# FOUNDATION INVESTIGATION REPORT
# PROPOSED STRUCTURE: HWY. NO. 401 AND ROAD TO ST. ANDREWS, LOTS 21 & 22, CON. 5, TWP. OF CORNWALL

WP 78-59 DISTRICT NO. 9

60-F-294C

DEPARTMENT OF HIGHWAYS OF ONTARIO.

Submitted by

ASSOCIATED GEOTECHNICAL SERVICES LIMITED
Toronto, Ontario.
June, 1960.

ONTARIO

DEPARTMENT OF HIGHWAYS

**Memo to** Mr. A. M. Toye,
Bridge Engineer.

**Date** August 10, 1960.

**Subject** FOUNDATION INVESTIGATION REPORT by: Associated Geotechnical Services Ltd.

**From** Materials & Research Section.

Attention: Mr. S. McCombie.

Re: Proposed Structure, Hwy. No. 401 and Road to St. Andrews, Lots 21 & 22, Con. 5, Twp. of Cornwall, District 9, W.P. 78-59.

Attached, we are forwarding to you, the above mentioned report submitted by Associated Geotechnical Services, Ltd. On the basis of the presented factual data, we would strongly recommend two basic changes in the proposed design to be made:-

1. The proposed grade of Hwy. #401 should be considerably lowered. This recommendation is made in order to avoid the very costly berming procedure. By the construction of berms, the stability of the fill would be assured, but the problem of settlements would still remain. To shorten the settlement rate, sand drains are suggested by the Consultant. This is a very costly procedure, and we think that it should be avoided, if possible. By lowering the grade and by surcharging the fill, the amount and rate of settlement can be reduced and made technically acceptable. The shear strength value of the soft clay layer of 350 lbs. per sq. ft. allows only for a 10 - 11-ft. high fill to be safely constructed without berms. Before construction, the layer of fibrous organic peat has to be removed. The excavation will be taken down either to the sand or clay layer. The height of the fill has to be considered from this excavated level. For example, the ground elevation at Borehole No. 8 is 239.5', the depth of the peat layer, 5.4 feet; therefore, the elevation of the bottom of the excavation will be 234.[illegible]'. Since the height of the fill should be 11 feet, the grade elevation will be 245.0'.

cont'd. /2 ...

Recommendations: (cont'd.) ...

1. (cont'd.) ...

It was established that the ground water table, in most places, corresponds to the ground level and it will therefore be necessary to excavate the ground below water. The same will be necessary with part of the fill embankment. It is therefore recommended to use granular material for the fill. For the submerged part of the fill, coarse granular material is recommended. Wherever the excavation will be carried down to the soft clay layer, at least 2 feet of fine sand should be placed prior to the coarse granular material.

A surcharge of 4 feet of material is recommended. The longer the surcharge remains, the less will be the settlements after removal of the surcharge. The surcharge can be used to flatten the slopes of the embankment.

The above proposals should be applied between approximately Stations 228+00 and 236+10.

Structure is at 227±

2. The proposed relocated County Road should be moved closer to its present location - i.e., further to the North-West. The grade of Hwy. 401 being lowered, a logical solution for this crossing now becomes an underpass. At the proposed new location, the soil conditions are very favourable (dense till material) and shallow spread footings with 3 T/sq.ft. can be used. No approach fill slope stability problems are anticipated, provided the fill is well compacted and the slopes 2:1.

We hope that these recommendations can be taken into account and the necessary changes made. We also believe that these recommendations, together with the attached report, will prove adequate for your future design work. However, should there be any other problems that you wish to discuss, please feel free to contact our Office.

L. G. Soderman,
PRINCIPAL FOUNDATIONS ENGR.
Per:

(A. Stermac,
FOUNDATIONS OFFICE ENGR.)

AS/MdeF
Attach.
cc: Messrs. A. M. Toye (2)
H. A. Tregaskes
D. G. Ramsay
J. Ford
L. E. Walker
J. E. Gruspier
A. Watt
Foundations Office
Gen. Files.

BA 1016

ONTARIO

DEPARTMENT OF HIGHWAYS

*Memo to* Mr. A. M. Toye, Bridge Engineer.

*Date* March 11, 1960.

*Subject*

*From* Materials & Research Section.

Attention: Mr. S. McCombie.

Re: Preliminary Subsoil Investigation at -- Hwy. 401 and Road crossing, between Lots 21 & 22 (Con.V), Twp. of Cornwall, District 9.
W.P. 78-59 (Profile 401-J-56, Sta.227+98)
W.J. 60-F-23.

A preliminary subsoil investigation was carried out at the above mentioned site by means of a power auger. The following stratification was observed:-

| | |
|---|---|
| 0 - 3.5' | -- Black topsoil clay. |
| 3.5'- 7' | -- Brown, desiccated, sandy clay with pebbles and boulders. |
| 7'- 12' | -- Grey, pebbly, sandy clay till. |

Large boulders or bedrock stopped further boring. The material in the holes was observed to be moist, but no underground water was apparent.

The subsoil at about 6 ft. below the existing ground level can provide support for spread footing foundations. A safe bearing pressure of 3 t.s.f. is recommended.

Any soft or loose pockets of material encountered below the proposed footings should be removed and replaced with well-compacted, granular material.

Since the topography of the site indicates that some problems may be encountered in connection with approach fill stability, a detailed foundation investigation is at present,

cont'd. /2 ...

in progress. The results of this investigation will be available in the near future.

It is hoped that this preliminary information will enable you to proceed with the design of the structure.

L. G. Soderman,
PRINCIPAL SOILS & FOUNDATIONS ENGR.
per:

(V. Korlu,
Project Foundation Engr.)

VK/MdeF

cc: Messrs. A. M. Toye (2)
H.A. Tregaskes
D. G. Ramsay
H. J. Ford
L. E. Walker
J. E. Gruspier
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## SECTION 1

## INTRODUCTION

The purpose of this report is to present the results of a foundation investigation made in connection with the proposed structure on Highway 401 and the County Road to St. Andrews between lots 21 and 22 in the Township of Cornwall.

This study was authorized by the A/Materials and Research Engineer, Department of Highways of Ontario, on March 30, 1960.

## SECTION 2

## SUMMARY AND RECOMMENDATIONS

The soils at the proposed structure site consist of medium dense to dense till textured material capable of supporting spread footing loads of 6.2 kips per square foot on a 5 foot wide footing with a minimum surcharge of 5 ft. Loads for other footing widths are given in table No. 2, Section 5.2.

To the east of the structure, between sta 228+ 50 and Sta 236+ 50, a layer of soft sensitive marine clay was encountered to a maximum depth of 35 feet. A series of stability analyses were carried out and it was found that a balanced berm embankment with berms approximately 60 feet wide would provide a safe fill cross section.

With the presently proposed grade of the fill, a maximum settlement of 70 inches will occur at Sta 232+ 50 and a maximum differerential settlement of 42 inches between Sta 235+ 70 and 236 + 10. Ordinarily this settlement would take place slowly, however, by installing a system of vertical drains, the majority of the settlement can be accelerated so that it takes place within 2 to 8 months depending on the spacing of the drains. The balance of the settlement would then proceed at a slow rate which would not cause excessive pavement damage.

## SECTION 3

## DISCUSSION OF PROCEDURES

The borehole locations for this investigation were established by the Field Soils Engineer by chaining from Highway 401 centreline stakes established by D. H. O. surveyors. The borehole locations are shown on Figure 1, Appendix I.

The elevation of each borehole was determined by spirit level from the ground surface beside centreline stake 220 +00. The elevation of this point was taken as 240.8.

A primary program consisting of 6 soil borings and 6 dynamic cone probes was carried out during late March and April in the vicinity of the proposed structure and eastern approach fill. Due to the presence of soft clay beneath the eastern approach fill, a secondary program of 7 boreholes and 7 dynamic cone probes was carried out in May, 1960.

Two skid-mounted Boyles screw-feed drilling rigs were used on the initial phase of this project. One machine was used during the second phase of the field investigation. All boring and sampling operations were completed by an experienced soil sampling crew under the full-time supervision of a qualified Soils Engineer.

In general, the soil borings were performed by standard wash boring sequences; however, in order to expedite the advance of the casing into the pebbly till layers encountered at the site, the bottom end of the casing was fitted with a diamond shoe bit and the casing fed into the ground by diamond drilling techniques. Water was used in this method to clean and cool the diamond bit as well as carry the sludge out of the hole during the actual drilling operations. The initial boring was carried out using BX casing, however, for the secondary work 3.2 inch I. D. casing was used.

Attempts were made to obtain soil samples in the cohesionless soils by means of a 2" O. D. standard split-spoon sampler. The standard penetration test using a 140 lb. hammer falling 30 inches was recorded for each foot of sampler penetration. All samples were visually examined and classified on the site, then placed in jars and forwarded to the engineering office.

Samples of cohesive soil were obtained using a 2" I. D. Shelby tube sampler. Upon removal from the borehole, these samples were classified, sealed with wax and forwarded to the engineering office.

Dynamic cone probes were made using a 2" O. D. 60° cone point fastened to the end of an A-rod. The number of blows required by a 140 lb. hammer falling 30 inches to drive the cone 12 inches were recorded for each foot of penetration.

In situ measurements of clay shear strength were made in boreholes 5 and 6 using a 2 inch by 4 inch vane and a torqometer calibrated in increments of 5 ft. lbs. The accuracy of the measurements of shear strength obtained by estimating the torque reading to the nearest foot-lb. was ± 30 lbs. per sq. ft. In boreholes 7 to 13 inclusive, a 3 inch by 6 inch vane and a torqometer calibrated in increments of 20 inch-lbs. were used. The accuracy of these shear strength determinations, by estimating the readings of torque to the nearest 5 in-lbs., was ± 4 lbs. per sq. ft. A thrust bearing was used in all measurements of shear strength taken with the 3 inch vane to take the weight of the drill rods.

## SECTION 4

## DISCUSSION OF SITE

### 4.1 Geographical Location

The proposed bridge site is located in lot 21, Concession 5, Township of Cornwall, County of Stormont where the County Road to St. Andrews will underpass Highway 401.

### 4.2 Geology of Site Area

The Pleistocene and Recent geology of the site area have been described by E. B. Owen in Paper 51-12 of the Geological Survey of Canada.

According to Owen, the topography of the area is complex, representing in part the original irregularities of the Pleistocene deposits. During the advance and retreat of the last ice sheet, deposits of till-textured soil were heaped up in irregular hills and ridges. During the retreat of the ice sheet, the relief of the area was somewhat subdued by deposition of glacial outwash deposits by the meltwaters. Further subduing of the relief was accomplished during the invasion of the marine water of the Champlain Sea. The result of this depositional history is a topography consisting of islands of till projecting above surrounding level tracts of flat-lying marine sediments.

Limestone bedrock of the Ordovician Period was found in several boreholes at the site.

### 4.3 Soil Conditions

The soils at the site are shown in cross-section on Figure 1, Appendix I.

At the proposed location of the structure, the soils consist of up to 8 feet of relatively unconsolidated sediment overlying a medium dense to very dense, till-textured, silt and sand, some gravel. The penetration resistance of this till varied from 25 blows per foot to well over 100 blows per foot with an average of about 50 blows per foot. Where the split-spoon samples from this material appeared relatively undisturbed, apparent density tests were made by the mercury displacement method. The unit weights thus determined ranged from about 145 to 153 pounds per cubic foot. The average of the values obtained was about 150 pounds per cubic foot. The moisture content of the till was found to vary from 7 to 13 per cent with values of 8 to 9 per cent most commond. For purposes of design, we estimate this soil to have an angle of internal friction of 35 degrees and a unit weight of 140 lbs. per cubic foot. Values of cohesion may be neglected for this material.

The soils in the eastern approach fill area, from Sta. 228+50 to Sta. 236+50, were found in the following order below ground surface:

Stratum 1) fibrous organic peat

Stratum 2) sand, occasional white shell fragment

Stratum 3) medium dense grey sand with silt, occasional pebble

Stratum 4) medium dense grey sand with silt, occasional pebble

Stratum 5) medium dense to very dense silt and sand, some gravel, till texture.

The upper one to four feet of soil between Sta. 228+50 and Sta 236+50 were found to consist of a fibrous organic peat. This material is submerged under water and has little or no structural strength.

Beneath the peat, a layer of marine sand varying in thickness from about one to three feet was found in all bore-holes and probes with the exception of B.H. 5 and B.H. 6 and P. 5, P.6, and P. 15. The penetration resistance of this material was found to be about 4 blows per foot. The sand contains occasional white marine shell fragments. The grading of this material is shown on the grain size distribution chart in Appendix III.

The prominent soil type between Sta 228+50 and Sta 236+50 was found to be a grey marine clay of varying strength. It was found down to bedrock in borehole 8 and appears to have filled the valley between the till hills to the east and west. The clay appeared to be massive with black flecks of decayed organic material in the upper sections of the bed. Toward the bottom of the bed, the clay became sandy and well laminated. Toward the east and west sides of the valley, pebbly clay sections were found in the middle of the bed.

Field determinations of insitu shear strength were made with a vane apparatus. The shear strength of the clay as determined by the vane tests varied from about 250 lbs. per sq. ft. to over 1200 lbs. per sq. ft. A centreline profile showing isolines of shear strength is presented on Figure 29, Appendix I. The shear strengths perpendicular to the centreline, which were used to determine the stability of the road cross-section are shown in Appendix IV along with the typical stability analysis calculations. The sensitivity of the marine clay shear strength to remoulding was found to range as high as about 20 with values of 10 to 15 most common. In general, the shear strength was found to increase with depth and with decreasing moisture contents. Lower moisture contents were found in sections of pebbly or sandy clay.

A number of laboratory tests were carried out on samples from borehole 12 to determine the variation of certain properties with depth. The results of these tests are shown overleaf in Table 1.

Examination of the samples in the laboratory indicated the presence of layering throughout the clay section. This layering became more prominent towards the bottom of the bed where it could be called varved. It thus appears that the permeability of the clay layer is likely to be greater in the horizontal direction than in the vertical. Moisture content determinations were made on all Shelby tube samples. The results of these tests are shown on the borehole logs in Appendix I.

Two consolidation tests were made on samples from the top and bottom of the clay layer in borehole 9. This location was chosen because of its proximity to the eastern clay till contact which will be the region of maximum differential settlement. The results of these tests are shown in Appendix II.

Beneath the clay, on the west side of the valley, a layer of medium dense grey sand with silt, occasional pebble as shown on the grain size distribution chart in Appendix III. The penetration resistance of this material varied from 16 to 32 blows per foot, however, most of the values obtained were between 16 and 18 blows per foot.

## TABLE NO. 1

### Summary of Laboratory Tests

### Borehole 12

| Spl. No. | Depth | Natural Moisture Content | Liquid Limit | Plastic Limit | Unconfined Compressive Shear Strength | Triazial Compression Shear Strength | Density Lbs/cft |
|---|---|---|---|---|---|---|---|
| 2 | 5.0-6.5 | 91.0 | 49.6 | 26.6 | 140 | | 93 |
| | | 102.0 | | | | | |
| 3 | 10.0-11.5 | 93.0 | | | | | |
| | | 81.0 | 46.0 | 26.5 | 240 | 392 | 95 |
| | | 98.0 | 54.2 | 24.3 | | | |
| | | 80.0 | 55.0 | 29.7 | | | |
| 4 | 15.0-16.5 | 70.0 | 58.4 | 25.4 | 362 | 316 | 99 |
| | | 68.0 | 55.8 | 25.9 | | | |
| | | 70.0 | 52.6 | 25.7 | | | |
| 5 | 20.0-21.5 | 66.0 | 57.2 | 24.9 | 362 | 425 | 103.5 |
| | | 59.0 | 53.2 | 22.0 | | | |
| | | 63.0 | 55.0 | 23.5 | | | |
| 6 | 25.0-26.5 | 81.0 | | | 275 | 390 | 98.5 |
| | | 78.0 | 68.4 | 27.1 | | | |
| | | 67.0 | 63.8 | 25.7 | | | |
| 7 | 30.0-31.5 | 72.0 | | | 370 | 455 | 100 |
| | | 99.0 | 62.0 | 27.8 | | | |
| | | 82.0 | 60.6 | 26.0 | | | |

The hills on either side of the valley were found to consist of a medium dense to very dense silt and sand, some gravel, till texture as shown on the grain size distribution Chart in Appendix III. The distribution of the till beneath the clay in the approach fill section can be seen on Figure 1, Appendix I.

4.4 Water Conditions

During the early part of the field investigation (March 1960), the area east of Sta. 228+50 was submerged under water to a maximum depth of about 3 feet. This was mostly due to melting snow and a poorly drained drainage area. During the latter part of the field investigation, the ground water table was found to be at or near the surface of the organic peat.

Artesian water was encountered in several boreholes throughout the area as shown on the borehole logs and on the centreline soil profile, shown in Figure 1, Appendix I. The maximum flow of artesian water was encountered in borehole 9 at 35 feet. Under no flow conditions the water rose in a stand pipe to a depth of 4'-2" above ground level. The flow at ground level was estimated to be about 6 g.p.m. In several other holes the flow was barely perceptible. Maximum flows were encounterd in boreholes with the lowest ground surface elevations.

4.5 Bedrock Conditions

Limestone bedrock of the Ordovician Period was encountered and cored in boreholes 5, 6 and 8. In boreholes 1, 2, 3 and 4, it is suspected that the bedrock was encountered as shown on the borehole logs, although the driller and the field soils engineer did not recognize it as such. In the writer's opinion the presence of bedrock is borne out by the following evidence.

(1) no split spoon samples were obtained below the suspected bedrock level.

(2) examination of the stones recovered in the core barrel in the questionable area were found to consist of a dark grey limestone similar to that found in the cored portions of bedrock in neighbouring boreholes.

(3) no Precambrian pebbles were found in this section

(4) due to the fact that the borehole was advanced through the overlying pebbly till textured soil by first advancing the casing then cleaning out with a core barrel before driving a split-spoon, the writer is of the opinion that the change in drilling characteristics between the pebbly till and the soft bedrock might not be recognizable, even to experienced personnel.

(5) the level of the suspected bedrock appears to tie in with the profile extended from other boreholes in which bedrock was cored.

## SECTION 5

## DISCUSSION OF STRUCTURE FOUNDATIONS

5.1 General

It is our understanding that the proposed structure will be designed to take the County Road to St. Andrews under Highway 401. The proposed elevation of the county road where it underpasses Highway 401 is elevation 243.

5.2 Spread Footings

Considering the use of spread footings for the abutments of this structure, the allowable bearing capacity, with a factor of safety of 3 against foundation shear failure for various footing widths is listed in the following tables. The base of the spread footings may be founded on the till-textured soil at the elevations indicated in these tables.

TABLE NO. 2

Allowable Bearing Capacity - West Abutment
Approximate ℄ Chainage - 227+75
Elevation of Footing Base - 239
Minimum Surcharge - 5 ft.

| | | | | | | |
|---|---|---|---|---|---|---|
| Effective Footing Width (Ft.) | 5 | 6 | 7 | 8 | 9 | 10 |
| Allowable Reactive Pressure (kips per sq. ft.) | 6.2 | 6.8 | 7.4 | 8.0 | 8.6 | 9.2 |
| Allowable Reactive Load (K/ft.) | 31.0 | 40.4 | 51.8 | 64.0 | 77.4 | 92.0 |

TABLE NO. 3

Allowable Bearing Capacity - East Abutment
Approximate ℄ Chainage - 228+20
Elevation of Footing base - 234
Minimum surcharge - 5 ft.

| | | | | | | |
|---|---|---|---|---|---|---|
| Effective Footing Width (Ft.) | 5 | 6 | 7 | 8 | 9 | 10 |
| Allowable Reactive Pressure (kips per sq. ft.) | 6.2 | 6.8 | 7.4 | 8.0 | 8.6 | 9.2 |
| Allowable Reactive Load (K/Ft.) | 31.0 | 40.4 | 51.8 | 64.0 | 77.4 | 92.0 |

With the permissible bearing capacities given above we are of the opinion that the maximum differential settlements between abutments would not likely exceed one-half inch.

Soil material will have to be excavated below the ground water table for placement of spread footings. No excavation difficulties are foreseen with the west abutment, however, for the east abutment, where the overburden is loose or permeable, it is suggested that a system of close boarded sheet piling be employed in conjunction with pumping operations in order to facilitate the excavation.

5.3 Piles

In the event that open abutments are contemplated or if structural requirements include the elimination of differential settlement, a pile foundation may be required. If steel H-piles are used for the foundation, these may be driven to refusal in the till-textured soil to obtain the desired load capacity per pile.

Estimated pile tip elevations are given in the following table:

TABLE NO. 4

| Location | Nearest Borehole | Pile Tip Elevation Steel H-Piles |
|---|---|---|
| 227+25 | 1, 2 | 239 |
| 227+75 | 1, 2 | 229 |
| 228+20 | 3, 4 | 227 |
| 228+55 | 3, 4, 5 | 218 |

# SECTION 6

## DISCUSSION OF APPROACH FILLS

### 6.1 General

To the west of the proposed structure, the approach fill will run to Sta 226+20 at which point it becomes an area of cut. The foundation soils in this fill area are expected to consist of dense till-textured soils.

To the east of the proposed structure, the fill will run to Station 239+60 where the road enters a cut section. Between Stations 236+00 and 239+60, the foundation soils consist of a dense till-textured soil, whereas west of Sta. 236+00, a 35 ft. deep bed of soft to medium strength sensitive marine clay was found. As it was apparent that a stability problem existed west of Sta. 236+00, studies were carried out to determine

(1) a safe embankment cross-section and

(2) the expected settlements which are likely to occur as a result of building the embankment over the clay.

