$ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20	40	60	80	100		
173.9 0.0	Ground Surface													
	200 mm GRANULAR		1	SS	0**									
	FILL: CLAYEY SILT some sand brown, moist, very soft		2	SS	14		173							
172.8 1.1		stiff	3	SS	27		172							
		very stiff	4	SS	50/14									
		hard	5	SS	50/10		171							
		brown	6	SS	50/13		170							
		grey	7	SS	50/13									
168.9 5.0	End of Borehole.						169							
	Borehole open to full depth on completion.													
	Piezometer installed to 4.6 m.													
	* Water level on: Dec. 05, 2003 - Dry Dec. 17, 2003 - 1.1 m (El. 172.8 m) Oct. 28, 2004 - 2.0 m (El. 171.9 m)													
	** Sampler sunk under the weight of hammer and rods.													

SPT 1103

# RECORD OF BOREHOLE No 2-7

1 OF 1

METRIC

GWP 158-00-00 LOCATION Hwy 401 EBL Collector Yonge St. to Bayview Ave., -Sta.: 10+266.7; Offset: 0.7m Lt EP ORIGINATED BY S.A.  
 DIST 8 HWY 401 BOREHOLE TYPE Solid Stem Augers COMPILED BY J.Z.  
 DATUM Geodetic DATE 10/12/2004 CHECKED BY R.M.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT $\gamma$ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20	40	60	80	100		
175.1	Ground Surface													
0.0	135 mm ASPHALT					*	175							
174.4	FILL: CRUSHED GRAVEL & SAND brown, damp, compact		1	SS	15									44 48 (8)
0.7														
	FILL: SAND trace to some gravel trace clayey silt pockets brown, damp, very loose to dense		2	SS	4		174							
			3	SS	36									1 84 (15)
172.8							173							
2.3			4	SS	82									
	SANDY SILT TILL some clayey silt till layers/interbeds moist, very dense		5	SS	58		172							
			6	SS	87									0 32 60 8
			7	SS	90		171							
169.6							170							
5.5			8	SS	50/13		169							
	CLAYEY SILT TILL grey, damp, hard						168							
167.2			9	SS	50/14									
7.9	End of Borehole.													
	*Borehole dry (not stabilized) and hole open to 6.7 m on completion.													

SPT 1103

# RECORD OF BOREHOLE No 2-8

1 OF 1

METRIC

GWP 158-00-00 LOCATION Hwy 401 EBL Collector Yonge St. to Bayview Ave., Sta.: 10+266.7; Offset: 7.7m Rt EP ORIGINATED BY Y.L.  
 DIST 6 HWY 401 BOREHOLE TYPE Solid Stem Augers COMPILED BY J.Z.  
 DATUM Geodetic DATE 10/26/2004 CHECKED BY R.M.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT  γ  kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa									
								○ UNCONFINED + FIELD VANE									
								● POCKET PENETR. x LAB VANE									
							20	40	60	80	100	WATER CONTENT (%)					
							20	40	60	80	100	20	40	60			
175.6	Ground Surface																
0.0	0.13 m TOPSOIL FILL: CLAYEY SILT trace sand, trace gravel trace to some topsoil pockets brown, moist, very stiff		1	SS	17								○				
174.9			2	SS	40								○				
0.7	CLAYEY SILT TILL some sand brown, damp to moist, hard		3	SS	39								○				
173.5			4	SS	92/25								○				
2.1	trace sand seams		5	SS	51/15								○				
			6	SS	50/10								○				
	SANDY SILT to SILTY SAND TILL brownish grey, moist, very dense		7	SS	50/15								○				
			8	SS	50/8												wet sample rod bouncing
																	rod bouncing
168.6																	
7.0	CLAYEY SILT TILL grey, moist, hard		9	SS	50/5								○				rod bouncing
167.8	End of Borehole.																
7.8	*Water level at 6.1 m (not stabilized) and hole open to full depth on completion.																

RECORD OF BOREHOLE No 2-9

1 OF 1

METRIC

GWP 156-00-00

LOCATION Hwy 401 EBL Collector Yonge St. to Bayview Ave., -Sta.:32+097.9; Offset:5.8m Rt EBC Crown

ORIGINATED BY S.A.

DIST 6 HWY 401

BOREHOLE TYPE Solid Stem Augers

COMPILED BY J.Z.

DATUM Geodetic

DATE 10/12/2004

CHECKED BY R.M.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT $\gamma$ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20	40	60	80	100		
174.4	Ground Surface													
0.0	150 mm ASPHALT FILL: CRUSHED GRAVEL & SAND brown, damp, compact		1	SS	28		174							
173.7														
0.7	FILL: CLAYEY SILT with silty clay seams some sand layers, trace gravel brown, damp to moist, very stiff		2	SS	16									
173.0							173							
1.4			3	SS	40									
			4	SS	61		172							
			5	SS	84		171							
			6	SS	54									
			7	SS	67		170							
168.9							169							
5.5	SAND brownish grey, wet, very dense		8	SS	59		168							
167.4														
7.0	SANDY SILT TILL some silty sand layers grey, moist, dense						167							
166.3			9	SS	46									
8.1	End of Borehole.													
	*Water level at 3.4 m (not stabilized) and hole open to 5.2 m on completion.													

+<sup>3</sup>, x<sup>3</sup>: Numbers refer to  
Sensitivity

20  
15 5  
10 (%) STRAIN AT FAILURE

SPT 1103

RECORD OF BOREHOLE No 2-10

1 OF 1

METRIC

GWP 158-00-00 LOCATION Hwy 401 EBL Collector Yonge St. to Bayview Ave., Sta.:32+097.9; Offset:11.5m Rt EBC Crown ORIGINATED BY Y.L.  
DIST 8 HWY 401 BOREHOLE TYPE Solid Stem Augers COMPILED BY J.Z.  
DATUM Geodetic DATE 10/26/2004 CHECKED BY R.M.

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT $\gamma$ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV. DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES		20	40	60	80	100		
173.5	Ground Surface												
0.0	0.1 m TOPSOIL		1	SS	7								
	loose												
	dense to very dense		2	SS	48								
	SANDY SILT TILL brown to grey, moist		3	SS	55								
			4	SS	61								
	sandy silt layer		5	SS	39								
			6	SS	86/28								
			7	SS	72								
168.1													
5.4	CLAYEY SILT TILL grey, moist, hard		8	SS	59								
165.6			9	SS	50/15								
7.9	End of Borehole.												
	*Water level at 4.9 m (not stabilized) and hole open to 4.6 m on completion.												
	Piezometer Installed at 5.2 m.												
	*Water level on: Oct. 28, 2004 - 0.9 m (El. 172.6 m) Nov. 26, 2004 - 1.6 m (El. 171.9 m)												

+<sup>3</sup>, ×<sup>3</sup>: Numbers refer to  
Sensitivity

20  
15  
10  
(%) STRAIN AT FAILURE

SPT 1103

RECORD OF BOREHOLE No 2-11

1 OF 1

METRIC

GWP 158-00-00 LOCATION Hwy 401 EBL Collector Yonge St. to Bayview Ave., -Sta.:32+161.7; Offset:4.9m Rt EBC Crown ORIGINATED BY S.A.  
DIST 6 HWY 401 BOREHOLE TYPE Solid Stem Augers COMPILED BY J.Z.  
DATUM Geodetic DATE 10/12/2004 CHECKED BY R.M.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT $\gamma$ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV. DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20	40	60	80	100		
174.2	Ground Surface													
0.0	170 mm ASPHALT 470 mm CRUSHED GRAVEL & SAND  FILL: SILTY SAND trace to some gravel brown, moist, loose to compact		1	SS	19		174							42 53 (5)
172.8			2	SS	8		173							5 54 25 16
1.4	FILL: CLAYEY SILT trace to some sand brown, moist, firm		3	SS	6									
172.1			4	SS	38		172							
2.1			5	SS	61		171							
			6	SS	63		170							
			7	SS	79		169							
			8	SS	37		168							
			9	SS	44		167							
166.1	End of Borehole.  *Borehole dry (not stabilized) and open to 7.3 m on completion.													
6.1														

+<sup>3</sup>, ×<sup>3</sup>: Numbers refer to  
Sensitivity

20  
15 5  
10 (%) STRAIN AT FAILURE



RECORD OF BOREHOLE No 2-12

1 OF 1

METRIC

GWP 158-00-00 LOCATION Hwy 401 EBL Collector Yonge St. to Bayview Ave., Sta.:32+161.7; Offset:12.7m Rt EBC Crown ORIGINATED BY M.L.  
DIST 6 HWY 401 BOREHOLE TYPE Solid Stem Augers COMPILED BY J.Z.  
DATUM Geodetic DATE 10/26/2004 CHECKED BY R.M.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W <sub>P</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT $\gamma$ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL			
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa										WATER CONTENT (%)		
								○ UNCONFINED + FIELD VANE												
								● POCKET PENETR. X LAB VANE												
171.9	Ground Surface						20	40	60	80	100	20	40	60						
0.0	0.1 m TOPSOIL CLAYEY SILT trace topsoil inclusions, trace rootlets, occasional gravel brown, damp, very stiff		1	SS	20															
171.2			2	SS	72															
0.7			3	SS	76															
	CLAYEY SILT TILL with sand brown to brownish grey, damp		4	SS	71															
	hard		5	SS	29															
	very stiff		6	SS	56															
	hard		7	SS	58															
			8	SS	79															
			9	SS	66															
163.8	End of Borehole.																			
8.1	*Borehole dry (not stabilized) and hole open to full depth on completion.  Piezometer installed at 7.6 m.  *Water level on: Oct. 28, 2004 - Dry Nov. 26, 2004 - Dry																			

+<sup>3</sup>, X<sup>3</sup>: Numbers refer to  
Sensitivity

20  
15-5  
10  
(%) STRAIN AT FAILURE



SPT 1103

RECORD OF BOREHOLE No 2-13

1 OF 1

METRIC

GWP 158-00-00 LOCATION Hwy 401 EBL Collector Yonge St. to Bayview Ave., -Sta.:32+202.4; Offset:4.3m Rt EBC Crown ORIGINATED BY Y.L.  
DIST 6 HWY 401 BOREHOLE TYPE Solid Stem Augers COMPILED BY J.Z.  
DATUM Geodetic DATE 10/12/2004 CHECKED BY R.M.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT γ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20	40	60	80	100		
173.7	Ground Surface													
0.0	160 mm ASPHALT 240 mm CRUSHED GRAVEL & SAND		1	AS	-									
	clayey silt fill layer		2	SS	9		173							
	FILL: SAND to SILTY SAND trace gravel trace clayey silt pockets/layers brown, moist, loose		3	SS	9		172							
			4	SS	8		171							12 65 (23)
170.6	FILL: CLAYEY SILT some organic dark brown, moist		5	SS	18		170							
170.0			6	SS	9		169							
3.7	CLAYEY SILT TILL some sandy silt seams/layers moist	stiff very stiff	7	SS	29		168							
		brown grey	8	SS	26		167							
166.4	SAND trace gravel, grey, wet, very dense		9	SS	50/15		166							
7.3														
165.9														
7.8	End of Borehole. *Water level at 5.5 m (not stabilized) and hole open to 7 m on completion.													

+<sup>3</sup>, ×<sup>3</sup>: Numbers refer to  
Sensitivity

20  
15 5  
10 (%) STRAIN AT FAILURE

SPT 1103

# RECORD OF BOREHOLE No 2-14

1 OF 1

METRIC

GWP 158-00-00

LOCATION Hwy 401 EBL Collector Yonge St. to Bayview Ave., -Sta.:32+202.4; Offset:13.9m Rt EBC Crown

DIST 6 HWY 401

BOREHOLE TYPE Solid Stem Augers

ORIGINATED BY M.L.

DATUM Geodetic

DATE 10/26/2004

COMPILED BY J.Z.

CHECKED BY R.M.

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W <sub>P</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			"N" VALUES	20 40 60 80 100					
170.7 0.0	Ground Surface												
169.8 0.9	0.2 m TOPSOIL FILL: CLAYEY SILT trace sand, trace gravel brown, moist, stiff		1	SS	10								
168.9 1.8	CLAYEY SILT TILL some sand brown, moist, very stiff		2	SS	21								
168.9 1.8	SILTY CLAY trace silt/silt till layers grey, moist		3	SS	18								
166.3 4.4	SAND some gravel grey, wet, dense		4	SS	30								
165.2 5.5	SILTY CLAY grey, moist, hard		5	SS	18								
162.6 8.1	very stiff hard		6	SS	42								
			7	SS	34								
			8	SS	57								
			9	SS	75/28								
	End of Borehole.												
	*Borehole dry (not stabilized) and hole open to full depth on completion.												
	Piezometer installed at 6.1 m.												
	*Water level on: Oct. 28, 2004 - 2.4 m (El. 168.3 m) Nov. 26, 2004 - 2.4 m (El. 168.3 m)												

SPT 1103

# RECORD OF BOREHOLE No 2-15

1 OF 1

METRIC

GWP 158-00-00

LOCATION Hwy 401 EBL Collector Yonge St. to Bayview Ave., Sta. 32+252.6; Offset: 3.8m Rt EBC Crown

ORIGINATED BY Y.L.

DIST 8 HWY 401

BOREHOLE TYPE Solid Stem Augers

COMPILED BY J.Z.

DATUM Geodetic

DATE 10/12/2004

CHECKED BY R.M.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT Y kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa						
173.2	Ground Surface													
0.0	90 mm ASPHALT 170 mm CONCRETE													
172.6	FILL: CRUSHED GRAVEL & SAND brown, damp		1	AS	-									
0.6			2	SS	12									
	FILL: SAND to SILTY SAND with clayey silt layers/pockets trace gravel brown, damp to moist, loose to compact		3	SS	9									
171.1			4	SS	13									
2.1	FILL: CLAYEY SILT trace to some gravel & sand brown, moist, firm to stiff		5	SS	8									
169.6			6	SS	18									
3.7	some silty sand seams		7	SS	18									
	CLAYEY SILT TILL with sand, moist		8	SS	53									
	very stiff hard													
	brown grey		9	SS	92/28									
165.1	End of Borehole.													
8.1	*Water level at 5.5 m (not stabilized) and hole open to full depth on completion.													

+<sup>3</sup>, X<sup>3</sup>: Numbers refer to  
Sensitivity

20  
15  
10  
(%) STRAIN AT FAILURE

SPT 1103

# RECORD OF BOREHOLE No 2-16

1 OF 1

METRIC

GWP 158-00-00

LOCATION Hwy 401 EBL Collector Yonge St. to Bayview Ave., Sta. 32+252.6; Offset: 10.8m Rt EBC Crown

DIST 6 HWY 401

BOREHOLE TYPE Solid Stem Augers

ORIGINATED BY M.L.

DATUM Geodetic

DATE 10/26/2004

COMPILED BY J.Z.

CHECKED BY R.M.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT W <sub>P</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	N <sub>60</sub> VALUES			SHEAR STRENGTH kPa								WATER CONTENT (%)
								○ UNCONFINED ● POCKET PENETR.	+ FIELD VANE × LAB VANE							
169.6 0.0	Ground Surface						20 40 60 80 100	20 40 60 80 100	20 40 60 80 100							
	0.05 m TOPSOIL		1	SS	11											
	FILL: CLAYEY SILT trace sand, trace gravel brown, damp, stiff		2	SS	15											
167.8 1.8			3	SS	13											
	CLAYEY SILT TILL with sand, some oxidized zones moist		4	SS	33											
			5	SS	49											
			6	SS	36											
165.2 4.4			7	SS	47											
	SILTY CLAY occasional gravel occasional silt pockets grey, moist, hard		8	SS	44											
162.3 7.3																
	SAND trace gravel grey, wet, compact		9	SS	19											
161.5 8.1	End of Borehole.															
	*Wet cave at 7.6 m on completion. Piezometer Installed at 7.6 m.  *Water level on: Oct. 28, 2004 - 1.5 m (El. 168.1 m) Nov. 26, 2004 - 1.5 m (El. 168.1 m)															

+ 3, X 3, Numbers refer to  
Sensitivity

20  
15 10 5  
(%) STRAIN AT FAILURE

SPT 1103

RECORD OF BOREHOLE No 2-17

1 OF 1

METRIC

GWP 158-00-00 LOCATION Hwy 401 EBL Collector Yonge St. to Bayview Ave., Sta.:32+298.3; Offset:3.6m Rt EBC Crown ORIGINATED BY Y.L.  
DIST 6 HWY 401 BOREHOLE TYPE Solid Stem Augers COMPILED BY J.Z.  
DATUM Geodetic DATE 10/13/2004 CHECKED BY R.M.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT  γ  kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)  GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa						
								20 40 60 80 100						
								○ UNCONFINED + FIELD VANE ● POCKET PENETR. X LAB VANE						
							WATER CONTENT (%)							
							20 40 60							
							PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT w <sub>p</sub> w w <sub>L</sub>							
172.7	Ground Surface													
0.0	100 mm ASPHALT 180 mm CONCRETE 200 mm CRUSHED GRAVEL & SAND		1	AS	-									
	clayey silt fill layer		2	SS	14									
	FILL: SAND trace gravel, trace silt brown, moist, loose to compact		3	SS	7									
170.1			4	SS	8									
2.6	FILL: CLAYEY SILT trace gravel, some sand, occasional sand seams brownish grey, moist, stiff		5	SS	14									
			6	SS	11									
168.3			7	SS	15									
4.4	CLAYEY SILT TILL some sand, moist		8	SS	47									
			9	SS	80									
164.6	End of Borehole.													
8.1	*Borehole dry (not stabilized) and hole open to full depth on completion.													

SPT 1103

# RECORD OF BOREHOLE No 2-18

1 OF 1

METRIC

GWP 158-00-00 LOCATION Hwy 401 EBL Collector Yonge St. to Bayview Ave., Sta. 32+298.3; Offset: 13.1m Rt EBC Crown ORIGINATED BY M.L.  
 DIST 6 HWY 401 BOREHOLE TYPE Solid Stem Augers COMPILED BY J.Z.  
 DATUM Geodetic DATE 10/26/2004 CHECKED BY R.M.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT $\gamma$ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	"N" VALUES			20	40	60	80	100		
169.0	Ground Surface						169							
0.0	0.3 m TOPSOIL FILL: SAND trace gravel brown, moist, loose		1	SS	9		168							
168.2			2	SS	11		167							
0.8	FILL: CLAYEY SILT trace rootlets, trace sand, trace gravel brown, moist, stiff		3	SS	14		166							
167.2			4	SS	22		165							
1.8	CLAYEY SILT TILL with sand, moist  brown, very stiff grey, hard		5	SS	32		164							
			6	SS	56		163							
			7	SS	69/25		162							
	silty clay layer		8	SS	79/28		161							
			9	SS	65									
160.9	End of Borehole.  *Water level at 7.6 m (not stabilized) and hole open to full depth on completion.													

RECORD OF BOREHOLE No 2-19

1 OF 1

METRIC

GWP 158-00-00 LOCATION Hwy 401 EBL Collector Yonge St. to Bayview Ave., Sta.:32+348.4; Offset:3.5m Rt EBC Crown ORIGINATED BY Y.L.  
DIST 6 HWY 401 BOREHOLE TYPE Solid Stem Augers COMPILED BY J.Z.  
DATUM Geodetic DATE 10/13/2004 CHECKED BY R.M.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20 40 60 80 100	20 40 60 80 100					
171.8 0.0	Ground Surface													
171.1 0.8	200 mm ASPHALT 250 mm CRUSHED GRAVEL & SAND FILL: SAND trace gravel, brown, moist		1	AS	-									
	FILL: CLAYEY SILT trace gravel trace sand seams/layers brown, stiff		2	SS	9									
			3	SS	10									
			4	SS	10									
168.7 3.2	TOPSOIL		5	SS	16									
168.4 3.5	CLAYEY SILT TILL with sand, moist		6	SS	14									
			7	SS	29									
			8	SS	47									
163.8 8.1	End of Borehole. *Borehole dry (not stabilized) and hole open to full depth on completion.		9	SS	80									



SPT 1103

## RECORD OF BOREHOLE No 2-20

1 OF 1

METRIC

GWP 158-00-00

LOCATION Hwy 401 EBL Collector Yonge St. to Bayview Ave., Sta. 32+348.4; Offset: 11.4m Rt EBC Crown

ORIGINATED BY Y.L.

DIST 6 HWY 401

BOREHOLE TYPE Solid Stem Augers

COMPILED BY J.Z.

DATUM Geodetic

DATE 10/27/2004

CHECKED BY R.M.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20 40 60 80 100	20 40 60 80 100					
166.7 0.0	Ground Surface													
	0.1 m TOPSOIL		1	SS	19									
	FILL: CLAYEY SILT with silt pockets, trace to some gravel brown, damp		2	SS	24									
		very stiff												
		stiff												
166.6 2.1			3	SS	14									
			4	SS	30									
	trace silty sand/sand seams		5	SS	25									
		brown, very stiff												
		grey, hard	6	SS	59									
	CLAYEY SILT TILL with silt layer moist		7	SS	54/15									
			8	SS	59/15									
			9	SS	89/28									
160.6 8.1	End of Borehole.													
	*Borehole dry (not stabilized) and hole open to full depth on completion.													
	Piezometer installed at 7.6 m.													
	*Water level on: Oct. 28, 2004 - 4.4 m (El. 164.3 m) Nov. 26, 2004 - 5.2 m (El. 163.5 m)													

+ 3, X 3 : Numbers refer to  
Sensitivity20  
15 10 5  
(%) STRAIN AT FAILURE



SPT 1103

RECORD OF BOREHOLE No 2-21

1 OF 1

METRIC

GWP 158-00-00 LOCATION Hwy 401 EBL Collector Yonge St. to Bayview Ave., -Sta.:32+397.9; Offset:3.5m Rt EBC Crown ORIGINATED BY Y.L.  
DIST 6 HWY 401 BOREHOLE TYPE Solid Stem Augers COMPILED BY J.Z.  
DATUM Geodetic DATE 10/14/2004 CHECKED BY R.M.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	"N" VALUES			20	40	60	80	100					
171.3	Ground Surface																
0.0	190 mm ASPHALT					*	171										
170.6	110 mm CRUSHED GRAVEL & SAND FILL: SAND some to trace gravel, brown, damp		1	AS	-												5 81 (14)
0.7			2	SS	14												
	FILL: CLAYEY SILT with sand layers trace gravel brown, moist, stiff to very stiff		3	SS	24		170										
			4	SS	17		169										
168.5																	
2.8	TOPSOIL		5	SS	19		168										
168.1			6	SS	14												
3.2	CLAYEY SILT TILL with sand, moist		7	SS	34		167										
			8	SS	54		166										
			9	SS	60		165										
							164										
163.2	End of Borehole.																
8.7	*Borehole dry (not stabilized) and hole open to full depth on completion.																

+<sup>3</sup>, ×<sup>3</sup>: Numbers refer to  
Sensitivity

20  
15 5  
10 (%) STRAIN AT FAILURE

SPT 1103

# RECORD OF BOREHOLE No 2-22

1 OF 1

METRIC

GWP 158-00-00 LOCATION Hwy 401 EBL Collector Yonge St. to Bayview Ave., -Sta.:32+397.8; Offset:12m Rt EBC Crown ORIGINATED BY M.L.  
 DIST 6 HWY 401 BOREHOLE TYPE Solid Stem Augers COMPILED BY J.Z.  
 DATUM Geodetic DATE 10/26/2004 CHECKED BY R.M.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT $\gamma$ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20	40	60	80	100		
168.4 0.0	Ground Surface													
	0.3 m TOPSOIL		1	SS	16		168							
	CLAYEY SILT TILL some sand		2	SS	32									
	damp moist		3	SS	12		167							
			4	SS	28		166							
			5	SS	35		165							
	brown grey		6	SS	26		164							
			7	SS	21		163							
	stiff to hard													
	hard		8	SS	41		162							
160.4 8.0	End of Borehole.		9	SS	93/23		161							
	*Borehole dry (not stabilized) and hole open to full depth on completion.  Piezometer installed at 7.3 m.  *Water level on: Oct. 28, 2004 - 3.7 m (El. 164.7 m) Nov. 26, 2004 - 3.7 m (El. 164.7 m)													

+<sup>3</sup>, X<sup>3</sup>: Numbers refer to  
Sensitivity

20  
15 5  
10 (%) STRAIN AT FAILURE

SPT 1103

RECORD OF BOREHOLE No 2-23

1 OF 1

METRIC

GWP 158-00-00 LOCATION Hwy 401 EBL Collector Yonge St. to Bayview Ave., Sta. 32+452.4; Offset: 3.8m Rt EBC Crown ORIGINATED BY Y.L.  
DIST 6 HWY 401 BOREHOLE TYPE Solid Stem Augers COMPILED BY J.Z.  
DATUM Geodetic DATE 10/14/2004 CHECKED BY R.M.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT $\gamma$ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20	40	60	80	100		
170.8	Ground Surface													
0.0	190 mm ASPHALT													
170.1	260 mm CRUSHED GRAVEL & SAND		1	AS	-									
0.7	FILL: SAND													
169.4	brown, moist		2	SS	14									
1.4	FILL: CLAYEY SILT													
168.5	with sand layer													
2.3	greyish brown, moist		3	SS	13									
168.2	FILL: SAND													
2.6	some clayey silt pockets/layers													
	greyish brown, wet		4	SS	16									
	TOPSOIL													
	CLAYEY SILT													
	some sand, occasional organic stained		5	SS	11									
	trace decayed rootlets													
	brown, moist to wet, stiff to firm		6	SS	7									
166.1	CLAYEY SILT TILL													
4.7	with sand		7	SS	34									
	brownish grey to grey													
	damp to moist, hard		8	SS	73									
162.7														
8.1			9	SS	48									
	End of Borehole.													
	*Borehole dry (not stabilized) and hole open to full depth on completion.													

SPT 1103

RECORD OF BOREHOLE No 2-24

1 OF 1

METRIC

GWP 158-00-00 LOCATION Hwy 401 EBL Collector Yonge St. to Bayview Ave., Sta.:32+452.3; Offset:11.6m Rt EBC Crown ORIGINATED BY M.L.  
DIST 8 HWY 401 BOREHOLE TYPE Solid Stem Augers COMPILED BY J.Z.  
DATUM Geodetic DATE 10/25/2004 CHECKED BY R.M.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT $\gamma$ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20	40	60	80	100		
167.9 0.0	Ground Surface													
	0.15 m TOPSOIL		1	SS	15									
	FILL: CLAYEY SILT trace rootlets, trace to some gravel, trace sand brown, damp to moist, very stiff		2	SS	23									
			3	SS	20									
165.8 2.1	CLAYEY SILT TILL with sand brown, moist		4	SS	40								21.8	10 37 38 15
			5	SS	48									
			6	SS	48									
			7	SS	21									
162.0 5.9	SANDY SILT to SILT TILL grey, moist, very dense		8	SS	50/8									
160.0 7.9	End of Borehole.  *Water level at 7.6 m (not stabilized) and hole open to 3.8 m on completion.		9	SS	50/13									

+<sup>3</sup>, ×<sup>3</sup>: Numbers refer to  
Sensitivity

20  
15 5  
10 (%) STRAIN AT FAILURE

SPT 1103

# RECORD OF BOREHOLE No RW2-73/74B

1 OF 1

METRIC

GWP 156-00-00 LOCATION Hwy 401 EBL Collector Yonge St. to Bayview Ave., Sta. 32+484; Offset: 10.8m Rt EBC Crown ORIGINATED BY R.A.  
DIST 6 HWY 401 BOREHOLE TYPE Solid Stem Augers COMPILED BY J.Z.  
DATUM Geodetic DATE 12/4/2003 CHECKED BY R.M.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			UNIT WEIGHT $\gamma$ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa				
167.9 0.0	Ground Surface						20 40 60 80 100	PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT				
	0.15 m TOPSOIL		1	SS	8			W P W W L				
167.0 0.9	FILL: CLAYEY SILT trace sand brown, moist, firm		2	SS	16		167	O UNCONFINED + FIELD VANE POCKET PENETR. X LAB VANE				
	FILL: SAND & GRAVEL greyish brown, wet							WATER CONTENT (%)				
166.1 1.8	compact		3	SS	35		166					
	dense											spoon wet
	CLAYEY SILT TILL with sand dry to damp, hard		4	SS	70		165					
	sandy		5	SS	95		164					
	brown		6	SS	51		163					
	grey		7	SS	43							
162.9 5.0	End of Borehole.											
	Wet cave at bottom and borehole open to full depth on completion.											
	Piezometer installed to 3.6 m.											
	* Water level on: Dec. 17, 2003 - 1.4 m (El. 166.6 m) Oct. 28, 2004 - 2.7 m (El. 165.2 m) Nov. 26, 2004 - 2.7 m (El. 165.2 m)											

+<sup>3</sup>, ×<sup>3</sup>: Numbers refer to  
Sensitivity

20  
15  
10  
(%) STRAIN AT FAILURE

SPT 1103

# RECORD OF BOREHOLE No RW2-73/74A

1 OF 1

METRIC

GWP 158-00-00

LOCATION Hwy 401 EBL Collector Yonge St. to Bayview Ave., Sta. 32+491.4; Offset: 3.7m Rt EBC Crown

ORIGINATED BY R.A.

DIST 6 HWY 401

BOREHOLE TYPE Solid Stem Augers

COMPILED BY J.Z.

DATUM Geodetic

DATE 11/19/2003

CHECKED BY R.M.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W <sub>P</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa	WATER CONTENT (%)					
168.0	Ground Surface													
0.0	165 mm ASPHALT 240 mm CRUSHED STONE BASE		1	SS	31									
	FILL: SILTY SAND occasional gravel brown, moist, compact to dense		2	SS	18									
166.6														
1.4	FILL: CLAYEY SILT with SAND moist, very stiff		3	SS	17									
	brown													
	dark grey some topsoil		4	SS	25									
165.1														
2.9			5	SS	16									
	very stiff													
	hard		6	SS	46									
			7	SS	46									
	CLAYEY SILT TILL with sand dry to damp													
			8	SS	50/14									
	brown													
	grey with brownish mottles													
159.9			9	SS	90/28									
8.1	End of Borehole.													
	*Borehole dry (not stabilized) and hole open to full depth on completion.													

+<sup>3</sup>, ×<sup>3</sup>: Numbers refer to Sensitivity

20  
15 10 5 0  
(%) STRAIN AT FAILURE

SPT 1103

RECORD OF BOREHOLE No RW2-73/74C

1 OF 1

METRIC

GWP 158-00-00 LOCATION Hwy 401 EBL Collector Yonge St. to Bayview Ave., Sta.:32+491.5; Offset: 10m Rt EBC Crown ORIGINATED BY R.A. ^  
DIST 8 HWY 401 BOREHOLE TYPE Solid Stem Augers COMPILED BY J.Z.  
DATUM Geodetic DATE 12/4/2003 CHECKED BY R.M.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT  $\gamma$ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL			
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa									
								○ UNCONFINED + FIELD VANE									
								● POCKET PENETR. X LAB VANE									
167.9 0.0	Ground Surface						20	40	60	80	100	PLASTIC LIMIT W <sub>P</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>			
166.8 1.1	0.15 m TOPSOIL  FILL: CLAYEY SILT some sand brown, moist, firm		1	SS	8												
			2	SS	13												
	weathered, stiff hard		3	SS	31												
	CLAYEY SILT TILL some sand brown, damp		4	SS	80												
			5	SS	50/14												
	sandy silt till seam		6	SS	61												
162.9 5.0	End of Borehole.  Borehole dry (not stabilized) and hole open to full depth on completion.		7	SS	41												

SPT 1103

# RECORD OF BOREHOLE No RW2-73/74D

1 OF 1

METRIC

GWP 158-00-00

LOCATION Hwy 401 EBL Collector Yonge St. to Bayview Ave., Sta. 32+499.6; Offset: 9.8m Rt EBC Crown

ORIGINATED BY R.A.

DIST 6 HWY 401

BOREHOLE TYPE Solid Stem Augers

COMPILED BY J.Z.

