

**ADDITIONAL FOUNDATION INVESTIGATION REPORT
PROPOSED HIGHWAY 17 (NEW)
FROM ECHO RIVER TO BAR RIVER ROAD
DISTRICT 62, SAULT STE. MARIE, ONTARIO
G.W.P. 354 AND 352-94-00**

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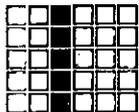
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1. INTRODUCTION

Shaheen & Peaker Limited (S&P) was retained by Marshall Macklin Monaghan Ltd. to conduct an additional foundation investigation for a number of cut and fill sections along the proposed realignment of Highway 17 from the Lower Echo River to Bar River Road in Sault Ste. Marie, Ontario. As requested, this investigation was carried out with minimal number of boreholes at generally about 200 m spacing in areas where a previous pavement investigation was performed by others*. In addition, a limited amount of the laboratory testing was performed, as was directed. This Additional Foundation Investigation Report should be read in conjunction with the previous Foundation Investigation Report** prepared by S & P for this project.

The sections investigated which are covered in this Additional Foundation Investigation are designated as Sites A, B, C and D for the purposes of this report and are described as follows:

Site A: Highway 17 (New) Fill Section between Stations 10+360 and 10+700 Westbound Lanes (WBL), between Site Nos. 1 and 2 of the previous investigation by S & P**.

Site B: Highway 17 (New) Fill and Cut Sections between Stations 11+000 and 11+350 EBL and WBL, between Site Nos. 3 and 4.

Site C: Highway 17 (New) Fill Section between Stations 13+400 and 15+470 EBL and WBL, between Site Nos. 5 and 6.

Site D: Highway 17 (New) Fill Section between Stations 16+600 and 17+700 EBL and WBL, between Site No.8 and south limit of project.

* DST Consulting Engineers in Thunder Bay, Ontario

** "Foundation Investigation Report, Proposed Highway 17(New)
From Echo River to Bar River Road, District 62, Sault Ste. Marie, Ontario
G.W.P. 354 and 352-94-00", prepared by S & P dated August 2003.

The findings of the present investigation are presented in this report. It should be noted that subsurface conditions between and beyond the borehole locations could be different from the ones encountered at the boreholes due to greater than normal borehole spacing.

2. SITE DESCRIPTION AND GEOLOGY

The realignment of the proposed Highway 17 (New) is located between the Lower Echo River and Bar River Road and east of the existing Highway 17.

The site is undulating with high ground and low-lying areas. Rock outcrops were observed in high ground areas located south of Echo River and west of the proposed Highway 17 alignment, east of Pioneer Road between Highway 638 and Findlay Hill Road, and east of Government Road and north of the Huron Central Rail (CPR) crossing. Low-lying areas, including a swamp section in the vicinity of Highway 638, are present within the project limits.

According to Map 2108 published by the Ontario Department of Mines, the bedrock at the site consists of Cambrian sandstone of Jacobsville Formation at the interface with Pre-cambrian Lorrain Formation which consists of quartzite, siltstone, greywacke and conglomerate.

Typically, in high ground, bedrock of undifferentiated igneous and metamorphic classifications (Southern Province) are exposed at surface forming shallow hills. These rocks are generally Pre-cambrian formations while some Cambrian unconformities are also noted. The rock generally dips rapidly to below surface and in the relatively higher lying foot-hill areas, the bedrock is covered with some glacial till and/or granular deposits. In the low-lying areas, peat, muck and marl are found, covering glaciolacustrine deposits. The glaciolacustrine deposits typically consist of clay and silt, minor sand deposited in basin and quiet water environments. The depth of clay in areas can exceed 40 m.

The massive bedrock outcrop, which is exposed to the north, northeast of the railway crossing, was identified as sandstone of Cambrian origin. Some Pre-cambrian quartzite is also present in the area.

3. INVESTIGATION PROCEDURES

The fieldwork for the investigation consisted of the following:

- Site A: 5 boreholes and 2 test pits plus 3 dynamic cone penetration tests (DCPT)
- Site B: 2 boreholes plus 1 DCPT
- Site C: 12 boreholes plus 4 DCPT
- Site D: 7 boreholes plus 3 DCPT

The boreholes were advanced using solid and hollow stem continuous flight augers with track-mounted vehicles owned and operated by Colbar Resources of Sudbury, Ontario, under the supervision and direction of Geotechnical Engineers from our office. Sampling in the overburden was effected starting at the ground surface 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 diameter O.D. split-spoon (split barrel) sampler into the relatively undisturbed ground. The number of blows required to drive the sampler into the ground by a vertical distance of 0.30 m is recorded as the Standard Penetration or the N-value of the soil and this gives an indication of the consistency or the compactness condition of the soil deposit. In the cohesive deposits where the consistency of the soil permitted, the undrained shear strength of the soil was measured in-situ by means of field vane tests using an MTO-type field vane and relatively undisturbed samples were taken by means of thin-walled Shelby tube samplers.

In addition, Dynamic Cone Penetration tests (DCPT) were performed at various borehole locations. This test consists of driving a 51 mm O.D., 60-degree apex cone, screw attached to the tip of an A-size rod, continuously into the undisturbed ground using the same driving energy as the SPT method. By recording the number of blows of the hammer to drive the cone/rod assembly into the soil every 0.3 m, a qualitative record of soil compactness condition is obtained.

Piezometers were installed in a number of boreholes to enable us to monitor the groundwater level over a prolonged period of time without interference from surface water.

The subsurface stratigraphy encountered in the boreholes and test pits, type of samples and sampling depths, N-values and DCPT results are presented on the Record of Borehole Sheets and Test Pit Logs, in Appendices A1, B1, C1 and D1 of this report.

Upon their completion, the boreholes were backfilled to about 6 to 8 m below the ground surface with soils brought up by augering (i.e. auger cuttings). The upper 6 to 8 m of the open boreholes was then grouted using a bentonite or a cement/bentonite mixture.

Test pits were dug on Site A using track-mounted backhoes, under the supervision of S&P technical personnel. The test pit results are shown on the Test Pit Logs in Appendix A1.

The borehole and test pit locations were established in the field by S & P personnel using centerline alignment and the ground surface elevations at the borehole and test pit locations along with co-ordinates were subsequently determined by surveyors from Marshall Macklin Monaghan Ltd.

A laboratory testing programme, consisting of natural moisture content measurement, bulk unit weight determination, Atterberg Limits, consolidation tests and grain-size analyses, was performed on selected soil samples. The results of the laboratory tests are presented on the appropriate Record of Borehole Sheets and also in Appendices A2, B2, C2 and D2.

4. SUBSURFACE CONDITIONS

4.1 SITE A : HIGHWAY 17 (NEW) FILL SECTION BETWEEN STATIONS 10+360 AND 10+700 WESTBOUND LANES

Site A is a relatively low-lying area between Site Nos. 1 and 2 along the westbound lanes (WBL) of the proposed Highway 17(New), near the north end of the project. The site is generally wooded, with bedrock outcrop at the south end of this section (between Stations 10+670 and 10+700).

The existing grade in this fill area varies from about Elevation 182.5 to 188.5m along the WBL centreline. The existing grades are also sloping down towards the left (east) at an average rate of about 7 to 23 %.

The location plan of the boreholes and test pits in this section is shown on Drawing No.1. The stratigraphic profile along WBL is presented in Drawing A.

Five boreholes were drilled, two test pits were dug and three DCPTs were put down in this area. Within the southern portion of this section, i.e., between Stations 10+580 and 10+700, the boreholes and test pits show, below about 0.15 to 0.5 m of topsoil or peat, the presence of bedrock or surficial layers of silt and silty sand till over bedrock. Between Stations 10+350 and about 10+570, the 0.2 to 0.5 m thick topsoil/peat layer is underlain by a clay deposit extending to about 8 m depth below existing grade, at the borehole locations. Below the clay, an about 0.3 to 0.7 m thick layer of silty sand till was contacted, which is further underlain by probable bedrock (inferred by refusal to augering).

Details of the subsurface conditions encountered in the boreholes and test pits are presented on the Record of Borehole Sheets and Test Pit Logs in Appendix A1. The individual strata are briefly described in the following paragraphs.

4.1.1 TOPSOIL AND PEAT

In the boreholes and test pits, topsoil and peat were encountered ranging in thickness between about 0.15 and 0.5 m.

4.1.2 SURFICIAL SILT

Below the topsoil and peat, Borehole 10+635 Lt contacted a surficial 0.5 m thick layer of silt extending to a depth of 1.0 m below existing grade. In Borehole 10+503 Lt, a 0.6 m thick layer of silt was encountered interbedded in the clay deposit at a depth of 0.7 m.

A grain-size distribution analysis was performed on a sample from the silt layer and the results are presented in Figure A2-1, Appendix A2. The results indicate the following particle size distribution:

Gravel =	0%
Sand =	2%
Silt =	71%
Clay =	27%

The above results indicate that this silt layer contains some clay.

Measured N-values in this layer were 6 and 12 blows/0.3 m indicating firm to stiff consistency.

4.1.3 SAND AND GRAVEL

In Borehole 10+460 Lt, a 0.4 m thick sand and gravel layer was contacted below the topsoil extending to a depth of 0.6 m below existing grade.

Measured N-value in this layer was 6 blows/0.3 m indicating loose relative density.

4.1.4 CLAY

Underneath the topsoil/peat and surficial deposits, Boreholes 10+460 Lt, 10+503 Lt and 10+540 Lt, which are located on the north side of the site in the relatively low lying areas away from the rock outcrop, encountered a clay deposit extending to depths of about 5 to 8 m below existing grade under the proposed WBL.

The results of the grain-size distribution analysis performed on one of the selected clay samples are presented in Figure A2-2, Appendix A2. The results indicate the following particle size distribution:

Gravel =	0%
Sand =	0%
Silt =	52%
Clay =	48%

Atterberg Limits tests carried out in the laboratory on two samples from the clay deposit gave the following index values:

Liquid Limit:	63 and 78%
Plastic Limit:	25 and 26%
Plasticity Index:	38 and 53%

As presented in Figure A2-3 in Appendix A2, these values are characteristics of clay soils of high plasticity. The measured natural moisture contents generally range from 33 to 85%.

The clay contains occasional seams / layers or pockets of silt or clayey silt. The measured index values for a sample obtained from such a layer/pocket are as shown in Figure A2-4, Appendix A2, as follows:

Liquid Limit:	32 %
Plastic Limit:	20 %
Plasticity Index:	12 %

These values indicate a clayey soil of low plasticity.

The measured bulk unit weights of the clay range from 14.8 to 17.5 kN/m³.

The results of a consolidation (oedometer) test performed on a sample from the clay deposit taken from Borehole 10+503 Lt are presented in Figure A2-5, Appendix A2. The test results show the probable pre-consolidation pressure (P_c) of about 90 kPa, which is about 60 kPa in excess of the existing effective overburden pressure.

Standard Penetration tests performed in the clay deposit gave N-values varying between 1 and 6 blows/0.3 m were recorded. Field vane tests yielded undrained in-situ shear strength values ranging from about 18 to 46 kPa. Variation of the measured undrained shear strengths with elevation are plotted and this plot is presented in Figure A3-1 in Appendix A3. Figure A3-2 (Appendix A3) shows typical plot of undrained shear strength versus elevation at Borehole 10+460 Lt. These values indicate that the consistency of the material can be described as generally soft to firm.

4.1.5 SILTY SAND TILL

Below the clay in Boreholes 10+460 Lt, 10+503 Lt and 10+540 Lt, silty sand till was encountered at depths ranging from 5.2 to 8.2 m below the ground surface. This deposit was penetrated for a vertical distance of 0.3 to 0.7 m where the borehole was terminated. In Boreholes 10+460 and 10+540, auger refusal was encountered. Surficial silty sand till was also encountered in Boreholes 10+635 Lt and 10+643 Lt. These extended to 1.7 m and 0.8 m below the ground surface where refusal to augering was encountered. This deposit is

a heterogeneous mixture of sand and silt, with some gravel and clay size particles. The presence of cobbles and boulders can also be expected in the glacial till deposits.

A grain-size distribution analysis was performed on a sample from this layer and the results are presented in Figure A2-6, Appendix A2. The results indicate the following particle size distribution:

Gravel =	10%
Sand =	43%
Silt =	34%
Clay =	13%

Measured N-values of greater than 50 blows/0.3 m at Boreholes 10+540 and 10+635 indicate a very dense relative density. However, a low N-value of 5 blows/0.3 m in Borehole 10+503 Lt could possibly be caused by disturbance of the soil due to hydrostatic uplift at the bottom of the hole during sampling.

4.1.6 BEDROCK

Boreholes, DCPTs and test pits from this investigation indicate that bedrock and probable bedrock was encountered along the WBL from about Stations 10+580 to 10+670. Beyond or north of Station 10+580 to Station 10+350 (north limit of this section), possible bedrock was encountered at depths of about 6 to 10 m below existing grade. The bedrock in this area is known to consist of quartzite.

4.1.7 GROUNDWATER CONDITIONS

Water level observations in the boreholes were made during drilling and at completion of each borehole. Boreholes 10+635 and 10+643 were dry at completion while in Boreholes 10+460, 10+503, and 10+540, the recorded water levels at completion range between 3.0 and 5.5 m below existing grade, but these are unlikely to represent the stabilized water levels.

Based on the above observations and the greyish colour of the clay, the groundwater table is believed to be close to the existing ground surface to the north of Station 10+570. To the south of this station (towards higher ground), the groundwater level is believed to be at or near ground surface. Due to the pervious nature of the surficial sand and gravel, silt and silty sand till layers over the bedrock and the impervious clay deposit, perched water condition could also be expected. The groundwater table can be expected to fluctuate seasonally and in response to weather events.

4.2 SITE B : HIGHWAY 17 (NEW) FILL SECTION BETWEEN STATIONS 11+000 AND 11+190, AND CUT SECTION BETWEEN STATIONS 11+190 AND 11+380

Site B is located between Site Nos. 3 and 4 of the proposed Highway 17(New). The northern portion of this section is a fill section and one borehole (Borehole 11+020 Rt) was drilled in this area. The southern portion is a cut section, and one borehole (Borehole 11+300 Lt) was also drilled to provide a limited subsurface information.

The existing grade in the fill section varies from about Elevation 190.2 to 191.0 m along the EBL and WBL centerlines; while the existing grade in the cut section ranges from about Elevation 187.5 to 192 m.

The location plan of the boreholes at Site B is shown on Drawing No. 1. The stratigraphic profile is presented in Drawing B.

In the fill section, Borehole 11+020 Rt was drilled to a depth of 7.3 m and this showed, below 0.25 m of topsoil, an extensive clay deposit to at least the bottom of the hole. A DCPT was extended from the bottom of the borehole from a depth of 7.3 m to 29.1 m below existing grade, where practical refusal was encountered. In the cut section, Borehole 11+300 Lt was drilled and this indicated, below 0.1 m of topsoil and 0.6 m of sand and gravel fill, the presence of an extensive clay deposit to a depth of at least 7.3 m.

Details of the subsurface conditions encountered in the boreholes are presented on the Record of Borehole Sheets in Appendix B1. The individual strata are briefly described in the following paragraphs.

4.2.1 TOPSOIL

In the boreholes, topsoil was encountered ranging in thickness between about 0.1 and 0.25 m.

4.2.2 SAND AND GRAVEL

In Borehole 11+300 Lt, a 0.6 m thick sand and gravel layer was contacted below the topsoil extending to a depth of 0.7 m below existing grade. The sand and gravel is believed to be a fill material. It also contains occasional cobbles.

A grain-size distribution analysis was performed on a sample from this layer and the results are presented in Figure B2-1, Appendix B2. The results indicate the following particle size distribution:

Gravel	=	50%
Sand	=	45%
Silt & Clay	=	5%

Measured N-value in this layer was greater than 50 blows/0.3 m indicating a very dense relative density.

4.2.3 CLAY

Below the topsoil and surficial deposits, both Boreholes 11+020 Rt and 11+300 Lt encountered a clay deposit extending to a depth of at least 7.3 m below existing grade. The clay contains occasional seams / layers or pockets of silt and clayey silt.

The results of the grain-size distribution analysis performed on a selected clay sample are presented in Figure B2-2, Appendix B2. The curve indicates the following particle size distribution:

Gravel	=	1%
Sand	=	3%
Silt	=	21%
Clay	=	75%

Atterberg Limits tests carried out in the laboratory on two samples from the clay deposit gave the following index values:

Liquid Limit:	60 to 68%
Plastic Limit:	25%
Plasticity Index:	35 to 43%

As presented in Figure B2-3 in Appendix B2, these values are characteristics of clay soils of high plasticity. The measured natural moisture contents generally range from 33 to 90%.

The measured bulk unit weights of the clay range from 14.3 to 18.0 kN/m³.

Standard Penetration tests performed in this deposit gave N-values varying between 2 and 20 blows/0.3 m. Field vane tests yielded undrained in-situ shear strength values ranging from about 56 to greater than 100 kPa within the top 1.5 to 4.5 m depth, indicating stiff to very stiff clay. Values of 24 to 40 kPa were recorded below these depths indicating firm consistency. Variation of measured undrained shear strengths

with elevations are plotted and this plot is presented in Figures B3-1 in Appendix B3. Figure B3-2 shows typical plot of undrained shear strength versus elevation at the location of Borehole 11+020 Rt. These values indicate that the consistency of the material can be described as generally soft to very stiff.

The DCPT at Borehole 11+020 Rt indicates that a 'stiffer' material is encountered at a depth of about 20 m, and a more competent material is probably encountered at a depth of 26 m below existing grade.

4.2.4 GROUNDWATER CONDITIONS

Water level observations in the boreholes were made during drilling and at completion of each borehole.

To enable us to monitor the groundwater level in Borehole 11+300 Lt, a piezometer was installed. Water level in the piezometer was measured two days after the completion of the borehole at a depth of 5.9 m below existing ground surface, or El. 185.1 m. This recorded water level is not believed to have stabilized.

Based on the above observations and the greyish colour of the clay, the groundwater table is believed to be at about 1 m below the ground surface at Borehole 11+020 Rt and at a depth of about 2 m below existing grade at Borehole 11+300 Lt.

The groundwater table can be expected to fluctuate seasonally and in response to weather events. In addition, due to the pervious nature of the granular fill layer over the impervious clay deposit, perched water condition could also be expected where such condition occur.

4.3 SITE C : HIGHWAY 17(NEW) FILL SECTION BETWEEN STATIONS 13+400 AND 15+470

Site C is a relatively low-lying area adjacent to and south of the swamp area (Site No. 5). The grade from the north of this section gradually rises southerly from an elevation of 180 m at about Station 13+400 to about Elevation 187 m at Station 14+500 along the westbound lanes (WBL) alignment and at Station 114+525 along EBL. Further south, the grade is drops to an elevation of about 184.5 to 185 m near Watson Road at about Station 14+550. The grade generally remains at about Elevation 184.5 ± m (lowest elevation in this area) at about Station 15+100 (just south of the creek). Further to the south, the grade follows the similar pattern such that the grade to the south of this section gradually rises southerly to an elevation of 187 m at about Station 15+450.

A total of 12 boreholes was put down at this site. The locations of the boreholes are shown in Drawings C and 4.

In general, the boreholes drilled along the proposed Highway 17 (New) show the presence of 0.1 to 0.4 m but generally 0.2 to 0.3 m thick topsoil layer. Borehole 14+668 C/L was drilled from the existing Watson Road, and this borehole encountered 0.7 m thick sand and gravel fill, underlain by 1.4 m of sandy silt fill extending to a depth of 2.1 m below existing grade.

Below the topsoil and fill, the boreholes encountered fine sand, sandy silt or silt layers generally to a maximum depth of 3.7 m below the ground surface. In Borehole 14+000 Lt, the sandy silt extends to the full depth of the borehole at a depth of 6.6 m and possibly below. These granular soils or topsoil are underlain by an extensive clay deposit. In two of the boreholes (13+576 Lt and 13+800 Rt), the clay is underlain by alternating layers of sandy silt and clay deposits at depths generally ranging from about 4 to 7 m below the ground surface while others were terminated at depths of up to 16.5 m within the clay deposit, without encountering these lower granular soils.

Details of the subsurface conditions encountered in the boreholes are given on the Record of Borehole Sheets in Appendix C1. The individual strata are briefly described in the following paragraphs.

4.3.1 TOPSOIL

All the boreholes, except for Boreholes 14+668 CL (which were drilled from the embankment of Watson Road) contacted topsoil extending to depths ranging from 0.1 to 0.4 m, but generally 0.2 to 0.3 m.

4.3.2 EMBANKMENT FILL

Borehole 14+668 CL was drilled from the existing Watson Road embankment and therefore, contacted embankment fill. The fill at the borehole location was found to consist of granular material (i.e. sand and gravel) and sandy silt. The depth of the fill at this borehole location was 2.1 m and extended to Elevation 182.9 m. Standard Penetration tests performed within the embankment fill yielded N-values ranging from 33 to 42 blows/0.3 m, indicating that the fill materials have received some systematic compaction when first placed.

4.3.3 SAND

Surficial fine sand to silty sand layers were encountered immediately below the topsoil at four boreholes at the north end of the site (north of Watson Road), in Boreholes 13+415 Rt, 13+576 Lt, 13+800 Rt and 14+000 Lt, and in one borehole drilled at the south end of the site, in Borehole 15+400 Rt.

The deposit was found to be thickest at the north end (3.3 m in Borehole 13+415 Rt) and decreasing towards the south (0.5 m thick in Borehole 14+000 Lt). At the south end of this section at Borehole 15+400 Rt, its thickness was found to be 0.2 m.

The grain-size distribution of a sample from this fine-grained granular deposit is given in Figure C2-1, in Appendix C2.

These indicate:

Sand	=	93 %
Silt	=	7 %
Clay	=	0 %

N-values recorded in this material ranged from 2 to 6 blows/0.3 m. Based on these values, the relative density of the soil is described as very loose to loose.

4.3.4 SANDY SILT

Below the topsoil and/or surficial sand layers, the boreholes, except Boreholes 13+415 Rt, 13+800 Rt, 14+200 Rt and 15+400 Rt, encountered sandy silt layers, which extended to depths of 0.7 m (Boreholes 15+000 Rt and 15+200 Lt) to in excess of 6.6 m (Borehole 14+000 Lt) below existing grade. In Boreholes 13+576 Lt and 13+800 Rt, sandy silt interbeds were encountered within the deep clay deposit.

The grain-size distribution of 3 samples from this deposit is given in Figure C2-2, in Appendix C2. These indicate:

Sand	=	22 – 44 %
Silt	=	48 – 74 %
Clay	=	4 – 12 %

Measured N-values recorded in this material widely ranged from 2 to 23 blows/0.3 m, indicating very loose to compact relative density.

4.3.5 CLAY

Underlying the surficial layers of topsoil, sand and sandy silt, all the boreholes, except for Borehole 14+000 Lt, encountered a major deposit of clay at depths ranging from 0.3 to 3.7 m below the ground surface.

To the south of Station 14+200, the clay extends to the full depth of exploration (i.e. about 7 to 16 m below the ground surface) while Dynamic Cone Penetration tests (DCPT) show probable greater depths. As mentioned before, in the borehole drilled at Station 14+000 the borehole was terminated at a depth of 6.6 m, and no clay was encountered within this depth. To the north of Station 14+000 (north end of site), in Boreholes 13+576 Lt and 13+800 Rt, as mentioned in Section 4.3.4, the clay is interbedded with sandy silt layers in alternating fashion.

DCPTs put down below the bottom of Boreholes 14+200 Rt and 15+400 Rt indicated that the clay probably extends to about 29 m (El. 156 m) and 20 m (El. 167 m), respectively, at these borehole locations.

In general, the clay is a highly plastic (fat) material with some medium and occasional low plasticity (lean) clay structure zones/layers. The grain-size distribution of 2 samples from the site is presented in Figure C2-3, in Appendix C2. These curves show the percentage of clay-size particles is very high (i.e. 77 to 80 %). From the grain-size distribution curves, the clay can be expected to be a practically impervious material.

Index properties of 3 samples from the clay deposit were determined in the laboratory and these indicate the following results,

Liquid Limit :	57 – 73 %
Plastic Limit :	25 – 31 %
Plasticity Index :	32 – 48 %

As shown in Figure C2-4, Appendix C2, these results are characteristic of clays of high plasticity.

The presence of some silty clay zones and clayey silt and silt seams in the clay deposit was also noted. The index values of samples from these seams/zones (as shown in Figure C2-5, Appendix C2) are as follows:

Liquid Limit :	30 to 31 %
Plastic Limit :	15 to 18 %
Plasticity Index :	13 to 16 %

The results of three consolidation (oedometer) tests performed on samples from the clay deposit within this section (including two samples from the culvert site at Station 15+086, which is within Site C) are presented in Figure C2-6 to C2-8, Appendix C2. The test results show the probable pre-consolidation pressure (P_c) ranging from 80 to 190 kPa, which are about 35 to 90 kPa, in excess of the existing effective overburden pressures.

N-values generally ranging from 0 (i.e., sampler sank under the static weight of the hammer plus rods) to 8 blows/0.3 m, were recorded in this deposit. In most cases, however, the recorded values were 0 to 2 blows/0.3 m. Undrained in-situ shear strengths as measured by Field Vane tests ranged from 15 to 78 kPa. These values indicate that the consistency of the material can be described as soft to stiff, but generally very soft to firm. A combined plot of all the in-situ vane test results from all the boreholes is presented in Figure C3-1, in Appendix C3. Figure C3-2 shows typical plot of undrained shear strength versus elevation at the location of Borehole 14+200 Rt.

4.3.6 GROUNDWATER CONDITIONS

The area is generally low lying and poorly drained, consequently, the groundwater can generally be expected at or near the ground surface level.

Based on observations made in the boreholes while drilling, water contents of the samples and the change of the colour of the soil from brown to grey, it is our opinion that the groundwater level at the site was at or very close to the ground surface, except at the north half of this section, where the groundwater level is expected to vary between about the ground surface at Station 13+400 (El. 180 ± m) to about 2m below existing grade at Station 14+500 (El. 184.5 ± m).

It should be pointed out that both surface and groundwater levels can be expected to fluctuate seasonally and in response to major weather events. In addition, due to the pervious nature of the surficial sand layer over the impervious clay deposit, perched water condition could also be expected.

4.4 SITE D : HIGHWAY 17(NEW) FILL SECTION BETWEEN STATIONS 16+600 AND 17+700

Site D is a low-lying area located to the south of Site No. 8, at the south end of the project. The existing grade from the north of this section is generally level at Elevation $187.5 \pm$ m for about 300 m to about at Station 16+900 where it starts to decrease. Further south, the grade gradually drops to an elevation of about 182.5 m. The grade generally remains at about Elevation $182.5 \pm$ m (lowest elevation in this area) from about Station 17+250 to Station 17+450. Further to the south, the grade follows the similar pattern and rises southerly to an elevation of 183.5 m at about Station 17+700. The low-lying area generally extends from about Station 17+000 to Station 17+680.

A total of 7 boreholes were drilled in this section of the site. The locations of the boreholes are shown in Drawing D.

In general, the boreholes show the presence of 0.2 to 0.4 m thick topsoil or peaty topsoil layer. Underlying the topsoil, Boreholes 16+650 Lt, 16+800 Rt, 17+000 Lt and 17+600 Lt encountered fine sand to silty sand layer to depths of 0.7 and 2.1 m below the ground surface. Underneath the topsoil and sand layers, all the boreholes contacted an extensive clay deposit to the full depth of the boreholes, except for Borehole 17+200 Rt, where the clay extends to a depth of 14.2 m followed by a silty sand till to the remaining depth of the borehole (15.7 m).

Details of the subsurface conditions encountered in the boreholes are given on the Record of Borehole Sheets in Appendix D1. The individual strata are briefly described in the following paragraphs.

4.4.1 TOPSOIL / PEATY TOPSOIL

All the boreholes contacted a topsoil or peaty topsoil layer extending to depths of 0.2 to 0.4 m.

4.4.2 SAND

Surficial fine sand to silty sand layers were encountered immediately below the topsoil at three boreholes at the north end of the site (in Boreholes 16+650 Lt, 16+800 Rt and 17+000 Lt) and in one borehole drilled at the south end of the site (in Borehole 17+600 Lt).

The thickness of the deposit varies from about 0.5 m at the north end of this section to 1.7 m at the south end (in Borehole 17+600 Lt).

The grain-size distribution of three samples from this fine-grained granular deposit is given in Figure Nos. D2-1 and D2-2, in Appendix D2.

These indicate:

Gravel	=	0 to 2 %
Sand	=	63 to 93 %
Silt & Clay	=	7 to 37 %

N-values recorded in this material ranged from 3 to 14 blows/0.3 m. Based on these values, the relative density of the soil is described as very loose to compact.

4.4.3 CLAY

Underlying the surficial layers of topsoil/peaty topsoil and sand, all the boreholes encountered a major deposit of clay at depths ranging from 0.2 to 2.1 m below the ground surface.

The clay extends to the full depth of exploration (i.e. about 7 to 16 m below the ground surface) except in Borehole 17+200 Rt, where the clay extends to a depth of 14.2 m.

DCPTs put down below the bottom of Boreholes 16+800 Rt and 17+450 Rt indicated that the clay probably extends to about 13 m (El. 175 m) and 24 m (El. 158 m), respectively, at these borehole locations.

In general, the clay is a highly plastic (fat) material with some medium and occasional low plasticity (lean) clay structure zones/layers or seams.

Index properties of 4 samples from the clay deposit were determined in the laboratory and these indicate the following results,

Liquid Limit :	55 – 69 %
Plastic Limit :	25 – 28 %
Plasticity Index :	30 – 41 %

As shown in Figure D2-3, Appendix D2, these results are characteristic of clays of high plasticity.

The results of two consolidation (oedometer) tests performed on samples from the clay deposit within this section are presented in Figure Nos. D2-4 and D2-5, Appendix D2. The test results show the probable pre-consolidation pressure (P_c) ranged from 33 to 98 kPa, which are about 18 to 30 kPa, in excess of the existing effective overburden pressure.

N-values generally ranging from 0 to 10 blows/0.3 m were recorded in this deposit. In most cases, however, the recorded values were 0 to 2 blows/0.3 m. Undrained in-situ shear strengths as measured by field vane tests ranged from 12 to 66 kPa. These values indicate that the consistency of the material can be described as very soft to stiff, but generally very soft to firm. A combined plot of all the in-situ vane test results from all the boreholes is presented in Figure D3-1, in Appendix D3. Figure D3-2 shows typical plot of undrained shear strength versus elevation at the location of Borehole 17+300 Lt.

Dynamic Cone Penetration Tests (DCPT) performed from the bottom of Boreholes 16+800 Rt and 17+450 Rt showed the probable presence of a more competent layer below depths of about 14 m and 24.5 m, respectively. The DCPT showed refusal at 17.2 m and 26.6 m at these two borehole locations, respectively.

4.4.4 SILTY SAND TILL

Below the clay in Borehole 17+200 Rt, a silty sand till was encountered at a depth of 14.2 m and this extends to the remaining depth of the borehole (15.7 m). This deposit is a heterogeneous mixture of silt and sand with gravel and clay size particles.

A grain-size distribution analysis was performed on a sample from this layer and the results are presented in Figure D2-6, Appendix D2. The results indicate the following particle-size distribution:

Gravel	=	30%
Sand	=	43%
Silt & Clay	=	27%

Measured N-value of 16 blows/0.3 m was recorded in the silty sand till indicating a compact relative density. However, DCPT performed from the bottom of the borehole showed the possible presence of a weak zone (i.e., probably loose to very loose) at a dept of 17 m. The test recorded refusal at a depth of 2 m below this or at a depth of 19 m below the ground surface.

4.4.5 GROUNDWATER CONDITIONS

The area is generally low lying and poorly drained, consequently, the groundwater can generally be expected at or near the ground surface level.

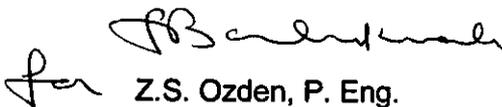
Based on observations made in the boreholes while drilling, water contents of the samples and the colour of the clay being reddish grey to grey, it is our opinion that the groundwater level at the site was at or very close to the ground surface.

It should be pointed out that both surface and groundwater levels can be expected to fluctuate seasonally and in response to major weather events. In addition, due to the pervious nature of the surficial sand layer overlying the impervious clay deposit, perched water condition could also be expected.

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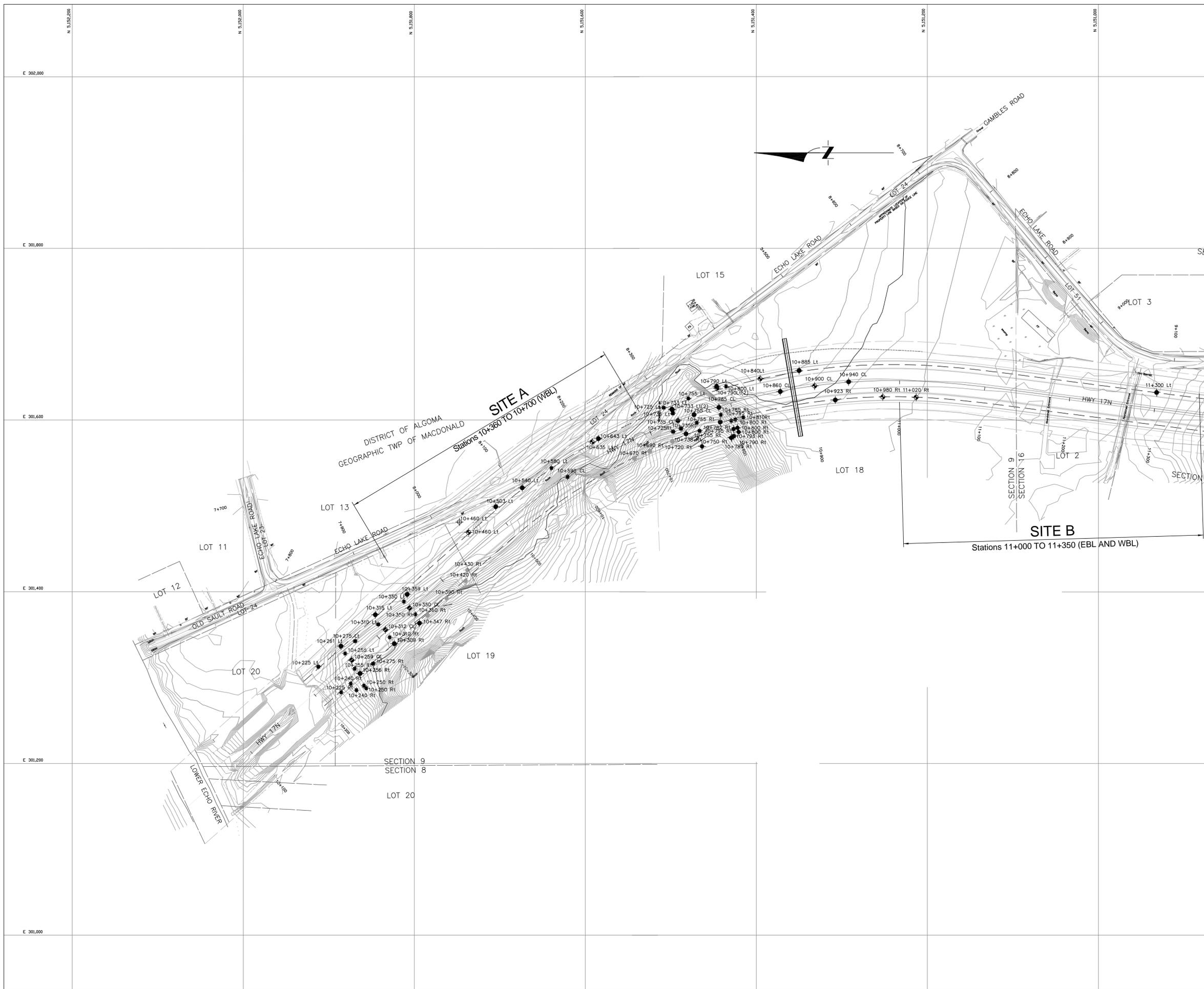

R. Miranda, P. Eng.




Z.S. Ozden, P. Eng.



