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ENGINEERING MATERIALS OFFICE
SOIL MECHANICS SECTION

WP 134-74-01 DIST 8

HWY 14 STR SITE 28-28

Bay of Quinte Crossing at Belleville

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FOUNDATION INVESTIGATION REPORT

For

Bay of Quinte Crossing at Belleville
Hwy. 14, District 8, Kingston
W.P. 134-74-01, Site 28-28

INTRODUCTION

This report contains the results of a foundation investigation carried out at the site of the above project. The fieldwork was carried out in three stages during the period of May 24, 1977 to June 17, 1977 and February 21, 1979 to March 14, 1979 and finally during the period of May 7, 1979 to May 18, 1979. In all a total of 56 boreholes, 33 accompanied by dynamic cone penetration tests were put down to depths of up to 22.7 metres below the bay water surface. For the 1977 fieldwork on the bay itself a diamond drill mounted on a drum floated raft and equipped with NX casing was used to advance the borings. The fieldwork on the bay during early 1979 was accomplished by auger machines working on the ice utilizing hollow stem continuous flight augers to advance the borings. An auger machine mounted on a barge equipped with hollow stem augers and also BX and AX casings was employed to carry out the borings for the May, 1979 fieldwork. During each stage of the investigation it was necessary to carry out borings on the land. These were put down utilizing auger machines equipped with hollow stem augers.

Bedrock was proven in a total of 22 borings by obtaining up to three metres of BXL size rock core.

SITE DESCRIPTION

The site is located on Hwy. 14 over the Bay of Quinte extending from immediately south of the City of Belleville, County of Hastings, to the Hamlet of Rossmore, Prince Edward County.

The north approach will extend over generally flat terrain immediately east of existing Hwy. 14 within Zwick Park. On the Prince Edward County side the south approach is just east of

existing Hwy. 14. Here generally flat terrain, developed for residential purposes, prevails.

The existing Hwy. 14 crossing extends from Zwick Park in the City of Belleville, some 950 metres southerly to Rossmore. It is accomplished by means of an earth causeway and two through truss type structures. The main structure adjacent to the Rossmore side is composed of one swing span and three fixed spans (39 m fixed, 61 m swing, 51 m fixed and 39 m fixed); and about 310 metres north of the swing span is a two fixed span structure (30 m, 33 m).

At the location of the proposed crossing, the Bay of Quinte is some 950 metres wide. The depth of the main channel at the swing bridge location, is up to 12 metres deep. Elsewhere along the proposed crossing the bay is some 3 to 5 metres deep.

Maps of the area prior to 1890 show the area now occupied by Zwick Park to be largely open water except for an island. This piece of land, about four acres in area, was named Zwick Island and is now currently occupied by Hwy. 14 and the buildings to the east of it that are immediately north of the causeway. This island was joined to the mainland by means of a causeway as part of the original 1890 Bay of Quinte Bridge. It is believed that this causeway resulted in the development of the swamp areas as shown in maps as early as the 1920's. In the 1960's these swamp areas located on both sides of Hwy. 14 were used for sanitary land fill. These areas have now been sodded and extensively developed into a park for day users known as Zwick Park. (Refer to Figure 1)

The original structure completed in 1891, was composed of about 17 spans between Zwick Island and Rossmore. The present causeway was constructed in the 1920's by placing dredged material between the piers. The original superstructure was removed after the causeway was brought up to final grade. The original piers were left in place. These piers were constructed of stone, timber, and concrete cribwork and are believed to be supported on timber piles. The causeway was completed by placing 1-3 tonne armour stone on the side slopes for protection against wave action.

GEOLOGY

The site borders the physiographic regions of the "Napanee Plains" and the "Prince Edward Peninsula". These regions are characterized by a thin veneer of glacial drift underlain by generally flat to undulating limestone of the Trenton-Black River Formation. At this site, limestone and shale bedrock outcrops appear on the Prince Edward County shore in the vicinity of existing Hwy. 14.

SUBSOIL DESCRIPTION

General

Subsoil conditions across the site are quite variable as a result of dredging and landfill operations carried out in this area in the past. General subsoil conditions are described briefly as follows.

Prince Edward County Side: Subsurface conditions here consist of shallow deposits 0.5 to 3.3 metres thick of loose to compact sandy gravel, some silt, trace of clay, overlying sound limestone bedrock.

Belleville Side: Two distinct subsurface stratifications were observed here. In the area of the original Zwick Island (See Figure 1) subsurface conditions consist of 4.0 to 6.8 metres of generally dense sandy gravel, trace to some silt, overlying 2.5 to 4.1 metres of generally firm to stiff clay overlying 0.5 to 2.6 metres of hard glacial till which in turn overlies limestone bedrock. Outside this original island on the Belleville side subsoil conditions have been substantially modified by land fill operations. Here subsurface conditions consist of up to 6.1 metres of layers of soft organic clay and/or fill material composed of random layers of sanitary land fill and sand and gravel. This fill material overlies 2.1 to 3.1 metres of firm to stiff clay overlying 0.5 to 1.3 metres of hard glacial till which in turn overlies limestone bedrock.

Bay of Quinte: Subsurface conditions here have been substantially altered by dredging and landfill operations. Parent subsoil conditions are found east of Hwy. 14 roughly between the Belleville shoreline and the existing two span fixed structure. Here up to 5.5 metres of water overlie 3.3 to 5.8 metres of compact to very dense sandy gravel. This granular stratum in turn overlies up to 2.0 to 4.3 metres of generally stiff clay overlying up to 6.1 metres of hard or very dense glacial till overlying limestone bedrock. Between the swing span structure and the two span fixed structure, subsurface conditions have been modified by dredging and landfill operations. Adjacent to the causeway up to 3.7 metres of water overlies up to 12.2 metres of a loose to compact fill composed of sandy gravel to gravelly sand which in turn overlies up to 3.1 metres of very dense glacial till which lies directly over limestone bedrock. In some locations up to 2.9 metres of firm organic clay and/or clayey silt to silt of slight plasticity was encountered between the sandy gravel to gravelly sand stratum and the underlying glacial till deposits. Proceeding east, away from the causeway, subsoil conditions were found to be up to 4.3 metres of water overlying up to 14.3 metres of very soft to soft organic clay which in turn overlies up to 2.8 metres of clayey silt or sandy gravel overlying bedrock. In the area of the swing span up to 9.5 metres of water was encountered overlying up to 7.8 metres of very soft to soft organic clay which in turn overlies either bedrock or up to 4.4 metres of cobbles and boulders which overly bedrock.

Because of the large variation in subsurface conditions encountered, reference should be made to the Record of Borehole Sheets for subsoil types and boundaries between the various deposits for the specific location. The locations and elevations of the borings are shown on Drawing No. 1347401-A, together with a simplified stratigraphical profile based on the borehole data. On Drawing No. 1347401-B and C are shown a total of 16 selected stratigraphical sections based on borehole information.

In the paragraphs to follow the major soil and bedrock types are described briefly.

Fill Material Within Zwick Park

This deposit was encountered in all borings put down within the area of Zwick Park immediately below a thin layer of topsoil and extending to a depth of up to 5.8 metres below ground surface. As mentioned earlier, this area was originally swamp and has been used for a sanitary land fill site and more recently has been landscaped for park purposes (See Figure 1). The composition of the fill material varies widely from thin pockets and layers of up to one metre thick of soft organic clay to up to 1.2 metres of clayey silt and up to 3 metres of garbage to up to 1.5 metres of sandy gravel.

The 'N' values for this fill material vary from one blow per 0.3 metres to up to 32 blows per 0.3 metres. Accordingly it is inferred that this fill material has undergone a random compactive effort.

Fill Material Within Causeway Between Existing Structures (Sandy Gravel to Gravelly Sand)

In all borings put down between the two existing structures within the causeway or immediately adjacent to it, fill material was encountered. The upper boundary of the fill material is at the causeway grade or immediately below the bay bottom and was found to extend to a total thickness of 7.7 to 13.1 metres. The composition of the fill material is sandy gravel to gravelly sand with a trace to some silt and a trace of clay. A grain size distribution envelope is shown on Figure 2 of the Appendix. In some locations layers of fine to medium sand was encountered and also layers of cobbles or occasional cobbles were noted in some borings.

Based on Standard Penetration Test 'N' values ranging generally from 4 to 39 blows per 0.3 metres the deposit is estimated to have undergone a moderate to high compactive effort.

Organic Clay

This material comprises the bay bottom, being generally a thin layer up to 2.7 metres thick overlying the parent subsoil. However, in some locations where the bay has been dredged (i.e. in the area of the swing span and east of the causeway

between the Rossmore shoreline and the existing two span fixed structure) the deposit was found to be up to 14.3 metres thick and extending almost to the bedrock surface. This cohesive stratum was also encountered beneath the causeway fill material and is up to 2.4 metres thick here. As described earlier the material also occurs as pockets or distinct layers within or immediately below the fill material in Zwick Park.

This cohesive deposit is generally black in colour and composed of organic clay with some sand. Laboratory and in-situ testing carried out on samples from this deposit gave the following results.