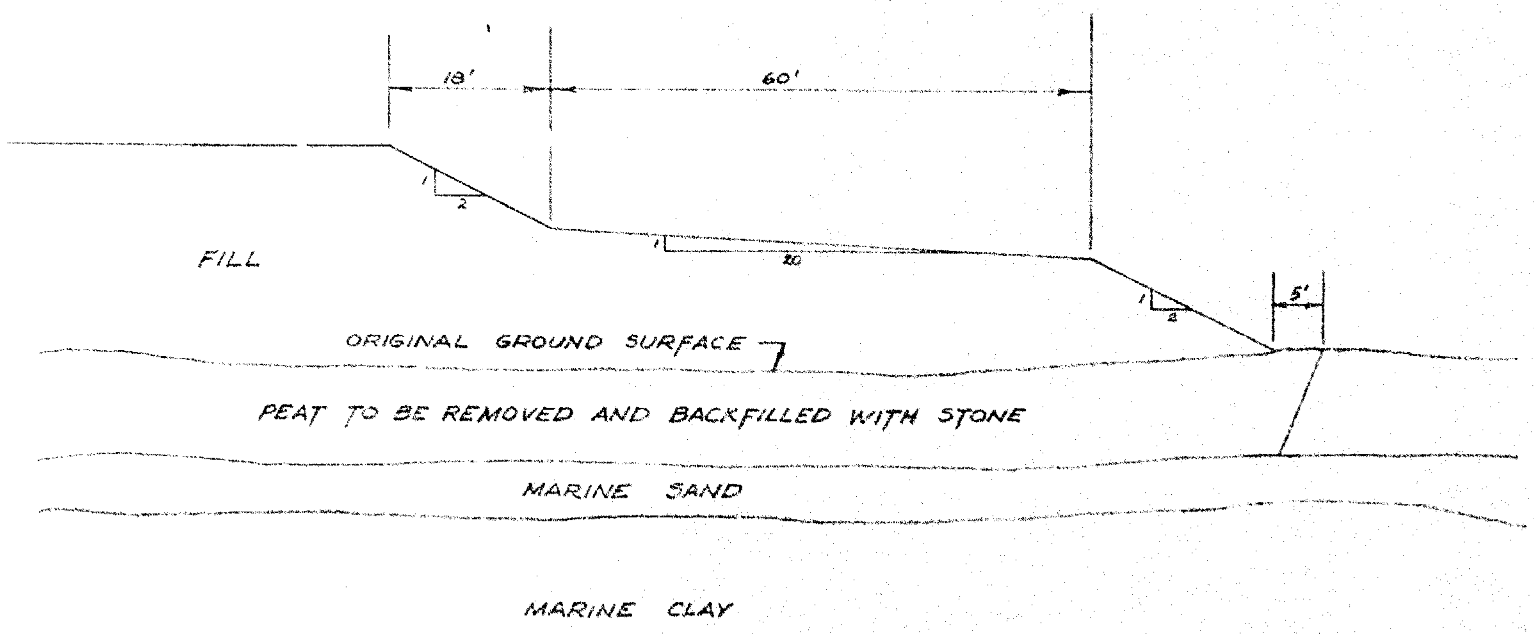
### 6.2 Stability

No stability problems are foreseen in areas where the subsoils consist of a dense till-textured soil. These areas are 1) to the west of the proposed structure and 2) east of Station 236+00.

Where the fill foundation soils consist of soft to medium strength marine clay, between Station 228+20 and Station 236+00, a series of stability analyses were carried out to determine a safe embankment cross-section. The calculations were carried out as a $\phi = 0$ analysis, using shear strengths measured by 3 inch vane tests in situ. The results of these calculations indicate that a balanced berm embankment section as shown on Figure 1, overleaf, would provide a minimum factor of safety of 1.28 against shear failure

A typical stability analysis calculation is shown in Appendix IV. The stability of the upper and lower berm sections was checked using a simple circular slip surface. The stability of the entire embankment section was determined by using compound

# CROSS SECTION SHOWING REQUIRED EMBANKMENT SLOPE




NOT TO SCALE

FIGURE 1

CLIENT DEPT. OF HIGHWAYS - ONTARIO
JOB. NO. 6010 LOCATION
BOREHOLE NUMBER DEPTH
SAMPLE NUMBER DATE

ASSOCIATED GEOTECHNICAL SERVICES
Limited

CALCULATION SHEET

sliding surfaces consisting of two circular slip planes connected by a plane parallel to the ground surface.

The possibility exists that the weight of the embankment will overstress certain sections of the clay layer and thus lead to progressive failure. This type of failure has not been considered at this time due to the possibility that sand drains will be installed to accelerate settlement (see Section 6.3) Accelerated consolidation of the clay would cause an increase in foundation strength. This type of failure could be checked after the embankment construction schedule is finalized, using shear strengths obtained from consolidated, quick triaxial tests.

We would like to point out that a sizeable portion of the resistance to sliding is derived from the strength of the embankment fill. Therefore, it will be necessary to provide adequate field control during earthfill placing operations to ensure that the design strengths are obtained.

6.3 Settlement

From the results of the consolidation tests on samples of clay from Borehole 9, estimates of the magnitude and rate of settlement at stations 232+50 and 235+70 were made. Sta. 232+50 represents the deepest part of the clay layer. The maximum differential settlement will occur at the eastern contact of the clay and the fill between Station 235+70 and 236 10. Values of vertical stress beneath the embankment were obtained using influence charts prepared by Dr. J. O. Osterberg. Our calculations indicate that there will be an ultimate settlement in the order of 70 inches at Sta 232+50 and a differential ultimate settlement between Sta 235+70 and 236+10 in the order of 42 inches.

The settlement of the clay layer will consist of two parts. The primary compression is that part due to the drainage of pore water because of the hydrostatic excess pressure. This pressure results when a saturated soil mass is subjected to a load increase which is carried initially by the water in the pores. When the water drains from the soil pores, the load is gradually shifted to the soil grains. The secondary compression is due to adjustment of the soil grains under load. Due to the fact that it is practically impossible to predict rates of secondary compression, our predicted settlements deal only with primary compression. From the clay consolidation tests, we have determined the ratio of primary compression to total compression, in the range of load increments due to the proposed fill, will vary between .60 and .95 with an average value of .77. The predicted rates of settlement are shown on the graphs in Figure 2 and Figure 3 overleaf. Our calculations indicate that the time required for 90 per cent primary compression will be in the order of 10 years at Sta 232+50 and 4 years at Sta 235+70.

In order to reduce pavement and other damage caused by settlement, the rate of the primary compression can be accelerated by shortening the escape path for the pore water. This can be accomplished by installing a series of vertical sand drains as shown schematically on Figure 4 overleaf. Our calculations indicate that the time required for 90 per cent primary compression can be shortened to about 7 months with one foot diameter sand drains spaced at 15 foot intervals or to about 2.5 months with a 10 foot spacing.

The rate of secondary compression cannot be calculated, however, it can be expected to take place slowly over the next 50 to 100 years. As a crude guess we would estimate the secondary compression to take place at a rate in the order of 0.1 inches per year at Sta. 235+70 and 0.2 inches per year at Sta. 232+50.

We would like to point out that the results of the settlement calculations should be taken with reservations as they were made on simplified conditions. The horizontal permeabilities have been chosen arbitrarily from the values found for vertical peremeability by means of the consolidation tests. Because of the stratification of the soil it is extremely difficult to obtain sufficient information for an accurate prediction of the rate of consolidation with vertical drains. To use laboratory tests would require a great number of very large samples to be tested with a "horizontal" consolidation pressure and even so the data obtained may still be a poor representation of the field conditions. We consider field measurements of consolidation pore pressure to be necessary for determining the effectiveness of the vertical drains.

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Limited

CALCULATION SHEET

CLIENT DEPARTMENT OF HIGHWAYS-ONT
JOB NO. 6013 LOCATION STA 232+50
BOREHOLE NUMBER ____ DEPTH ____
SAMPLE NUMBER ____ DATE ____

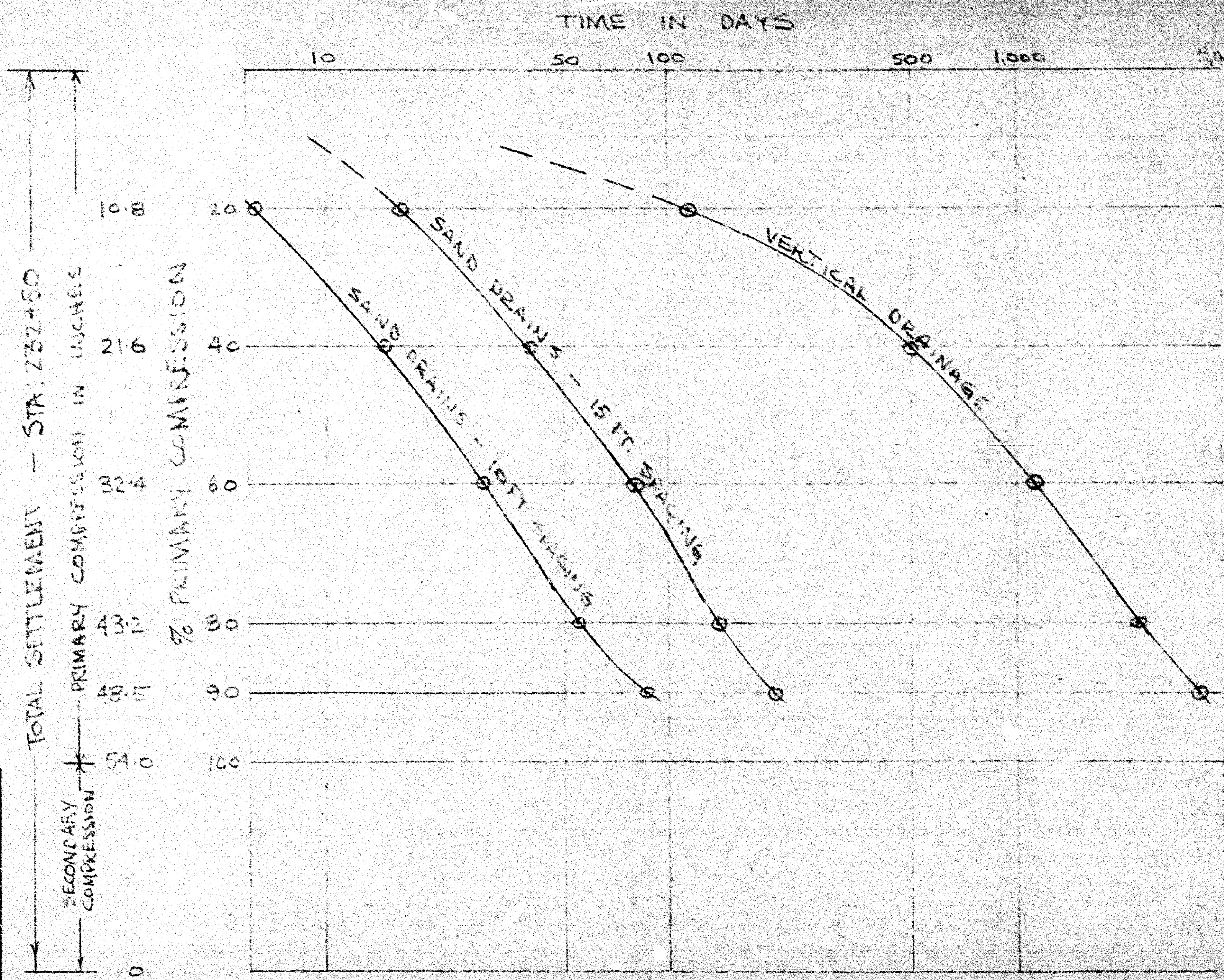



CHART SHOWING RATES OF SETTLEMENT - STA: 232+50

FIGURE 2

ASSOCIATED GEOTECHNICAL SERVICES Limited

CALCULATION SHEET

CLIENT DEPARTMENT OF HIGHWAYS - ONT.

JOB NO. 6010 LOCATION STA. 235+70

BOREHOLE NUMBER ______ DEPTH ______

SAMPLE NUMBER ______ DATE ______

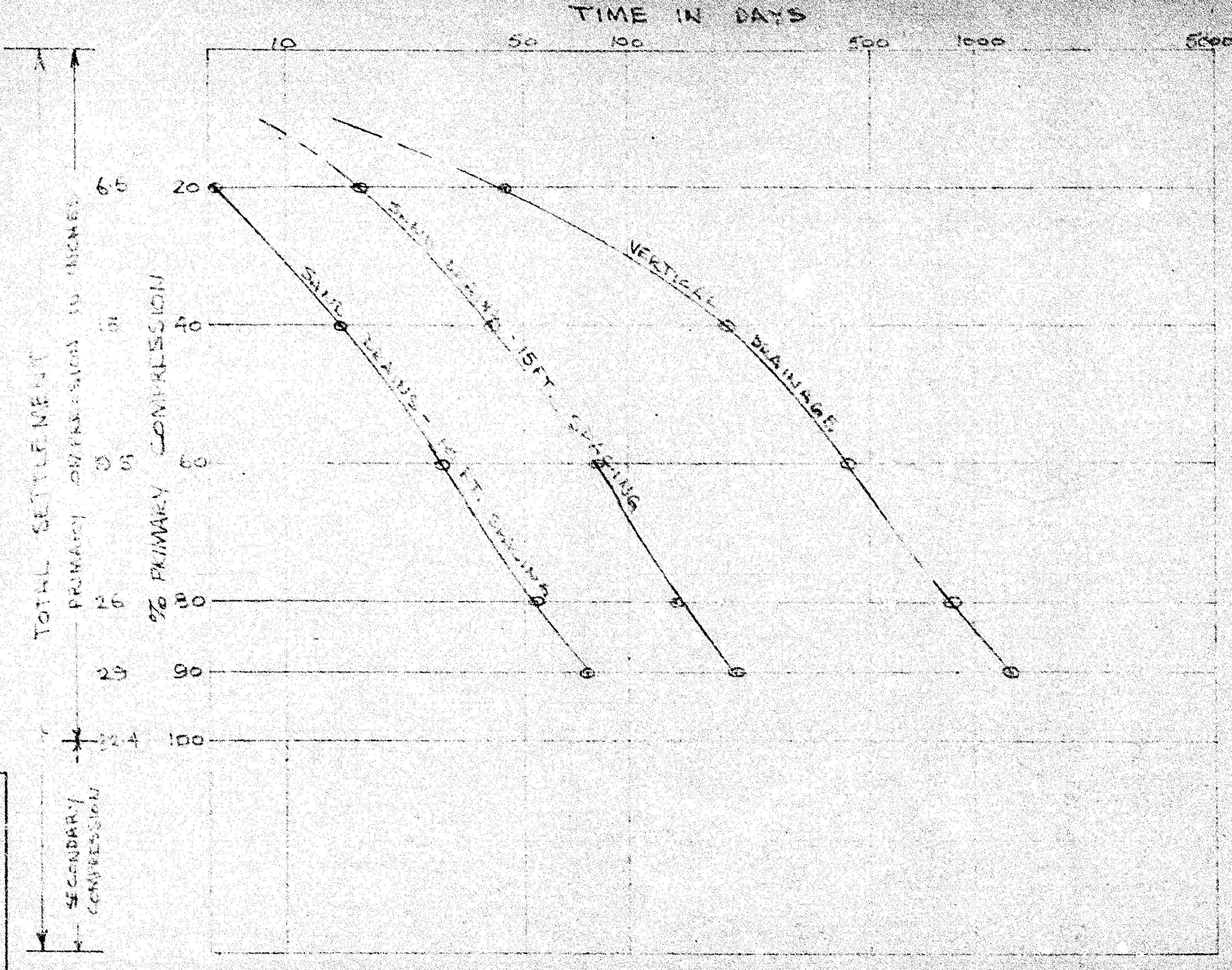
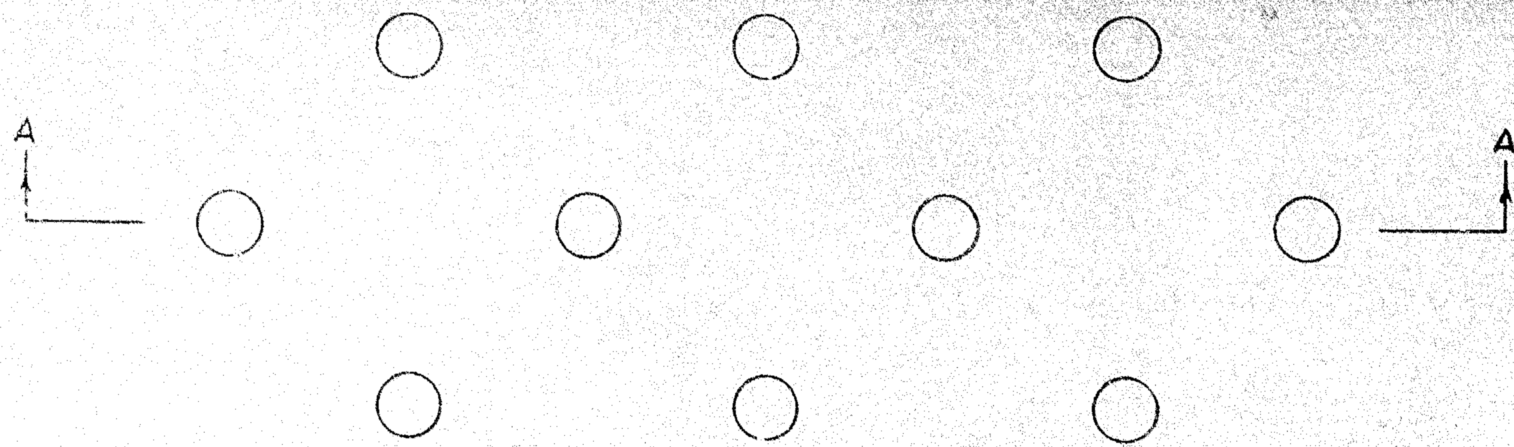
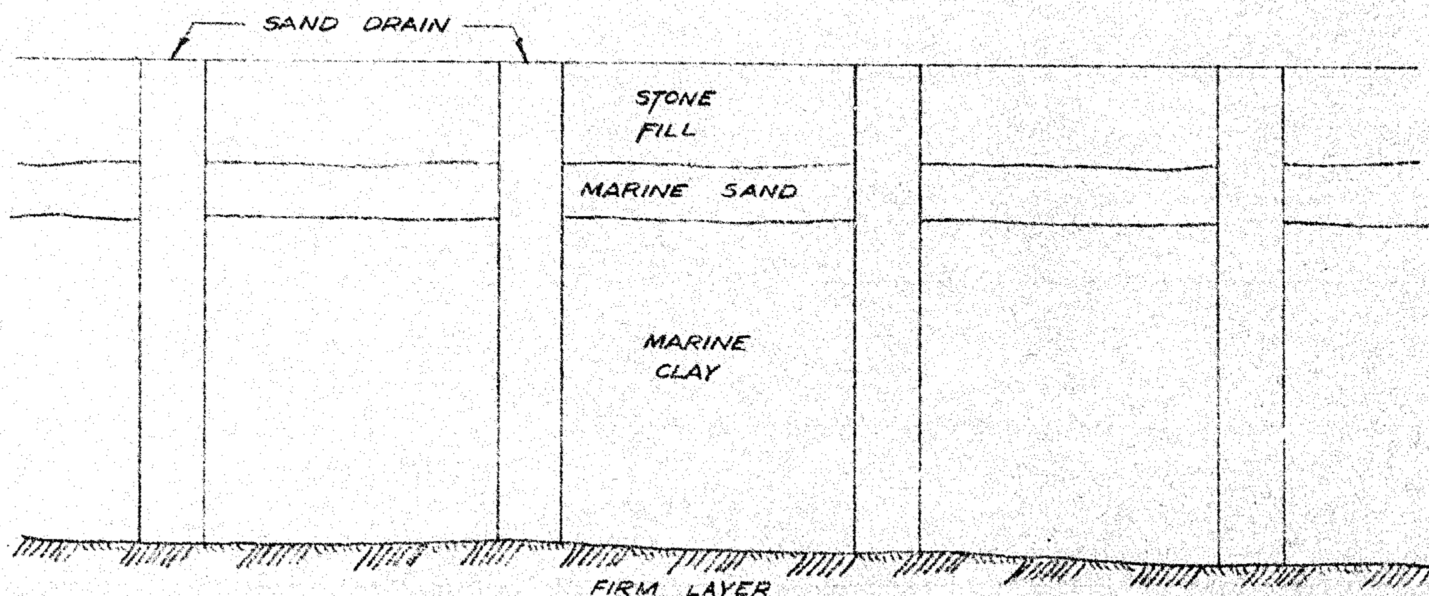



CHART SHOWING RATES OF SETTLEMENT STA. 235+70

FIGURE 3




PLAN SHOWING LAYOUT OF VERTICAL SAND DRAINS




PROFILE "A-A"

NOT TO SCALE

FIGURE 4

CLIENT DEPT. OF HIGHWAYS - ONTARIO
JOB. NO. 6010 LOCATION
BOREHOLE NUMBER DEPTH
SAMPLE NUMBER DATE

ASSOCIATED GEOTECHNICAL SERVICES Limited

CALCULATION SHEET

6.4 Construction Comments

1. It will be necessary to remove the organic peat found in the proposed fill area. The peat must be removed with care so as not to disturb the underlaying clay.