Drawings



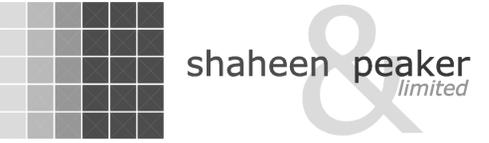
LEGEND

- Bore Hole
- ⊕ Dynamic Cone Penetration Test (Cone)
- ⊕ Bore Hole & Cone
- ⊕ Test Pit
- Bore Hole Done by DST Consulting Engineers Inc

No	ELEVATION	CO-ORDINATES		No	ELEVATION	CO-ORDINATES	
		NORTH	EAST			NORTH	EAST
10+225 Rt	184.0	5 151 885.4	301 283.0	10+460 Lt	182.6	5 151 736.6	301 469.3
10+225 Lt	182.2	5 151 912.1	301 312.8	10+460 Lt	182.0	5 151 747.1	301 481.4
10+240 Rt	185.6	5 151 874.2	301 293.0	10+503 Lt	182.5	5 151 704.7	301 499.2
10+240 Lt	185.5	5 151 867.6	301 285.5	10+540 Lt	182.6	5 151 673.7	301 521.1
10+250 Rt	186.9	5 151 858.8	301 290.7	10+580 Lt	184.4	5 151 639.6	301 544.1
10+250 Lt	187.0	5 151 856.1	301 287.7	10+590 CL	189.3	5 151 620.7	301 533.8
10+255 Lt	185.4	5 151 885.0	301 325.3	10+635 Lt	184.6	5 151 591.9	301 574.5
10+255 Rt	186.7	5 151 869.7	301 310.4	10+643 Lt	185.0	5 151 584.7	301 578.5
10+256 Rt	187.3	5 151 863.4	301 304.9	11+020 Rt	190.0	5 151 213.2	301 626.5
10+259 CL	186.3	5 151 873.1	301 320.4	11+300 Lt	191.0	5 150 931.9	301 632.2
10+261 Lt	183.8	5 151 885.7	301 336.7	10+980 Rt	189.7	5 151 252.1	301 627.0
10+275 Lt	183.7	5 151 874.8	301 346.1	10+840 Lt	188.0	5 151 395.4	301 648.2
10+275 Rt	189.0	5 151 848.1	301 316.3				
10+309 Rt	189.3	5 151 823.4	301 339.7				
10+310 Lt	185.1	5 151 842.0	301 362.0				
10+310 Rt	188.3	5 151 828.7	301 347.0				
10+312 CL	187.0	5 151 833.7	301 355.8				
10+315 Lt	183.1	5 151 845.6	301 373.4				
10+347 Rt	189.5	5 151 793.9	301 363.5				
10+350 CL	185.9	5 151 805.5	301 381.1				
10+350 Rt	188.2	5 151 798.8	301 373.7				
10+350 Lt	184.0	5 151 812.2	301 388.6				
10+359 Lt	182.9	5 151 808.2	301 397.1				
10+725 Lt	190.8	5 151 508.4	301 614.4				
10+725 Rt	195.0	5 151 497.3	301 586.5				
10+733 Lt	191.7	5 151 498.7	301 612.8				
10+733 Lt(2)	191.7	5 151 498.3	301 611.9				
10+735 Rt	194.9	5 151 488.1	301 590.1				
10+735 Lt	192.5	5 151 493.3	301 606.8				
10+735 CL	193.7	5 151 491.7	301 599.4				
10+738 Rt	196.4	5 151 482.2	301 584.0				
10+750 Rt	200.2	5 151 464.7	301 568.9				
10+755 Rt	197.8	5 151 466.3	301 587.5				
10+755 Lt	196.7	5 151 469.6	301 596.9				
10+755 Lt	193.5	5 151 479.5	301 625.2				
10+755 CL	195.6	5 151 472.9	301 606.4				
10+782 Rt	197.6	5 151 442.2	301 597.8				
10+785 Rt	196.1	5 151 441.5	301 606.1				
10+785 CL	195.0	5 151 443.8	301 614.9				
10+789 Rt	198.7	5 151 429.4	301 579.5				
10+790 Lt	189.2	5 151 446.0	301 637.2				
10+790 Lt(2)	189.2	5 151 446.5	301 639.1				
10+790 Rt	198.6	5 151 428.5	301 579.8				
10+793 Rt	198.0	5 151 426.1	301 581.5				
10+795 Rt	197.0	5 151 426.5	301 589.7				
10+800 Lt	189.3	5 151 435.4	301 639.2				
10+800 Rt	195.0	5 151 428.5	301 600.7				
10+800 Rt	196.3	5 151 421.9	301 591.0				
10+800 Rt	196.7	5 151 420.5	301 586.2				
10+860 CL	188.6	5 151 372.0	301 633.3				
10+885 Lt	188.1	5 151 350.0	301 657.7				
10+900 CL	188.7	5 151 331.8	301 639.8				
10+923 Rt	189.6	5 151 307.6	301 623.5				
10+940 CL	189.2	5 151 292.1	301 644.7				

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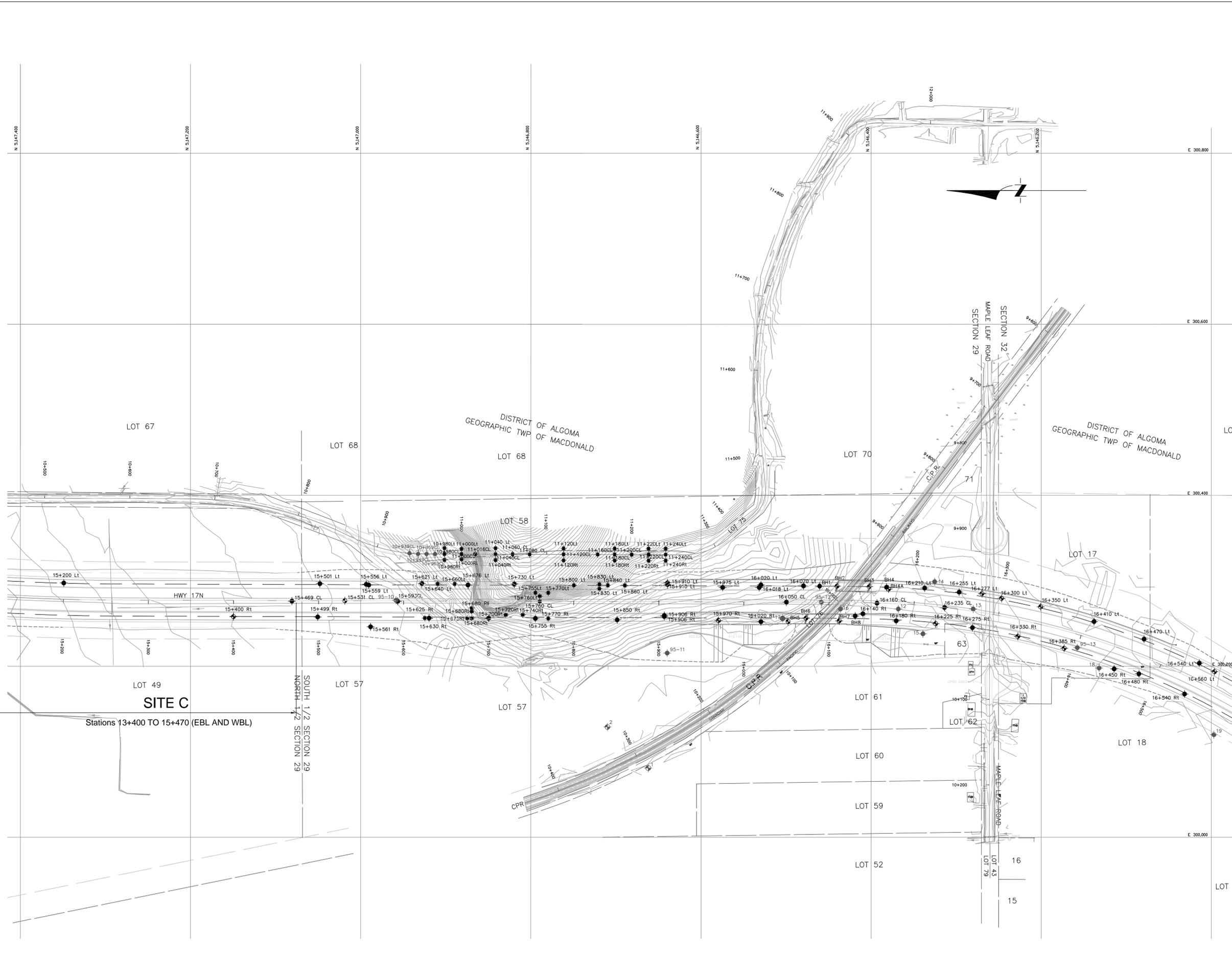
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HIGHWAY 17 (NEW) ECHO RIVER TO BAR RIVER ROAD

SAULT SAINT MARIE, DIST. 62

TITLE: BOREHOLE LOCATION PLAN	
SCALE: 1:2000	DATE: Sep. 2003
DRAWN BY: JZ	PROJECT NO.: SPT1055
APPROVED BY: ZO	DRAWING NO.: 1



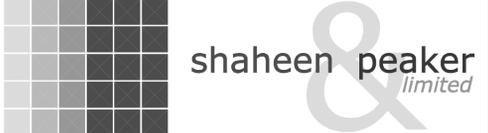
LEGEND

- Bore Hole
- ⊕ Dynamic Cone Penetration Test (Cone)
- ⊕ Bore Hole & Cone
- ⊕ Test Pit
- ⊕ Bore Hole Done by MTD, DST Consulting Engineers Inc, Golder Associates Ltd.
- ⊕ Bore Hole & Cone Done by MTD

No	ELEVATION	CO-ORDINATES NORTH	EAST	No	ELEVATION	CO-ORDINATES NORTH	EAST
15+200 Lt	185.7	5 147 349.0	300 297.4	BH3	188.5	5 146 402.1	300 293.1
15+400 Rt	187.0	5 147 149.6	300 258.1	BH4	188.6	5 146 381.8	300 292.5
15+469 CL	187.4	5 147 080.8	300 276.3	BH4A	188.6	5 146 379.6	300 290.3
15+499 Rt	187.4	5 147 050.5	300 257.7	BH5	188.6	5 146 497.6	300 252.3
15+501 Lt	187.5	5 147 048.0	300 296.6	BH6	188.6	5 146 476.6	300 256.3
15+531 CL	187.6	5 147 018.3	300 268.0	BH7	188.2	5 146 437.7	300 253.1
15+556 Lt	187.8	5 146 993.4	300 295.9	BH8	188.4	5 146 418.7	300 258.9
15+559 Lt	187.8	5 146 990.4	300 295.0	15+625 Rt	188.0	5 146 924.6	300 256.4
15+561 Rt	187.8	5 146 988.4	300 246.2	15+640 Lt	191.0	5 146 909.4	300 296.3
15+593 CL	188.0	5 146 956.5	300 276.0	15+660 Lt	193.8	5 146 889.4	300 296.3
15+621 Lt	191.1	5 146 928.0	300 296.8	15+675 Rt	191.9	5 146 874.6	300 256.2
15+630 Rt	187.9	5 146 919.6	300 256.4	15+680 Rt	192.5	5 146 869.6	300 256.2
15+676 Lt	194.9	5 146 873.9	300 295.0	15+680 Rt	193.6	5 146 869.5	300 268.2
15+700 Rt	195.0	5 146 849.6	300 256.2	15+720 Rt	196.1	5 146 869.5	300 264.2
15+730 Lt	211.8	5 146 819.4	300 296.1	15+740 Rt	195.8	5 146 809.5	300 260.0
15+755 Rt	195.7	5 146 794.6	300 256.0	15+755 Lt	204.1	5 146 794.5	300 286.0
15+850 Rt	192.6	5 146 698.5	300 254.3	15+760 CL	198.7	5 146 789.5	300 276.0
15+910 Lt	194.4	5 146 639.4	300 295.5	15+770 Lt	204.3	5 146 779.5	300 285.9
15+910 Lt	194.4	5 146 639.4	300 297.5	15+770 Rt	195.6	5 146 779.6	300 255.9
15+906 Rt	191.3	5 146 643.1	300 259.5	15+800 Lt	205.7	5 146 749.4	300 294.8
15+906 Rt	191.3	5 146 643.1	300 258.3	15+830 Lt	197.4	5 146 719.4	300 290.8
15+970 Rt	199.1	5 146 579.6	300 253.3	15+830 Lt	198.8	5 146 719.4	300 295.8
15+975 Lt	193.1	5 146 574.4	300 292.3	15+840 Lt	197.1	5 146 709.4	300 294.7
16+018 Lt	192.5	5 146 531.4	300 292.2	15+860 Lt	196.3	5 146 689.4	300 294.7
16+020 Lt	192.6	5 146 529.4	300 295.2	GOVERNMENT ROAD			
16+020 Rt	189.0	5 146 529.6	300 252.2	10+990 CL	196.3	5 146 901.4	300 331.3
16+050 CL	191.1	5 146 495.5	300 275.1	10+980 Rt	196.8	5 146 901.4	300 336.3
16+070 Lt	191.7	5 146 479.4	300 294.0	10+980 Rt	195.6	5 146 901.5	300 324.3
16+140 Rt	188.5	5 146 409.8	300 261.5	11+000 CL	197.2	5 146 881.4	300 331.3
16+160 CL	188.6	5 146 393.1	300 273.8	11+000 Rt	196.6	5 146 881.5	300 325.3
16+180 Rt	188.8	5 146 370.5	300 253.2	11+000 Lt	197.7	5 146 881.4	300 337.3
16+210 Lt	188.7	5 146 337.1	300 291.5	11+016 CL	201.7	5 146 865.4	300 331.2
16+225 Rt	188.9	5 146 324.0	300 249.9	11+040 CL	212.6	5 146 841.4	300 331.1
16+235 CL	189.0	5 146 313.6	300 268.8	11+040 Rt	211.4	5 146 841.5	300 324.1
16+255 Lt	188.6	5 146 296.5	300 286.7	11+040 Lt	213.9	5 146 841.4	300 338.1
16+275 Rt	189.8	5 146 280.9	300 245.2	11+060 CL	214.7	5 146 821.4	300 331.1
16+277 Lt	188.2	5 146 269.7	300 285.1	11+080 CL	212.1	5 146 801.4	300 331.0
16+300 Lt	188.0	5 146 246.7	300 279.5	11+120 CL	212.1	5 146 781.4	300 330.9
16+330 Rt	188.0	5 146 227.5	300 234.9	11+120 Rt	211.3	5 146 781.5	300 323.9
16+350 Lt	187.6	5 146 200.7	300 269.6	11+120 Lt	212.9	5 146 781.4	300 337.9
16+385 Rt	187.8	5 146 173.1	300 221.1	11+160 CL	205.9	5 146 721.4	300 330.8
16+410 Lt	187.5	5 146 137.6	300 294.1	11+180 CL	203.5	5 146 701.4	300 330.7
16+450 Rt	187.4	5 146 114.3	300 196.9	11+180 Rt	204.3	5 146 701.4	300 337.7
16+470 Lt	186.7	5 146 081.9	300 228.6	11+180 Lt	202.8	5 146 701.5	300 323.7
16+480 Rt	187.2	5 146 085.2	300 191.2	11+200 CL	201.4	5 146 681.4	300 330.6
16+540 Lt	187.3	5 146 014.2	300 203.6	11+220 CL	199.4	5 146 661.4	300 330.6
16+540 Rt	187.2	5 146 031.5	300 167.6	11+220 Lt	201.4	5 146 661.4	300 337.6
16+560 Lt	187.1	5 145 996.3	300 193.7	11+220 Rt	198.4	5 146 661.5	300 323.6
BH1	190.8	5 146 460.4	300 293.7	11+240 CL	197.5	5 146 641.4	300 330.5
BH2	189.4	5 146 440.4	300 293.6	11+240 Lt	198.4	5 146 641.4	300 337.5
				11+240 Rt	196.9	5 146 641.5	300 323.5

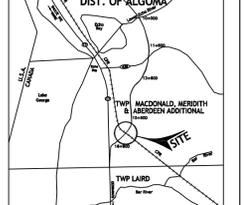
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NO.	DESCRIPTION	DATE

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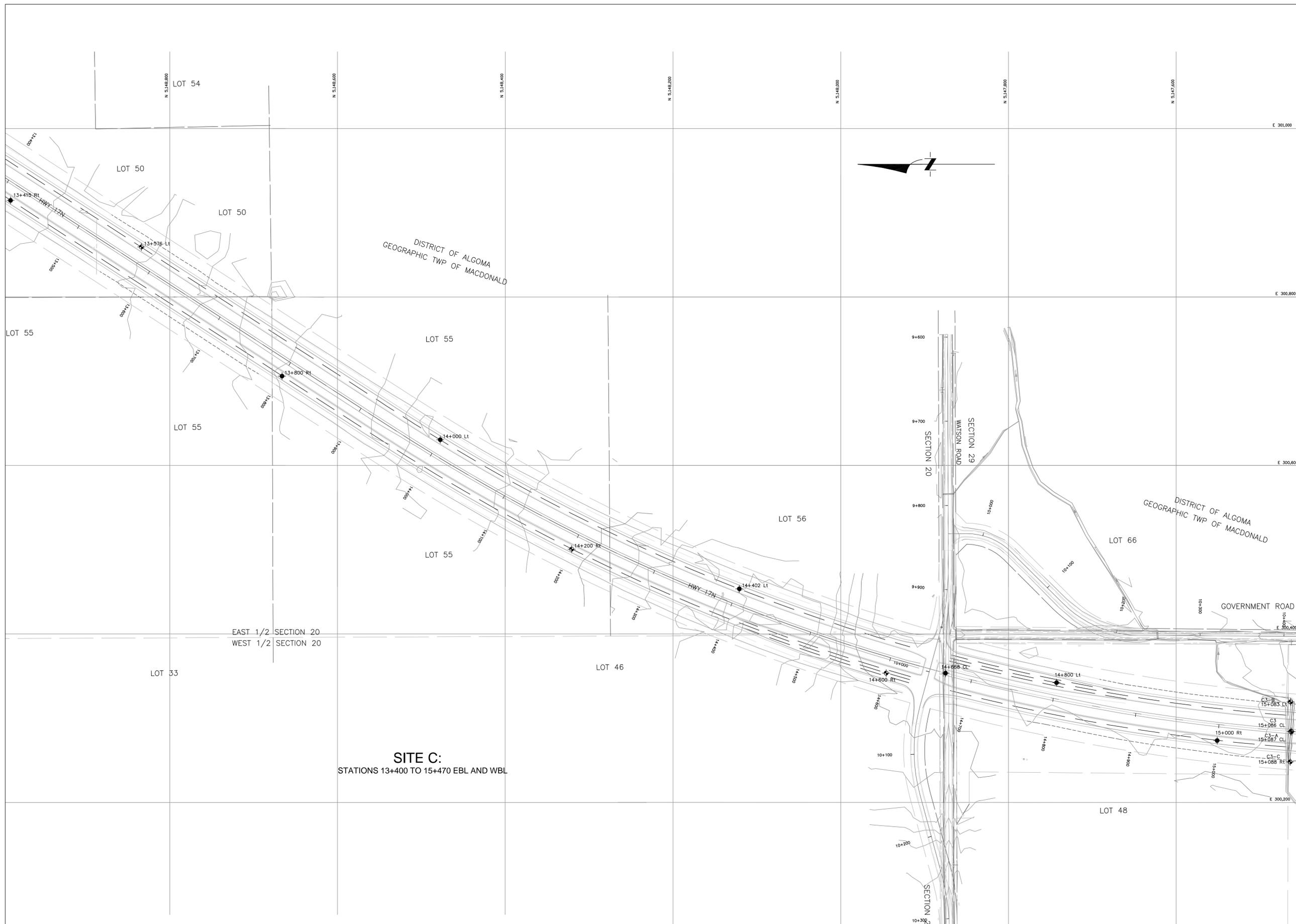



**HIGHWAY 17 (NEW)
ECHO RIVER TO
BAR RIVER ROAD**

SAULT SAINT MARIE, DIST. 62

TITLE: **BOREHOLE LOCATION PLAN**

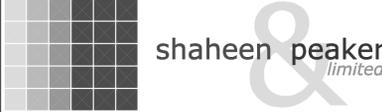
SCALE: 1:2000	DATE: Sep.2003
DRAWN BY: JZ	PROJECT NO.: SPT1055
APPROVED BY: ZO	DRAWING NO.: 4



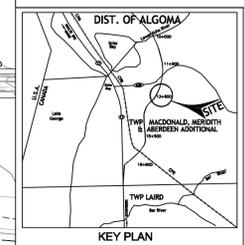
LEGEND			
◆	Bore Hole		
◆	Bore Hole & Cone		
No	ELEVATION	CO-ORDINATES	
		NORTH	EAST
13+415 Rt	180.2	5 148 989.8	300 914.6
13+576 Lt	180.9	5 148 833.9	300 859.4
13+800 Rt	182.5	5 148 666.2	300 706.1
14+000 Lt	183.8	5 148 477.5	300 630.6
14+200 Rt	184.7	5 148 320.8	300 500.7
14+402 Lt	186.4	5 148 120.8	300 453.6
14+600 Rt	184.8	5 147 945.8	300 353.5
14+668 CL	185.0	5 147 875.0	300 353.5
14+800 Lt	184.3	5 147 742.6	300 342.2
15+000 Rt	184.5	5 147 551.1	300 273.5
C3-B	184.6	5 147 463.6	300 319.3
C3	184.4	5 147 463.3	300 284.2
C3-A	184.5	5 147 462.3	300 284.1
C3-C	184.5	5 147 464.0	300 248.2

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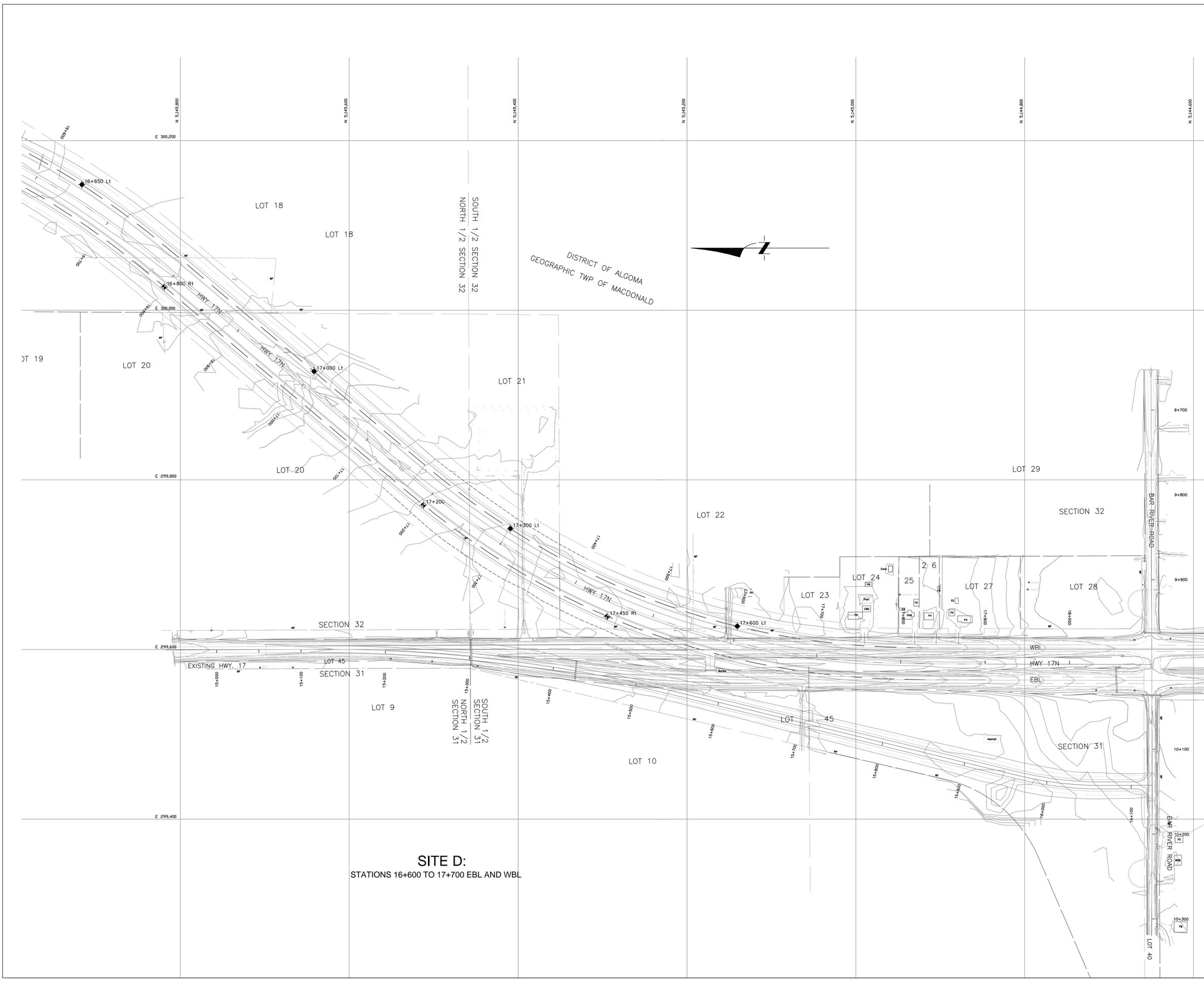


HIGHWAY 17 (NEW) ECHO RIVER TO BAR RIVER ROAD

SAULT SAINT MARIE, DIST. 62

TITLE:
BOREHOLE LOCATION PLAN

SCALE: 1:2000	DATE: Sep.2003
DRAWN BY: JZ	PROJECT NO.: SPT1055
APPROVED BY: ZO	DRAWING NO.: C



LEGEND			
◆	Bore Hole		
◆	Bore Hole & Cone		
No	ELEVATION	CO-ORDINATES	
		NORTH	EAST
16+650 Lt	187.6	5 145 916.5	300 148.1
16+800 Rt	187.4	5 145 819.2	300 027.4
17+000 Lt	186.3	5 145 641.6	299 927.9
17+200 Rt	182.9	5 145 512.2	299 770.2
17+300 Lt	182.5	5 145 409.1	299 742.5
17+450 Rt	182.4	5 145 294.5	299 638.8
17+600 Lt	183.2	5 145 140.4	299 627.4

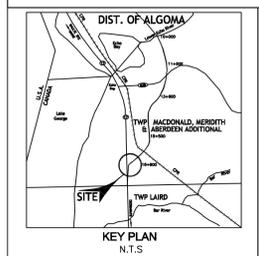


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shaheen & peaker
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transportation & building science engineers

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HIGHWAY 17 (NEW) ECHO RIVER TO BAR RIVER ROAD

SAULT SAINT MARIE, DIST. 62

TITLE:
BOREHOLE LOCATION PLAN

SCALE: 1:2000	DATE: Sep.2003
DRAWN BY: JZ	PROJECT NO.: SPT1055
APPROVED BY: ZO	DRAWING NO.: D

APPENDICES

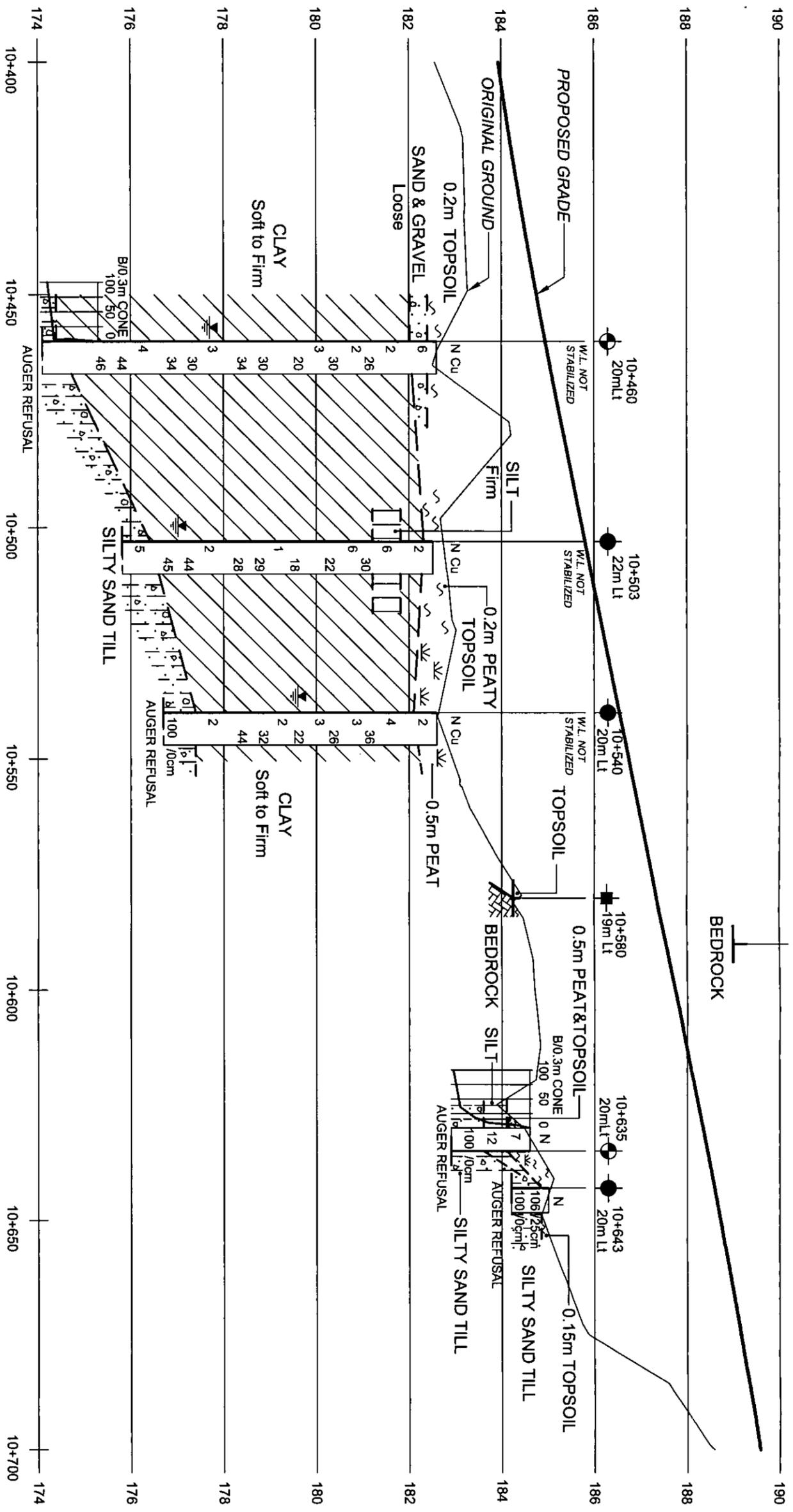
FOR SITE A

Drawing

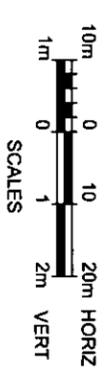
(Soil Strata)

METRIC

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



PROFILE WESTBOUND LANES

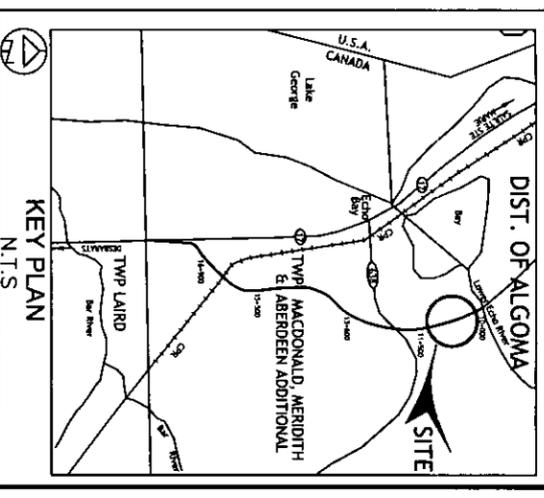


NOTE:
FOR DETAILED SUBSURFACE CONDITIONS OF ALL
BOREHOLES REFER TO RECORD OF BOREHOLE
SHEETS.



CONT NO.	
GWP: 354-94-00	
HIGHWAY 17 (NEW) WBL ECHO RIVER TO BAR RIVER ROAD ADDITIONAL WORK(STA. 10+360 TO 10+700) BORE HOLE SOIL STRATA	

SHAHEEN & PEAKER LIMITED



LEGEND

- Bore Hole
 - Bore Hole & Cone
 - N Blows/0.3m (Std. Pen. Test, 475 Jblow)
 - Cu Undrained Shear Strength measured by Field Vane Test
 - Test Pit
 - ▲ Water Level at Time of Investigation
- Jun. 2002

No.	ELEV.	CO-ORDINATES	
		NORTH	EAST
10+460 Lt	182.6	5 151 736.6	301 469.3
10+503 Lt	182.5	5 151 704.7	301 499.2
10+540 Lt	182.6	5 151 673.7	301 521.1
10+580 Lt	184.4	5 151 639.6	301 544.1
10+590 CL	189.3	5 151 620.7	301 533.8
10+635 Lt	184.6	5 151 591.9	301 574.5
10+643 Lt	185.0	5 151 584.7	301 578.5

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.

Geocres No. 41KD0-063		DIST 62	
HWY No. 17 (New)	CHECKED RM	DATE Sep. 2003	SITE
SUBMD ZO	CHECKED	APPROVED	DWG A

Appendix A1

Site A

Record of Borehole Sheets and Test Pit Logs

SPT 1055

RECORD OF BOREHOLE No 10+460; 20 m Lt 1 OF 1 METRIC

GWP 354-94-00 LOCATION Echo River to Bar River Road, Sault Ste. Marie - Coords: N 5 151 736.6; E 301 489.3 ORIGINATED BY Y.L.
 DIST 62 HWY 17 (New) BOREHOLE TYPE Hollow Stem Augers COMPILED BY Y.L.
 DATUM Geodetic DATE 6/3/2003 CHECKED BY R.A.

SOIL PROFILE		STRAT PLOT	SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT w _p	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)	
ELEV. DEPTH	DESCRIPTION		NUMBER	TYPE	"N" VALUES			20	40	60						80
182.6	Ground Surface															
0.0	0.2 m Topsoil	○	1	SS	6	**									** Low recovery, auger sample taken	
182.0	SAND and GRAVEL grey/brown, wet, loose	○	2	SS	2								15.5			
0.6	CLAY occasional silt seams and pockets reddish grey, wet soft to firm	▨	3	SS	2											
			4	SS	3											
			5	TW	PH											
			6	SS	3											
			7	SS	4										15.1	
			8	AS	-											
			9	AS	-											
174.4	SILTY SAND TILL grey, wet	○	8	AS	-											
8.2	End of Borehole.															
174.1	Dynamic Cone Penetration Test (D.C.P.T) performed from 7.3 m to 8.4 m.															
8.5	Auger refusal at 8.5 m															
	* Water level at 4.9 m (not stabilized), and hole open to full depth on completion.															

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

SPT 1055

RECORD OF BOREHOLE No 10+460; 36 m Lt 1 OF 1 METRIC

GWP 354-94-00 LOCATION Echo River to Bar River Road, Sault Ste. Marie - Coords: N 5 151 747.1; E 301 481.4 ORIGINATED BY Y.L.
 DIST 62 HWY 17 (New) BOREHOLE TYPE D.C.P.T. COMPILED BY Y.L.
 DATUM Geodetic DATE 8/3/2003 CHECKED BY R.A.

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV. DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			"N" VALUES	SHEAR STRENGTH kPa						
182.0 0.0	Ground Surface						20 40 60 80 100	20 40 60						
172.6 9.4	End of D.C.P.T. Dynamic Cone Penetration Test (D.C.P.T) performed from 0 m to 9.4 m.						20 40 60 80 100	20 40 60						

+ 3. x 3. Numbers refer to Sensitivity 20 15 10 (% STRAIN AT FAILURE

SPT 1055

RECORD OF BOREHOLE No 10+503; 22 m Lt 1 OF 1 METRIC

GWP 354-94-00 LOCATION Echo River to Bar River Road, Sault Ste. Marie - Coords: N 5 151 704.7; E 301 499.2 ORIGINATED BY Y.L.
 DIST 62 HWY 17 (New) BOREHOLE TYPE Hollow Stem Augers COMPILED BY Y.L.
 DATUM Geodetic DATE 6/3/2003 CHECKED BY R.A.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)			
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa									WATER CONTENT (%)		
							20	40	60	80	100	20	40	60	GR	SA	SI	CL	
182.5	Ground Surface																		
0.0	0.2 m Peaty Topsoil		1	SS	2														
181.8	CLAY reddish grey, damp																		
0.7	SILT some clay, grey, wet, firm		2	SS	6														0 2 71 27
181.2																			
1.3			3	SS	6														
	CLAY reddish grey, wet soft to firm		4	TW	PH										14.8				0 0 52 48
			5	SS	1														
			6	SS	2										15.3				
176.4																			
6.1	SILTY SAND TILL grey, wet		7	SS	5*														* possibly disturbed
175.8																			
6.7	End of Borehole.																		
	* Water level at 5.5 m (not stabilized), and hole open to full depth on completion.																		