		Range	Average
Natural Moisture Content	(W %)	99-334	198
Liquid Limit	(W_L %)	148-358	287
Plastic Limit	(W_p %)	55- 95	79
Plasticity Index	(I_p %)	93-267	276
Bulk Unit Weight	(kN/m^3)	9.6-13.8	11.7
Organic Content	(Om %)	16-27	17

Undrained Shear Strength	General Range	Sensitivity
Field Vane Tests (γkPa)	10-40	2-8

The Atterberg Limits plot either slightly above or below the 'A' and well past the liquid limit of 50%. Accordingly the deposit may be described as organic of high plasticity, OH zone.

The natural moisture content generally decreases with depth while the undrained shear strength generally increases with depth. The field vane tests gave undrained shear strengths increasing with depth from 2 to 61 kPa but generally ranging from 10 to 40 kPa. Since the upper surface of this deposit is literally in suspension the lower boundary of the shear strength is difficult to estimate with in-situ devices. Based on these values, the consistency is described as very soft to firm. Exceptions to this estimate of consistency occur in areas where the organic clay is encountered beneath causeway fill material and has been subject to consolidation. Here Standard Penetration Test 'N' values of 2 to 19 blows per 0.3 metres indicate that the deposit in these areas has a firm to stiff consistency.

Sandy Gravel

This deposit is a parent surficial deposit and was found on the Rossmore side immediately below a thin veneer of topsoil and extending down, up to 3.3 metres to the bedrock surface. This stratum was also encountered within the original Zwick Island extending from the ground surface to a depth of 4.0 to 6.8 metres below ground surface. This deposit was also encountered east of the existing causeway between the Zwick Park shoreline and the two fixed span structure. Here the deposit was encountered immediately below a thin veneer of organic clay or at the bay bottom and extends for a total thickness of 1.9 to 4.9 metres. The composition of the deposit varies slightly from a sandy gravel, trace silt to a sandy gravel some silt with a trace of clay. A grain size distribution envelope for this deposit is shown on Figure 3. In some locations occasional boulders and cobbles were encountered within this granular stratum and in other locations the lower 2.3 to 3.5 metres of the deposit is composed of medium to coarse sand.

The Standard Penetration Test 'N' values were found to range from 5 to 103 blows per 0.3 metres. Based on these the relative density is estimated to range from loose to very dense; however, generally the deposit is dense.

Clay

This parent subsurface stratum was encountered in all borings put down north of the existing two fixed span bridge. It occurs immediately below the parent sandy gravel stratum where it is present and elsewhere occurs beneath a layer of organic clay. The thickness of the deposit ranges between 2.0 and 4.1 metres thick. The deposit is composed of grey clay which is somewhat fissured and laminated. In some locations the deposit contains random layers of clayey silt.

The results of laboratory and field testing on representative samples taken from this stratum are summarized below.

Natural Moisture Content, Atterberg Limits and Bulk Unit Weight

		Clay		Clayey Silt Layers	
		Range	Average	Range	Average
Natural Moisture Content	(W%)	42-72	56	30-44	36
Liquid Limit	(W_L%)	58-80	69	22-35	31
Plastic Limit	(W_p%)	19-24	23	14-24	18
Plasticity Index	(I_p%)	39-54	46	8-17	12
Bulk Unit Weight	(γ kN/m^3)	15.2-17.2	16.3		

Undrained Shear Strengths (Su. kPa .)

	Range	Sensitivity
Field Vane Tests	20-115	3-8
Laboratory Vane Tests	36-135	2-4
Laboratory Unconfined Tests	39-92	
Laboratory Quick Triaxial Tests	83-90	

Consolidation Tests (7 tests)

Initial Void Ratio	e_o	0.9-2.0
Coefficient of Consolidation	c_c	0.2-2.2
Degree of Preconsolidation	$P'_c - P'_o$ (kPa.)	153-315

The results of the Atterberg Limit testing are plotted on the Plasticity Chart, Figure 4. The Atterberg Limit testing indicates that the clay deposit is generally inorganic and of high plasticity, whereas the layers of clayey silt are inorganic and of low plasticity. The Natural Moisture Content of the clay is between the Plastic Limit and the Liquid Limit.

Seven consolidation tests were performed on samples from this deposit and are summarized on Figure 5 and 6. The consolidation testing indicates that the deposit has been preconsolidated by a pressure of 153 to 413 kPa in excess of the existing overburden pressure. The high initial void ratio 0.9 to 2.1, together with the high coefficient of consolidation 0.2 to 2.2 indicates that upon loading in excess of the preconsolidation pressure, the deposit will undergo significant consolidation.

The undrained shear strength as measured by laboratory and in-situ testing ranges from greater than 96 kPa to as low as 20 kPa decreasing with depth. The sensitivity as measured by vane testing (both laboratory and field testing) indicates that in general the deposit is slightly to moderately sensitive to re-moulding. Furthermore, the undrained shear strengths indicate that the consistency of the deposit varies from very stiff in the upper portion changing to firm, generally decreasing with depth.

Glacial Till

A deposit of glacial till up to 5.9 metres thick was encountered in all borings except those in the area of the south shore and also in areas where the parent subsoil has been completely dredged or scoured out. The deposit generally is found immediately below the clay deposit and extends to the bedrock surface. The composition of the glacial till varies slightly across the site being either a slightly cohesive heterogeneous mixture of clayey silt, sand and gravel or a granular deposit composed of a heterogeneous mixture of silt, sand and gravel, trace of clay. In some locations the glacial drift was found to contain occasional cobbles and boulders in the lower portion of the deposit.

Finally, the results of laboratory testing on representative samples from this deposit are shown on the Plasticity Chart, Figure 7, and on the Grain Size Distribution Envelope, Figure 8. The Atterberg Limits indicate that the cohesive glacial drift has an inorganic matrix of low plasticity (M.L. to C.L.-M.L. zone).

The range of 'N' values from the Standard Penetration Testings in this deposit is 15 blows to over 100 blows per 0.3 metres. Based on these the cohesive glacial till has a firm to hard consistency. Similarly, the relative density of the granular till is estimated to have a compact to very dense relative density that in general increases with depth.

Bedrock

Limestone bedrock was encountered immediately below the overburden. The bedrock was proven in a total of 22 borings by obtaining up to three metres of BX or AX size rock core; elsewhere, the bedrock was taken to be at the point at which the casing or augers met refusal.

The bedrock may be described as limestone, medium to dark grey colour, medium to fine texture and medium to thick bedded with few shaley sections and shale partings throughout.

The bedrock surface is plotted on a longitudinal profile section on Drawing 1347401-A. The surface of the bedrock on the south shore is as high as elevation 71.9 which corresponds to a depth of 3.2 metres below ground surface. Proceeding north from the Rossmore shoreline the bedrock dips down to elevation 64.8, some 10.4 metres below water surface, in the area of the existing swing span. From here the bedrock dips gradually down to the north to a low point at elevation 55.5 metres at the approximate location of Pier 3. From here the bedrock rises gradually north to a high point at elevation 66.6 metres some 9.3 metres below ground surface in the area of the north approach.

In some isolated locations the upper 0.7 to 1.7 metres of the bedrock are fractured with corresponding R.Q.D. values of 35 percent. Elsewhere the bedrock is sound and of fair to excellent quality based on R.Q.D. values ranging from 50 to 97 percent.

Water and Groundwater Conditions

Observations on the groundwater level were carried out during the fieldwork by measuring in the open boreholes. The measurements place the groundwater level at elevation 74.8 metres on the south shore which corresponds with the elevation of water in the bay (elev. 74.9, May, 1977) at the time of investigation. On the north shore the water level readings can be summarized as follows.

Time of Investigation	Groundwater Level Depth Below Ground	Elev.	Bay Water/ Ice Elevation
May, 1977	0.8	75.1	74.9
March, 1979	1.1 to 1.4	74.1-74.9	74.7
May, 1979	0.6 to 1.2	74.7-76.3	75.2

These observations indicate that the groundwater level is approximately at the bay water level.

Bay water level readings were taken during the course of each stage of the investigation. The water elevation is shown in the above table and indicates only a slight fluctuation during the periods of investigation.

During the March, 1979 investigation observations were also carried out on the thickness of ice. These observations were made after a two week period of extremely cold weather and hence represents a maximum ice thickness that could be expected over any given average year. It was noted that during periods of extremely cold weather the entire bay in the area of concern freezes over. However, generally speaking, the portions of the bay downstream (east side of Hwy. 14) of the existing openings (i.e. at the swing span structure location at the two span fixed structure location) are not frozen over. In areas where the downstream portion of the bay is protected by the existing causeway ice was observed to be 0.4 to 0.7 metres thick.

DISCUSSION AND RECOMMENDATIONS

General

It has been proposed to replace the crossing of Hwy. 14 over the Bay of Quinte between the City of Belleville and the Hamlet of Rossmore. The existing crossing spans some 950 metres of water and is accomplished by means of an earth causeway and two through truss type structures. The new crossing will be two lanes with a maximum grade of 5% and of 11 spans, total length 897 metres, with a maximum vertical navigational clearance of 22.86 metres above the mean water level, elevation 74.16 metres, I.G.L.D. Approach fills will be in the order of 5.0 metres above mean water level for the south approach and 12.7 metres above mean water level for the north approach.