2. It is suggested that a layer of open gravel protected by adequate sand filters be placed between the bottom of the fill and the top of the marine sand or clay in order to (a) allow drainage of artesian water from the boreholes (b) permit the overlaying embankment fill to be placed in the dry (c) allow drainage from the vertical sand drain system to take place.

3. The usual method of constructing vertical drains is to drive a mandrel into the ground, fill it with sand then withdraw it.

While the installation of a vertical sand drain system sounds easy, there are practical problems which make it difficult to obtain a continuous column of sand in the drain. Experience has shown that sometimes these drains do not work because of pinching out by the clay. In order to overcome these difficulties it is suggested that the following be investigated.

(a) The use of something like untreated sonotubes to provide a means of obtaining a continuous column of sand.

(b) The use of permeable fines free concrete in lieu of sand in the vertical drain.

(c) The use of Franki-Kjellman carboard wicks. Although this drain has been used successfully in Europe to the writer's knowledge, no installations have been made in Canada. Thus, the Contractor may be prepared to demonstrate the effectiveness of this type of drain to the Ontario Department of Highways at a reasonable cost.

4. In order to check the efficiency of the drainage system and to determine when the primary compression is nearing completion, it is recommended that an appropriate system of piezometer tubes be installed with the clay layer prior to fill placing operations.

## SECTION 7

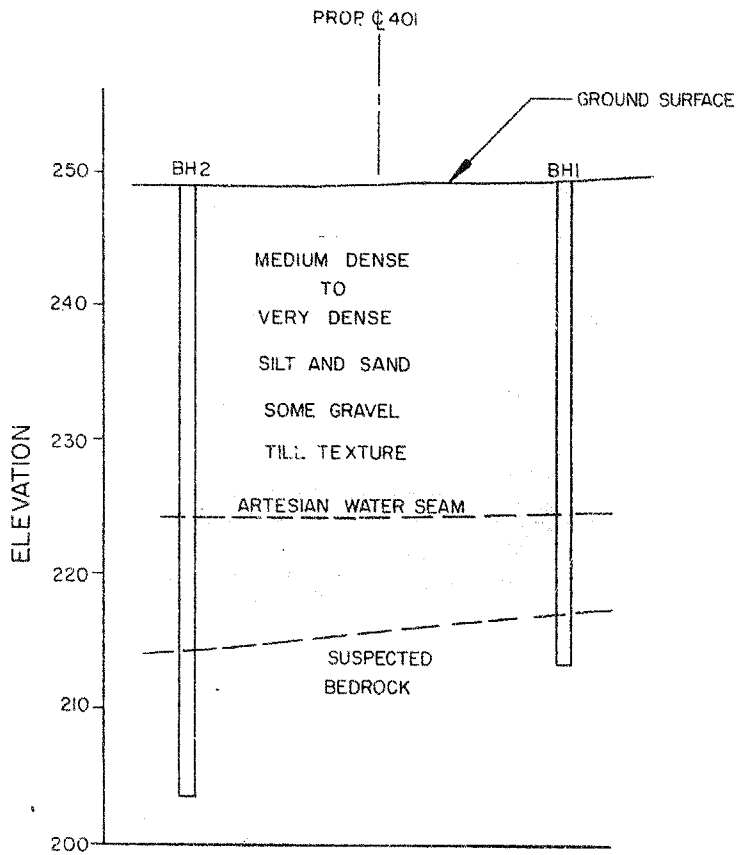
## PERSONNEL

The field work for this investigation was supervised by W. Naumko, P. Eng., for the first phase of the project and by J. Kilgour, P. Eng. for the second phase.

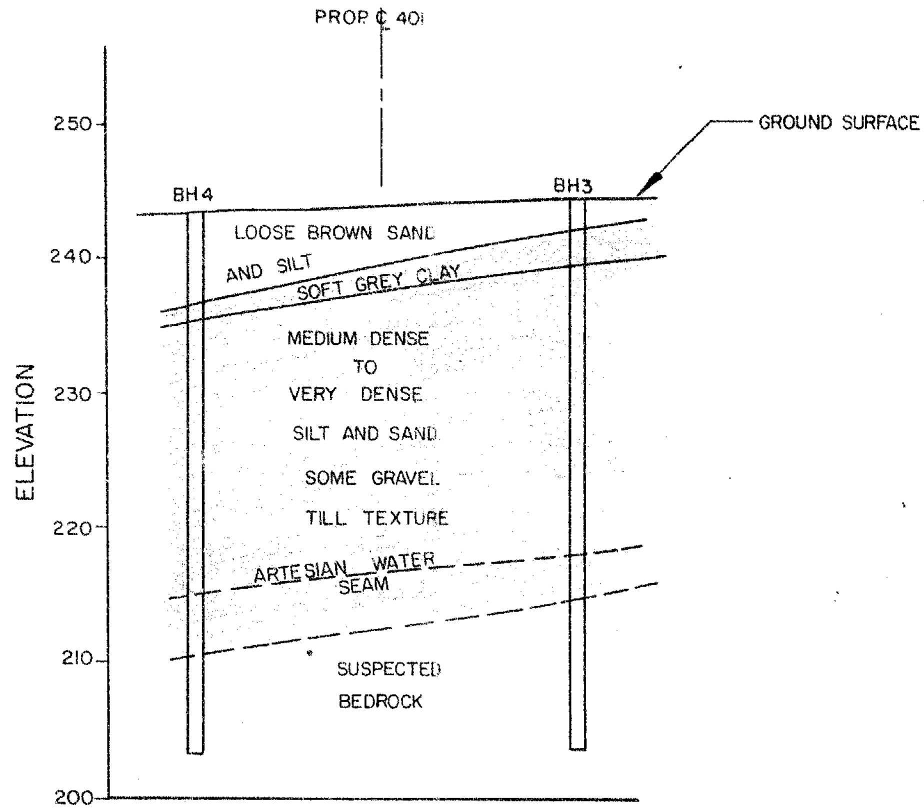
The writing of this report was the responsibility of J. Kilgour, P. Eng. All mathematical calculations were checked by W. Naumko, P. Eng.

APPENDIX I

| | | | |
|---|---|---|---|
| CLIENT Department of Highways of Ontario.<br>JOB NO. 6010 LOCATION Twp. of Cornwall<br>PROJECT WP 78-59<br>DATE FIELD INVESTIGATION April, 1960.<br>DATE REPORT ______ BY ______ CHKD. ______ | LEGEND | SCALES<br>HORIZONTAL 1" = 50'<br>VERTICAL 1" = 10' | ASSOCIATED GEOTECHNICAL SERVICES Limited<br><br>ABUTMENT SOIL PROFILES |




SOIL PROFILE - WEST ABUTMENT




SOIL PROFILE - EAST ABUTMENT

**ASSOCIATED GEOTECHNICAL SERVICES Limited**

**OFFICE BOREHOLE LOG**

BOREHOLE NO. 1

CLIENT: Department of Highways of Ontario
JOB NO.: 6010 LOCATION: Twp. of Cornwall
CO-ORDINATES: See Plan
ELEVATION (SURFACE): 249.4 (COLLAR): DATUM: DHO
DATE (STARTED): 24/3/60 (FINISHED): 29/3/60 COMPILED: JK
RIG NO.: 1 TYPE: Boyles FIELD SUP.: W. Naumko

SYMBOLS: SILT, CLAY, SAND, GRAVEL, PEAT, FILL; ▲ VANE SHEAR (NATURAL); ○ VANE SHEAR (REMOLDED); ● STANDARD PENETRATION

ABBREVIATIONS: UNDISTURBED; DISTURBED BUT REPRESENTATIVE; FAIR; LOST; SS - SPLIT SPOON; ST - SHELBY TUBE; T.W. - THIN WALLED PISTON; DB - DIAMOND BIT; C - CONSOLIDATION TEST; M - MECHANICAL ANALYSIS; T - TRIAXIAL COMPRESSION; K - PERMEABILITY; U - UNCONFINED COMP.; PCF - POUNDS PER CUBIC FOOT; WN - NATURAL WATER CONTENT

| Depth (ft) | Elev. (ft) | Description | Penetration Resistance (blows per foot) | Sample No. | From (ft) | To (ft) | Type | Recovery | Remarks |
|---|---|---|---|---|---|---|---|---|---|
| 1.0 | 248.4 | Organic material | 4 | 1 | 1.0 | 2.0 | SS | 8/12 | |
| | | Medium dense to very dense grey silt and sand, some gravel Till Texture | 158 | 2 | 5.0 | 6.0 | SS | 4/12 | Stone wedged in split spoon |
| | | | 47 | 3 | 10.0 | 11.0 | SS | 4/12 | |
| | | | 36 | 4 | 15.0 | 16.0 | SS | 5/12 | |
| | | | 24 | 5 | 20.0 | 21.0 | SS | 4/12 | Barely perceptible Artesian flow at 25 ft. |
| 25 | 224.4 | | 50 | 6 | 25.0 | 26.5 | SS | 15/18 | |
| | | | 100/3" | 7 | 30.0 | 30.3 | SS | 0/3 | |
| | | | 100/6" | 8 | 31.5 | 32.0 | SS | 2/6 | |
| | | Suspected bedrock | | | 32.0 | 34.0 | DB | 12/24 | |
| 36 | 213.4 | | | | 34.0 | 36.0 | DB | 14/24 | |
| | | End of Borehole | | | | | | | Limestone Pebble and cobble core recovered |

Appendix I - Fig. 3

CLIENT Department of Highways of Ontario
JOB NO. 6010 LOCATION Twp. of Cornwall
CO-ORDINATES See Plan
ELEVATION (SURFACE) 248.7 (COLLAR) DATUM DHO
DATE (STARTED) 24/3/60 (FINISHED) 30/3/60 (COMPILED) JK
RIG. NO. 2 TYPE Boyles FIELD SUP. W. Naumko

SYMBOLS: SILT, GRAVEL, CLAY, PEAT, SAND, FILL
▲ - VANE SHEAR (NATURAL)
○ - VANE SHEAR (REMOLDED)
● - STANDARD PENETRATION

ABBREVIATIONS:
UNDISTURBED; DISTURBED BUT REPRESENTATIVE; FAIR; LOST
SS - SPLIT SPOON
ST - SHELBY TUBE
TWP. - THIN WALLED PISTON
DB - DIAMOND BIT
C - CONSOLIDATION TEST
M - MECHANICAL ANALYSIS
T - TRIAXIAL COMPRESSION
K - PERMEABILITY
U - UNCONFINED COMP.
PCF - POUNDS PER CUBIC FOOT
WN - NATURAL WATER CONTENT

# ASSOCIATED GEOTECHNICAL SERVICES Limited

## OFFICE BOREHOLE LOG

BOREHOLE NO. 2

BORING LOG | FIELD TESTS | SAMPLING | LABORATORY TESTS | REMARKS

Shear strength (tons per square foot); Standard penetration test (blows per foot) 20 40 60 80; Unit weight PCF 140 150; Atterberg limits WP x — WN ● — o WL 5 10

| Depth (feet) | Elev. (feet) | Description | Penetration resistance (blows per foot) | Sample number | From (feet) | To (feet) | Type | Recovery length rec./dist. driv. | Remarks |
|---|---|---|---|---|---|---|---|---|---|
| 1.0 | | Organic material | | | | | | | |
| | | Medium dense to very dense grey silt and sand some gravel Till texture | 20 | 1 | 1.0 | 2.5 | SS | 15/18 | |
| | | | 70 | 2 | 6.0 | 7.5 | SS | 10/18 | |
| | | | 74 | 3 | 11.0 | 12.5 | SS | 3/18 | |
| | | | 62 | 4 | 16.0 | 17.5 | SS | 0/18 | |
| | | | 25 | 4A | 18.0 | 19.5 | SS | 8/18 | |
| 24 | 224.7 | | 134/9" | 5 | 24.0 | 24.8 | SS | 5/9 | Barely perceptible Artesian flow at 24 ft. |
| | | | 170/8" | 6 | 30.0 | 30.7 | SS | 7/8 | |
| | | Suspected Bedrock | 96/7" | 7 | 35.0 | 35.6 | SS | 0/7 | Sampler Bouncing |
| | | | 100/2" | 8 | 40.0 | 40.2 | SS | 0/2 | " " |
| | | | | | 40.2 | 45.0 | DB | | |
| 45.0 | 203.7 | End of Borehole | | | | | | | |

Appendix I - Fig. 4

CLIENT: Department of Highways of Ontario
JOB NO. 60101 LOCATION: Twp. of Cornwall
CO-ORDINATES: See Plan
ELEVATION (SURFACE) 244.2 (COLLAR) DATUM DHO
DATE (STARTED) 29/3/60 (FINISHED) 1/4/60 (COMPILED) JK
RIG. NO. 1 TYPE Boyles FIELD SUP. W. Naumko

SYMBOLS: SILT, GRAVEL, CLAY, PEAT, SAND, FILL
▲ - VANE SHEAR (NATURAL)
○ - VANE SHEAR (REMOLDED)
● - STANDARD PENETRATION

ABBREVIATIONS: UNDISTURBED; DISTURBED BUT REPRESENTATIVE; FAIR; LOST
SS - SPLIT SPOON
ST - SHELBY TUBE
TWP. - THIN WALLED PISTON
DB - DIAMOND BIT
C - CONSOLIDATION TEST
M - MECHANICAL ANALYSIS
T - TRIAXIAL COMPRESSION
K - PERMEABILITY
U - UNCONFINED COMP.
PCF - POUNDS PER CUBIC FOOT
WN - NATURAL WATER CONTENT

**ASSOCIATED GEOTECHNICAL SERVICES Limited**

**OFFICE BOREHOLE LOG**

BOREHOLE NO. 3

BORING LOG | FIELD TESTS | SAMPLING | LABORATORY TESTS

Shear strength (tons per square foot); Standard penetration test (blows per foot) 20 40 60 80; Unit weight PCF 140 DRY 150; Atterberg limits WP X — 5 — WN ● — 10 — O WL

| Depth (feet) | Elev. (feet) | Description | Penetration resistance (blows per foot) | Sample number | From (feet) | To (feet) | Type | Recovery length (rec./dist. driv.) | Remarks |
|---|---|---|---|---|---|---|---|---|---|
| 2.3 | 241.9 | Organic material sand and silt | 4 | 1 | 1.0 | 2.5 | SS | 18/18 | |
| 4.5 | 239.7 | Soft grey clay | | | | | | | |
| | | Very dense grey silt and sand, some gravel. Till texture | 58 | 2 | 5.5 | 7.0 | SS | 11/18 | |
| | | | 64 | 3 | 10.0 | 11.5 | SS | 9/18 | |
| | | | 44 | 4 | 15.9 | 17.4 | SS | 10/18 | |
| | | | 66 | 5 | 20.5 | 22.0 | SS | 11/18 | |
| 26 | 218.2 | | 257 | 6 | 25.5 | 27.0 | SS | 5/18 | Barely perceptible Artesian flow at 26 ft. |
| | | Suspected bedrock | 180 | 7 | 30.0 | 31.0 | SS | 0/12 | |
| | | | 161 | 8 | 34.4 | 35.5 | SS | 0/12 | |
| | | | 170 | 9 | 37.0 | 37.9 | SS | 0/11 | |
| | | | | | 38.0 | 40.5 | SS | 3/30 | |
| 40.5 | 203.7 | End of Borehole | | | | | | | |

Appendix I - Fig. 5

CLIENT Department of Highways of Ontario
JOB NO. 6010 LOCATION Twp. of Cornwall
CO-ORDINATES See Plan
ELEVATION (SURFACE) 243.1 (COLLAR) DATUM DHO
DATE (STARTED) (FINISHED) (COMPILED) JK
RIG. NO. 2 TYPE Boyles FIELD SUP. W. Naumko

SYMBOLS: SILT, CLAY, SAND, GRAVEL, PEAT, FILL
▲ - VANE SHEAR (NATURAL)
○ - VANE SHEAR (REMOLDED)
● - STANDARD PENETRATION

ABBREVIATIONS: UNDISTURBED; DISTURBED BUT REPRESENTATIVE; FAIR; LOST
SS - SPLIT SPOON; ST - SHELBY TUBE; TWP. - THIN WALLED PISTON; DB - DIAMOND BIT
C - CONSOLIDATION TEST; M - MECHANICAL ANALYSIS; T - TRIAXIAL COMPRESSION; X - PERMEABILITY; U - UNCONFINED COMP.; PCF - POUNDS PER CUBIC FOOT; WN - NATURAL WATER CONTENT

**ASSOCIATED GEOTECHNICAL SERVICES Limited**

**OFFICE BOREHOLE LOG**
BOREHOLE NO. 4

| Depth (feet) | Elev. (feet) | Description | Penetration Resistance (blows per foot) | Sample Number | From (feet) | To (feet) | Type | Recovery Length Rec./Dist. Driv. | Remarks |
|---|---|---|---|---|---|---|---|---|---|
| 1.0 | 242.1 | Organic material | | | | | | | |
| | | Loose brown sand and silt | 4 | 1 | 1.0 | 2.5 | SS | 18/18 | |
| 6.7 | 236.4 | | | | | | | | |
| 7.7 | 235.4 | Grey clay | 10 | 2 | 6.0 | 7.5 | SS | 9/18 | γ = 119.0 pcf $W_N$ = 35.3 |
| | | Medium dense to very dense silt and sand, some gravel | 25 | 3 | 10.0 | 11.5 | SS | 9/18 | |
| | | Till Texture | 54 | 4 | 15.0 | 16.5 | SS | 0/18 | |
| | | | 44 | 5 | 17.0 | 18.5 | SS | 0/18 | |
| | | | 78 | 6 | 19.0 | 20.5 | SS | 10/18 | |
| | | | 265 | 7 | 25.0 | 26.0 | SS | 8/12 | |
| 28 | 215.1 | | | | | | | | Barely perceptible Artesian flow at 28.0 ft. |
| | | | 64 | 8 | 30.0 | 31.5 | SS | 18/18 | |
| | | Suspected bedrock | 120 | 9 | 35.0 | 35.7 | SS | 0/9 | |
| 39.8 | 203.3 | End of Borehole | | | | | | | |

Shear strength (tons per square foot); Standard penetration test (blows per foot) 20 40 60 80
Laboratory: Unit weight PCF 110 DY 150; Atterberg limits WP x — WN ● — ○ WL 5 10

Scale (feet): 5 10 15 20 25 30 35 40 45 50 55 60 65 70

Appendix I - Fig. 6

CLIENT Department of Highways of Ontario.
JOB NO. 6010 LOCATION Twp. of Cornwall
CO-ORDINATES Sta. 229-50 on ℄
ELEVATION (SURFACE) 240.2 (COLLAR) 242.7 DATUM DHO
DATE (STARTED) 4/4/60 (FINISHED) (COMPILED) WN
RIG. NO. 2 TYPE Boyles FIELD SUP. W. Naumko

SYMBOLS: SILT, CLAY, SAND, GRAVEL, PEAT, FILL
▲ - VANE SHEAR (NATURAL)
O - VANE SHEAR (REMOLDED)
● - STANDARD PENETRATION

ABBREVIATIONS
UNDISTURBED; DISTURBED BUT REPRESENTATIVE; FAIR; LOST
SS - SPLIT SPOON
ST - SHELBY TUBE
TWP. - THIN WALLED PISTON
DB - DIAMOND BIT
C - CONSOLIDATION TEST
M - MECHANICAL ANALYSIS
T - TRIAXIAL COMPRESSION
K - PERMEABILITY
U - UNCONFINED COMP.
PCF - POUNDS PER CUBIC FOOT
WN - NATURAL WATER CONTENT

**ASSOCIATED GEOTECHNICAL SERVICES Limited**

**OFFICE BOREHOLE LOG**
BOREHOLE NO. 5

BORING LOG | FIELD TESTS | SAMPLING | LABORATORY | TESTS

Shear strength (tons per square foot): .25 .50 .75 1.00
Standard penetration test (blows per foot): 20 40 60 80
Unit weight PCF: 140 150
Atterberg limits: WP 5, WN 10, WL

| Depth (feet) | Elev. (feet) | Description | Penetration resistance (blows per foot) | Sample number | From (feet) | To (feet) | Type | Recovery length rec./dist. driv. | Remarks |
|---|---|---|---|---|---|---|---|---|---|
| 2.5 | 240.2 | Casing in water | | | | | | | |
| 3.5 | 239.2 | Organic peat | | 1 | 3.5 | 5.0 | ST | 11/18 | |
| | | Soft grey clay, some silt occasional pebble | | 2 | 7.5 | 9.0 | ST | 19/18 | |
| | | | | 3 | 12.0 | 14.0 | ST | 19/18 | |
| 16.5 | 226.2 | Bedded medium dense grey sand, some silt, occasional pebble | 32 | 4 | 17.5 | 19.0 | SS | 7/18 | |
| | | | 18 | 5 | 22.5 | 24.0 | SS | 0/18 | |
| | | | 16 | 6 | 24.5 | 26.0 | SS | 10/18 | |
| 27 | 213.2 | Very dense grey silt and sand some gravel till texture | 111 | 7 | 29.5 | 31.0 | SS | 8/18 | |
| 34.5 | 208.2 | | 318 | 8 | 34.5 | 35.5 | SS | 0/12 | |
| 37 | 205.7 | Limestone bedrock | | | 37.0 | 41.0 | DB | 46/48 | Barely perceptible Artesian flow at 37.5 |
| 41. | 201.7 | End of Borehole | | | | | | | |