+³, X³: Numbers refer to Sensitivity $\frac{20}{15} \times \frac{5}{10}$ (%) STRAIN AT FAILURE

SPT 1055

RECORD OF BOREHOLE No 10+540; 20 m Lt 1 OF 1 METRIC

GWP 354-94-00 LOCATION Echo River to Bar River Road, Sault Ste. Marie - Coords: N 5 151 673.7; E 301 521.1 ORIGINATED BY Y.L.
 DIST 62 HWY 17 (New) BOREHOLE TYPE Hollow Stem Augers COMPILED BY Y.L.
 DATUM Geodetic DATE 6/3/2003 CHECKED BY R.A.

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT w _p	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)		
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			"N" VALUES	SHEAR STRENGTH kPa									WATER CONTENT (%)	
						20	40	60	80	100	20	40	60	KN/m ³	GR SA SI CL			
182.8	Ground Surface																	
0.0	PEAT																	
182.0	dark brown to black, wet, soft		1	SS	2									12				
0.5	CLAY occasional silt seams and pockets wet, soft to firm reddish gray grey, with silt layers		2	SS	4									17.5				
			3	SS	3										16.1			
			4	SS	3													
			5	SS	2													
			6	SS	2													
177.4		SILTY SAND TILL		7	AS	-										10	43	34
5.2	gery, wet																	
176.6	End of Borehole.		8	SS	100/0													
5.9	Auger refusal at 5.9 m, probably on a cobble or boulder. Moved to Sta. 10+542; 20m Lt, auger refusal at 5.9 m; moved to Sta. 10+538; 20 m Lt, auger refusal at 5.8 m. * Water level at 3.0 m (not stabilized), and hole open to full depth on completion. ** Unable to push vane below 5.2 m. *** Rod and Sampler bouncing, refusal probably on a cobble or boulder.																	

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

SPT 1055

RECORD OF BOREHOLE No 10+635; 20 m Lt 1 OF 1 METRIC

GWP 354-94-00 LOCATION Echo River to Bar River Road, Sault Ste. Marie - Coords: N 5 151 591.9; E 301 574.5 ORIGINATED BY Y.L.
 DIST 62 HWY 17 (New) BOREHOLE TYPE Solid Stem Augers COMPILED BY Y.L.
 DATUM Geodetic DATE 6/3/2003 CHECKED BY R.A.

ELEV. DEPTH	SOIL PROFILE DESCRIPTION	STRAT PLOT	SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT γ KN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)			
			NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa							WATER CONTENT (%)		
							20	40	60	80	100	W _p	W	W _L			
184.8	Ground Surface																
0.0	PEAT and TOPSOIL with rootlets, dark brown to black	[Strat Plot]	1	SS	7												
184.1																	
0.9																	
183.6	SILT some clay below 0.9 m grey, moist, firm to stiff	[Strat Plot]	2	SS	12												
1.0																	
183.0	Heterogeneous mixture of silt, sand and gravel, grey, moist, compact to dense (SILTY SAND TILL)	[Strat Plot]	3	SS	100/0												
1.7																	
	End of Borehole.																
	Auger refusal at 1.7 m, probably on a boulder or bedrock. Moved to Sta. 10+635; 22m Lt, auger refusal at 1.5 m; moved to Sta. 10+635; 18 m Lt, auger refusal at 1.7 m.																
	* Borehole dry (not stabilized), and open to full depth on completion.																
	** Rod and Sampler bouncing, refusal probably on a boulder or bedrock. Auger sample collected.																

+ 3, x 3; Numbers refer to Sensitivity 20 15 10 5 10 (% STRAIN AT FAILURE

SPT 1055

RECORD OF BOREHOLE No 10+643; 20 m Lt 1 OF 1 METRIC

GWP 354-94-00 LOCATION Echo River to Bar River Road, Sault Ste. Marie - Coords: N 5 151 584.7; E 301 578.5 ORIGINATED BY Y.L.
 DIST 62 HWY 17 (New) BOREHOLE TYPE Solid Stem Augers COMPILED BY Y.L.
 DATUM Geodetic DATE 6/3/2003 CHECKED BY R.A.

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT w _p	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)		
ELEV. DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			"N" VALUES	20	40	60	80						100	20
185.0	Ground Surface																	
0.0	0.15 m Topsoil Heterogeneous mixture of silt, sand and gravel, grey, moist, very dense (SILTY SAND TILL)		1	SS	100/25													
184.2	End of Borehole. Auger refusal at 0.8 m, probably on bedrock. Moved to Sta. 10+642; 20m Lt, auger refusal at 0.3 m; moved to Sta. 10+643; 20 m Lt, auger refusal at 0.3 m. * Borehole dry (not stabilized), and open to full depth on completion. ** Rod and Sampler bouncing, auger sample collected.		2	SS	100/0													

TEST PIT LOGS

SITE A
HIGHWAY 17 (New), Sault Ste. Marie
(Offset distances are from median centreline)

Highway 17 (New)

10+580 19m Lt C/L (El. 184.4m)

0	-	150	Tps mixed with Sa and Gr, Moist
		150	NFP BR

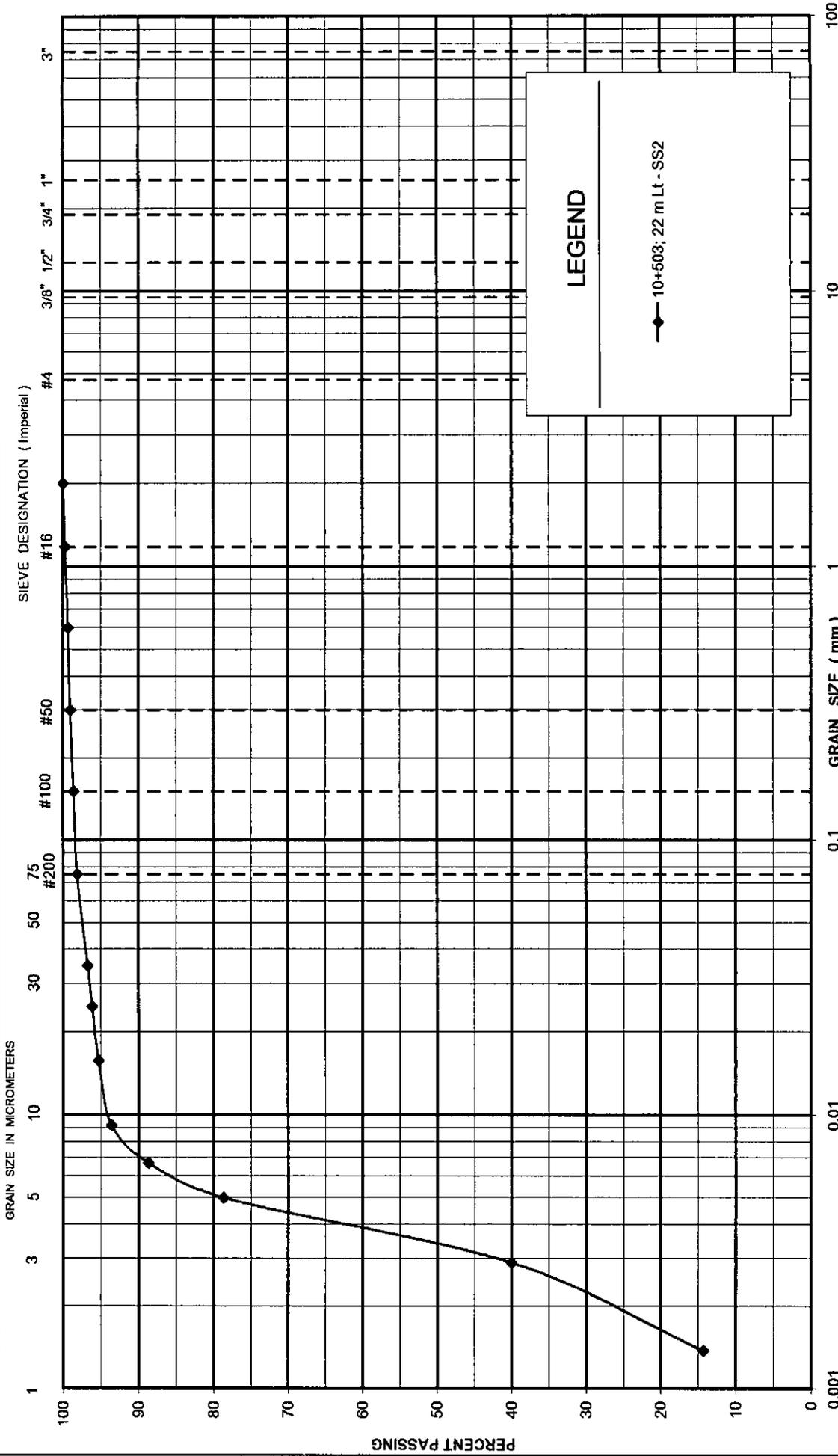
10+590 C/L (El. 189.3m)

0	-	300	Tps, Rootlets with Blds
		300	NFP BR

Appendix A2 Site A Laboratory Test Results

UNIFIED SOIL CLASSIFICATION SYSTEM

CLAY AND SILT		SAND			GRAVEL		
		Fine	Medium	Coarse	Fine	Coarse	



GRAIN SIZE DISTRIBUTION
SILT, some clay

SHAHEEN & PEAKER LIMITED

FIGURE No. A2 - 1
REF. No. SPT 1055
GWP: 354-94-00

UNIFIED SOIL CLASSIFICATION SYSTEM

CLAY AND SILT

SAND

GRAVEL

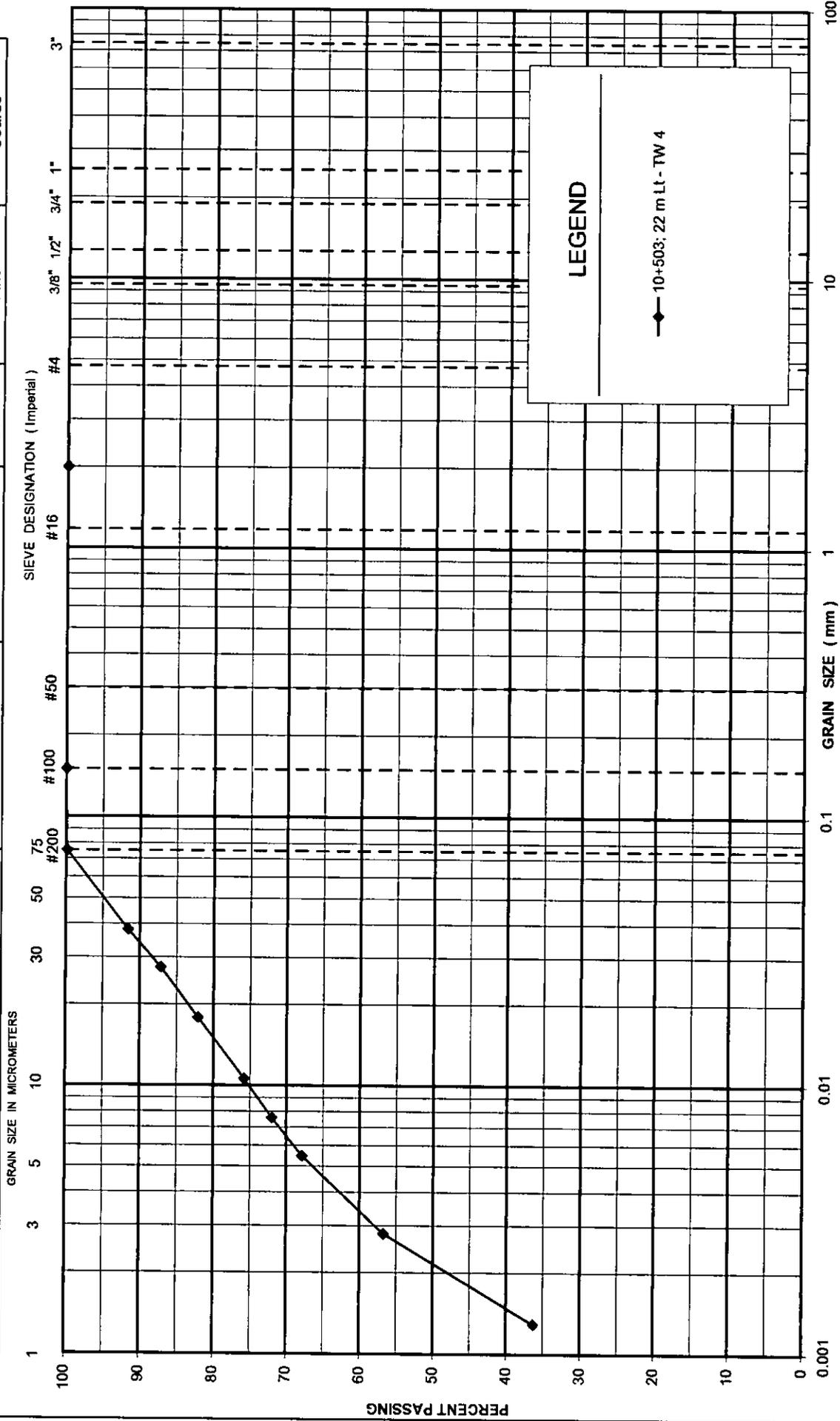
Fine

Medium

Coarse

Fine

Coarse



GRAIN SIZE DISTRIBUTION
CLAY

SHAHEEN & PEAKER LIMITED

FIGURE No. A2 - 2

REF. No. SPT 1055

GWP: 354-94-00

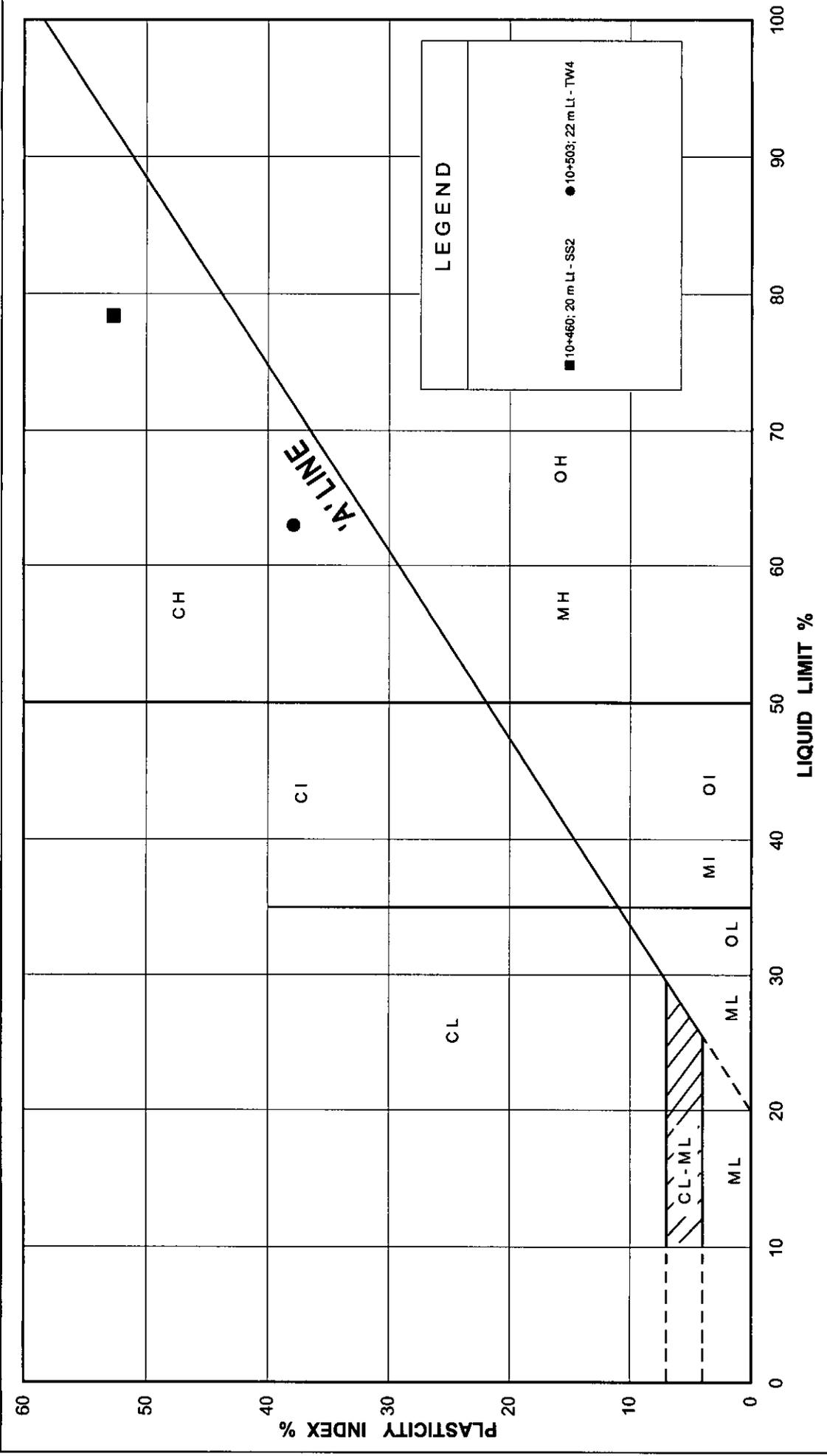


FIG No A2 - 3

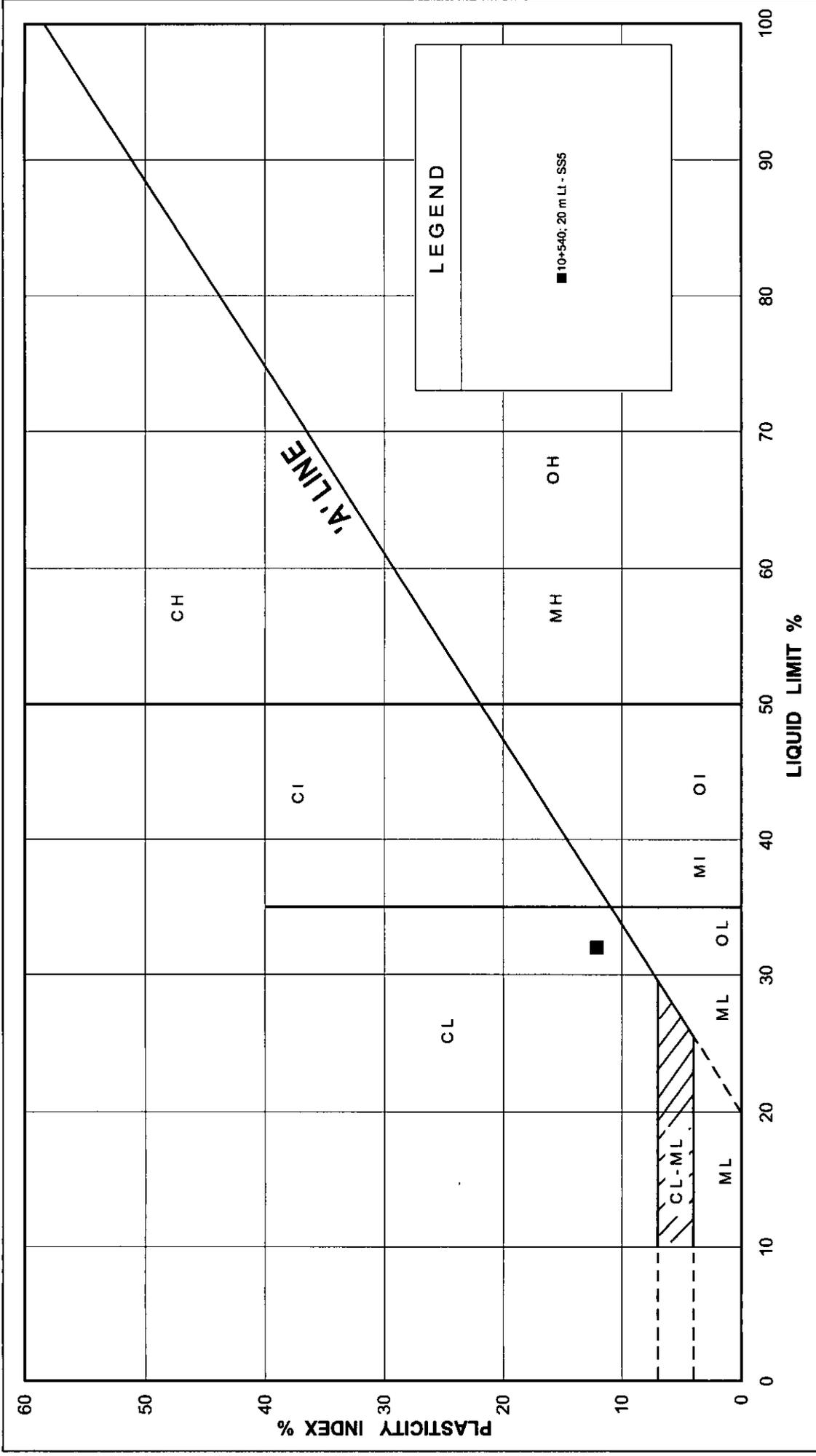
G.W.P. 354-94-00

SPT 1055

PLASTICITY CHART

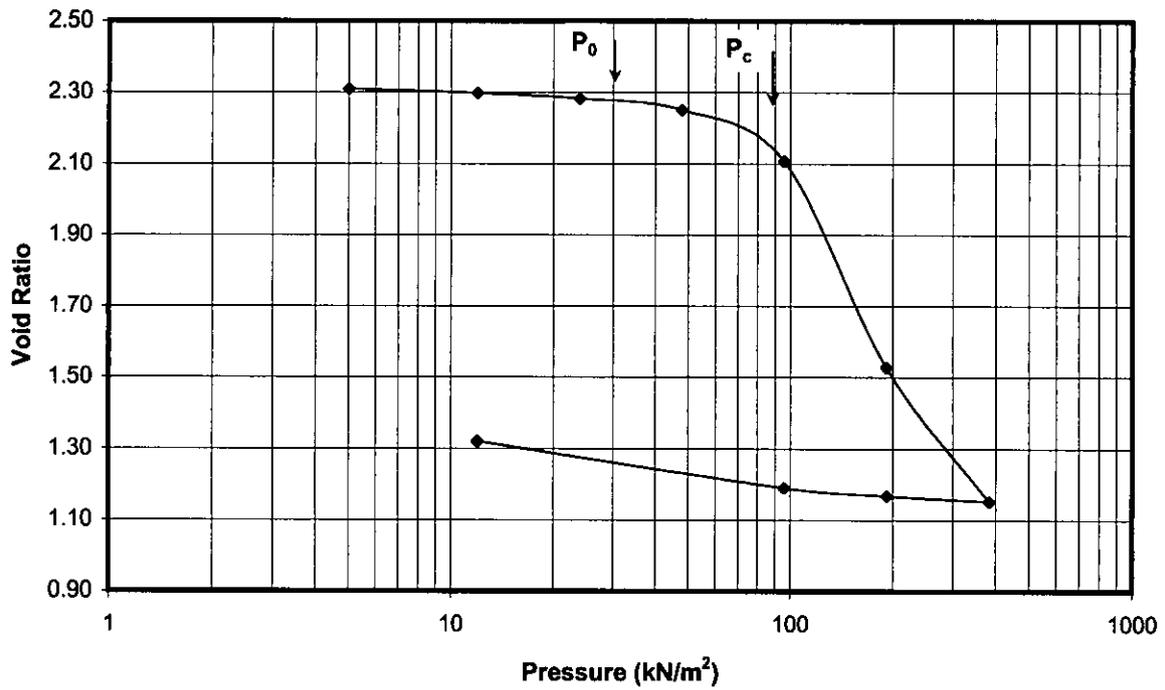
CLAY

SHAHEEN & PEAKER LIMITED

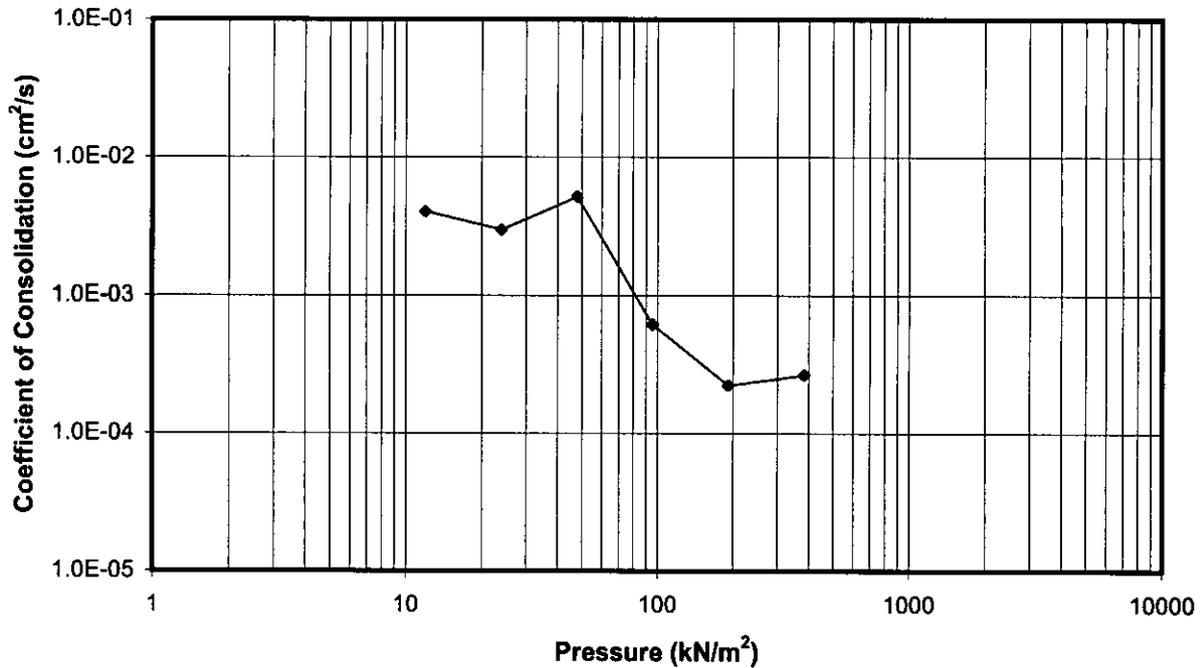


<p>PLASTICITY CHART</p> <p>CLAYEY SILT SEAMS in the Clay Deposit</p>	<p>FIG No A2 - 4</p> <p>G.W.P. 354-94-00</p> <p>SPT 1055</p>
<p>SHAHEEN & PEAKER LIMITED</p>	

Void Ratio versus Pressure

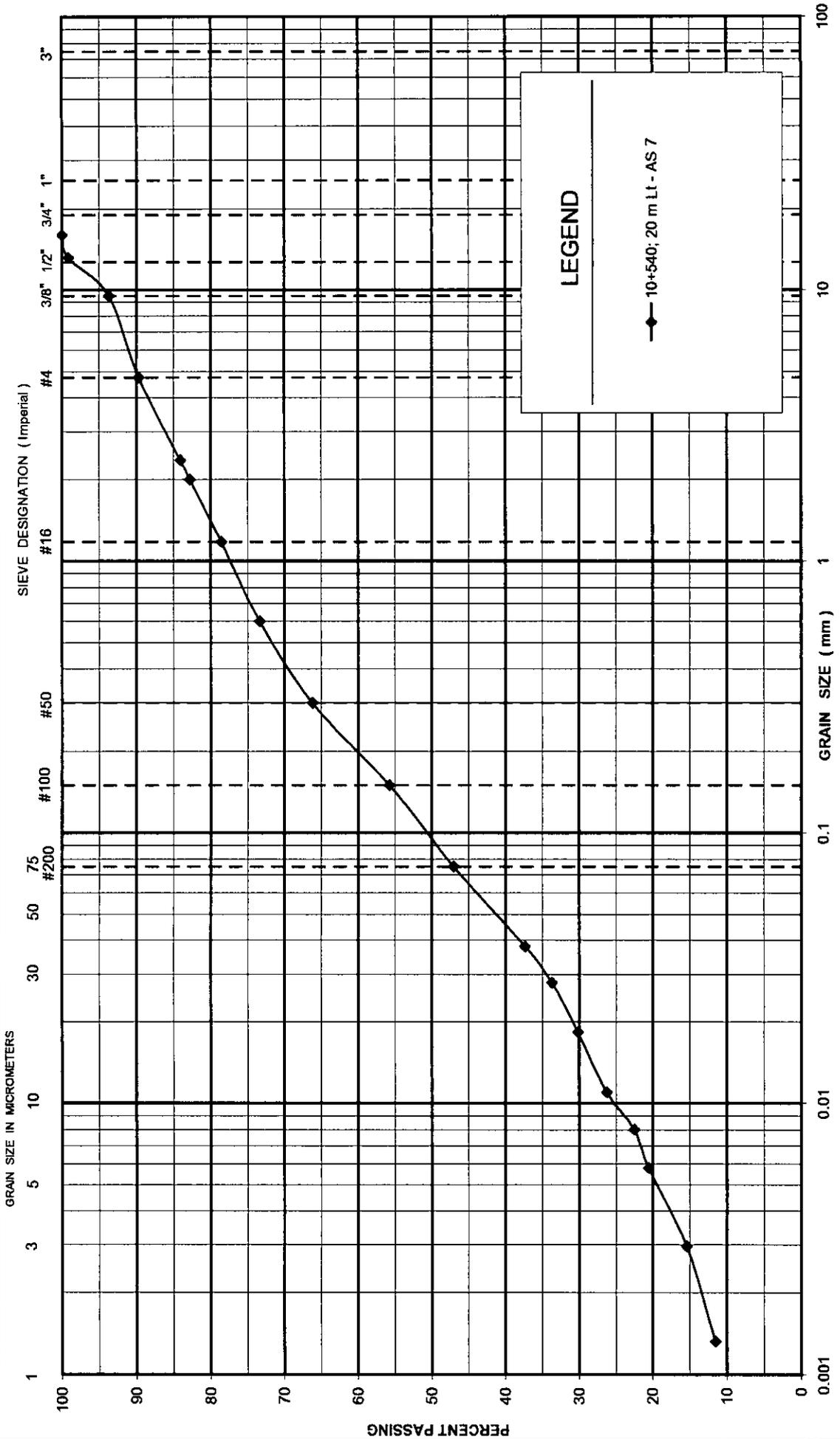


Coefficient of Consolidation vs. Pressure



UNIFIED SOIL CLASSIFICATION SYSTEM

CLAY AND SILT			SAND			GRAVEL		
			Fine	Medium	Coarse	Fine	Coarse	



**GRAIN SIZE DISTRIBUTION
SILTY SAND TILL**

FIGURE No. A2 - 6
REF. No. SPT 1055
GWP: 354-94-00

SHAHEEN & PEAKER LIMITED

Appendix A3

Site A

Measured Undrained Shear Strength Results

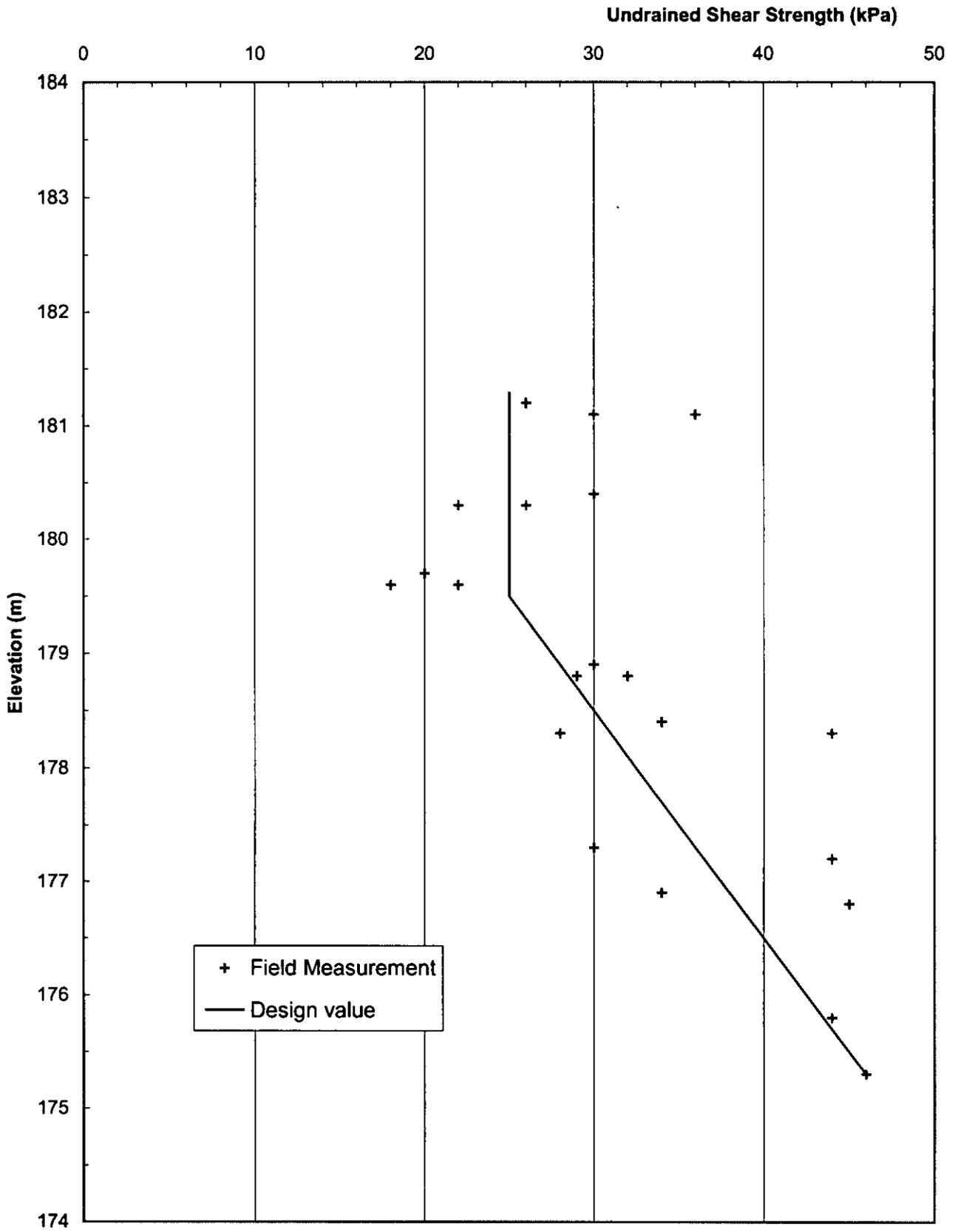


Fig. A3-1: Variation of Undrained Shear Strength (as measured by field vane tests) and the design value with Elevation in clay deposit