Subsoil conditions vary substantially across the site. Parent subsoil conditions consist of 4 to 6.8 metres of loose to compact sandy gravel , trace to some silt, overlying 2.5 to 4.1 metres of generally firm to stiff clay overlying 0.5 to 2.6 metres of hard glacial till which in turn overlies limestone bedrock. These conditions have been extensively modified across the site by dredging and landfill operations. In some areas of the Bay the entire parent subsoil has been removed by dredging leaving only a thin veneer of glacial till over bedrock. In areas of the earth causeway the dredged portions have been backfilled by up to 12.2 metres of loose to compact sandy gravel to gravelly sand. In some areas where dredging or scouring has at one time been in effect recent bay deposits have placed up to 14.3 metres of very soft to firm organic clay.

A Feasibility Foundation Investigation for this project was carried out by this office and issued on November 2, 1977 under W.P. 137-74-01. Based on the results of this report and other considerations,profile grades and the abutment and pier locations were established. Further fieldwork was required to enable detailed foundation design to proceed . The results of the fieldwork have already been discussed elsewhere in this report and the following paragraphs deal with detailed

recommendations for the design and construction of the proposed multi-span high level bridge, together with related approaches.

Approaches

South Approach (Reference Section A-A, Drawing 1347401-B): The south approach fill will extend partially into the Bay area. The profile grade at the south abutment will be at elevation 79.2±, whereas the bay bottom at the toe of the approach fill is at elevation 70±.

Generally, flat terrain is prevalent at the south approach on land but the bay floor drops off at an average rate of 1 metre in 7 metres. Subsoil conditions on land consist of 0.5 to 3.2 metres of sandy gravel, some silt overlying limestone bedrock. Beneath the bay bottom subsoil consists of a thin veneer of organic clay or 0.6 to 2.4 metres of very loose sandy silt with organics which in turn overlies limestone bedrock.

Subsoil conditions are such that the proposed fill height will be stable with respect to deep seated rotational failure provided the following measures are adopted (refer to sketch on page 15). As stated previously the south approach fill will extend into the Bay of Quinte. In order to place and compact fill material below the water level rockfill should be utilized with 1½ to 1 forward and side slopes. It will be necessary to key the rockfill through the overburden to bedrock. In view of the requirement for "keying" the rockfill to bedrock silt curtains are recommended to prevent environmental disturbance during construction activities. The rockfill will also provide the necessary protection against scour and wave action and should extend to elevation 76.25 metres. Earthfill could be utilized above this level with side slopes of 2 to 1. It may be advantageous from the construction viewpoint to provide a three metre wide berm between the crest of the rockfill slope and the toe of the above earthfill slope and a seven metre wide berm between the crest of the rockfill and the abutment itself. In addition, it is important to note that piles will be driven through this fill to support the abutment loads. In view of this it

will be necessary to provide a granular core within the rockfill portion of the approach embankment in areas where piles are to be driven. In order to achieve underwater compaction and to prevent segregation of material, the granular core should be comprised of a select granular material. The Regional Geotechnical Office has suggested a Granular 'C' modified for backfill underwater utilizing crushed quarried material conforming to the following requirements.

Imperial Sieve Designation	Percent Passing
3"	100
1"	50 - 100
½"	35 - 100
No. 4	20 - 90
No. 16	10 - 55
No. 50	5 - 30
No. 200	0 - 12

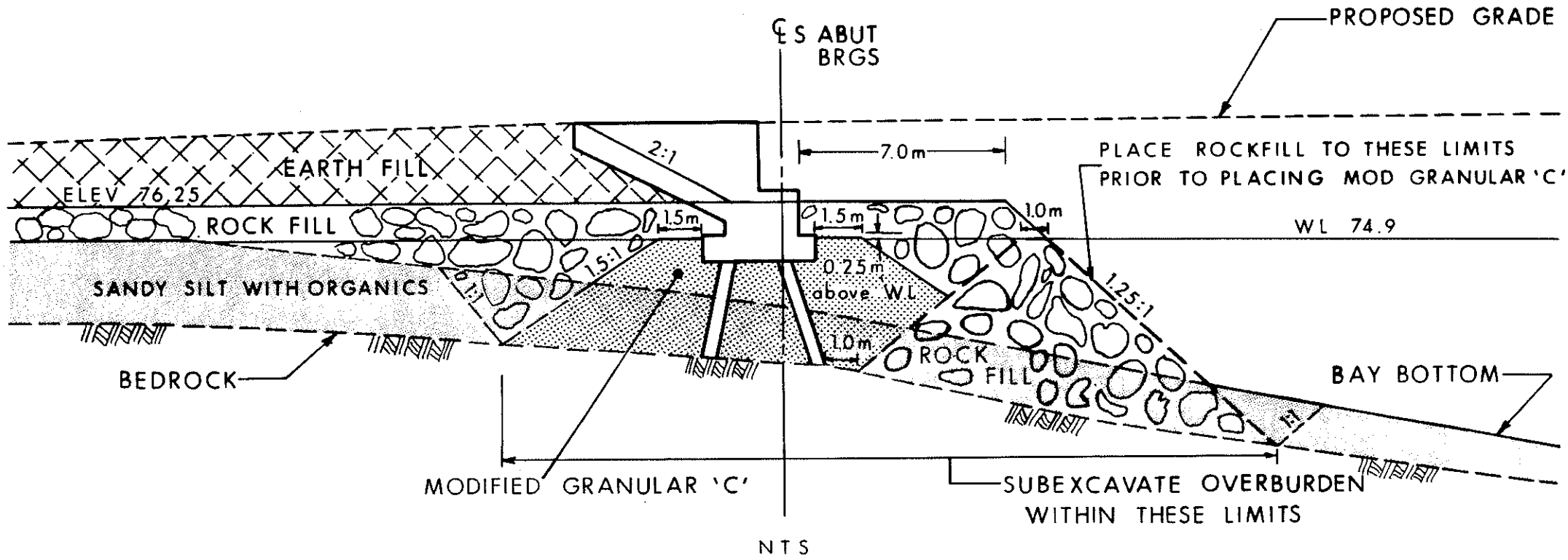
All other requirements of MTC Form 314 shall apply.

For this core material no granular or synthetic filter is required between the core material and the rockfill.

A suggested construction sequence is as follows:

1. Erect silt curtains
2. Subexcavate to bedrock for rockfill keys
3. Place rockfill in a cofferdam fashion leaving the required dimensions for the granular core
4. Place granular core
5. Drive south abutment piles
6. Construct abutment
7. Complete placement of rockfill
8. Place earthfill
9. Remove silt curtains

NOTE :
IF FINE GRAINED GRANULAR MATERIAL IS USED TO CONSTRUCT THE EARTHFILL EMBANKMENT, A TRANSITION ZONE WILL BE REQUIRED BETWEEN THE EARTHFILL AND THE ROCKFILL TO PREVENT LOSS OF MATERIAL INTO THE ROCKFILL.



DETAIL OF RECOMMENDATIONS FOR SOUTH APPROACH

WP 134-74-01

North Approach: The centerline of the new highway will be located some 18 to 31 metres east of the existing Hwy. 14. At the hotel entrance Sta. 21+357, the profile grade will be at elevation 78.0, some 2.0 metres above existing ground surface. From here the profile grade rises to approximate elevation 86.9 metres at the abutment, Sta. 21+160, with the approach fill spilling into the bay. At the toe of the slope the bay bottom is at elevation 73.± which results in a total fill height in the order of 13.9 metres above the bay bottom.

The existing terrain in this area is flat on land and drops off gradually out into the bay. Surficial soil conditions and fill heights (as discussed above) vary considerably from the hotel entrance to the abutment and accordingly the design and construction requirements will similarly vary. In view of these variances, design and construction recommendations for the north approach fill will be discussed in two parts. The first part includes the vicinity of the abutment to Sta. 21+260. The second section discussed will cover the area from Sta. 21+260 to Sta. 21+357.

North Approach - Vicinity of the Abutment: (Reference Drawing 1347401-C, Sections R-R and N-N) - Subsoil conditions on land consist of 4.0 to 6.8 metres of loose to compact sandy gravel trace to some silt overlying 2.5 to 4.1 metres of firm to stiff clay overlying 0.5 to 2.6 metres of hard glacial till which in turn overlies limestone bedrock. In the bay area the surficial granular stratum found on land is absent; in its place is up to three metres of organic clay overlying inorganic clay.

Here the organic clay deposit is very soft to soft and very compressible. Embankments of the magnitude contemplated, founded directly on this deposit, will undergo excessive settlements and hence it is imperative that this deposit be entirely removed or displaced beneath the plan limits of the approach embankment. Based on the engineering properties of this organic clay (i.e. water content 99 to 334%, bulk unit weight 9.6 to 13.8 kN/m^3 and shear

strength 10 to 20 kPa with sensitivities as high as 8 the material would not be entirely displaced by end dumping techniques. In certain locations the undrained shear strength of this material is somewhat higher than that required for displacement techniques. It is, therefore, recommended that subexcavation procedures should be followed to remove the compressible organic material prior to placement of the rock embankments. The rockfill should extend to a minimum height of 0.5 metres above high water level at elevation 76.5 for purposes of wave and scour protection. It is important to note that excessive environmental disturbance is expected during construction while removing the organic clay. In order to contain this and hence minimize environmental disturbance, silt curtains should be employed.