Appendix I - Fig. 7

# ASSOCIATED GEOTECHNICAL SERVICES Limited

## OFFICE BOREHOLE LOG
BOREHOLE NO. 6

CLIENT: Department of Highways of Ontario
JOB NO.: 6010 LOCATION: Twp. of Cornwall
CO-ORDINATES: Sta 231+100 on ℄
ELEVATION (SURFACE): 240.2 (COLLAR): 242.2 DATUM: DHO
DATE (STARTED): 2/4/60 (FINISHED): 5/4/60 (COMPILED): WN
RIG. NO.: 1 TYPE: Boyles FIELD SUP.: W. Naumko

**SYMBOLS:** SILT, CLAY, SAND, GRAVEL, PEAT, FILL; ▲ - VANE SHEAR (NATURAL); ○ - VANE SHEAR (REMOLDED); ● - STANDARD PENETRATION

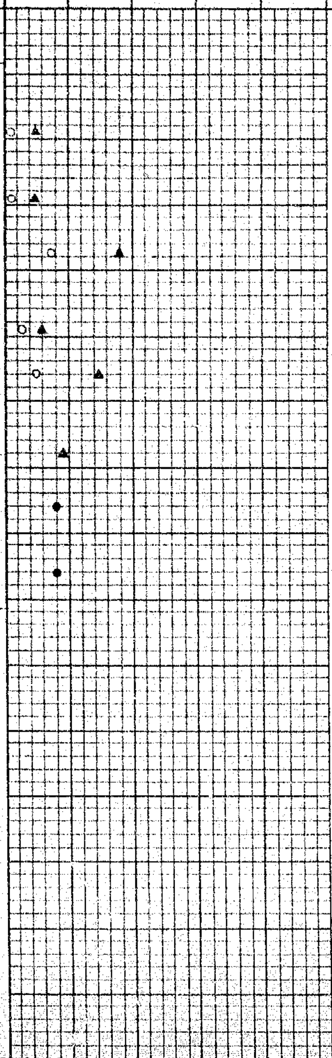
**ABBREVIATIONS:** UNDISTURBED; DISTURBED BUT REPRESENTATIVE; FAIR; LOST. SS - SPLIT SPOON; ST - SHELBY TUBE; TWP. - THIN WALLED PISTON; DB - DIAMOND BIT. C - CONSOLIDATION TEST; M - MECHANICAL ANALYSIS; T - TRIAXIAL COMPRESSION; K - PERMEABILITY; U - UNCONFINED COMP.; PCF - POUNDS PER CUBIC FOOT; WN - NATURAL WATER CONTENT

### BORING LOG

| DEPTH FEET | ELEV. FEET | DESCRIPTION |
|---|---|---|
| 2.0 | 240.2 | Casing in water |
| 4.5 | 237.7 | Organic peat |
| | | Soft Grey Clay Occasional pebble |
| 34.2 | 208.0 | |
| 35.5 | 206.7 | Bedded medium dense grey sand with silt occasional pebble |
| 46 | 196.2 | Limestone bedrock |
| 54.7 | 187.5 | End of Borehole |

### FIELD TESTS

SHEAR STRENGTH (TONS PER SQUARE FOOT) .25 .50 .75 1.00; STANDARD PENETRATION TEST (BLOWS PER FOOT) 20 40 60 80

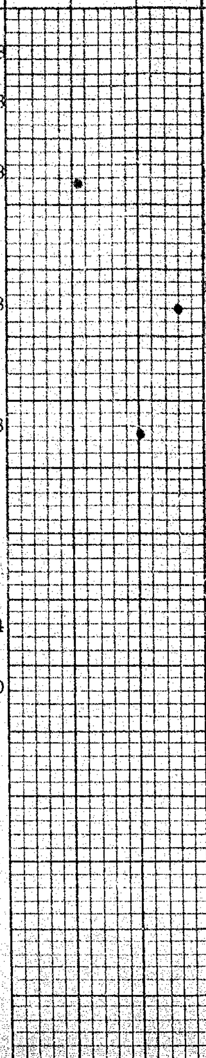


### SAMPLING

| Penetration Resistance (Blows per foot) | Sample Number | From Feet | To Feet | Type | Recovery Length Rec./Dist. Driv. | Remarks |
|---|---|---|---|---|---|---|
| | 1 | 3.0 | 4.5 | ST | 5/18 | Vane shear attempted material too soft |
| | 2 | 7.0 | 8.5 | ST | 21/18 | |
| | 3 | 12.0 | 13.9 | ST | 20/18 | WN = 58.1% |
| | | | | | | Vane appeared to be turning with pebble |
| | 4 | 22.0 | 23.5 | ST | 16/18 | |
| | 5 | 32.0 | 32.8 | ST | 19/18 | Vane appeared to be turning with pebble |
| 16 | 6 | 37.3 | 38.8 | SS | 1/8 | Barely perceptible Artesian flow at 35'.5 |
| 16 | 7 | 42.3 | 43.8 | SS | 8/18 | |
| | | 46.0 | 49.7 | DB | 44/44 | |
| | | 49.7 | 54.7 | DB | 60/60 | |

### LABORATORY

UNIT WEIGHT PCF; ATTERBERG LIMITS WP × — ● WN — ○ WL; 40 60



Appendix I - Fig. 8

CLIENT Department of Highways of Ontario.
JOB NO. 6010 LOCATION Twp. of Cornwall
CO-ORDINATES STA. 231+70 on ℄
ELEVATION (SURFACE) 239.5 (COLLAR) DATUM DHO
DATE (STARTED) 3/5/60 (FINISHED) 4/5/60 (COMPILED) JK
RIG. NO. 1 TYPE Boyles FIELD SUP. J. Kilgour

SYMBOLS: SILT, GRAVEL, CLAY, PEAT, SAND, FILL
▲ - VANE SHEAR (NATURAL)
○ - VANE SHEAR (REMOLDED)
● - STANDARD PENETRATION

ABBREVIATIONS
UNDISTURBED; DISTURBED BUT REPRESENTATIVE; FAIR; LOST
SS - SPLIT SPOON
ST - SHELBY TUBE
TWP. - THIN WALLED PISTON
DB - DIAMOND BIT
C - CONSOLIDATION TEST
M - MECHANICAL ANALYSIS
T - TRIAXIAL COMPRESSION
K - PERMEABILITY
U - UNCONFINED COMP.
PCF - POUNDS PER CUBIC FOOT
WN - NATURAL WATER CONTENT

# ASSOCIATED GEOTECHNICAL SERVICES Limited

## OFFICE BOREHOLE LOG

BOREHOLE NO. 7

BORING LOG

| Depth feet | Elev. feet | Description |
|---|---|---|
| | | Fibrous organic peat |
| 3.2 ? | 236.3 | Sand, some gravel occ. white shell |
| 6.0 ? | 233.5 | Soft to medium grey clay with black specks |
| 22 | 217.5 | Stiff grey clay occ. pebble |
| 26- ? | 213.5 | medium to stiff grey clay |
| 39.6 | 199.9 | Gradation change |
| 40.8 | 198.7 | Gravel, some sand |
| | | Casing refusal |

FIELD TESTS — Shear strength (tons per square foot) .25 .50; Standard penetration test (blows per foot)

Penetration resistance (blows per foot): 310, 310, 340, 456, 410, 572, 555, 1070, 780, 1280+

SAMPLING

| Sample number | Condition | Depth from (feet) | Depth to (feet) | Type | Recovery length rec./dist. driv. | Remarks |
|---|---|---|---|---|---|---|
| 1 | Undisturbed | 2.3 | 4.0 | ST | 10/20 | |
| 2 | Undisturbed | 5.3 | 7.0 | ST | 20/20 | WN = 97.7% |
| 3 | Undisturbed | 10.0 | 11.5 | ST | 21/18 | WN = 86.2% |
| 4 | Undisturbed | 15.0 | 16.5 | ST | 22/18 | WN = 84.4% |
| 5 | Undisturbed | 20.0 | 21.5 | ST | 15/18 | WN = 62.8% |
| 6 | Disturbed but representative | 22.2 | 23.8 | SS | 18/18 | |
| 7 | Undisturbed | 24.9 | 26.4 | ST | 16/18 | WN = 31% |
| | | | | | | WN = 68.3% |
| 8 | Undisturbed | 30.0 | 31.6 | ST | 23/18 | |
| 9 | Undisturbed | 35.0 | 36.5 | ST | | WN = 59% |

LABORATORY TESTS — Unit weight PCF; Atterberg limits WP x — WN ● — ○ WL; 60 80

REMARKS

Artesian flow encountered at 40 ft. Head = 3.0 ft above ground level
Flow at ground level = 0.1 G. P. M.

Appendix I - Fig. 9

CLIENT: Department of Highways of Ontario
JOB NO. 6010 LOCATION Twp. of Cornwall
CO-ORDINATES Sta. 232+46 on ℄
ELEVATION (SURFACE) 239.5 (COLLAR) ____ DATUM DHO
DATE (STARTED) 4/5/60 (FINISHED) 5/5/60 (COMPILED) JK
RIG NO. 1 TYPE B FIELD SUP. J. Kilgour

SYMBOLS: SILT, CLAY, SAND, GRAVEL, PEAT, FILL
▲ - VANE SHEAR (NATURAL)
○ - VANE SHEAR (REMOLDED)
● - STANDARD PENETRATION

ABBREVIATIONS
UNDISTURBED; DISTURBED BUT REPRESENTATIVE; FAIR; LOST
SS - SPLIT SPOON
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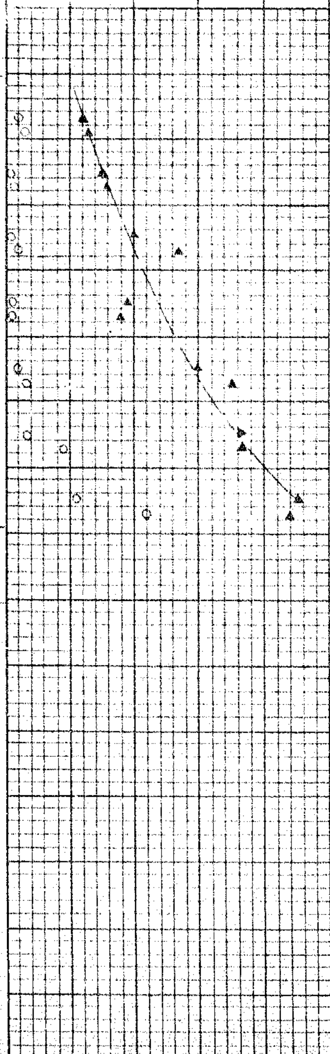
TWP - THIN WALLED PISTON
DB - DIAMOND BIT
C - CONSOLIDATION TEST
M - MECHANICAL ANALYSIS
T - TRIAXIAL COMPRESSION
K - PERMEABILITY
U - UNCONFINED COMP.
PCF - POUNDS PER CUBIC FOOT
WN - NATURAL WATER CONTENT

# ASSOCIATED GEOTECHNICAL SERVICES Limited

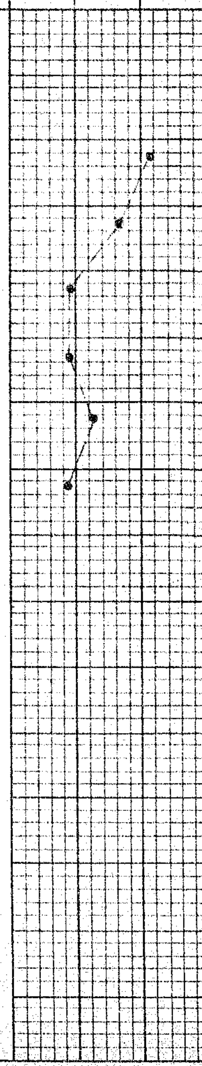
## OFFICE BOREHOLE LOG
BOREHOLE NO. 8

| Depth (feet) | Elev. (feet) | Water observation | Description | Penetration resistance (blows per foot) | Sample number | From (feet) | To (feet) | Type | Recovery length Rec./Dist. Driv. | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | Fibrous organic peat | | | | | | | |
| 4.0 | 235.5 | | | | | | | | | |
| 5.4 | 234.1 | GWT | Sand, some gravel | | | | | | | |
| | | | Soft grey clay with black specks | 1/2 | 1 | 5.0 | 7.3 | SS | 1/28 | |
| | | | | 301* | | | | | | |
| | | | | 334* | 2 | 10.0 | 11.5 | ST | 23/18 | WN = 84% |
| | | | | 392* | | | | | | |
| | | | | 392* | | | | | | |
| | | | | 605* | 3 | 15.0 | 16.5 | ST | 22/18 | WN = 72.2% |
| | | | | 685* | | | | | | WN = 58.7% |
| | | | | 456* | 4 | 20.0 | 21.5 | ST | 21/18 | |
| 24.0 | 215.5 | | | 440* | | | | | | |
| | | | Medium to stiff grey clay | 750* | 5 | 25.0 | 26.4 | ST | 21/16 | WN - 59.5% |
| | | | | 880* | 6 | 30.0 | 31.2 | ST | 19/14 | WN = 65% |
| | | | | 910* | | | | | | |
| | | | | 910* | 7 | 35.0 | 37.2 | ST | 20/14 | Some gravel in clay at top of sample WN = 56% |
| | | | | 1130* | | | | | | |
| 39.8 | 199.7 | | | 1100* | | | | | | |
| | | | Limestone bedrock | | | | | | | * Shear strength in lbs. per sq. ft. |
| 45.2 | 194.3 | | | | | | | | | |

Field tests — Shear strength (tons per square foot) / Standard penetration test (blows per foot):




Laboratory tests — Unit weight PCF / Atterberg limits:




Appendix I - Fig. 10

CLIENT Department of Highways of Ontario
JOB NO. 6010 LOCATION Twp. of Cornwall
CO-ORDINATES Sta 234+53 on ℄
ELEVATION (SURFACE) 241.0 (COLLAR) ______ DATUM DHO
DATE (STARTED) 6/5/60 (FINISHED) 9/5/60 (COMPILED) JK
RIG. NO. 5 TYPE Boyles FIELD SUP. J. Kilgour

SYMBOLS: SILT, CLAY, SAND, GRAVEL, PEAT, FILL
▲ - VANE SHEAR (NATURAL)
○ - VANE SHEAR (REMOLDED)
● - STANDARD PENETRATION

ABBREVIATIONS
UNDISTURBED; DISTURBED BUT REPRESENTATIVE; FAIR; LOST
SS - SPLIT SPOON
ST - SHELBY TUBE
TWP. - THIN WALLED PISTON
DB - DIAMOND BIT
C - CONSOLIDATION TEST
M - MECHANICAL ANALYSIS
T - TRIAXIAL COMPRESSION
K - PERMEABILITY
U - UNCONFINED COMP.
PCF - POUNDS PER CUBIC FOOT
WN - NATURAL WATER CONTENT

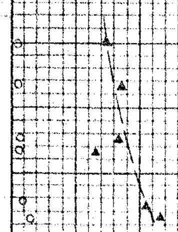
# ASSOCIATED GEOTECHNICAL SERVICES Limited

## OFFICE BOREHOLE LOG

BOREHOLE NO. 9

BORING LOG — FIELD TESTS — SAMPLING — LABORATORY — TESTS — REMARKS

Shear strength (tons per square foot) .25 .50; Standard penetration test (blows per foot); Unit weight PCF; Atterberg limits WP x —— ● WN —— o WL, 50 70



| Depth feet | Elev. feet | Description | Penetration resistance (blows per foot) | Sample number | From feet | To feet | Type | Recovery length rec. / dist. driv. | Remarks |
|---|---|---|---|---|---|---|---|---|---|
| 1.5 | 239.5 | Peat | | | | | | | |
| 3.3 | 237.7 | Sand, white shells | 3 | 1 | 2.5 | 4.0 | SS | 13/18 | WN - 52.9% |
| | | Soft grey clay with black flecks | 390* | | | | | | |
| | | | 431* | 2 | 6.0 | 7.2 | ST | 20/14 | |
| | | | 407* | 3 | 10.0 | 11.2 | ST | 20/14 | WN = 73.5% $W_p$ = 22.5% = 41% |
| | | | 310* | | | | | | |
| 17 | 224.0 | | 520* | 4 | 15.0 | 16.2 | ST | 14/14 | WN = 56.0% |
| | | Grey sandy clay occasional pebble | 585* | | | | | | |
| | | | | 5 | 20.0 | 21.2 | ST | 15/14 | WN = 28.2% Could not push vane into this material |
| 24 | 217.0 | | 8 | 6 | 21.7 | 23.2 | SS | 18/18 | |
| | | Medium grey clay | 1270* | 7 | 25.7 | 26.8 | ST | 16/14 | |
| | | | 1270* | | | | | | |
| | | | 990* | 8 | 30.3 | 31.5 | ST | 18/14 | WN = 69.5% |
| 34 | 207.0 | | | | | | | | |
| 35.9 | 206.1 | Sand and gravel | | 9 | 35.1 | 35.9 | SS | 0/9 | Sampler refusal at 35.9 hammer bouncing |
| | | End of Borehole | | | | | | | |

Tests: no flow

Artesian water at 35'.
head 4' 2" above ground level
- flow at ground level
= 6 G. P. M. (est.)

*shear strength in lbs. per sq. ft.

Appendix I - Fig. 11

CLIENT Department of Highways of Ontario
JOB NO. 6010 LOCATION Twp. of Cornwall
CO-ORDINATES Sta 236+17 on ℄
ELEVATION (SURFACE) 243.0 (COLLAR) DATUM DHO
DATE (STARTED) 9/5/60 (FINISHED) 9/5/60 (COMPILED) JK
RIG. NO. 1 TYPE Boyles FIELD SUP. J. Kilgour

SYMBOLS: SILT, GRAVEL, CLAY, PEAT, SAND, FILL
▲ - VANE SHEAR (NATURAL)
○ - VANE SHEAR (REMOLDED)
● - STANDARD PENETRATION

ABBREVIATIONS: UNDISTURBED; DISTURBED BUT REPRESENTATIVE; FAIR; LOST
SS - SPLIT SPOON; ST - SHELBY TUBE; TWP. - THIN WALLED PISTON; DB - DIAMOND BIT
C - CONSOLIDATION TEST; M - MECHANICAL ANALYSIS; T - TRIAXIAL COMPRESSION; K - PERMEABILITY; U - UNCONFINED COMP.; PCF - POUNDS PER CUBIC FOOT; WN - NATURAL WATER CONTENT

## ASSOCIATED GEOTECHNICAL SERVICES Limited

### OFFICE BOREHOLE LOG
BOREHOLE NO. 10

| SCALE FEET | DEPTH FEET | ELEV. FEET | WATER OBSERVATION | DESCRIPTION | PENETRATION RESISTANCE (BLOWS PER FOOT) | SAMPLE NUMBER | FROM FEET | TO FEET | TYPE | RECOVERY LENGTH REC./DIST. DRIV. | REMARKS |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1.0 | 242.0 | | Peat | | | | | | | |
| | 3.8 | 239.2 | | Brown sand, white shells | 4 | 1 | 2.5 | 4.0 | SS | 10/18 | |
| 5 | 5.2 | 237.8 | | Stiff brown clay | 41 | 2 | 5.0 | 6.5 | SS | 14/18 | |
| | | | None | Silt and sand occasional pebble, till texture | | | | | | | |
| 10 | 11 | 232.0 | | | 37 | 3 | 10.0 | 11.0 | SS | 7/12 | |
| 15 | | | | End of borehole | | | | | | | |
| 20 | | | | | | | | | | | |
| 25 | | | | | | | | | | | |
| 30 | | | | | | | | | | | |
| 35 | | | | | | | | | | | |
| 40 | | | | | | | | | | | |

Appendix 1 - Fig. 12

**ASSOCIATED GEOTECHNICAL SERVICES Limited**

**OFFICE BOREHOLE LOG**

**BOREHOLE NO. 11**

CLIENT: Department of Highways of Ontario

JOB NO. 6010 LOCATION: Twp. of Cornwall

CO-ORDINATES: Sta 233+09 - 3.0'L

ELEVATION (SURFACE) 239.8 (COLLAR) DATUM DHO

DATE (STARTED) 10/5/60 (FINISHED) 10/5/60 (COMPILED) JK

RIG NO. 1 TYPE Boyles FIELD SUP. J Kilgour

SYMBOLS: SILT, GRAVEL, CLAY, PEAT, SAND, FILL

▲ - VANE SHEAR (NATURAL)
○ - VANE SHEAR (REMOLDED)
● - STANDARD PENETRATION

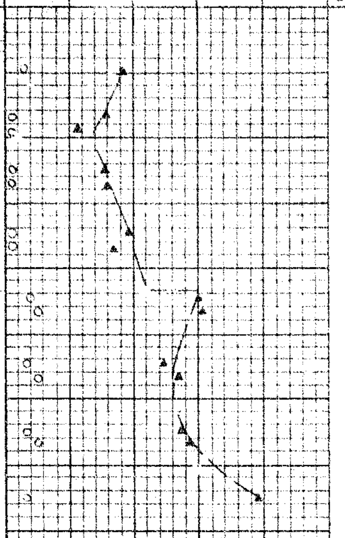
ABBREVIATIONS: UNDISTURBED; DISTURBED BUT REPRESENTATIVE; FAIR; LOST

SS - SPLIT SPOON; ST - SHELBY TUBE; TWP - THIN WALLED PISTON; DO - DIAMOND BIT

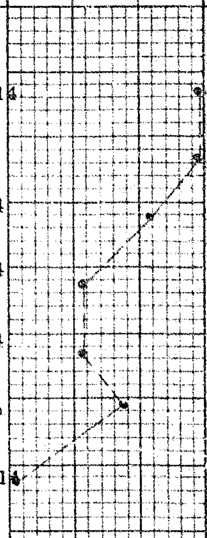
C - CONSOLIDATION TEST; M - MECHANICAL ANALYSIS; T - TRIAXIAL COMPRESSION; K - PERMEABILITY; U - UNCONFINED COMP.; PCF - POUNDS PER CUBIC FOOT; WN - NATURAL WATER CONTENT

| Depth (feet) | Elev. (feet) | Description | Penetration resistance (blows per foot) | Sample number | Type | From (feet) | To (feet) | Recovery length rec./dist. driv. | Remarks |
|---|---|---|---|---|---|---|---|---|---|
| | | Fibrous organic peat | | | | | | | |
| 2.7 | 237.1 | Sand white shells | 9 | 1 | SS | 2.5 | 4.0 | 9/18 | |
| 3.6 | 236.2 | Soft grey clay with black flecks | 456* | 2 | ST | 6.0 | 7.3 | 16.5/14 | WN = 99% |
| | | | 400* | | | | | | |
| | | | 342* | 3 | ST | 10.0 | 11.2 | 11/14 | |
| | | | 390* | | | | | | WN = 100% |
| | | | 400* | | | | | | |
| | | | 480* | 4 | ST | 15.0 | 16.2 | 19.5/14 | WN = 83% |
| | | | 440* | | | | | | |
| 21.7 | 218.1 | Medium grey clay | 750* | 5 | ST | 20.0 | 21.2 | 14/14 | WN = 63% |
| | | | 765* | | | | | | |
| | | | 604* | 6 | ST | 25.0 | 26.2 | 20/14 | WN = 62.8% |
| | | | 685* | | | | | | |
| | | | 685* | 7 | ST | 30.0 | 31.3 | 20/16 | WN = 75.2% |
| 33 | 206.8 | Becoming sandy | 700* | | | | | | |
| | | | 980* | 8 | ST | 35.0 | 36.2 | 14.5/14 | WN = 42% |
| 38.1 | 201.7 | Casing refusal. End of Borehole | | | | | | | |

FIELD TESTS – SHEAR STRENGTH (TONS PER SQUARE FOOT) .25 .50 / STANDARD PENETRATION TEST (BLOWS PER FOOT)



LABORATORY – UNIT WEIGHT PCF / ATTERBERG LIMITS WP × — WN ● — ○ WL, 60 80



* Shear strength in lbs. per sq. ft.