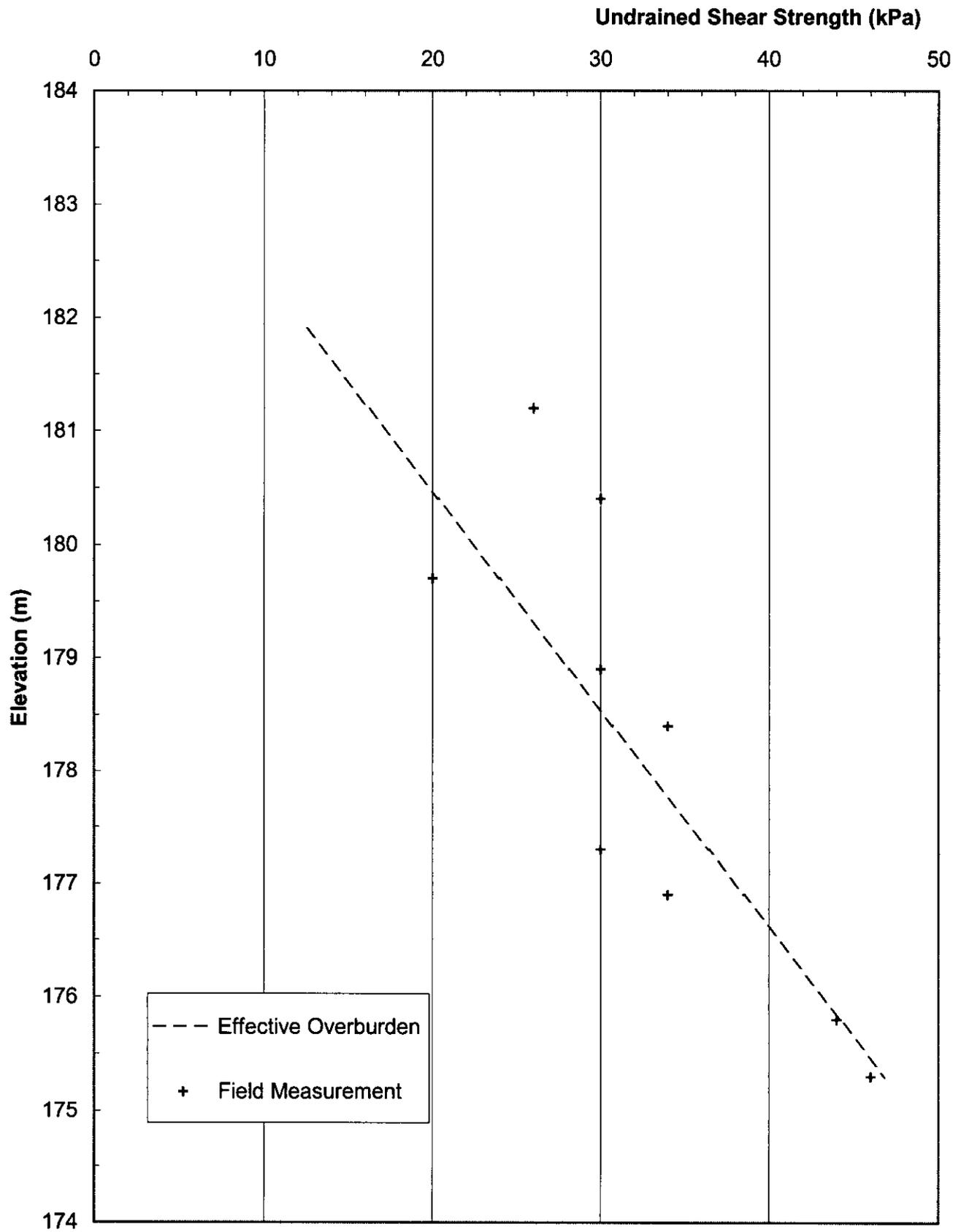


Fig. A3-2: Variation of Undrained Shear Strength (as measured by field vane tests) with Elevation (Boreholes 10+460; 20 m Lt)

APPENDICES

FOR SITE B

Drawing

(Soil Strata)

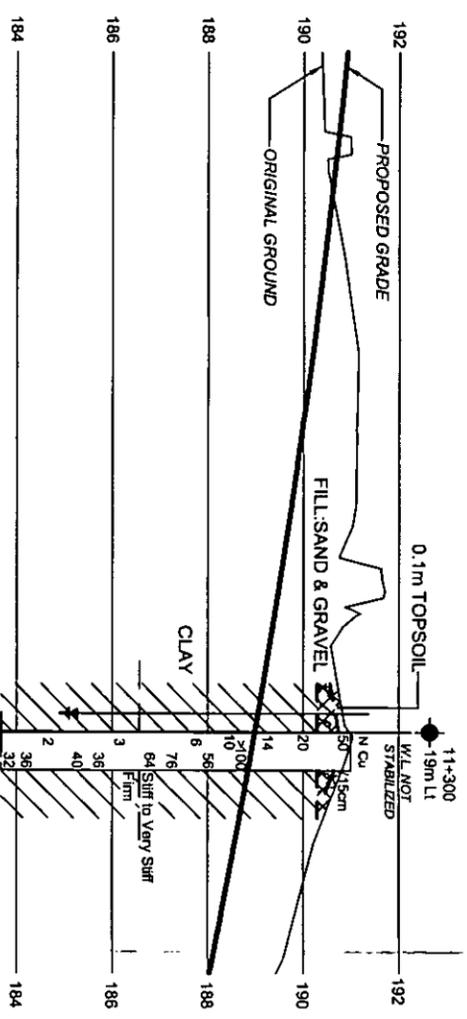
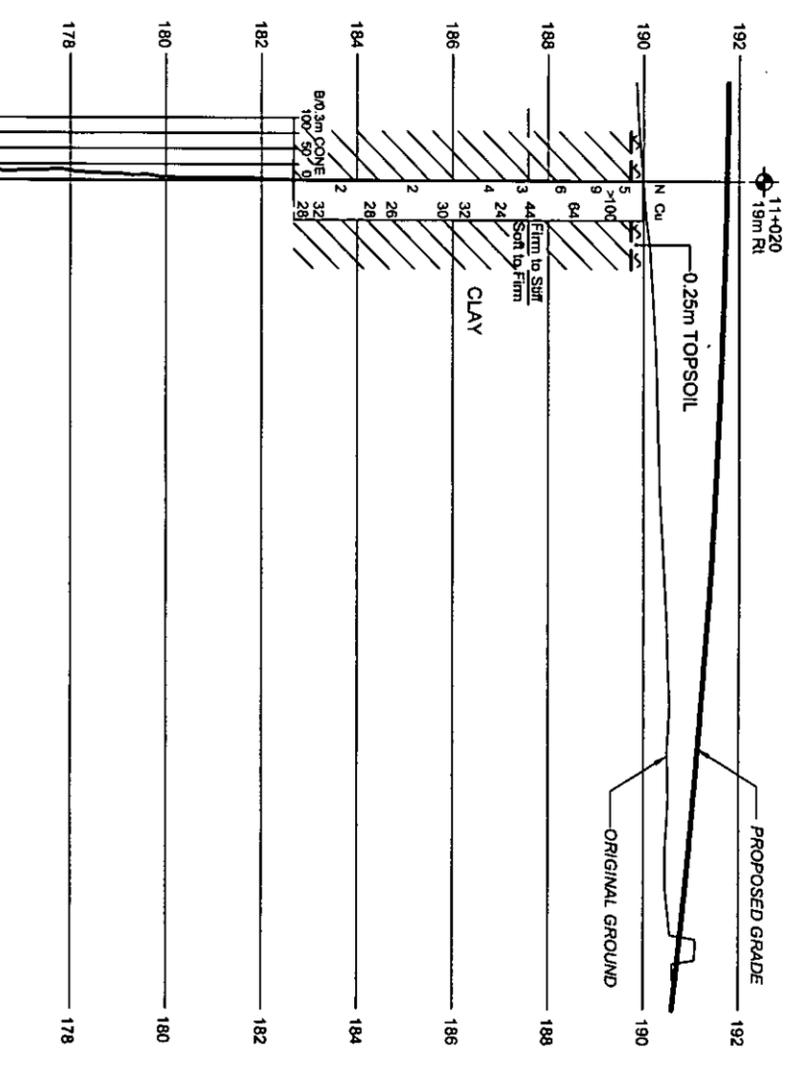
METRIC

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

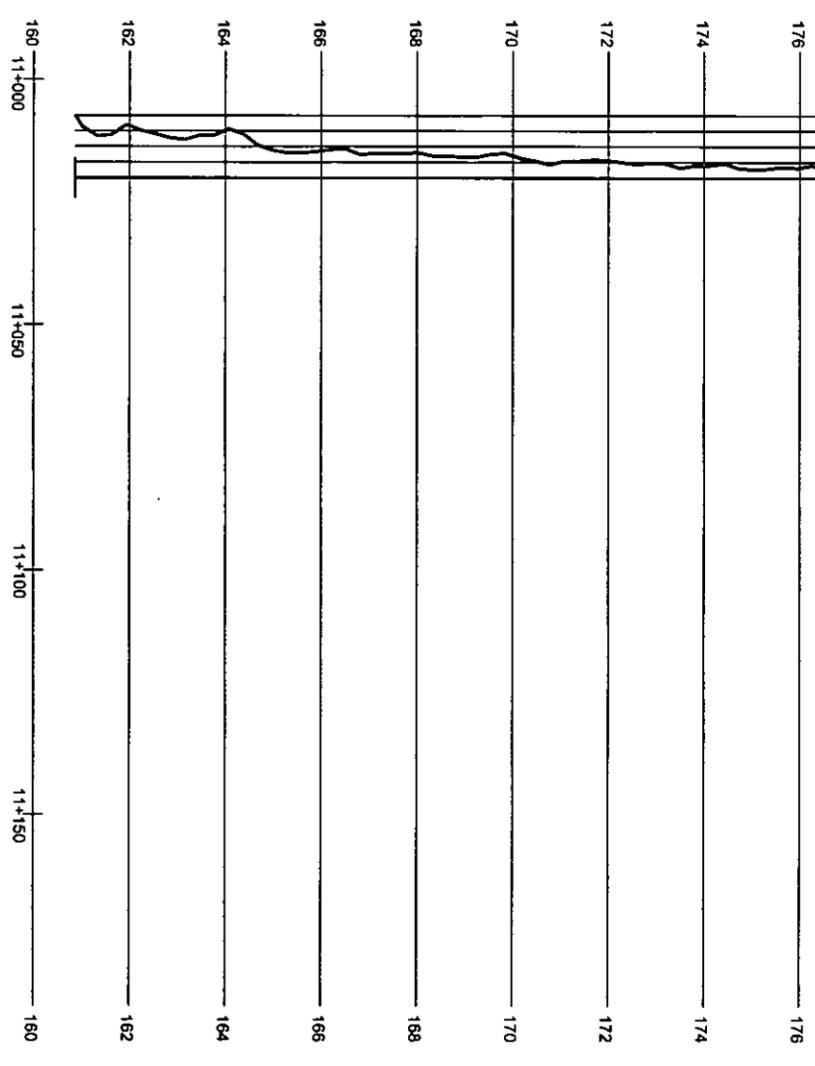
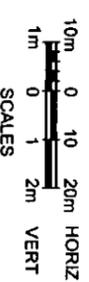
NOTE:
FOR DETAILED SUBSURFACE CONDITIONS OF ALL
BOREHOLES REFER TO RECORD OF BOREHOLE
SHEETS.

CONT NO.
GWP: 354-94-00
HIGHWAY 17 (NEW)
ECHO RIVER TO BAR RIVER ROAD
ADDITIONAL WORK(STA. 11+000 TO 11+350)
BORE HOLE SOIL STRATA

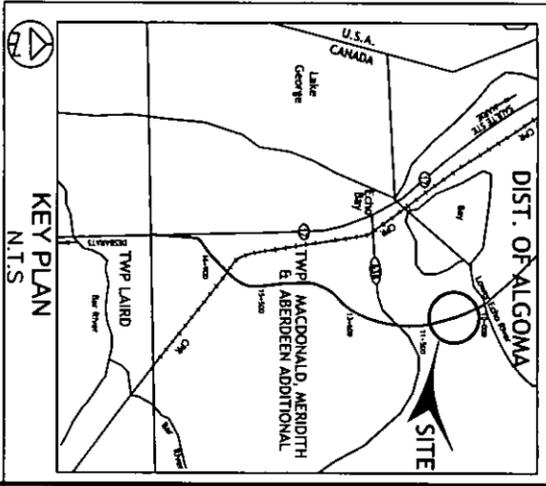
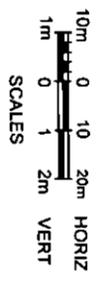
SHAHEEN & PEAKER LIMITED



PROFILE WESTBOUND LANES



PROFILE EASTBOUND LANES



LEGEND

- Bore Hole
- Bore Hole & Cone
- N Blows/0.3m (Std. Pen. Test, 475 Jblow)
- Cu Undrained Shear Strength measured by Field Vane Test
- Water Level in Piezometer
Jun., 2002
- ⊕ Piezometer

No.	ELEV.	CO-ORDINATES NORTH	EAST
11+020 RI	190.0	5 151 213.2	301 626.5
11+300 Lt	191.0	5 150 931.9	301 632.2

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 included in this report and related documents are specifically excluded in accordance with the conditions of Section GC 2.01 of OPS Gen. Cond.

DATE	BY	DESCRIPTION

Geocres No. 41K00-063		
Hwy No. 17 (New)		DIST 82
SUBMID ZO	CHECKED RM	DATE Sep. 2003
DRAWN 12	CHECKED	APPROVED
		DWG B



Appendix B1

Site B

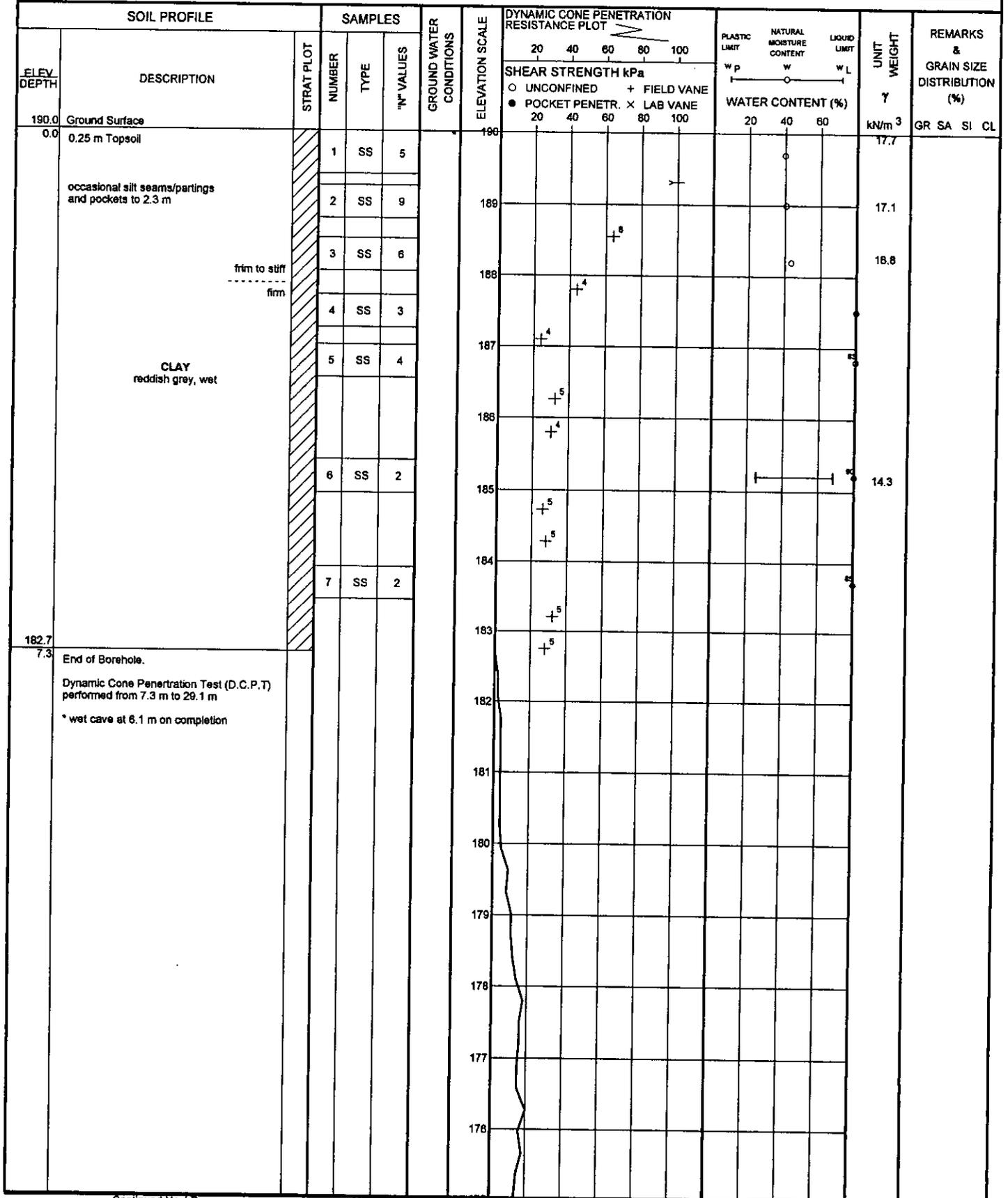
Record of Borehole Sheets

SPT1055

RECORD OF BOREHOLE No 11+020; 19 m Rt 1 OF 2

METRIC

GWP 354-94-00 LOCATION Echo River to Bar River Road, Sault Ste. Marie, ON - Coords: N 5 151 213.2; E 301 626.5 ORIGINATED BY G.I.
 DIST 62 HWY 17 (New) BOREHOLE TYPE Hollow Stem Augers & D.C.P.T. COMPILED BY Y.L.
 DATUM Geodetic DATE 6/2/2003 CHECKED BY R.A.



Continued Next Page

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

SPT1056

RECORD OF BOREHOLE No 11+020; 19 m Rt 2 OF 2 METRIC

GWP 354-04-00 LOCATION Echo River to Bar River Road, Sault Ste. Marie, ON - Coords: N 5 151 213.2; E 301 626.5 ORIGINATED BY G.I.
 DIST 62 HWY 17 (New) BOREHOLE TYPE Hollow Stem Augers & D.C.P.T. COMPILED BY Y.L.
 DATUM Geodetic DATE 8/2/2003 CHECKED BY R.A.

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100	PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT W _p W W _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV. DEPTH	DESCRIPTION	STRAT PLOT NUMBER	TYPE	T _v VALUES						
175										
174										
173										
172										
171										
170										
169										
168										
167										
166										
165										
164										
163										
162										
161										
160.8 28.1	End of D.C.P.T.									

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

SPT1055

RECORD OF BOREHOLE No 11+300; 19 m Lt 1 OF 1 METRIC

GWP 354-94-00 LOCATION Echo River to Bar River Road, Sault Ste. Marie, ON - Coords: N 5 150 931.9; E 301 632. 2 ORIGINATED BY G.I.
 DIST 62 HWY 17 (New) BOREHOLE TYPE Hollow Stem Augers COMPILED BY Y.L.
 DATUM Geodetic DATE 6/2/2003 CHECKED BY R.A.

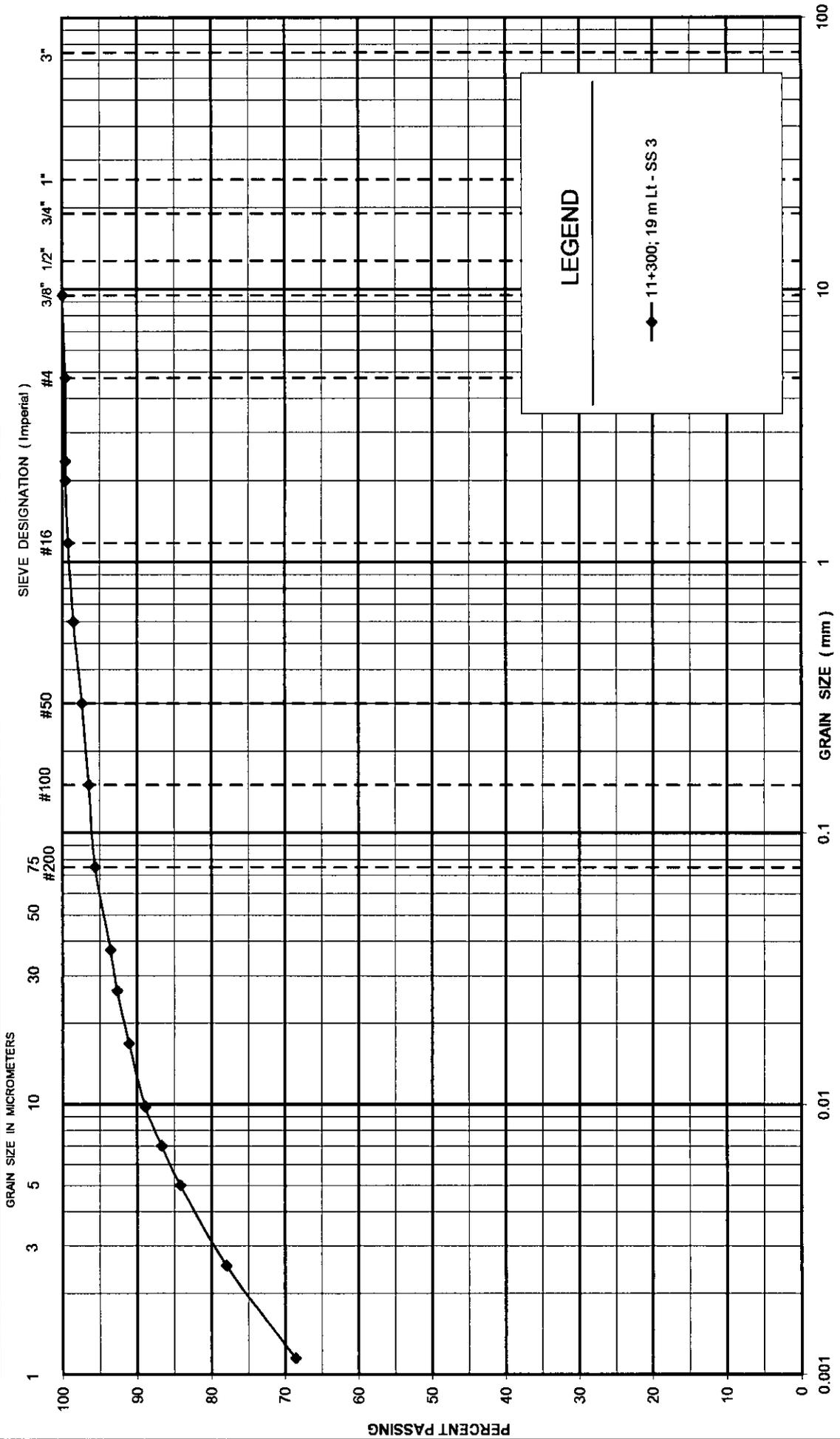
SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)						
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE			"N" VALUES	20						40	60	80	100	20	40
191.0	Ground Surface																		
0.0	0.1 m Topsoil FILL: Gravel and Sand, some silt, occasional cobbles, brown, dry		1	SS	50/15*													50 45 (5)	
190.3	CLAY occasional sandy silt seams and partings to 4.4 m, reddish gray moist to damp stiff to very stiff damp to wet firm		2	SS	20													18.0	
0.7				3	SS	14													18.0
				4	SS	10													17.3
				5	SS	6													16.3
				7	SS	3													15.9
				8	SS	2													
183.7	End of Borehole. Piezometer installed to 6.1 m. Water level on: June 4, 2003 - 5.9 m (El. 185.1 m)(not stabilized) * High blow count probably due to a cobble.																		

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

Appendix B2 Site B Laboratory Test Results

UNIFIED SOIL CLASSIFICATION SYSTEM

CLAY AND SILT			SAND			GRAVEL		
			Fine	Medium	Coarse	Fine	Coarse	Coarse



**GRAIN SIZE DISTRIBUTION
CLAY**

SHAHEEN & PEAKER LIMITED

FIGURE No. B2 - 2
REF. No. SPT 1055
GWP: 354-94-00

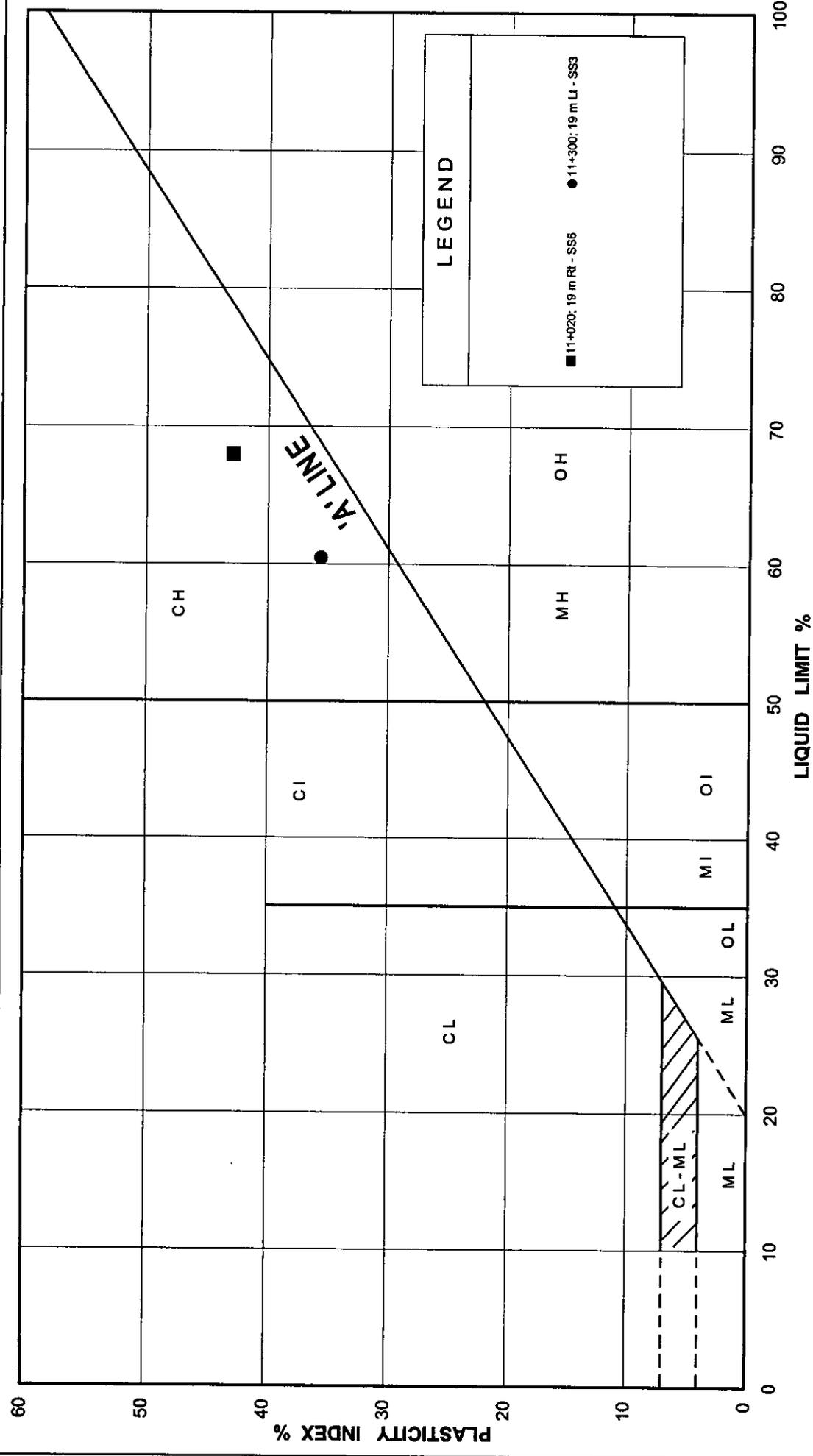


FIG No B2-3
 G.W.P. 354-94-00
 SPT 1055

PLASTICITY CHART
 CLAY

SHAHEEN & PEAKER LIMITED

Appendix B3 Site B Measured Undrained Shear Strength Results

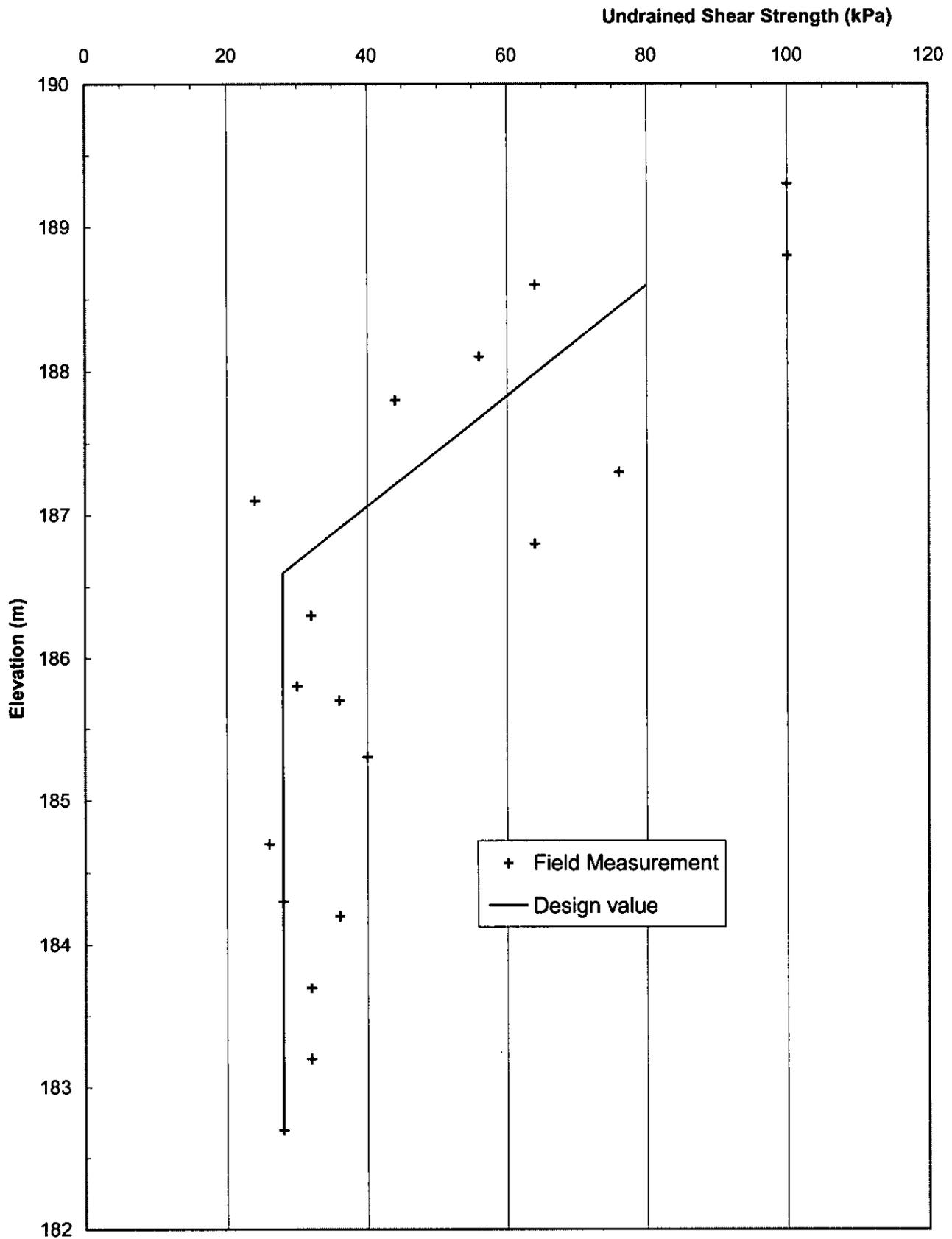


Fig. B3-1: Variation of Undrained Shear Strength (as measured by field vane tests) and the design value with Elevation in clay deposit

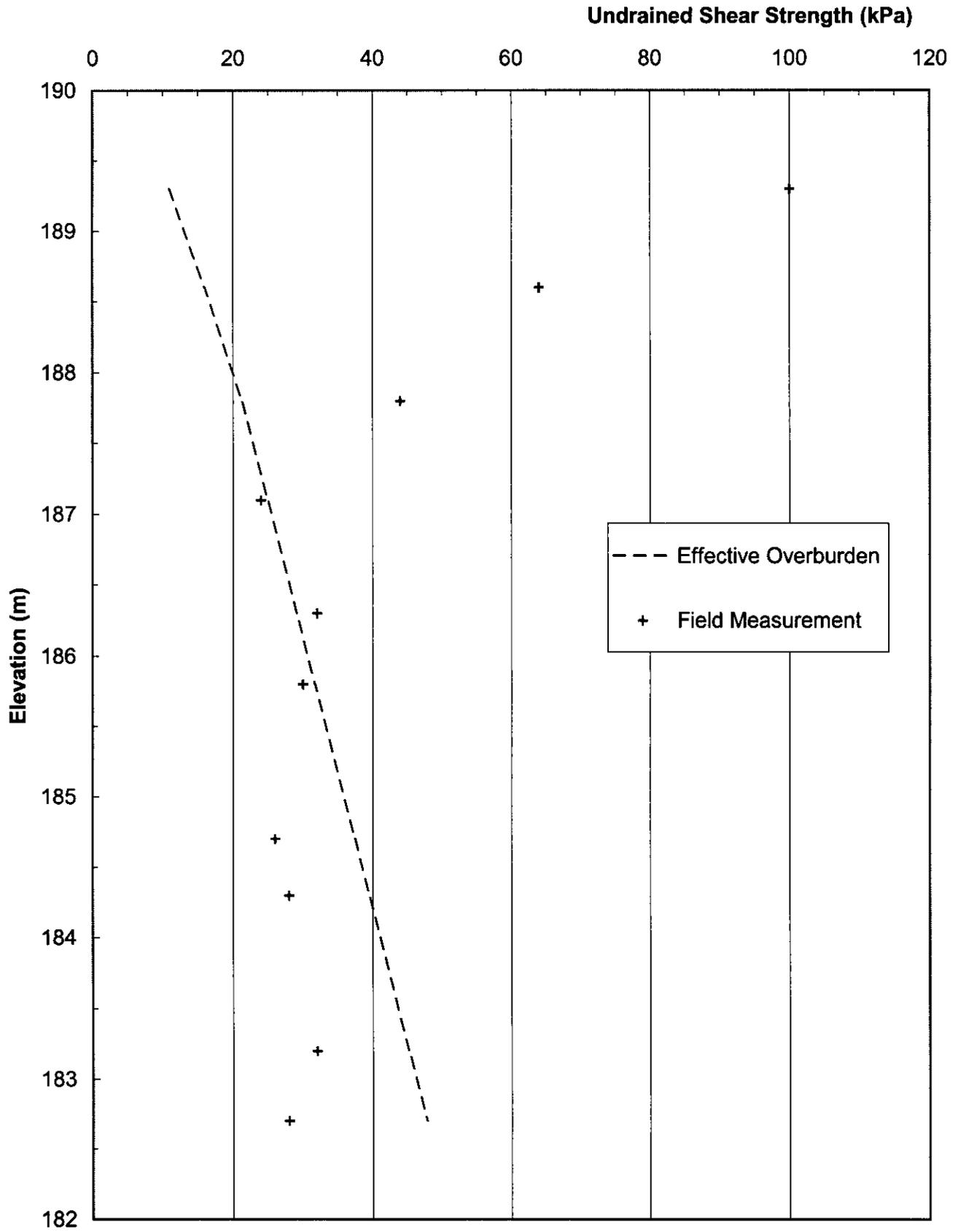


Fig. B3-2: Variation of Undrained Shear Strength (as measured by field vane tests) with Elevation (Boreholes 11+020; 19 m Rt)

APPENDICES

FOR SITE C

Appendix C1 Site C Record of Borehole Sheets

RECORD OF BOREHOLE No 13+415; 19 m Rt 1 OF 1 METRIC

GWP 354-94-00 LOCATION Echo River to Bar River Road, Sault Ste. Marie - Coords: N 5 148 989.8; E 300 914.6 ORIGINATED BY G.I.
 DIST 62 HWY 17 (New) BOREHOLE TYPE Hollow Stem Augers COMPILED BY J.Z.
 DATUM Geodetic DATE 5/27/2003 CHECKED BY R.M.

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				PLASTIC LIMIT W _P	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)			
ELEV. DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			"N" VALUES	20	40	60						80	100	20
180.2	Ground Surface																	
0.0	0.3m TOPSOIL		1	SS	4													
	FINE SAND trace to some silt brown to grey brown moist to wet, very loose		2	SS	5													
			3	SS	2													
			4	SS	3													
			5	SS	3													
176.6	frequent silt seams/partings		6	SS	2													
3.6			7	TW	PH													
	CLAY grey, firm		8	SS	1													
172.9																		
7.3	End of Borehole.																	
	* Water level at 1.5m (not stabilized) and hole open to 1.8m on completion																	

RECORD OF BOREHOLE No 13+576; 19 m Lt 1 OF 3 METRIC

GWP 354-94-00 LOCATION Echo River to Bar River Road, Sault Ste. Marie - Coords: N 5 148 833.9; E 300 859.4 ORIGINATED BY G.I.
 DIST 62 HWY 17 (New) BOREHOLE TYPE Hollow Stem Augers & D.C.P.T. COMPILED BY J.Z.
 DATUM Geodetic DATE 5/27/2003 CHECKED BY R.M.