The inorganic clay deposit is stiff in the upper portion gradually decreasing to a soft consistency at the interface with the lower glacial till deposit. The strength and compressibility of this clay deposit is the governing factor for the design of the approach embankment from a foundation point of view as it is imperative not to overstress this deposit. Hence, stability analysis in terms of total stress were employed in order to design the embankment ensuring that the clay deposit would not be overstressed.

The types and properties of the fill material assumed for design are as follows.

Fill Material	Cohesion C (kPa)	Angle of Internal Friction Ø	Bulk Unit Weight (kN/m^3)	Submerged Unit Weight (kN/m^3)
Earthfill Above Elev. 77.0	0	30	22.0	12.0
Rockfill Below Elev. 77.0	0	35	22.0	12.0

Following are the assumed subsurface properties used for total stress design and are representative of conditions beneath the land.

Elevation Metres	Soil Type	Cohesion C (kPa)	Angle of Internal Friction Ø	Bulk Unit Weight (kN/m^3)	Submerged Unit Weight (kN/m^3)
74.6-70.2	Sandy Gravel	0	30	22.0	12.0
70.2-68.2	Clay	80	0	15.7	5.9
68.2-67.2	Clay	60	0	15.7	5.9
67.2-66.2	Clay	20	0	15.7	5.9
66.2	Glacial Till	0	35	22.0	12.0

Similiarly the assumed subsurface properties used for total stress design beneath the bay are given below.

Elevation Metres	Soil Type	Cohesion C (kPa)	Angle of Internal Friction Ø	Bulk Unit Weight (kN/m^3)	Submerged Unit Weight (kN/m^3)
74.8-72.0	Water	Nil	Nil	9.8	0
72.0-70.2	Organic Clay	5	0	11.0	1.0
70.2-68.2	Clay	80	0	15.7	5.9
68.2-67.2	Clay	60	0	15.7	5.9
67.2-66.2	Clay	20	0	15.7	5.9
66.2	Glacial Till	0	35	22.0	12.0

Tension cracks were generally assumed to be equal to 1/3 the fill height. It is important to note that it was assumed for design purposes that the organic clay will be totally removed within the plan limits of the embankment and replaced with rock fill.

The berm dimension constraints were to some extent imposed on the design due to access road requirements. The original Feasibility Foundation Investigation Report under W.P. 134-74-01 recommended 2:1 side and forward slopes with a 15.5 metre wide mid-height counterbalancing berm for stability with respect to deep seated rotational failure. Based on negotiations between the Region and external concerns it was deemed advantageous to have an access road located on this berm linking both sides of Zwick Park. This necessitated a lowering of the grade of this berm to allow sufficient vertical clearance between the berm and

the bridge soffit; hence, a complete redesign of the approach embankment. The redesign, lowering the berm height, necessitated a two level berm for stability purposes. Further discussions between the Region and external groups resulted in two scenarios for the approach embankment dimensions. One option includes the provision for the access road on the upper berm with vertical clearance dictating a maximum upper berm elevation of 79.25. The second option includes the provision of the access road on the lower berm with no restraint on the upper berm elevation.

Stability analysis, as discussed, were carried out in the longitudinal and transverse direction incorporating the aforementioned details. The results of the critical longitudinal analysis are given on Figure 9 for the access road on the upper berm and on Fig. 10 for the access road on the lower berm. Also shown on the figures are the required berm dimensions for stability against a deep seated rotational failure. These dimensions and requirements are briefly presented below.

Option 1: Access Road Situated on Upper Berm (Refer Figure 9)

Forward and Side Slopes:

2:1 for earthfill

1.25:1 for rockfill

Berm Requirements

Upper Berm: 12 metre constant width and constant elevation at 79.75. Behind the centreline of abutment bearings Sta. 21+160.5 the berm should be provided with a 5% gradient.

Lower Berm: 7 metre constant width and constant elevation at 77.0. The berm should grade gradually to existing conditions past contour 75.0.

Fill Material

Rockfill: Organic clay subexcavated and rockfill to extend to elevation 77.0. The rockfill should grade gradually to existing conditions past contour 75.0. No rockfill should be employed in areas where piles are to be driven.

Earthfill: To be used above elevation 77.0

Option 2: Access Road on Lower Berm (Refer Figure 10)

Forward and Side Slopes:

2:1 for earthfill

1.25:1 for rockfill

Berm Requirements

Upper Berm: 8 metre constant width and constant elevation at 81.6. Behind the centreline of abutment bearings Sta. 21+160.5, the berm should be provided with a 5% gradient to meet existing conditions.

Lower Berm: 12 metre constant width and constant elevation at 77.0. The berm should grade gradually to required access road grade past contour 75.0.

Fill Material (As discussed under Option 1)

The fill material will undergo settlement due to the consolidation of the underlying clay deposit. Time-rate settlement and total settlement estimates were made based on laboratory consolidation tests and induced stresses as calculated by the Boussinesq stress distribution theory. Calculations were carried out across a transverse section located at the centreline of the abutment bearings Sta. 21+160; this section would give the highest total settlement and also the largest differential settlements across any chosen longitudinal or transverse section. The results of the calculations and the assumed stratigraphy and berm geometry are shown in graphical form on Figure 11. Although the berm configuration shown is that for the access road situated on the upper berm, the settlement estimates can be assumed applicable for the berm situated on the lower access road. As shown, settlements will vary substantially across the transverse profile from a maximum total settlement of 0.26 metres under the upper berm to almost nil at the toe of the slopes. Furthermore, as can be seen on the Time vs. % of Total Settlement Curve, consolidation will take place relatively rapidly, i.e. 90% of total settlement within eight months upon completion of construction. In order to avoid maintenance problems due to post construction settlements it is recommended that paving of the north approach be delayed for as long a period as possible upon completion

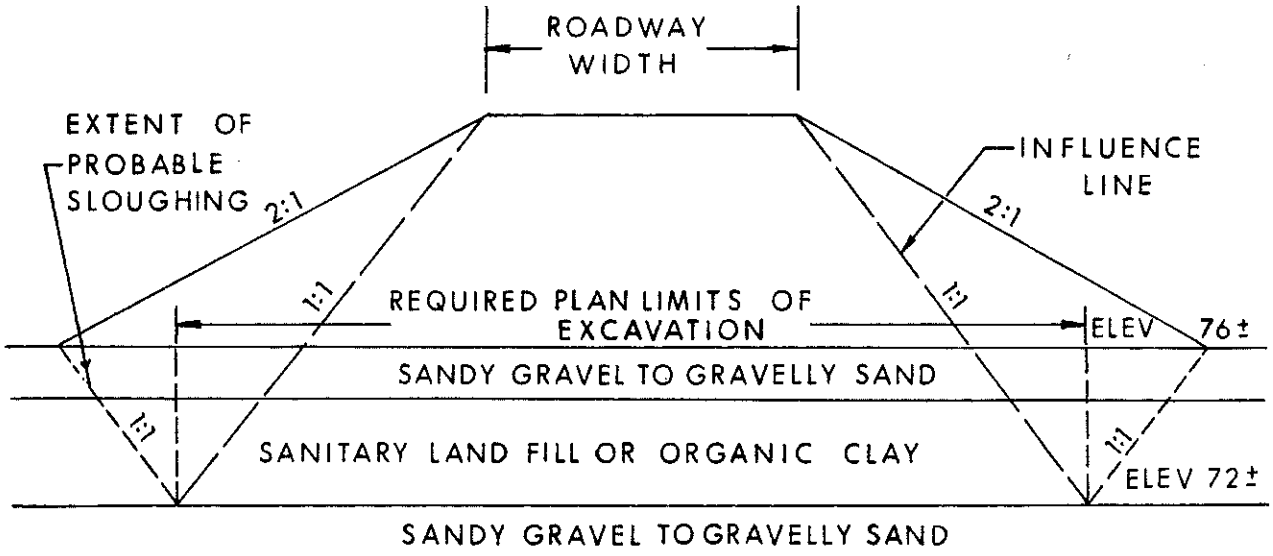
of placing fill. The minimum period between placing the fill material and paving the approaches should be at least six months. In this period approximately 80% of total settlements would occur (i.e. 80% of 0.26 m is 0.21 metres) leaving only 0.05 metres of settlement to occur after paving is completed.

North Approach - Sta. 21+260 to Sta. 21+357: (Reference Drawing 1347401-C, Section S-S) The profile grade in this area is at elevation 78.0± at Sta. 21+357 and rises gradually to elevation 82.0± at Sta. 21+260. Within this area the average ground surface is at about elevation 76.0 which indicates that fill heights of 2.0 to 6.0 metres are required.

Subsoil conditions here consist of up to 6.6 metres of fill material overlying 2.1 to 3.1 metres of stiff to very stiff clay which in turn overlies hard glacial till. The fill material is quite random in composition and also in relative density or consistency. The fill material may be subdivided into three distinct zones. The upper 1.6 to 2.3 metres of the fill material is competent (N values 4 to 26 blows per 0.3 metres) and composed of gravelly sand to sandy gravel with some silt and a trace of clay. The middle zone extends to a total depth of 2.4 to 4.3 metres below ground surface and consists of either a firm organic clay or a sanitary land fill comprised of metal, mortar, plastic, glass and organic debris. The lower zone of fill material composed of a competent (N values 16 to 81 blows per 0.3 metres) sandy gravel to gravelly sand some silt and a trace of clay. The groundwater level is 0.6 to 1.3 metres below ground surface.