Appendix I - Fig. 13

**ASSOCIATED GEOTECHNICAL SERVICES Limited**

**OFFICE BOREHOLE LOG**

BOREHOLE NO. 12

CLIENT: Department of Highways of Ontario
JOB NO. 6010 LOCATION: Twp. of Cornwall
CO-ORDINATES: Sta. 232+46 - 100' R
ELEVATION (SURFACE) 239.5 (COLLAR) ____ DATUM DHO
DATE (STARTED) 11/5/60 (FINISHED) 11/5/60 COMPILED JK
RIG. NO. 1 TYPE Boyles FIELD SUP. J. Kilgour

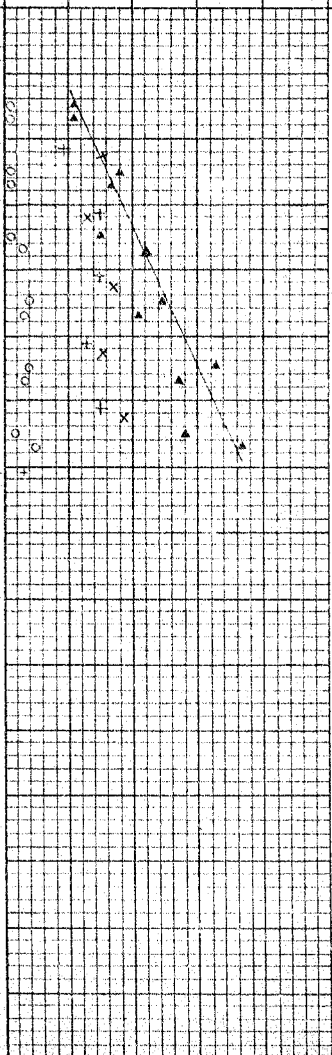
SYMBOLS: SILT, CLAY, SAND, GRAVEL, PEAT, FILL
▲ - VANE SHEAR (NATURAL)
○ - VANE SHEAR (REMOLDED)
● - STANDARD PENETRATION
+ - Unconfined Comp.
x - Triaxial Comp.

ABBREVIATIONS:
UNDISTURBED; DISTURBED BUT REPRESENTATIVE; FAIR; LOST
SS - SPLIT SPOON; ST - SHELBY TUBE; TWP. - THIN WALLED PISTON; DB - DIAMOND BIT
C - CONSOLIDATION TEST; M - MECHANICAL ANALYSIS; T - TRIAXIAL COMPRESSION; K - PERMEABILITY; U - UNCONFINED COMP.; PCF - POUNDS PER CUBIC FOOT; WN - NATURAL WATER CONTENT

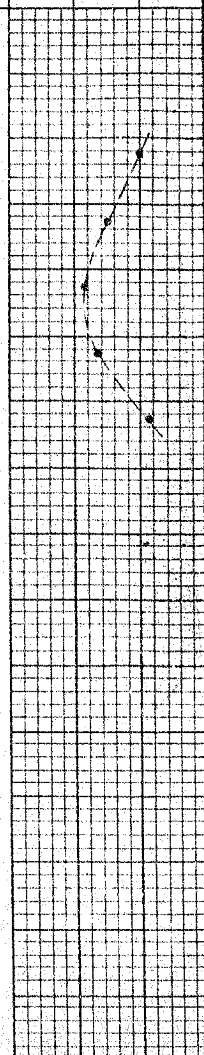
BORING LOG — FIELD TESTS — SAMPLING — LABORATORY TESTS — REMARKS

| Depth (feet) | Elev. (feet) | Water observation | Description | Penetration resistance (blows per foot) | Sample number | Depth from (feet) | Depth to (feet) | Type | Recovery length rec./dist. driv. |
|---|---|---|---|---|---|---|---|---|---|
| | | | Fibrous organic peat | | | | | | |
| 3.2 | 236.3 | | Sand, white shells | | 1 | 2.5 | 4.0 | SS | 11/18 |
| 4.2 | 235.3 | GWT | Soft grey clay | 270* | 2 | 5.0 | 6.5 | ST | 18/18 |
| | | | | 260* | | | | | |
| 10.5 | ? | | Soft grey clay with black flecks | 456* | 3 | 10.0 | 11.5 | ST | 21/18 |
| | | | | 430* | | | | | |
| | | | | 366* | 4 | 15.0 | 16.5 | ST | 19/18 |
| 18 | 221.5 | | Medium grey clay | 554* | | | | | |
| | | | | 660* | 5 | 20.0 | 21.5 | ST | 23/18 |
| | | | | 505* | | | | | |
| | | | | 815* | 6 | 25.0 | 26.5 | ST | 21/18 |
| | | | | 684* | | | | | |
| | | | | 700* | 7 | 30.0 | 31.5 | ST | 20/18 |
| | | | Sandier | 910* | | | | | |
| 35.5 | 204 | | Sandy clay | | 8 | 35.0 | 35.5 | ST | 4/6 |
| 36.5 | | | Broken rock | 81 | 9 | 35.5 | 37.0 | SS | 18/18 |
| 37.2 | | | Casing refusal | | | | | | |

Shear strength (tons per square foot) / Standard penetration test (blows per foot):




Unit weight PCF DY / Atterberg limits WP x — ● WN — ○ WL:




REMARKS: * Shear strength in pounds per sq. ft.

Appendix I - Fig. 14

**ASSOCIATED GEOTECHNICAL SERVICES Limited**

**OFFICE BOREHOLE LOG**

BOREHOLE NO. 13

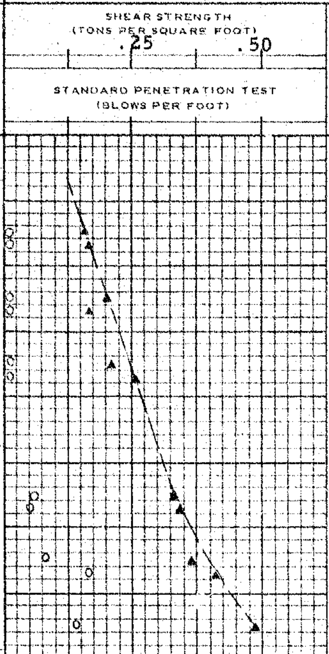
CLIENT Department of Highways of Ontario
JOB NO. 6010 LOCATION Twp. of Cornwall
CO-ORDINATES STA: 232-46 - 100' Lt.
ELEVATION (SURFACE) 239.5 (COLLAR) DATUM DHO
DATE (STARTED) 12/5/60 (FINISHED) 12/5/60 COMPILED JK
RIG. NO. 1 TYPE Boyles FIELD SUP. J. Kilgour

SYMBOLS: SILT, CLAY, SAND, GRAVEL, PEAT, FILL; ▲ - VANE SHEAR (NATURAL), O - VANE SHEAR (REMOLDED), ● - STANDARD PENETRATION

ABBREVIATIONS: UNDISTURBED; DISTURBED BUT REPRESENTATIVE; FAIR; LOST; SS - SPLIT SPOON; ST - SHELBY TUBE; TWP. - THIN WALLED PISTON; DB - DIAMOND BIT; C - CONSOLIDATION TEST; M - MECHANICAL ANALYSIS; T - TRIAXIAL COMPRESSION; K - PERMEABILITY; U - UNCONFINED COMP.; PCF - POUNDS PER CUBIC FOOT; WN - NATURAL WATER CONTENT

BORING LOG / FIELD TESTS / SAMPLING / LABORATORY TESTS

| Depth (feet) | Elev. (feet) | Description | Penetration resistance (blows per foot) | Sample number | From (feet) | To (feet) | Type | Recovery length Rec./Dis. | Remarks |
|---|---|---|---|---|---|---|---|---|---|
| | | Fibrous organic peat | | | | | | | |
| 2.8 | 236.7 | Sand white shells | 8 | 1 | 2.5 | 4.3 | SS | 12/21 | |
| 3.7 | 235.8 | Soft grey clay | 310* 318* | 2 | 5.0 | 6.5 | ST | 12/18 | WN = 88.5% |
| 11(?) | 228.5 | Soft grey clay with black flecks | 400* 342* | 3 | 10.0 | 11.5 | ST | 19/18 | WN = 88.5% |
| | | | 432* 520* | 4 | 15.0 | 16.5 | ST | 21/18 | WN - 103.5% |
| 18.4 | 221.1 | Grey sandy clay, frequent pebble | | 5 | 20.0 | 21.5 | ST | 22/18 | WN = 35% Could not push vane into this layer |
| 24 | 215.5 | Medium grey clay | 1.5 650* 685* | 6 | 25.0 | 26.5 | SS | 18/18 | |
| | | | 735* 815* | 7 | 30.0 | 31.5 | ST | 22/18 | WN = 70% |
| | | Sandier | 978* | 8 | 35.0 | 36.5 | ST | 23/18 | WN = 41% |
| 39.5 | 200.0 | grey sand, some silt and gravel | 20 | 9 | 40.0 | 41.6 | SS | 4/18 | |
| | | Casing refusal | | | | | | | |




LABORATORY: UNIT WEIGHT PCF DY; ATTERBERG LIMITS WP x 60 WN 80 o WL

* Shear strength in lbs. per sq. ft.

Appendix I - Fig. 15

# DYNAMIC CONE PROBE

No: P1

Location:

Station: ) See Plan
Offset: )
Elev: 249.4

| Depth | Blows/ft |
|---|---|
| 1 | 4 |
| 2 | 7 |
| 3 | 25 |
| 4 | 40 |
| 5 | 140 |
| 6 | 204 |
| 7 | 221 |
| 8 | 78 |
| 9 | 55 |
| 10 | 77 |
| 11 | 110 |
| 12 | 113 |
| 13 | 42 |
| 14 | 55 |
| 15 | 54 |
| 16 | 44 |
| 17 | 67 |
| 18 | 64 |
| 19 | 86 |
| 20 | 122 |
| 21 | 131 |
| 22 | 84 |
| 23 | 166 |
| 23.4 | 194 |

Appendix I - Fig. 16

# DYNAMIC CONE PROBE

No: P2

Location:

Station: )
) See Plan
Offset: )

Elevation: 249.2

| Depth | Blows/ft |
|---|---|
| 1 | 1 |
| 2 | 7 |
| 3 | 38 |
| 4 | 96 |
| 5 | 156 |
| 5.3 | 200 |

Appendix I- Fig. 17

## DYNAMIC CONE PROBE

No. P3

Location:

Station: ) See plan
Offset: )
Elev: 243.4

| Depth | Blows/ft |
|---|---|
| 1 | 2 |
| 2 | 3 |
| 3 | 3 |
| 4 | 3 |
| 5 | 8 |
| 6 | 15 |
| 7 | 63 |
| 8 | 59 |
| 9 | 54 |
| 10 | 46 |
| 11 | 53 |
| 12 | 52 |
| 13 | 53 |
| 14 | 52 |
| 15 | 51 |
| 16 | 33 |
| 17 | 32 |
| 18 | 60 |
| 19 | 98 |
| 20 | 60 |
| 21 | 54 |
| 22 | 108 |

Appendix I - Fig. 18

## DYNAMIC CONE PROBE

No: P4

Location:

Station: ) See Plan
Offset: )
Elev: 243.9

| Depth | Blows/ft |
|---|---|
| 1 | 2 |
| 2 | 3 |
| 3 | 3 |
| 4 | 2 |
| 5 | 9 |
| 6 | 74 |
| 7 | 95 |
| 8 | 77 |
| 9 | 60 |
| 10 | 46 |
| 11 | 48 |
| 12 | 72 |
| 13 | 57 |
| 14 | 52 |
| 15 | 61 |
| 16 | 138 |
| 17 | 159 |
| 18 | 121 |
| 18.4 | 200 |

Appendix I - Fig. 19

# DYNAMIC CONE PROBE

No: P5

Location:

Station: 229+46
Offset: On ℄
Elev: 240.2

| Depth | Blows/ft |
|---|---|
| 1 | 2 |
| 2 | 1 |
| 3 | 1 |
| 4 | 1 |
| 5 | 1/2 |
| 6 | 1/2 |
| 7 | 1 |
| 8 | 2 |
| 9 | 2 |
| 10 | 2 |
| 11 | 2 |
| 12 | 3 |
| 13 | 4 |
| 14 | 6 |
| 15 | 30 |
| 15.1 | 100 |

Appendix I - Fig 20

## DYNAMIC CONE PROBE

No: P6

Location:

Station: 230-94
Offset: on ℄
Elev: 240.2

| Depth | Blows/ft | Depth | Blows/ft |
|---|---|---|---|
| 1 | 1 | 26 | 4 |
| 2 | 1 | 27 | 3 |
| 3 | 1 | 28 | 3 |
| 4 | 1 | 29 | 3 |
| 5 | 1 | 30 | 4 |
| 6 | 1 | 31 | 5 |
| 7 | 1 | 32 | 4 |
| 8 | 1 | 33 | 5 |
| 9 | 1 | 34 | 6 |
| 10 | 2 | 35 | 10 |
| 11 | 2 | 36 | 12 |
| 12 | 2 | 37 | 15 |
| 13 | 2 | 38 | 15 |
| 14 | 2 | 39 | 22 |
| 15 | 2 | 40 | 35 |
| 16 | 2 | 41 | 38 |
| 17 | 2 | 42 | 30 |
| 18 | 3 | 43 | 57 |
| 19 | 8 | 43.3 | 75 (hammer bouncing) |
| 20 | 3 | | |
| 21 | 4 | | |
| 22 | 2 | | |
| 23 | 3 | | |
| 24 | 3 | | |
| 25 | 4 | | |

Appendix I - Fig. 21

# DYNAMIC CONE PROBE

No: P12

Location:

Station: ) See Plan
Offset: )
Elev: 239.5

| Depth | Blows/ft | Depth | Blows/ft |
|---|---|---|---|
| 1 | 1/2 | 26 | 2 |
| 2 | 1/2 | 27 | 2 |
| 3 | 1 | 28 | 1 |
| 4 | 12 | 29 | 2 |
| 5 | 1 | 30 | 1 |
| 6 | 1/2 | 31 | 6 |
| 7 | 1/2 | 32 | 4 |
| 8 | 1/2 | 33 | 3 |
| 9 | 1/2 | 34 | 4 |
| 10 | 1 | 35 | 8 |
| 11 | 1 | 36 | 16 |
| 12 | 1 | 36.5 | 44 |
| 13 | 1/2 | | |
| 14 | 1/2 | | |
| 15 | 1 | | |
| 16 | 1/2 | | |
| 17 | 1/2 | | |
| 18 | 1 | | |
| 19 | 1 | | |
| 20 | 1 | | |
| 21 | 1 | | |
| 22 | 1 | | |
| 23 | 2 | | |
| 24 | 1 | | |
| 25 | 1 | | |

Refusal at 36'.5

Appendix I - Fig. 22

# DYNAMIC CONE PROBE

No: P13

Location:

Station: ) See Plan
Offset )
Elev: 289.5

| Depth | Blows/ft | Depth | Blows/ft |
|---|---|---|---|
| 1 | 1/2 | 26 | 2 |
| 2 | 1/2 | 27 | 2 |
| 3 | 5 | 28 | 2 |
| 4 | 15 | 29 | 3 |
| 5 | 7 | 30 | 1 |
| 6 | 3 | 31 | 3 |
| 7 | 1 | 32 | 3 |
| 8 | 1 | 33 | 4 |
| 9 | 1 | 34 | 3 |
| 10 | 1 | 35 | 3 |
| 11 | 2 | 36 | 4 |
| 12 | 1 | 37 | 4 |
| 13 | 1 | 38 | 4* |
| 14 | 1 | 39 | 10 |
| 15 | 1 | 40 | 9 |
| 16 | 1 | 41 | 16 |
| 17 | 3 | 41.9 | 24 |
| 18 | 1 | | |
| 19 | 1 | | |
| 20 | 2 | | |
| 21 | 4 | | |
| 22 | 12 | | |
| 23 | 4 | | |
| 24 | 4 | | |
| 25 | 3 | | |

Refusal at 41.9

* Change at 38.8

Appendix I - Fig. 23

# DYNAMIC CONE PROBE

No: P14

Location:

Station: ) See Plan
Offset: )
Elev: 289.5

| Depth | Blows/ft | Depth | Blows/ft |
|---|---|---|---|
| 1 | 1 | 26 | 1 |
| 2 | 1 | 27 | 2 |
| 3 | 1 | 28 | 2 |
| 4 | 13 | 29 | 2 |
| 5 | 9 | 30 | 3 |
| 6 | 1 | 31 | 3 |
| 7 | 1 | 32 | 3 |
| 8 | 1 | 33 | 3 |
| 9 | 1 | 34 | 3 |
| 10 | 7 | 35 | 3 |
| 11 | 3 | 36 | 2 |
| 12 | 1 | 37 | 5 |
| 13 | 1 | 38 | 3* |
| 14 | 1 | 39 | 16 |
| 15 | 1 | 40 | 26 |
| 16 | 1 | 41 | 19 |
| 17 | 2 | 42 | 8 |
| 18 | 1 | 43 | 25 |
| 19 | 1 | 43.4 | 11 |
| 20 | 1 | | |
| 21 | 1 | | |
| 22 | 3 | | |
| 23 | 1 | | |
| 24 | 2 | | |
| 25 | 1 | | |

Refusal at 43.4'

* Change at 38.3

Appendix I - Fig. 24

# DYNAMIC CONE PROBE

No: P15

Location:

Station: )See Plan
Offset: )
Elev: 289.5

| Depth | Blows/ft | Depth | Blows/ft |
|---|---|---|---|
| 1 | 1 | 26 | 1 |
| 2 | 1 | 27 | 2 |
| 3 | 1 | 28 | 2 |
| 4 | 1/2 | 29 | 2 |
| 5 | 1/2 | 30 | 2 |
| 6 | 1/2 | 31 | 3 |
| 7 | 1/2 | 32 | 2 |
| 8 | 1 | 33 | 3 |
| 9 | 1 | 34 | 3 |
| 10 | 2 | 35 | 2 |
| 11 | 1 | 36 | 3 |
| 12 | 1/2 | 37 | 3 |
| 13 | 1/2 | 38 | 23* |
| 14 | 1 | 39 | 33 |
| 15 | 1 | 40 | 31 |
| 16 | . | 41 | 17 |
| 17 | 1 | 42 | 19 |
| 18 | 1 | 42.5 | 12 |
| 19 | 2 | | |
| 20 | 1 | | |
| 21 | 1 | | |
| 22 | 1 | | |
| 23 | 1 | | |
| 24 | 1 | | |
| 25 | 2 | | |

Refusal at 42.5

* Change at 37'.4

Appendix I - Fig. 25

## DYNAMIC CONE PROBE

No: P16

Location:

Station: ) See Plan
Offset: )
Elev: 289.5

| Depth | Blows/ft | Depth | Blows/ft |
|---|---|---|---|
| 1 | 1/2 | 26 | 2 |
| 2 | 1/2 | 27 | 1 |
| 3 | 1 | 28 | 1 |
| 4 | 2 | 29 | 2 |
| 5 | 14 | 30 | 1 |
| 6 | 6 | 31 | 2 |
| 7 | 1/2 | 32 | 2 |
| 8 | 1/2 | 33 | 3 |
| 9 | 1/2 | 34 | 2 |
| 10 | 1/2 | 35 | 2 |
| 11 | 1 | 36 | 3 |
| 12 | 1/2 | 37 | 13 |
| 13 | 1/2 | 38 | 51 |
| 14 | 1 | 38.3 | 44 |
| 15 | 1 | | |
| 16 | 1 | | |
| 17 | 1/2 | | |
| 18 | 1/2 | | |
| 19 | 1/2 | | |
| 20 | 1/2 | | |
| 21 | 1 | | |
| 22 | 1 | | |
| 23 | 1 | | |
| 24 | 2 | | |
| 25 | 1 | | |

Refusal at 38'.3

Appendix I - Fig. 26

# DYNAMIC CONE PROBE

No. P17

Location:

Station: ) See Plan
Offset: )
Elev: 239.5

| Depth | Blows/ft | Depth | Blows/ft |
|---|---|---|---|
| 1 | 1/2 | 21 | 2 |
| 2 | 1/2 | 22 | 1 |
| 3 | 1 | 23 | 1 |
| 4 | 8 | 24 | 1 |
| 5 | 1/2 | 25 | 1 |
| 6 | 1/2 | 26 | 2 |
| 7 | 1 | 27 | 1 |
| 8 | 1 | 28 | 1 |
| 9 | 1/2 | 29 | 2 |
| 10 | 1/2 | 30 | 1 |
| 11 | 1/2 | 31 | 3 |
| 12 | 1/2 | 32 | 2 |
| 13 | 1 | 33 | 3 |
| 14 | 1 | 34 | 5 |
| 15 | 1/2 | 35 | 19 |
| 16 | 1/2 | 36 | 44 |
| 17 | 1 | 36.9 | 60 |
| 18 | 1 | | |
| 19 | 1/2 | Refusal at 36'.9 | |
| 20 | 1/2 | | |

Appendix I - Fig. 27

# DYNAMIC CONE PROBE

No. P18.