DATUM Geodetic

DATE 12/4/2003

CHECKED BY R.M.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W <sub>P</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20	40					
167.9	Ground Surface													
0.0	0.2 m TOPSOIL		1	SS	6									
167.0	FILL: CLAYEY SILT trace sand brown, moist, firm		2	SS	15									
0.9	CLAYEY SILT TILL damp		3	SS	29									
	very stiff		4	SS	71									
	hard		5	SS	60/10									
	brown		6	SS	48									
	grey		7	SS	32									
162.9	occasional silty fine sand seams													
5.0	End of Borehole.													
	Borehole open to full depth on completion.													
	Piezometer installed to 4.6 m.													
	* Water level on: Dec. 04, 2003 - Dry Dec. 17, 2003 - 1.5 m (El. 166.4 m) Oct. 27, 2004 - 2.7 m (El. 165.2 m) Nov. 26, 2004 - 2.8 m (El. 165.1 m)													



SPT 1103

## 1 OF 1

**METRIC**

**LOCATION** Hwy 401 EBL Collector Yonge St. to Bayview Ave., Sta.:32+535.9; Offset:3.9m Rt EBC Crown

ORIGINATED BY Y.L.

**BOREHOLE TYPE** Solid Stem Augers

COMPILED BY J.Z.

DATE 10/14/2004

CHECKED BY R.M.

+<sup>3</sup>, ×<sup>3</sup>: Numbers refer to Sensitivity

SPT 1103

RECORD OF BOREHOLE No 2-26

1 OF 1

METRIC

GWP 158-00-00 LOCATION Hwy 401 EBL Collector Yonge St. to Bayview Ave., Sta.:32+535.9; Offset:11.9m Rt EBC Crown ORIGINATED BY M.L.  
DIST 6 HWY 401 BOREHOLE TYPE Solid Stem Augers COMPILED BY J.Z.  
DATUM Geodetic DATE 10/26/2004 CHECKED BY R.M.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT $\gamma$ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20	40	60	80	100		
167.7 0.0	Ground Surface													
	0.2 m TOPSOIL		1	SS	7		167							
	FILL: CLAYEY SILT trace sand, trace gravel, trace rootlets brown, moist, firm to stiff		2	SS	15									
166.3 1.4														
			3	SS	21		166						19.7	2 42 37 19
	very stiff													
			4	SS	34		165							
	brown, hard													
			5	SS	46									
							164							
	grey, very stiff		6	SS	23									
	hard		7	SS	43		163							
	CLAYEY SILT TILL with sand moist													
							162							
			8	SS	62									
							161							
159.6 8.1	End of Borehole.		9	SS	48		160							
	*Borehole dry (not stabilized) and hole open to full depth on completion.													

+<sup>3</sup>, ×<sup>3</sup>: Numbers refer to  
Sensitivity

20  
15 5  
10 (%) STRAIN AT FAILURE

SPT 1103

RECORD OF BOREHOLE No RW2-82/83B

1 OF 1

METRIC

GWP 158-00-00 LOCATION Hwy 401 EBL Collector Yonge St. to Bayview Ave., Sta.:32+561; Offset:9.5m Rt EBC Crown ORIGINATED BY R.A.  
DIST 6 HWY 401 BOREHOLE TYPE Solid Stem Augers COMPILED BY J.Z.  
DATUM Geodetic DATE 12/4/2003 CHECKED BY R.M.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W <sub>P</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20	40	60	80	100					
167.7	Ground Surface																
0.0	0.15 m TOPSOIL FILL: CLAYEY SILT trace sand, trace gravel brown, moist, firm		1	SS	7	*	167										
166.9			2	SS	11												
0.8			3	SS	30		166										
		stiff															
		hard	4	SS	47		165										
	CLAYEY SILT TILL some sand dry to damp		5	SS	100		164										
		brown															
		greyish brown occasional silt seams	6	SS	64		163										
		grey	7	SS	47												
162.7	End of Borehole.																
5.0	*Borehole dry (not stabilized) and hole open to full depth on completion.																

+<sup>3</sup>, ×<sup>3</sup>: Numbers refer to  
Sensitivity

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

SPT 1103

# RECORD OF BOREHOLE No RW2-82/83C

1 OF 1

METRIC

GWP 158-00-00 LOCATION Hwy 401 EBL Collector Yonge St. to Bayview Ave., Sta. 32+571.3; Offset: 7.2m Rt EBC Crown ORIGINATED BY R.A.  
DIST 6 HWY 401 BOREHOLE TYPE Solid Stem Augers COMPILED BY J.Z.  
DATUM Geodetic DATE 12/4/2003 CHECKED BY R.M.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				UNIT WEIGHT $\gamma$ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20 40 60 80 100	20 40 60 80 100	20 40 60 80 100	20 40 60 80 100		
168.0	Ground Surface						168						
0.0	0.15 m TOPSOIL		1	SS	5								
	FILL: CLAYEY SILT												
	trace sand, occasional gravel												
167.0	dark brown, moist, firm		2	SS	11		167						
1.0		stiff											
		very stiff	3	SS	25		166						
		hard											
	CLAYEY SILT TILL		4	SS	59		165						
	some sand, trace gravel												
	damp to moist		5	SS	80		164						
		brown											
		grey	6	SS	38		163						
163.0	End of Borehole.		7	SS	31								
5.0													
	Piezometer installed to 4.6 m.												
	* Water level on:												
	Dec. 04, 2003 - Dry												
	Dec. 17, 2003 - 2.1 m (El. 165.9 m)												
	Oct. 28, 2004 - 2.5 m (El. 165.5 m)												
	Nov. 26, 2004 - 2.5 m (El. 165.5 m)												



SPT 1103

RECORD OF BOREHOLE No RW2-82/83A

1 OF 1

METRIC

GWP 168-00-00 LOCATION Hwy 401 EBL Collector Yonge St. to Bayview Ave., Sta.:32+572.5; Offset:3m Rt EBC Crown ORIGINATED BY R.A.  
DIST 6 HWY 401 BOREHOLE TYPE Solid Stem Augers COMPILED BY J.Z.  
DATUM Geodetic DATE 11/19/2003 CHECKED BY R.M.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT $\gamma$ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	"N" VALUES			20	40	60	80	100		
169.3 0.0	Ground Surface													
	125 mm ASPHALT 200 mm CRUSHED STONE		1	SS	22		169							
	FILL: SAND some gravel, some silt, trace clayey seams brown, moist		2	SS	13									
	compact													
	loose						168							14 59 18 9
167.1 2.2	black organic, clayey		3	SS	10									
			4	SS	10		167							
		stiff												
		very stiff	5	SS	17		166							
		hard	6	SS	53		165							
	CLAYEY SILT TILL some sand, damp		7	SS	50/13									
		brown												
		grey	8	SS	33		164							
		very stiff	9	SS	25		163							
		hard					162							
			10	SS	50/8									
		silt lenses												
161.2 8.1	End of Borehole.													
	*Borehole dry (not stabilized) and hole open to full depth on completion.													

+<sup>3</sup>, X<sup>3</sup>; Numbers refer to  
Sensitivity

20  
15 10 5  
10 (%) STRAIN AT FAILURE

**SPT 1103**

## 1 OF 1

**METRIC**

GWP	158-00-00	LOCATION	Hwy 401 EBL Collector Yonge St. to Bayview Ave., -Sta.:32+580.0; Offset:7.3m Rt EBC Crown	ORIGINATED BY	R.A.
DIST	6	HWY	401	BOREHOLE TYPE	Solid Stem Augers
DATUM	Geodetic	DATE	12/4/2003	COMPILED BY	J.Z.
				CHECKED BY	R.M.

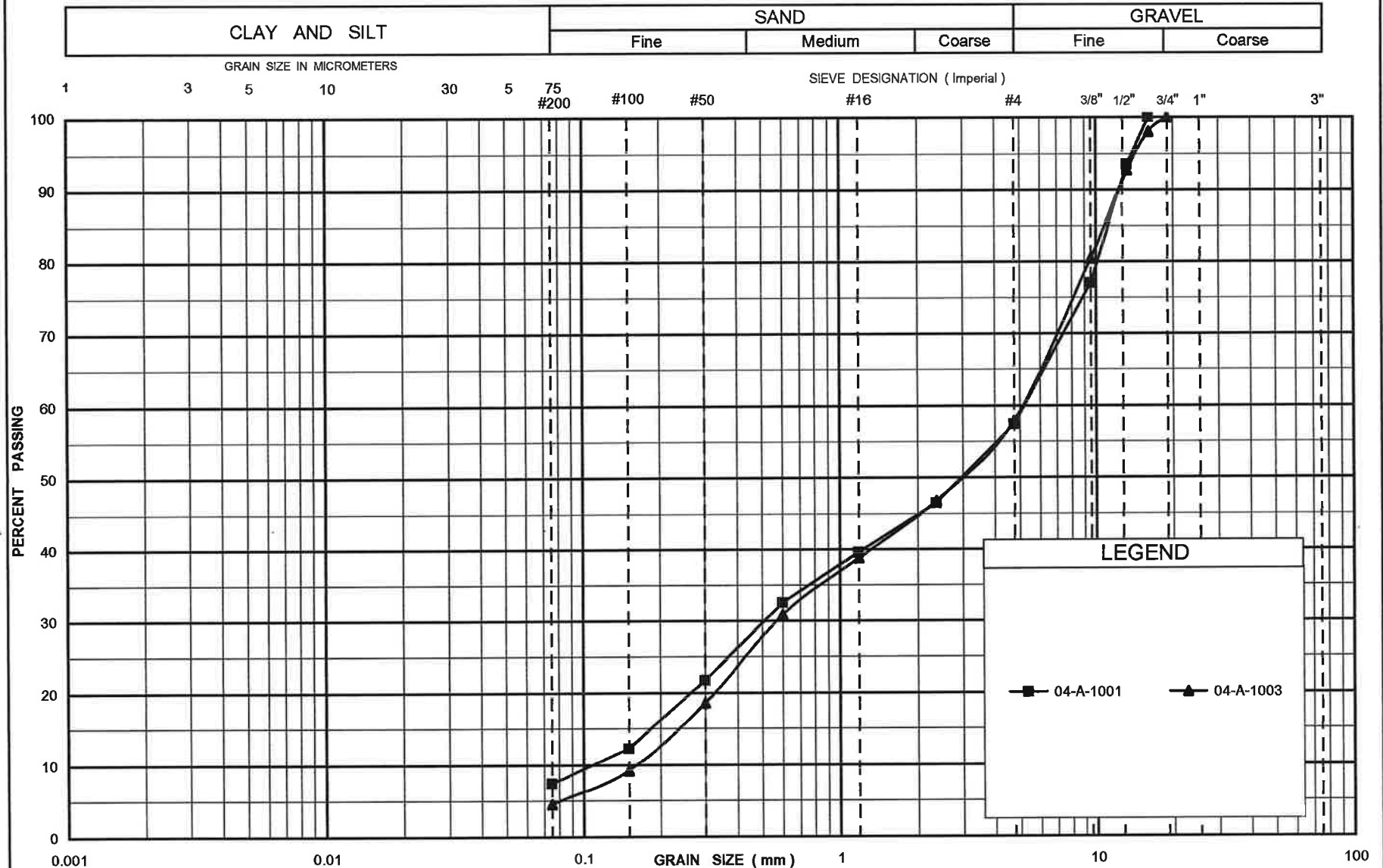
+<sup>3</sup>, ×<sup>3</sup>: Numbers refer to Sensitivity

# Appendix B

## Laboratory Test Results for Retaining Wall 2



# UNIFIED SOIL CLASSIFICATION SYSTEM



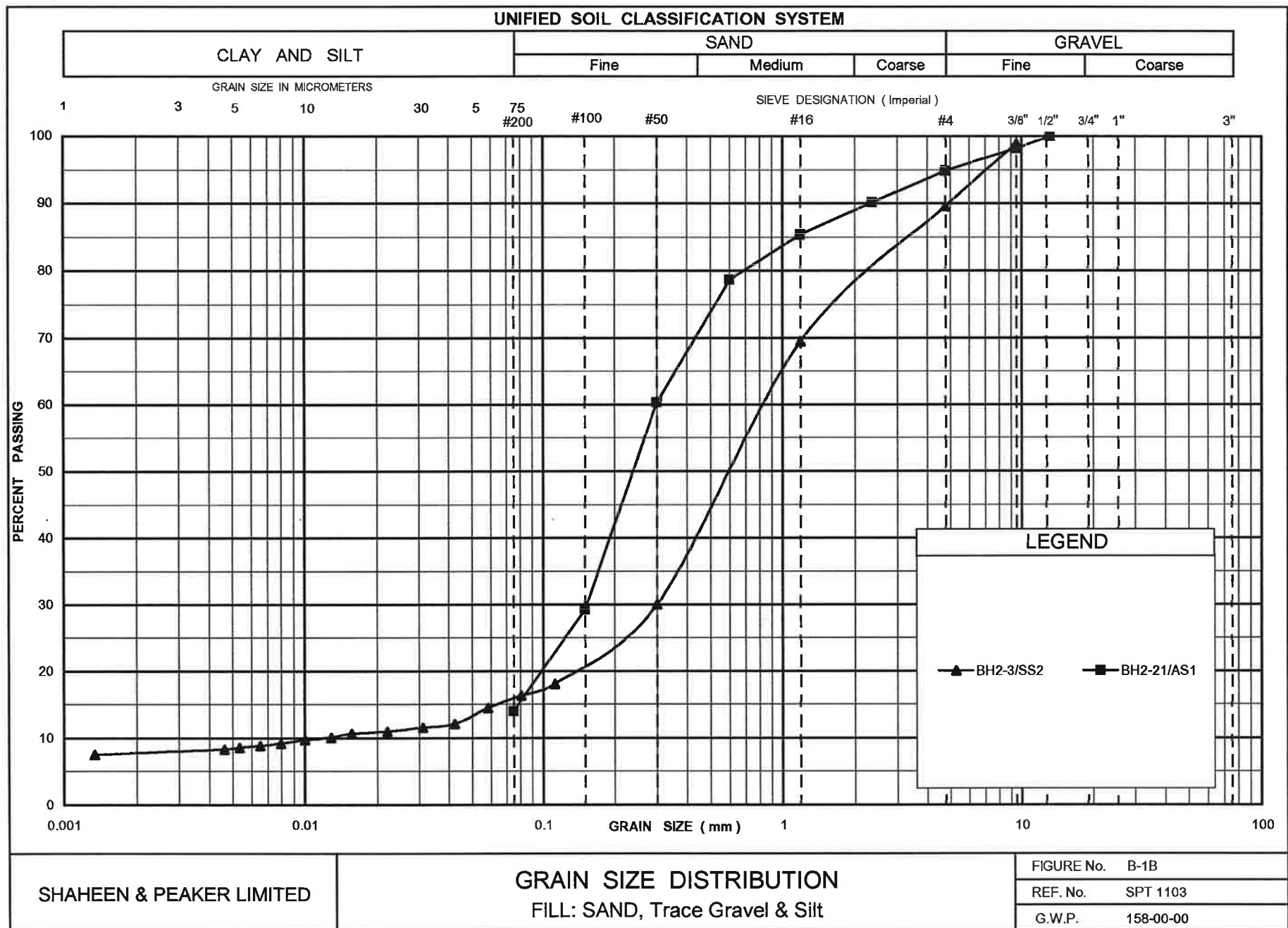
SHAHEEN & PEAKER LIMITED

GRAIN SIZE DISTRIBUTION  
SAND & GRAVEL

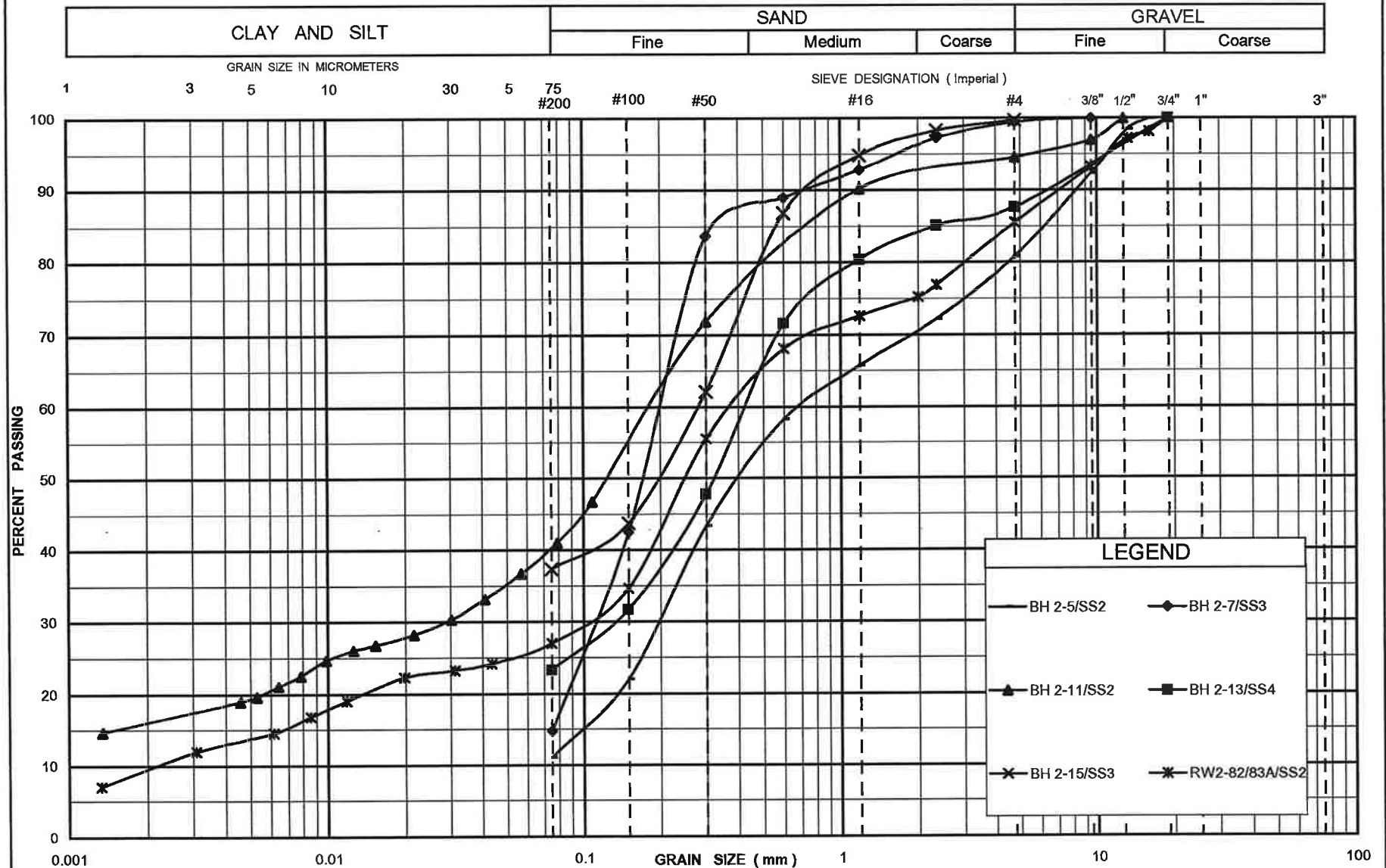
FIGURE No. B-1A

REF. No. SPT 1103

G.W.P. 158-00-00



# UNIFIED SOIL CLASSIFICATION SYSTEM



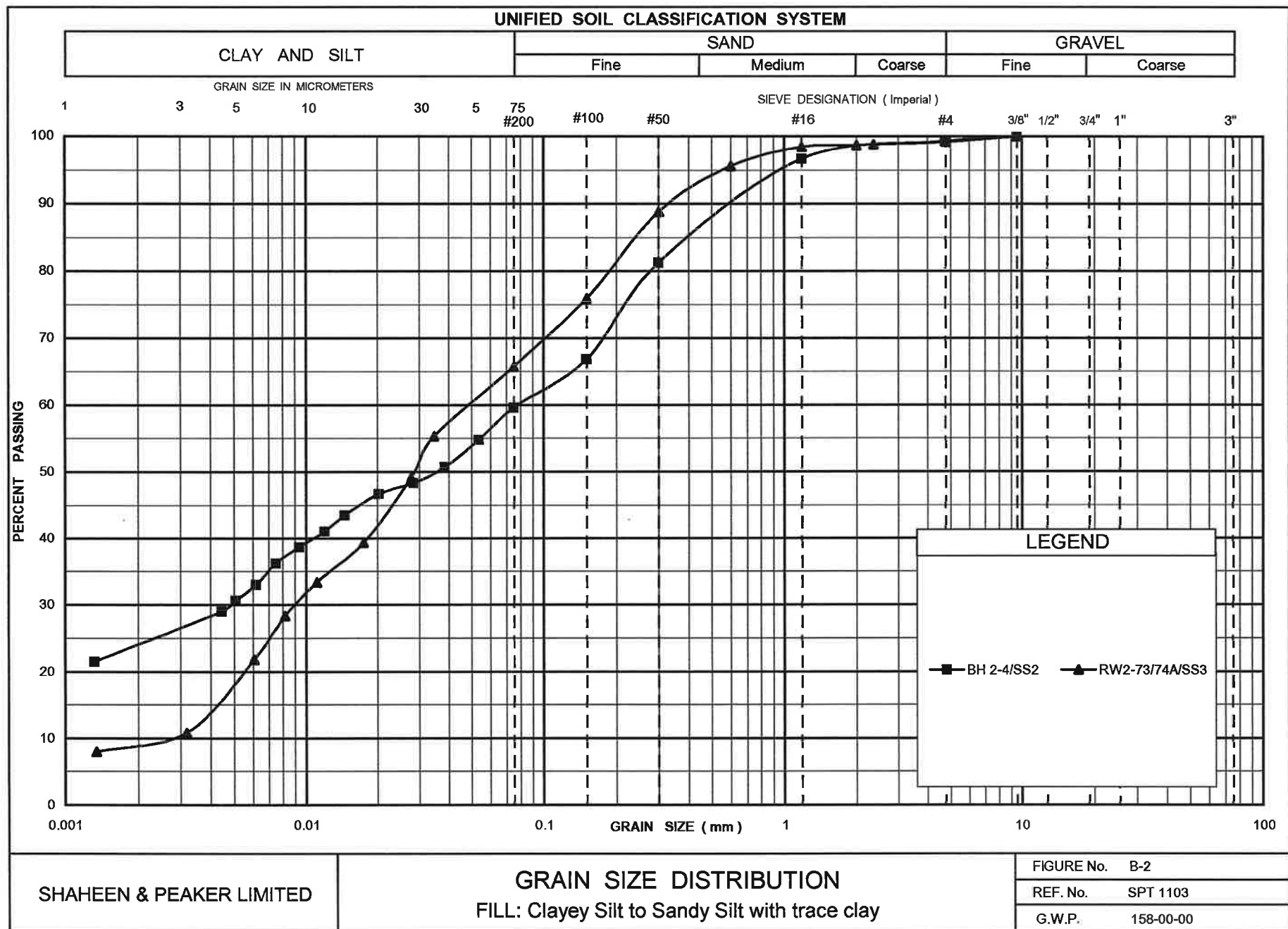
SHAHEEN & PEAKER LIMITED

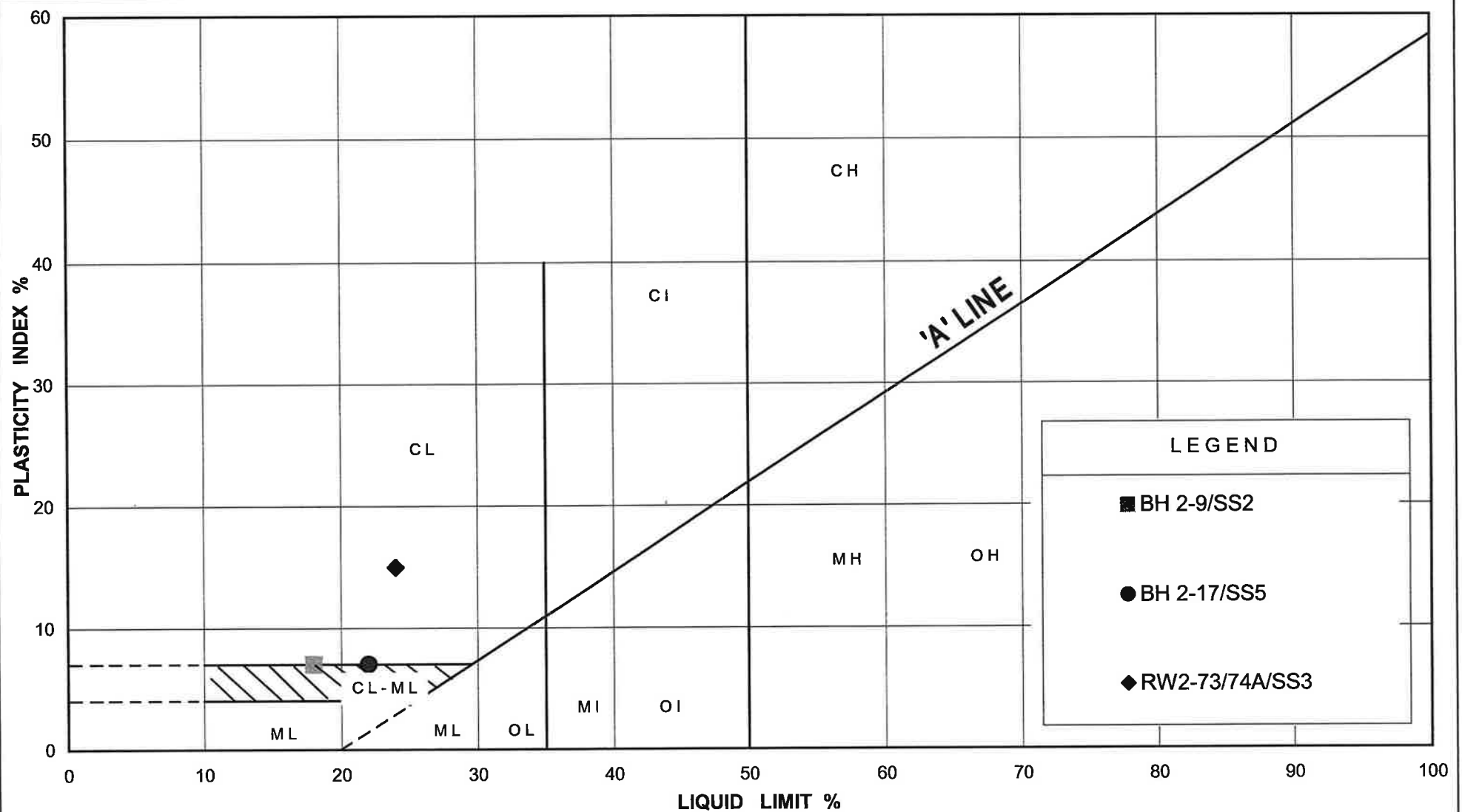
**GRAIN SIZE DISTRIBUTION**  
FILL: SILTY SAND to SAND, some to trace gravel