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT w _p	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV. DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			"N" VALUES	20	40	60	80					
180.9 0.0	Ground Surface															
	0.3m TOPSOIL		1	SS	4											
	FINE SAND trace silt brown, wet, very loose		2	SS	4										0 93 (7)	
			3	SS	2											
178.8 2.1			4	SS	3											
	SANDY SILT grey, wet and dilatant very loose		5	SS	2										0 44 48 8	
177.2 3.7			6	SS	1											
	frequent silt seams/partings		7	SS	2									14.8		
	CLAY reddish grey soft to firm		8	SS	2									15.3		
173.6 7.3			9	SS	2											
	SANDY SILT grey, wet and dilatant very loose		10	SS	2											
172.3 8.6			11	SS	23											
	SILTY CLAY occasional sandy silt seams grey, firm		12	SS	16											
170.4 10.5			13	SS	4										0 22 74 4	
	SANDY SILT grey, wet and dilatant															
	compact very loose															
															low N value probably due to hydrostatic uplift	

Continued Next Page

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

RECORD OF BOREHOLE No 13+576; 19 m Lt 3 OF 3 METRIC

GWP 354-94-00 LOCATION Echo River to Bar River Road, Sault Ste. Marie - Coords: N 5 148 833.9; E 300 859.4 ORIGINATED BY G.I.
 DIST 82 HWY 17 (New) BOREHOLE TYPE Hollow Stem Augers & D.C.P.T. COMPILED BY J.Z.
 DATUM Geodetic DATE 5/27/2003 CHECKED BY R.M.

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT Y kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV. DEPTH	DESCRIPTION	STRAT PLOT NUMBER	TYPE	"N" VALUES			20	40	60	80	100					
150.4 30.5	End of D.C.P.T. * Wet caved at 3.0m on completion															

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

RECORD OF BOREHOLE No 13+800; 19 m Rt 1 OF 1 METRIC

GWP 354-94-00 LOCATION Echo River to Bar River Road, Sault Ste. Marie - Coords: N 5 148 866.2; E 300 706.1 ORIGINATED BY G.I.
 DIST 62 HWY 17 (New) BOREHOLE TYPE Hollow Stem Augers COMPILED BY J.Z.
 DATUM Geodetic DATE 5/26/2003 CHECKED BY R.M.

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)		
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			"N" VALUES	20	40	60	80						100	20
182.5	Ground Surface																	
0.0	0.3m TOPSOIL		1	SS	4													
	FINE SAND trace silt wet, very loose		2	SS	4													
		brown ----- grey																
			3	SS	3													
			4	SS	2													
179.6	CLAY occasional sandy silt seams/partings grey, soft		5	SS	2													
2.9																		
178.7	SANDY SILT reddish grey wet and dilatant		6	SS	15													
3.8																		
			7	SS	16													
176.9	CLAY occasional silt seams/partings grey, soft		8	SS	2													
5.6																		
175.6	End of Borehole.																	
6.9																		
	* Water level at 5.2 m (not stabilized) and hole open to 5.5 m on completion ** Attempted vane test at 7.3m. Unable to push vane beyond 6.9m																	

RECORD OF BOREHOLE No 14+000; 19 m Lt 1 OF 1 METRIC

GWP 354-94-00 LOCATION Echo River to Bar River Road, Sault Ste. Marie - Coords: N 5 148 477.5; E 300 630.6 ORIGINATED BY G.I.
 DIST 62 HWY 17 (New) BOREHOLE TYPE Hollow Stem Augers COMPILED BY J.Z.
 DATUM Geodetic DATE 5/26/2003 CHECKED BY R.M.

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV. DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			"N" VALUES	SHEAR STRENGTH kPa								
						20	40	60	80	100						
183.8	Ground Surface															
0.0	0.2m TOPSOIL FINE SAND some silt seams, brown, wet, loose		1	SS	6											
183.1																
0.7	SANDY SILT with silt zones, brown to 1.4m, grey below wet and dilatant		2	SS	5											
	very loose to loose		3	SS	2											
	compact															
			4	SS	16											
			5	SS	21											
			6	SS	15											
	loose occasional clay pockets		7	SS	7											
177.2			8	SS	10											
6.6	End of Borehole.															
	* Water level at 3.4 m (not stabilized) and hole open to 3.7 m on completion															

+³ × 3³: Numbers refer to Sensitivity 20 15 10 (5) (% STRAIN AT FAILURE

RECORD OF BOREHOLE No 14+200; 19 m Rt 2 OF 3 METRIC

GWP 354-94-00 LOCATION Echo River to Bar River Road, Sault Ste. Marie - Coords: N 5 148 320.8; E 300 500.7 ORIGINATED BY G.I.
 DIST 62 HWY 17 (New) BOREHOLE TYPE Hollow Stem Augers & D.C.P.T. COMPILED BY J.Z.
 DATUM Geodetic DATE 5/25/2003 CHECKED BY R.M.

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV. DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			"N" VALUES	SHEAR STRENGTH kPa					
						20	40	60	80	100	20	40	60
168.2	CLAY reddish grey soft to firm ----- stiff	[Hatched Box]	13	SS	2								
16.5			End of Borehole. Dynamic Cone Penetration Test (D.C.P.T) performed from 16.5m to 30.3m										
169													
168													
167													
166													
165													
164													
163													
162													
161													
160													
159													
158													
157													
156													
155													

Continued Next Page

+³ × 3³: Numbers refer to Sensitivity
 20
 15
 10
 (%) STRAIN AT FAILURE

RECORD OF BOREHOLE No 14+200; 19 m Rt 3 OF 3 METRIC

GWP 354-84-00 LOCATION Echo River to Bar River Road, Sault Ste. Marie - Coords: N 5 148 320.8; E 300 500.7 ORIGINATED BY G.I.
 DIST 62 HWY 17 (New) BOREHOLE TYPE Hollow Stem Augers & D.C.P.T. COMPILED BY J.Z.
 DATUM Geodetic DATE 5/25/2003 CHECKED BY R.M.

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT NUMBER	TYPE	"N" VALUES			20	40	60	80	100					
154.4 30.3	End of D.C.P.T. * Wet caved at 11.6m on completion															

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

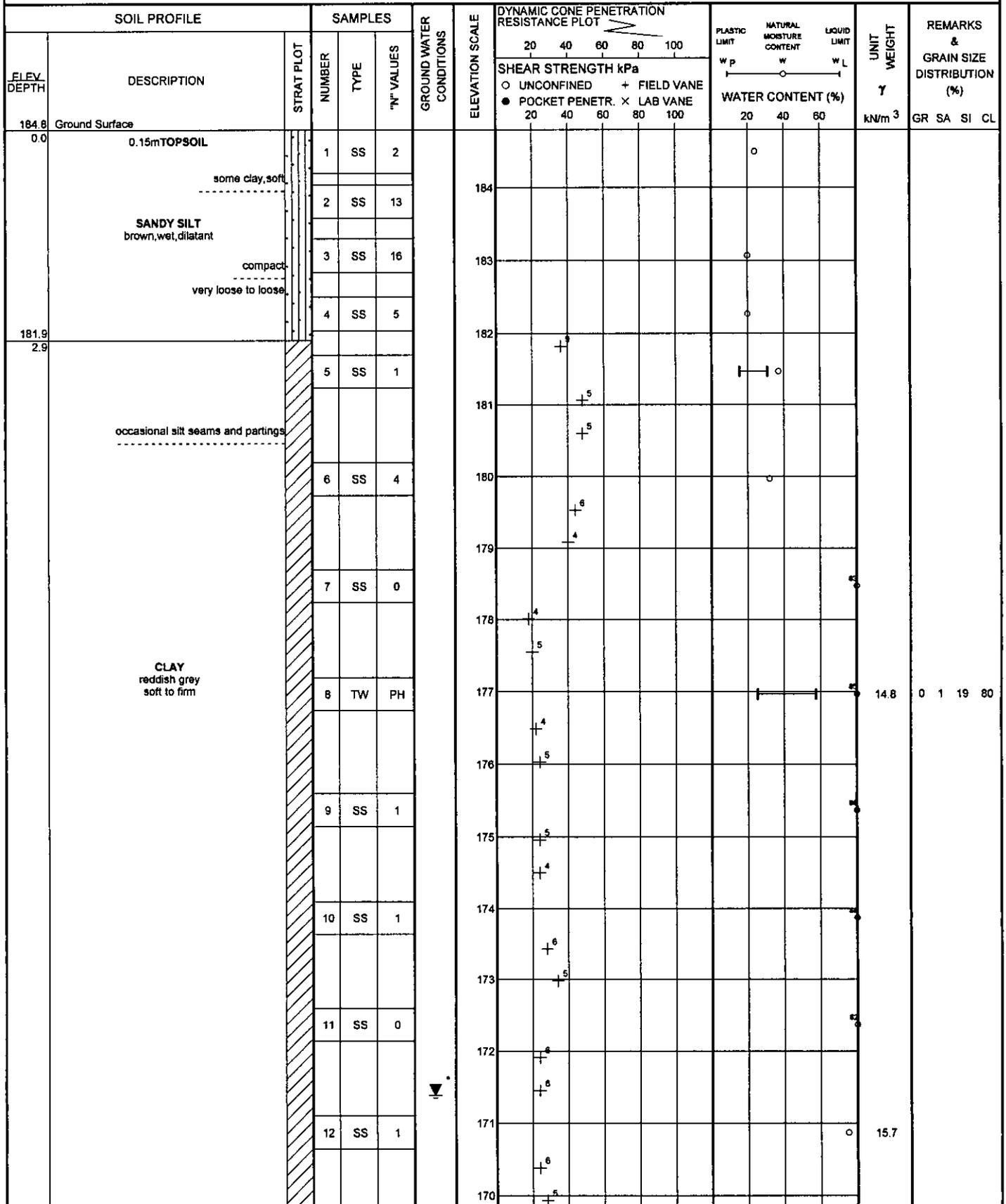
RECORD OF BOREHOLE No 14+402; 19 m Lt 1 OF 1 METRIC

GWP 354-84-00 LOCATION Echo River to Bar River Road, Sault Ste. Marie - Coords: N 5 148 120.8; E 300 453.6 ORIGINATED BY G.I.
 DIST 62 HWY 17 (New) BOREHOLE TYPE Hollow Stem Augers COMPILED BY J.Z.
 DATUM Geodetic DATE 5/25/2003 CHECKED BY R.M.

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV. DEPTH	DESCRIPTION	NUMBER	TYPE	"N" VALUES			20	40					
186.4	Ground Surface												
0.0	0.1m TOPSOIL SANDY SILT wet and dilatant loose to compact	1	SS	5									
		2	SS	12									
		3	SS	18									
	brown grey	4	SS	8									
183.5	SILTY CLAY occasional silt seams/partings 100mm brown sand seam at 4.6m firm to stiff	5	SS	2									
2.9		6	SS	8									
		7	SS	3									
	grey/brown reddish grey										19.1		
179.1	End of Borehole.												
7.3	* Water level at 5.5 m (not stabilized) and hole open to 5.8 m on completion												

RECORD OF BOREHOLE No 14+600; 19 m Rt 1 OF 3 METRIC

GWP 354-94-00 LOCATION Echo River to Bar River Road, Sault Ste. Marie - Coords: N 5 147 945.8 ; E 300 353.5 ORIGINATED BY G.I.
 DIST 62 HWY 17 (New) BOREHOLE TYPE Hollow Stem Augers & D.C.P.T. COMPILED BY J.Z.
 DATUM Geodetic DATE 5/25/2003 CHECKED BY R.M.



Continued Next Page

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

RECORD OF BOREHOLE No 14+600; 19 m Rt 3 OF 3 METRIC

GWP 354-94-00 LOCATION Echo River to Bar River Road, Sault Ste. Marie - Coords: N 5 147 945.8 ; E 300 353.5 ORIGINATED BY G.I.
 DIST 62 HWY 17 (New) BOREHOLE TYPE Hollow Stem Augers & D.C.P.T. COMPILED BY J.Z.
 DATUM Geodetic DATE 5/25/2003 CHECKED BY R.M.

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			"N" VALUES	SHEAR STRENGTH kPa								
							20	40	60	80	100					
154.3 30.5	End of D.C.P.T. * Water level at 13.4 m (not stabilized) and hole open to 15.8 m on completion					154										

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

RECORD OF BOREHOLE No 14+668 CL 1 OF 1 METRIC

GWP 354-94-00 LOCATION Echo River to Bar River Road, Sault Ste. Marie - Coords: N 5 147 875.0; E 300 353.5 ORIGINATED BY G.I.
 DIST 62 HWY 17 (New) BOREHOLE TYPE Hollow Stem Augers COMPILED BY J.Z.
 DATUM Geodetic DATE 6/1/2003 CHECKED BY R.M.

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)		
ELEV. DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			"N" VALUES	20	40	60	80						100	20
185.0	Ground Surface																	
0.0	FILL: SAND & GRAVEL brown, moist, dense	○	1	SS	42													
184.3		○																
0.7	FILL: SANDY SILT brown, wet, dilatant compact to dense	○	2	SS	33													
182.9		○																
182.1	SANDY SILT trace clay, reddish grey moist to wet, compact	○	3	SS	35													
182.1		○																
182.1		○	4	SS	14													
182.1		○																
182.1	CLAY reddish grey soft to firm	○	5	SS	2													
182.1		○																
181.0		+																
180.5		+																
180.0		+	6	SS	7													
179.5		+																
179.0		+																
178.5		+	7	SS	2													
178.0		+																
177.7	End of Borehole.																	
177.7	Borehole caved @ 3.7m on completion																	

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

RECORD OF BOREHOLE No 14+800 19 m Lt 1 OF 1 METRIC

GWP 354-94-00 LOCATION Echo River to Bar River Road, Sault Ste. Marie - Coords: N 5 147 742. 7; E 300 342.2 ORIGINATED BY G.I.
 DIST 62 HWY 17 (New) BOREHOLE TYPE Hollow Stem Augers COMPILED BY J.Z.
 DATUM Geodetic DATE 5/24/2003 CHECKED BY R.M.

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)					
ELEV DEPTH	DESCRIPTION	NUMBER	TYPE	"N" VALUES			20	40						60	80	100	20	40
184.3	Ground Surface																	
0.0	0.2m TOPSOIL SANDY SILT moist to wet, brown	1	SS	4								19.8						
	very loose																	
	compact	2	SS	19														
		3	SS	14														
182.2	CLAY reddish grey	4	SS	3														
2.1																		
			5	SS	3													
			6	SS	2													
			7	SS	1													
	firm to stiff																	
	soft																	
177.0	End of Borehole.																	
7.3	* Water level at 5.2 m (not stabilized) and hole open to 6.1 m on completion																	

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

RECORD OF BOREHOLE No 15+000; 19 m Rt 1 OF 1 METRIC

GWP 354-94-00 LOCATION Echo River to Bar River Road, Sault Ste. Marie - Coords: N 5 147 551.1; E 300 273.5 ORIGINATED BY G.I.
 DIST 62 HWY 17 (New) BOREHOLE TYPE Hollow Stem Augers COMPILED BY J.Z.
 DATUM Geodetic DATE 5/23/2003 CHECKED BY R.M.

SOIL PROFILE		STRAT PLOT	SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV. DEPTH	DESCRIPTION		NUMBER	TYPE	"N" VALUES			20	40	60	80	100					
184.5	Ground Surface																
0.0	0.2m TOPSOIL SANDY SILT grey/brown, moist, very loose		1	SS	2												
183.8			2	SS	2												
0.7	CLAY reddish grey 0.15m organic seam		3	SS	2												
			4	SS	2												
			5	SS	4												
			6	SS	1												
	firm to stiff soft		7	SS	1												
177.2	End of Borehole.																
7.3	* Wet caved at 4.3m on completion																

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

RECORD OF BOREHOLE No 15+200; 19 m Lt 1 OF 1 METRIC

GWP 354-84-00 LOCATION Echo River to Bar River Road, Sault Ste. Marie - Coords: N 5 147 349.0; E 300 297.4 ORIGINATED BY G.I.
 DIST 82 HWY 17 (New) BOREHOLE TYPE Hollow Stem Augers COMPILED BY J.Z.
 DATUM Geodetic DATE 5/24/2003 CHECKED BY R.M.

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV. DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			"N" VALUES	SHEAR STRENGTH kPa						
						20	40	60	80	100	20	40	60	
185.7	Ground Surface													
0.0	0.2m TOPSOIL SANDY SILT grey/brown, moist, very loose		1	SS	2									
185.0														
0.7	CLAY trace rootlets to 1.2m reddish grey		2	SS	4								18.6	
			3	SS	2									
			4	SS	2								17.0	
			5	SS	1									
			6	SS	0									
			7	SS	1									
178.4	End of Borehole.													
7.3														
	* Wet cave at 5.5m on completion													

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

RECORD OF BOREHOLE No 15+400; 19 m Rt 1 OF 2 METRIC

GWP 354-94-00 LOCATION Echo River to Bar River Road, Sault Ste. Marie - Coords: N 5 147 149.6; E 300 258.1 ORIGINATED BY G.I.
 DIST 62 HWY 17 (New) BOREHOLE TYPE Hollow Stem Augers & D.C.P.T. COMPILED BY J.Z.
 DATUM Geodetic DATE 5/23/2003 CHECKED BY R.M.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20	40	60					
187.0	Ground Surface														
0.0	0.4m TOPSOIL SILTY SAND brown, wet, loose		1	SS	4										
186.4			2	SS	4										
0.6			3	SS	4										
	CLAY reddish grey soft to firm		4	SS	1										
			5	TW	PH										
			6	SS	0										
			7	SS	1										
			8	SS	1										
			9	SS	2										
			10	SS	2										
			11	SS	1										
			12	SS	2										

Continued Next Page

+ 3, x 3. Numbers refer to
Sensitivity 20
15 10 (% STRAIN AT FAILURE

RECORD OF BOREHOLE No 15+400; 19 m Rt 2 OF 2 METRIC

GWP 354-94-00 LOCATION Echo River to Bar River Road, Sault Ste. Marie - Coords: N 5 147 149.8; E 300 258.1 ORIGINATED BY G.I.
 DIST 62 HWY 17 (New) BOREHOLE TYPE Hollow Stem Augers & D.C.P.T. COMPILED BY J.Z.
 DATUM Geodetic DATE 5/23/2003 CHECKED BY R.M.

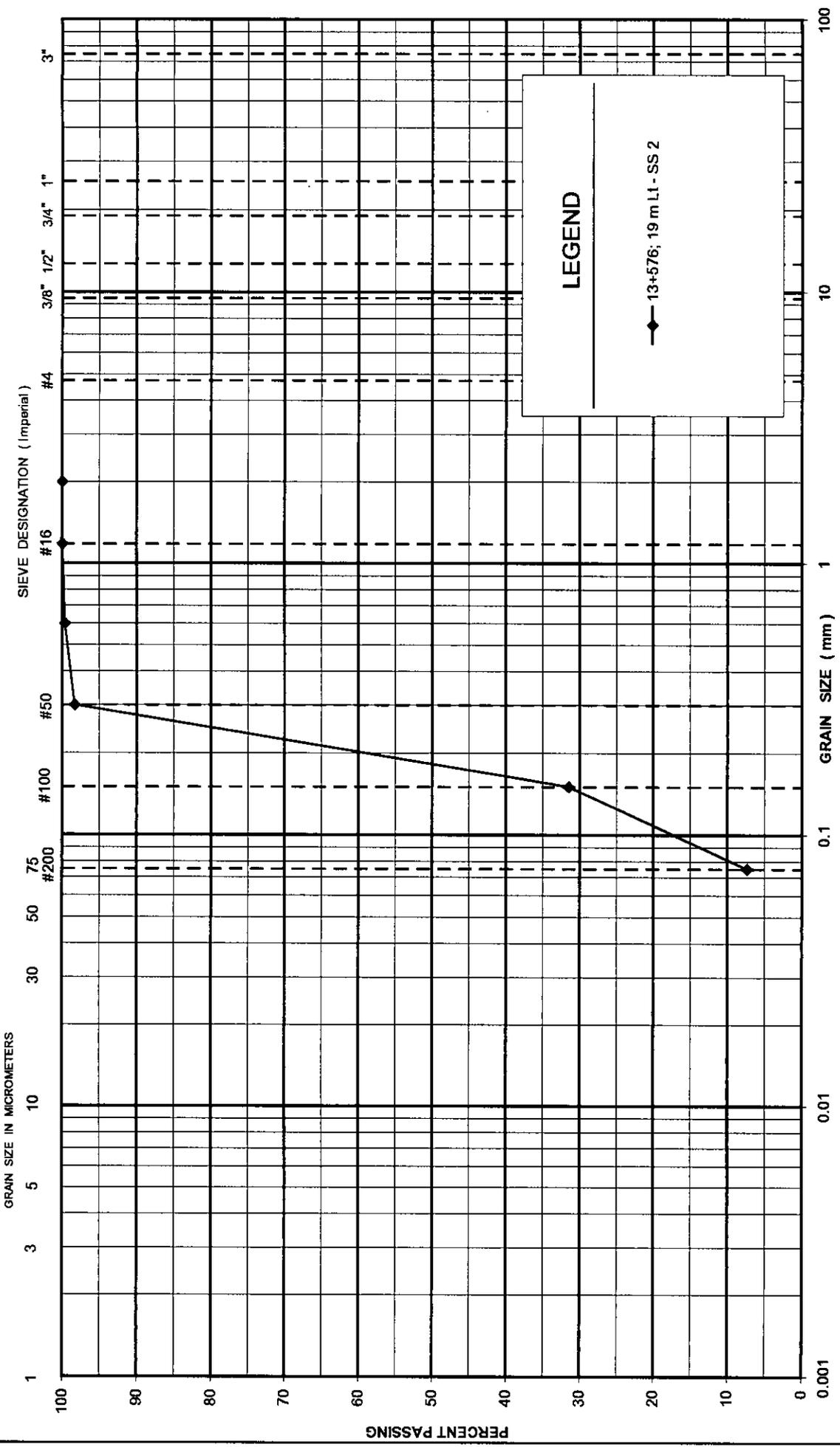
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20	40	60					
170.5	CLAY reddish grey soft to firm soft to firm ----- firm to stiff occasional silt seams/partings	[Hatched Box]	13	SS	3										
167.1															
16.5	End of Borehole.														
167.1	Dynamic Cone Penetration Test (D.C.P.T) performed from 16.5m to 19.9m														
19.9	End of D.C.P.T * Wet cave at 14.3m on completion														

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

Appendix C2 Site C Laboratory Test Results

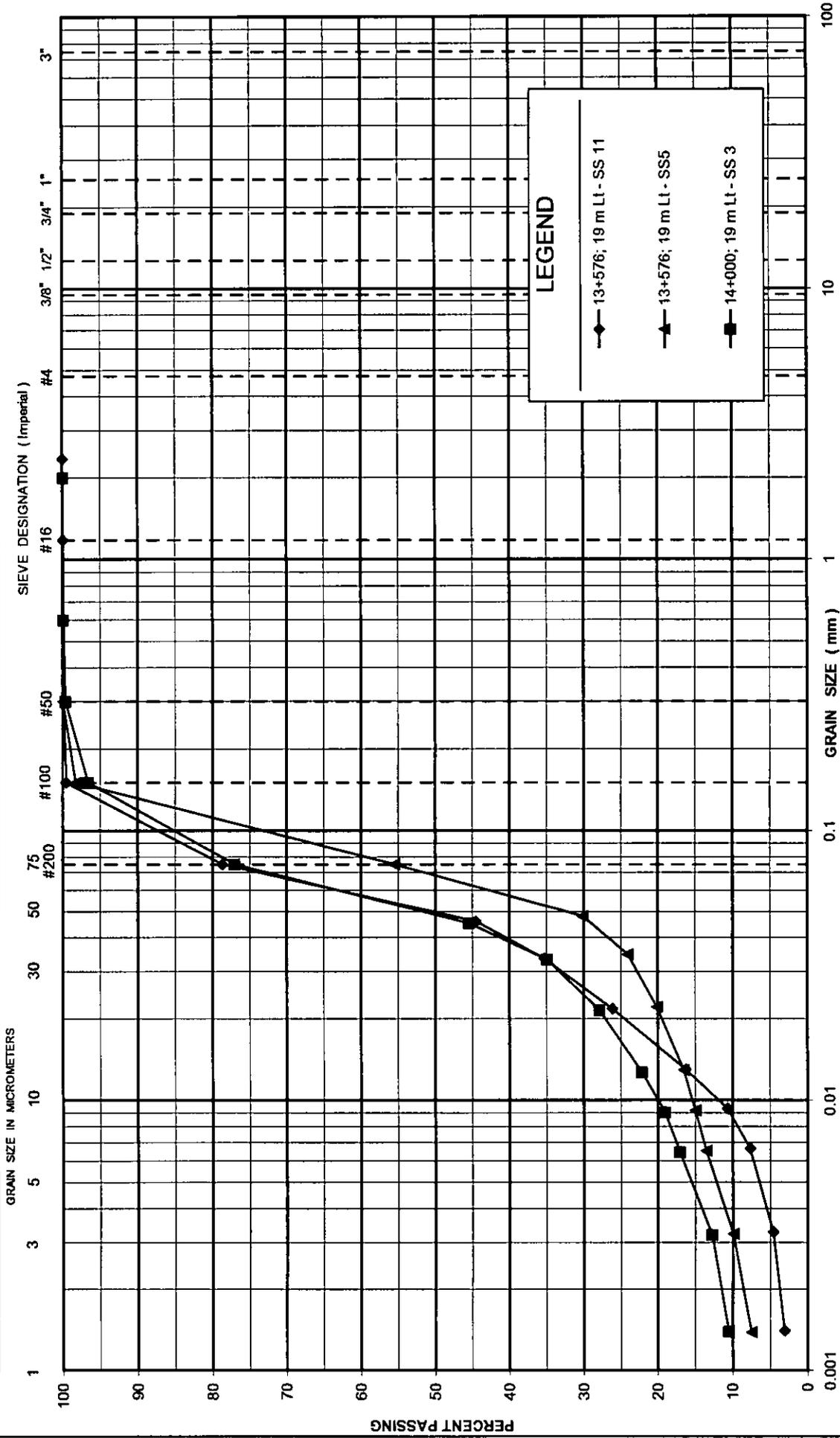
UNIFIED SOIL CLASSIFICATION SYSTEM

CLAY AND SILT			SAND			GRAVEL		
			Fine	Medium	Coarse	Fine	Coarse	



UNIFIED SOIL CLASSIFICATION SYSTEM

CLAY AND SILT		SAND			GRAVEL		
		Fine	Medium	Coarse	Fine	Coarse	



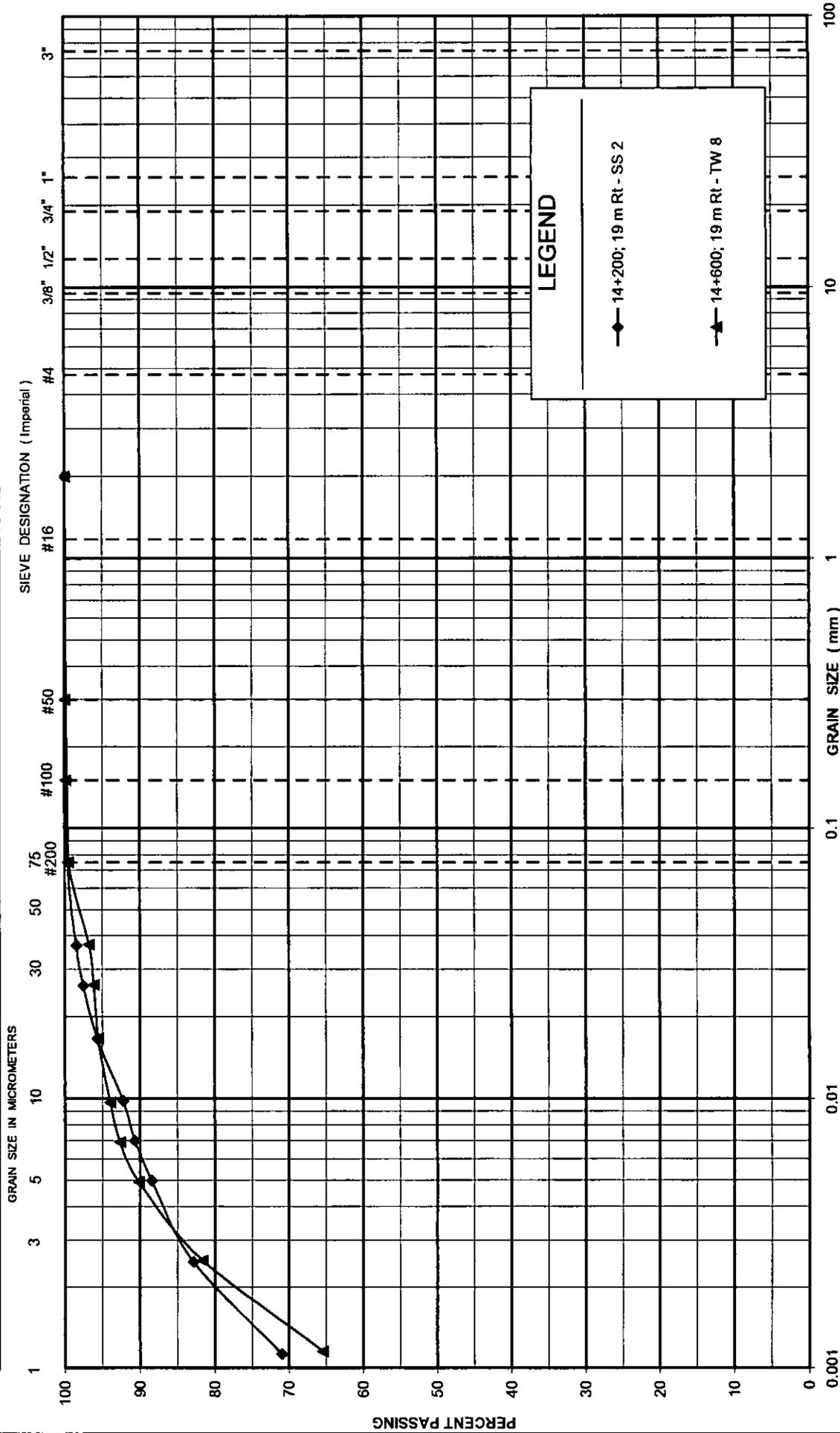
**GRAIN SIZE DISTRIBUTION
SANDY SILT**

SHAHEEN & PEAKER LIMITED

FIGURE No. C2 - 2
REF. No. SPT 1055
GWP: 354-94-00

UNIFIED SOIL CLASSIFICATION SYSTEM

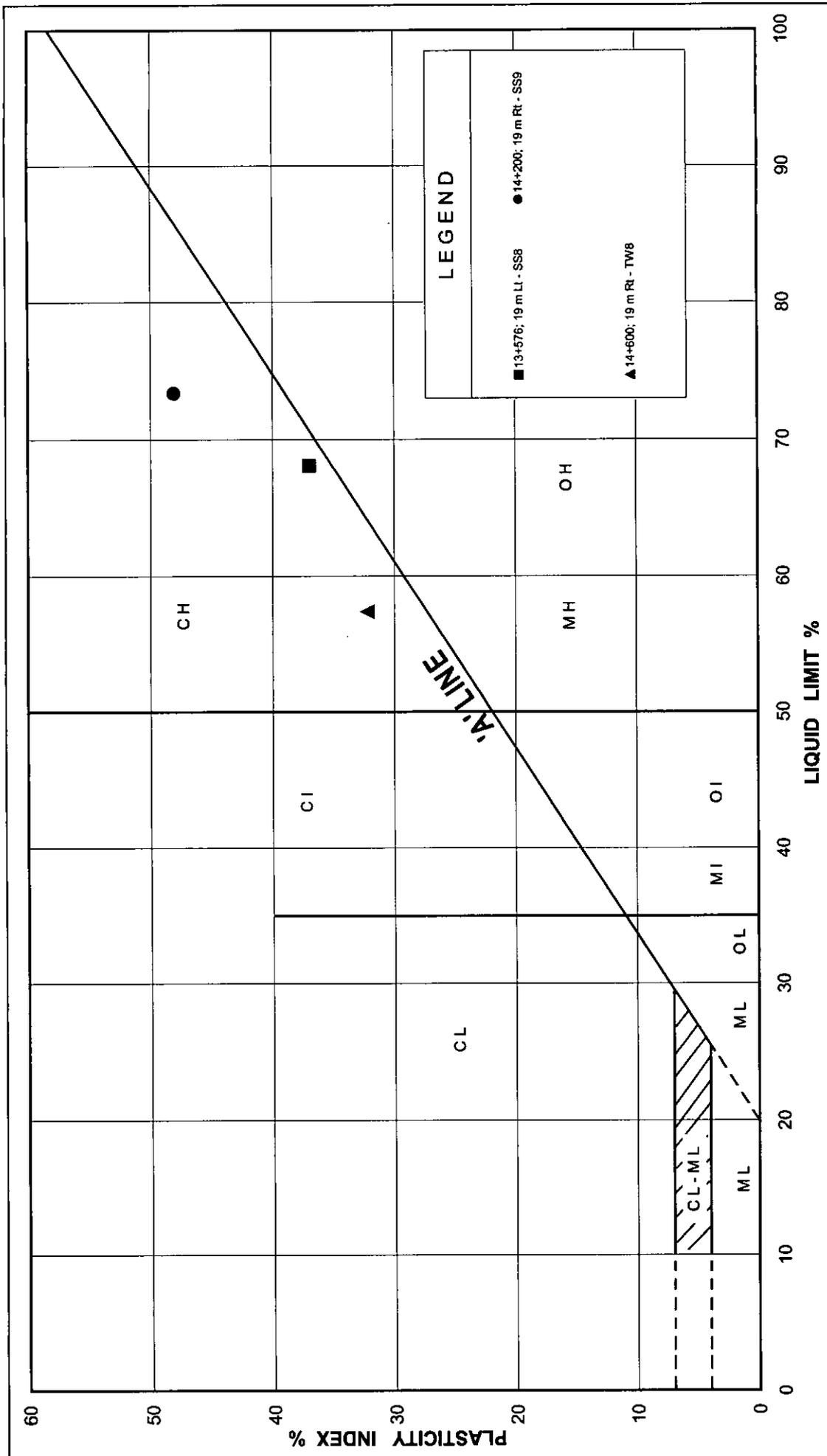
CLAY AND SILT		SAND			GRAVEL		
		Fine	Medium	Coarse	Fine	Coarse	