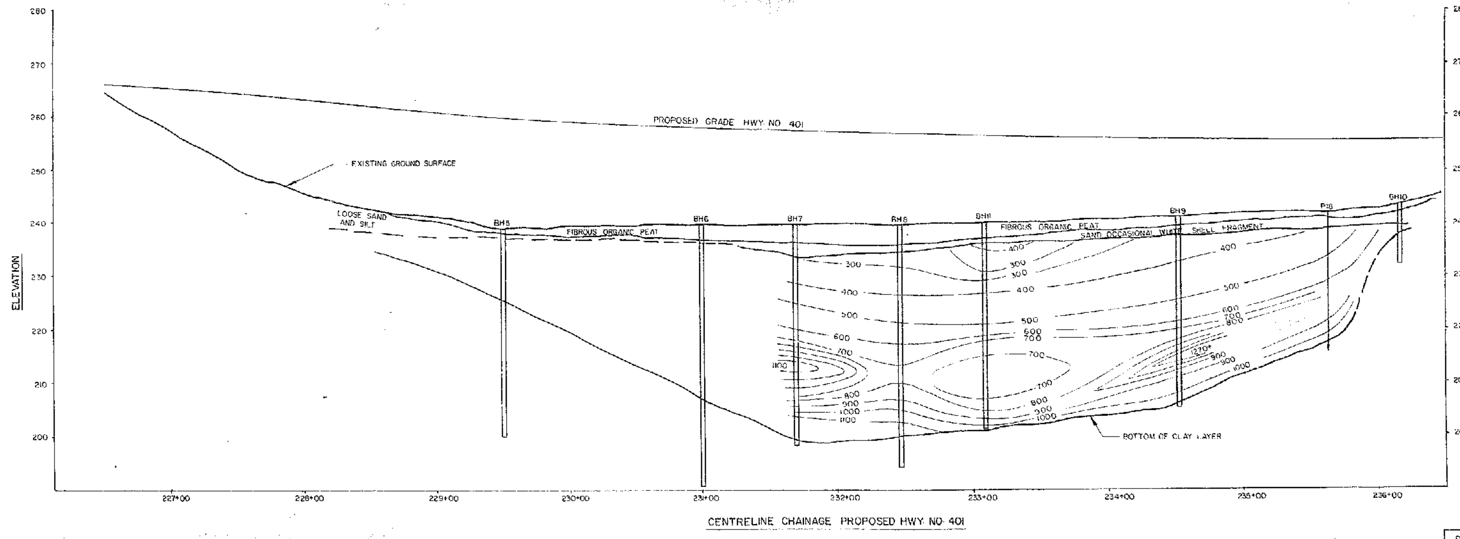
Location:

Station: 235+56.5
Offset: On ℄
Elev: 242.2

| Depth | Blows/ft | Depth | Blows/ft |
|---|---|---|---|
| 1 | 1 | 21 | 4 |
| 2 | 3 | 22 | 4 |
| 3 | 6 | 23 | 4 |
| 4 | 5 | 24 | 4 |
| 5 | 1/2 | 25 | 4 |
| 6 | 1/2 | 26 | 12 |
| 7 | 3 | 27 | 50 |
| 8 | 1 | 27.3 | 50 |
| 9 | 1 | | |
| 10 | 1 | Refusal at 27'.3 | |
| 11 | 1 | | |
| 12 | 1 | | |
| 13 | 1 | | |
| 14 | 2 | | |
| 15 | 2 | | |
| 16 | 2 | | |
| 17 | 2 | | |
| 18 | 2 | | |
| 19 | 3 | | |
| 20 | 3 | | |

Appendix I - Fig. 28

# APPENDIX II




| JOB NO 6010 |
|---|

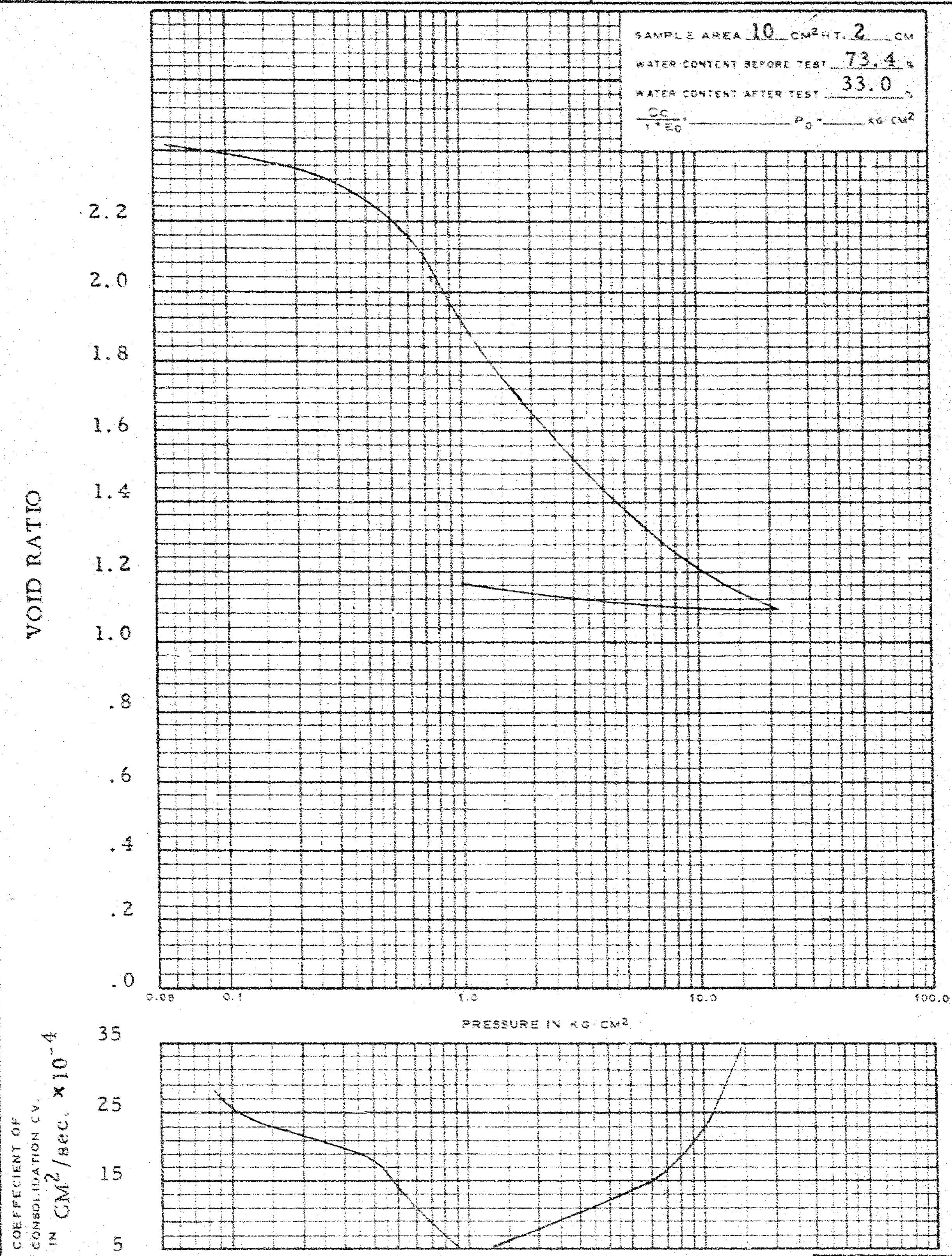
ASSOCIATED GEOTECHNICAL SERVICES LIMITED

DEPARTMENT OF HIGHWAYS - ONTARIO

CENTRE LINE PROFILE SHOWING ISOLINES OF SHEAR STRENGTH IN CLAY LAYER AS DETERMINED WITH 3 INCH VANE APPARATUS

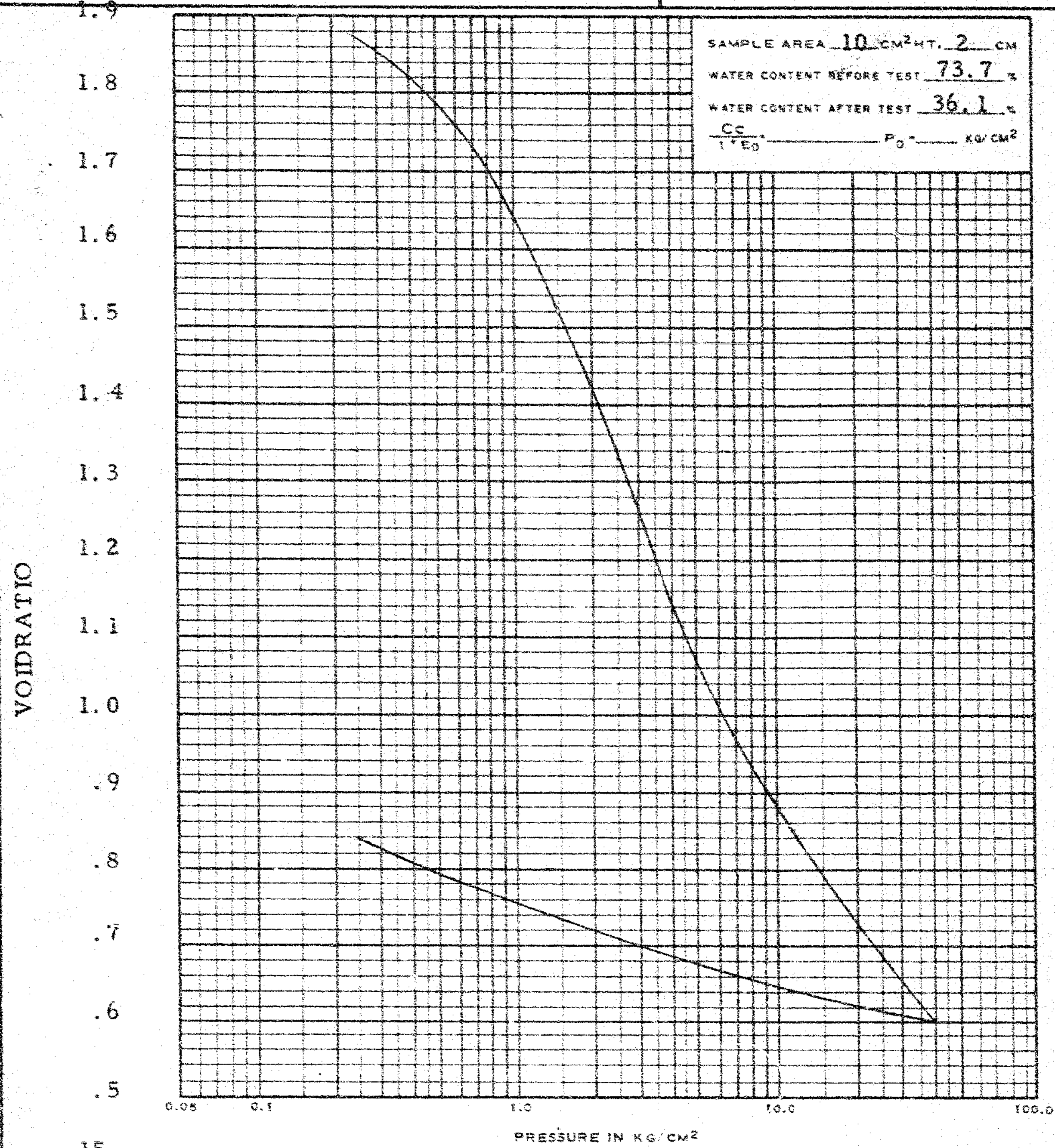
| DWG NO 1-29 | SCALE-1" 20'-0" | DATE JUNE 1960 |
|---|---|---|

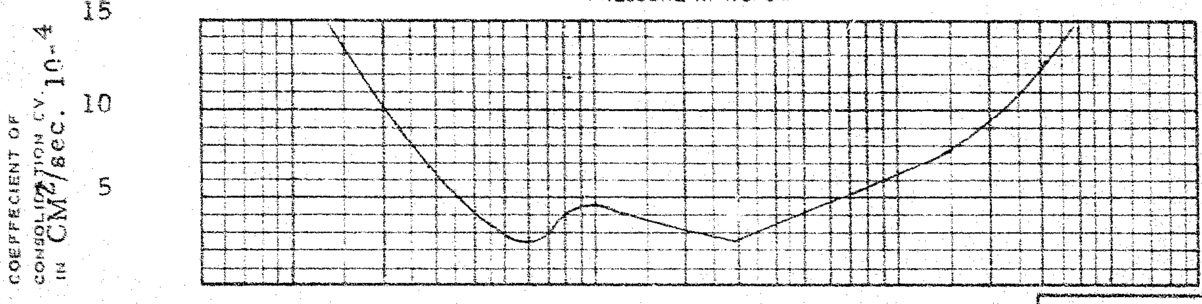
| | |
|---|---|
| CLIENT Department of Highways of Ontario | **ASSOCIATED GEOTECHNICAL SERVICES** Limited |
| JOB NO. 6010 LOCATION Cornwall, Ontario | |
| BOREHOLE NUMBER 9 DEPTH 11.0-11.2 | **SOIL MECHANICS LABORATORY** |
| SAMPLE NUMBER 3 DATE 7/6/60 | CONSOLIDATION TEST |




Appendix II - Fig. 1

| | |
|---|---|
| CLIENT Department of Highways of Ontario | **ASSOCIATED GEOTECHNICAL SERVICES** Limited |
| JOB NO. 6010 LOCATION Cornwall, Cnt. | |
| BOREHOLE NUMBER 9 DEPTH 26.6-26.8 | **SOIL MECHANICS LABORATORY** |
| SAMPLE NUMBER 7 DATE 21/6/60 | CONSOLIDATION TEST |




Appendix II - Fig. 2

# APPENDIX III

# SOIL CLASSIFICATION SYSTEM

The following system was used to describe the various soils encountered at the site as determined by visual field examination and test. It was also used to classify those soils upon which a laboratory grain size determination had been made.

| Soil Components | Particle Size |
|---|---|
| Clay | < .002 mm |
| Silt | > .002 mm < .06 mm |
| Sand | > .06 mm < 2.0 mm |
| Gravel | > 2.0 mm < 2 in. |
| Cobbles | > 2 in. < 6 in. |
| Boulders | > 6 in. |

| Descriptive Terms | Range of Proportions |
|---|---|
| and | greater than 40% |
| with | 25% to 40% |
| some | 10% to 25% |
| trace | less than 10% |

Examples

1. Silt (predominant type) with (25% - 40%) sand.

2. Sand and silt (predominant types), some (10% - 25%) gravel, trace (< 10%) clay.

# STANDARD PENETRATION CLASSIFICATION

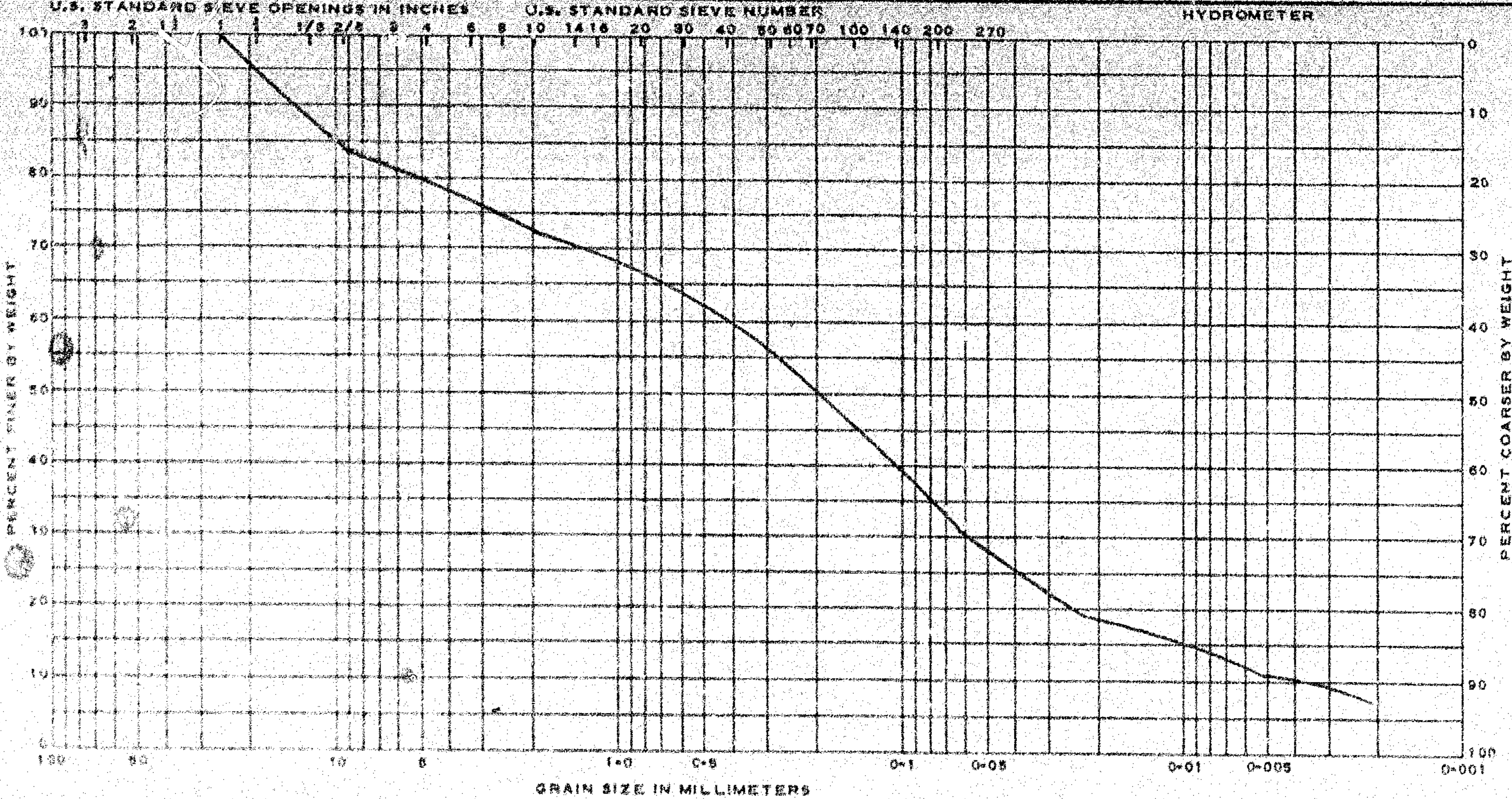
| Relative Density of Sands as determined by Standard Penetration Tests | | |
|---|---|---|
| N | $D_d$ | Designation on Borehole Log |
| 0 - 4 | 0 - 0.2 | Very Loose |
| 4 - 10 | 0. 2 - 0.4 | Loose |
| 10 - 30 | 0. 4 - 0.6 | Medium Dense |
| 30 - 50 | 0. 6 - 0.8 | Dense |
| Over 50 | 0. 8 - 1.0 | Very dense |

| Shear Strengths of Clays as determined by Standard Penetration Tests | | |
|---|---|---|
| N | s psf | Designation on Borehole Log |
| 2 | 250 | Very Soft |
| 2 - 4 | 250 - 500 | Soft |
| 4 - 8 | 500 - 1000 | Medium |
| 8 - 15 | 1000 - 2000 | Stiff |
| 15 - 30 | 2000 - 4000 | Very Stiff |
| 30 | 4000 | Hard |

# ASSOCIATED GEOTECHNICAL SERVICES
Limited

SOIL MECHANICS LABORATORY
MECHANICAL ANALYSIS

CLIENT Department of Highways of Ontario.
JOB. NO. 6010 LOCATION Cornwall, Ont.
BOREHOLE NUMBER 3 DEPTH 5'5"-7'
SAMPLE NUMBER 2 DATE 24/6/60