This fill material is the governing factor for the design of the approach embankments in this area from a geotechnical point of view. Embankments of the magnitude contemplated and constructed directly on this fill material will undergo excessive total as well as differential settlements indefinitely resulting in poor pavement performance and high post construction maintenance costs. In order to minimize post construction maintenance costs the following design and construction procedures are recommended.

- For embankment fill heights up to three metres high, Sta. 21+357 to 21+307, the fill material shall be left in place and the roadway shall be surcharge loaded with one metre of additional fill for a period of up to six months.
- For fills in excess of three metres in height (Sta. 21+307 to 21+260), the sanitary fill material and organic silt shall be subexcavated entirely to approximate elevation 72.0±. The limits of subexcavation shall be as defined by a 1:1 influence line from the crest of the embankment slope down to the base of the subexcavation. Subexcavation will be carried out under water and in order to obtain acceptable underwater compaction a modified Granular 'C' as discussed previously for the South Approach embankment should be adopted. (See Sketch below)



TREATMENT OF FILLS IN EXCESS OF 3.0m HIGH

STA 21+307 to STA 21+360

NTS

Structure

General: The proposed structure will be comprised of 11 spans, total structure length 897 metres with a maximum vertical clearance of 22.86 metres above mean water level 74.16 metres. Two superstructure designs are being submitted, one steel and one concrete. A typical deck cross section includes 0.43 m Barrier Wall, 1.25 m Shoulder, 3.750 S.B.L., 3.750 N.B.L, 1.25 m Shoulder, 0.38 m Barrier Wall, 1.25 m Sidewalk and 0.20 m Pedestrian Railing for a total deck width of 12.25 metres.

The Feasibility Foundation Investigation for this project under W.P. 134-74-01 discussed various types of structure foundations that could be adopted for this structure. In view of the widely varying soil conditions and the high design loading requirements, it was decided to adopt a steel 'H' pile foundation for the abutments and for piers a scheme utilizing 3-HP 310 steel piles inside a 1.2 m ø steel tube pile. Specific recommendations for abutment and pier foundations are as follows.

South Abutment: (Reference Drawing 1347401-B, Section B-B) The south abutment can be founded on steel 'H' piles driven to the bedrock surface. Heavy steel sections i.e. HP 310 x 110 or equivalent should be utilized to suit the required driving conditions. A maximum allowable design load of 1100 kN per pile can be assumed for design purposes.

North Abutment: (Reference Drawing 1347401-C, Section N-N) The north abutment can also be founded on steel 'H' piles driven to the bedrock surface. The steel 'H' piles can be driven upon completion of placing fill material for the north approach. However, as discussed previously the underlying clay will undergo consolidation due to the imposed loading of the approach fill. This consolidation will cause negative skin friction forces on the pile and hence, the maximum allowable design load should be reduced by 10% to account for this. For example, an HP 310 x 110 can be designed for a maximum allowable design load of 1000 kN per pile.

Piers

For the pier foundation a combination of 3 HP 310 piles located inside a 1.2 ø m steel tube will be employed. This design requires that the steel tube be driven to the bedrock surface. In some isolated locations the contractor may have to employ churn drilling techniques to advance the steel tube through the cobbles and boulders located in the overburden. The presence of cobbles and boulders are noted on the borehole log sheets. A special provision should be included in the contract for the attention of the contractor for the presence of isolated boulders and also requiring the contractor to employ churn drilling techniques if necessary, in these areas.

In order to provide sufficient lateral resistance for the foundation units it will be necessary to churn drill 0.5 metres into bedrock, a hole of sufficient diameter to accommodate the 3 'H' pile system. The hole is then cleared out of all debris and thereafter the contractor shall exercise extreme care to prevent migration of fines into the churned drilled hole or caisson. The 'H' piles are then placed in the caisson and tapped by a pile driving hammer so that the piles are seated on sound bedrock. Finally, tremie concrete methods are employed to complete the caisson construction. Piles constructed in such a manner can be designed for a maximum allowable load of 2700 kN per caisson.

Because of the shallow depth of water and the relatively high lateral resistance offered by the overburden at Piers 8, 9 and 10, consideration should be given to support these piers on conventional 'H' piles. To achieve higher design loads per pile, thereby reducing the required number of piles per pier, heavier steel 'H' sections could be employed (i.e. H310 x 152 incorporating a safe design of 1250 kN per pile).

A breakdown of individual piers and the related subsurface conditions can be provided at a later date if required by the Structural Design Office for design purposes.

A suggested construction sequence for the piers is as follows.

- Precast concrete forms for pile cap floated into position and anchored by means of temporary piles driven outside the pile cap.
- 1.2 ø metre steel tube located by means of guides cast in the precast pile cap. Steel tube driven to the bedrock surface and cleaned out.
- Churn drilling techniques employed to socket a hole of sufficient diameter to accommodate 3 'H' piles 0.5 metres into bedrock
- 'H' piles placed inside tube and hammered to seat onto bedrock
- Construct caisson by tremie methods
- Unwater precast concrete pier cap, place reinforcing steel and pour pier cap
- Remove temporary piles used to locate precast conctete pile cap.

Structure Miscellaneous: For estimating earth pressures behind abutments of wingwalls the following may be assumed for design purposes.

- coefficient of active earth pressure 0.33 if movement at the top of the abutment wall is permitted
- coefficient of earth pressure at rest 0.5 if no movement at the top of the wall is anticipated

Relocation of Navigation Channel

The construction of the proposed structure necessitates relocation of the main navigation channel from its present location at the swing structure to the point of maximum navigation clearance for the proposed structure located between Pier 6 and 7. This relocation will require removal of the existing two span fixed structure and some of the existing causeway fill. A boring was carried out in the area of the proposed causeway excavation at the request of the Region to determine existing fill and

subsurface conditions in order to assess scour and wave protection requirements (Refer to B.H. 100).

Based on the field data it is inferred that the subsoil conditions prior to constructing the causeway were as follows.

Elev. 74.8± to Elev. 62.0± - Water and very soft organic clay (bay mud)

Elev. 62.0± to Elev. 58.0± - Glacial till, dense to very dense or hard

Elev. 58.0± and Below - Bedrock

Further, it is inferred from the historical records that the existing causeway was constructed in the following manner.

- Fill material composed of sandy gravel to gravelly sand, trace of silt and numerous cobbles or boulders was transported to the causeway and placed by bottom dump barge.
- This method was supposed to displace the organic clay but our recent borings revealed pockets or layers up to 1.4 metres thick of organic material sandwiched between the fill and underlying subsoil.
- Wave and scour protection was accomplished by placing heavy armour stone on the causeway slopes.

No stability problems are anticipated for the proposed excavation provided cut slopes are not steeper than 2:1 and further, the slopes are protected against wave and scour action as per hydrological requirements. It is understood that a special consultant has been engaged by the region and the pertinent recommendations will be provided by the consultant.

It is important to note that the required excavation for relocating the navigation channel will necessitate the removal of not only the present two span structures',south abutment and pier , but also the removal of at least one and possibly two piers of the original structure constructed in the 1890's. One of the original piers can still be seen directly in front of the south abutment of the present two span structure. These details should be brought to the attention of the contractor.

MISCELLANEOUS

The fieldwork for the original Feasibility Investigation and for the final investigation under various stages was carried out under the general supervision of Mr. M. MacLean, Project Engineer. The equipment used was owned and operated by private companies operating out of the Toronto area.

Our appreciation is extended to the various offices and District within the Region that cooperated and assisted us in carrying out each stage of the fieldwork. In particular, the technical assistance provided by Mr. D. McClay of the Regional Geotechnical Office is greatly appreciated.

This report was written by Mr. M. MacLean and reviewed by Mr. M. Devata, Supervising Engineer.