FIGURE No. B-1

REF. No. SPT 1103

G.W.P. 158-00-00





SHAHEEN & PEAKER LIMITED

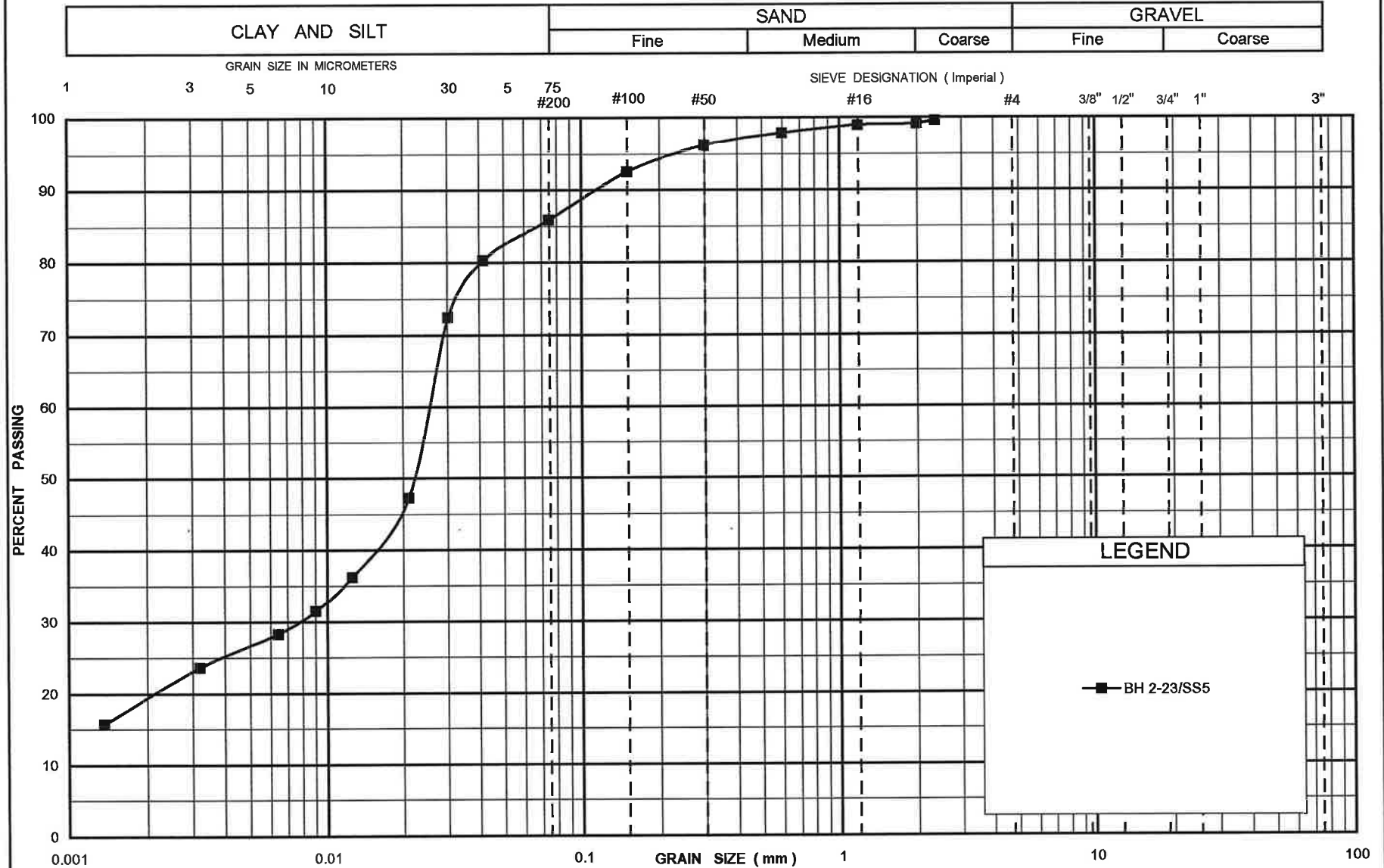
PLASTICITY CHART  
FILL: CLAYEY SILT

FIG No B-3

REF. No. SPT 1103

G.W.P. 158-00-00

# UNIFIED SOIL CLASSIFICATION SYSTEM



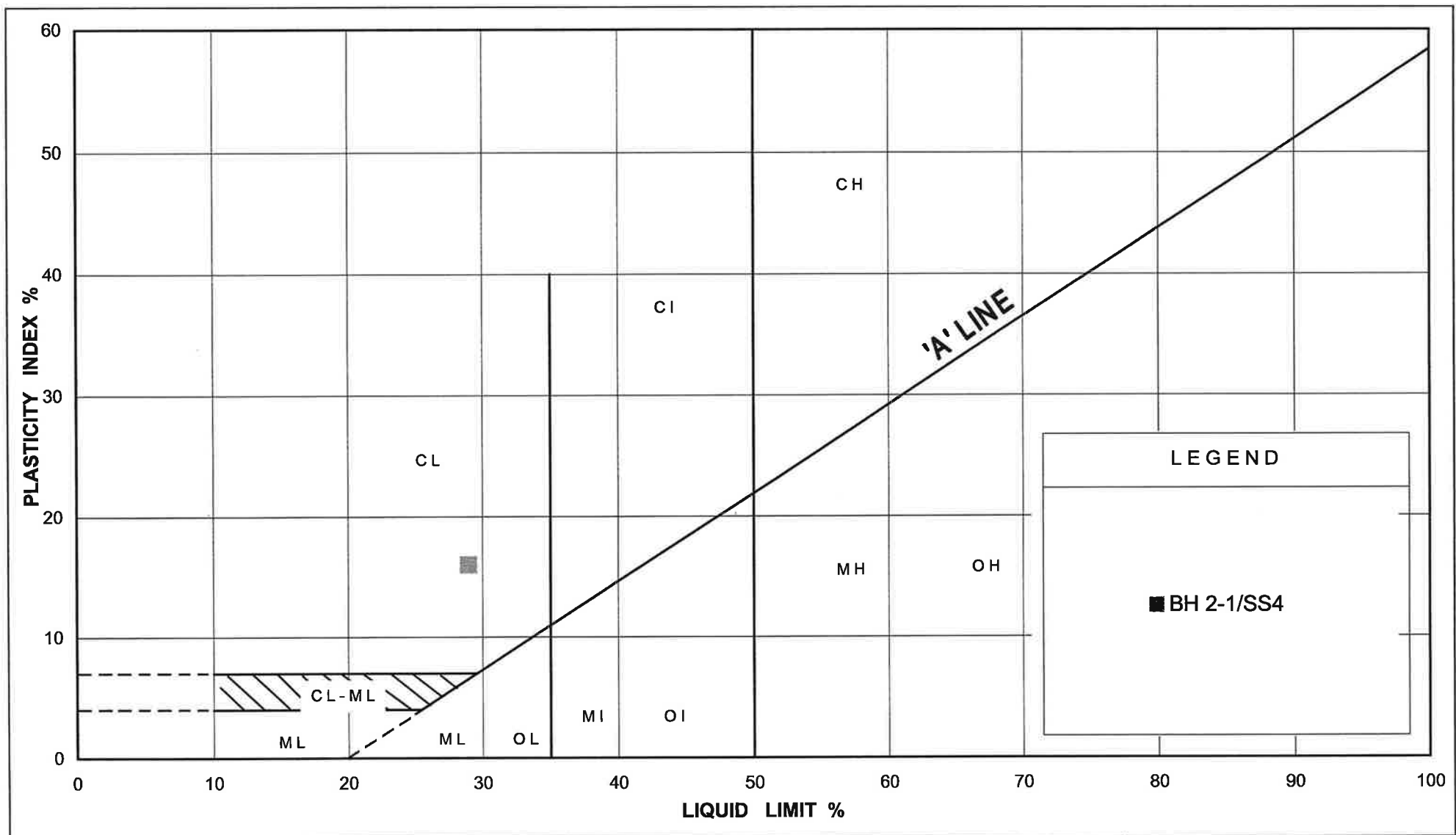
SHAHEEN & PEAKER LIMITED

**GRAIN SIZE DISTRIBUTION  
CLAYEY SILT**

FIGURE No. B-4

REF. No. SPT 1103

G.W.P. 158-00-00



SHAHEEN & PEAKER LIMITED

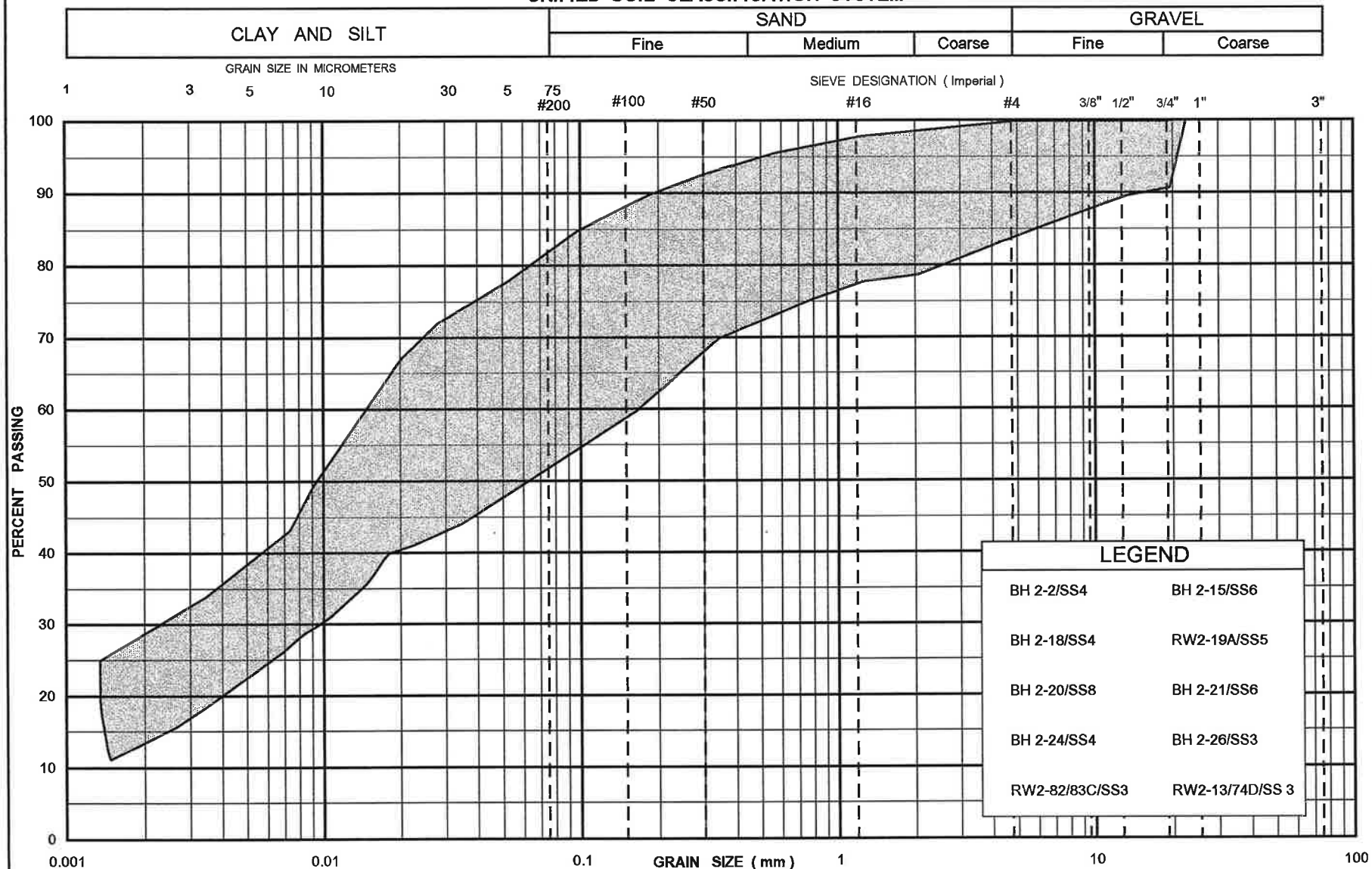
PLASTICITY CHART  
CLAYEY SILT

FIG No B-5

REF. No. SPT 1103

G.W.P. 158-00-00

# UNIFIED SOIL CLASSIFICATION SYSTEM



SHAHEEN & PEAKER LIMITED

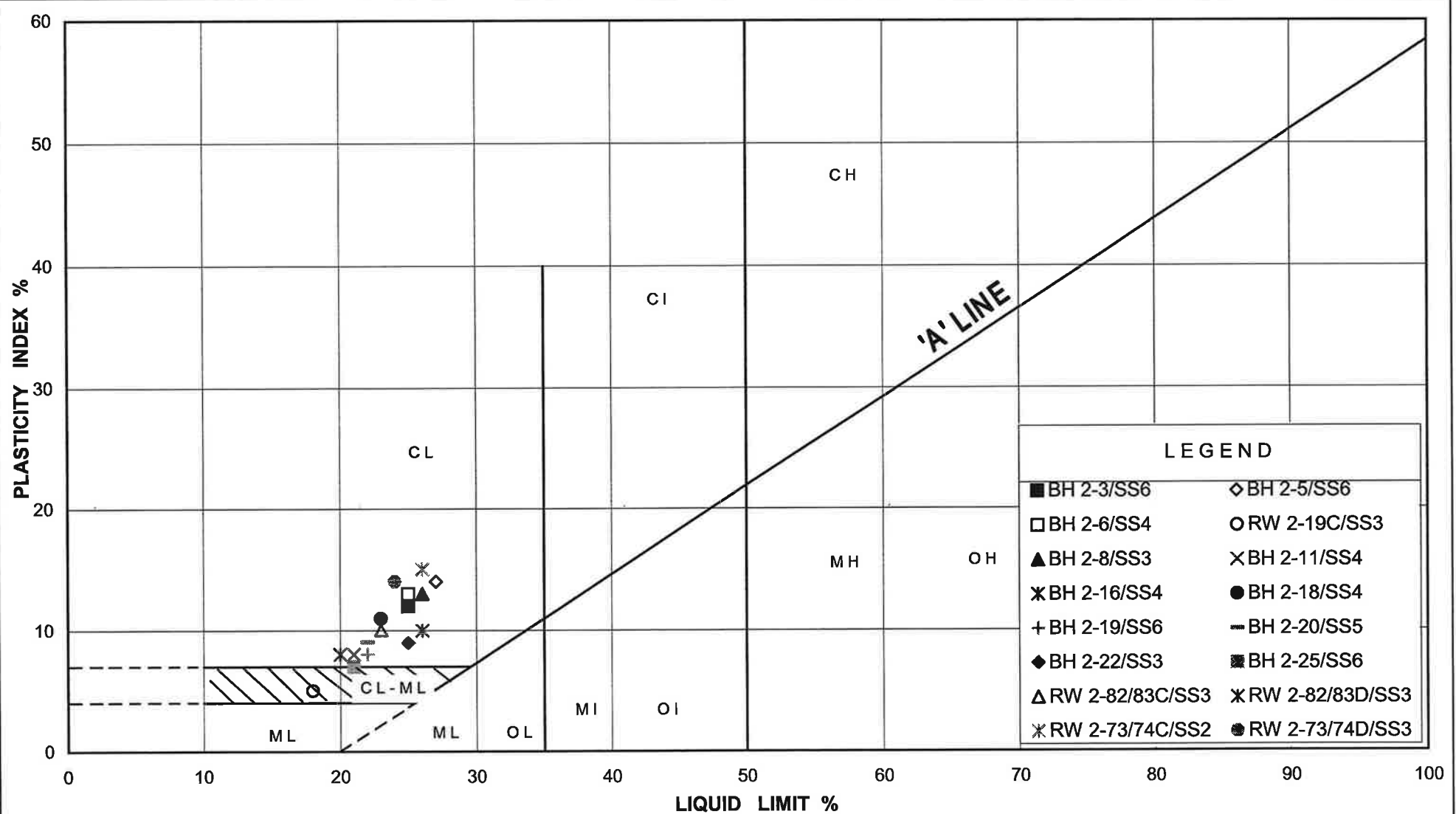
GRAIN SIZE DISTRIBUTION  
CLAYEY SILT TILL

FIGURE No. B-6

REF. No. SPT 1103

G.W.P. 158-00-00





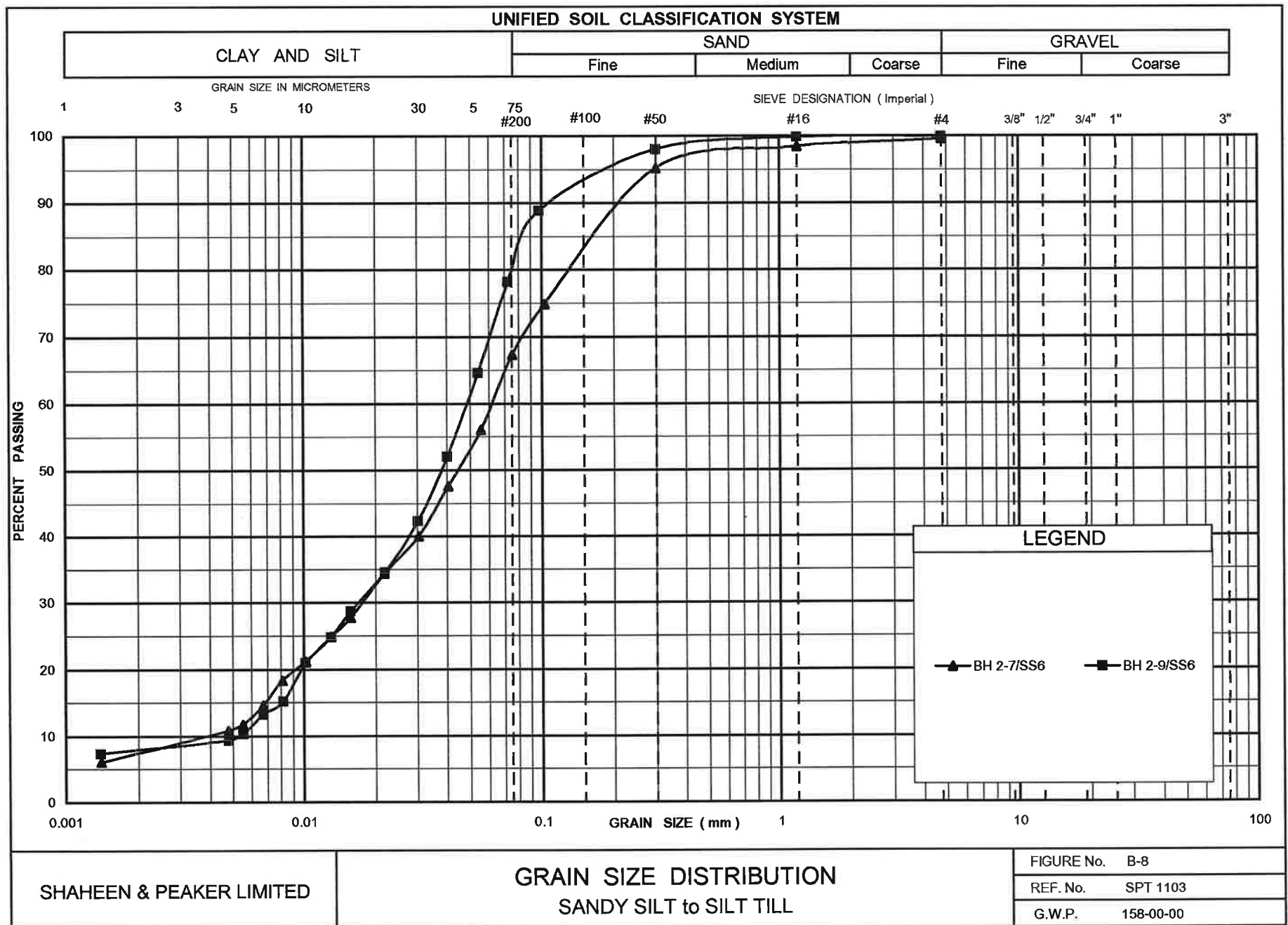
SHAHEEN & PEAKER LIMITED

PLASTICITY CHART  
CLAYEY SILT TILL

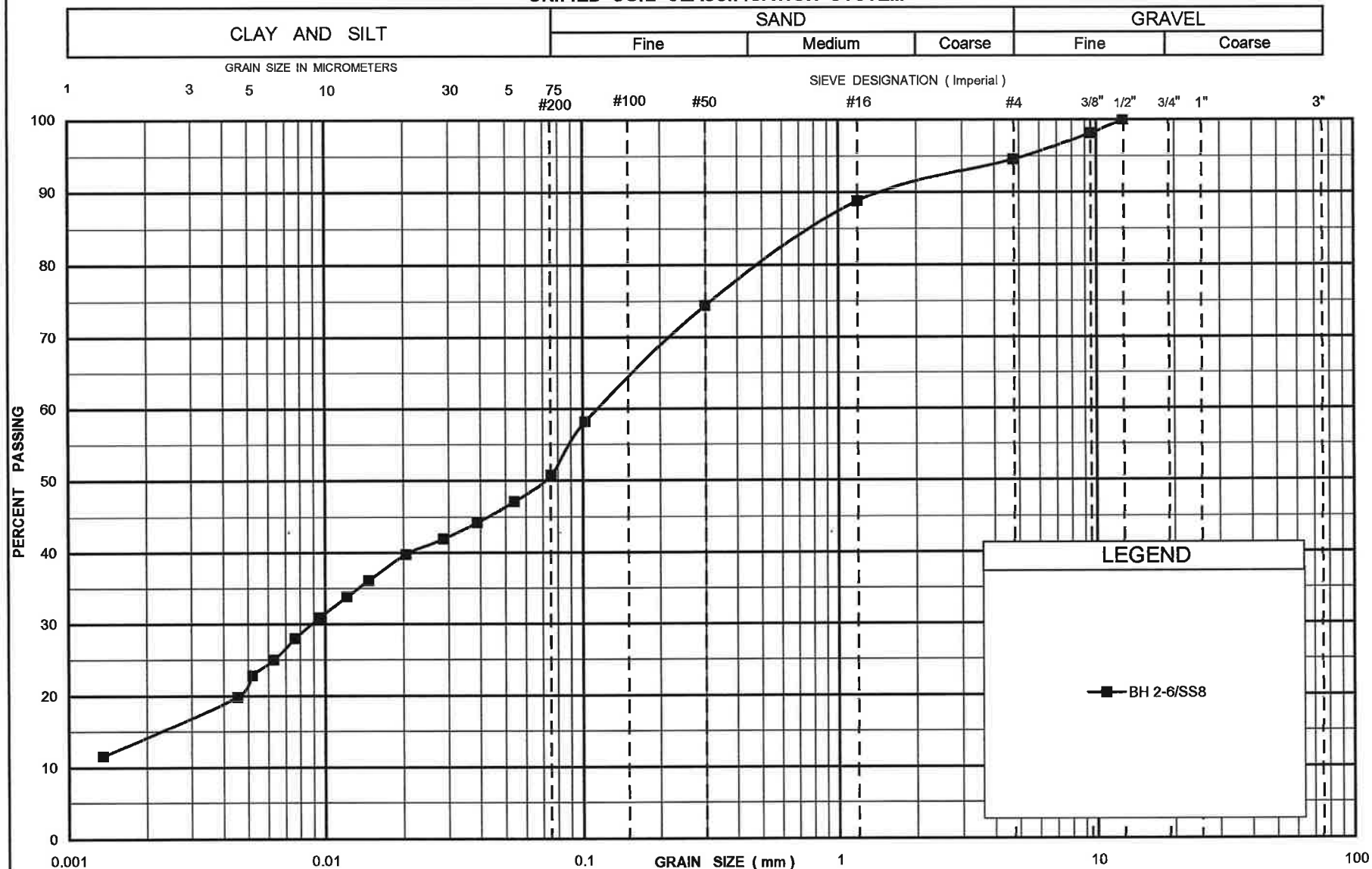
FIG No B-7

REF. No. SPT 1103

G.W.P. 158-00-00



# UNIFIED SOIL CLASSIFICATION SYSTEM



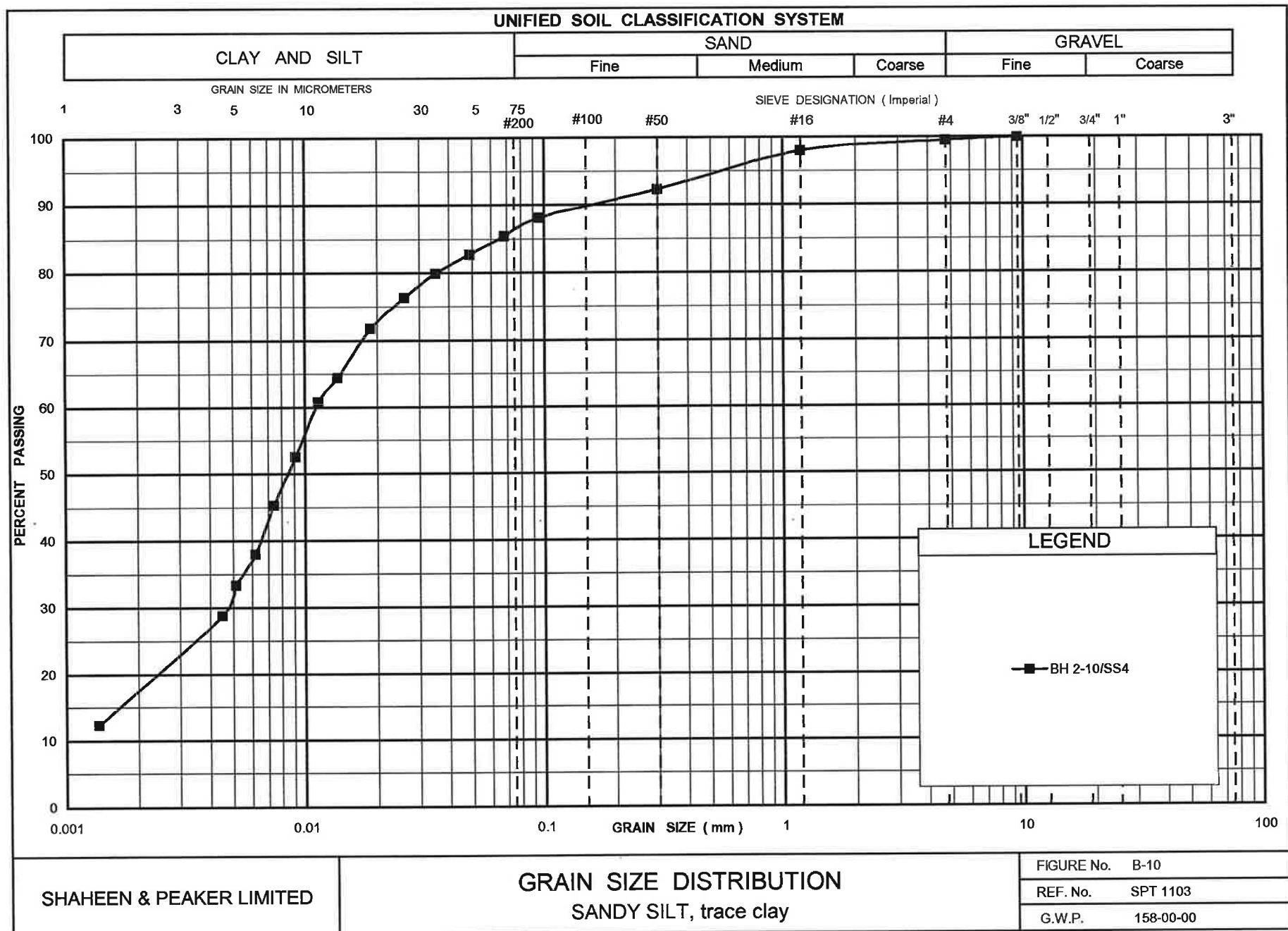
SHAHEEN & PEAKER LIMITED

**GRAIN SIZE DISTRIBUTION**  
SILTY SAND to SANDY SILT TILL

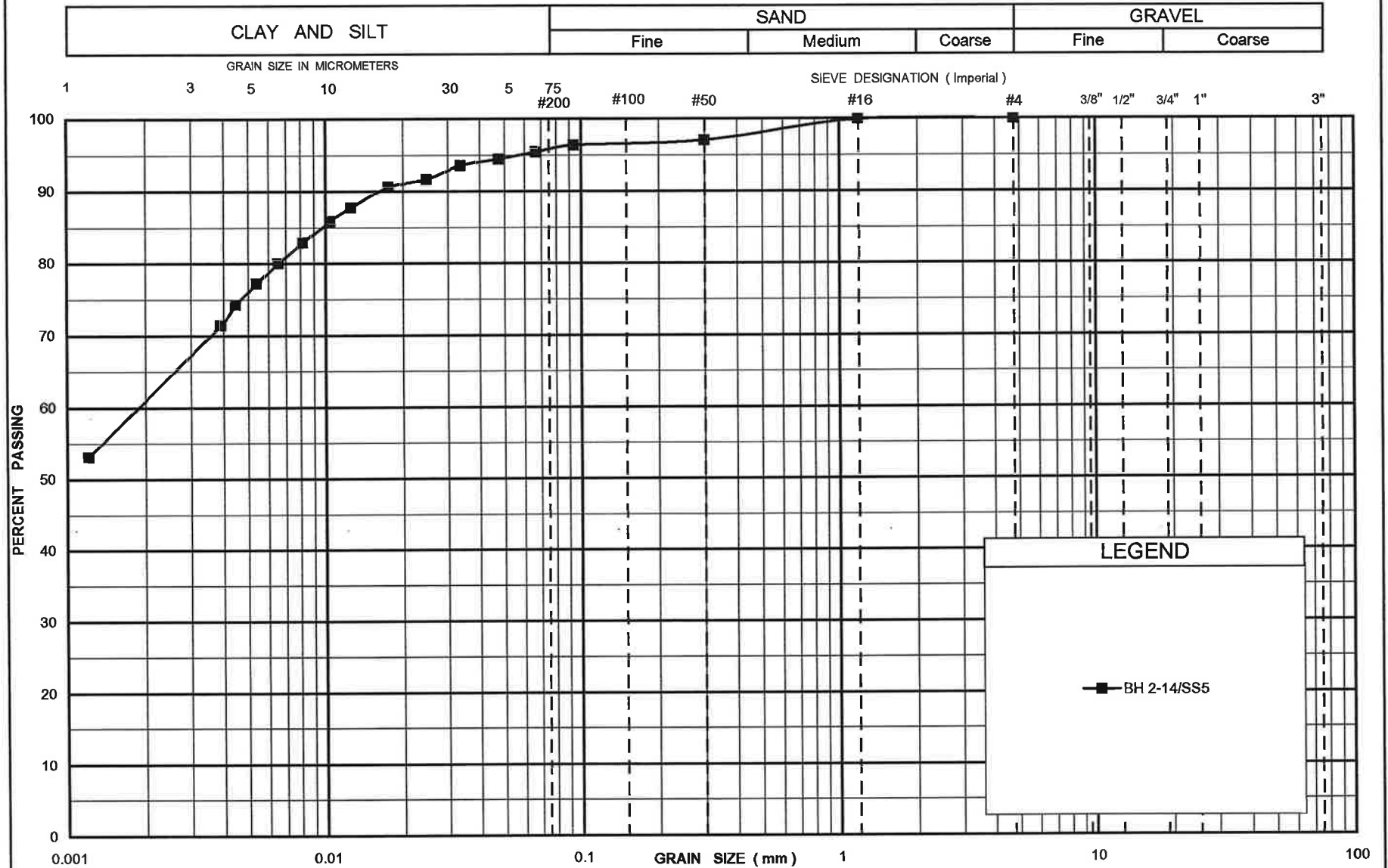
FIGURE No. B-9

REF. No. SPT 1103

G.W.P. 158-00-00



# UNIFIED SOIL CLASSIFICATION SYSTEM



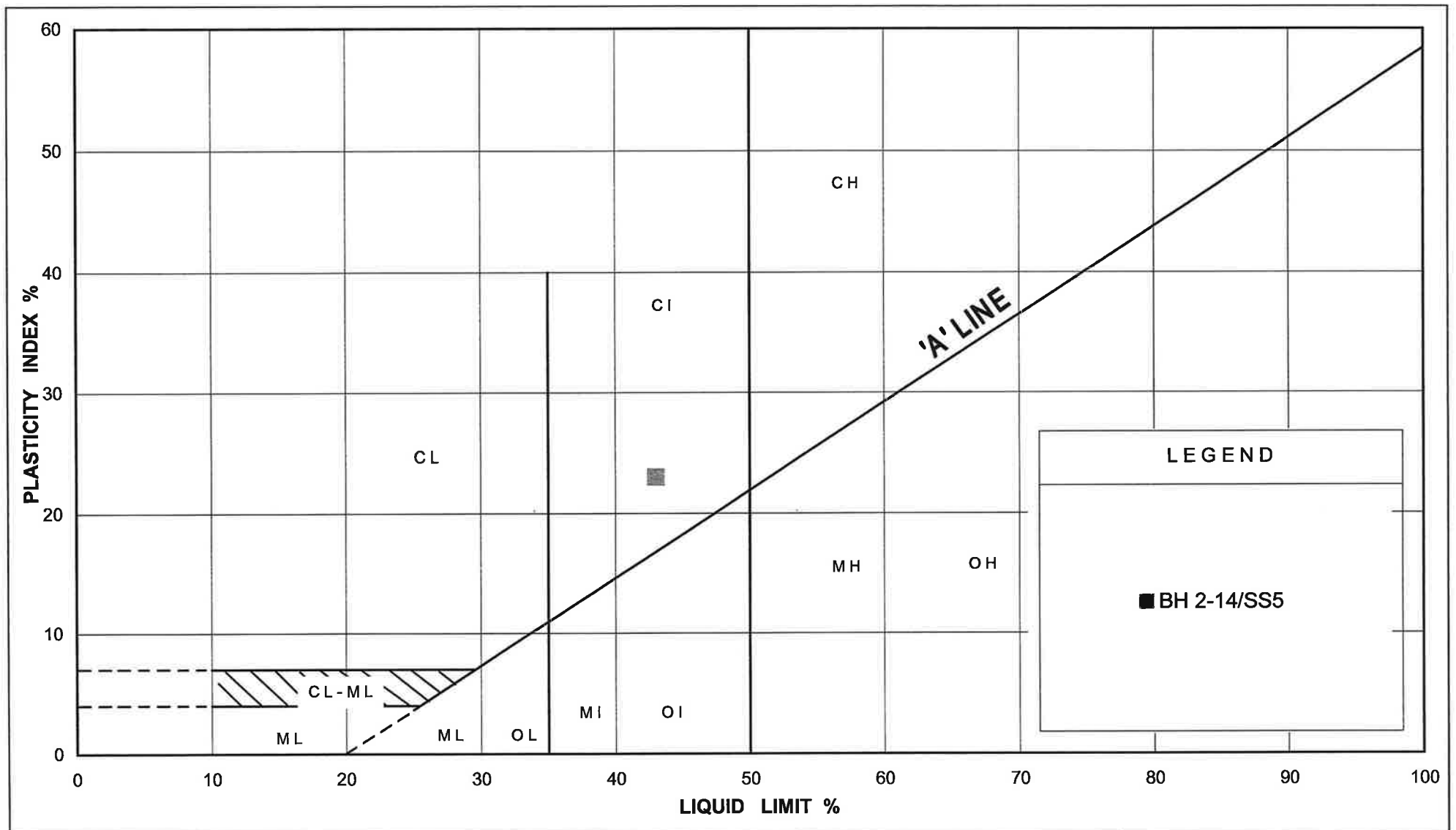
SHAHEEN & PEAKER LIMITED

**GRAIN SIZE DISTRIBUTION  
SILTY CLAY**

FIGURE No. B-11

REF. No. SPT 1103

G.W.P. 158-00-00



SHAHEEN & PEAKER LIMITED

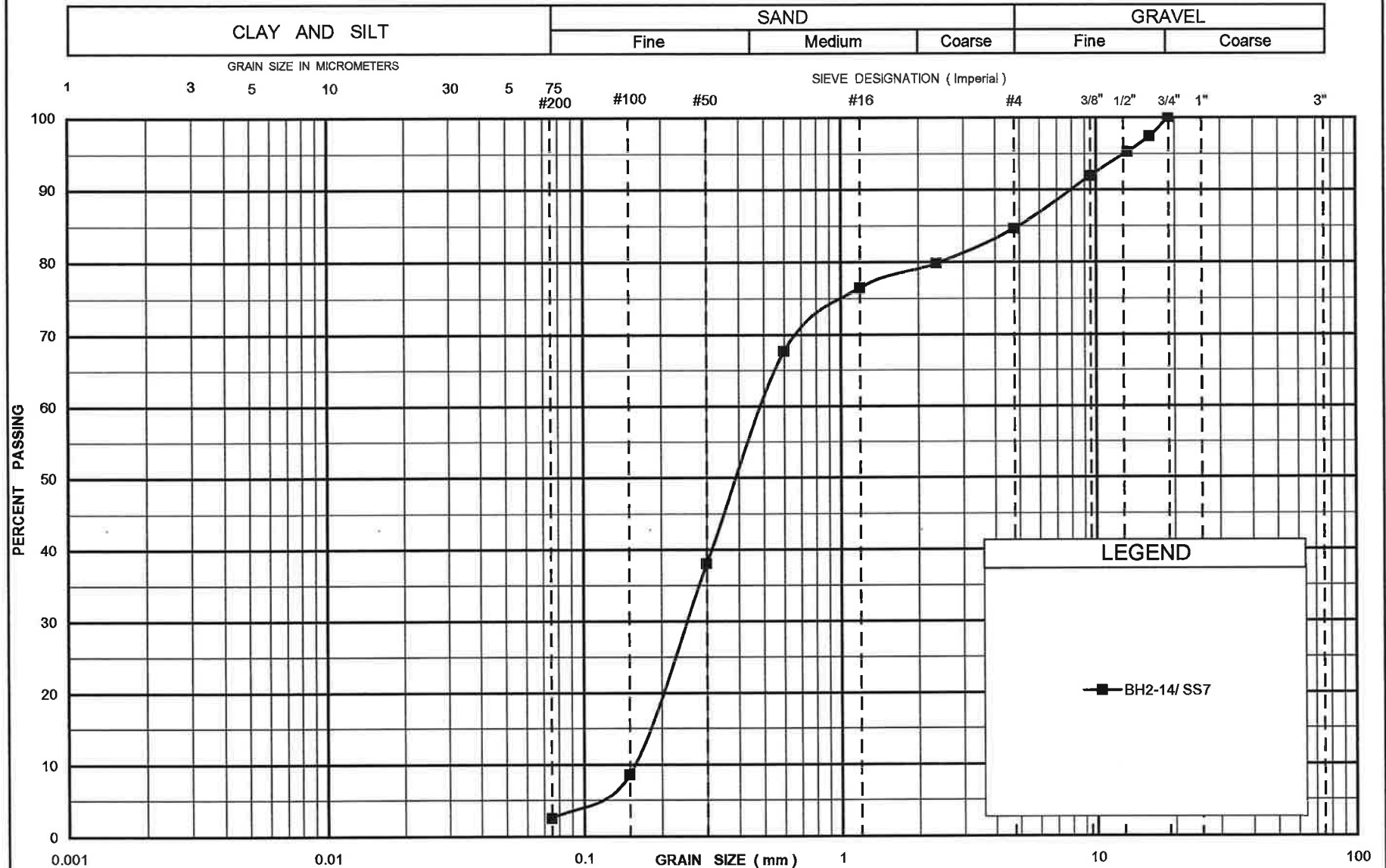
PLASTICITY CHART  
SILTY CLAY

FIG No B-12

REF. No. SPT 1103

G.W.P. 158-00-00

# UNIFIED SOIL CLASSIFICATION SYSTEM



SHAHEEN & PEAKER LIMITED

**GRAIN SIZE DISTRIBUTION**  
SAND, some gravel

FIGURE No. B-13

REF. No. SPT 1103

G.W.P. 158-00-00

# Appendix C

## Records of Boreholes for Retaining Wall 3



SPT 1103

RECORD OF BOREHOLE No RW3-6A

1 OF 1

METRIC

GWP 158-00-00 LOCATION Hwy 401 EBL Collector Yonge St. to Bayview Ave., Sta.:32+913.5; Offset:12.7m Rt EBC Crown ORIGINATED BY D.P.  
DIST 6 HWY 401 BOREHOLE TYPE Dynamic Ram Sounder COMPILED BY J.Z.  
DATUM Geodetic DATE 11/19/2003 to 11/20/2003 CHECKED BY R.M.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT $\gamma$ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20	40	60	80	100		
170.1	Ground Surface													
0.0	0.15 m TOPSOIL with humus dark brown, moist, very loose		1	SS	3	*	170							
	brown, moist, compact, rootlets		2	SS	21		169							1 74 (25)
168.4	FILL: SILTY SAND trace gravel		3	SS	36		168							
1.7	CLAYEY SILT TILL with sand brown, damp to moist, hard		4	SS	49		167							2 37 50 11
166.2			5	SS	90									
3.9	End of Borehole.		6	SS	32/13									
	*Borehole dry (not stabilized) and hole open to full depth on completion.													
	Spoon/hammer bouncing at 3.9 m.													