M.I.T. CLASSIFICATION

| STONES | GRAVEL | SAND | | | SILT | | | CLAY |
|---|---|---|---|---|---|---|---|---|
| | | COARSE | MEDIUM | FINE | COARSE | MEDIUM | FINE | |

CLASSIFICATION

Sand, some silt, some gravel
Till texture

SOIL MECHANICAL ANALYSIS

BOREHOLE - 3 DEPTH - 5'5"-7'

Appendix III

CLIENT Department of Highways of Ontario

JOB NO. 6010 LOCATION Cornwall, Ont

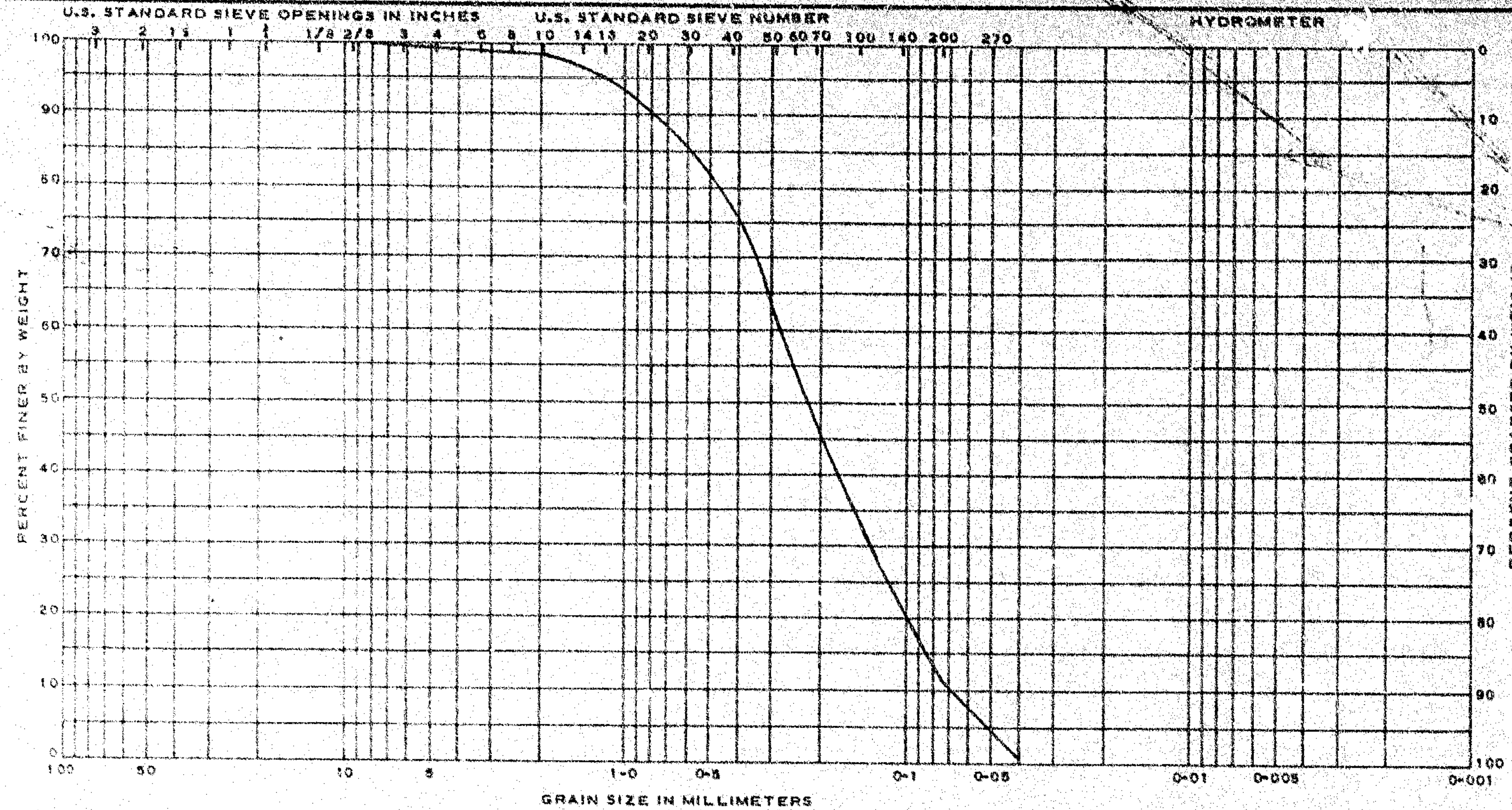
BOREHOLE NUMBER 6 DEPTH 42'3"-43'8"

SAMPLE NUMBER 7 DATE 23/6/60

**ASSOCIATED GEOTECHNICAL SERVICES**
Limited

**SOIL MECHANICS LABORATORY**

**MECHANICAL ANALYSIS**




M.I.T. CLASSIFICATION

| STONES | GRAVEL | SAND | | | SILT | | | CLAY |
|---|---|---|---|---|---|---|---|---|
| | | COARSE | MEDIUM | FINE | COARSE | MEDIUM | FINE | |

CLASSIFICATION

Kame sand, trace of silt,

SOIL MECHANICAL ANALYSIS

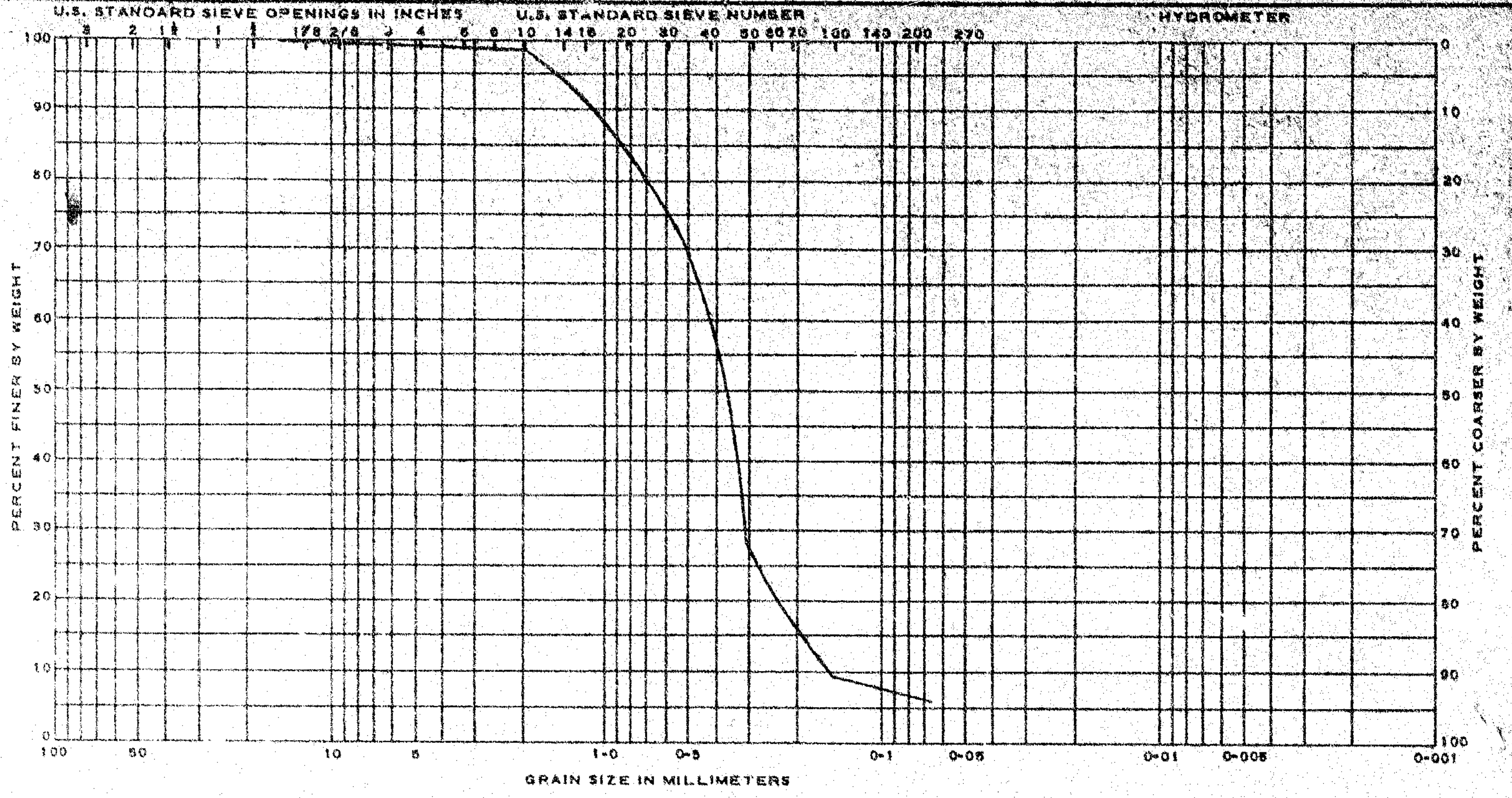
BOREHOLE - 6 DEPTH - 42'3"-43'8"

Appendix III

**ASSOCIATED GEOTECHNICAL SERVICES**
Limited

**SOIL MECHANICS LABORATORY**
**MECHANICAL ANALYSIS**

CLIENT Department of Highways of Ontario
JOB. NO. 6010 LOCATION Cornwall, Ontario
BOREHOLE NUMBER 10 DEPTH 3'
SAMPLE NUMBER ____ DATE 23/6/60




M.I.T. CLASSIFICATION

| STONES | GRAVEL | SAND | | | SILT | | | CLAY |
|---|---|---|---|---|---|---|---|---|
| | | COARSE | MEDIUM | FINE | COARSE | MEDIUM | FINE | |

CLASSIFICATION

Marine sand, occasional white shell fragment

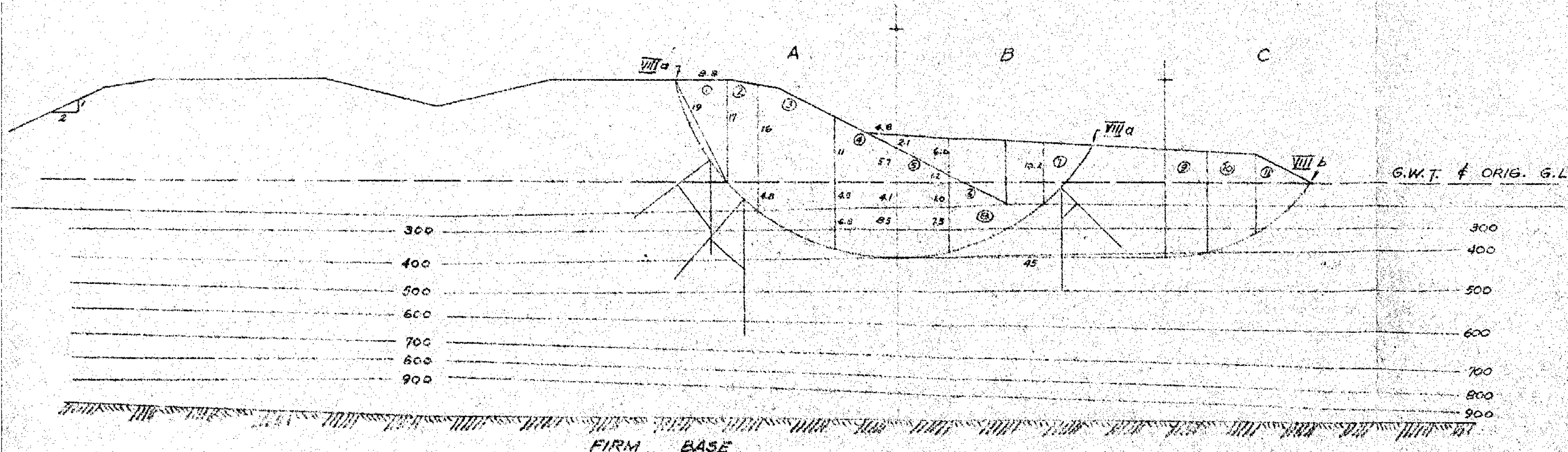
SOIL MECHANICAL ANALYSIS

BOREHOLE - 10 DEPTH - 3'

Appendix III

# APPENDIX IV

| | | | |
|---|---|---|---|
| CLIENT DEPT. OF HIGHWAYS - ONTARIO<br>JOB NO. 6010 LOCATION CORNWALL, ONT.<br>PROJECT<br>DATE FIELD INVESTIGATION<br>DATE REPORT BY CHKD. | LEGEND<br>MID POINT CIRCLE<br>SLIP SURFACE VIII | SCALES<br>HORIZONTAL 1" = 20'<br>VERTICAL 1" = 20' | ASSOCIATED GEOTECHNICAL SERVICES Limited<br>STABILITY ANALYSIS |




① SECTION A : $w_1 d_1 - \frac{S_1 L_1 R_1}{F} = P_A a_1$

② SECTION B : $P_P = P_A - \frac{S_2 L_2}{F}$

③ SECTION C : $P_P a_3 = w_3 d_3 + \frac{S_3 L_3 R_3}{F}$

---

$a_1 = \frac{2}{3} \times 20.5 + 17.7 = 31.4$

$a_3 = \frac{2}{3} \times 18.0 + 11.6 = 23.6$

CLIENT: DEPT. OF HIGHWAYS - ONTARIO

JOB. NO.: 6010 LOCATION: CORNWALL, ONT.

BOREHOLE NUMBER: DEPTH:

SAMPLE NUMBER: DATE:

**ASSOCIATED GEOTECHNICAL SERVICES Limited**

**CALCULATION SHEET**

## SLIP SURFACE VIII a

### WEIGHTS OF SLICES IN KIPS:

① ½ × 8.8 × 17 × 0.130 = 9.72

½ × 1.3 × 19 × 0.130 = 1.60

11.32

② 16.5 × 5.1 × 0.130 = 10.92

½ × 5.1 × 4.8 × 0.0675 = 0.82

11.74

③ ½ (11 + 16) × 12.8 × 0.130 = 22.45

½ (4.8 + 4.5) × 12.8 × 0.0675 = 4.02

½ × 12.8 × 6.8 × 0.0475 = 2.07

28.54

④ ½ × 4.8 × 2.1 × 0.130 = 0.65

½ (11 + 5.7) × 10.2 × 0.130 = 11.07

½ (4.5 + 4.1) × 10.2 × 0.0675 = 2.96

½ (6.8 + 8.5) × 10.2 × 0.0475 = 3.71

18.39

⑤ ½ (2.1 + 6.0) × 8.8 × 0.130 = 4.52

½ (1.2 + 5.7) × 8.8 × 0.130 = 3.94

½ (4.0 + 4.1) × 8.8 × 0.0675 = 2.40

½ (8.5 + 7.5) × 8.8 × 0.0475 = 3.34

14.20

CLIENT DEPT. OF HIGWAYS – ONTARIO

JOB. NO. 6010 LOCATION CORNWALL, ONT.

BOREHOLE NUMBER ______ DEPTH ______

SAMPLE NUMBER ______ DATE ______

**ASSOCIATED GEOTECHNICAL SERVICES Limited**

**CALCULATION SHEET**

⑥ ½ (7.2 + 6.6) × 15.9 × 0.130 = 14.26

½ (4.0 + 3.6) × 15.9 × 0.0675 = 4.07

18.33

⑦ ½ (3.5 + 8.0) × 6.6 × 0.130 = 4.94

½ × 3.6 × 3.5 × 0.0675 = 0.42

5.36

⑧ ½ × 7.5 × 15.9 × 0.0475 = 2.83

DRIVING MOMENT :

11.32 × 31.1 = 352

11.74 × 25.5 = 300

28.54 × 16.6 = 474

18.39 × 5.1 = 94

1220 KIP FT.

RESISTING MOMENT DUE TO WEIGHT :

14.20 × 4.4 = 62.5

18.33 × 16.8 = 308

5.36 × 27.4 = 147

2.83 × 14.1 = 39.9

557.4 KIP FT.

| | |
|---|---|
| CLIENT: DEPT. OF HIGHWAYS - ONTARIO | **ASSOCIATED GEOTECHNICAL SERVICES Limited** |
| JOB. NO. 6010 LOCATION CORNWALL, ONT. | |
| BOREHOLE NUMBER ____ DEPTH ____ | **CALCULATION SHEET** |
| SAMPLE NUMBER ____ DATE ____ | |

RESISTING MOMENT IN TILL:

① WEIGHT = 11.32 NORMAL FORCE = 6.7

② WEIGHT = 11.74 NORMAL FORCE = 8.8

③ WEIGHT = 5.36 NORMAL FORCE = 3.8

19.3

MOMENT = 19.3 × 38.3 × 0.7 = 517 KIP FT.

RESISTING MOMENT IN CLAY:

6 × 0.275 = 1.65

18.8 × 0.350 = 6.57

19.0 × 0.350 = 6.65

7.3 × 0.275 = 2.01

16.88

MOMENT = 16.88 × 38.3 = 646 KIP FT.

$$F = \frac{557.4 + 517 + 646}{1220} = 1.41$$

| | |
|---|---|
| CLIENT: DEPT. OF HIGHWAYS - ONTARIO | **ASSOCIATED GEOTECHNICAL SERVICES Limited** |
| JOB. NO. 6010 LOCATION CORNWALL, ONT. | **CALCULATION SHEET** |
| BOREHOLE NUMBER ______ DEPTH ______ | |
| SAMPLE NUMBER ______ DATE ______ | |

## SLIP SURFACE VIII b

WEIGHTS OF SLICES IN KIPS - BLOCK C :

(9) 5.3 × 7 × 0.130 = 4.82

3.7 × 7 × 0.0675 = 1.75

8.4 × 7 × 0.0475 = 2.78

9.35

(10) 4.8 × 8 × 0.130 = 4.99

3.7 × 8 × 0.0675 = 2.00

½ (4.5 + 7.9) × 8 × 0.0475 = 2.35

9.34

(11) ½ × 4.6 × 9.5 × 0.130 = 2.84

½ (9.5 + 5.5) × 3.7 × 0.0675 = 1.87

½ × 5.5 × 4.8 × 0.0475 = 0.63

5.34

RESISTING MOMENT DUE TO WEIGHT - BLOCK C :

9.35 × 3.5 = 32.7

9.34 × 11.0 = 102.7

5.34 × 18.2 = 97.1

232.5

CLIENT DEPT. OF HIGHWAYS - ONTARIO

JOB. NO. 6010 LOCATION CORNWALL, ONT.

BOREHOLE NUMBER DEPTH

SAMPLE NUMBER DATE

ASSOCIATED GEOTECHNICAL SERVICES Limited

CALCULATION SHEET

RESISTING MOMENT DUE TO SHEAR STRENGTH - BLOCK C :

$$17.0 \times 0.350 = 5.95$$

$$6.0 \times 0.275 = 1.65$$

$$7.60$$

$$\text{MOMENT} = 29.6 \times 7.60 = 225 \text{ KIP FT.}$$

RESISTING MOMENT DUE TO SHEAR STRENGTH - BLOCK A :

$$(1.65 + 6.57) \times 38.3 = 315 \text{ KIP FT.}$$

SUBSTITUTING IN FORMULAE :

FROM ① -

$$w_1 d_1 - \frac{S_1 L_1 R_1}{F} = P_A a_1$$

$$1220 - \frac{(517 + 315)}{F} = 31.4 P_A$$

$$P_A = 38.9 - \frac{26.5}{F}$$

FROM ② -

$$P_P = P_A - \frac{S_2 L_2}{F}$$

$$= 38.9 - \frac{26.5}{F} - \frac{45 \times 0.400}{F}$$

$$= 38.9 - \frac{44.5}{F}$$

| | |
|---|---|
| CLIENT DEPT. OF HIGHWAYS – ONTARIO | **ASSOCIATED GEOTECHNICAL SERVICES Limited** |
| JOB. NO. 6010 LOCATION CORNWALL, ONT. | **CALCULATION SHEET** |
| BOREHOLE NUMBER ____ DEPTH ____ | |
| SAMPLE NUMBER ____ DATE ____ | |

FROM ③ – $P_p a_3 = W_3 d_3' + \frac{S_2 L_3 R_3}{F}$

$$23.6\left(38.4 - \frac{44.5}{F}\right) = 252.5 + \frac{225}{F}$$

$$F = \frac{1275}{687} = \underline{\underline{1.86}}$$

FOUNDATION FILES

# ASSOCIATED GEOTECHNICAL SERVICES LIMITED

CONSULTING ENGINEERS

YOUR REF.
OUR REF.

211 DAVENPORT ROAD
TORONTO 5, ONTARIO
WA. 3-3371

July 22, 1960.

Mr. A. Rutka,
A/Materials and Research Engineer,
Department of Highways of Ontario.
Parliament Bldgs., Queen's Park,
Toronto 2, Ontario.

Attn: Mr. A. Stermac

Dear Sirs:

Re: Proposed Structure: Hwy. 401 and Rd. to St. Andrews, Lot 21 and 22, Con. 5, Twp. of Cornwall W. P. 78-59 District No. 9

Further to our discussion with Mr. Stermac, we have carried out additional slip surface analyses on the eastern approach fill embankment section for the above structure.

Our calculations indicate that a revised balanced berm cross section as shown on the attached drawing will have a minimum factor of safety of 1.36 for a simple circular slip surface and a minimum factor of safety of 1.29 for a compound sliding surface consisting of two circular slip planes connected by a plane parallel to the ground surface. By reducing the height of the berm by one foot, the minimum factor of safety for a simple circular slip surface becomes 1.23.

We will be happy to forward copies of the calculations for the above critical slip surfaces if you so desire.