M. MacLean

M. MacLean, P. Eng.
Project Engineer

M. Devata

M. Devata, P. Eng.
Supervising Engineer

August, 1979

APPENDIX

RECORD OF BOREHOLE No 1

METRIC

W P 134-74-01 LOCATION Coords. N 4 889 389.0; E 233 952.5 ORIGINATED BY JW
DIST 8 HWY 14 BOREHOLE TYPE Solid Stem Augers COMPILED BY SC
DATUM Geodetic DATE 77 05 25 CHECKED BY RS

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: 'N' VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH: o UNCONFINED, • QUICK TRIAXIAL, + FIELD VANE, x LAB VANE	PLASTIC LIMIT Wp / NATURAL MOISTURE CONTENT W / LIQUID LIMIT WL — WATER CONTENT (%)	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
77.1	Ground Surface										
76.6	Sandy Gravel					*					
0.5	Refusal to Augering Probable Bedrock End of Borehole * Note: Water Level Not Established						76				

RECORD OF BOREHOLE No 2

METRIC

W P 134-74-01 LOCATION Coords. N 4 889 410.0; E 233 947.5 ORIGINATED BY JW
DIST 8 HWY 14 BOREHOLE TYPE Hollow Stem Augers & BXL Rock Coring COMPILED BY SC
DATUM Geodetic DATE 77 05 25 CHECKED BY

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: 'N' VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH: o UNCONFINED, • QUICK TRIAXIAL, + FIELD VANE, x LAB VANE	PLASTIC LIMIT Wp / NATURAL MOISTURE CONTENT W / LIQUID LIMIT WL — WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
75.1	Ground Surface										
0.0	Sandy Gravel Some Silt Trace of Clay Trace of Shells Loose to Compact		1	SS	12	▽	74		o		36 55 5 4
			2	SS	9				o		50 31 15 4
			3	SS	5				o		33 30 29 8
71.9	Boulders						72				
3.2	Limestone Bedrock Sound		4	RC BXL	Rec 95%						RQD 86%
			5	RC BXL	Rec 100%		70				RQD 80%
	Shale Bed		6	RC BXL	Rec 93%		68				RQD 70%
67.1											
8.0	End of Borehole										

+3, x5 : Numbers refer to Sensitivity

20 / 15 ◇ 5 / 10 (%) STRAIN AT FAILURE

RECORD OF BOREHOLE No 4

METRIC

W P 134-74-01 LOCATION Coords. N 4 890 383.5; E 233 756.0 ORIGINATED BY JW
DIST 8 HWY 14 BOREHOLE TYPE Hollow Stem Augers, BXL Rock Dynamic Coring, Cone Test COMPILED BY SC
DATUM Geodetic DATE 77 05 27 CHECKED BY RS

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	TYPE	'N' VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH kPa (o UNCONFINED, • QUICK TRIAXIAL, + FIELD VANE, × LAB VANE) / WATER CONTENT (%) (Wp PLASTIC LIMIT, W NATURAL MOISTURE CONTENT, Wl LIQUID LIMIT)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
75.9	Ground Surface									
0.0	**Fill** Sand and Gravel With Inclusions and Layers of Clayey Silt Trace of Organics		1	SS	17	*	75		Om 4%	44 31 18 7
			2	SS	4				Om 2%	27 40 19 14
			3 4	TW SS	PH 2				Om 7%	21 32 26 21
			5	SS	14		73			
	With Cobbles and Boulders		6	SS	11					64 34 (2)
71.3							71			
4.6	Clay Stiff		7	SS	8					
			8	TW	PH		69	7	16.4	
			9	TW	PM					
67.5			10	SS	42				15.4	
8.4	Glacial Till, Hard						67			12 28 37 23
66.6										
9.3	Limestone Bedrock Sound		11	RC BXL	Rec 100%			100/0.05 m		RQD 60%
65.1										
10.8	End of Borehole * Note: Water Level Not Established									

RECORD OF BOREHOLE No 5

METRIC

W P 134-74-01 LOCATION Coords. N 4 890 456.0; E 233 711.0 ORIGINATED BY JW
DIST 8 HWY 14 BOREHOLE TYPE Hollow Stem Augers, Cone Test COMPILED BY SC
DATUM Geodetic DATE 77 05 26 CHECKED BY RS

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	TYPE	'N' VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH kPa (o UNCONFINED, • QUICK TRIAXIAL, + FIELD VANE, × LAB VANE) / WATER CONTENT (%) (Wp PLASTIC LIMIT, W NATURAL MOISTURE CONTENT, Wl LIQUID LIMIT)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
76.4	Ground Surface									
0.0	**Fill** Sand and Gravel With Inclusions and Layers of Clayey Silt		1	SS	22	*	76			38 34 19 9
			2	SS	3					
74.2			3	SS	14					41 43 10 6
2.2	Organic Clay Soft		4	SS	2		74	+ 3 × 2		
			5	TW	PW				w=134%	12.2
72.1			6	TW	PH				w=143%	15.4
4.3	Clayey Silt to Clay Very Stiff		7	SS	24		72			
			8	SS	16					
69.6			9	SS	13		70			
6.8	Glacial Till, Het. Mixture Clayey Silt, Sand & Gravel, Hard		10	SS	80/ 0.08 m					11 38 36 15
68.3			11	SS	20/ 0.08 m					
8.1	End of Borehole Refusal to Augering Probable Bedrock * Note: Water Level Not Established									

+3, ×5 : Numbers refer to Sensitivity

20 / 15 ◇ 5 / 10 (%) STRAIN AT FAILURE

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RECORD OF BOREHOLE No 7

METRIC

W P 134-74-01 LOCATION Coords. N 4 890 315.0; E 233 740.6 ORIGINATED BY JW
DIST 8 HWY 14 BOREHOLE TYPE Hollow Stem Augers, BXL Rock Coring, Cone Test COMPILED BY SC
DATUM Geodetic DATE 77 05 30 CHECKED BY RS

SOIL PROFILE ELEV/DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	TYPE	'N' VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	PLASTIC LIMIT Wp — NATURAL MOISTURE CONTENT W — LIQUID LIMIT WL / WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
75.9	Ground Surface										
0.0	Trace of Organic Matter		1	SS	12	▼	74			Om 4%	46 25 19 10
	Sandy Gravel Some Silt, Trace Clay		2	SS	32						
	Cobbles @ 0.9 m, 1.5 m & 3 m		3	SS	31						33 52 13 2
72.5	Dense		4	SS	15		72				
3.4	Sand Medium to Coarse Compact		5	SS	28						
			6	SS	27						2 93 (5)
69.1			7	SS	17		70				3 87 (10)
6.8	Clay		8	SS	8						0 4 24 72
	Firm to Stiff		9	SS	3		68				
66.5											
9.4 / 65.7	Glacial Till Hard		10	TW	PH		66			21.8	
10.2	Sound Limestone Bedrock		11	BXL RC	Rec	100%					RQD 63%
64.2											
11.7	End of Borehole										

RECORD OF BOREHOLE No 8

METRIC

W P 134-74-01 LOCATION Coords. N 4 890 387.0; E 233 717.3 ORIGINATED BY JW
DIST 8 HWY 14 BOREHOLE TYPE Hollow Stem Augers and Cone Test COMPILED BY SC
DATUM Geodetic DATE 1977 05 31 CHECKED BY RS

SOIL PROFILE ELEV/DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	TYPE	'N' VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	PLASTIC LIMIT Wp — NATURAL MOISTURE CONTENT W — LIQUID LIMIT WL / WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
76.0	Ground Surface										
0.0	Fill Sand and Clayey					*					
74.9	Silt, Some Organics		1	SS	5					Om 7%	7 54 29 10
1.1	Sandy Gravel Trace Silt		2	SS	44		74				60 30 7 3
	Sand, Medium to Coarse Trace Silt		3	SS	38						
71.4	Dense		4	SS	16/ 0.08 m		72				6 87 (7)
4.6	Clay		5	SS	8						
	Stiff		6	TW	PH		70			17.1	
68.3			7	TW	PH					16.8	
7.7	Glacial Till, Hard, Het. Mixture Clayey Silt Sand and Gravel		8	SS	55		68				19 25 27 29
67.2											
8.8	End of Borehole										
	*Note: Water Level Not Established										

+3, ×5 : Numbers refer to Sensitivity

15 20 10 5 (%) STRAIN AT FAILURE

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RECORD OF BOREHOLE No10 METRIC

W P 134-74-01 LOCATION Coords. N 4 890 291.0; E 233 780.6 ORIGINATED BY MM
DIST 8 HWY 14 BOREHOLE TYPE Washboring with NX Casing, BXL Rock Core, Cone Test COMPILED BY SC
DATUM Geodetic DATE 1977 05 26 CHECKED BY RS

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES	GROUND WATER CONDITIONS	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
74.9	Water Surface						
0.0	Water						
72.4	Bay Bottom						
2.5	Organic Clay Very Soft		1	SS	10		w_n=159%
69.8			2	SS	2		
5.1	Clay Stiff		3	TW	PH		γ = 15.7 kN/m^3 e_o=2.05 C_c=1.45
65.7			4	TW	PM		
9.2	Glacial Till Hard		5	SS	76		4 64 8 24
64.7							
10.2	Sound Limestone Bedrock		6	BXL RC	Rec 97% RQD 70%		RQD 70%
63.1							
11.8	End of Borehole						

DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100
SHEAR STRENGTH kPa
○ UNCONFINED + FIELD VANE
● QUICK TRIAXIAL × LAB VANE
20 40 60 80 100
ELEVATION SCALE 74 72 70 68 66 64
+ 5 × 2 + 8
PLASTIC LIMIT W_p NATURAL MOISTURE CONTENT W LIQUID LIMIT W_L
WATER CONTENT (%) 20 40 60
UNIT WEIGHT γ kN/m^3

RECORD OF BOREHOLE No 14 METRIC

W P 134-74-01 LOCATION Coords. N 4 890 249.2; E 233 787.1 ORIGINATED BY MM
DIST 8 HWY 14 BOREHOLE TYPE Continuous Vane Tests COMPILED BY SC
DATUM Geodetic DATE 1977 06 06 CHECKED BY

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES	GROUND WATER CONDITIONS	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
74.9	Water Surface						
0.0	Water						
72.5	Bay Bottom						
2.4	Organic Clay Very Soft		1	TP	PM		w_n=270% w_L=87% w_p=67% γ = 10.1 kN/m^3
69.8							
5.1	Refusal to Pushing Vane End of Borehole						

DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100
SHEAR STRENGTH kPa
○ UNCONFINED + FIELD VANE
● QUICK TRIAXIAL × LAB VANE
20 40 60 80 100
ELEVATION SCALE 74 72 70
× 2 + 8 + 2 + 2
PLASTIC LIMIT W_p NATURAL MOISTURE CONTENT W LIQUID LIMIT W_L
WATER CONTENT (%) 20 40 60
UNIT WEIGHT γ kN/m^3

$+^3$, $\times^5$: Numbers refer to Sensitivity

15 20 10 5 (%) STRAIN AT FAILURE

Ontario Transportation and Communications

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RECORD OF BOREHOLE No 16

METRIC

W P 134-74-01 LOCATION Coords. N 4 890 324.0; E 233 785.5 ORIGINATED BY MM

DIST 8 HWY 14 BOREHOLE TYPE Continuous Vane Test COMPILED BY SC

DATUM Geodetic DATE 1977 06 06 CHECKED BY PS

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES 'N' VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH kPa (○ UNCONFINED, ● QUICK TRIAXIAL, + FIELD VANE, × LAB VANE)	PLASTIC LIMIT Wp / NATURAL MOISTURE CONTENT W / LIQUID LIMIT WL / WATER CONTENT (%)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
74.9	Water Surface										
0.0	Water										
73.0	Bay Bottom						74				
1.9	Organic Clay Very Soft to Soft		1	TP	PM			× 2			
70.7							72	+ 2 + 3 +3 +1	w = 282% w_L = 92% w_p = 77%	10.8	
4.2	End of Borehole Refusal to Pushing Vane										

RECORD OF BOREHOLE No 17

METRIC

W P 134-74-01 LOCATION Coords. N 4 889 913.0; E 233 828.2 ORIGINATED BY MM

DIST 8 HWY 14 BOREHOLE TYPE Washboring With NX Casing & BXL Rock Coring COMPILED BY SC

DATUM Geodetic DATE 1977 06 07 CHECKED BY

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES 'N' VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH kPa (○ UNCONFINED, ● QUICK TRIAXIAL, + FIELD VANE, × LAB VANE)	PLASTIC LIMIT Wp / NATURAL MOISTURE CONTENT W / LIQUID LIMIT WL / WATER CONTENT (%)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
74.9	Water Surface										
0.0	Water						74				
71.6	Bay Bottom										
3.3	Organic Clay Very Soft		1	SS	12		72			Om 4.0%	
70.8											
4.1	Fill: Sandy Gravel to Gravelly Sand Trace of Silt		2	SS	40		70				50 36 9 5
			3	SS	7						58 39 (3)
			4	SS	13		68				
			5	SS	31		66				36 62 (2)
63.3			6	SS	26		64				
11.6	Organic Clay Stiff		7	SS	19					w=102%	
61.8							62				
13.1	Glacial Till, Het. Mixture Sand, Gravel Some Silt, Trace of Clay Dense		8	SS	41						14 62 18 6
	Cobbles		9	SS	100/0.00 m		60				
	Very Dense		10	RC	100%						
58.7											
16.2	Sound Limestone Bedrock With Shaley Sections		11	RC	50%		58				
57.2			12	RC BXL	Rec 100%						RQD 90%
17.7	End of Borehole										

$+^3$, $\times^5$: Numbers refer to Sensitivity

20 / 15 ◇ 5 / 10 (%) STRAIN AT FAILURE

RECORD OF BOREHOLE No 20 METRIC

W P 134-74-01 LOCATION Coords. N 4 889 655.2; E 233 888.2 ORIGINATED BY MM
DIST 8 HWY 14 BOREHOLE TYPE Washboring With NX Casing, BXL Rock Coring COMPILED BY SC
DATUM Geodetic DATE 1977 06 14 CHECKED BY FC

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES 'N' VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH (o UNCONFINED, • QUICK TRIAXIAL, + FIELD VANE, x LAB VANE)	PLASTIC LIMIT Wp / NATURAL MOISTURE CONTENT W / LIQUID LIMIT WL — WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
74.9	Water Surface										
0.0	Water						74				
71.5	Bay Bottom						72				
3.4	Fill Sandy Gravel to Gravelly Sand Trace of Silt With Shells With Decayed and Undecayed Wood Chips to Elev. 64.0		1	SS	3				o	Om3.0%	
			2	SS	8		70				
			3	SS	48				o	Om 0.5%	11 86 (3)
			4	SS	92		68				
			5	SS	18		66			Om13.1%	25 60 (15)
			6	SS	41		64		o		53 42 (5)
59.1			7	SS	120		62		o		20 72 (8)
15.8	Glacial Till, Het. Mixture of Sand, Gravel, Trace of Silt With Cobbles and Boulders up to 250 mm Thick		8	RC	Rec	100%	60				
			9	RC	Rec	0%	58				
55.9	Very Dense		10	RC	Rec	25%	56				
19.0	Sound Limestone Bedrock		11	RC BXL	Rec 94%						RQD 80%
54.2											
20.7	End of Borehole										

+3, x5 : Numbers refer to Sensitivity

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

Ministry of Transportation and Communications
Ontario

HIGHWAY ENGINEERING DIVISION - ENGINEERING MATERIALS OFFICE - SOIL MECHANICS SECTION

RECORD OF BOREHOLE No 21

METRIC

W P 134-74-01 LOCATION Coords. N 4 889 819.5; E 233 876.1 ORIGINATED BY MM

DIST 8 HWY 14 BOREHOLE TYPE Washboring with NX Casing & BXL Rock Coring COMPILED BY SC

DATUM Geodetic DATE 1977 06 15 CHECKED BY RS

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES 'N' VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED, ● QUICK TRIAXIAL, + FIELD VANE, × LAB VANE) (20 40 60 80 100)	PLASTIC LIMIT Wp / NATURAL MOISTURE CONTENT W / LIQUID LIMIT Wl — WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
74.9	Water Surface										
0.0	Water						74				
70.4	Bay Bottom						72				
4.5	Organic Clay With Sand Very Soft to Firm						70				
			1	SS	2		68		w=107%		
			2	SS	1/0.61 m		66	+ 2			
							64	+ 2			
60.5							62	+ 2			
14.4	Glacial Till Clayey Silt with Sand, Hard		3	SS	25		60		o		0 17 71 12
58.8											
58.3	Limestone Bedrock, Sound		4	RC	Rec 100%						RQD 50%
16.6	End of Borehole										

$+^3$, $\times^5$: Numbers refer to Sensitivity

20
15 ⊹ 5 (%) STRAIN AT FAILURE
10

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Ontario

HIGHWAY ENGINEERING DIVISION - ENGINEERING MATERIALS OFFICE - SOIL MECHANICS SECTION

RECORD OF BOREHOLE No 22 METRIC

W P 134-74-01 LOCATION Coords. N 4 889 449.7; E 233 936.0 ORIGINATED BY MM
DIST 8 HWY 14 BOREHOLE TYPE Washboring with NX Casing, BX Rock Coring COMPILED BY SC
DATUM Geodetic DATE 1977 06 15 CHECKED BY EC

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES 'N' VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE) / WATER CONTENT (%) (Wp W WL)	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
74.9	Water Surface									
0.0	Water						74			
							72			
							70			
69.0	Bay Bottom									
68.5	Organic Clay, V. Soft									
67.9	Sandy Silt, Some Gravel, Loose		1	SS	9		68			15 42 35 8
6.9	Sound Limestone Bedrock		2	RC BXL	Rec 100%					RQD 80%
66.4	With Shaley Sections									
8.5	End of Borehole									

RECORD OF BOREHOLE No 23 METRIC

W P 134-74-01 LOCATION Coords. N 4 889 487.1; E 233 920.2 ORIGINATED BY MM
DIST 8 HWY 14 BOREHOLE TYPE Washbore With NX Casing COMPILED BY SC
DATUM Geodetic DATE 1977 06 15 CHECKED BY EC

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES 'N' VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE) / WATER CONTENT (%) (Wp W WL)	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
74.9	Water Surface									
0.0	Water						74			
							72			
							70			
							68			
							66			
64.4	Bottom of Bay									
10.5	Refusal to Driving Casing Probable Bedrock End of Borehole									

$+^3$, $\times^5$: Numbers refer to Sensitivity

$15 \overset{20}{\underset{10}{\diamond}} 5$ (%) STRAIN AT FAILURE

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HIGHWAY ENGINEERING DIVISION - ENGINEERING MATERIALS OFFICE - SOIL MECHANICS SECTION

RECORD OF BOREHOLE No 24 METRIC

W P 134-74-01 LOCATION Coords. N 4 889 569.2; E 233 913.0 ORIGINATED BY MM
DIST 8 HWY 14 BOREHOLE TYPE Washboring With NX Casing COMPILED BY SC
DATUM Geodetic DATE 1977 06 16 CHECKED BY R.S

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES 'N' VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE)	PLASTIC LIMIT Wp / NATURAL MOISTURE CONTENT W / LIQUID LIMIT W_L — WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
74.9	Water Surface										
0.0	Water						74				
							72				
							70				
							68				
65.7	Bay Bottom						66				
9.2	Organic Clay With Sand Very Soft						64				
			1	SS	1		62		w=264%		
59.5							60				
15.4	Refusal to Driving Casing, Probable Cobbles and Boulders End of Borehole										