+<sup>3</sup>, X<sup>3</sup>: Numbers refer to  
Sensitivity

20  
15 10 5  
(%) STRAIN AT FAILURE

SPT 1103

# RECORD OF BOREHOLE No RW3-6B

1 OF 1

METRIC

GWP 158-00-00 LOCATION Hwy 401 EBL Collector Yonge St. to Bayview Ave., Sta.:32+910.4; Offset:7m Rt EBC Crown ORIGINATED BY R.A.  
 DIST 6 HWY 401 BOREHOLE TYPE Solid Stem Augers COMPILED BY J.Z.  
 DATUM Geodetic DATE 11/19/2003 CHECKED BY R.M.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W <sub>P</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20	40					
166.9	Ground Surface													
0.0	110 mm ASPHALT FILL: CRUSHED GRAVEL & SAND brown, damp, dense		1	SS	41									
166.2			2	SS	22									
0.7			3	SS	- **									
	very stiff hard cobbles													
	brown		4	SS	50/14									
	grey		5	SS	50/13									
	CLAYEY SILT TILL with sand damp to dry													
162.0			6	SS	50/10									
4.9	End of Borehole.													
	*Borehole dry (not stabilized) and hole open to full depth on completion.													
	**Spoon bouncing.													

RECORD OF BOREHOLE No RW3-6D

1 OF 1

METRIC

GWP 158-00-00 LOCATION Hwy 401 EBL Collector Yonge St. to Bayview Ave., -Sta.:32+912.1; Offset:14.5m Rt EBC Crown ORIGINATED BY R.A.  
DIST 6 HWY 401 BOREHOLE TYPE Dynamic Ram Sounder COMPILED BY J.Z.  
DATUM Geodetic DATE 12/11/2003 CHECKED BY R.M.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT γ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20	40	60	80	100		
170.6 0.0	Ground Surface													
	0.2 m TOPSOIL		1	SS	5		170							
	FILL: CLAYEY SILT occasional gravel, trace rootlets brown, damp		2	SS	14									
169.5 1.1														
	CLAYEY SILT TILL with sand brown, dry to damp, hard		3	SS	49		169							
			4	SS	50/15									
168.0 2.6	End of Borehole.						168							
	*Borehole dry (not stabilized) and hole open to full depth on completion.													



SPT 1103

RECORD OF BOREHOLE No RW3-6C

1 OF 1

METRIC

GWP 158-00-00 LOCATION Hwy 401 EBL Collector Yonge St. to Bayview Ave., -Sta. 32+914.3; Offset 6.9m Rt EBC Crown ORIGINATED BY R.A.  
DIST 6 HWY 401 BOREHOLE TYPE Solid Stem Augers COMPILED BY J.Z.  
DATUM Geodetic DATE 11/19/2003 CHECKED BY R.M.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W <sub>P</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20	40					
166.9	Ground Surface													
0.0	130 mm ASPHALT FILL: CRUSHED GRAVEL & SAND brown, damp, compact		1	SS	27									
166.2														
0.7	traces of organics		2	SS	34									
			3	SS	50/15									
	CLAYEY SILT TILL with sand dry to damp, hard		4	SS	50/15									
			5	SS	50/13									
162.0			6	SS	50/15									
4.9	End of Borehole. *Borehole dry (not stabilized) and hole open to full depth on completion.													


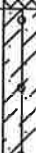
SPT 1103

RECORD OF BOREHOLE No 3-39

1 OF 1

METRIC

GWP 158-00-00 LOCATION Hwy 401 EBL Collector Yonge St. to Bayview Ave., Sta.:32+958.0; Offset:12.2m Rt EBC Crown ORIGINATED BY S.A.  
DIST 6 HWY 401 BOREHOLE TYPE Dynamic Ram Sound COMPILED BY J.Z.  
DATUM Geodetic DATE 10/19/2004 CHECKED BY R.M.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			UNIT WEIGHT $\gamma$ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa				
170.9 0.0	Ground Surface							20 40 60 80 100				
170.1 0.8	0.15 m TOPSOIL FILL: CLAYEY SILT trace rootlets, some topsoil pockets/layer brown, moist, stiff		1	SS	10			20 40 60 80 100				
168.6 2.3	CLAYEY SILT TILL with sand brown, moist, stiff		2	SS	14		170	20 40 60 80 100			20.0	
			3	SS	8		169	20 40 60 80 100				2 42 34 22
165.9 5.0	End of Borehole.  Dynamic Cone Penetration Test (D.C.P.T.) performed from 2.3 m to 5.0 m.						168	20 40 60 80 100				
							167	20 40 60 80 100				
							166	20 40 60 80 100				
	End of Dynamic Cone Penetration Test.  *Borehole dry (not stabilized) on completion.							20 40 60 80 100				

+<sup>3</sup>, x<sup>3</sup>: Numbers refer to  
Sensitivity

20  
15 5  
10 (%) STRAIN AT FAILURE

SPT 1103

# RECORD OF BOREHOLE No 3-38

1 OF 1

METRIC

GWP 158-00-00 LOCATION Hwy 401 EBL Collector Yonge St. to Bayview Ave., -Sta.:32+972.9; Offset:6.8m Rt EBC Crown ORIGINATED BY S.A.  
 DIST 6 HWY 401 BOREHOLE TYPE Solid Stem Augers COMPILED BY J.Z.  
 DATUM Geodetic DATE 10/13/2004 CHECKED BY R.M.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			UNIT WEIGHT $\gamma$ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20 40 60 80 100	PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	
166.5 0.0	Ground Surface											
	130 mm ASPHALT 450 mm CRUSHED GRAVEL & SAND FILL: SAND trace gravel brown, moist, compact		1	SS	15		166					
165.1 1.4			2	SS	25							
			3	SS	78		165					
	CLAYEY SILT TILL with sand brown to brownish grey, damp to moist hard		4	SS	94/25		164					
			5	SS	58		163					
			6	SS	31		162					
			7	SS	45		161					
160.7 5.8												
	SANDY SILT TILL brown, wet, compact		8	SS	20		160					
159.9 6.6	End of Borehole. *Wet cave at 6.1 m.											

SPT 1103

# RECORD OF BOREHOLE No RW3-19/20D

1 OF 1

METRIC

GWP 158-00-00 LOCATION Hwy 401 EBL Collector Yonge St. to Bayview Ave., Sta. 33+021; Offset 6m Rt EBC Crown ORIGINATED BY G.I.  
 DIST 6 HWY 401 BOREHOLE TYPE Solid Stem Augers COMPILED BY J.Z  
 DATUM Geodetic DATE 11/19/2003 to 11/20/2003 CHECKED BY R.M.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT $\gamma$ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV. DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20	40	60	80	100		
165.3 0.0	Ground Surface													
	125 mm ASPHALT 300 mm CRUSHED STONE BASE FILL: SILTY SAND brown, compact, moist		1	SS	23		166							
165.5 0.8			2	SS	7									
	CLAYEY SILT TILL with sand brown, moist	firm hard	3	SS	32		165							
			4	SS	50/8		164							
163.4 2.8		some cobbles												
	SILT to SANDY SILT TILL brown, compact		5	SS	19		163							
		moist wet	6	SS	21		162							
161.3 5.0	End of Borehole.  * Water level at 4.3 m (not stabilized) and hole open to 4.3 m on completion.		7	SS	16									

+ 3 x 3 Numbers refer to  
Sensitivity

20  
15 5  
10 (%) STRAIN AT FAILURE

SPT 1103

# RECORD OF BOREHOLE No RW3-19A

1 OF 1

METRIC

GWP 158-00-00 LOCATION Hwy 401 EBL Collector Yonge St. to Bayview Ave., Sta.:33+030.0; Offset:12m Rt EBC Crown ORIGINATED BY D.P.  
 DIST 6 HWY 401 BOREHOLE TYPE Dynamic Ram Sounder COMPILED BY J.Z.  
 DATUM Geodetic DATE 11/19/2003 to 11/20/2003 CHECKED BY R.M.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT $\gamma$ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	"N" VALUES			20	40	60	80	100		
168.7 0.0	Ground Surface													
	0.12 m TOPSOIL FILL: CLAYEY SILT trace sand, trace gravel brown to dark brown, moist	soil very stiff	1	SS	3		168							
167.2 1.5			2	SS	28									
166.4 2.3	CLAYEY SILT TILL with sand brown, damp, hard		3	SS	78		167							5 27 45 23
	End of Borehole. *Borehole dry (not stabilized) and hole open to full depth on completion.													

+<sup>3</sup>, ×<sup>3</sup>: Numbers refer to  
Sensitivity

20  
15  
10  
(%) STRAIN AT FAILURE



SPT 1103

# RECORD OF BOREHOLE No RW3-19/20B

1 OF 1

METRIC

GWP 158-00-00 LOCATION Hwy 401 EBL Collector Yonge St. to Bayview Ave., -Sta.:33+040.6; Offset:8.1m Rt EBC Crown ORIGINATED BY R.A.  
DIST 6 HWY 401 BOREHOLE TYPE Solid Stem Augers COMPILED BY J.Z.  
DATUM Geodetic DATE 11/19/2003 CHECKED BY R.M.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT γ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	"N" VALUES			20 40 60 80 100	20 40 60 80 100	20 40 60 80 100	20 40 60 80 100	20 40 60 80 100		
166.3 0.0	Ground Surface													
	125 mm ASPHALT		1	SS	24		166							
	FILL: CRUSHED GRAVEL & SAND brown, damp, compact		2	SS	44									
165.2 1.1	CLAYEY SILT TILL with sand damp, hard		3	SS	50/15		165							
			4	SS	88		164							
163.4 2.9	SILT dense		5	SS	61		163							
			6	SS	50/13		162							
161.3 5.0	End of Borehole. *Borehole dry (not stabilized) and hole open to full depth on completion.													

+<sup>3</sup>, ×<sup>3</sup>: Numbers refer to  
Sensitivity

20  
15  
10  
(%) STRAIN AT FAILURE

SPT 1103

# RECORD OF BOREHOLE No RW3-20A

1 OF 1

METRIC

GWP 158-00-00 LOCATION Hwy 401 EBL Collector Yonge St. to Bayview Ave., Sta.:33+042.5; Offset:10.8m Rt EBC Crown ORIGINATED BY R.A.  
 DIST 6 HWY 401 BOREHOLE TYPE Dynamic Ram Sounder COMPILED BY J.Z.  
 DATUM Geodetic DATE 11/19/2003 to 11/20/2003 CHECKED BY R.M.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT  Y kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa						
167.9	Ground Surface							20	40	60	80	100		
0.0	0.08 m TOPSOIL FILL: CLAYEY SILT trace rootlets, dark brown	wet, soft	1	SS	1		167							
166.7		moist, stiff	2	SS	13									
1.2	CLAYEY SILT TILL with sand brown, damp, hard		3	SS	36		166							
165.3			4	SS	60/15									
2.6														
End of Borehole. *Borehole dry (not stabilized) and hole open to full depth on completion.														

+<sup>3</sup>, X<sup>3</sup>: Numbers refer to  
Sensitivity

20  
15 10 5  
(%) STRAIN AT FAILURE

SPT 1103

RECORD OF BOREHOLE No RW3-19/20E

1 OF 1

METRIC

GWP 158-00-00 LOCATION Hwy 401 EBL Collector Yonge St. to Bayview Ave., Sta. 33+044.5; Offset: 13m Rt EBC Crown ORIGINATED BY R.A.  
DIST 6 HWY 401 BOREHOLE TYPE Dynamic Ram Sounder COMPILED BY J.Z.  
DATUM Geodetic DATE 12/11/2003 CHECKED BY R.M.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT $\gamma$ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	"N" VALUES			20	40	60	80	100		
168.9 0.0	Ground Surface		1	SS	3	*								
168.0 0.9	0.15 m TOPSOIL FILL: CLAYEY SILT some sand, trace gravel brown, moist, very soft		2	SS	11		168							
	CLAYEY SILT TILL with sand brown, damp	stiff hard	3	SS	35		167							
166.0 2.9			4	SS	80		166							
	End of Borehole. *Borehole dry (not stabilized) and hole open to full depth on completion.													

+<sup>3</sup>, X<sup>3</sup>: Numbers refer to  
Sensitivity

20  
15  
10  
(%) STRAIN AT FAILURE

SPT 1103

RECORD OF BOREHOLE No 3-40

1 OF 1

METRIC

GWP 158-00-00 LOCATION Hwy 401 EBL Collector Yonge St. to Bayview Ave., Sta.:33+100.7; Offset:7.2m Rt EBC Crown ORIGINATED BY S.A.  
DIST 6 HWY 401 BOREHOLE TYPE Solid Stem Augers COMPILED BY J.Z.  
DATUM Geodetic DATE 10/13/2004 CHECKED BY R.M.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT $\gamma$ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20	40	60	80	100		
166.3	Ground Surface													
0.0	160 mm ASPHALT		1	SS	18		166							
165.7	FILL: CRUSHED GRAVEL & SAND brown, damp, compact													
0.6			2	SS	22		165							
	FILL: SAND trace to some gravel some clayey silt layers/zones brown, moist, compact													
164.2			3	SS	14		164							
2.1	SAND some gravel, some silt brown, moist, compact		4	SS	28		163							
			5	SS	20		162							
162.6	CLAYEY SILT TILL with sand brownish grey, moist to very moist firm to very stiff		6	SS	7		161							
3.7			7	SS	21		160							
160.5	SAND trace to some silt brown, wet, compact		8	SS	23									
5.8														
159.7														
6.6	End of Borehole.													
	*Water level at 4.3 m (not stabilized) and hole open to 4.9 m on completion.													

+<sup>3</sup>, X<sup>3</sup>: Numbers refer to  
Sensitivity

20  
15-5  
10 (%) STRAIN AT FAILURE

SPT 1103

## 1 OF 1

**METRIC**

GWP	158-00-00	LOCATION	Hwy 401 EBL Collector Yonge St. to Bayview Ave., Sta.:33+105.8; Offset:14.8m Rt EBC Crown	ORIGINATED BY	Y.L.
DIST	6	HWY	401	BOREHOLE TYPE	Solid Stem Augers
DATUM	Geodetic	DATE	10/27/2004	COMPILED BY	J.Z.
				CHECKED BY	R.M.

+<sup>3</sup>, ×<sup>3</sup>: Numbers refer to Sensitivity

SPT 1103

RECORD OF BOREHOLE No 3-43

1 OF 1

METRIC

GWP 158-00-00

LOCATION Hwy 401 EBL Collector Yonge St. to Bayview Ave., -Sta.:33+138.6; Offset:13.8m Rt EBC Crown

DIST 6 HWY 401

BOREHOLE TYPE Solid Stem Augers

ORIGINATED BY Y.L.  
COMPILED BY J.Z.

DATUM Geodetic

DATE 10/27/2004

CHECKED BY R.M.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT $\gamma$ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	"N" VALUES			20 40 60 80 100	20 40 60 80 100	20 40 60 80 100	20 40 60 80 100	20 40 60 80 100		
166.6 0.0	Ground Surface													
	0.13 m TOPSOIL		1	SS	17		166							
	SANDY SILT trace gravel, trace clay occasional topsoil pockets brown, moist, compact		2	SS	18									
165.2 1.4			3	SS	6		165							
	CLAYEY SILT TILL with sand brown, moist to wet	firm very stiff to hard	4	SS	32		164							
			5	SS	22									
162.6 4.0	SILT trace gravel, trace clay grey, moist to wet, dilatant compact to very dense		6	SS	22		163							
161.8 4.8			7	SS	55		162							
	SILTY SAND TILL brown, wet, dense to very dense						161							
160.0 6.6	End of Borehole.		8	SS	37		160							
	*Water level at 5.5 m (not stabilized) and hole open to 5.8 m on completion.													

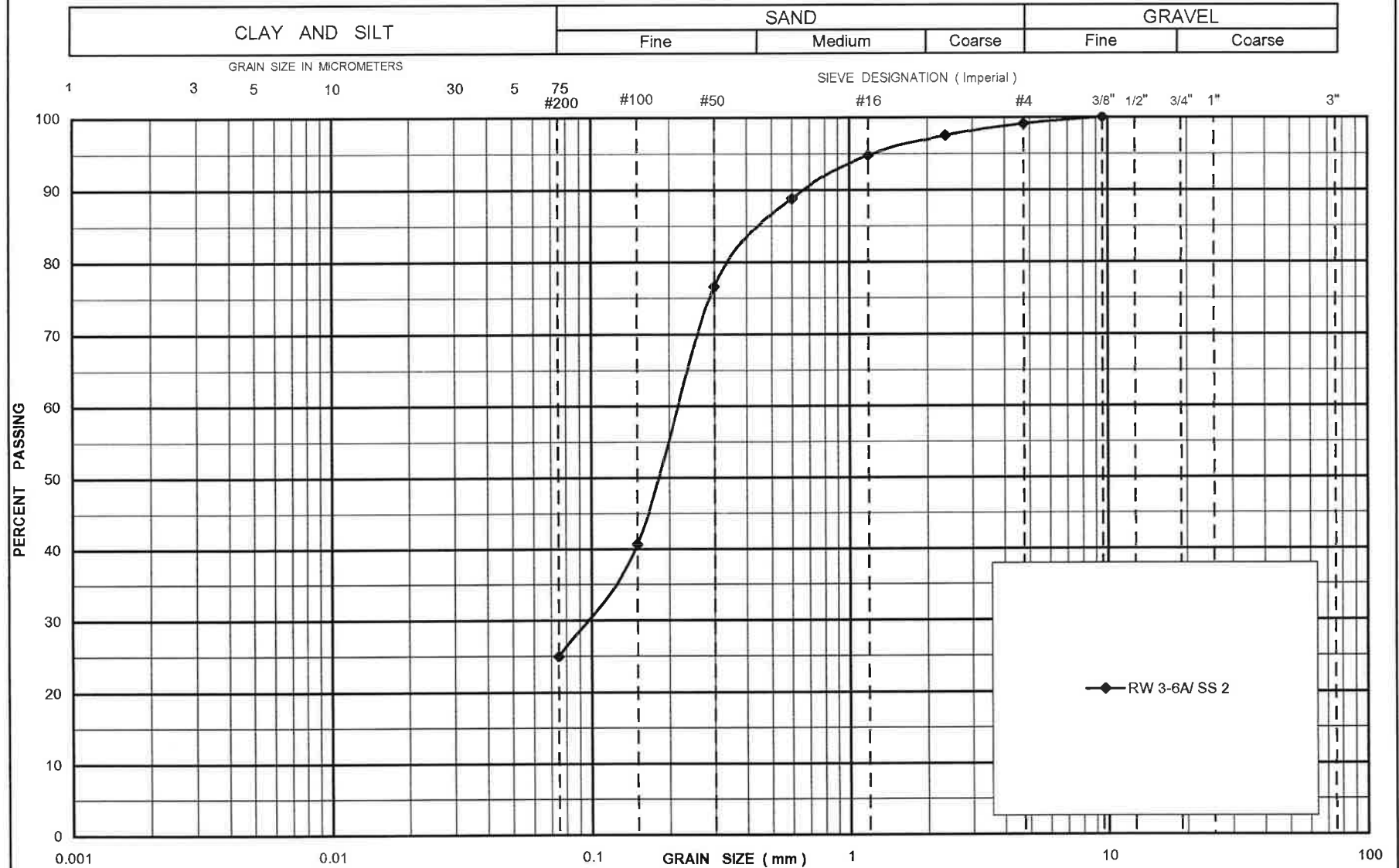
+<sup>3</sup>, X<sup>3</sup>: Numbers refer to  
Sensitivity