SHAHEEN & PEAKER LIMITED

**GRAIN SIZE DISTRIBUTION
CLAY**

FIGURE No. C2 - 3
REF. No. SPT 1055
GWP: 354-94-00



SHAHHEEN & PEAKER LIMITED

PLASTICITY CHART

CLAY

FIG No C2-4

G.W.P. 354-94-00

SPT 1055

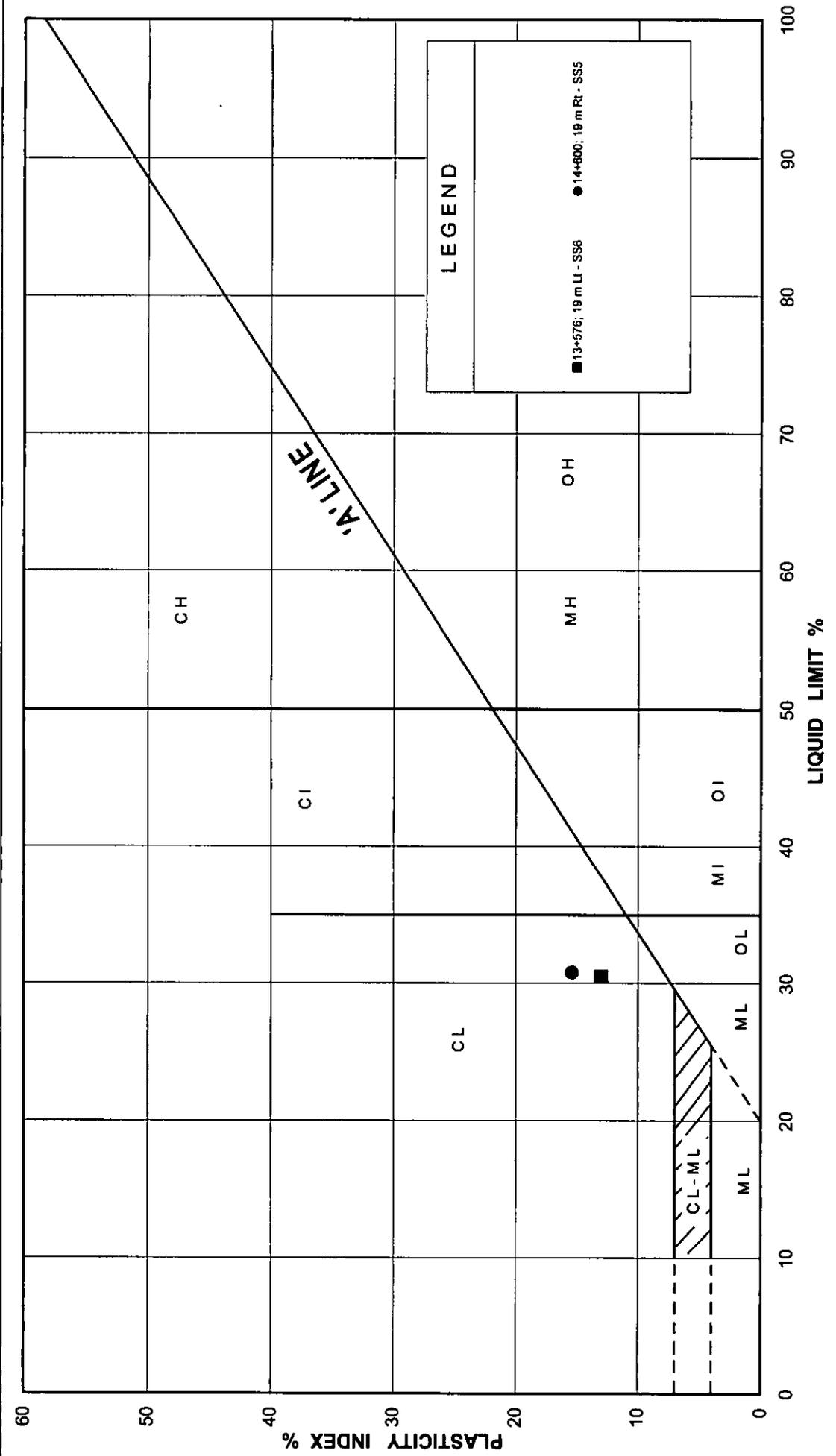
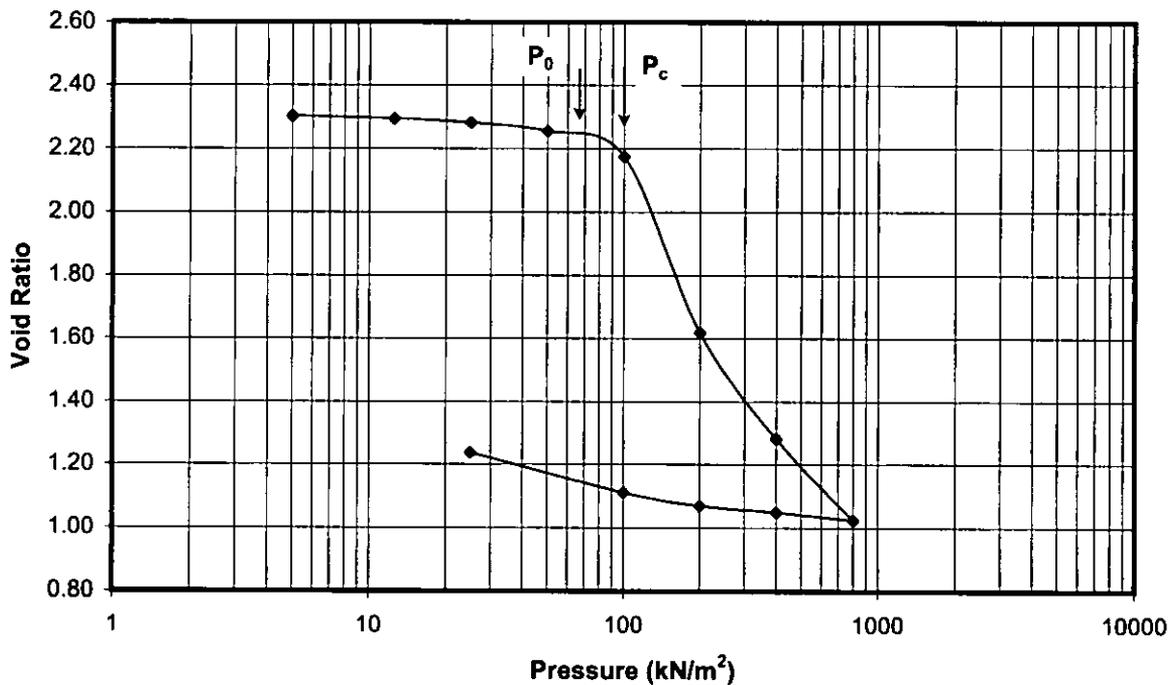


FIG No C2-5
 G.W.P. 354-94-00
 SPT 1055

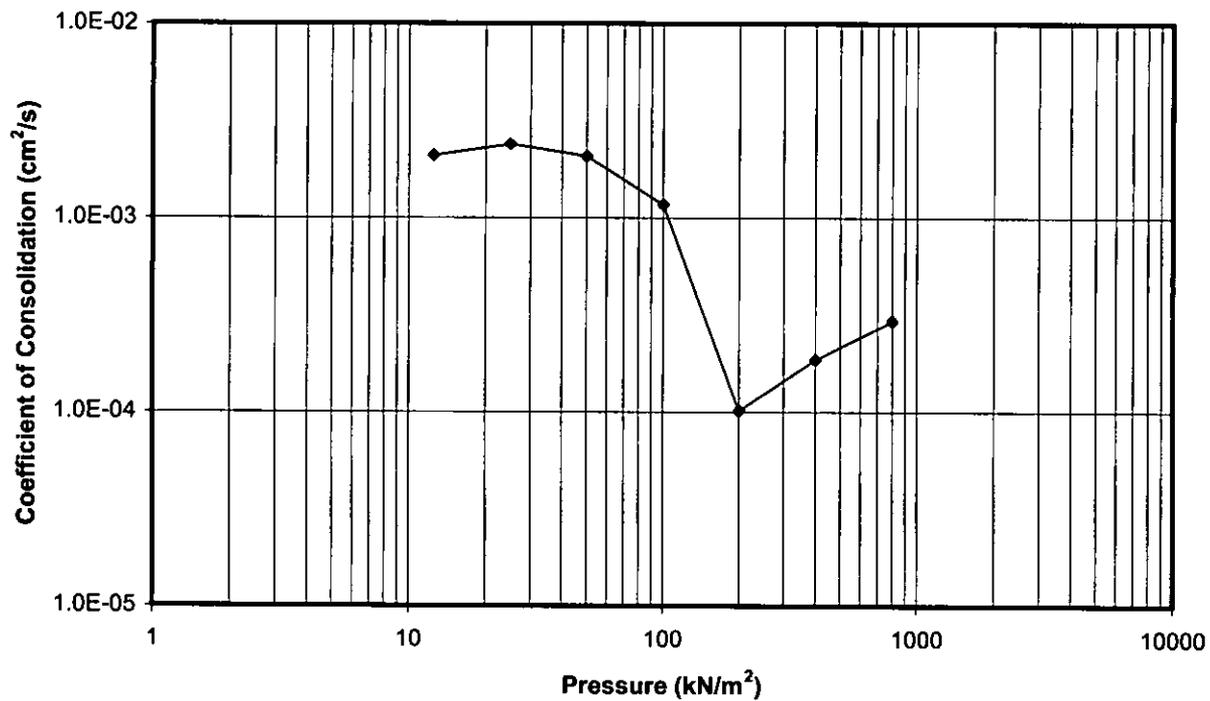
PLASTICITY CHART
 CLAYEY SILT SEAMS in the Clay Deposit

SHAHEEN & PEAKER LIMITED

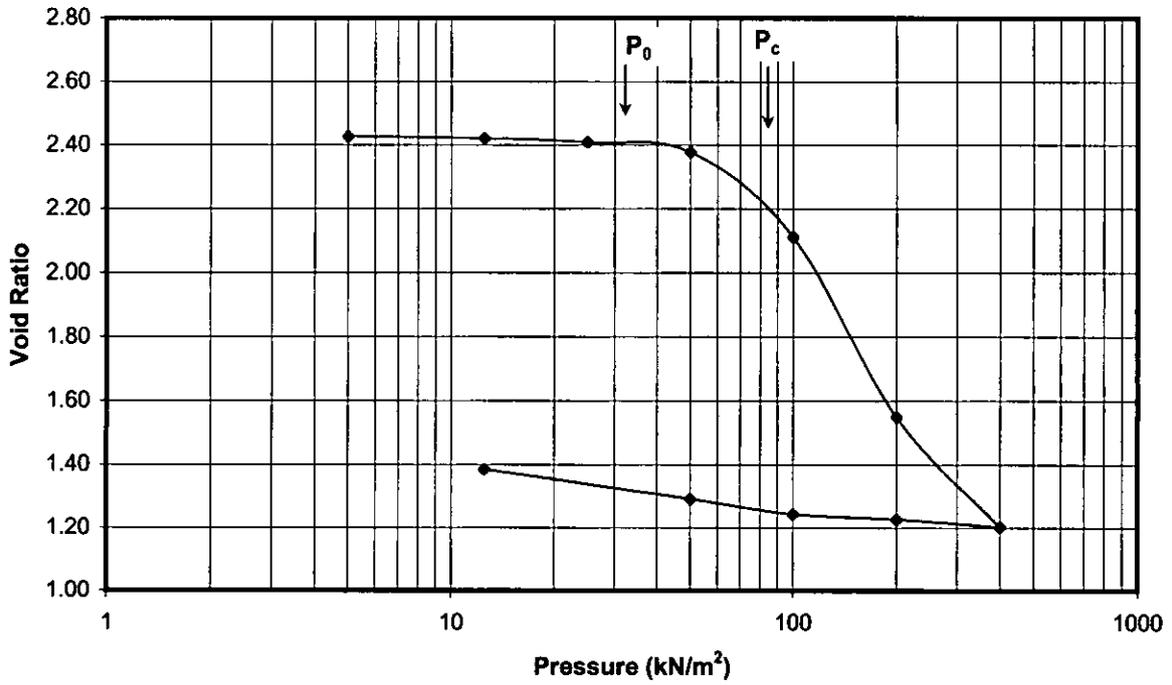
Void Ratio versus Pressure



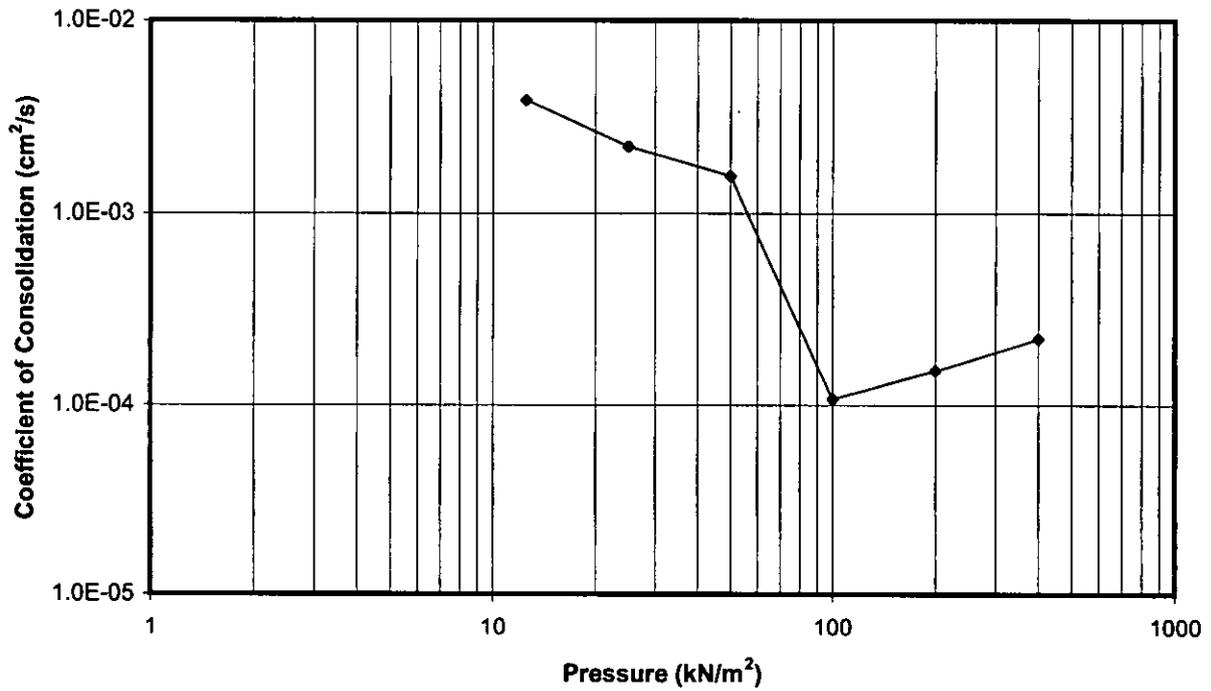
Coefficient of Consolidation vs. Pressure



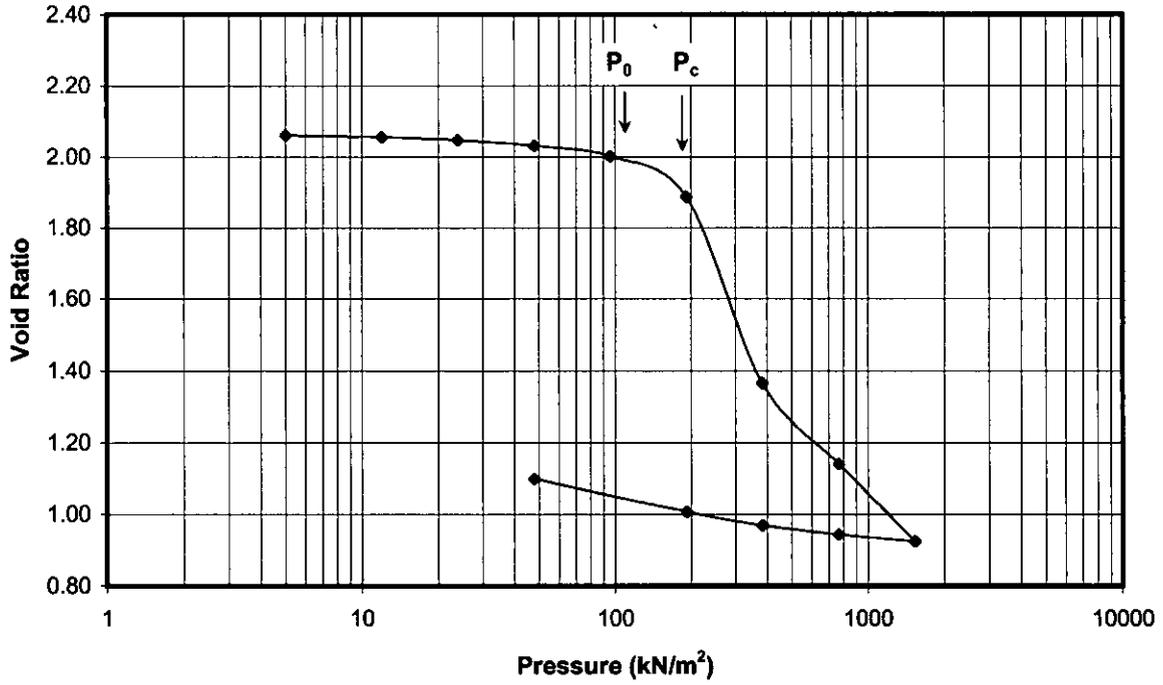
Void Ratio versus Pressure



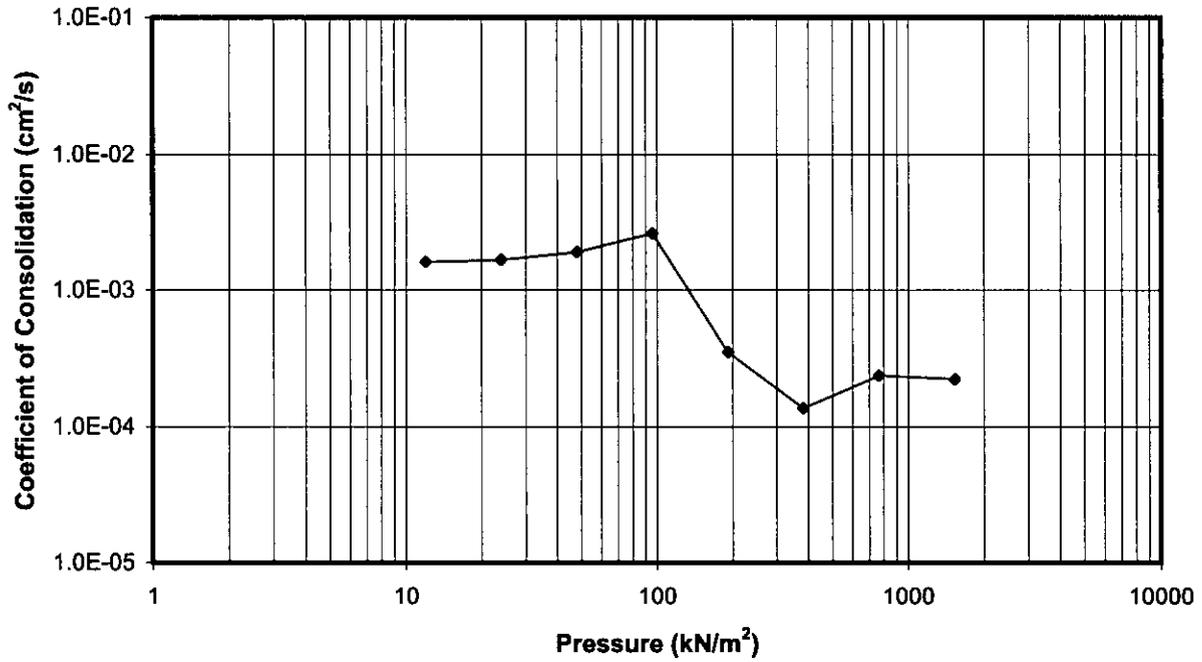
Coefficient of Consolidation vs. Pressure



Void Ratio versus Pressure



Coefficient of Consolidation vs. Pressure



Appendix C3

Site C

Measured Undrained Shear Strength Results

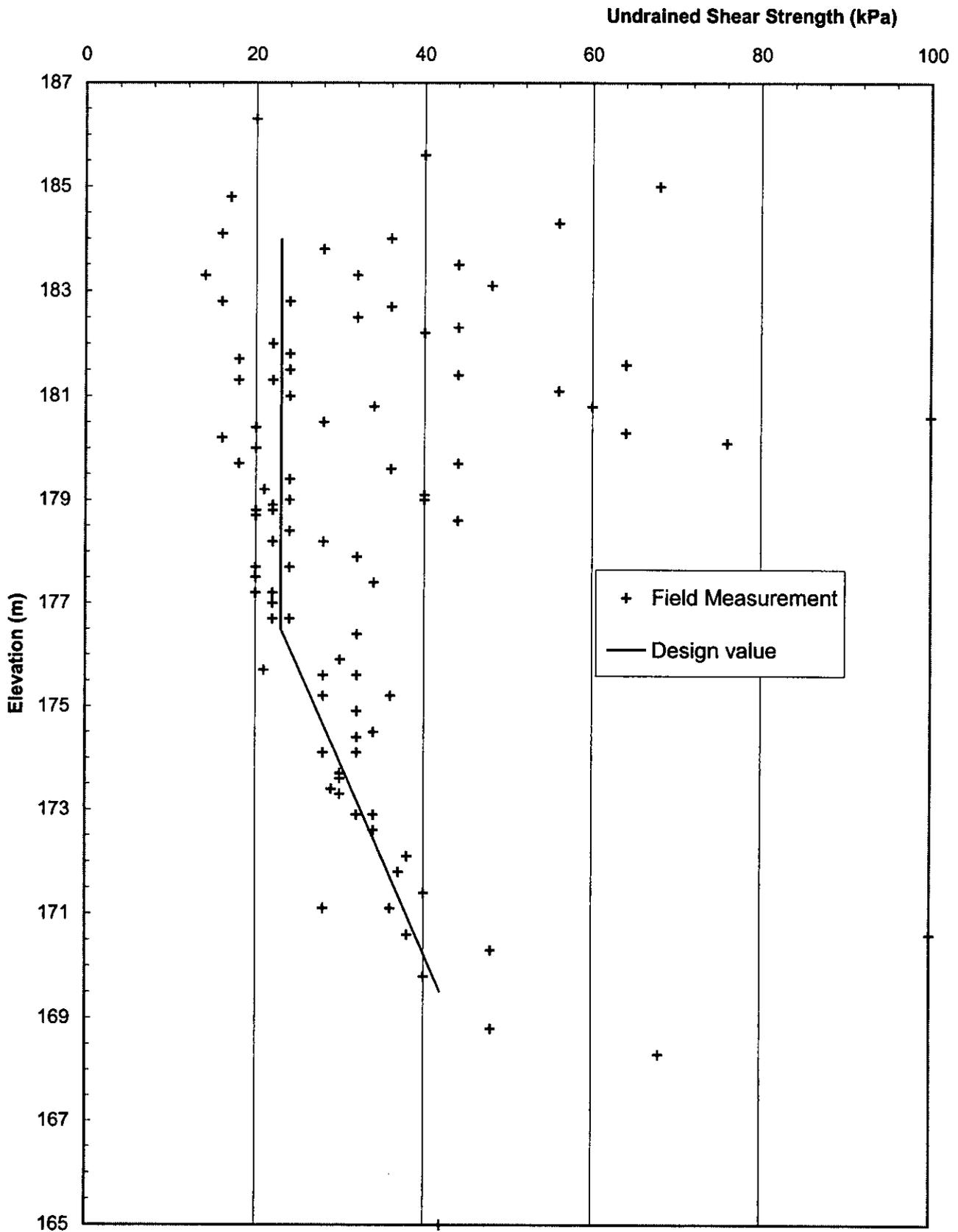


Fig. C3-1: Variation of Undrained Shear Strength (as measured by field vane tests) and the design value with Elevation in clay deposit

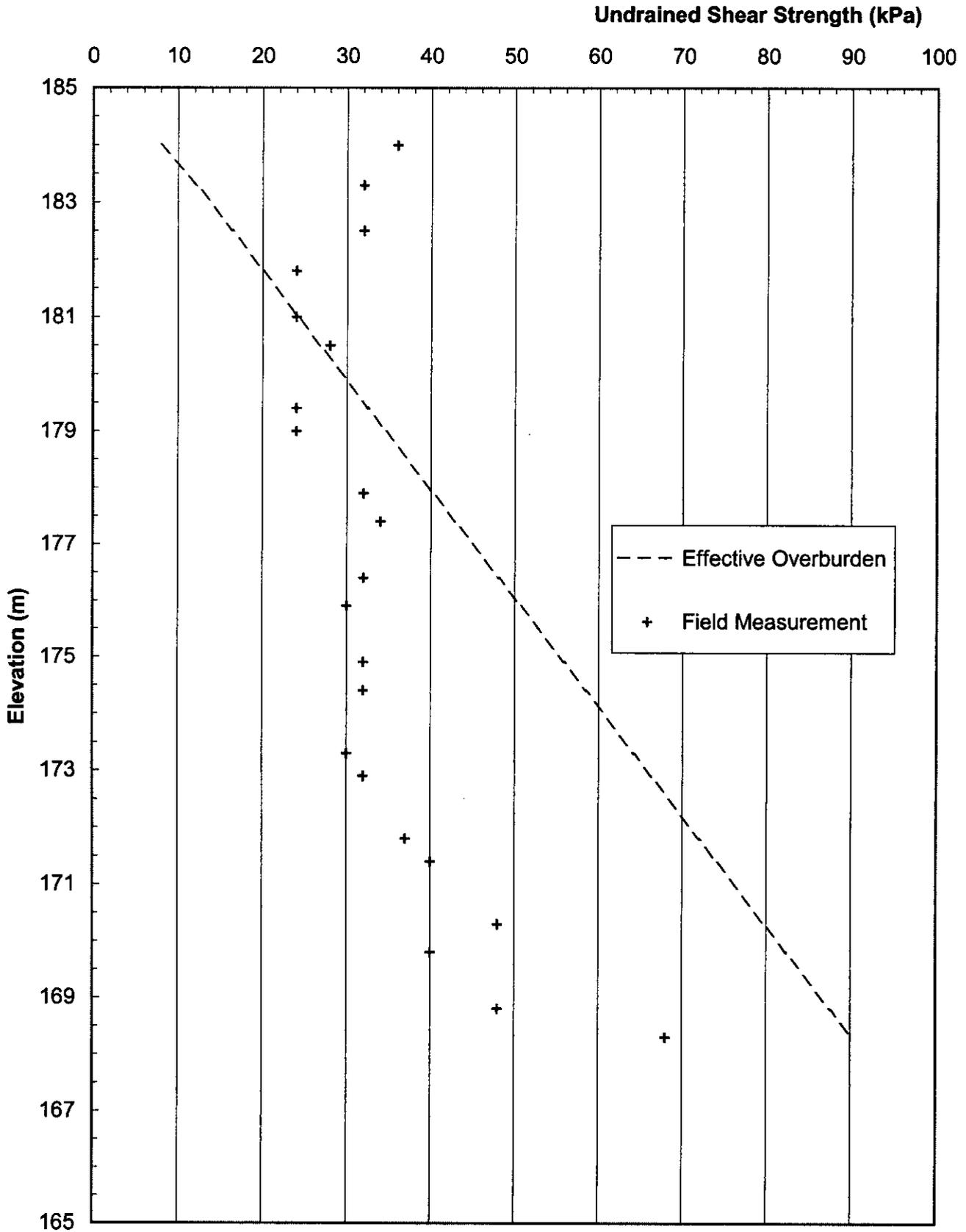


Fig. C3-2: Variation of Undrained Shear Strength (as measured by field vane tests) with Elevation (Boreholes 14+200; 19 m Rt)

APPENDICES

FOR SITE D

Appendix D1 Site D Record of Borehole Sheets

SPT 1055

RECORD OF BOREHOLE No 16+650; 19 m Lt 1 OF 1 METRIC

GWP 354-94-00 LOCATION Echo River to Bar River Road, Sault Ste. Marie - Coords: N 5 145 916.5; E 300 148.1 ORIGINATED BY G.I.
 DIST 62 HWY 17 (New) BOREHOLE TYPE Hollow Stem Augers COMPILED BY Y.L.
 DATUM Geodetic DATE 5/30/2003 CHECKED BY R.M.

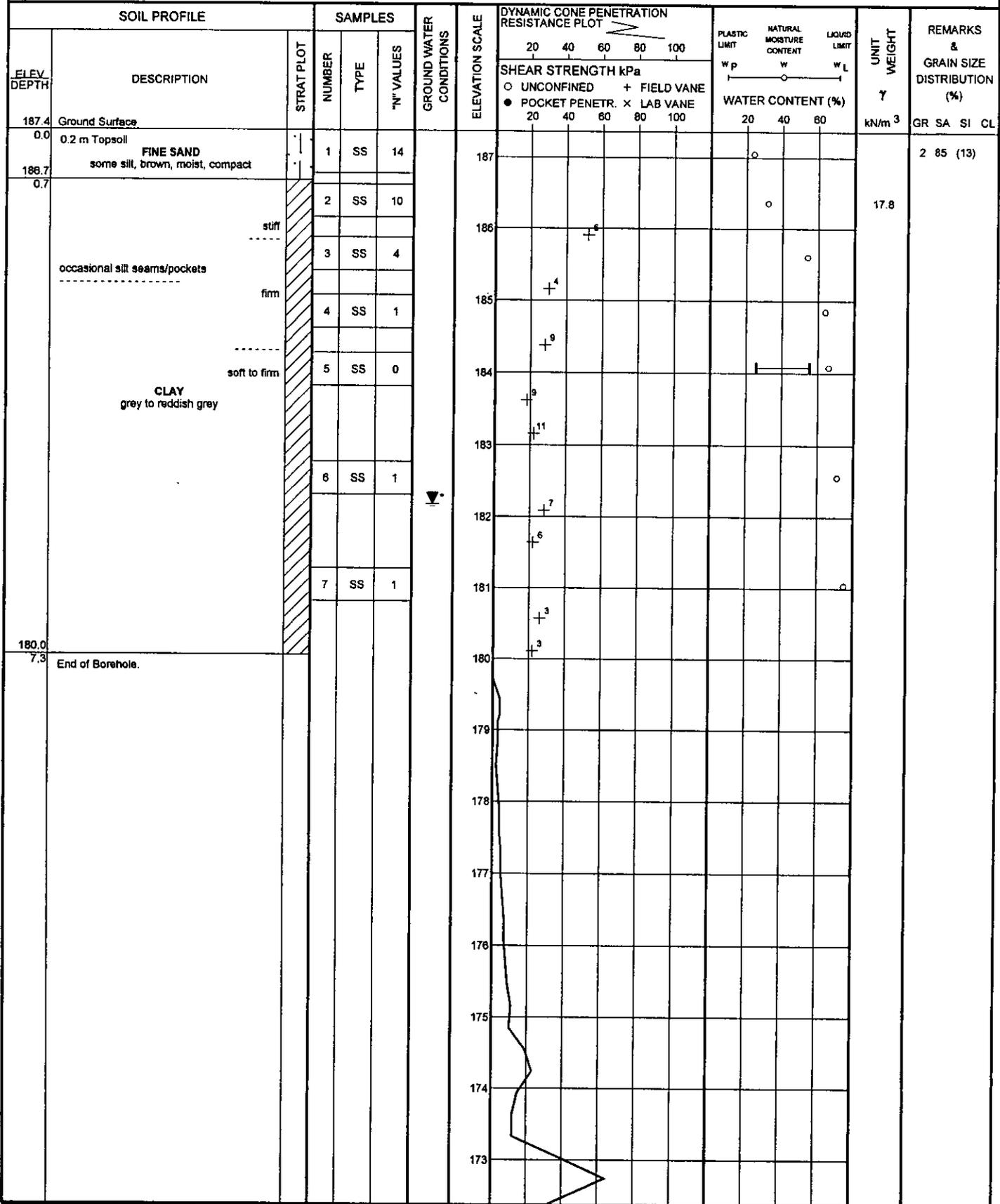
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV. DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● POCKET PENETR. X LAB VANE									
						20	40	60	80	100	20	40	60				
187.6	Ground Surface																
0.0	0.2 m Topsoil		1	SS	3											0 93 (7)	
186.9	trace to some silt, brown, moist, very loose																
0.7	frequent silt seams/partings		2	SS	6											17.7	
	stiff																
	soft to firm		3	SS	5											16.1	
			4	SS	2												
			5	SS	1												
	CLAY reddish grey to gray																
			6	TW	PH												
			7	SS	0												
180.3	End of Borehole.																
7.3	* Wet cave at 4.9 m on completion																

+³, X³: Numbers refer to Sensitivity 20 15 10 (%) STRAIN AT FAILURE

SPT 1055

RECORD OF BOREHOLE No 16+800; 19 m Rt 1 OF 2 METRIC

GWP 354-94-00 LOCATION Echo River to Bar River Road, Sault Ste. Marie - Coords: N 5 145 819.2; E 300 027.4 ORIGINATED BY G.I.
 DIST 82 HWY 17 (New) BOREHOLE TYPE Hollow Stem Augers & D.C.P.T. COMPILED BY Y.L.
 DATUM Geodetic DATE 5/30/2003 CHECKED BY R.M.



Continued Next Page

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

SPT 1055

RECORD OF BOREHOLE No 17+200; 19 m Rt 1 OF 2 METRIC

GWP 354-94-00 LOCATION Echo River to Bar River Road, Sault Ste. Marie - Coords: N 5 145 512.2; E 299 770.2 ORIGINATED BY G.I.
 DIST 62 HWY 17 (New) BOREHOLE TYPE Hollow Stem Augers & D.C.P.T. COMPILED BY Y.L.
 DATUM Geodetic DATE 5/29/2003 CHECKED BY R.M.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			UNIT WEIGHT γ KN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV. DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20 40 60 80 100	PLASTIC LIMIT w _p	NATURAL MOISTURE CONTENT w		
182.9	Ground Surface											
182.8	Peaty Topsoil		1	SS	4							
0.3			2	SS	4							
			3	SS	2							
			4	SS	1							
			5	SS	0							
			6	SS	1							
			7	SS	1							
	CLAY occasional silt seams/partings reddish grey to grey, wet soft to firm		8	SS	0							
			9	TW	PH						15.1	
			10	SS	2							
			11	SS	2						15.1	
168.7	SILTY SAND, some gravel (TILL) reddish brown, wet, compact		12	SS	0							
14.2												

Continued Next Page

+ 3 . x 3: Numbers refer to Sensitivity 20 15 10 (% STRAIN AT FAILURE

SPT 1055

RECORD OF BOREHOLE No 17+200; 19 m Rt 2 OF 2 METRIC

GWP 354-94-00 LOCATION Echo River to Bar River Road, Sault Ste. Marie - Coords: N 5 145 512.2; E 299 770.2 ORIGINATED BY G.I.
 DIST 62 HWY 17 (New) BOREHOLE TYPE Hollow Stem Augers & D.C.P.T. COMPILED BY Y.L.
 DATUM Geodetic DATE 5/29/2003 CHECKED BY R.M.

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT w _p	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV. DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			"N" VALUES	SHEAR STRENGTH kPa						
						20	40	60	80	100	20	40	60	GR SA SI CL
167.2	SILTY SAND, some gravel (TILL) reddish brown, wet, compact		13	SS	16									30 43 (27)
15.7			End of Borehole.											
163.9	End of D.C.P.T. Dynamic Cone Penetration Test (D.C.P.T.) performed from 15.7 m to 19 m. * Water level at 6.1 m (not stabilized), and hole open to 16.8 m on completion.													
19.0														

SPT 1055

RECORD OF BOREHOLE No 17+300; 19 m Lt 1 OF 2 METRIC

GWP 354-94-00 LOCATION Echo River to Bar River Road, Sault Ste. Marie - Coords: N 5 145 409.1; E 299 742.5 ORIGINATED BY G.I.
 DIST 62 HWY 17 (New) BOREHOLE TYPE Hollow Stem Augers COMPILED BY Y.L.
 DATUM Geodetic DATE 5/29/2003 CHECKED BY R.M.

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL	
ELEV. DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			"N" VALUES	20	40						60
182.5 0.0	Ground Surface 0.3 m Topsoil		1	SS	2										
	CLAY trace rootlets to 1.5 m reddish grey grey reddish grey soft to firm firm to stiff		2	SS	1										
			3	SS	1										
			4	SS	0										
			5	SS	0										
			6	SS	1										
			7	SS	1										
			8	SS	2										
			9	SS	2										
			10	SS	1										
			11	TW	PH										
			12	SS	2										

Continued Next Page

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

SPT 1055

RECORD OF BOREHOLE No 17+300; 19 m Lt 2 OF 2 METRIC

GWP 354-94-00 LOCATION Echo River to Bar River Road, Sault Ste. Marie - Coords: N 5 145 409.1; E 299 742.5 ORIGINATED BY G.I.
 DIST 62 HWY 17 (New) BOREHOLE TYPE Hollow Stem Augers COMPILED BY Y.L.
 DATUM Geodetic DATE 5/29/2003 CHECKED BY R.M.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● POCKET PENETR. × LAB VANE								
168.1 16.5	CLAY reddish grey, stiff		13	SS	2		167									
	End of Borehole. * Water level at 12.8 m (not stabilized), and hole open to 13.1 m on completion.															

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

SPT 1055

RECORD OF BOREHOLE No 17+450; 19 m Rt 1 OF 2 METRIC

GWP 354-94-00 LOCATION Echo River to Bar River Road, Sault Ste. Marie - Coords: N 5 145 294.5; E 299 638.8 ORIGINATED BY G.I.
 DIST 62 HWY 17 (New) BOREHOLE TYPE Hollow Stem Augers & D.C.P.T. COMPILED BY Y.L.
 DATUM Geodetic DATE 5/28/2003 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 γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV. DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			"N" VALUES	SHEAR STRENGTH kPa		W _p	W		
						20 40 60 80 100	20 40 60 80 100						
182.4 0.0	Ground Surface 0.2 m Topsoil		1	SS	4								
	very stiff stiff to firm		2	SS	2								
			3	TW	PH							15.4	
			4	SS	0								
			5	SS	0								
			6	SS	1								
	CLAY trace rootlets to 0.7 m												
			7	SS	0								
			8	SS	1								
	reddish gray												
			9	SS	1								
	grey		10	SS	1								
	reddish gray		11	SS	2							15.1	
			12	SS	1							15.4	
	stiff												

Continued Next Page

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

SPT 1055

RECORD OF BOREHOLE No 17+450; 19 m Rt 2 OF 2 METRIC

GWP 354-94-00 LOCATION Echo River to Bar River Road, Saut Ste. Marie - Coords: N 5 145 294.5; E 299 638.8 ORIGINATED BY G.I.
 DIST 62 HWY 17 (New) BOREHOLE TYPE Hollow Stem Augers & D.C.P.T. COMPILED BY Y.L.
 DATUM Geodetic DATE 5/28/2003 CHECKED BY R.M.