Should any additional queries arise, we will be pleased to answer them.

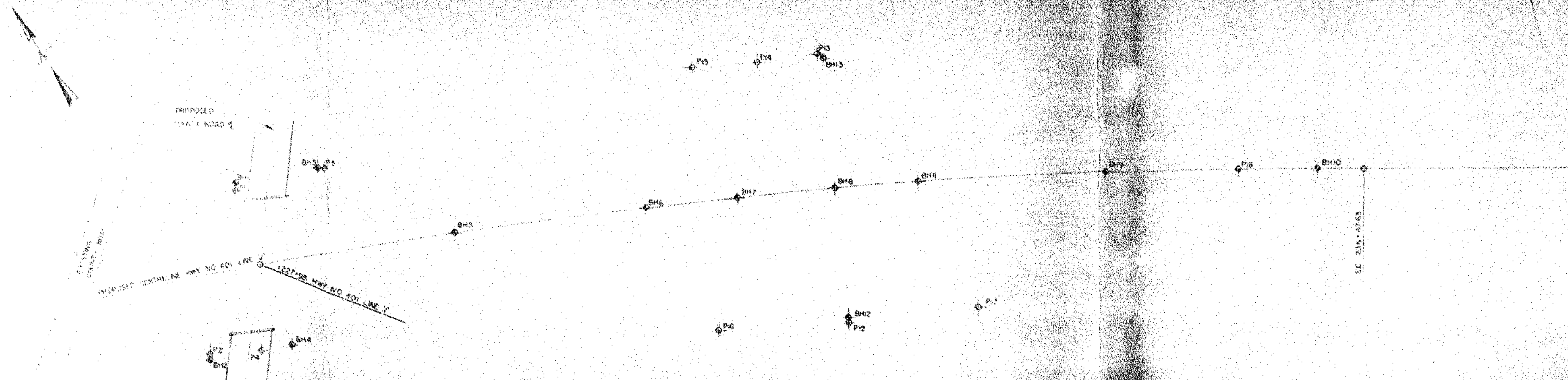
Yours very truly,

ASSOCIATED GEOTECHNICAL SERVICES LIMITED

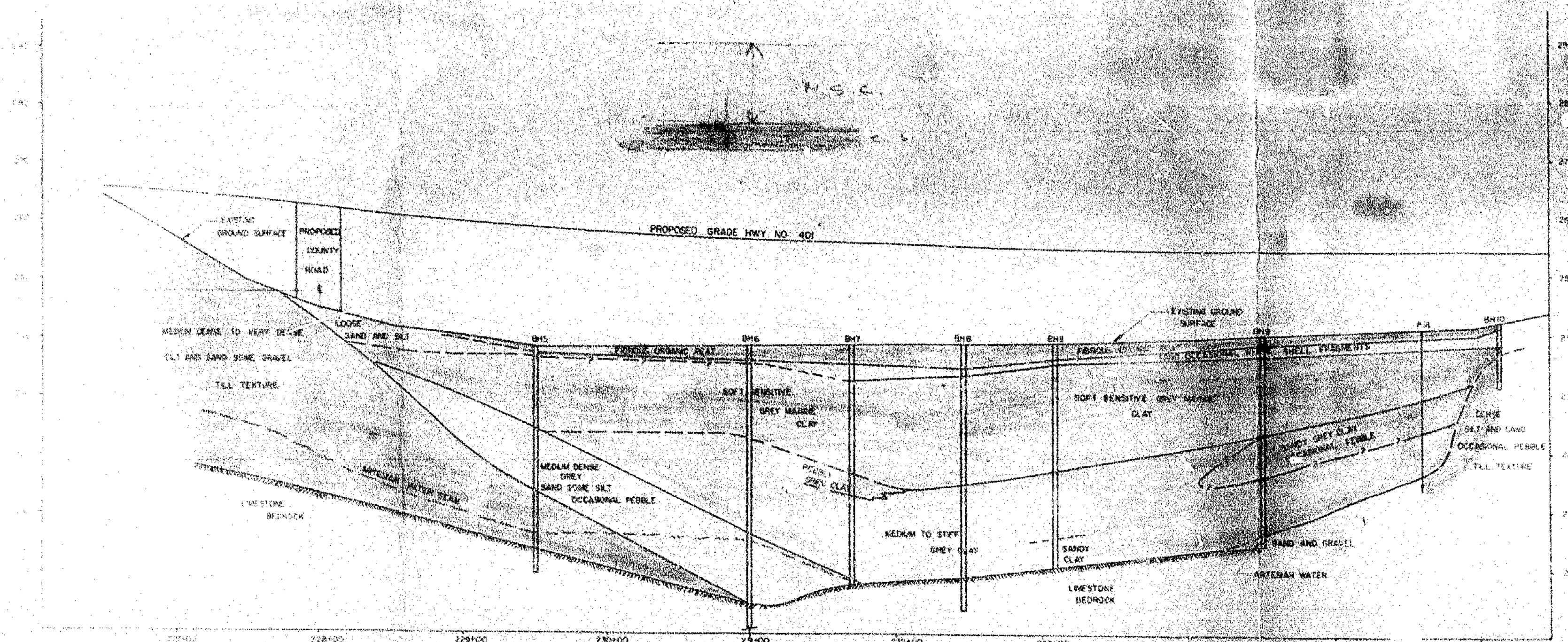
J. Kilgour

J. Kilgour, P. Eng.,
President.

JK:gc




PLAN SHOWING LOCATION OF BORHOLES AND PROBES
SCALE-1"=40'



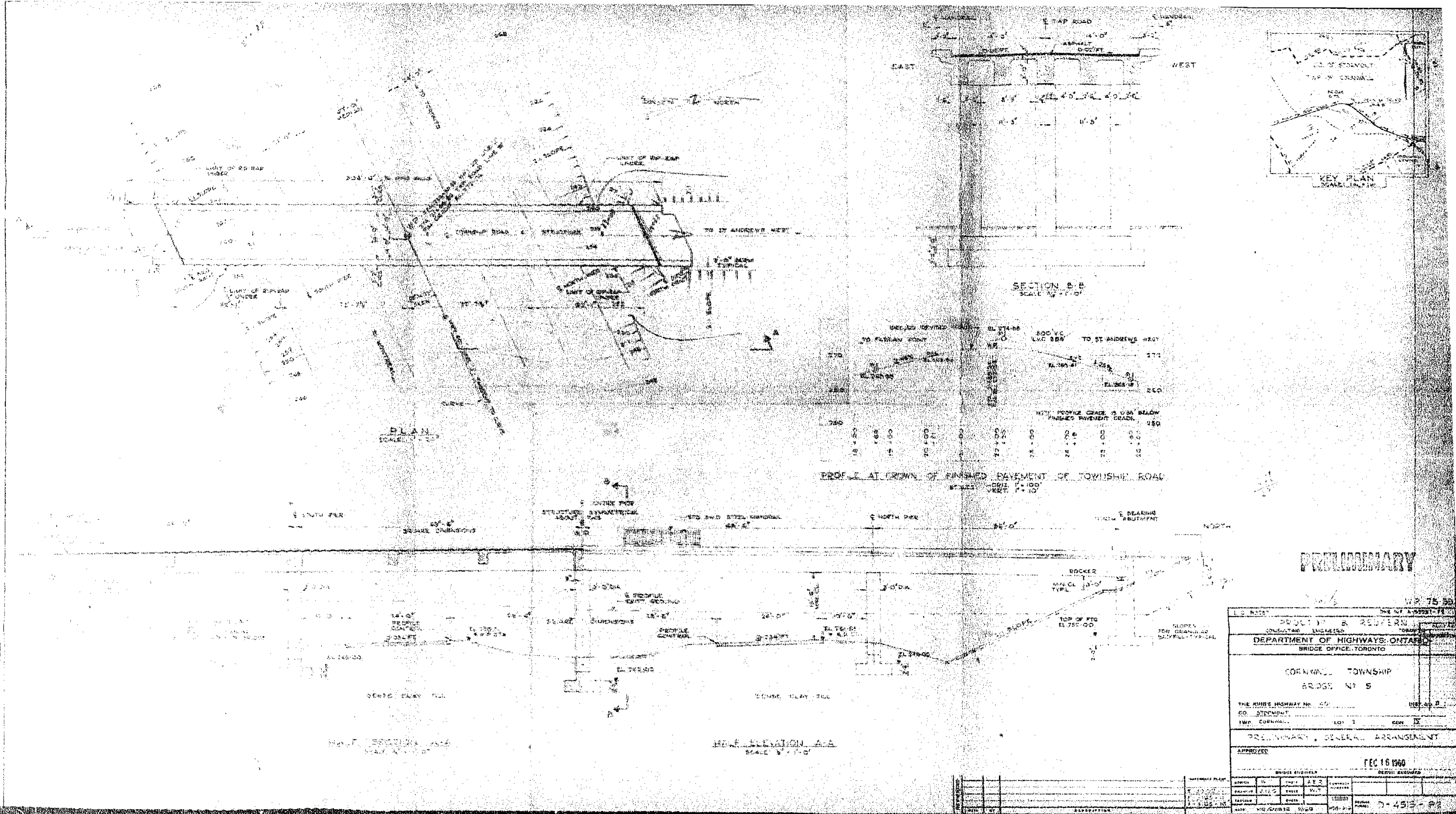

PROBABLE SOILS PROFILE ALONG CENTRE LINE PROPOSED HWY NO 401
HOR SCALE-1"=40' VERT SCALE-1"=10'

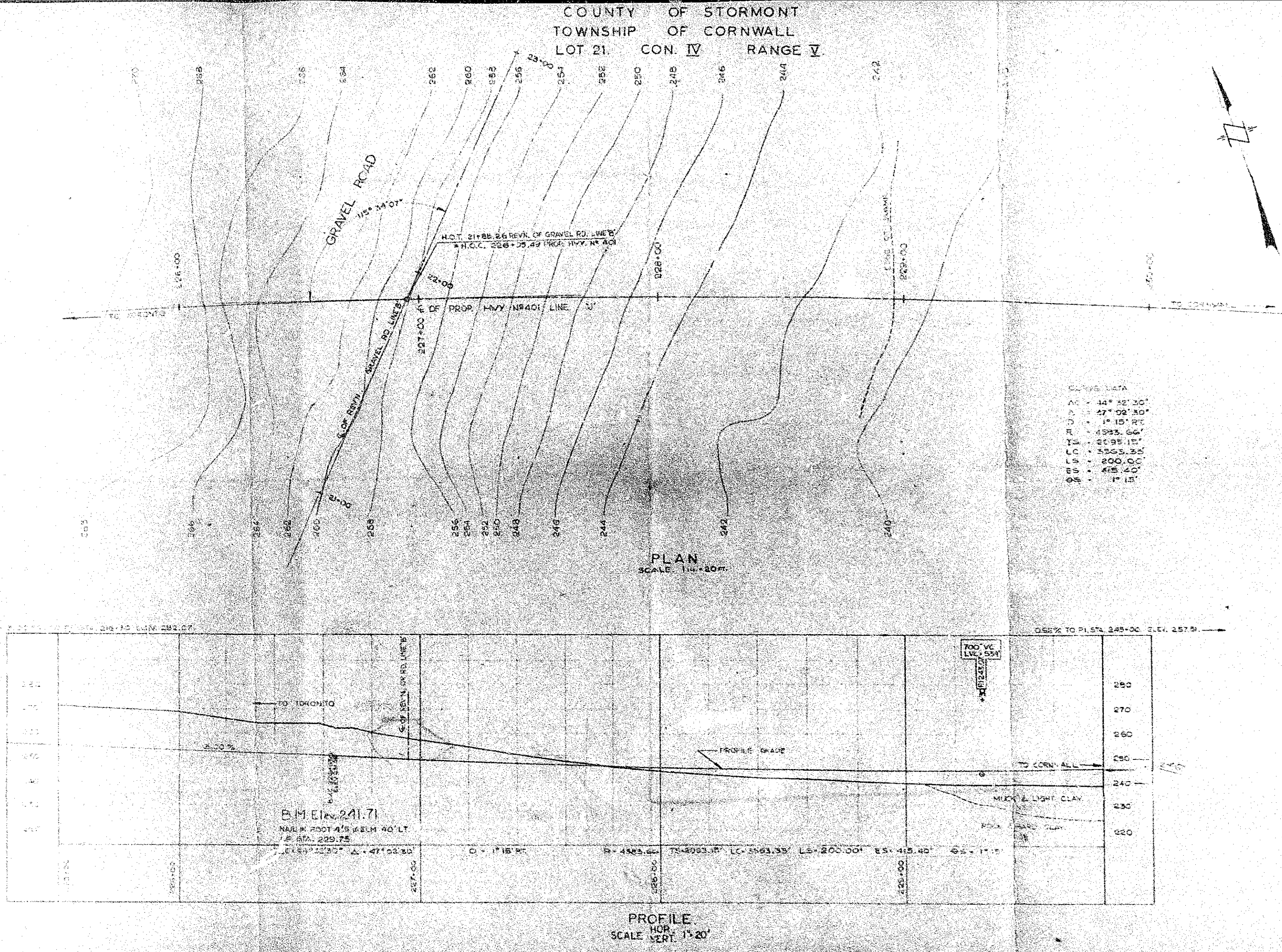
## LEGEND

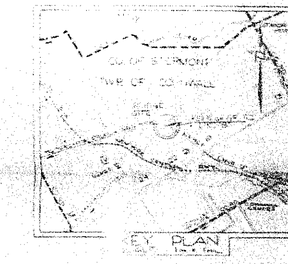
- BOREHOLE
- DYNAMIC CONE PROBE

ASSOCIATED GEOTECHNICAL SERVICES LIMITED
DEPARTMENT OF HIGHWAYS - ONTARIO

PLAN AND SOIL PROFILE
PROPOSED STRUCTURE AND
APPROACH FILL
HWY 401 AND RD TO ST ANDREWS


EAST
WEST
SECTION B-B
KEY PLAN
PLAN
TO ST ANDREWS WEST
PROFILE AT CROWN OF FINISHED PAVEMENT OF TOWNSHIP ROAD
NORTH
ROCKER
HALF SECTION A-A
HALF ELEVATION A-A
PRELIMINARY
DEPARTMENT OF HIGHWAYS: ONTARIO
BRIDGE OFFICE: TORONTO
CORNWALL TOWNSHIP
BRIDGE No 5
PRELIMINARY GENERAL ARRANGEMENT
APPROVED
DEC 16 1960
BRIDGE ENGINEER




WP 78 - 59

| EC. 59257 | DWG. No A-59257-21 |
|---|---|

PROCTOR & REDFERN
CONSULTING ENGINEERS TORONTO.

DEPARTMENT OF HIGHWAYS ONTARIO

DISTRICT No. 9

PROPOSED CROSSING
AT
PROP. KINGS HWY. No 401 LINE [illegible]
AND
REVISION OF GRAVEL RD. LINE 'B'

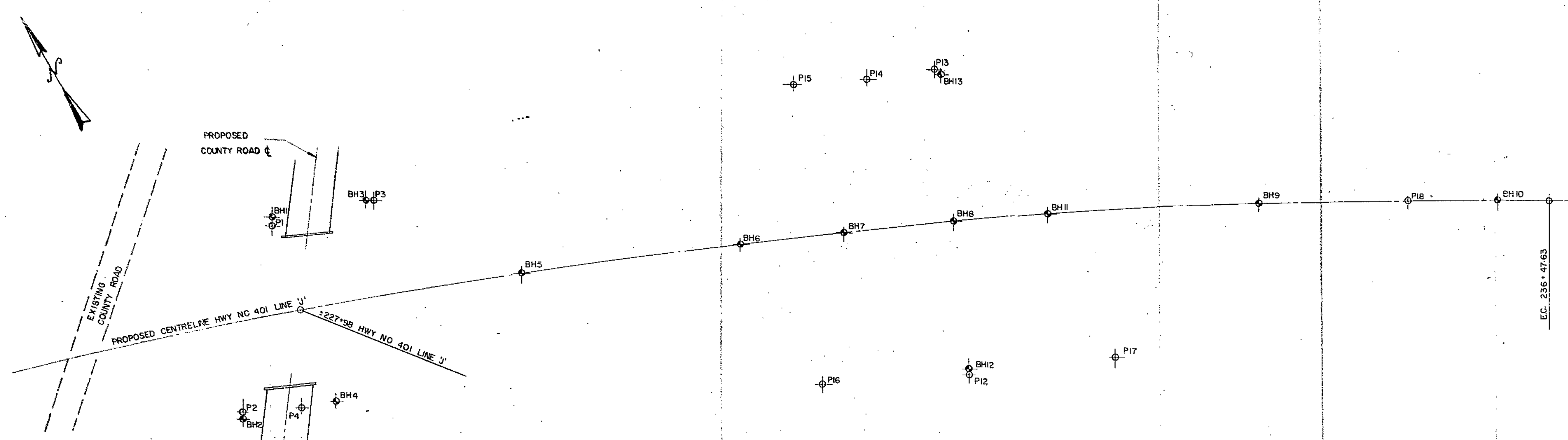
LOT. 21 CON IV RANGE V

TOWNSHIP OF CORNWALL COUNTY OF STORMONT.

BRIDGE SITE

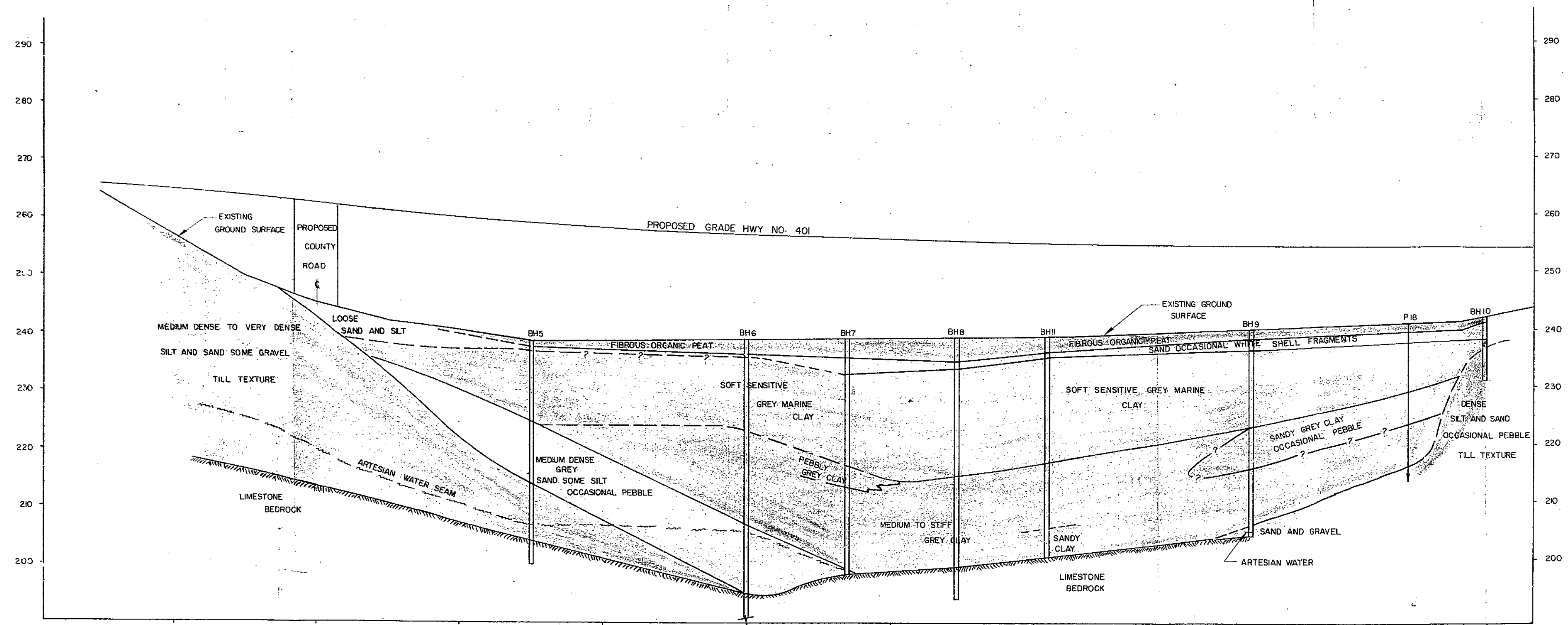
| | |
|---|---|
| [illegible] | Director of Planning & Design |
| DRAWN BY [illegible] | SCALE AS SHOWN |
| | DATE OF SURVEY [illegible] / DATE OF PLAN [illegible] |
| CHECKED BY DRAFTSMAN [illegible] | FILE No |
| | PLAN No E 3902-[illegible] |

#60-F-294-C
W.P. 78-59
PROP. STR. HWY. #
401 & RD. TO
ST. ANDREWS




PLAN SHOWING LOCATION OF BORHOLES AND PROBES

SCALE-1"= 40'




PROBABLE SOILS PROFILE ALONG CENTRELINE PROPOSED HWY NO 401

HOR. SCALE-1"= 40'    VERT SCALE-1"= 10'

LEGEND

- BOREHOLE
- DYNAMIC CONE PROBE

| | |
|---|---|
| ASSOCIATED GEOTECHNICAL SERVICES LIMITED | |
| DEPARTMENT OF HIGHWAYS-ONTARIO | |
| PLAN AND SOIL PROFILE<br>PROPOSED STRUCTURE AND<br>APPROACH FILL<br>HWY 401 AND RD. TO ST. ANDREWS | |
| DWG I-1 SCALE AS SHOWN | DATE JUNE 1960 |