20  
15-5  
10 (%) STRAIN AT FAILURE

# Appendix D

## Laboratory Test Results for Retaining Wall 3

# UNIFIED SOIL CLASSIFICATION SYSTEM



SHAHEEN & PEAKER LIMITED

**GRAIN SIZE DISTRIBUTION**  
FILL: Silty Sand

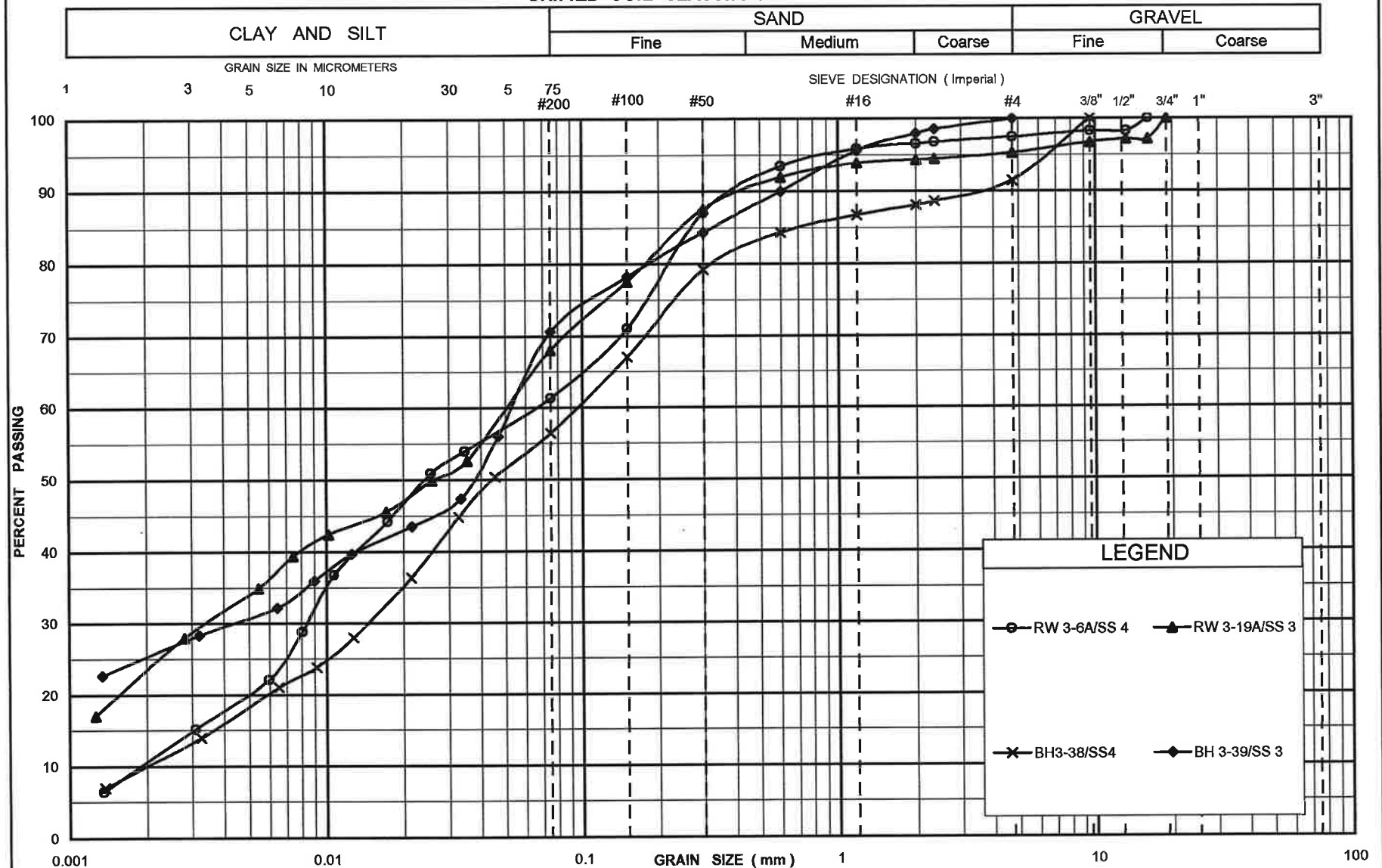
FIGURE No. D-1A

REF. No. SPT 1103

DATE May 2005



# UNIFIED SOIL CLASSIFICATION SYSTEM



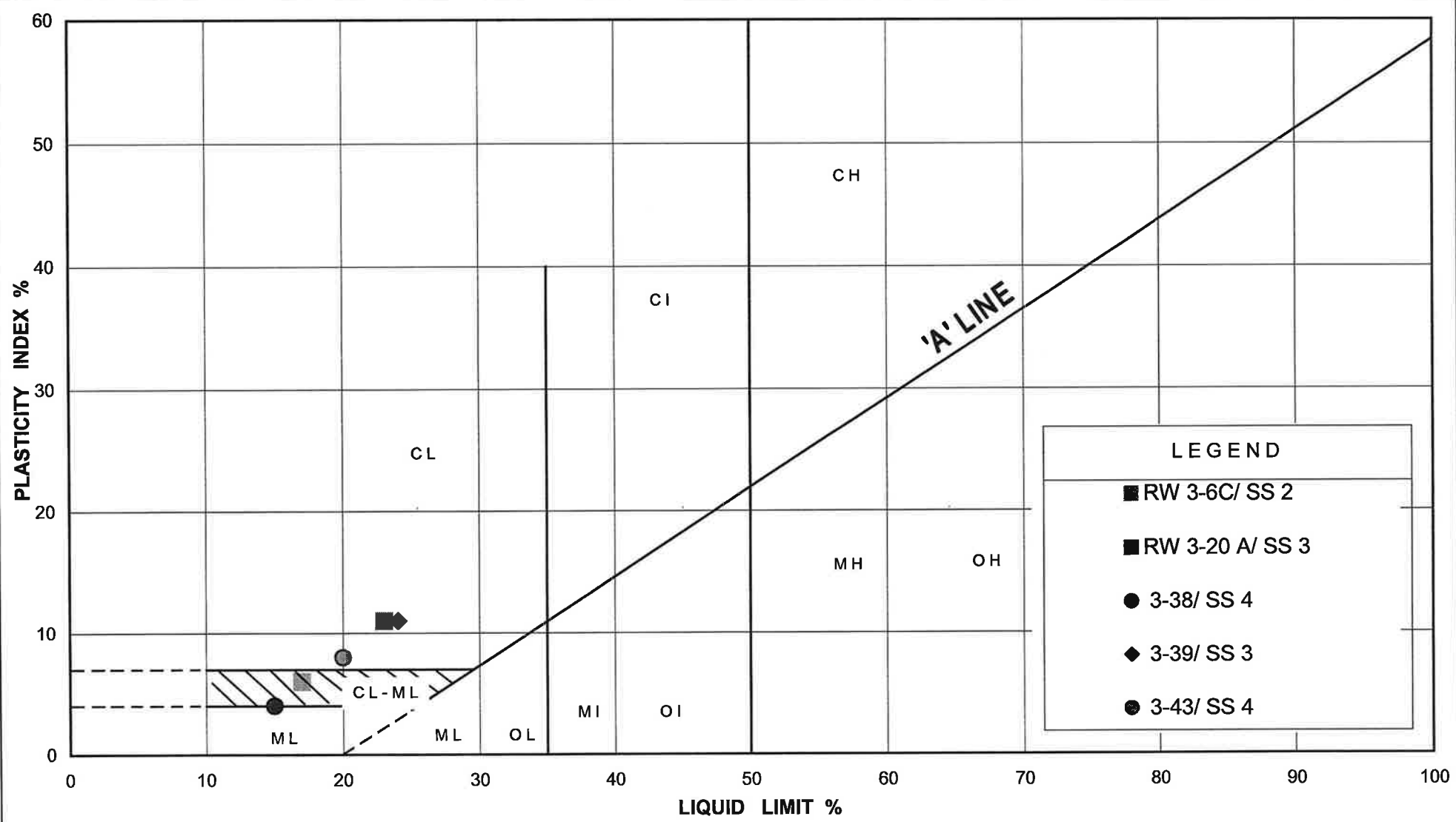
SHAHEEN & PEAKER LIMITED

**GRAIN SIZE DISTRIBUTION**  
CLAYEY SILT TILL WITH SAND

FIGURE No. D-1

REF. No. SPT 1103

G.W.P. 158-00-00



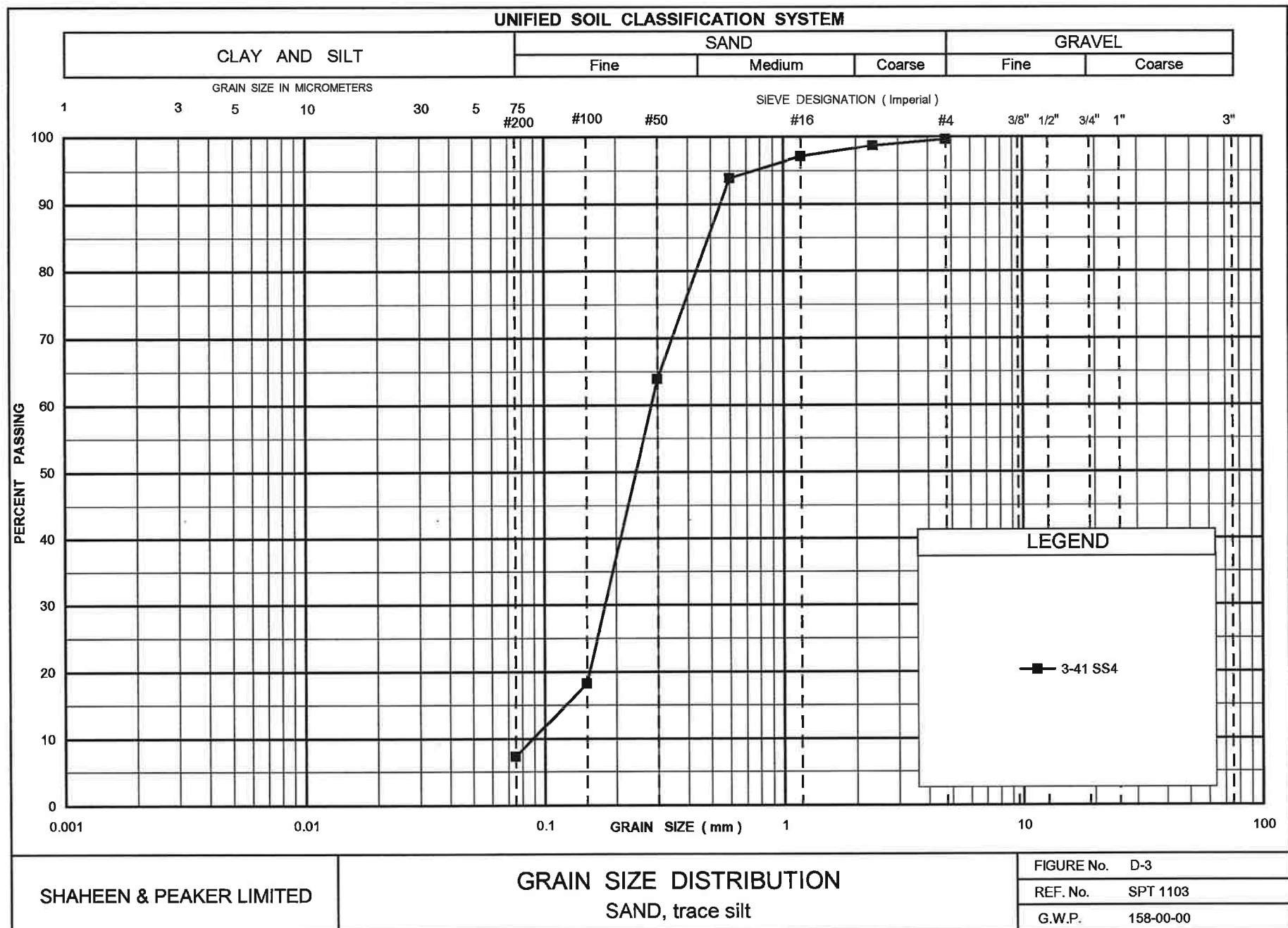
SHAHEEN & PEAKER LIMITED

PLASTICITY CHART  
SILTY CLAY to CLAY

FIG No D-2

REF. No. SPT 1103

G.W.P. 158-00-00



# Appendix E

## Records of Boreholes for Noise Barrier Wall between Retaining Walls No. 2 and 3

SPT 1103

# RECORD OF BOREHOLE No 28

1 OF 1

METRIC

GWP 158-00-00 LOCATION Hwy 401 EBL Collector Yonge St. to Bayview Ave. Sta. 32+643.8; Offset 12.6m R1 EBC Crow ORIGINATED BY S.A.  
 DIST 6 HWY 401 BOREHOLE TYPE Solid Stem Augers COMPILED BY J.Z.  
 DATUM Geodetic DATE 10/13/2004 CHECKED BY R.M.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				UNIT WEIGHT  $\gamma$ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa					
								○ UNCONFINED + FIELD VANE					
								● POCKET PENETR. x LAB VANE					
				WATER CONTENT (%)									
				PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT									
				W <sub>P</sub> W W <sub>L</sub>									
				20 40 60 80 100									
				20 40 60 80 100									
168.5	Ground Surface												
0.0	0.2 m TOPSOIL		1	SS	9		168						
	CLAYEY SILT (possible fill) trace rootlets, trace sand occasional gravel brown, moist, stiff		2	SS	8								
167.1			3	SS	14		167						
1.4			4	SS	49		166						
	CLAYEY SILT TILL damp	stiff hard	5	SS	47		165						
			6	SS	44		164						
		brown grey	7	SS	50/8		163						
162.2	End of Borehole.		8	SS	50/8								
6.3	*Borehole dry (not stabilized) and hole open to 5.8 m on completion.												

+ 3, x 3: Numbers refer to  
Sensitivity

20  
15  
10

(%) STRAIN AT FAILURE

SPT 1103

# RECORD OF BOREHOLE No 31

1 OF 1

METRIC

GWP 158-00-00 LOCATION Hwy 401 EBL Collector Yonge St. to Bayview Ave., Sta. 32+696.7; Offset: 10.9m Rt EBC Crown ORIGINATED BY Y.L.  
DIST 6 HWY 401 BOREHOLE TYPE Solid Stem Augers COMPILED BY J.Z.  
DATUM Geodetic DATE 10/14/2004 CHECKED BY R.M.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT  γ  kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV. DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa						
168.5	Ground Surface							20 40 60 80 100						
0.0	0.15 m TOPSOIL FILL: CLAYEY SILT trace rootlets, trace topsoil inclusions occasional gravel brown, damp to moist, very stiff		1	SS	20									
167.6			2	SS	43									
0.9			3	SS	66									
	CLAYEY SILT TILL brown, moist, hard		4	SS	56									
			5	SS	50/8									
			6	SS	50/10									
	sandy silt till layer		7	SS	50/10									
162.2	grey		8	SS	50/10									
6.4	End of Borehole.													
	*Borehole dry (not stabilized) and hole open to full depth on completion.													
	Piezometer installed at 6.1 m.													
	*Water level on: Oct. 14, 2004 - Dry Oct. 28, 2004 - Dry Nov. 26, 2004 - Dry													

+ 3 × 3 Numbers refer to  
Sensitivity

20  
15 5  
10 (%) STRAIN AT FAILURE

SPT 1103

RECORD OF BOREHOLE No 33

1 OF 1

METRIC

GWP 158-00-00 LOCATION Hwy 401 EBL Collector Yonge St. to Bayview Ave., -Sta.:32+746.6, Offset 10.4m Rt EBC Crown ORIGINATED BY Y.L.  
DIST 6 HWY 401 BOREHOLE TYPE Solid Stem Augers COMPILED BY J.Z.  
DATUM Geodetic DATE 10/15/2004 CHECKED BY R.M.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			UNIT WEIGHT $\gamma$ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)				
ELEV. DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa ○ UNCONFINED    + FIELD VANE ● POCKET PENETR.    x LAB VANE					PLASTIC LIMIT W <sub>P</sub> NATURAL MOISTURE CONTENT W LIQUID LIMIT W <sub>L</sub>			
168.1	Ground Surface						20	40	60	80	100					
0.0	0.18 m TOPSOIL CLAYEY SILT (possible fill) trace rootlets, trace gravel trace topsoil inclusions brown, damp, very stiff		1	SS	21											
167.4																
0.7	CLAYEY SILT trace rootlets, trace gravel brown, damp, very stiff		2	SS	24											
166.7																
1.4	CLAYEY SILT TILL trace silt seams/layers brown, moist, hard		3	SS	78											
166.0																
2.1	SILT brown, moist, very dense		4	SS	50/13											
	clayey		5	SS	92/23											
			6	SS	94/28											
163.4																
4.7	CLAYEY SILT TILL brown, damp, hard		7	SS	50/8											
161.9																
6.2	End of Borehole.		8	SS	50/13											
	*Water level at 6.0 m (not stabilized) and hole open to full depth on completion.															

SPT 1103

RECORD OF BOREHOLE No 35

1 OF 1

METRIC

GWP 158-00-00 LOCATION Hwy 401 EBL Collector Yonge St. to Bayview Ave., Sta :32+798.2; Offset: 10.6m Rt EBC Crow ORIGINATED BY Y.L.  
DIST 6 HWY 401 BOREHOLE TYPE Solid Stem Augers COMPILED BY J.Z.  
DATUM Geodetic DATE 10/15/2004 CHECKED BY R.M.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT w <sub>p</sub>	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w <sub>L</sub>	UNIT WEIGHT  γ  kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)  GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● POCKET PENETR. × LAB VANE						
167.4	Ground Surface													
0.0	0.2 m TOPSOIL		1	SS	18									
	CLAYEY SILT (possible fill) with sand, trace rootlets brown, damp, very stiff		2	SS	9									0 40 38 22
166.0														
1.4	CLAYEY SILT TILL trace topsoil inclusion brown, moist, stiff		3	SS	14									
165.2														
2.2			4	SS	46									
	dense ----- SILT trace sand brown, moist to wet very dense		5	SS	61									
163.4			6	SS	50/13									
4.0	CLAYEY SILT TILL grey, moist, hard		7	SS	50/15									
161.2														
6.2	End of Borehole.		8	SS	50/13									
	*Water level at 5.0 m (not stabilized) and hole open to full depth on completion.  Piezometer installed at 6.1 m.  *Water level on: Nov. 26, 2004 - 4.1 m (El. 163.3 m)													



SPT 1103

# RECORD OF BOREHOLE No 37

1 OF 1

METRIC

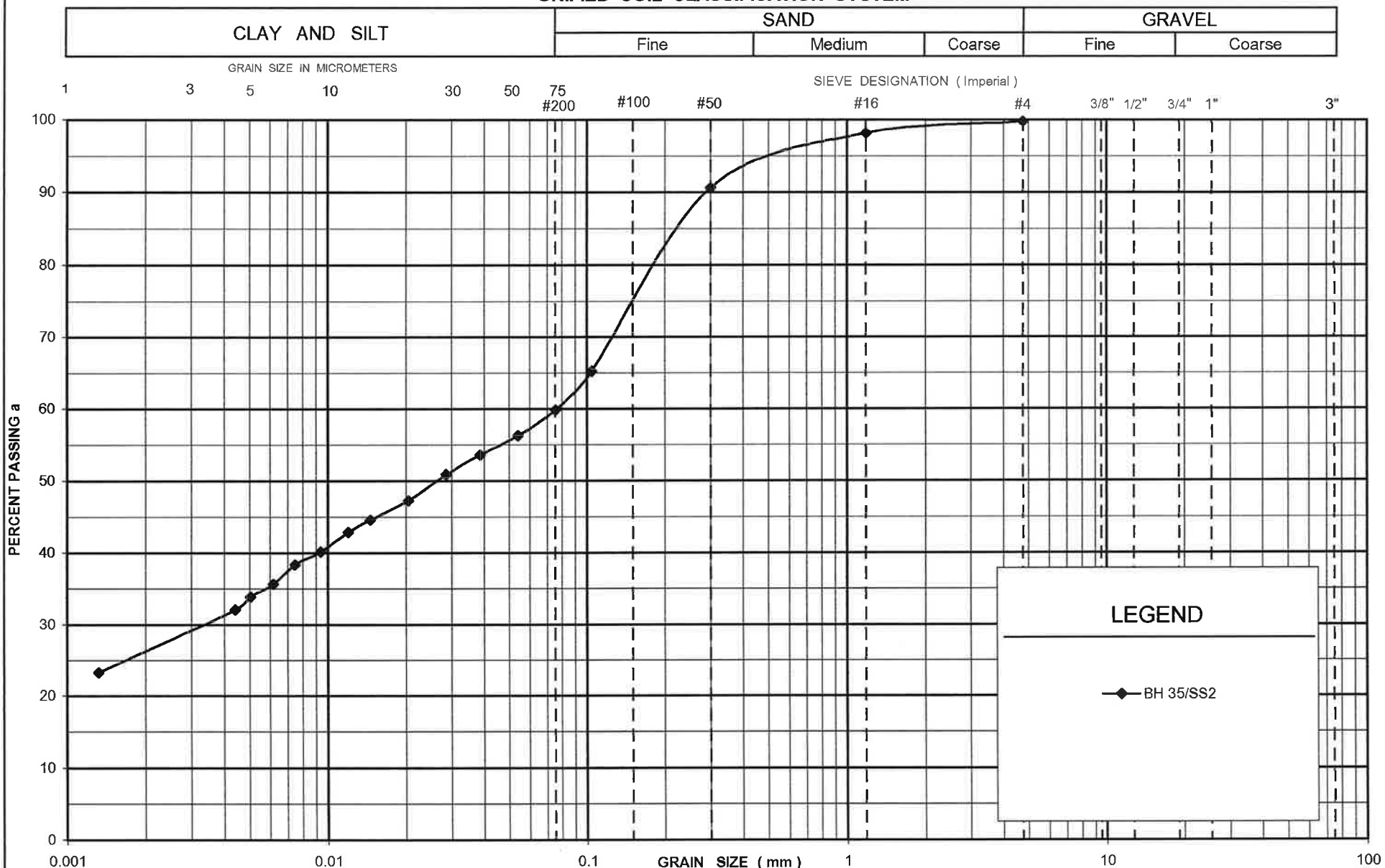
GWP 158-00-00 LOCATION Hwy 401 EBL Collector Yonge St. to Bayview Ave., -Sta. 32+836.3; Offset: 11.9m Rt EBC Crowe ORIGINATED BY Y.L.  
DIST 6 HWY 401 BOREHOLE TYPE Solid Stem Augers COMPILED BY J.Z.  
DATUM Geodetic DATE 10/15/2004 CHECKED BY R.M.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			UNIT WEIGHT  $\gamma$ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV. DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa				
167.9	Ground Surface							20 40 60 80 100				
0.0	0.1 m TOPSOIL		1	SS	19			○ UNCONFINED + FIELD VANE				
167.3	CLAYEY SILT (possible fill)							● POCKET PENETR. X LAB VANE				
0.6	trace topsoil inclusions		2	SS	25			WATER CONTENT (%)				
	CLAYEY SILT TILL							PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT				
	brown, damp, very stiff		3	SS	45			W <sub>p</sub> W W <sub>L</sub>				
	CLAYEY SILT TILL											
	brown, damp to moist											
	very stiff											
	hard											
165.8			4	SS	50/10							
2.1	SILTY SAND TILL											
	brown, damp to moist, very dense		5	SS	50/10							
			6	SS	50/8							
163.5			7	SS	50/13							
4.4	SILT											
	brown, wet, dilatant, very dense											
			8	SS	75							
161.3	End of Borehole.											
6.6	*Water level at 5.2 m (not stabilized) and hole open to 5.8 m on completion.											

## Appendix F

# Laboratory Test Results for Noise Barrier Wall between Retaining Walls No. 2 and 3

# UNIFIED SOIL CLASSIFICATION SYSTEM



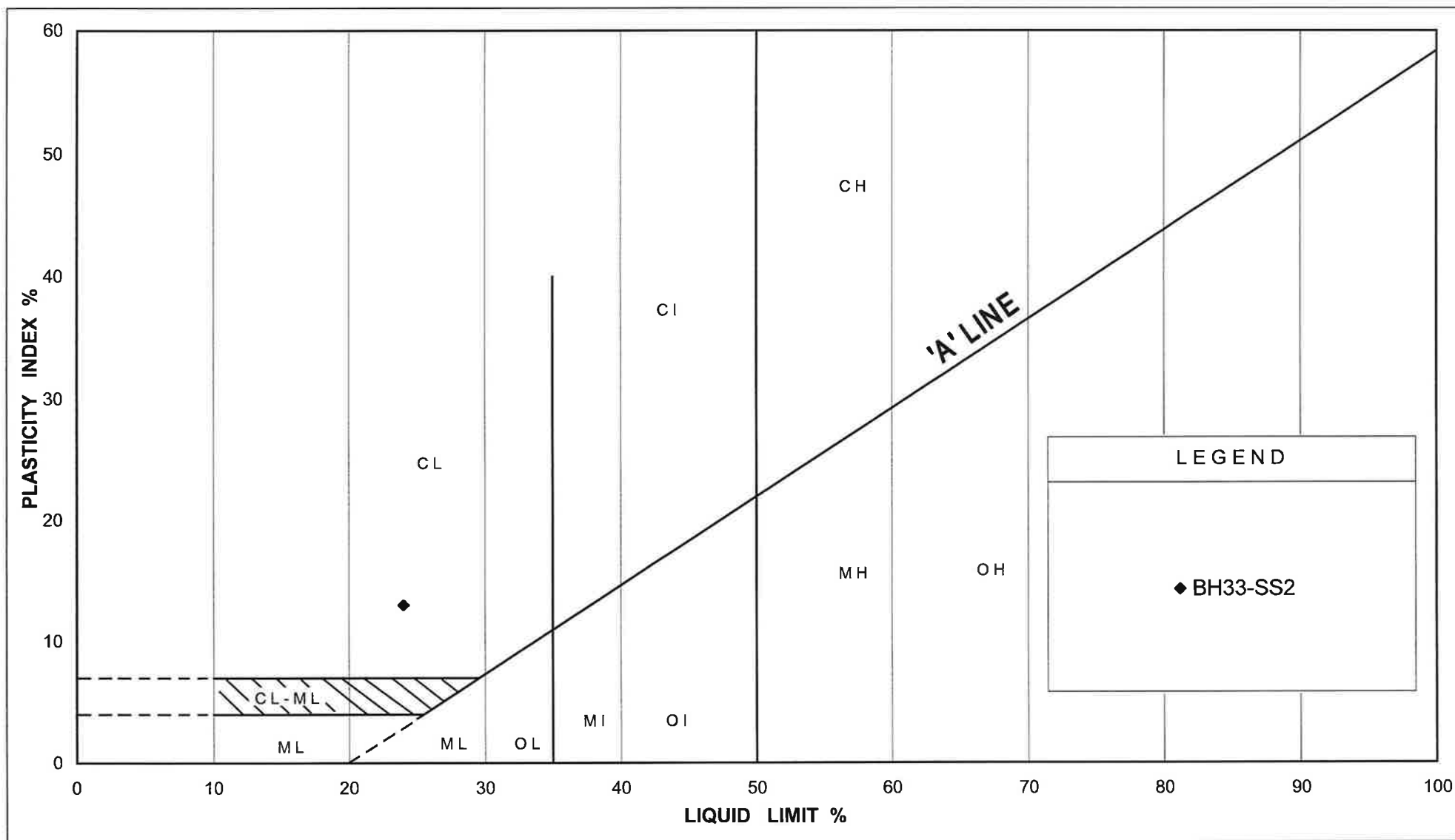
SHAHEEN & PEAKER LIMITED

**GRAIN SIZE DISTRIBUTION**  
POSSIBLE FILL: CLAYEY SILT, with sand

FIGURE No. F-1

REF. No. SPT 1103

GWP: 158-00-00



SHAHEEN & PEAKER LIMITED

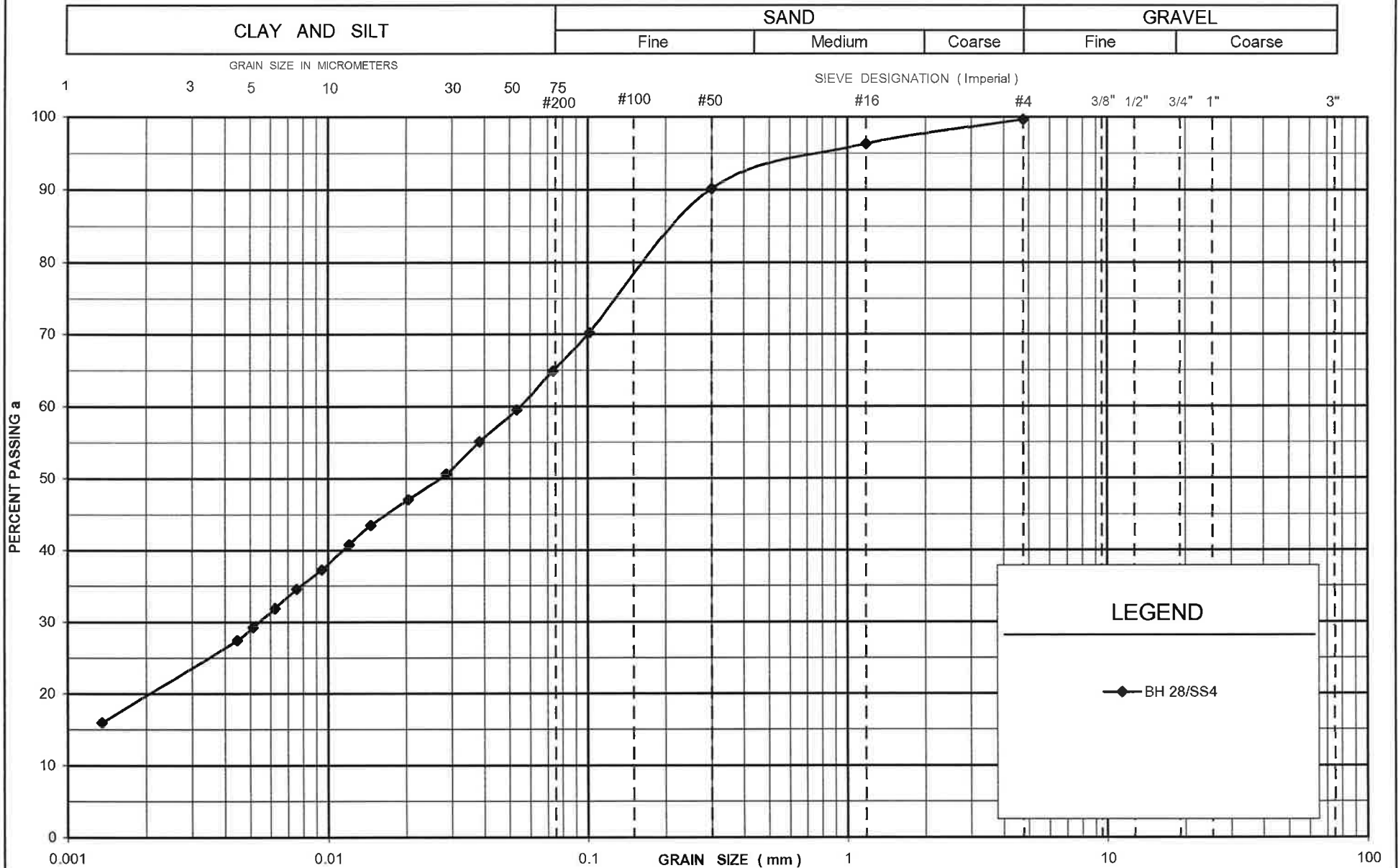
PLASTICITY CHART  
CLAYEY SILT

FIG No F-2

G.W.P. 158-00-00

REF No SPT 1103

# UNIFIED SOIL CLASSIFICATION SYSTEM



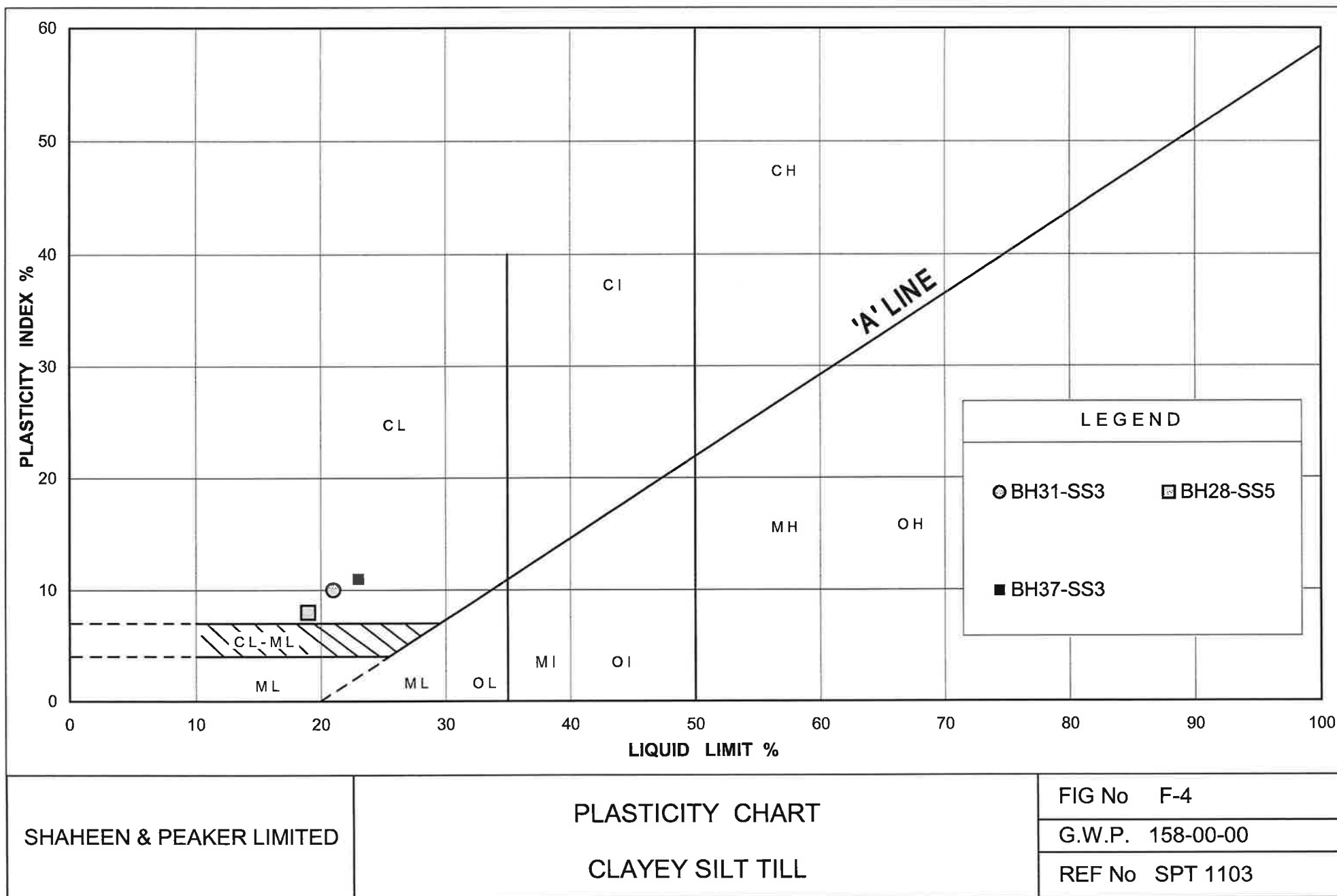
SHAHEEN & PEAKER LIMITED

**GRAIN SIZE DISTRIBUTION**  
CLAYEY SILT TILL

FIGURE No. F-3

REF. No. SPT 1103

GWP: 158-00-00



CLAY AND SILT	SAND			GRAVEL	
	Fine	Medium	Coarse	Fine	Coarse

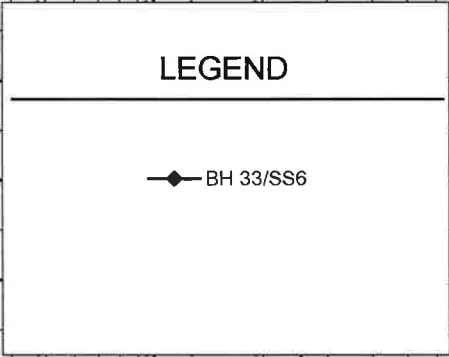
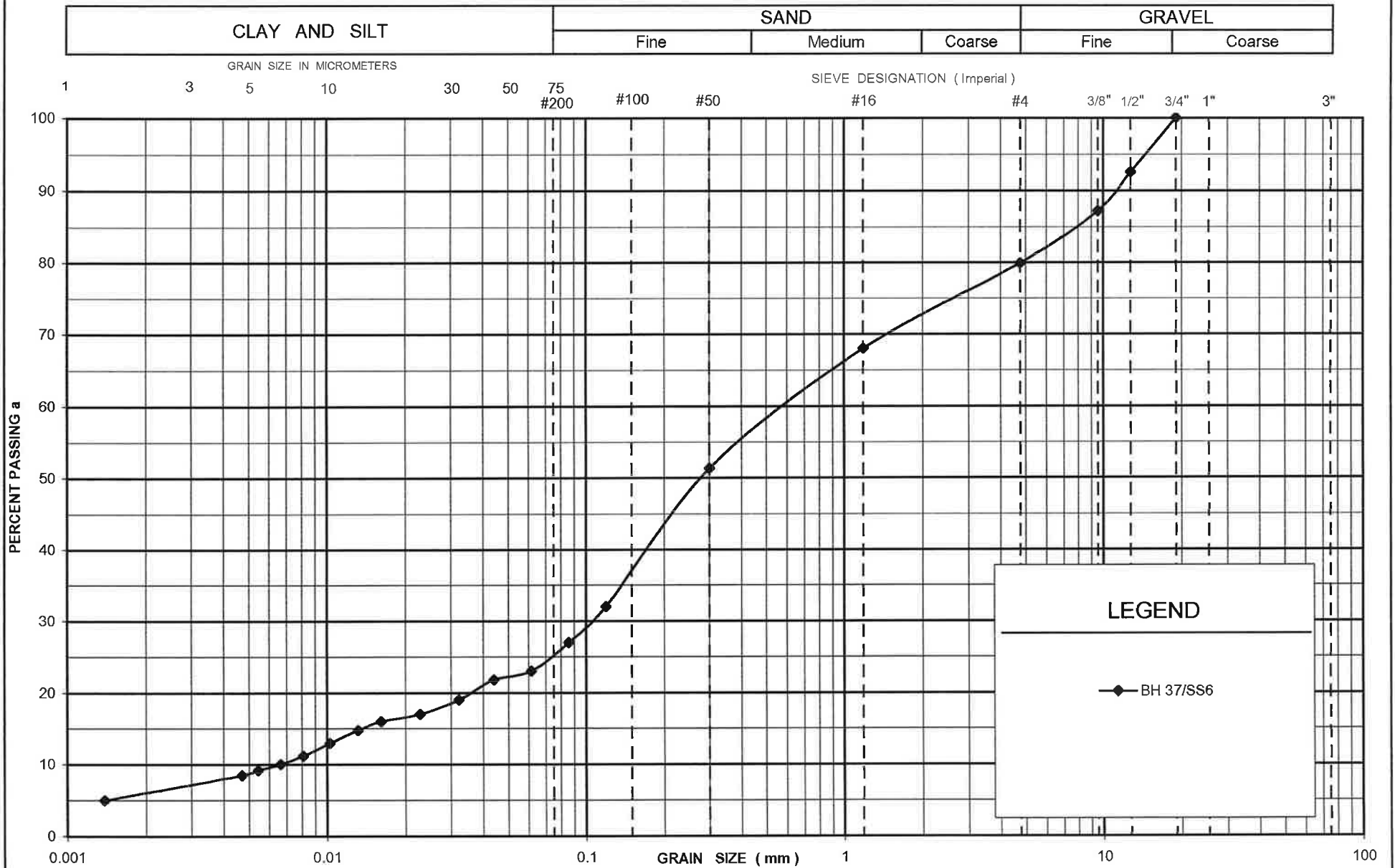


FIGURE No.	F-5
REF. No.	SPT 1103
GWP:	158-00-00

# UNIFIED SOIL CLASSIFICATION SYSTEM



SHAHEEN & PEAKER LIMITED

**GRAIN SIZE DISTRIBUTION  
SILTY SAND TILL**

FIGURE No. F-6

REF. No. SPT 1103

GWP: 158-00-00



# Appendix G

## Records of Boreholes for Retaining Wall 5

SPT 1103

# RECORD OF BOREHOLE No RW5-3A

1 OF 1

METRIC

GWP 158-00-00 LOCATION Hwy 401 EBL Collector Yonge St. to Bayview Ave., -Sta.:33+269.2; Offset: 10m Rt EBC Crown. ORIGINATED BY R.A.  
 DIST HWY 401 BOREHOLE TYPE Solid Stem Augers COMPILED BY J.Z.  
 DATUM Geodetic DATE 11/19/2003 CHECKED BY R.M.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT $\gamma$ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20	40	60	80	100		
167.1	Ground Surface													
0.0	150 mm ASPHALT FILL: SAND & GRAVEL brown, damp, compact		1	SS	28	*	167							
166.4														
0.7	FILL: SILTY FINE SAND occasional gravel brown, damp		2	SS	19		166							13 56 20 11
		compact dense	3	SS	43									
164.9							165							
2.2	SILTY SAND to SANDY SILT brown, damp, very dense		4	SS	85/28									
			5	SS	75		164							
163.1														
4.0	SILTY SAND TILL grey, wet, very dense						163							
162.1			6	SS	50/15									
5.0	End of Borehole.													
	*Borehole dry (not stabilized) and open to the full depth on completion.													