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)		
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			"N" VALUES	20						40	60
166.0	CLAY reddish grey, stiff	[Hatched]	13	SS	2	[Symbol]	20	40	60	80	100				
165			End of Borehole.												
155.8	End of D.C.P.T. Dynamic Cone Penetration Test (D.C.P.T) performed from 15.7 m to 19 m. * Water level at 15.2 m (not stabilized), and hole open to 15.8 m on completion.						20	40	60	80	100				
28.6															

+ 3, x 3; Numbers refer to Sensitivity 20 15 10 (% STRAIN AT FAILURE

SPT 1055

RECORD OF BOREHOLE No 17+600; 19 m Lt 1 OF 1

METRIC

GWP 354-94-00 LOCATION Echo River to Bar River Road, Saut Ste. Marie - Coords: N 5 145 140.4; E 299 627.4 ORIGINATED BY G.I.
 DIST 82 HWY 17 (New) BOREHOLE TYPE Hollow Stem Augers COMPILED BY Y.L.
 DATUM Geodetic DATE 5/28/2003 CHECKED BY R.M.

SOIL PROFILE		STRAT PLOT	SAMPLES		GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT w _p	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)	
ELEV. DEPTH	DESCRIPTION		NUMBER	TYPE			T _N VALUES	20	40	60	80						100
183.2	Ground Surface																
0.0	0.4 m Topsoil		1	SS	5												
	SILTY SAND moist to wet loose to compact		2	SS	10												
			3	SS	6												
181.1			4	SS	4												
2.1	CLAY reddish grey, wet		5	SS	2												
			6	SS	1												
			7	SS	0												
175.9																	
7.3	End of Borehole.																

* Water level at 3.0 m (not stabilized), and hole open to 5.2 m on completion.

Appendix D2 Site D Laboratory Test Results

UNIFIED SOIL CLASSIFICATION SYSTEM

CLAY AND SILT

SAND

GRAVEL

Fine

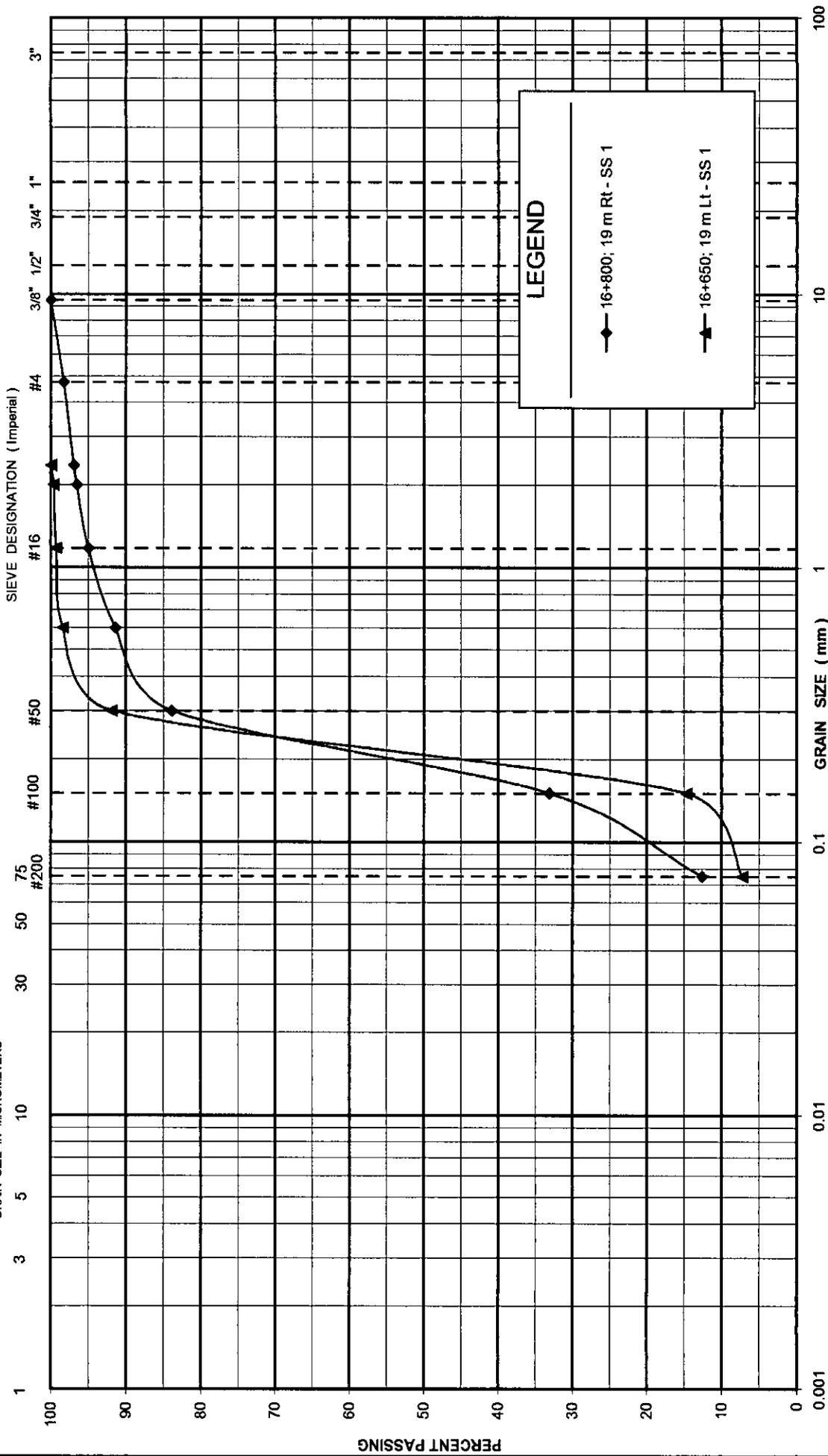
Medium

Coarse

Fine

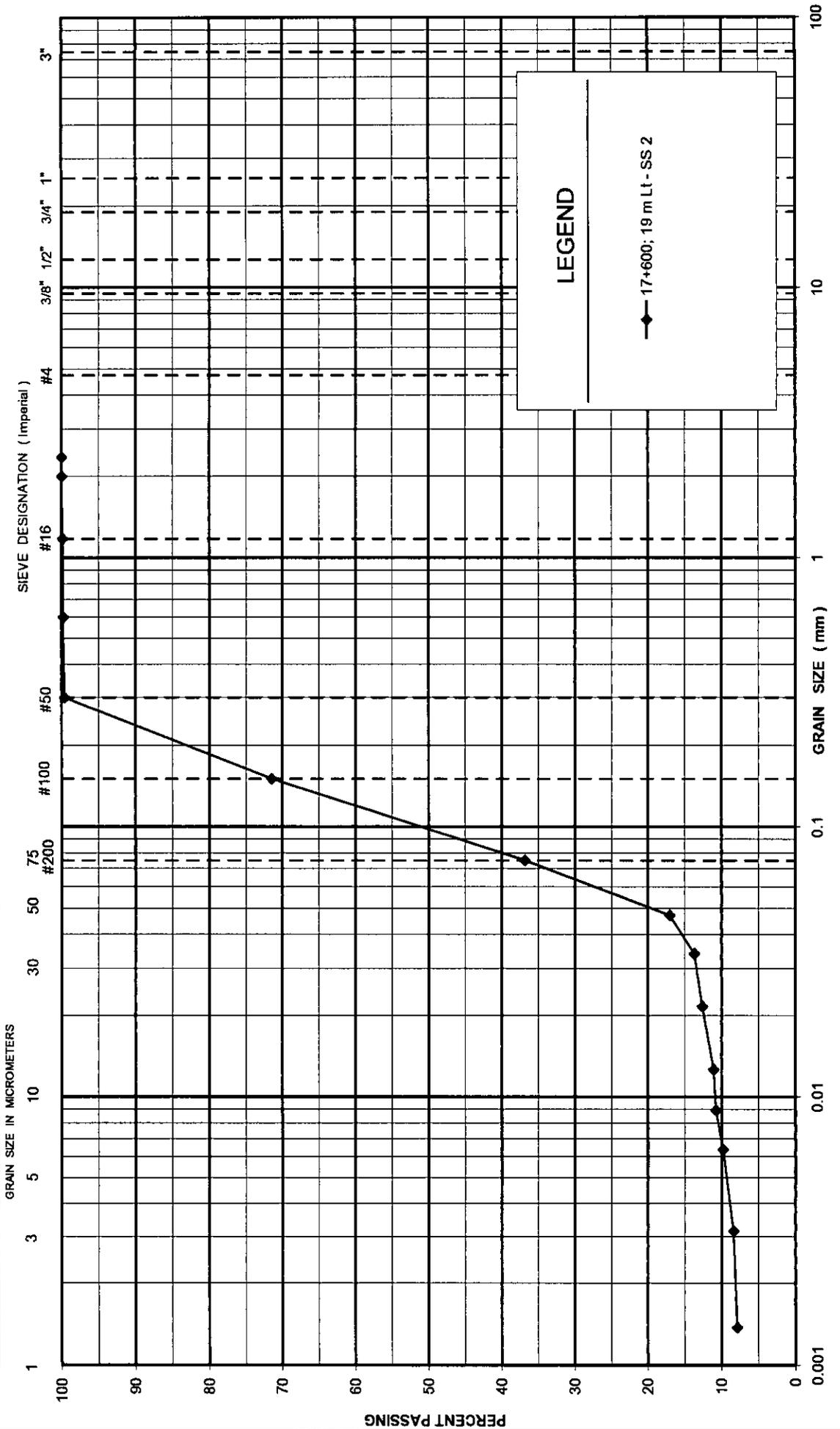
Coarse

GRAIN SIZE IN MICROMETERS



UNIFIED SOIL CLASSIFICATION SYSTEM

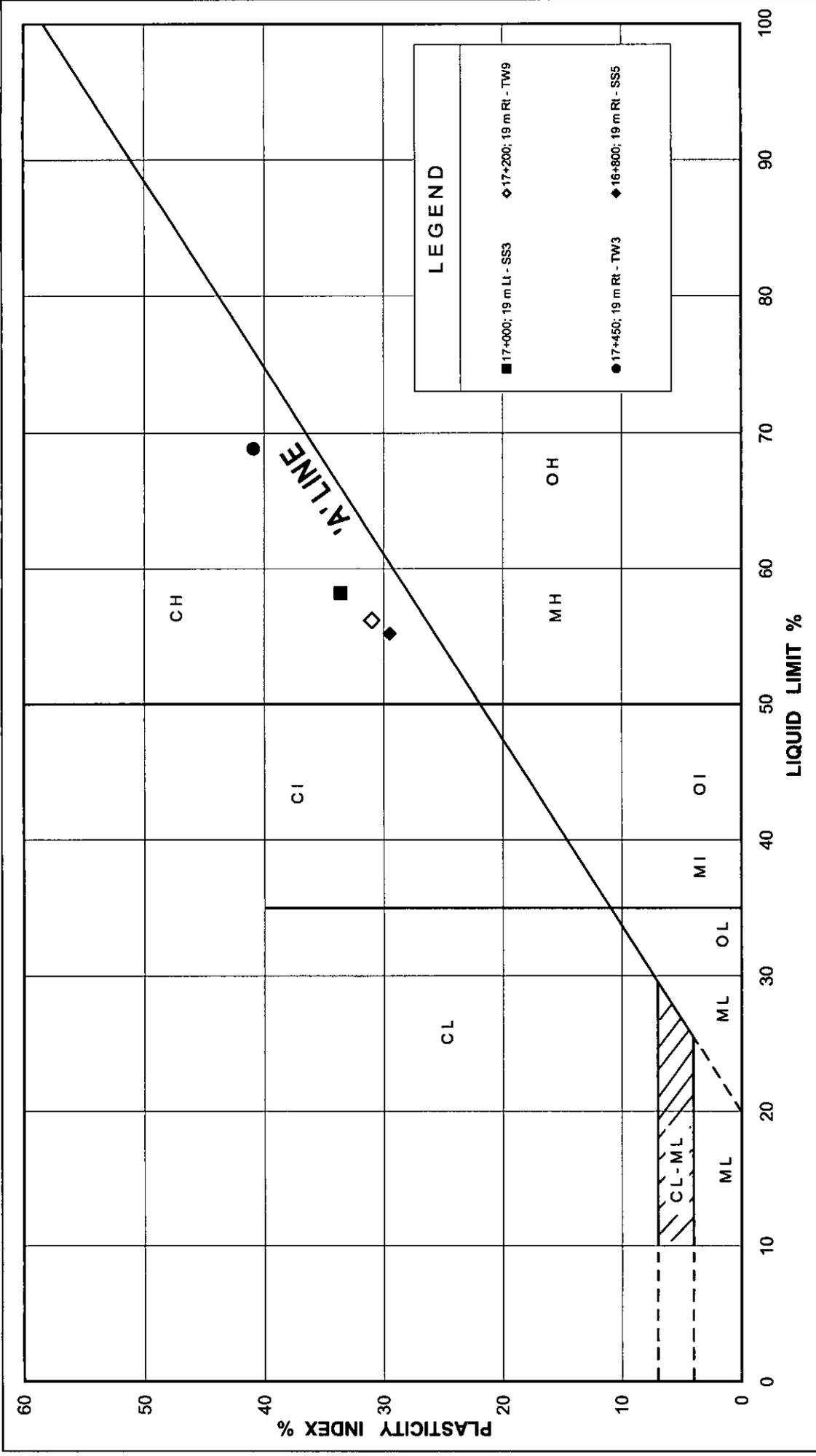
CLAY AND SILT			SAND			GRAVEL		
			Fine	Medium	Coarse	Fine	Coarse	



**GRAIN SIZE DISTRIBUTION
SILTY SAND**

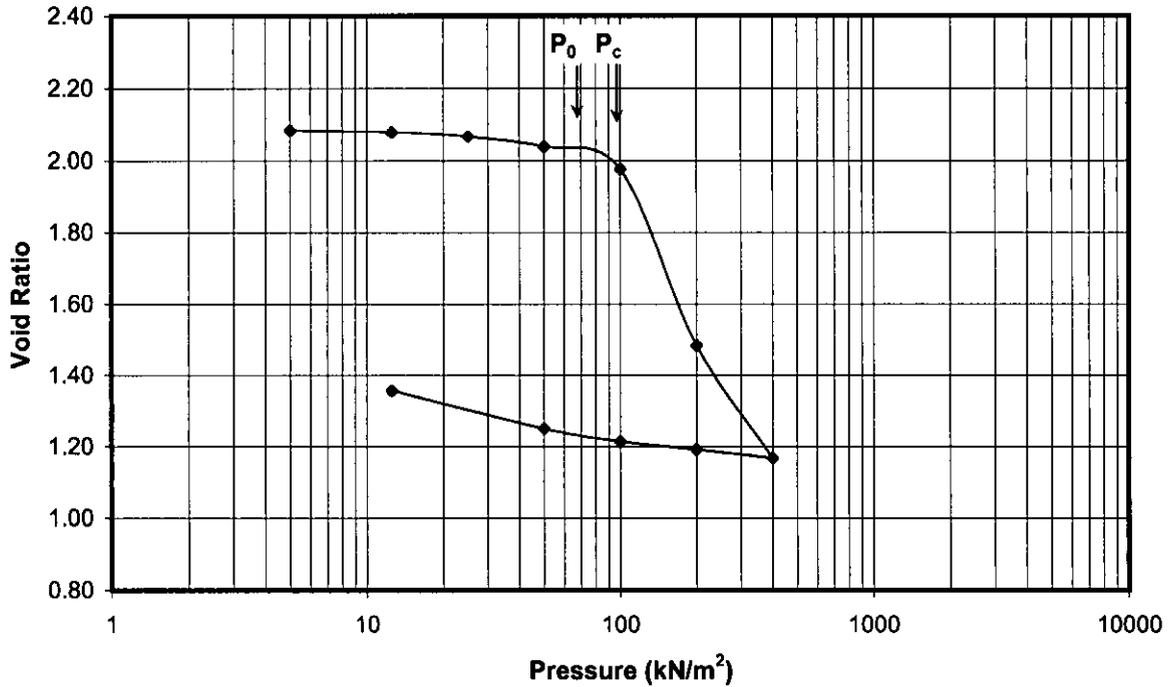
SHAHEEN & PEAKER LIMITED

FIGURE No. D2 - 2
REF. No. SPT 1055
GWP: 354-94-00

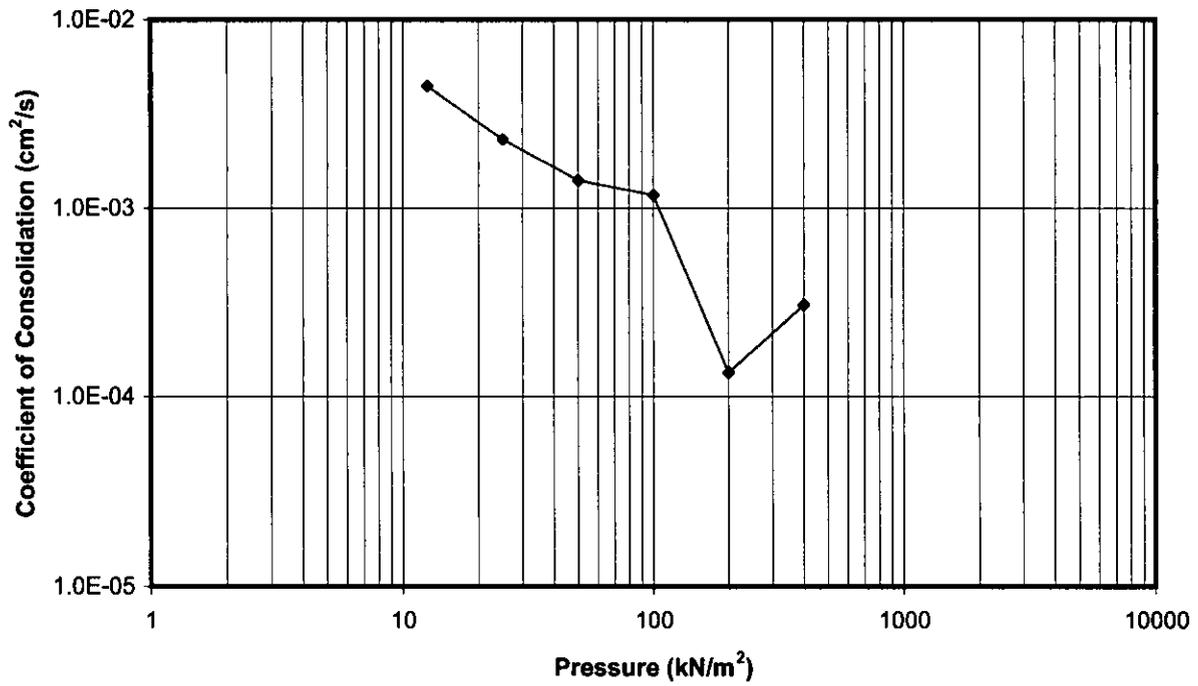


<p>PLASTICITY CHART</p> <p>CLAY</p>	<p>FIG No D2-3</p> <p>G.W.P. 354-94-00</p> <p>SPT 1055</p>
<p>SHAHEEN & PEAKER LIMITED</p>	

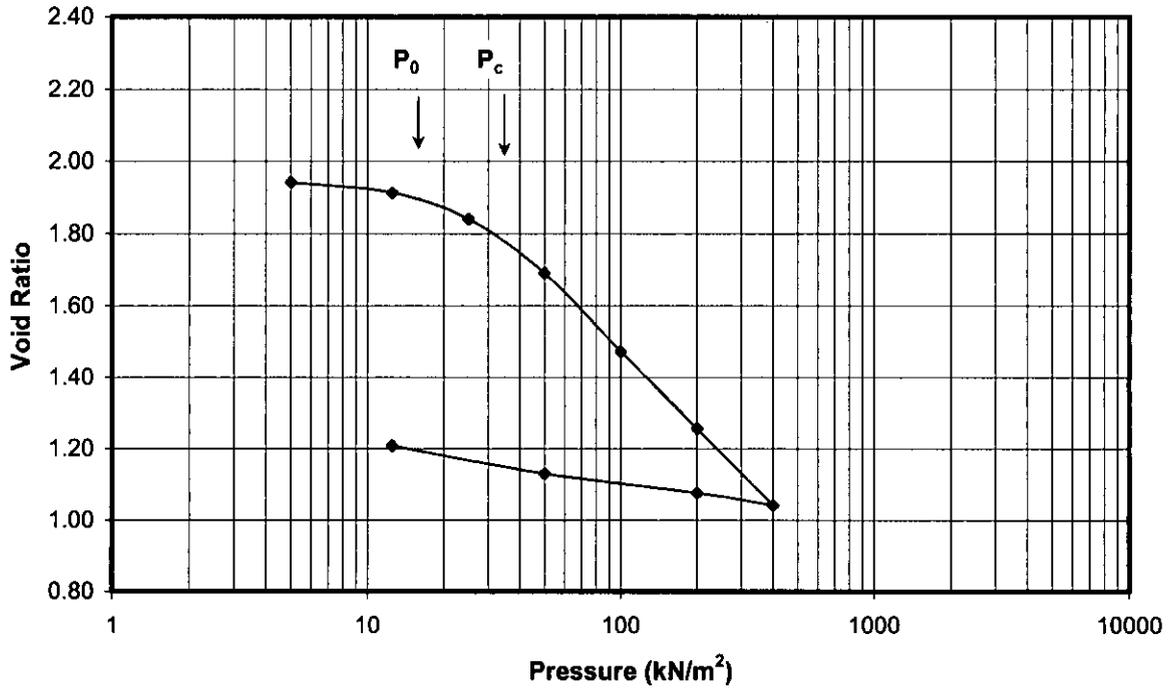
Void Ratio versus Pressure



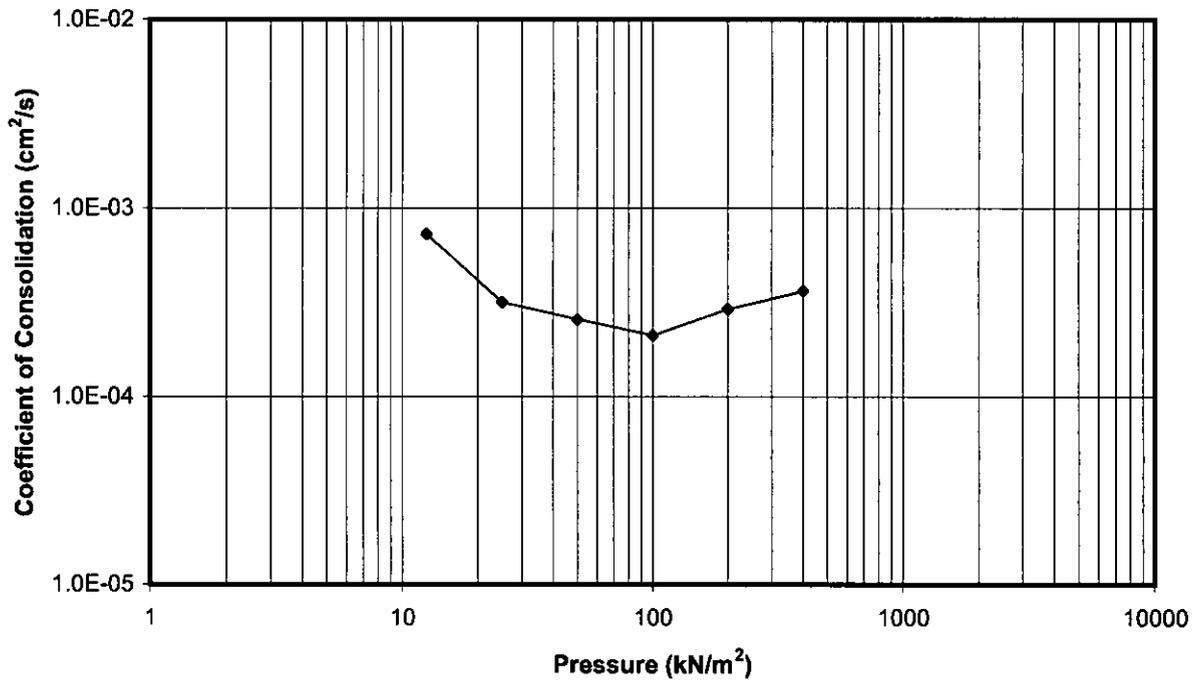
Coefficient of Consolidation vs. Pressure



Void Ratio versus Pressure



Coefficient of Consolidation vs. Pressure

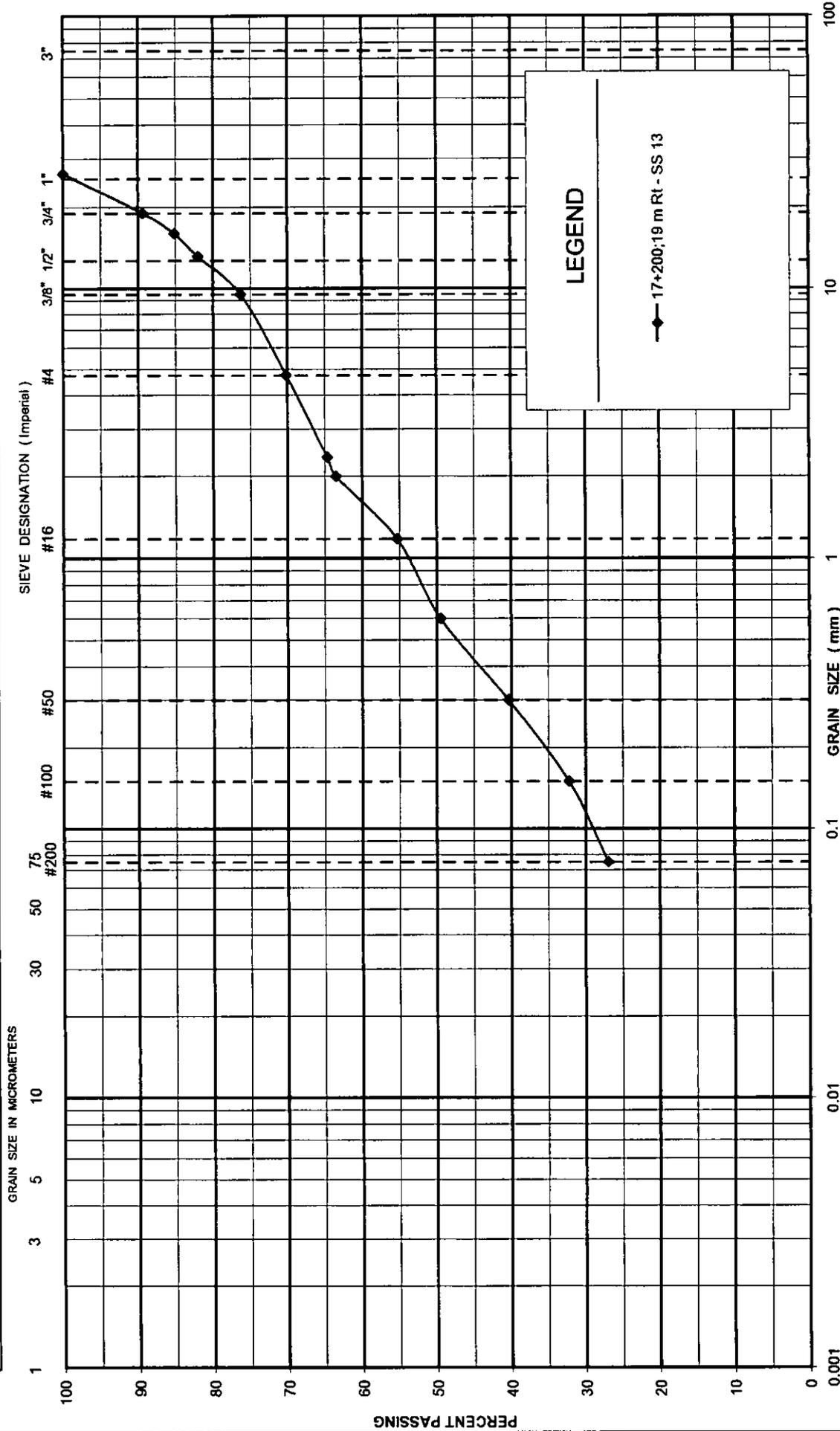


UNIFIED SOIL CLASSIFICATION SYSTEM

CLAY AND SILT

SAND
Fine Medium Coarse

GRAVEL
Fine Coarse



LEGEND

—●— 17-200;19 m Rt - SS 13

GRAIN SIZE DISTRIBUTION
SILTY SAND, some gravel (Till)

SHAHEEN & PEAKER LIMITED

FIGURE No. D2 - 6
REF. No. SPT 1055
GWP: 354-94-00

Appendix D3 Site D Measured Undrained Shear Strength Results

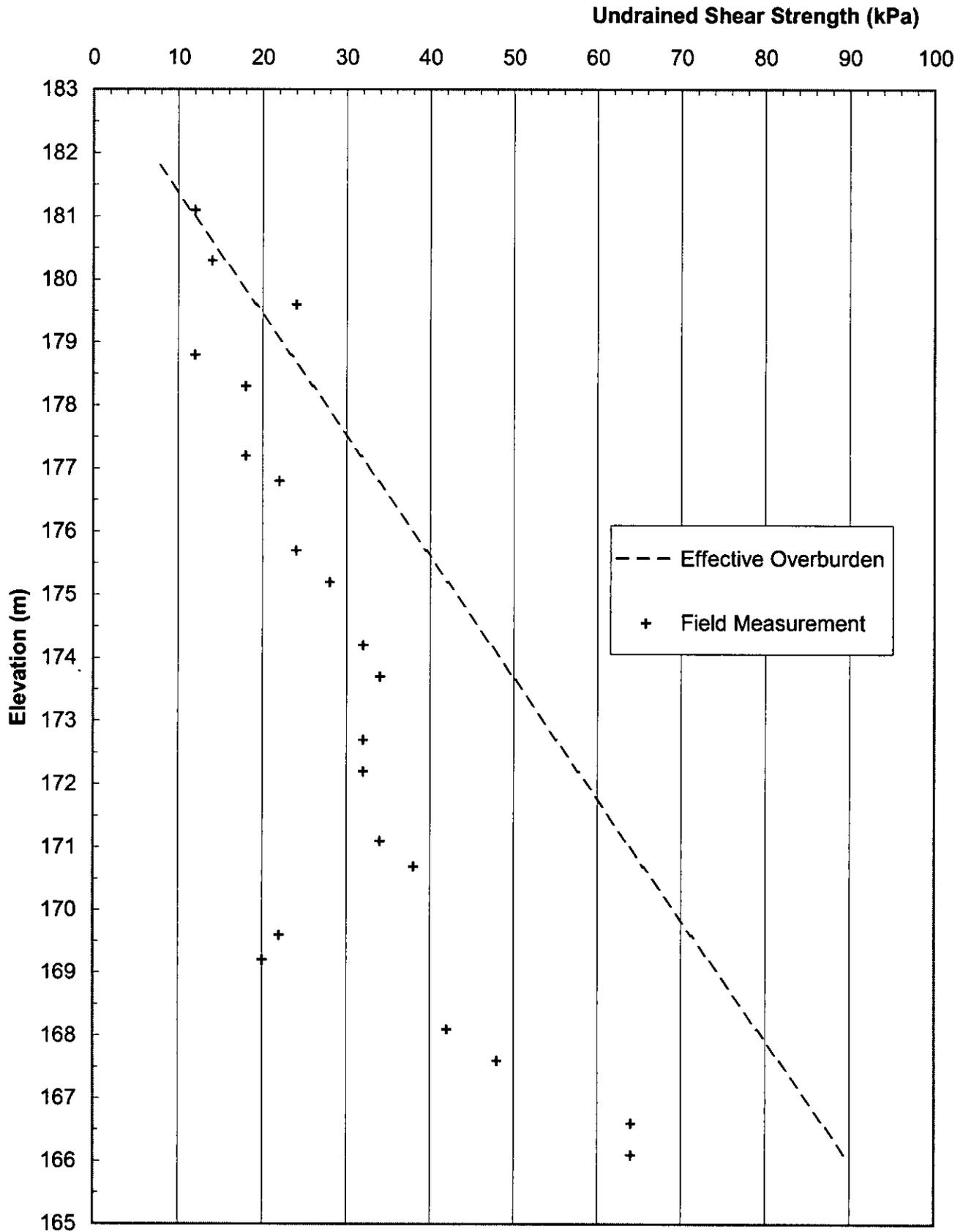


Fig. D3-2: Variation of Undrained Shear Strength (as measured by field vane tests) with Elevation (Boreholes 17+300; 19 m Lt)

Appendix E

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 63.5kg. 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 \bar{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

JOINTING AND BEDDING:

	50mm	50 - 300mm	0.3m - 1m	1m - 3m	>3m
SPACING					
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
σ	kPa	TOTAL NORMAL STRESS
σ'	kPa	EFFECTIVE NORMAL STRESS
τ	kPa	SHEAR STRESS
$\sigma_1, \sigma_2, \sigma_3$	kPa	PRINCIPAL STRESSES
ϵ	%	LINEAR STRAIN
$\epsilon_1, \epsilon_2, \epsilon_3$	%	PRINCIPAL STRAINS
E	kPa	MODULUS OF LINEAR DEFORMATION
G	kPa	MODULUS OF SHEAR DEFORMATION
μ	1	COEFFICIENT OF FRICTION

MECHANICAL PROPERTIES OF SOIL

m_v	kPa ⁻¹	COEFFICIENT OF VOLUME CHANGE
C_c	1	COMPRESSION INDEX
C_s	1	SWELLING INDEX
C_α	1	RATE OF SECONDARY CONSOLIDATION
C_v	m ² /s	COEFFICIENT OF CONSOLIDATION
H	m	DRAINAGE PATH
T_v	1	TIME FACTOR
U	%	DEGREE OF CONSOLIDATION
σ_{vo}	kPa	EFFECTIVE OVERBURDEN PRESSURE
σ'_p	kPa	PRECONSOLIDATION PRESSURE
τ_r	kPa	SHEAR STRENGTH
c'	kPa	EFFECTIVE COHESION INTERCEPT
ϕ	-°	EFFECTIVE ANGLE OF INTERNAL FRICTION
c_u	kPa	APPARENT COHESION INTERCEPT
ϕ_u	-°	APPARENT ANGLE OF INTERNAL FRICTION
τ_u	kPa	RESIDUAL SHEAR STRENGTH
τ_r	kPa	REMOULDED SHEAR STRENGTH
S_t	1	SENSITIVITY = c_u / τ_r

PHYSICAL PROPERTIES OF SOIL

A	kg/m ³	DENSITY OF SOLID PARTICLES	e	1.0%	VOID RATIO	e_{min}	1.0%	VOID RATIO IN DENSEST STATE
γ_s	kN/m ³	UNIT WEIGHT OF SOLID PARTICLES	n	1.0%	POROSITY	I_p	1	DENSITY INDEX = $\frac{e_{max} - e}{e_{max} - e_{min}}$
ρ_w	kg/m ³	DENSITY OF WATER	w	1.0%	WATER CONTENT	D	mm	GRAIN DIAMETER
γ_w	kN/m ³	UNIT WEIGHT OF WATER	S_r	%	DEGREE OF SATURATION	D_n	mm	n PERCENT - DIAMETER
ρ	kg/m ³	DENSITY OF SOIL	w_L	%	LIQUID LIMIT	C_u	1	UNIFORMITY COEFFICIENT
γ	kN/m ³	UNIT WEIGHT OF SOIL	w_p	%	PLASTIC LIMIT	h	m	HYDRAULIC HEAD OR POTENTIAL
ρ_d	kg/m ³	DENSITY OF DRY SOIL	w_s	%	SHRINKAGE LIMIT	q	m ³ /s	RATE OF DISCHARGE
γ_d	kN/m ³	UNIT WEIGHT OF DRY SOIL	I_p	%	PLASTICITY INDEX = $(w_L - w_p) / I_p$	v	m/s	DISCHARGE VELOCITY
ρ_{sat}	kg/m ³	DENSITY OF SATURATED SOIL	I_L	1	LIQUIDITY INDEX = $(w - w_p) / I_p$	i	1	HYDRAULIC GRADIENT
γ_{sat}	kN/m ³	UNIT WEIGHT OF SATURATED SOIL	I_c	1	CONSISTENCY INDEX = $(w_L - w) / I_p$	k	m/s	HYDRAULIC CONDUCTIVITY
ρ'	kg/m ³	DENSITY OF SUBMERGED SOIL	e_{max}	1.0%	VOID RATIO IN LOOSEST STATE	j	kN/m ²	SEEPAGE FORCE
γ'	kN/m ³	UNIT WEIGHT OF SUBMERGED SOIL						

**ADDITIONAL FOUNDATION DESIGN REPORT
PROPOSED HIGHWAY 17 (NEW)
FROM ECHO RIVER TO BAR RIVER ROAD
DISTRICT 62, SAULT STE. MARIE, ONTARIO
G.W.P. 354 AND 352-94-00**

GEOCRES NO. 41K00-063

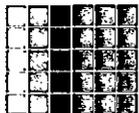
Prepared For:

MARSHALL MACKLIN MONAGHAN LTD.