+<sup>3</sup>, ×<sup>3</sup>: Numbers refer to  
Sensitivity

20  
15 10 5  
(%) STRAIN AT FAILURE

SPT 1103

RECORD OF BOREHOLE No RW5-3B

1 OF 1

METRIC

GWP 158-00-00 LOCATION Hwy 401 EBL Collector Yonge St. to Bayview Ave., -Sta.:33+274.1; Offset:21m Rt EBC Crown ORIGINATED BY R.A.  
DIST 6 HWY 401 BOREHOLE TYPE Solid Stem Augers COMPILED BY J.Z.  
DATUM Geodetic DATE 12/5/2003 CHECKED BY R.M.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT $\gamma$ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20	40	60	80	100	W <sub>P</sub>	W	W <sub>L</sub>		
167.6	Ground Surface																
0.0	0.15 m TOPSOIL		1	SS	6												
	FILL: CLAYEY SILT some sand, occasional gravel brown, damp to moist, firm																
166.6			2	SS	55												
1.2	End of Borehole. Spoon rods bouncing due to possible roof of underground garage. *Borehole dry (not stabilized) and open to the full depth on completion.																

+<sup>3</sup>, ×<sup>3</sup>: Numbers refer to  
Sensitivity

20  
15 10 5  
(%) STRAIN AT FAILURE



SPT 1103

## RECORD OF BOREHOLE No RW5-3C

1 OF 1

METRIC

GWP 158-00-00 LOCATION Hwy 401 EBL Collector Yonge St. to Bayview Ave., Sta.:33+277.4; Offset:20.9m Rt EBC Crown ORIGINATED BY R.A.  
DIST 6 HWY 401 BOREHOLE TYPE Dynamic Rem Sounder COMPILED BY J.Z.  
DATUM Geodetic DATE 12/11/2003 CHECKED BY R.M.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W <sub>P</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa									
168.0	Ground Surface						20	40	60	80	100						
0.0	0.15 m TOPSOIL FILL: CLAYEY SILT trace sand, brown, damp, soft		1	SS	3												
167.2																	
0.8	FILL: SILTY FINE SAND occasional gravel brown, damp		2	SS	14												
	compact																
	very dense		3	SS	66												
165.7																	
2.3	End of Borehole.  *Borehole dry (not stabilized) and open to the full depth on completion.																

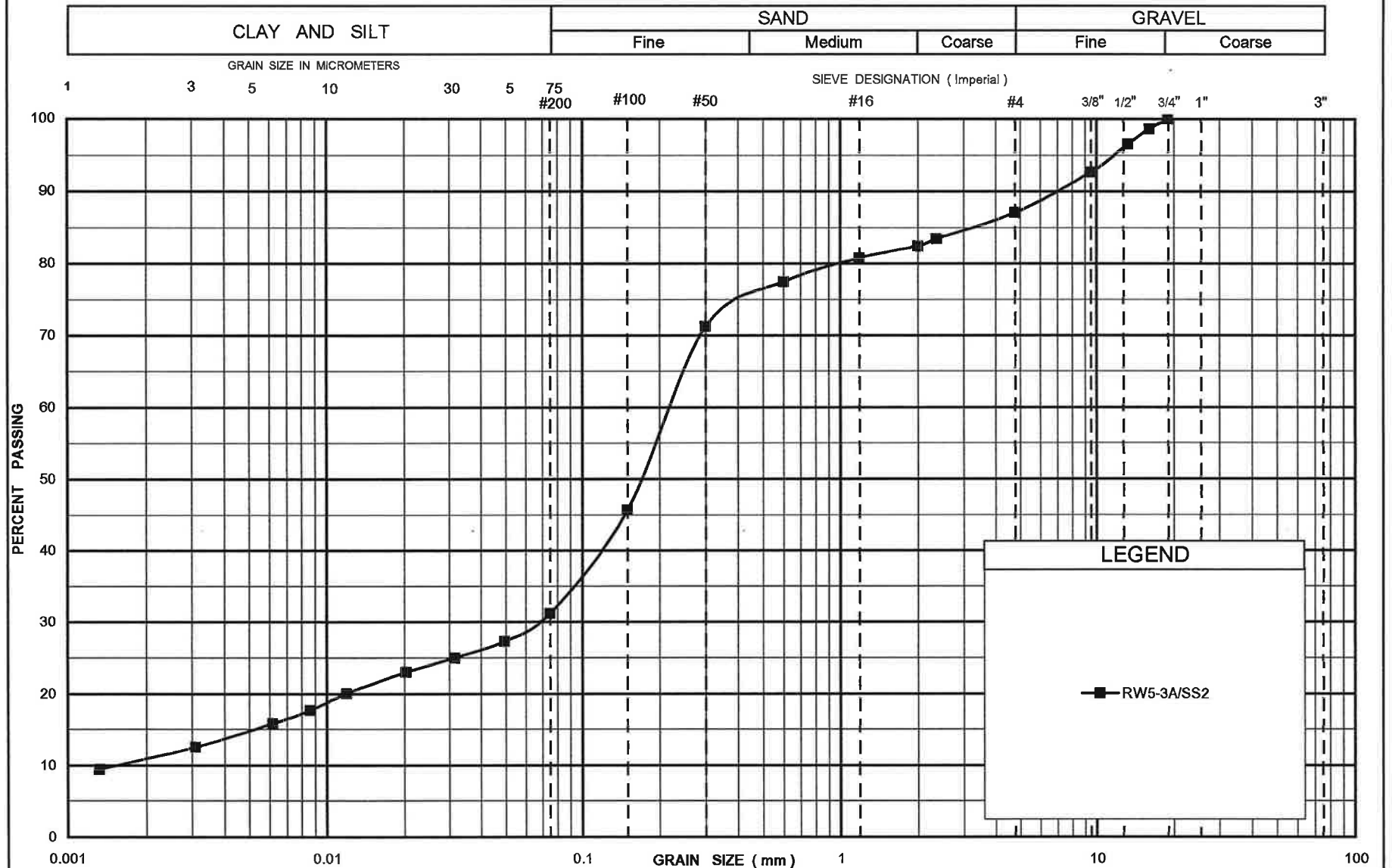
+ 3, × 3: Numbers refer to  
Sensitivity

20  
15 5  
10 (%) STRAIN AT FAILURE

# Appendix H

## Laboratory Test Results for Retaining Wall 5

# UNIFIED SOIL CLASSIFICATION SYSTEM



SHAHEEN & PEAKER LIMITED

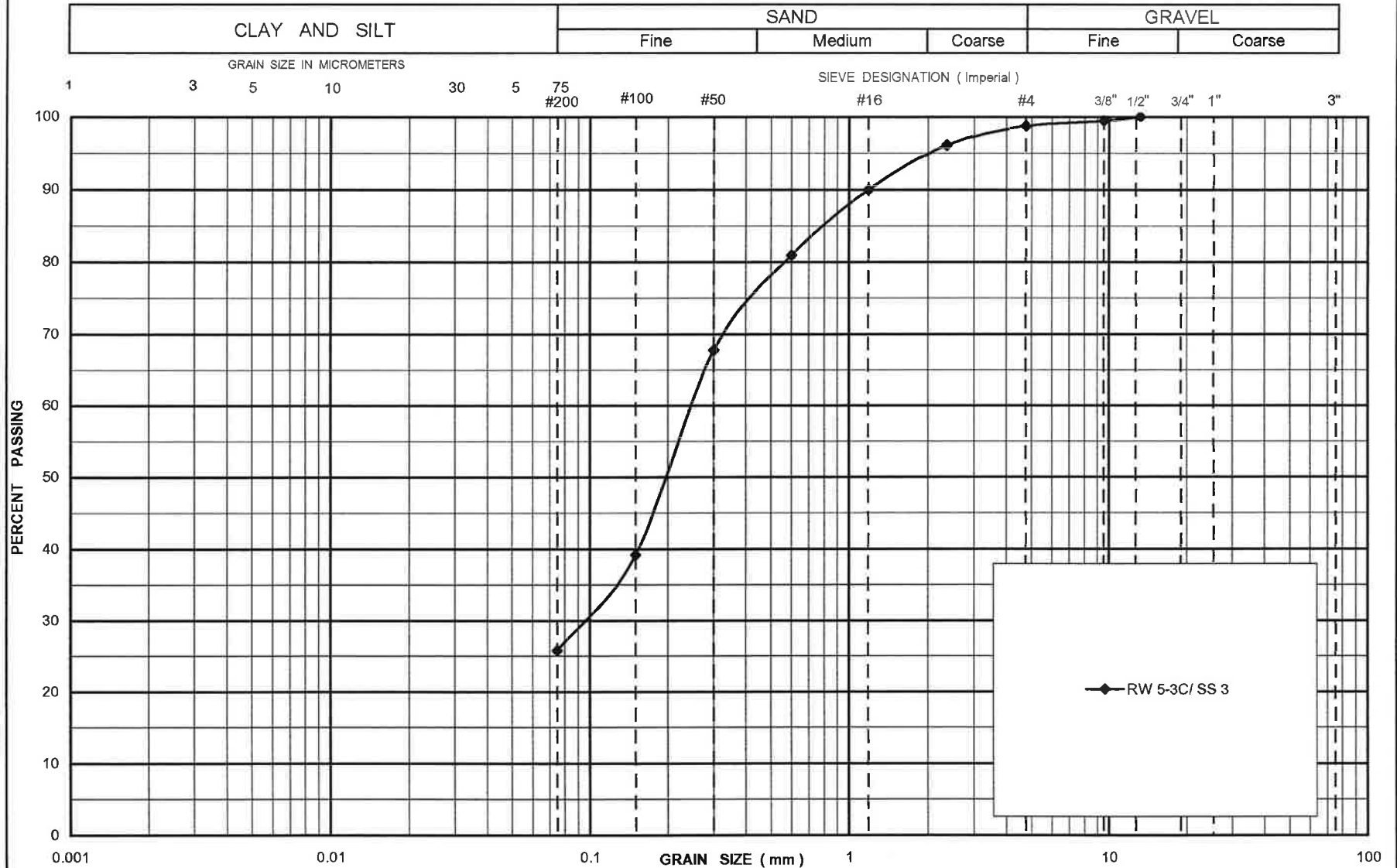
**GRAIN SIZE DISTRIBUTION**  
SAND, some gravel

FIGURE No. G-1

REF. No. SPT 1103

G.W.P. 158-00-00

# UNIFIED SOIL CLASSIFICATION SYSTEM



SHAHEEN & PEAKER LIMITED

**GRAIN SIZE DISTRIBUTION**  
FILL: Silty Sand

FIGURE No. G-2

REF. No. SPT 1103

DATE May 2005

## Appendix I

# Explanation of Terms Used in Report



## EXPLANATION OF TERMS USED IN REPORT

**N-VALUE:** THE STANDARD PENETRATION TEST (SPT) N-VALUE IS THE NUMBER OF BLOWS REQUIRED TO CAUSE A STANDARD 51mm O.D SPLIT BARREL SAMPLER TO PENETRATE 0.3m INTO UNDISTURBED GROUND IN A BOREHOLE WHEN DRIVEN BY A HAMMER WITH A MASS OF 63.5 kg, FALLING FREELY A DISTANCE OF 0.76m. FOR PENETRATIONS OF LESS THAN 0.3m N-VALUES ARE INDICATED AS THE NUMBER OF BLOWS FOR THE PENETRATION ACHIEVED. AVERAGE N-VALUE IS DENOTED THUS N.

**DYNAMIC CONE PENETRATION TEST:** CONTINUOUS PENETRATION OF A CONICAL STEEL POINT (51mm O.D. 60° CONE ANGLE) DRIVEN BY 475J IMPACT ENERGY ON 'A' SIZE DRILL RODS. THE RESISTANCE TO CONE PENETRATION IS MEASURED AS THE NUMBER OF BLOWS FOR EACH 0.3m ADVANCE OF THE CONICAL POINT INTO THE UNDISTURBED GROUND.

SOILS ARE DESCRIBED BY THEIR COMPOSITION AND CONSISTENCY OR DENSENESS.

**CONSISTENCY:** COHESIVE SOILS ARE DESCRIBED ON THE BASIS OF THEIR UNDRAINED SHEAR STRENGTH ( $c_u$ ) AS FOLLOWS:

$C_u$ (kPa)	0 – 12	12 – 25	25 – 50	50 – 100	100 – 200	>200
	VERY SOFT	SOFT	FIRM	STIFF	VERY STIFF	HARD

**DENSENESS:** COHESIONLESS SOILS ARE DESCRIBED ON THE BASIS OF DENSENESS AS INDICATED BY SPT N VALUES AS FOLLOWS:

N (BLOWS/0.3m)	0 – 5	5 – 10	10 – 30	30 – 50	>50
	VERY LOOSE	LOOSE	COMPACT	DENSE	VERY DENSE

ROCKS ARE DESCRIBED BY THEIR COMPOSITION AND STRUCTURAL FEATURES AND/OR STRENGTH.

**RECOVERY:** SUM OF ALL RECOVERED ROCK CORE PIECES FROM A CORING RUN EXPRESSED AS A PERCENT OF THE TOTAL LENGTH OF THE CORING RUN.

**MODIFIED RECOVERY:** SUM OF THOSE INTACT CORE PIECES, 100mm+ IN LENGTH EXPRESSED AS A PERCENT OF THE LENGTH OF THE CORING RUN. THE ROCK QUALITY DESIGNATION (RQD), FOR MODIFIED RECOVERY IS:

RQD (%)	0 – 25	25 – 50	50 – 75	75 – 90	90 – 100
	VERY POOR	POOR	FAIR	GOOD	EXCELLENT

**JOINT AND BEDDING:**

SPACING	50mm	50 – 300mm	0.3m – 1m	1m – 3m	>3m
JOINTING	VERY CLOSE	CLOSE	MOD. CLOSE	WIDE	VERY WIDE
BEDDING	VERY THIN	THIN	MEDIUM	THICK	VERY THICK

## ABBREVIATIONS AND SYMBOLS

### FIELD SAMPLING

SS	SPLIT SPOON	TP	THINWALL PISTON
WS	WASH SAMPLE	OS	OSTERBERG SAMPLE
ST	SLOTTED TUBE SAMPLE	RC	ROCK CORE
BS	BLOCK SAMPLE	PH	TW ADVANCED HYDRAULICALLY
CS	CHUNK SAMPLE	PM	TW ADVANCED MANUALLY
TW	THINWALL OPEN	FS	FOIL SAMPLE

### STRESS AND STRAIN

$u_w$	kPa	PORE WATER PRESSURE
$r_u$	1	PORE PRESSURE RATIO
$\sigma$	kPa	TOTAL NORMAL STRESS
$\sigma'$	kPa	EFFECTIVE NORMAL STRESS
$\tau$	kPa	SHEAR STRESS
$\sigma_1, \sigma_2, \sigma_3$	kPa	PRINCIPAL STRESSES
$\epsilon$	%	LINEAR STRAIN
$\epsilon_1, \epsilon_2, \epsilon_3$	%	PRINCIPAL STRAINS
E	kPa	MODULUS OF LINEAR DEFORMATION
G	kPa	MODULUS OF SHEAR DEFORMATION
$\mu$	1	COEFFICIENT OF FRICTION

### MECHANICAL PROPERTIES OF SOIL

$m_v$	kPa <sup>-1</sup>	COEFFICIENT OF VOLUME CHANGE
$c_c$	1	COMPRESSION INDEX
$c_s$	1	SWELLING INDEX
$c_\alpha$	1	RATE OF SECONDARY CONSOLIDATION
$c_v$	m <sup>2</sup> /s	COEFFICIENT OF CONSOLIDATION
H	m	DRAINAGE PATH
$T_v$	1	TIME FACTOR
U	%	DEGREE OF CONSOLIDATION
$\sigma'_{vo}$	kPa	EFFECTIVE OVERBURDEN PRESSURE
$\sigma'_p$	kPa	PRECONSOLIDATION PRESSURE
$\tau_f$	kPa	SHEAR STRENGTH
$c'$	kPa	EFFECTIVE COHESION INTERCEPT
$\phi'$	-°	EFFECTIVE ANGLE OF INTERNAL FRICTION
$c_u$	kPa	APPARENT COHESION INTERCEPT
$\phi_u$	-°	APPARENT ANGLE OF INTERNAL FRICTION
$\tau_R$	kPa	RESIDUAL SHEAR STRENGTH
$\tau_r$	kPa	REMOULDED SHEAR STRENGTH
$S_t$	1	SENSITIVITY = $c_u / \tau_r$

## PHYSICAL PROPERTIES OF SOIL

$P_s$	kg/m <sup>3</sup>	DENSITY OF SOLID PARTICLES	$e$	1, %	VOID RATIO	$e_{min}$	1, %	VOID RATIO IN DENSEST STATE
$\gamma_s$	kN/m <sup>3</sup>	UNIT WEIGHT OF SOLID PARTICLES	$n$	1, %	POROSITY	$I_D$	1	DENSITY INDEX = $\frac{e_{max} - e}{e_{max} - e_{min}}$
$\rho_w$	kg/m <sup>3</sup>	DENSITY OF WATER	$w$	1, %	WATER CONTENT	D	mm	GRAIN DIAMETER
$\gamma_w$	kN/m <sup>3</sup>	UNIT WEIGHT OF WATER	$s_r$	%	DEGREE OF SATURATION	$D_n$	mm	N PERCENT – DIAMETER
$P$	kg/m <sup>3</sup>	DENSITY OF SOIL	$w_L$	%	LIQUID LIMIT	$C_u$	1	UNIFORMITY COEFFICIENT
$\gamma$	kN/m <sup>3</sup>	UNIT WEIGHT OF SOIL	$w_p$	%	PLASTIC LIMIT	$h$	m	HYDRAULIC HEAD OR POTENTIAL
$\rho_d$	kg/m <sup>3</sup>	DENSITY OF DRY SOIL	$w_a$	%	SHRINKAGE LIMIT	$q$	m <sup>3</sup> /s	RATE OF DISCHARGE
$\gamma_d$	kN/m <sup>3</sup>	UNIT WEIGHT OF DRY SOIL	$I_p$	%	PLASTICITY INDEX = $(w_L - w_p)$	$v$	m/s	DISCHARGE VELOCITY
$\rho_{sat}$	kg/m <sup>3</sup>	DENSITY OF SATURATED SOIL	$I_L$	1	LIQUIDITY INDEX = $(w - w_p) / I_p$	$i$	1	HYDRAULIC GRADIENT
$\gamma_{sat}$	kN/m <sup>3</sup>	UNIT WEIGHT OF SATURATED SOIL	$I_c$	1	CONSISTENCY INDEX = $(w_L - w) / 1_p$	$k$	m/s	HYDRAULIC CONDUCTIVITY
$\rho'$	kg/m <sup>3</sup>	DENSITY OF SUBMERGED SOIL	$e_{max}$	1, %	VOID RATIO IN LOOSEST STATE	$j$	kN/m <sup>2</sup>	SEEPAGE FORCE
$\gamma'$	kN/m <sup>3</sup>	UNIT WEIGHT OF SUBMERGED SOIL						

**FOUNDATION DESIGN REPORT  
PROPOSED RETAINING WALL REPLACEMENT  
WIDENING OF HIGHWAY 401 EASTBOUND COLLECTORS  
FROM YONGE STREET TO BAYVIEW AVENUE  
TORONTO, ONTARIO  
G.W.P. 158-00-00**

**Prepared For:**

**MORRISON HERSHFIELD LIMITED**

**Prepared by:**

**SHAHEEN & PEAKER LIMITED**

**Project: SPT1103  
October 21, 2005**



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**APPENDIX I: EXISTING STORM SEWER PLAN AND PROFILE**

**APPENDIX J: LIMITATIONS OF REPORT**

**FOUNDATION DESIGN REPORT  
PROPOSED RETAINING WALL REPLACEMENTS  
WIDENING OF HIGHWAY 401 EASTBOUND COLLECTORS  
FROM YONGE STREET TO BAYVIEW AVENUE  
TORONTO, ONTARIO  
G.W.P. 158-00-00**

## **5. DISCUSSION & RECOMMENDATIONS**

### **5.1 GENERAL**

Future improvements at Highway 401 Eastbound Collector (EBC) Lanes between Yonge Street and Bayview Avenue require the existing retaining walls and noise barrier walls to be moved to the south to accommodate an extra lane. Based on the drawing provided to us by MHL, the chainage alignment for this project is referenced along the crown of the N/S-E Ramp and Eastbound Collector Lanes. There is one chainage equation on this project,  $10+279.514 \text{ N/S-E Ramp} = 32+049.185 \text{ EBC-Crown}$ , as shown on Drawing No. 1 in the Foundation Investigation section of this report.

The existing Retaining Wall Nos. 2 and 3 are reinforced concrete cantilever retaining walls located in the project area. Retaining Wall No. 2, which is a fill retaining wall starting from Ramp Station  $10+058$  and ending at EB Collector Station  $32+600$ , consists of 85 panels with a total length of about 770 m. The maximum height of the existing Retaining Wall No. 2 is about 3.3 m. Towards east, Retaining Wall No. 3 consists of 29 concrete panels stretching from Stations  $32+889$  to  $33+115$ . This retaining wall includes two sections: a cut retaining wall section from Stations  $32+865$  to  $33+066$  with a maximum height of 3.8 m and a fill retaining wall section from Stations  $33+066$  to  $33+128$  with a maximum height of about 3.5 m.

At the time of writing this report, the information available to us indicates that the new retaining walls will be built about 1.1 to 5.7 m south of the existing walls to accommodate a new lane. Within the limits of the existing Retaining Wall No. 2, two sections of existing storm sewer are situated approximately 3 to 13 m behind the existing retaining wall from Ramp Stations  $10+058$  to  $10+222$  and from EBC Stations  $32+325$  to  $32+600$ . The locations and depths of the existing sewers are shown in Appendix I. Based on the Contract Drawing No. 65-131, these sewers are located approximately 1.8 to 2.4 m below the ground surface. The approximate locations and height of the proposed retaining walls, and the existing sewers locations are presented in Table 5.1.

**Table 5.1 Approximate locations and heights of the proposed retaining walls, and the sewer locations behind the existing retaining walls**

Approximate Sta. Nos.	Existing Retaining Wall Height (m)	Proposed Retaining Wall Offset from Existing Wall (m)	Proposed Retaining Wall Height (m)	Sewer Invert Depth below Existing Grade (m)	Notes (replacements for the existing retaining walls)
Retaining Wall No. 2					
10+058 – 10+110	0.4 – 1.2	Retaining Wall Not Proposed	N/A	2.1 to 2.4	2:1 slope
10+110 – 10+135	2.2	1.4 – 1.5	2.0 – 2.2	2.1	fill retaining wall
10+135 – 10+235	1.3 – 2.2	Retaining Wall Not Proposed	N/A	2.1	2:1 slope
10+235 – 32+162	0 – 1.2	Retaining Wall Not Proposed	N/A	N/A	2:1 / 3:1 slopes
32+162 – 32+310	2.5 – 2.7	1.8 – 5.1	2.4 – 3.2	N/A	fill retaining wall
32+310 – 32+600	0.8 – 2.6	4.4 – 5.0	1.1 – 4.0	1.6 to 2.1	fill retaining wall
Retaining Wall No. 3					
32+865 – 32+880	0.3 – 1.4	Retaining Wall Not Proposed	N/A	N/A	2:1 slope
32+880 – 33+066	1.4 – 3.5	1.2 – 1.5	1.8 – 3.7	N/A	cut retaining wall
33+066 – 33+120	1.8 – 3.0	1.0 – 1.1	1.6 – 2.9	N/A	fill retaining wall
33+120 – 33+128	N/A	Retaining Wall Not Proposed	N/A	N/A	slopes

The boreholes put down for Retaining Wall No.2 have shown, in general, below the pavement fill and topsoil, the presence of the granular and clayey silt fill to a depth of about 0.7 to 4.4 m underlain by clayey silt till and sandy silt till. In some boreholes, the glacial till deposit was found to be underlain or interbedded by silt and/or sand deposits.

The compactness of the fill in the vicinity of the existing retaining wall is variable, ranging from very loose to dense, as measured by SPT with 'N' values varying from 2 to 35 blows/0.3 m. The glacial till deposits below the fill is generally stiff to hard clayey soil or dense to very dense cohesionless material. The groundwater level is believed to be at about El. 168.0 to 172.0 m at the west portion of the Retaining Wall No. 2 and between El. 163.0 and 166.0 m in the east portion of the retaining wall. In addition, a perched water

condition is likely occurring at the tilted retaining wall panel locations, due to the accumulation of surface water in the relatively pervious fill materials overlying the relatively impervious clayey silt till.

At Retaining Wall No. 3, in general, the boreholes have shown below the pavement fill and topsoil the presence of the granular and clayey silt fill to a depth of about 0.8 to 2.1 m (El. 161.4 to 170.1 m), underlain by clayey silt till and silty sand till. In some boreholes, the glacial till deposit was found to be underlain by silt to sandy silt deposits. In Borehole 3-41, which was drilled near the Wilket Creek Culvert, a wet sand deposit was encountered below the fill material at El. 164.4 m, underlain by sandy silt to silty sand till. The compactness of the fill in the vicinity of the existing retaining wall is variable, ranging from very loose to compact, as measured by SPT with 'N' values varying from 1 to 28 blows/0.3 m. The glacial till deposits below the fill is generally stiff to hard or compact to dense. The groundwater level is believed to be between El. 162.0 and 164.0 m, while in the area close of Wilket Creek Culvert (Station 33+100) the permanent groundwater table is approximately at El. 161.2 m. In addition, a perched water condition is also likely occurring at the tilted retaining wall panel locations, due to the accumulation of surface water in the relatively pervious fill materials overlying the relatively impervious clayey silt till.

## 5.2 RETAINING WALL OPTIONS

New retaining walls are to be constructed on the south side of the existing retaining walls to accommodate for a new lane. In view of the presence of existing utilities (e.g. storm sewers), the south limit of the right of way and the findings of the boreholes, different retaining wall options are considered for this project. These alternatives are as follows:

Alternative 1: Construction of a gravity concrete retaining wall;

Alternative 2: Construction of a cantilevered reinforced concrete retaining wall;

Alternative 3: Construction of Retained Soil System (RSS);

Alternative 4: Construction of a soldier pile and lagging wall, with tiebacks.

Alternative 5: Construction of a soldier pile and lagging wall, without tiebacks

### Alternative No. 1 (gravity concrete retaining wall):

The construction of a gravity retaining wall would take up a relatively large amount of space. This may require the complete demolition of the existing retaining walls before the construction of the new wall, and in the cut section, where the right of way is tight this retaining wall may require temporary shoring to support the excavation and the existing

slope during the construction. Therefore, the gravity retaining wall option is considered impractical.

Alternative No 2 (cantilevered reinforced concrete retaining walls):

The existing retaining walls are cantilevered reinforced concrete walls, which performed satisfactorily at the site except at some sections, where the retaining wall panels are slightly tilted, but still appear to be structurally intact.

In the fill section, the cantilevered reinforced concrete retaining wall is considered a good option. Since at the longest section where the proposed wall is more than 4 m away from the existing one (e.g. Stations 32+220 to 32+575), the cantilevered reinforced concrete wall can be constructed before the demolition of the existing wall. Thus, the construction could minimize the impact on traffic. In addition, in the fill section of Retaining Wall No. 3 (between Stations 33+066 and 33+120) where Wilket Creek Culvert is located, replacing the existing wall with one of similar geometry and type is considered a better choice. Moreover, in view of future rehabilitation of the road, unlike RSS, cantilevered concrete retaining wall will not affect the reconstruction and maintenance of the roadway and the utilities buried behind it.

The construction of a new cantilevered reinforced wall at cut section, especially from Station 32+880 to Station 32+060 is not considered feasible, due to the limited space between the proposed wall footing location and the right of way (where steeper than 1:1 excavation is anticipated), where vertical support of the excavation face using temporary shoring, such as soldier piles and lagging, is required. This will substantially increase the cost and duration of the construction.

Therefore, Alternative No. 2 is considered a good option for the replacement of the fill retaining walls but not in the cut section based on constructability and cost.

Alternative No. 3 (RSS):

When compared to conventional retaining walls (gravity and cantilevered), RSS are usually economical especially for large and open retaining areas, and are relatively flexible and can tolerate relatively large lateral deformations and vertical differential settlements. Furthermore, the construction of RSS is generally rapid and does not require specialized equipment. Since, facing elements play only a secondary structural role, a greater flexibility is available to meet aesthetic requirements than conventional retaining walls.

However, the construction of an RSS would take up a relatively large amount of space for the installation of reinforcement behind the retaining wall system, and therefore, the complete demolition of the existing walls and larger road closure space for the construction

of RSS are required. In addition, the metallic reinforcement could potentially deteriorate under corrosive condition with salt, and although polymeric reinforcement is robust, some decrease in strength may occur due to abrasion during construction. Furthermore, because the excavation behind the RSS walls is restricted, this may cause some problems for future rehabilitation of the highway and installation or maintenance of the utilities behind the RSS walls.

Therefore, in fill section in Retaining Wall No. 2, RSS could be considered provided large construction space during the construction is available and future development behind the retaining wall is well planned (i.e., no future subdrainage work on the road or shoulder).

Alternative No.3 is not feasible in cut section due to limited space in the right of way, based on constructability.

Alternative No. 4 (soldier pile wall and lagging, with tiebacks):

As discussed in the previous alternatives, in the cut section (Stations 32+880 to 33+066) due to the tight space behind the proposed wall and the right of way, in order to construct conventional retaining walls, vertical support of the excavation face by temporary shoring may be required.

With this concern, construction of a permanent soldier pile and lagging wall is considered a feasible option. In addition, the borehole findings indicate competent soils (hard clayey silt till and compact sandy silt till) below 2.0 m depth from the road surface. This would enable the soldier pile wall to be constructed with a relatively shallow embedment depth below the proposed road grade to provide sufficient lateral resistance.

This retaining wall system with the provision of tiebacks, if properly designed and installed, can restrict potential horizontal movement of the wall. However, the tight space behind the retaining wall may require the tiebacks to be installed beyond the property line.

Due to the nature of the deposition of the glacial till, the presence of cobbles and boulders should be expected in glacial till deposits. Therefore, this should be taken into account in the construction of a socketed soldier pile wall with tiebacks.

In this case, the piles would be placed in pre-augered holes cased with temporary steel liners. The annular space between the pile and the hole would be filled with structural concrete from the bottom of the hole to the specified caisson height. Unshrinkable fill would be placed above the top of the caisson.

This alternative (No. 4) is considered a good choice in cut retaining wall section based on reliability, cost and constructability.



Alternative No. 5 (soldier pile wall, without tiebacks):

Similar to Alternative No. 4, socketed soldier pile and lagging without tiebacks could be constructed. However, in this case, the piles would have to be extended to a greater depth than the previous option to obtain sufficient lateral support (cantilever piles normally require embedment of twice the effective support length). Also, cantilever piles will deflect reducing the confinement of the soil behind them; it is anticipated that the horizontal movement will be in the range of 1 to 2% of the retained height. This reduction in confinement (horizontal movement) may lead to the creeping and cracking of the soil. As a rule of thumb, soldier pile walls without tie-backs would not be cost effective for wall heights in excess of about 3 m. In this case, there is a section of Retaining Wall No. 3 which is higher than 3m and therefore, Alternative No. 5 is not recommended in this particular section, based on performance and reliability.

The different retaining wall options are summarized in table 5.2.

**Table 5.2 Summary of Foundation Alternatives**

<b>Retaining Wall Type</b>	<b>Comments</b>	<b>Recommendations</b>
1. Gravity retaining wall	Not feasible due to large excavation requirement, cost and practicability of construction	Not recommended based on cost and practicability of construction
2. Cantilevered reinforced concrete retaining wall	At some sections can be constructed before the demolition of the existing walls, less space required than RSS.	Recommended for the replacement of Retaining Wall No.2 and the fill section of Retaining Wall No.3 based on scheduling and practicability of construction
3. Retained Soil System (RSS)	Pros: Cost effective in comparison with conventional retaining walls, easy to construct and not settlement sensitive. Cons: Large excavation requirement and future restriction in excavation behind the retaining wall.	Feasible alternative for the replacement of Retaining wall No.2 based on cost.
4. Socketed soldier pile and lagging wall with tiebacks	Good option to solve the space limitation in the cut section.	Recommended for the cut section of Retaining Wall No.3 based on cost and practicability of construction.
5. Socketed soldier pile and lagging wall without tiebacks	Potential large horizontal movement and deeper pile penetrations	Not recommended based on cost and reliability for wall heights in excess of about 3 m.

### 5.3 RECOMMENDED RETAINING WALL SYSTEM

Based on the options presented, Alternative No. 2, construction of cantilevered reinforced concrete retaining wall is considered a feasible option for the replacements (Stations 10+110 to 10+135 and Stations 32+170 to 32+580) of the existing Retaining Wall No. 2 and the fill section (Stations 33+060 to 33+120) of the existing Retaining Wall No. 3.

Alternatively, Retained Soil System (RSS) can also be used as the replacements (Stations 10+110 to 10+135 and Stations 32+170 to 32+580) of the existing Retaining Wall No. 2.

For the retaining wall replacement in the cut section (Stations 32+880 to 33+066) of the existing Retaining Wall No. 3, a socketed soldier pile wall with tiebacks, is considered the most feasible alternative for this section.

## 5.4 DESIGN PARAMETERS

### 5.4.1 DESIGN PARAMETERS FOR THE CANTILEVERED REINFORCED CONCRETE RETAINING WALL

Cantilevered reinforced concrete retaining walls can be used as replacements (Stations 10+110 to 10+135 and Stations 32+170 to 32+580) of the existing Retaining Wall No. 2 and the fill section (Stations 33+066 to 33+120) of the existing Retaining Wall No. 3. Based on the subgrade conditions and the height of the retained soil (less than 4.0 m), global stability is not considered to be a problem.

Backfill material was found in the boreholes located south of the existing Retaining Wall No. 2 (adjacent to the wall), mainly due to the grading and construction of the storm sewers below the ditchline at some sections (see Table 5.1 for sewer locations and depths). Considering these existing storm sewers are very close or under the proposed retaining wall sections, the footings for the new retaining wall should be placed below the fill materials in these sections.

The recommended founding depths and geotechnical resistances on undisturbed competent natural soils are tabulated in Table 5.4.1.1, based on suitability of the founding soils. In addition, the frost depth and the existing footing locations should also be considered in choosing the actual footing elevations.

**Table 5.4.1.1**

Borehole Nos. & Stations	Ground Surface Elevation at BH Location (m)	Recommended Highest Footing Base (Bottom) Level Below Existing Ground Surface (m)	Recommended Highest Footing Base (Bottom) Elevation (m)	* Factored Bearing Resistance at U.L.S. (kPa)	* Bearing Resistance at S.L.S. (kPa)	Subgrade Material
Retaining Wall No.2						
2-4 (10+136)	174.2	2.4**	171.8	450	300	Clayey Silt Till
2-14 (32+202.4)	170.7	1.5	169.2	300	200	Clayey Silt Till
2-16 (32+252.6)	169.6	2.1	167.5	300	200	Clayey Silt Till
2-18 (32+298.3)	169.0	2.4	166.6	300	200	Clayey Silt Till
2-20 (32+348.4)	168.7	2.5**	166.2	450	300	Clayey Silt Till
2-22 (32+397.8)	168.4	2.3**	166.1	300	200	Clayey Silt Till
2-24 (32+452.3)	167.9	2.2**	165.7	450	300	Clayey Silt Till
RW2-73/74B (32+484)	167.9	2.0**	165.9	450	300	Clayey Silt Till
RW2-73/74C (32+491.5)	167.9	2.0**	165.9	450	300	Clayey Silt Till
RW2-73/74D (32+499.6)	167.9	2.0**	165.9	450	300	Clayey Silt Till
2-26 (32+535.9)	167.7	2.2**	165.5	450	300	Clayey Silt Till
RW2-82/83B (32+561)	167.7	2.2**	165.5	450	300	Clayey Silt Till
RW2-82/83C (32+571.3)	168.0	2.4**	165.6	500	350	Clayey Silt Till
RW2-82/83D (32+580)	168.3	2.7**	165.6	500	350	Clayey Silt Till
Retaining Wall No.3						
RW3-19/20B (33+040.6)	166.3	1.2	165.1	600	400	Clayey Silt Till
3-40 (33+100.7)	166.3	4.7	161.6	300	200	Clayey Silt Till
3-41 (33+105.8)	163.5	4.0	159.5	500	350	Sandy Silt to Silty Sand Till
3-43 (33+138.6)	166.6	2.6	164.0	400	250	Clayey Silt Till

\* In general, higher bearing resistance values are available with greater depth.

\*\* Considering the presence of existing sewer south of the existing Retaining Wall No. 2.

Based on the information provided by MHL, at Wilket Creek Culvert location (approximately at Station 33+090, panel # 25 of the existing retaining wall) the existing outlet of the culvert is founded on a massive concrete block which we understand is considered adequate for the future widening (by about 1 m at this location). Therefore, no new footing construction or extension of the existing footing is required for this panel for the new retaining wall. For the replacement of the existing Retaining Wall No. 3 beyond the culvert area in this fill section, it is suggested that as much as possible the footing founding elevation should match the existing footing.

Alternatively, the footing can be founded at higher elevation on engineered Granular 'A' pad or unshrinkable fill. In this case, all fill materials (e.g., trench backfill) and storm sewer pipe within the influence zone (i.e., below the 45-degree line from the outside edge plus 1 m) of the new footing should be removed to the competent clayey till. As mentioned before, the removed material can then be replaced with compacted (to 100% SPMDD in 200 mm lifts) Granular 'A' or unshrinkable fill. Tentatively, a bearing resistance of 250 kPa at SLS and a factored bearing resistance of 400 kPa at ULS is recommended on engineered fill. Once details of the retaining wall footings are finalized and the actual location and depth of the trench backfill and sewers are established with respect to the new footings, detailed recommendations can then be provided. For sliding resistance of concrete on Granular 'A', a value of 35 degrees (unfactored) can be adopted for angle of internal friction.

The serviceability values quoted are based on maximum 25 mm total and 20 mm differential settlements, provided that the founding natural soil is undisturbed during the construction. This differential settlement should be taken into consideration by designing construction joints (constructing the retaining wall in panels) to accommodate the estimated differential settlement.

For the replacement of the existing retaining walls, the groundwater level is believed to be generally below the footing founding elevations. However, a perched water condition is likely to occur due to the accumulation of surface water in the relatively pervious fill materials overlying the relatively impervious clayey silt till. The seepage of this perched water condition into footing excavations through the fill material should be moderate, and can be controlled by gravity drainage and pumping from strategically placed filtered sumps.

Where weak, organic or otherwise unsuitable soils are encountered at the foundation subgrade level, they should be removed and replaced with lean concrete. All founding subgrades should be inspected, evaluated and approved by the Quality Verification Engineer (QVE), at the time of construction, as per the requirement outlined in SP 902S01 – Excavation and Backfilling to Structures.

Following the construction of the footings, backfill should be placed to a sufficient height above the footing (i.e. at least 1.2 m) to prevent disturbance and frost penetration.

Under inclined loading conditions, the bearing resistance at U.L.S. should be reduced in accordance with the Canadian Highway Bridge Design Code (C.H.B.D.C.). For the evaluation of sliding resistance of the foundations, the ultimate angle of friction between the underside of the foundation and the undisturbed bearing stratum is given as below:

Clayey Silt Till :  $\phi = 27$  degrees

Backfill behind the new retaining wall should consist of select, suitable free-draining granular materials in accordance with the Ontario Ministry of Transportation Standards. Free draining backfill materials, weepholes, etc. should be provided in order to prevent hydrostatic build-up, as shown on OPSD-3501.000.

At the toe of the retaining wall, the backfill materials could consist of clean on-site selected material (SSM). The fill should be compacted in shallow lifts, not exceeding 200 mm loose thickness, to at least 98% of the material's Standard Proctor Maximum Dry Density (SPMDD). To avoid damaging or laterally dislocating the structure, care should be exercised when compacting fill adjacent to the retaining wall. Compaction equipment should be restricted in size as per MTO standard practice to prevent structural damage to the wall. The backfilling operation should be carried out simultaneously on both sides of the retaining wall as per MTO specifications.

Computation of earth pressures acting against the retaining walls should be in accordance with the Canadian Highway Bridge Design Code, CAN/CSA-S6-00 dated March 2001. For design purposes, the following properties of the granular backfill material can be assumed in calculating the earth pressures and forces on the side of Highway 401 (behind the retaining wall).

**Compacted Granular 'A' and Granular 'B' Type II**

Angle of Internal Friction  $\phi = 35^\circ$  (unfactored)

Unit Weight =  $22 \text{ kN/m}^3$

Coefficient of Lateral Earth Pressure (level backfill):

$$K_a = 0.27$$

$$K_o = 0.43$$

**Compacted Granular 'B'**

Angle of Internal Friction  $\phi = 32^\circ$  (unfactored)

Unit Weight =  $21 \text{ kN/m}^3$

Coefficient of Lateral Earth Pressure (level backfill):

$$K_a = 0.31$$

$$K_o = 0.50$$

NOTE:  $K_a$  is the coefficient of active earth pressure.  
 $K_o$  is the coefficient of earth pressure at rest.

These values are based on the assumption that the backfill behind the retaining structure is free-draining granular material and adequate drainage is provided. It is also assumed that the grade behind the structure is substantially level.

For rigid retaining walls which will not yield sufficiently to develop active earth pressures, at rest earth pressures should be used. Further, the effects of compaction will cause additional pressures which should be taken into consideration as per Clause 6.9.3 of the Canadian Highway Bridge Design Code (CHBDC) 2001. The movements required to activate active and passive earth pressure conditions can be determined by referring to Figure C 6.9.1 (a) and Table C 6.9.1 (a) of the CHBDC 2001.

In the design of retaining walls, the value of the wall friction angle can be assumed to be between  $\phi/2$  and  $2/3 \phi$ .

For the computation of the passive earth pressures and forces at the resisting side (at the toe of the retaining wall), the following parameters can be used:

**Compacted Clayey Silt Backfill**

Unit Weight = 20.5 kN/m<sup>3</sup>

Coefficient of Lateral Earth Pressure:

$K_p = 2.0$  (unfactored)

**Clayey Silt Till**

Unit Weight = 21.5 kN/m<sup>3</sup>

Coefficient of Lateral Earth Pressure:

$K_p = 3.4$  (unfactored)

NOTE:  $K_p$  is the coefficient of passive earth pressure.

#### 5.4.2 RETAINED SOIL SYSTEM (RSS)

As an alternative to conventional retaining walls, MTO's Retained Soil System may be used. RSS can be used as replacements (from Stations 10+110 to 10+135 and from Stations 32+170 to 32+580) of the existing Retaining Wall No. 2.

An RSS wall consists of the original ground, concrete leveling pad, wall facing panels, coping, soil reinforcement, selected backfill. All of these items have an affect on the performance of the RSS wall and should be taken into the account in the stability analysis. Based on the subgrade conditions and the height of the retained soil (less than 4.0 m), global stability is not considered to be a problem.

The following should be included in the Contract Documents:

- identify longitudinal extent in plan of the Retained Soil System

- identify in plan transverse space constraints (top of wall and bottom of wall)
- identify elevation of top of wall and bottom of wall
- include NSSP for Retained Soil Systems in Contract Documents

The Retained Soil System (RSS) should be of high performance and high appearance.

The design of the RSS, including the foundation for the facing wall of the RSS, is the responsibility of the RSS provider.

As mentioned before, this option requires the removal of the existing retaining wall before the construction of the RSS wall. The footprint area of the RSS wall, that is, the zone of the wall facing, soil reinforcement and selected backfill, should be graded level for a width equal to or exceeding the length of soil reinforcement. Where weak, organic or otherwise unsuitable soils are encountered at the footprint zone, they should be compacted or removed and replaced. All founding subgrades should be inspected, evaluated and approved by the Quality Verification Engineer (QVE), at the time of construction.

#### 5.4.3 DESIGN PARAMETERS FOR THE SOLDIER PILE WALL

The following parameters can be used in the shoring and soil anchor design.

**Table 5.4.3.1 Recommended Unfactored Parameters for Shoring Design**

Soil Type	Ka	Ko	Kp	$\gamma$ (kN/m <sup>3</sup> )
Granular Fill (Granular Base and Subbase)	0.3	0.43	3.0	21.5
Clayey Silt Fill (behind the retaining wall)	0.40	0.50	2.0	20.0
Clayey Silt Till	0.34	0.48	3.4	21.5
Sandy Silt Till	0.36	0.45	3.0	21.5
Silt/Sandy Silt	0.36	0.47	3.0	21.5

The soldier pile should be installed in pre-augered holes taken below the deepest excavation. The holes should be filled with concrete below the excavation level and unshrinkable fill above the base of the excavation. The concrete strength must be specified by the shoring designer. Temporary liners may be required to help prevent the wet cohesionless deposits (sandy silt till and silt/sandy silt) below 4.0 to 5.0 m from the road surface from caving during the installation period. Positive measures may be required to prevent the loss of soil through the spaces between the lagging boards. This could probably be achieved by placing well-graded sand and gravel behind the lagging boards or by installing a geotextile filter cloth.

Adhesion on the buried caisson shaft or behind the shoring system must be neglected when designing the shoring system.

For permanent soil anchor tieback system providing horizontal support for the shoring system, a tentative bond resistance at U.L.S. of 50 kPa be used in the hard clayey silt till, and S.L.S. will not govern. The bond value depends on anchor installation methods and grouting procedures. Gravity poured concrete can result in low bond values while pressure grouted anchors will give higher values and produce a more satisfactory anchor.

The anchors must be of a length that meets Canadian Foundation Manual recommendations. It is important to note that the minimum length lies beyond the  $45-\phi/2 + 0.15H$  line drawn from the base of the soldier pile (where H is height of excavation and  $\phi$  is the angle of shearing resistance) and the overall stability of the system must be checked at each anchor level.

The top anchor must not be placed lower than 3.0 m below the top of ground surface. Anchors will require casing when penetrating through wet sand and silt layers.

Movement of the shoring system is inevitable. Vertical movements will result from the vertical load on the soldier piles resulting from the inclined tiebacks and horizontal movement results from earth and water pressures. The magnitude of this movement can be controlled by sound construction practices, and it is anticipated that the horizontal movement will be in the range of 0.1 to 0.25% H. Therefore, assuming height of excavation H=4 m, movements of about 5 mm should be expected. Vertical movements increase the horizontal movements because of the reduced stress in the inclined anchors and must be kept well below this value.

To ensure that movements of the shoring are within an acceptable range, monitoring must be carried out. Vertical and horizontal targets on the soldier piles must be located and surveyed before excavation begins. Weekly readings during excavation should show that the movements will be within those predicted; if not, the monitoring results will enable directions to be given to improve the shoring.

Proper testing procedures should be followed for testing the anchors. At least one anchor in 100 of those actually used in the project should be tested to twice the design load while the remaining anchors must be tested to 1.33 times the design load. Anchor tests must be continued for 24 hrs as these are permanent anchors. Testing should follow the suggestions of the Canadian Foundation Manual. All anchors require corrosion protection.

For the determination of the lateral pile deflection under the horizontal load, coefficient of horizontal subgrade reaction ( $k_s$ ) is required. In the hard clayey silt till, the coefficient of horizontal subgrade reaction can be estimated from:



$$k_s = 67c_u/d$$

where  $k_s$  = coefficient of horizontal subgrade reaction  
d = pile width  
 $c_u$  = undrained shear strength of the soil

In this case, between Stations 32+880 and 33+060 in Retaining Wall No. 3, an average value of 200 kPa can be used for the undrained shear strength of the hard clayey silt till.

Boreholes 3-38, RW3-19/20B and RW3-19/20D contacted, sandy silt till and sandy silt/silt below the clayey silt till. In these cohesionless soils, the coefficient of horizontal subgrade reaction can be estimated from:

$$k_s = n_h z/d$$

Where  $k_s$  = coefficient of horizontal subgrade reaction  
z = depth  
d = pile width  
 $n_h$  = coefficient related to soil density as given in Table 5.4.3.2

Also as presented in the same table are estimated values for angle of internal friction and bulk unit weights.

**Table 5.4.3.2 Recommended Soil Parameters**

Borehole No. (Station)	Applicable Elevation (m)	Soil Type	Bulk Unit Weight (kN/m <sup>3</sup> )	Angle of Internal Friction ( $\phi$ ) Degrees	Recommended $n_h$ Value (MN/m <sup>3</sup> )
3-38 (32+972.9)	160.7-159.9	Sandy Silt Till	21.5	32	4.4
RW3-19/20D (33+027)	163.4-162.1 162.1-161.3	Silt to Sandy Silt Till Silt to Sandy Silt Till	21.0 21.0	32 32	6.6 4.4
RW3-19/20B (33+040.6)	163.4-162.3 162.3-161.3	Silt Silt	22.0 22.0	31 31	18.0 11.0

The following geotechnical resistances are available for the design of reinforced caissons (cast-in-place concrete piles) for the soldier piles. The caisson normally consists of the poured concrete shaft with a steel H-section providing reinforcement for the shaft and acting as the structural soldier pile above ground surface.

**Table 5.4.3.3**

Borehole No. (Station)	Existing Ground Elevation at Borehole Location (m)	Recommended Minimum Caisson Base Elevation (m)	Factored Axial Resistance at U.L.S. (kPa)	Axial Resistance at S.L.S. (kPa)	Subgrade Material
RW3-6B (32+910.4)	166.9	163.9	800	500	Hard clayey silt till
RW3-6C (32+914.3)	166.9	163.9	800	500	Hard clayey silt till
3-38 (32+972.9)	166.5	163.5	600	400	Hard clayey silt till
RW3-19/20D (33+027)	166.3	163.8	400	250	Hard clayey silt till
RW3-19/20B (33+040)	166.3	163.8	800	500	Hard clayey silt till

In order to provide these resistances, the caissons may require the use of temporary steel casings during their installation to enable the holes to be properly cleaned of any disturbed soils and to enable the inspection and approval of the base by the engineer. The casings would be carefully withdrawn as the concrete is poured. If the bases are not required to be inspected, lower geotechnical resistances (e.g. 200 kPa for SLS and 300 kPa ULS) should be specified.

## 5.5 CONSTRUCTION COMMENTS

All excavations, shoring and backfilling should be carried out in conformance with the safety regulations of the province, as well as the following specifications.

SP 539S01 – Protection Schemes

SP 902S01 – Excavation and Backfilling to Structures

The recommended performance level of the protection system is Level 1, i.e., lateral movement of any portion of the protection system shall not exceed 5 mm.

The granular and clayey backfills can be classified as Type 3 soil, while the clayey silt till can also be classified as Type 1 to 2 soil above the groundwater level. The sand deposit in Borehole 3-41 can be classified as Type 4 soil below the groundwater level.

Being of glacial origin, the glacial till deposits can be expected to contain random cobbles and boulders. Cobbles may also be present in the fill deposits. In view of these, a Non-Standards Special Provision (NSSP) should be provided in the contractor document to make the contractor aware that the presence of cobbles and boulders can always be expected which can cause problems during the pile driving and/or the installation of the

caissons, such as increasing the time required for drilling, the employment of special equipment, etc.

## 6. CLOSURE

We recommend that once the details of the structure are finalized, our recommendations be reviewed for their specific applicability.

The Limitations of Report, as quoted in Appendix J are an integral part of this report.

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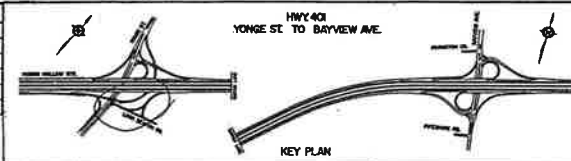


## Appendix I

# Existing Storm Sewer Plan and Profile

# COUNTY OF YORK TOWNSHIP OF NORTH YORK

REVISIONS				
DATE	NAME	DESCRIPTION	PAGE	
JUN 22/65	J.K.	LORD SEATON DR., RAMP N-S-E	36-A	
AUG 17/65	E.H.	ADD'N OF ST. B. GUIDE RAIL	36-A	
		AT A		



CONTRACT No. 65-131  
W.P. No. 252-61-142 **36A**  
GRADING, PAVEMENT & DRAINAGE  
LORD SEATON DR., RAMP N-S-E  
DEPARTMENT OF HIGHWAYS-ONTARIO

NOTE:  
THIS SHEET TO BE USED IN  
CONJUNCTION WITH SHEET  
No 36 OF THE CONTRACT

LOT 13  
CON. I. E.Y.S.

NOTE:-  
RE: Manholes  
NR 177 - Adjust (Exist. San. Sewer)  
NR 180 - " ( " " )

REMOVE CULVERT AND  
REPLACE ASPH. ENTRANCE  
AND ASPH. WALK

SCALE  
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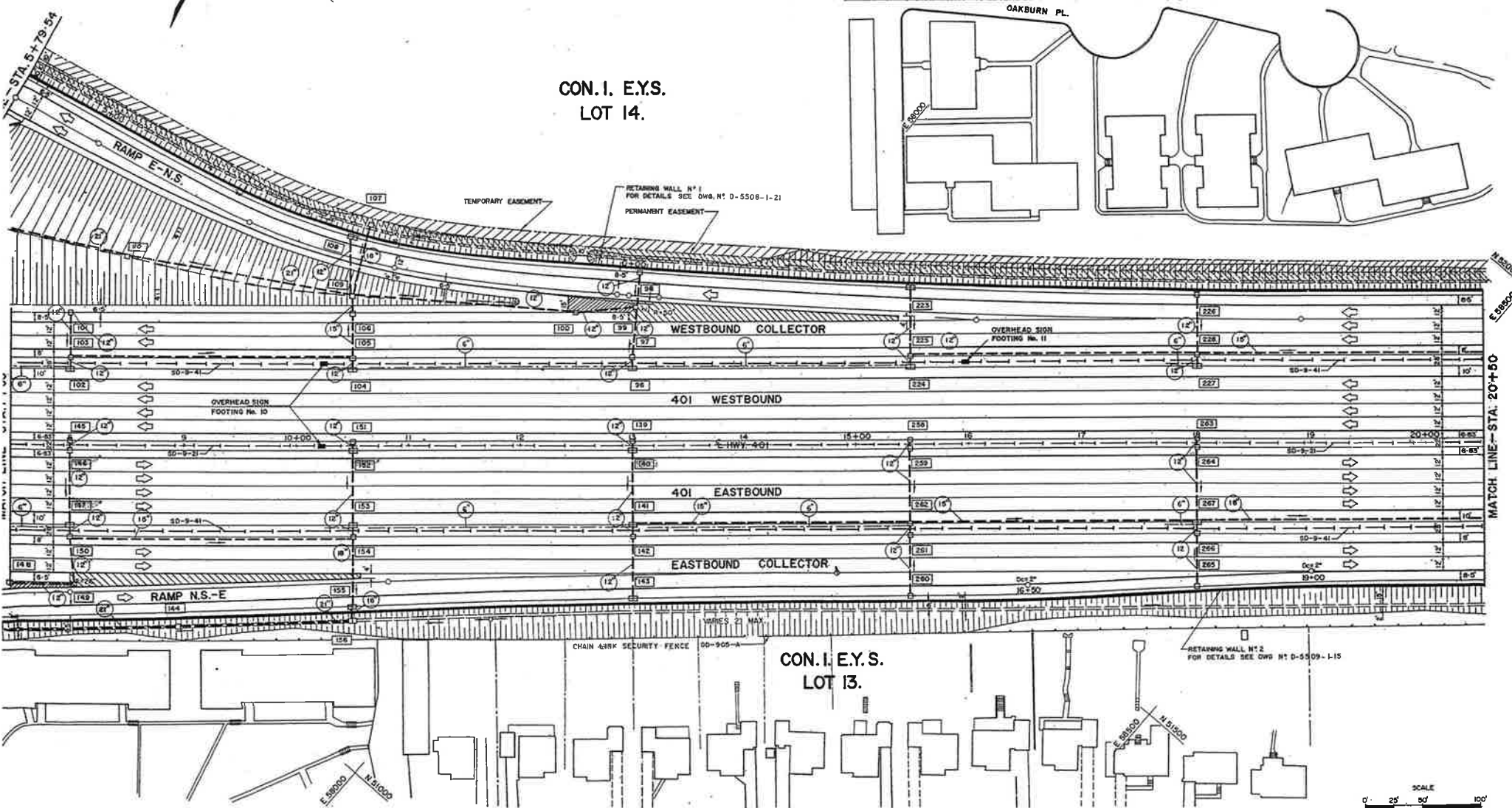
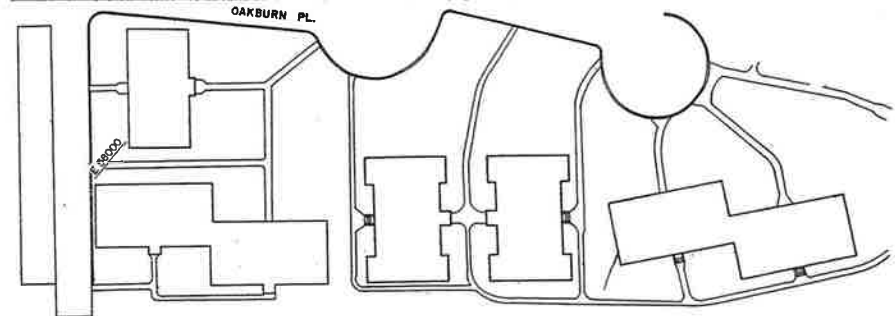
E 5/2600  
N 5/500

COUNTY OF YORK.  
TOWNSHIP OF NORTH YORK

CON. I. E.Y.S.  
LOT 14.