Prepared by:

SHAHEEN & PEAKER LIMITED

**Project: SPT1055
September 17, 2003**



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**ADDITIONAL FOUNDATION DESIGN REPORT
PROPOSED HIGHWAY 17 (NEW)
FROM ECHO RIVER TO BAR RIVER ROAD
DISTRICT 62, SAULT STE. MARIE, ONTARIO
G.W.P. 354 AND 352-94-00**

5. DISCUSSION AND RECOMMENDATIONS

The sections investigated which are covered in this Additional Foundation Investigation are designated as Sites A, B, C and D for the purposes of this report and are described as follows:

Site A: Highway 17 (New) Fill Section between Stations 10+360 and 10+700 Westbound Lanes (WBL), between Site Nos. 1 and 2 of the previous investigation by S & P*.

This site is a fill section along WBL and the proposed heights of fill (along road centerline) within this section vary from 0 to about 4 m over existing grades.

Site B: Highway 17 (New) Fill and Cut Sections between Stations 11+000 and 11+350 EBL and WBL, between Site Nos. 3 and 4.

The fill section of the site is from Station 11+000 to about 11+190 and the proposed maximum height of fill (along road centerline) is about 2 m over existing grade. The cut section is from about Station 11+190 to 11+350 and up to about 2 m of cut is anticipated in this area.

Site C: Highway 17 (New) Fill Section between Stations 13+400 and 15+470 EBL and WBL, between Site Nos. 5 and 6.

The proposed heights of fill in this 2 km section vary from about 1.1 to 2.9 m, the maximum height of fill being at about Station 14+600, just north of Watson Road.

Site D: Highway 17 (New) Cut and Fill Section between Stations 16+600 and 17+700 EBL and WBL, between Site No.8 and south limit of project.

Between Stations 16+600 and 16+800, the proposed heights of fill in this section vary from about 2 to 2.5 m at Station 16+600 to zero fill at Station 16+800. Towards south from Station 16+800, the profile drawing indicates cut section (maximum cut of about 0.8 m along EBL and 0.3 m along WBL) to Station 17+000. Further south from Station 17+000 to the south limit is a fill section with a maximum fill height of about 2.8 m.

The recommendations presented in this report are summarized in Table 1. This Additional Foundation Design Report should be read in conjunction with previous Foundation Design Report* prepared by S & P for this project.

Slope stability analyses were conducted at each section. For the undrained (short-term) stability analyses, undrained shear strengths (c-values) of the clay were utilized based on the Field Vane Tests results, assuming angle of internal friction (ϕ) of the soil being zero. For the drained (long-term) analyses, an estimated ϕ -angle together with a small value of shear strength (c) were used. The analyses were performed using limit state equilibrium (Bishop's Simplified Method by the computer program Slope/W). Typical embankment slope stability sections are presented in Appendix F.

Settlement analyses were performed based on the heights of fill taken from the vertical profile provided to us and any surcharge that we recommended.

Based on the above analyses, the design recommendations for each site are presented in Table 1.

In any event, surcharging at Site-C and D should be carried out with proper instrumentation for field monitoring. It is furthermore recommended that the surcharge be placed gradually (i.e., preferably at least 3 layers, starting from one end of the site and proceeding to the other end), to allow excess pore pressures to dissipate.

Fills at the above section should be provided with a widened cross-section to allow for settlements of the underlying soils and a future grade raise. In this case, we recommend that the road platform should be widened by at least 2 m on each side of the centreline (total of 4 m), or otherwise noted. This is also in accordance with the Northern Region Engineering Directive NRE 98-200. At Site A between Stations 10+370 and 10+570, Site C (between Stations 13+400 and 15+470), and Site D (from Station 16+600 to 17+500), platform widening of at least 3 m should be provided on each side of the road centerline.

* "Foundation Design Report, Proposed Highway 17(New)
From Echo River to Bar River Road, District 62, Sault Ste. Marie, Ontario
G.W.P. 354 and 352-94-00", prepared by S & P, dated August 2003.

Table 1 Summary Table of Design Recommendations

SITE A

Station to Station	Lane	Approx. Maximum Embankment Height (m)	Embankment Type or (Cut Material)	Average Stripping Depth (m)	Side Slopes	Surcharge	Remarks	Estimated Maximum Post-Construction Settlement after Min. 1.5 years of Surcharging (mm)		
								0 ~ 5 Yrs	5 ~ 10 Yrs	10 ~ 20 Yrs
10+360 to 10+700	WBL	4.0	EF	0.5	3H : 1V*	From Station 10+360, gradually increase surcharge to 1.0 m at Station 10+370 Maintain 1.0 m surcharge between Stations 10+370 and 10+570 Gradually reduce surcharge to zero at Station 10+580	Prompt Seed and Cover or Sodding	30	10	10

Notes: 1. * The recommended side slopes could be flattened to 4H:1V; surplus material can be used for this purpose, if desired.
 2. We recommend at least 3 m platform widening on left side of the road centreline and at least 2 m platform widening on right side of the road centreline.

LEGEND: EF - Earthfill RF - Rockfill
 EBL - Eastbound Lanes WBL - Westbound Lanes
 () - for Cut Sections/Slopes

SITE B

Station to Station	Lane	Approx. Maximum Embankment Height (m)	Embankment Type or (Cut Material)	Average Stripping Depth (m)	Side Slopes	Surcharge	Remarks	Estimated Maximum Post-Construction Settlement after Min. 1.5 years of Surcharging (mm)		
								0 ~ 5 Yrs	5 ~ 10 Yrs	10 ~ 20 Yrs
11+000 to 11+190	EBL	1.8	EF	0.3	2H : 1V*	Continuing from north of Station 11+000, maintain 1.7 m surcharge between Stations 11+000 and 11+040 Gradually reduce surcharge to zero at Station 11+100	Prompt Seed and Cover or Sodding	30	10	10
	WBL	1.9								
11+190 to 11+350	EBL	(2.0)**	(Earth)	N / A	(3H : 1V)	N / A	Erosion Control Blanket	---	---	---
	WBL									

Note: 1.* The recommended side slopes could be flattened to 4H:1V; surplus materials could be used for this purpose, if desired.

SITEC

Station to Station	Lane	Approx. Maximum Embankment Height (m)	Embankment Type or (Cut Material)	Average Stripping Depth (m)	Side Slopes	Surcharge	Remarks	Estimated Maximum Post-Construction Settlement after Min. 1.5 years of Surcharging (mm)		
								0 ~ 5 Yrs	5 ~ 10 Yrs	10 ~ 20 Yrs
13+400 to 14+500	EBL	1.8	EF	0.5	2H : 1V*	Preload WBL between Stations 13+400 and 14+020. Gradually apply surcharge along WBL starting at Station 14+020 and increasing to 0.5 m at Station 14+030. Maintain 0.5 m surcharge between Stations 14+030 and 14+300	Prompt Seed and Cover or Sodding.	150	60	10
14+500 to 14+550		flatten to 4H : 1V at Station 14+550								
14+550 to 15+200		4H : 1V**								
15+200 to 15+470	WBL	2.5	EF	0.5	2H : 1V*	Gradually reduce surcharge to zero at Station 14+310	Settlement Rod at Stations 14+370 WBL, 14+570 WBL, 14+600 EBL, 14+950 WBL, 15+000 EBL and 15+125 EBL	150	60	10
13+400 to 14+500		2H : 1V*								
14+500 to 14+550		flatten to 4H : 1V at Station 14+550								
14+550 to 15+200	WBL	2.2	EF	0.5	4H : 1V**	Preload between Stations 14+310 and 14+500	Settlement Rod at Stations 14+370 WBL, 14+570 WBL, 14+600 EBL, 14+950 WBL, 15+000 EBL and 15+125 EBL	150	60	10
15+200 to 15+470		2H : 1V*								
15+200 to 15+470		2H : 1V*								

Notes: 1. * The recommended side slopes could be flattened to 4H:1V; surplus materials can be used for this purpose, if desired.
2. ** Alternative of using 2H:1V side slopes and flatten to 4H:1V 'BEFORE' surcharging; surplus materials can be used for flattening purpose, if desired.
3. We recommend at least 3 m platform widening on each side of the road centreline.

SITE D

Station to Station	Lane	Approx. Maximum Embankment Height (m)	Embankment Type or (Cut Material)	Average Stripping Depth (m)	Side Slopes	Surcharge	Remarks	Estimated Maximum Post-Construction Settlement after Min. 1.5 years of Surcharging (mm)		
								0 ~ 5 Yrs	5 ~ 10 Yrs	10 ~ 20 Yrs
16+600 to 16+720		2.0			2H : 1V*					
16+720 to 17+020		N/A			Note 2**					
17+020 to 17+200	EBL	2.8			2H : 1V*	Gradually reduce surcharge from 1.2 m at Station 16+600 to zero at Station 16+720		160	110	40
17+200 to 17+500		2.8			4H : 1V	Apply surcharge starts from zero at Station 17+020 increasing to 0.4 m at Station 17+040	Prompt Seed and Cover or Sodding			
17+500 to 17+700		1.7	EF	0.5	2H : 1V*	Maintain 0.4 m surcharge between Stations 17+040 and 17+490. With a view of placing an additional 0.4 m surcharge after 6 months, subject to monitoring	Settlement Rod at Stations 17+450 EBL			
16+600 to 16+720		2.5			2H : 1V*	Gradually reduce surcharge to zero at Station 17+500	Settlement Rod, Vibrating Wire Piezometers and Standpipe at Stations 17+250 EBL and 17+300 WBL			
16+720 to 17+020		N/A			Note 2**	Preload between Stations 17+500 and 17+700				
17+020 to 17+200	WBL	2.5			2H : 1V*			180	130	50
17+200 to 17+500		2.5			4H : 1V					
17+500 to 17+700		1.5			2H : 1V*					

- Notes: 1. * The recommended side slopes could be flattened to 4H:1V; surplus materials can be used for this purpose, if desired.
2. ** Between Stations 16+720 and 17+020 the height of fill is very shallow or cut. Therefore, use standard procedures. Settlements should be less than 50 mm.
3. We recommend at least 3 m platform widening on each side of the road centreline.

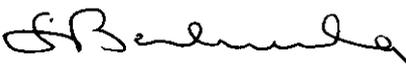
6. CLOSURE

The Limitations of Report, as quoted in Appendix G, are an integral part of this report. It should be noted that the recommendations presented in this report are based on widely spaced (generally 200 m) boreholes and subsurface conditions in between and beyond the borehole locations could vary from the ones encountered at the boreholes and therefore the recommendations given may not be applicable if found different.

SHAHEEN & PEAKER LIMITED


R. Miranda, P.Eng.



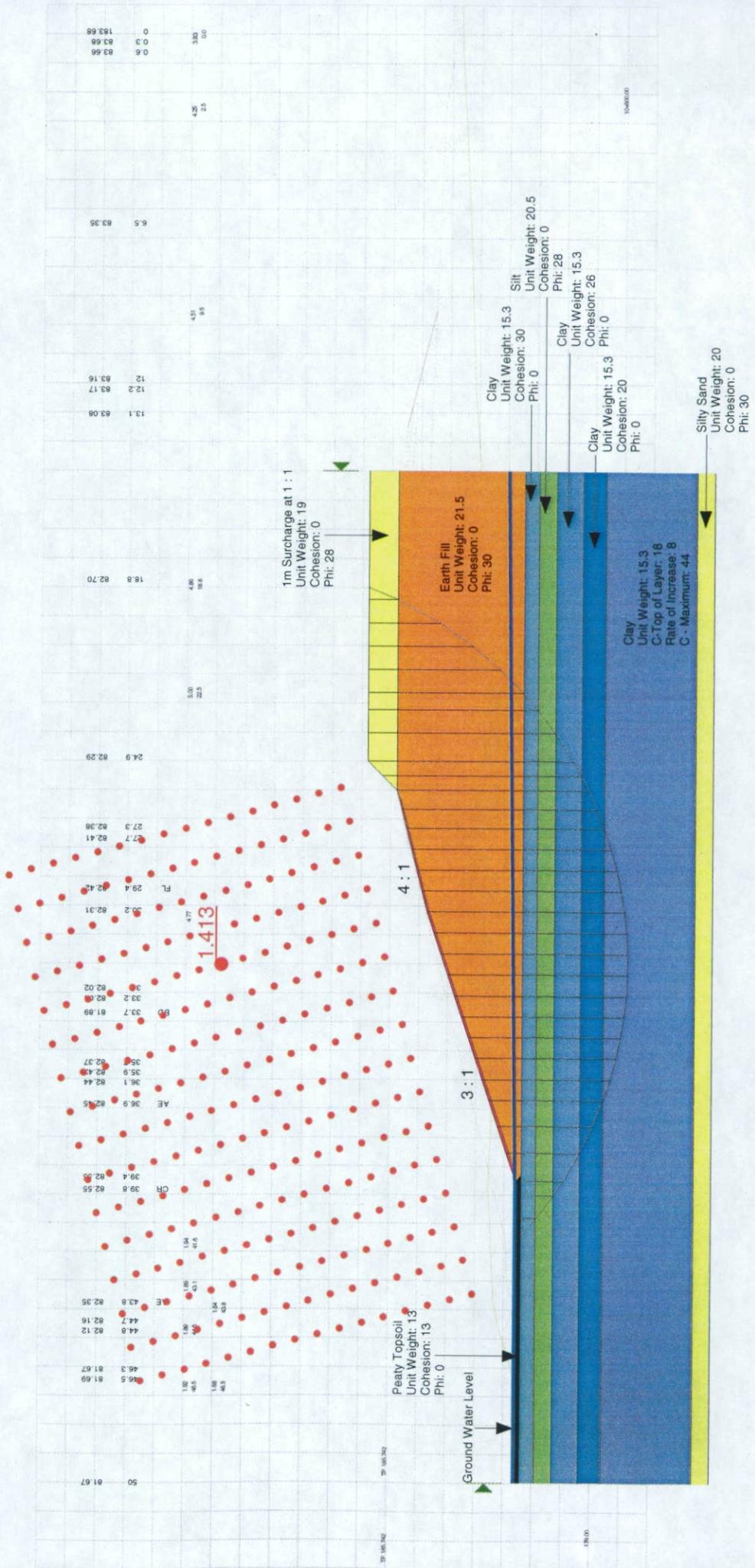

for Z.S. Ozden, P.Eng



Appendix F

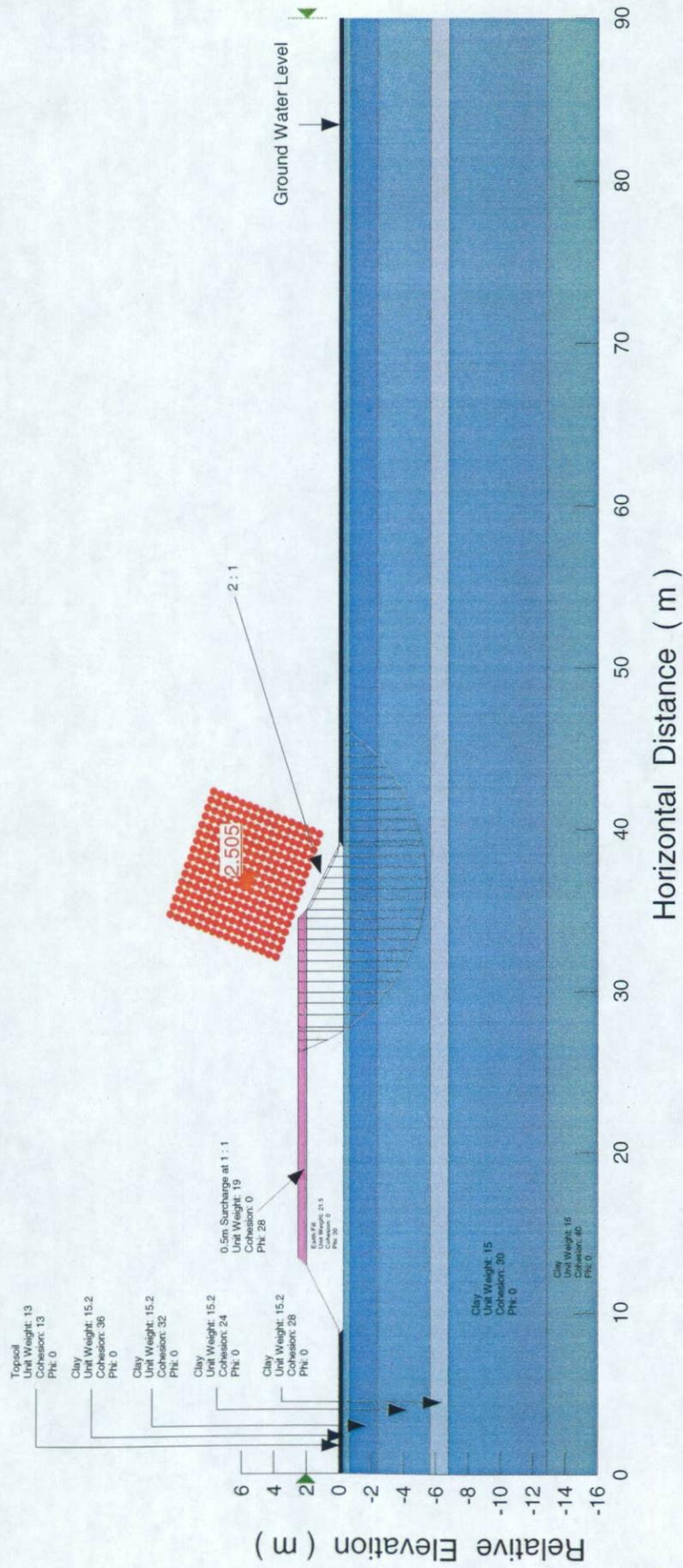
Slope Stability Analysis Results

SPT 1055, Highway 17 (New), Sault Ste. Marie
 Station 10+500, WBL, 4.0m High, Earth Fill Embankment (Plus 1.0m Surcharge)
 Undrained Case (Total Stress Analysis)



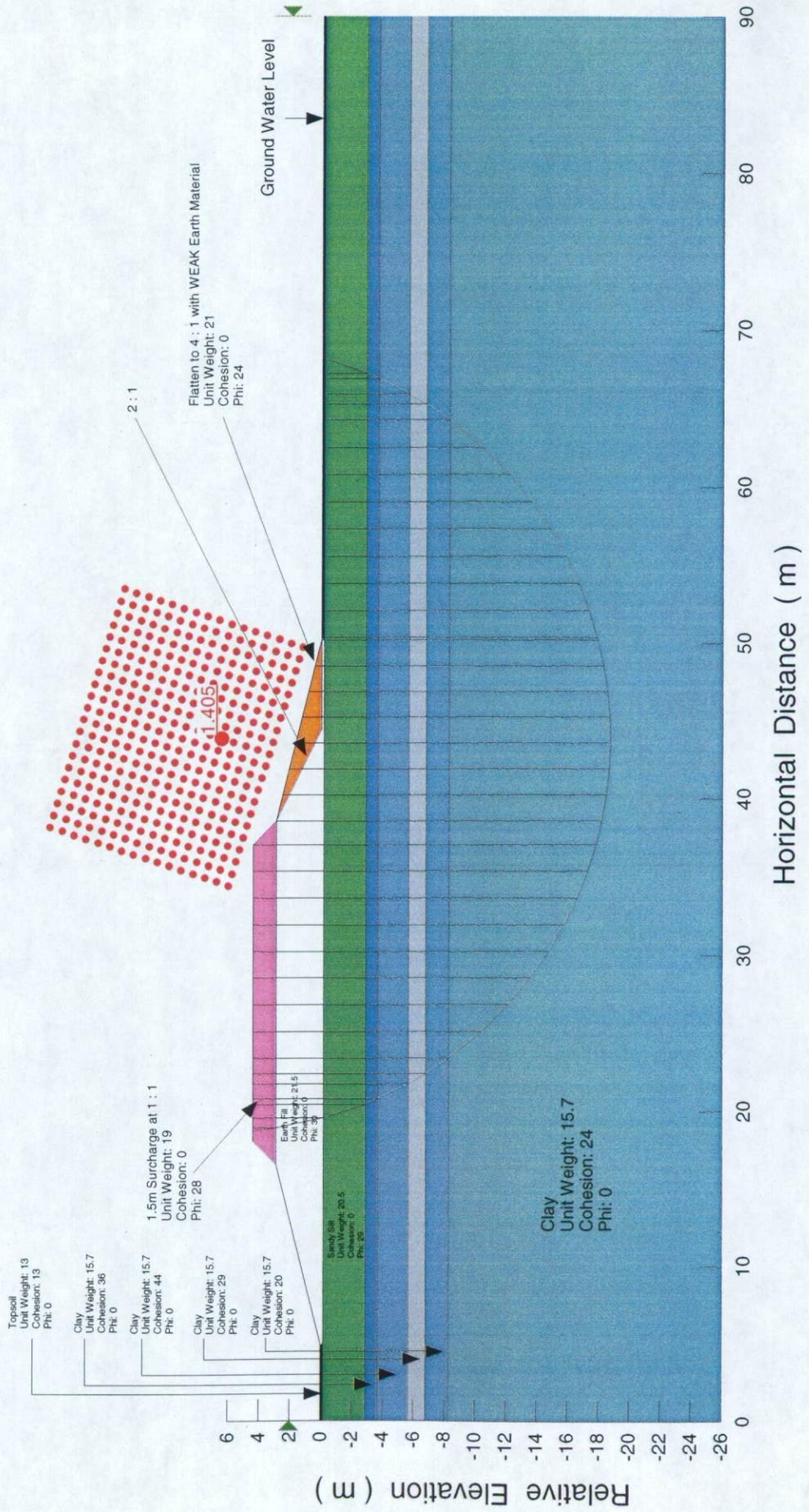
SPT 1055, Highway 17 (New), Sault Ste. Marie
 Station 14+200, EBL, 2.0m High, Earth Fill Embankment (Plus 0.5m Surcharge)
 Undrained Case (Total Stress Analysis)

Platform Width = 22m

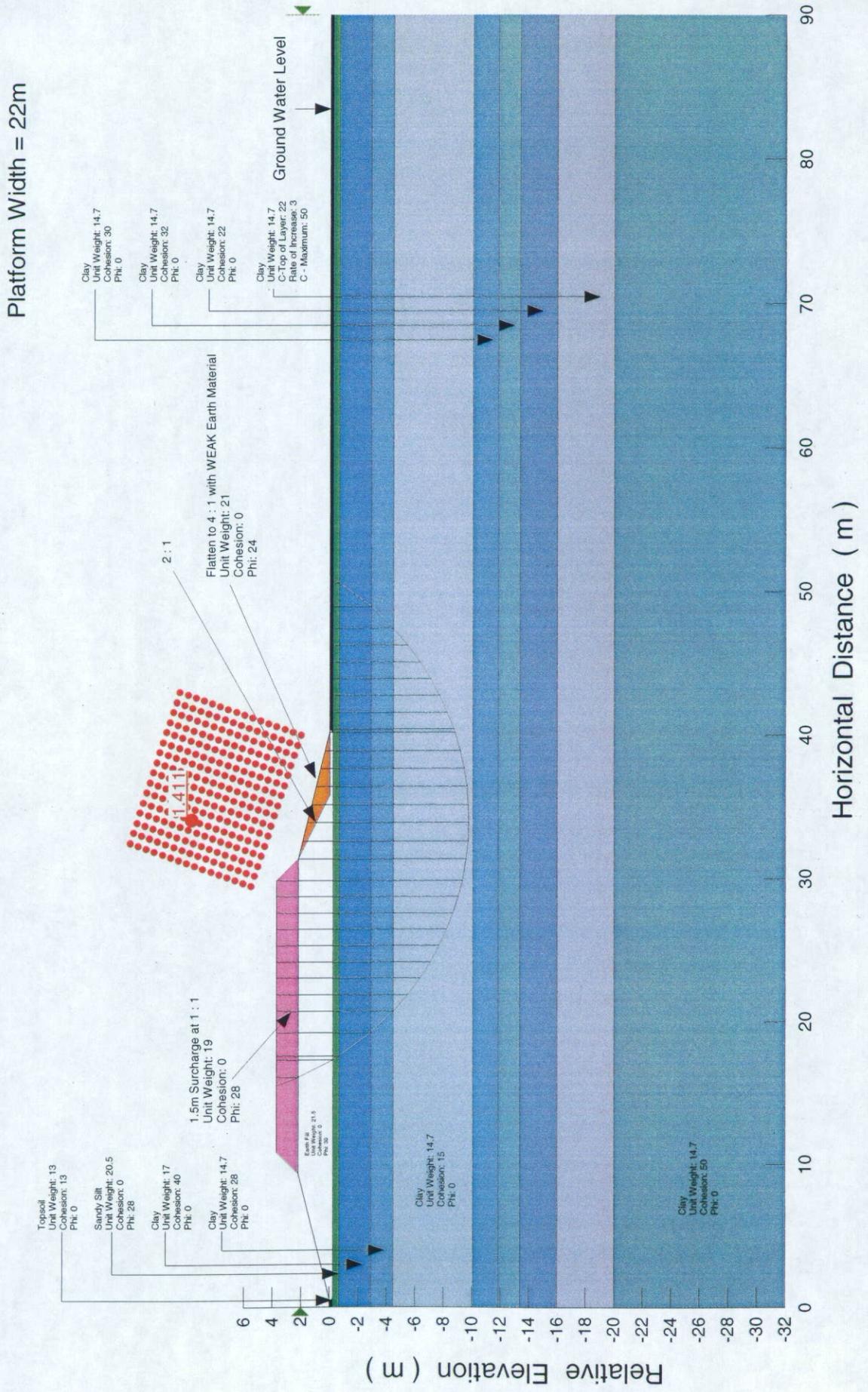


SPT 1055, Highway 17 (New), Sault Ste. Marie
 Station 14+600, EBL, 2.9m High, Earth Fill Embankment (Plus 1.5m Surcharge)
 Undrained Case (Total Stress Analysis)

Platform Width = 22m



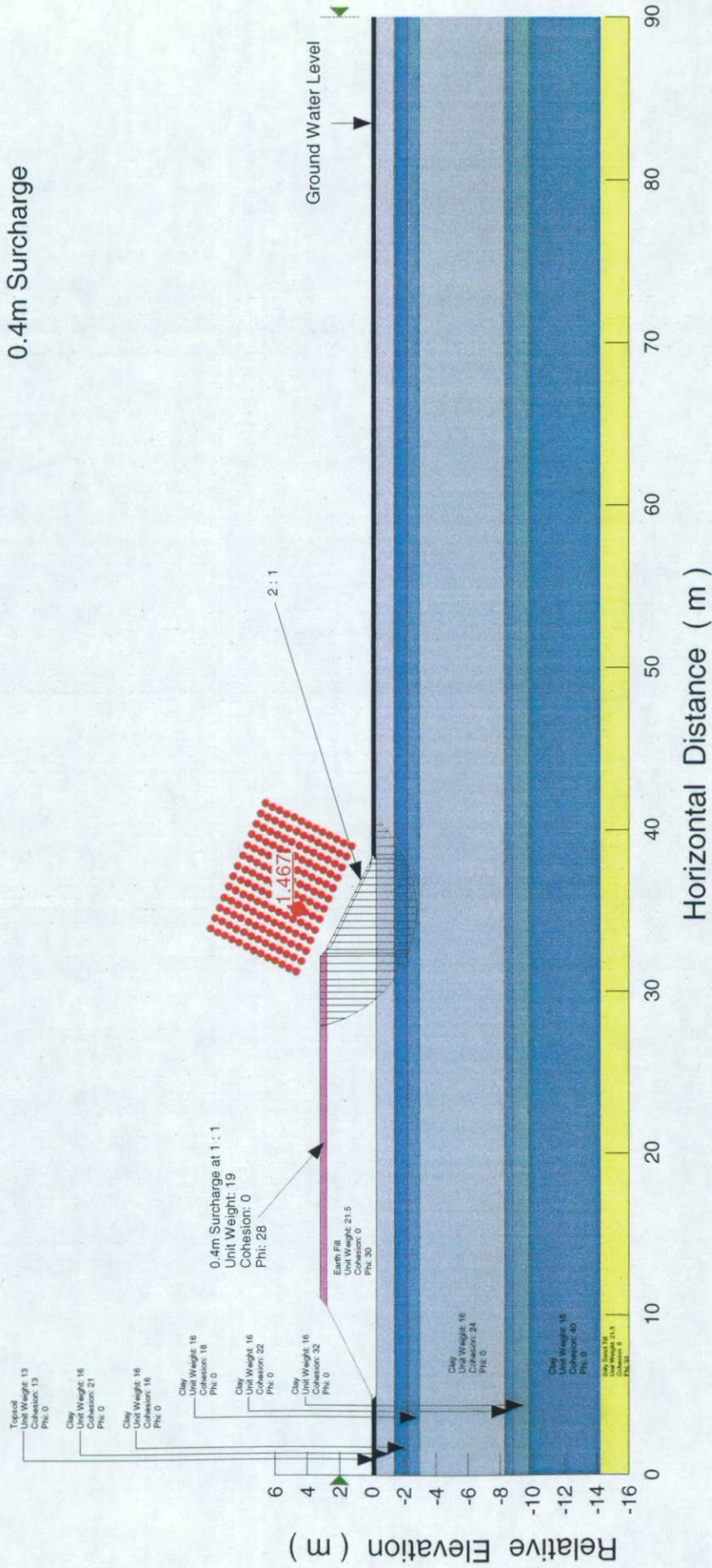
SPT 1055, Highway 17 (New), Sault Ste. Marie
 Station 15+083, WBL, 2.2m High, Earth Fill Embankment (Plus 1.5m Surcharge)
 Undrained Case (Total Stress Analysis)



SPT 1055, Highway 17 (New), Sault Ste. Marie
 Station 17+200, EBL, 2.8m High, Earth Fill Embankment (i.e. 0.8m Grade Drop)
 Undrained Case (Total Stress Analysis)

Platform Width = 22m

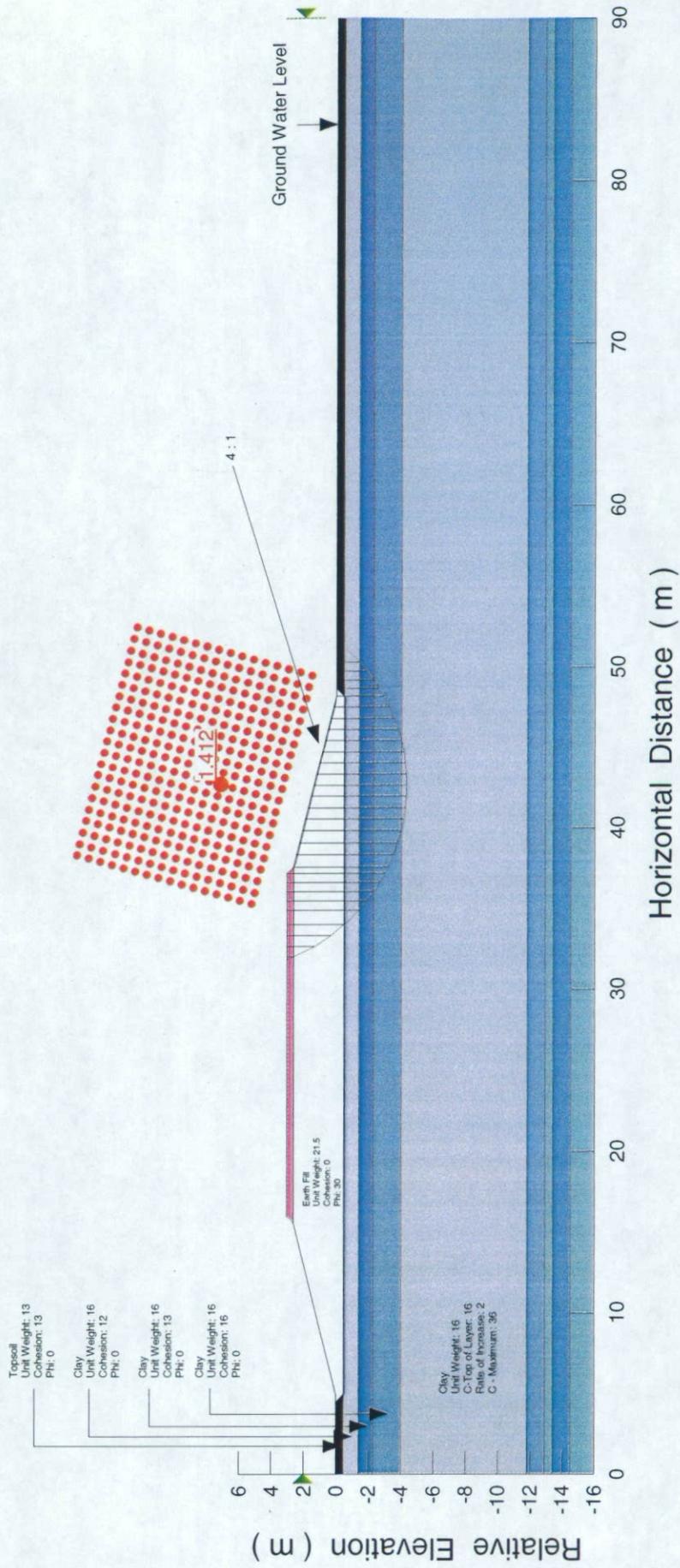
0.4m Surcharge



SPT 1055, Highway 17 (New), Sault Ste. Marie
 Station 17+300, WBL, 2.65m High, Earth Fill Embankment (i.e. 0.8m Grade Drop)
 Undrained Case (Total Stress Analysis)

Platform Width = 22m

0.4m Surcharge



Appendix G

Limitations of Report

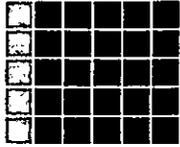
LIMITATIONS OF REPORT

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.

The design recommendations given in this report are applicable only to the project described in the text and then only if constructed substantially in accordance with the details stated in this report.

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.



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Our Reference No. SPT 1055

September 18, 2003

Ministry of Transportation, Ontario
Pavements and Foundations Section
Room 232, Building C
Downsview, Ontario

Attention: Ms. Anna Piascik, P. Eng.
Foundation Engineer

Re: Draft Additional Foundation Investigation and Design Reports
Highway 17 (New) from Echo River to Bar River Road
GWP 354-94-00, Sault Ste. Marie

Dear Sirs:

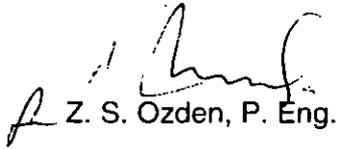
Further to your memorandum dated September 11, 2003, regarding your review of the above captioned report, the following is our response.

1. The Geocres Number you have provided will be shown on the cover page of the final Foundation Investigation and Design Reports and on the Drawings.
2. Project details will be removed from Section 2 of the Investigation Report.
3. In Section 3, boreholes were backfilled to about 6 to 8 m below ground surface with soils brought up by augering (auger cuttings) and the upper 6 to 8 m of the open borehole was then grouted using a bentonite or a cement/bentonite mixture.
4. The attached Soil Strata Drawings were re-drawn to MTO standards. Key Plans were prepared with larger fonts for better legibility.
5. The Appendices in the Foundation Investigation Report will be placed at the end of the report.
6. On Drawings 1, 4, C and D, limits of the present investigation will be shown.
7. In Table 1 of the Design Report, the estimated maximum post construction settlements will be revised to account for the secondary consolidation.

We thank you for your fair review of our draft report and hope to be of service to you on similar projects in the near future.

Yours very truly,

Shaheen & Peaker Limited



Z. S. Ozden, P. Eng.

ZSO/rm:TSPT1055\AdditionalWorks-Comments