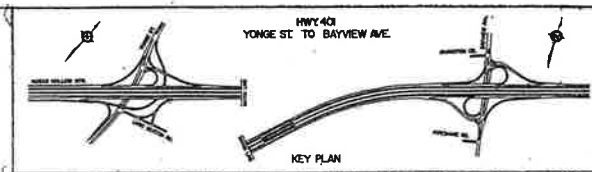


CONTRACT No. 65-131  
W.P. No. 252-61-1 & 2 **38**  
GRADING, PAVEMENT & DRAINAGE  
HWY. 401 STA. 7+50 TO STA. 20+50  
DEPARTMENT OF HIGHWAYS - ONTARIO

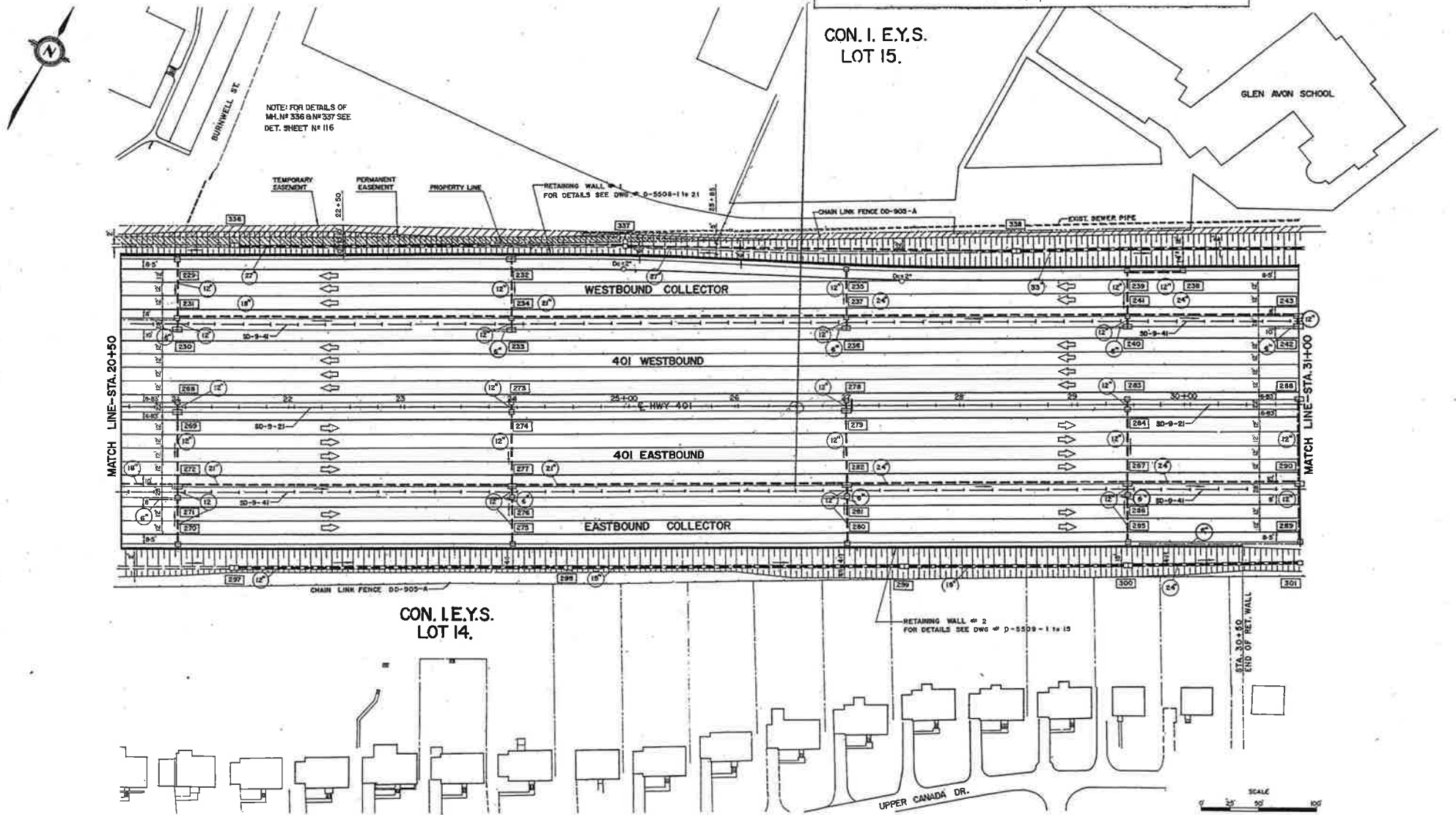


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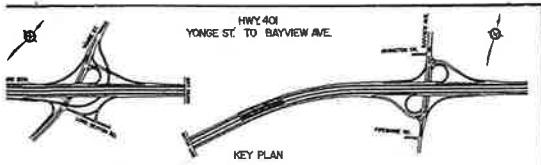
COUNTY OF YORK  
TOWNSHIP OF NORTH YORK



CONTRACT No. 65-131  
W.P. No. 252-61-1 & 2 **39**  
GRADING, PAVEMENT & DRAINAGE  
HWY. 401, STA. 30+50 TO STA. 31+00  
DEPARTMENT OF HIGHWAYS-ONTARIO





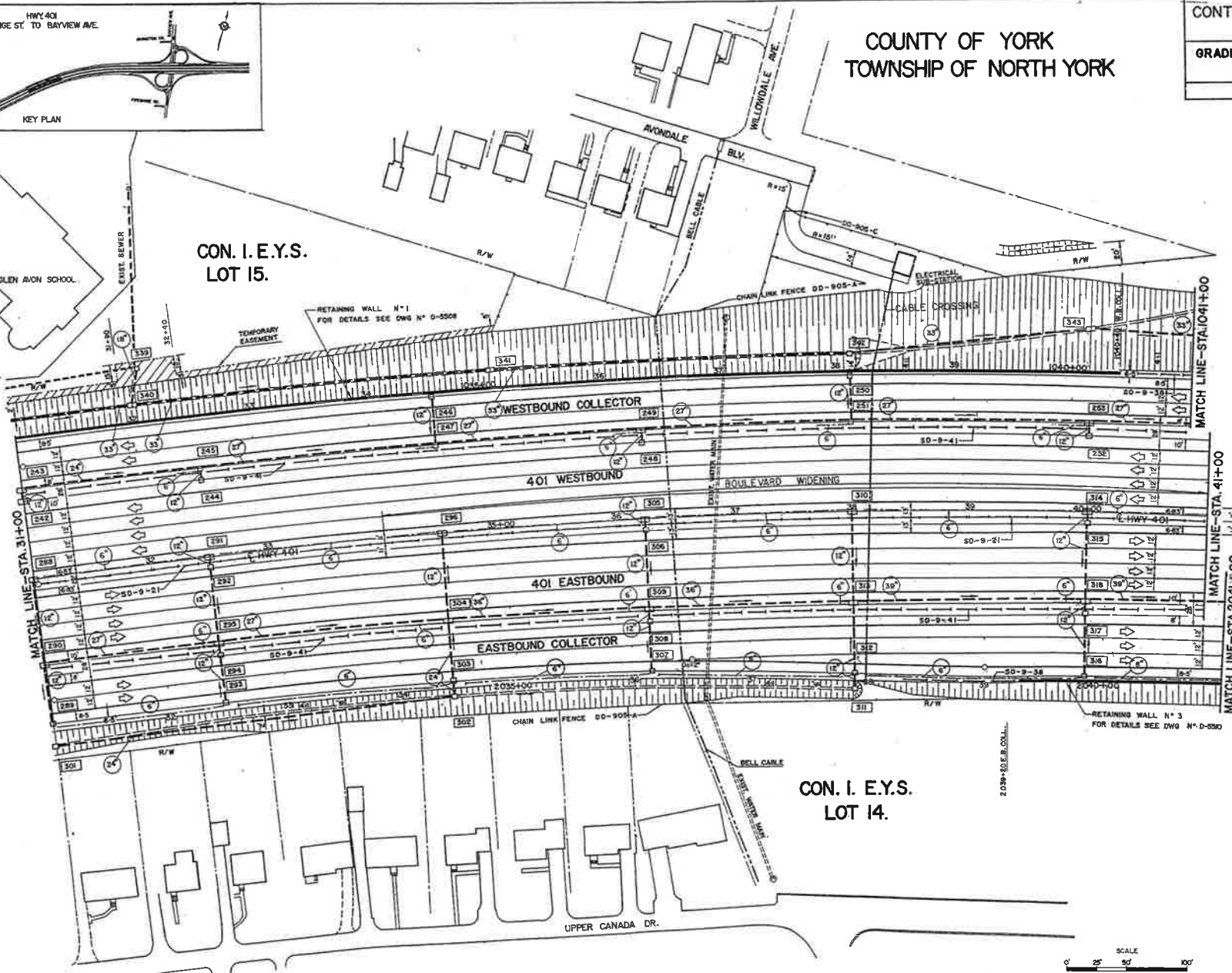


# COUNTY OF YORK TOWNSHIP OF NORTH YORK

CONTRACT No. 65-131  
W.P. No. 252-61-1 & 2 **40**  
GRADING, PAVEMENT & DRAINAGE  
HWY 401 STA. 31+00 TO STA. 41+00  
DEPARTMENT OF HIGHWAYS—ONTARIO

CON. I.E.Y.S.  
LOT 15.

CON. I. E.Y.S.  
LOT 14.

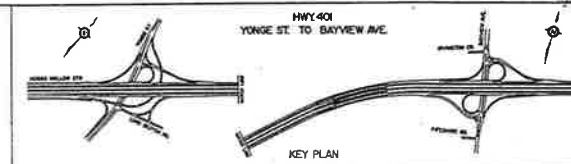


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2101

# OF YORK OF NORTH YORK

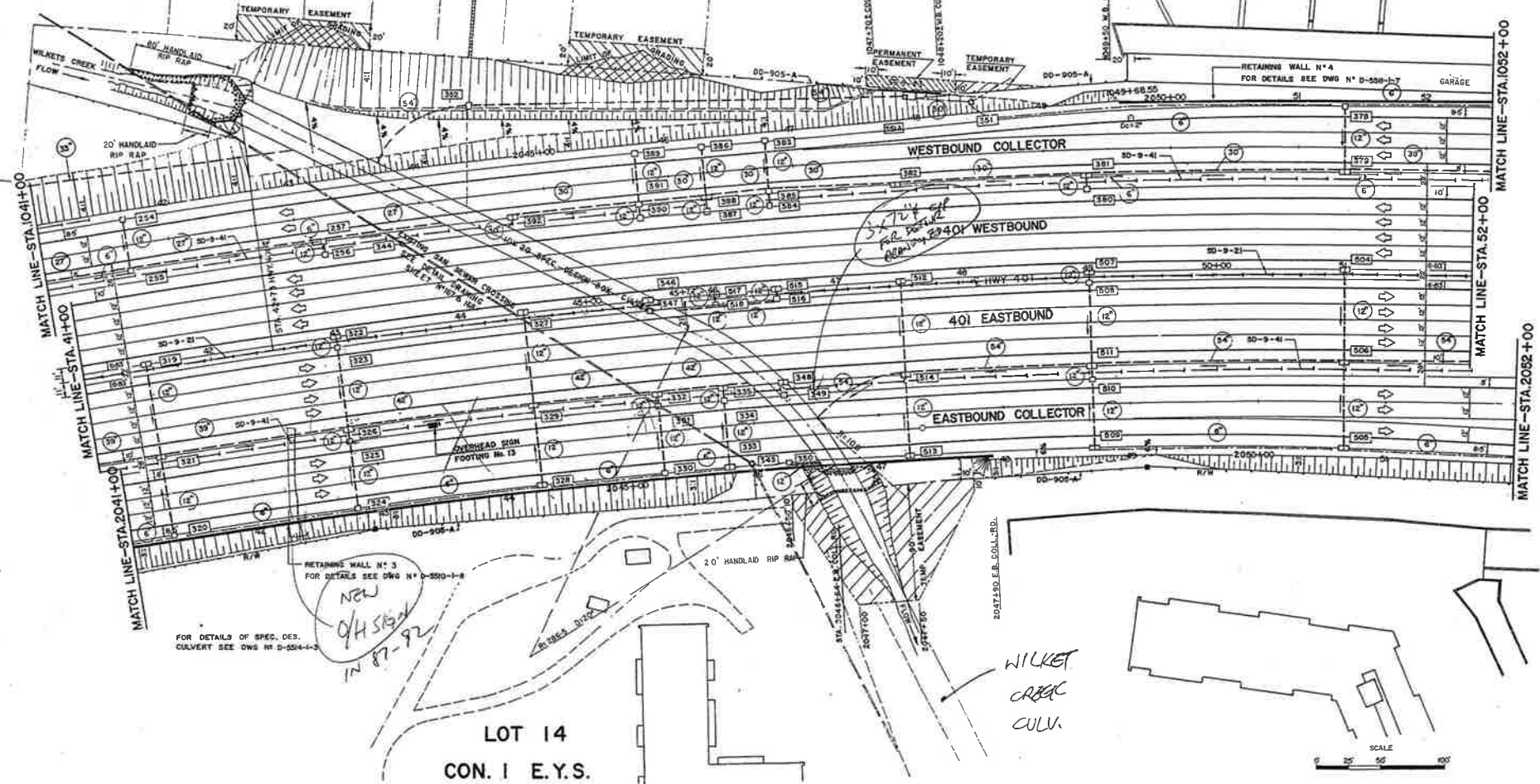


CONTRACT No. 65-131  
W.P. No. 252-61-1 & 2  
GRADING, PAVEMENT & DRAINAGE  
HWY. 401, STA. 41+00 TO STA. 52+00  
DEPARTMENT OF HIGHWAYS-ONTARIO



GLENDORA BLVD.

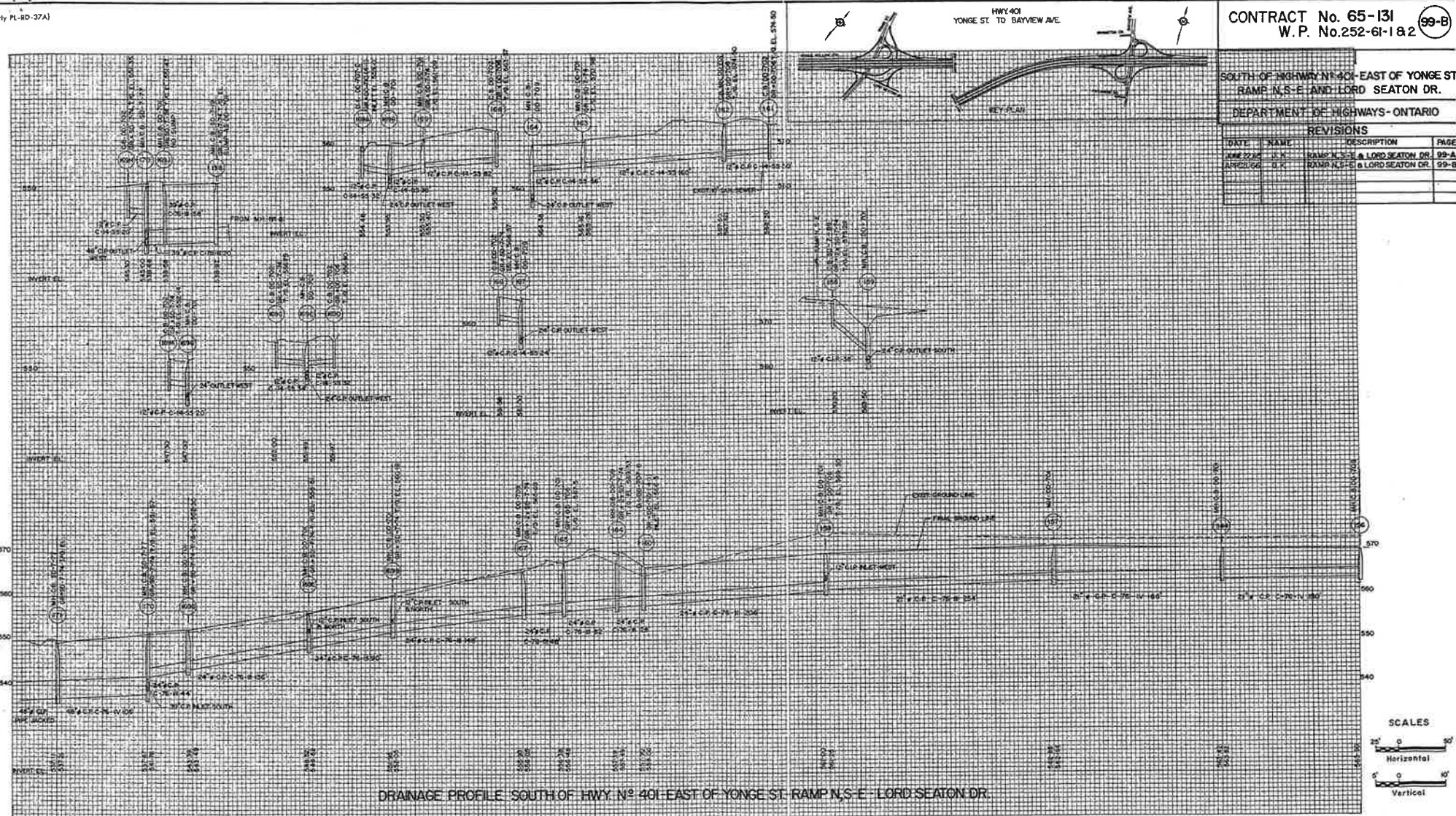
FOR DETAILS OF SPEC. DESIGN  
D.I. N° 351A SEE DWG N° D-551-1-7



LOT 14  
CON. I E.Y.S.

WILKET  
CREEK  
CULV.





		Totals	
Excavation	Earth Cut		
	Sub-Excavation		
	Stripping		
	Ditching		
	Mucking Excav.		
Fill	Earth Fill		
	Rock Cut		
	Shutter		
Grill	Rock Fill		
	Mucking Backfill		



Totals	
	Earth Cut
	Sub-Excavation
	Stripping
	Ditching
	Muckbag Export
	Earth Fill
	Rock Cut
	Shutter
	Rock Fill
	Muckbag Backfill

# Appendix J

## Limitations of Report

## **LIMITATIONS OF REPORT**

This report is intended solely for the Client named. The material in it reflects our best judgment in light of the information available to Shaheen & Peaker Limited at the time of preparation. Unless otherwise agreed in writing by Shaheen & Peaker Limited, it shall not be used to express or imply warranty as to the fitness of the property for a particular purpose. No portion of this report may be used as a separate entity, it is written to be read in its entirety.

The conclusions and recommendations given in this report are based on information determined at the testhole locations. The information contained herein in no way reflects on the environment aspects of the project, unless otherwise stated. Subsurface and groundwater conditions between and beyond the testholes may differ from those encountered at the testhole locations, and conditions may become apparent during construction, which could not be detected or anticipated at the time of the site investigation. The benchmark and elevations used in this report are primarily to establish relative elevation differences between the testhole locations and should not be used for other purposes, such as grading, excavating, planning, development, etc.

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The comments made in this report on potential construction problems and possible methods are intended only for the guidance of the designer. The number of testholes may not be sufficient to determine all the factors that may affect construction methods and costs. For example, the thickness of surficial topsoil or fill layers may vary markedly and unpredictably. The contractors bidding on this project or undertaking the construction should, therefore, make their own interpretation of the factual information presented and draw their own conclusions as to how the subsurface conditions may affect their work. This work has been undertaken in accordance with normally accepted geotechnical engineering practices.

Any use which a third party makes of this report, or any reliance on or decisions to be made based on it, are the responsibility of such third parties. Shaheen & Peaker Limited accepts no responsibility for damages, if any, suffered by any third party as a result of decisions made or actions based on this report.



**FOUNDATION DESIGN REPORT  
PROPOSED NOISE BARRIER WALL REPLACEMENT  
WIDENING OF HIGHWAY 401 EASTBOUND COLLECTORS  
FROM YONGE STREET TO BAYVIEW AVENUE  
TORONTO, ONTARIO  
G.W.P. 158-00-00**

**Prepared For:**

**MORRISON HERSHFIELD LIMITED**

**Prepared by:**

**SHAHEEN & PEAKER LIMITED**

**Project: SPT1103  
October 21, 2005**



**20 Meteor Drive  
Toronto, Ontario  
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E-mail: [info@shaheenpeaker.ca](mailto:info@shaheenpeaker.ca)**

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## APPENDIX

### LIMITATIONS OF REPORT

### APPENDIX K



**FOUNDATION DESIGN REPORT  
PROPOSED NOISE BARRIER WALL REPLACEMENTS  
WIDENING OF HIGHWAY 401 EASTBOUND COLLECTORS  
FROM YONGE STREET TO BAYVIEW AVENUE  
TORONTO, ONTARIO  
G.W.P. 158-00-00**

**5. DISCUSSION AND RECOMMENDATIONS**

**5.1 GENERAL**

As part of the improvement at Highway 401 Eastbound Collector Lanes between Yonge Street and Bayview Avenue, the existing retaining walls and noise barrier walls are intended to be moved to the south to accommodate for an extra lane. This report is intended to focus on the foundation design aspects for the proposed noise barrier walls, while the proposed retaining wall replacements are discussed under a separate cover.

Currently, noise barrier walls are present through the project area. At the existing retaining walls locations, the noise walls are either attached to the existing retaining walls or located about 3 to 5 m south of the retaining walls. Between existing Retaining Walls Nos 2 and 3, the noise walls are situated about 10 m south of existing E/P (edge of pavement).

It is understood that at some locations, especially where the fill retaining wall will be constructed, the new noise wall may be attached to the retaining wall panels to become an integrated concrete noise barrier, while at most parts of the project, the new wall will be constructed near the property line of the highway. This new wall is likely to comprise of fitted panels retained within the vertical chases of posts.

The boreholes put down in the vicinity of the proposed noise walls locations have shown, in general, below the topsoil, the presence of the clayey silt fill or silty sand fill to a depth of about 0.6 to 2.1 m, underlain by clayey silt till and sandy silt till. In some boreholes, the glacial till deposit was found to be underlain or interbedded by silt and/or sand deposits.

The compactness condition of the fill is generally very loose to compact or the consistency is firm to stiff. The glacial till deposits below the fill is generally stiff to hard clayey soil or dense to very dense cohesionless material. The groundwater level is believed to be at about El. 168.0 to 172.0 m at the west portion of the site (Retaining Wall No. 2) and between El. 162.0 to 164.0 m towards east (Retaining Wall No. 3), while at the area close to Wilket Creek Culvert (Station 23+100) the permanent groundwater table is approximately at El. 161.2 m.

## 5.2 NOISE BARRIER WALLS

### 5.2.1 Design Considerations

The noise barrier walls will typically extend about 5 m above the ground surface. It is likely that most of these walls will be supported on augered caissons (i.e. drilled and poured-in-place concrete foundations). Typical caisson diameters range from 0.6 m to 0.9 m.

The recommended soil parameters for the design of augered caisson foundations units at each borehole location are given in the following table.

**TABLE 5.2.1.1**  
**Recommended Soil Parameters for the Design of Augered**  
**Caisson Foundation Units**

BH No.	Elevation (m)		Type of Soil	Consistency or Compactness Condition	q <sub>u</sub> (kPa) *	φ (degrees) **	γ (kN/m <sup>3</sup> ) ***	Water Level depth (Elevation) (m)
	From	To						
2-2	175.1	173.7	Fill	Firm	60	-	19.0	7.3♦ (167.9)♦
	173.7	173.0	Cohesive	Firm	70	-	20.5	
	173.0	171.5	Cohesive	Hard to very stiff	300	-	21.0	
	171.5	169.0	Cohesive	Hard	500	-	21.5	
	169.0	167.1	Cohesionless	Very dense	-	35	22.0	
2-4	174.0	172.1	Fill	Firm to stiff	60	-	19.0	6.0♦ (168.2)♦
	172.1	170.5	Cohesive	Very stiff to hard	320	-	21.0	
	170.5	169.2	Cohesive	Hard	460	-	21.5	
	169.2	167.2	Cohesionless	Very dense	-	34	22.0	
	167.2	166.3	Cohesionless	Very dense	-	35	22.0	
2-6	173.6	172.4	Fill	Very stiff	160	-	19.5	4.9♦ (169.0)♦
	172.4	171.7	Fill	Very dense	-	33	21.0	
	171.7	170.2	Cohesive	Very stiff to hard	260	-	21.0	
	170.2	168.9	Cohesive	Hard	500	-	22.0	
	168.9	166.5	Cohesionless	Very dense	-	33	22.0	
	166.5	165.9	Cohesionless	Very dense	-	35	21.5	
RW2-19/B	173.6	172.9	Fill	Very soft	30	-	18.5	2.6♦ (171.0)♦
	172.9	171.5	Cohesive	Firm to very stiff	200	-	21.0	
	171.5	168.6	Cohesive	Hard	420	-	21.5	
2-8	175.5	174.9	Fill	Very stiff	120	-	20.5	4.6♦ (171.0)♦
	174.9	173.5	Cohesive	Hard	400	-	21.0	
	173.5	168.6	Cohesionless	Very dense	-	33	22.0	
	168.6	167.8	Cohesive	Hard	500	-	22.0	
2-10	173.4	172.8	Cohesionless	loose	-	30	20.5	4.6♦ (171.0)♦
	172.8	168.1	Cohesionless	Very dense	-	33	22.0	
	168.1	165.6	Cohesive	Hard	500	-	21.5	
2-12	171.8	171.2	Cohesive	Very stiff	200	-	21.0	Below 8.1♦ (163.8)♦
	171.2	163.8	Cohesive	Hard	400	-	21.5	
2-14	170.5	169.8	Fill	Stiff	80	-	19.0	2.4♦ (168.3)♦
	169.8	168.9	Cohesive	Very stiff	200	-	20.5	
	168.9	166.3	Cohesive	Very stiff to hard	300	-	20.5	
	166.3	165.2	Cohesionless	Dense	-	33	21.0	
	165.2	162.6	Cohesive	Hard	500	-	21.0	

BH No.	Elevation (m)		Type of Soil	Consistency or Compactness Condition	q <sub>u</sub> (kPa) *	φ (degrees) **	γ (kN/m <sup>3</sup> ) ***	Water Level depth (Elevation) (m)
	From	To						
2-16	169.5	167.8	Fill	Stiff	100	-	19.0	3.6♦ (166.0)♦
	167.8	165.2	Cohesive	Hard	360	-	20.5	
	165.2	162.3	Cohesive	Hard	420	-	20.0	
	162.3	161.5	Cohesionless	Compact	-	32	21.5	
2-18	168.7	168.2	Fill	Loose	-	28	20.0	3.0♦ (166.0)♦
	168.2	167.2	Fill	Stiff	80	-	19.5	
	167.2	165.0	Cohesive	Very stiff to hard	220	-	20.5	
	165.0	160.9	Cohesive	Hard	500	-	21.0	
2-20	168.6	166.6	Fill	Very stiff to stiff	110	-	19.5	5.2♦ (163.5)♦
	166.6	165.0	Cohesive	Very stiff	250	-	20.5	
	165.0	160.6	Cohesive	Hard	500	-	21.5	
2-22	168.1	162.5	Cohesive	Stiff to hard	200	-	20.5	3.7♦ (164.7)♦
	162.5	160.4	Cohesive	Hard	420	-	21.0	
RW2-73/74C	167.8	166.8	Fill	Firm	80	-	19.0	Below 5.0♦ (162.9)♦
	166.8	165.5	Cohesive	Stiff to hard	360	-	20.5	
	165.5	162.9	Cohesive	Hard	450	-	21.0	
2-24	167.8	165.8	Fill	Very stiff	140	-	19.5	5.9♦ (162.0)♦
	165.8	163.5	Cohesive	Hard	420	-	21.5	
	163.5	162.0	Cohesive	Very stiff	210	-	21.0	
	162.0	160.0	Cohesionless	Very dense	-	34	22.0	
2-26	167.5	166.3	Fill	Firm to stiff	80	-	19.0	3.7♦ (164.0)♦
	166.3	163.0	Cohesive	Very stiff to hard	220	-	20.5	
	163.0	159.6	Cohesive	Hard	450	-	21.0	
RW2-82/83C	167.9	167.0	Fill	Firm	50	-	19.0	2.5♦ (165.5)♦
	167.0	165.8	Cohesive	Stiff to very stiff	180	-	20.5	
	165.8	163.0	Cohesive	Hard	400	-	21.0	
28	168.3	167.1	Cohesive	Stiff	80	-	19.0	4.5♦ (164.0)♦
	167.1	166.0	Cohesive	Stiff	140	-	20.5	
	166.0	162.2	Cohesive	Hard	400	-	21.5	
31	168.4	167.6	Fill	Very stiff	200	-	19.5	6.0♦ (162.5)♦
	167.6	162.2	Cohesive	Hard	500	-	21.5	
33	167.9	166.7	Cohesive	Very stiff	200	-	19.5	6.0♦ (162.1)♦
	166.7	166.0	Cohesive	Hard	420	-	21.0	
	166.0	163.4	Cohesionless	Very dense	-	34	21.5	
	163.4	161.9	Cohesive	Hard	500	-	21.5	
35	167.2	166.7	Cohesive	Very stiff	120	-	19.0	4.1♦ (163.3)♦
	166.7	165.2	Cohesive	Stiff	150	-	20.0	
	165.2	163.4	Cohesionless	Dense to v. dense	-	34	21.5	
	163.4	161.2	Cohesive	Hard	500	-	21.5	
37	167.8	167.3	Cohesive	Very stiff	200	-	19.5	5.2♦ (161.3)♦
	167.3	165.8	Cohesive	Very stiff to hard	300	-	20.5	
	165.8	163.5	Cohesionless	Very dense	-	34	22.0	
	163.5	161.3	Cohesionless	Very dense	-	33	21.5	
RW3-6A	170.0	168.4	Fill	V. loose to compact	-	28	19.0	Below 3.9♦ (166.2)♦
	168.4	166.2	Cohesive	Hard	400	-	21.5	
RW3-6B	166.2	165.4	Cohesive	Hard	350	-	21.0	2.2♦ (164.7)♦
	165.4	162.0	Cohesive	Hard	500	-	21.5	
39	170.8	170.1	Fill	Stiff	80	-	19.0	Below 2.3♦ (168.6)♦
	170.1	168.6	Cohesive	Stiff	100	-	20.5	
38	165.1	163.0	Cohesive	Hard	500	-	21.0	5.8♦ (160.7)♦
	163.0	160.7	Cohesive	Hard	400	-	21.0	
	160.7	159.9	Cohesionless	Compact	-	32	21.5	

BH No.	Elevation (m)		Type of Soil	Consistency or Compactness Condition	q <sub>u</sub> (kPa) *	φ (degrees) **	γ (kN/m <sup>3</sup> ) ***	Water Level depth (Elevation) (m)
	From	To						
RW3-19/20E	168.8	168.0	Fill	Very soft	30	-	19.0	Below 2.9♦ (166.0)♦
	168.0	167.0	Cohesive	Stiff	100	-	20.5	
	167.0	166.0	Cohesive	Hard	400	-	22.0	
RW3-19/20B	165.2	163.4	Cohesive	Hard	500	-	21.5	4.3♦ (162.0)♦
	163.4	161.3	Cohesionless	Very dense	-	33	22.0	
3-41	163.4	161.4	Fill	Loose to very loose	-	28	19.5	2.3m♦ (161.2)♦
	161.4	159.9	Cohesionless	Compact	-	31	21.0	
	159.9	158.0	Cohesionless	Dense to v. dense	-	33	22.0	
	158.0	155.4	Cohesionless	Compact to dense	-	32	21.5	
3-43	166.6	165.2	Cohesionless	Compact	-	28	21.0	3.6m♦ (163.0)♦
	165.2	164.4	Cohesive	Firm	60	-	20.5	
	164.4	162.6	Cohesive	Very stiff to hard	240	-	21.0	
	162.6	161.8	Cohesionless	Compact to v dense	-	32	21.5	
	161.8	160.0	Cohesionless	V. dense to dense	-	34	21.5	

\* q<sub>u</sub> = unconfined compressive strength in kPa (q<sub>u</sub> = 2xC<sub>u</sub>) for cohesive soils

\*\* φ = angle of internal friction for cohesionless (i.e. granular) soils in degrees

\*\*\* γ = bulk unit weight of soil in kN/m<sup>3</sup>

♦ = estimated

The contribution to lateral resistance of the soil within the frost depth (i.e. 1.2 m) should not be included in the calculations, except of course, for the weight of the soil. Research shows, however, that restraint (fixity) provided at the ground surface level plays a significant role in the performance of pole structures and, therefore, the placement of well compacted, competent material at and near the ground surface immediately around the pole is recommended.

For foundation design it can be assumed that full resistance will only be mobilized where the width of soil in front of or behind the caisson foundation is equal to or greater than eight caisson diameters. For sloping ground in front of the caisson foundations the magnitude of the passive resistance can be calculated by interpolating between zero passive resistance at the ground surface level increasing to full resistance at the depth where the slope face is greater than eight caisson diameters away from the face of the caisson. In addition passive resistance within 1.2 m of the ground surface (including slope face) should be neglected in consideration of frost action.

## 5.2.2 Construction Considerations

The boreholes show the presence of generally cohesive surficial fill deposits followed by essentially competent cohesive deposit interbedded or underlain with competent cohesionless deposits.

The clayey silt till deposit can be expected to be self-supporting and should not yield significant amounts of water in the short term, in caisson holes, even below the groundwater table. However, the concrete should be poured expeditiously on completion of the caisson hole, without undue delay. At locations where relatively more pervious water bearing soils (i.e. sandy fill, wet silt/sand interbeds inside the till or wet sand deposit e.g. in Borehole 3-41) were encountered, problems may occur during the installation of the caissons, as discussed below.

Water bearing non-cohesive (i.e. granular) layers may yield significant amounts of water and may cause instability problems during the installation of the caissons. Where these layers are rather thin and the soil is relatively fine grained, it may be possible to effect construction by pouring the concrete rapidly upon the completion of the excavation of the caisson hole. In other cases, however, the relatively coarse sand seams/layers may cause cave-ins or excessive groundwater seepage in unlined caisson holes and will necessitate special precautions. The use of dewatering techniques to lower the groundwater table during construction is unlikely to be economically viable due to the limited construction effort required and space limitations on Highway 401.

If relatively coarse textured layers are encountered below the water table the soil is likely to be susceptible to disturbance due to the unbalanced hydrostatic head and seepage and will likely become unstable, especially with increased depth of excavation below the water table. The contractor should maintain the stability of the soil at the sides and bases of the holes for the concrete footings, at all times from the commencement of excavation to the completion of the pouring of the concrete.

In view of these, we recommend that the following special provisions be included in the contract documents:

- At the various foundation locations, strata may consist of fill, clayey silt till, sandy silt to silty sand till, silty sand and sand. Groundwater and/or perched water is likely to be encountered above the base of the excavations.
- The contractor shall maintain the stability of the soil along the sides and in the bases of the holes for the concrete footings at all times from the commencement of their construction to the placing of the concrete.
- Dewatering may be required to maintain a sufficiently dry condition for proper installation of the caisson and the placement of concrete.

Being of glacial origin, the glacial till deposits can be expected to contain random cobbles and boulders. The majority of the overlying fill appears to be derived from this source and as such may also contain cobbles and boulders. Therefore, a Non-Standard Special

Provision (NSSP) should be provided in the contractor document to make the contractor aware that the presence of cobbles and boulders can always be expected which can cause problems during the installation of the caissons, such as increasing the time required for drilling, the employment of special equipment, etc.

## 6. CLOSURE

The Limitations of Report, as quoted in Appendix K, is an integral part of this report.

### SHAHEEN & PEAKER LIMITED



  
Yuxin Lang, P.Eng.



  
R. Miranda, P.Eng.



Z. S. Ozden, M.A.Sc., P.Eng.



# APPENDIX K

## Limitations of Report

## **LIMITATIONS OF REPORT**

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