+3, x5 : Numbers refer to Sensitivity

15 ◇ 5 (%) STRAIN AT FAILURE (20 / 10)

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HIGHWAY ENGINEERING DIVISION - ENGINEERING MATERIALS OFFICE - SOIL MECHANICS SECTION

RECORD OF BOREHOLE No 98 METRIC

W P 134-74-01 LOCATION Coords. N 4 890 370.0; E 233 738.7 ORIGINATED BY MM
DIST 8 HWY 14 BOREHOLE TYPE Hollow Stem Augers and Cone Test COMPILED BY MM
DATUM Geodetic DATE 1979 03 14 CHECKED BY ES

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	TYPE	'N' VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH kPa (○ UNCONFINED, ● QUICK TRIAXIAL, + FIELD VANE, × LAB VANE)	PLASTIC LIMIT Wp / NATURAL MOISTURE CONTENT W / LIQUID LIMIT Wl — WATER CONTENT (%)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
75.5	Ground Surface							20 40 60 80 100	20 40 60		
0.0	Sandy Gravel Trace of Silt Numerous Cobbles Dense		1	SS	37	▼	74				
			2	SS	56		72				
70.3			3	SS	45						
5.2	Clay Firm to Very Stiff		4	TW	PH		70	× 147		17.5	
			5	TW	PH			+ > 95			
68.0			6	TW	PH		68	+ > 95 × 136		16.4	
7.5	(Glacial Till) Het. Mixture Clayey Silt, Sand and Gravel Firm / Hard		7	TW	PH						16 25 39 20
66.0			8	TW	PH			+3 ×2			
9.5	End of Borehole Refusal to Augering Probable Bedrock										

RECORD OF BOREHOLE No 99 99A Continuous Vane Testing 99B Continuous Sampling METRIC

W P 134-74-01 LOCATION Coords. N 4 890 368.0; E 233 768.5 ORIGINATED BY MM
DIST 8 HWY 14 BOREHOLE TYPE Hollow Stem Augers and Cone Test COMPILED BY MM
DATUM Geodetic DATE 1979 03 13 CHECKED BY ES

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	TYPE	'N' VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH kPa (○ UNCONFINED, ● QUICK TRIAXIAL, + FIELD VANE, × LAB VANE)	PLASTIC LIMIT Wp / NATURAL MOISTURE CONTENT W / LIQUID LIMIT Wl — WATER CONTENT (%)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
75.2	Ground Surface							20 40 60 80 100	20 40 60		
0.0	Fill Cobbles Sandy Gravel to Gravelly Sand Trace of Silt Occasional Cobbles Compact					▼		140/0.25 m			
			1	SS	8		74				
			2	SS	20		72				
70.3			3	SS	21			+ > 95			
4.9	Clay Firm to Very Stiff		4	TW	PH		70	+ 10		15.9	
			5	TW	PH			+ 5			
			6	TW	PH			+ 8		16.4	
			7	TW	PH		68	+ 7		16.8	
67.0			8	TW	PH			6 × + 3		22.2	
8.2	Glacial Till Stiff		9	TW	PH			+ > 95		24.2	
65.7			10	SS	15/ 0.13 m		66				22 24 34 20
9.5	End of Borehole Refusal to Augering Probable Bedrock										

$+^3$, $\times^5$: Numbers refer to Sensitivity

20
15 ⊹ 5 (%) STRAIN AT FAILURE
10

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HIGHWAY ENGINEERING DIVISION - ENGINEERING MATERIALS OFFICE - SOIL MECHANICS SECTION

RECORD OF BOREHOLE No 100

METRIC

W P 134-74-01 LOCATION Coords. N 4 889 928.0; E 233 793.3 ORIGINATED BY MM

DIST 8 HWY 14 BOREHOLE TYPE Hollow Stem Augers 0-9 m) BX Casing (9-20 m) COMPILED BY MM

DATUM Geodetic DATE 1977 03 09 CHECKED BY GS

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	TYPE	'N' VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (o UNCONFINED, + FIELD VANE, ● QUICK TRIAXIAL, × LAB VANE) (20 40 60 80 100)	PLASTIC LIMIT Wp / NATURAL MOISTURE CONTENT W / LIQUID LIMIT Wl / WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
77.5	Ground Surface										
0.0	**Fill** Sandy Gravel to Gravelly Sand Trace Silt Numerous Cobbles		1	SS	22	▼	76				
			2	SS	13		74		o		49 46 (5)
			3	SS	21				o		51 45 (4)
	Uniform Medium Sand		4	SS	9		72		o		0 92 (8)
			5	SS	32				o		22 69 (9)
			6	SS	26				o		
	Cobbles		7	SS	24		70			Hollow Stem Augers	
			8	SS	25				o		41 48 (11)
	Cobbles		9	SS	22		68				
			10	SS	39				o	BN Casing	65 31 (4)
	Cobbles		11	SS	20		66				
			12	SS	18						
64.4			13	SS	25		64			w=151%	
13.1	Organic Clay Black Stiff		14	SS	13			180 s=3			
62.0			15	TW	PH		62	×	+	19.5	Om 1.5%
15.5	Glacial Till Heterogeneous Mixture Silt, Sand and Gravel Dense to Very Dense		16	SS	30						
			17	SS	60/ 0.15 m		60		o		51 35 (14)
			18	SS	100/ 0.15 m				o		42 36 16 6
58.0			19	SS	Bouncing						
19.5	End of Borehole Probable Bedrock										

+³, ×⁵ : Numbers refer to Sensitivity

20 / 15 ◇ 5 / 10 (%) STRAIN AT FAILURE

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HIGHWAY ENGINEERING DIVISION - ENGINEERING MATERIALS OFFICE - SOIL MECHANICS SECTION

RECORD OF BOREHOLE No 101

METRIC

W P 134-74-01 LOCATION Coords. N 4 890 344.2; E 233 715.6 ORIGINATED BY MM
DIST 8 HWY 14 BOREHOLE TYPE Hollow Stem Augers and Cone Test COMPILED BY MM
DATUM Geodetic DATE 1979 03 08 CHECKED BY RS

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES 'N' VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (o UNCONFINED, ● QUICK TRIAXIAL, + FIELD VANE, × LAB VANE)	PLASTIC LIMIT Wp / NATURAL MOISTURE CONTENT W / LIQUID LIMIT W_L — WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
76.2	Ground Surface										
0.0	Sandy Gravel Trace of Silt Numerous Cobbles and Boulders Very Dense		1	SS	55	▼	76		o		72 22 (4)
			2	SS	57		74				
70.8			3	SS	103		72		o		73 24 (3)
5.4	Clay Very Stiff		4	SS	19		70	+>95			
			5	TW	PH		68	+>95			
66.7			6	SS	22				o		35 31 24 10
9.5 66.1	Glacial Till, Hard										
10.1	End of Borehole Refusal to Augering Probable Bedrock										

$+^3$, $\times^5$: Numbers refer to Sensitivity

15 ◇ 5 (%) STRAIN AT FAILURE (20 / 10)

RECORD OF BOREHOLE No 102 METRIC

W P 134-74-01 LOCATION Coords. N 4 890 287.0; E 233 710.0 ORIGINATED BY MM
DIST 8 HWY 14 BOREHOLE TYPE Hollow Stem Augers and Cone Test COMPILED BY MM
DATUM Geodetic DATE 1979 03 08 CHECKED BY RS

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH (o UNCONFINED, • QUICK TRIAXIAL, + FIELD VANE, × LAB VANE)	PLASTIC LIMIT Wp / NATURAL MOISTURE CONTENT W / LIQUID LIMIT Wl — WATER CONTENT (%)	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
76.3	Ground Surface										
0.0	Sandy Gravel Trace of Silt Very Dense Occasional Cobbles		1	SS	53	▼	76	100/0.15 m	o		68 24 (8)
			2	SS	60		74				
72.6											
3.7	Sandy Gravel to Gravelly Sand Trace Silt Very Dense		3	SS	78		72		o		46 42 (12)
			4	SS	N/A		70				
			5	SS	N/A		68				
			6	SS	N/A						
65.6							66				
10.7	End of Borehole Refusal to Augering Probable Bedrock										

RECORD OF BOREHOLE No 103 METRIC

W P 134-74-01 LOCATION Coords. N 4 890 324.2; E 233 759.0 ORIGINATED BY MM
DIST 8 HWY 14 BOREHOLE TYPE Hollow Stem Augers and Cone Test COMPILED BY MM
DATUM Geodetic DATE 1979 03 12 CHECKED BY RS

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH kPa (o UNCONFINED, • QUICK TRIAXIAL, + FIELD VANE, × LAB VANE)	PLASTIC LIMIT Wp / NATURAL MOISTURE CONTENT W / LIQUID LIMIT Wl — WATER CONTENT (%)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
74.7	Ice Surface					▼					
74.1	Ice						74				
0.6	Water										
73.4	Bay Bottom										
1.3	Organic Clay										
72.7	Soft		1	SS	3						
2.0	Sandy Gravel Trace of Silt Occasional Cobbles						72		o		68 27 (5)
70.8	Dense		2	SS	81						
3.9	Clay										
	Firm to Stiff		3	TW	PH		70	+18 +5			
68.2			4	TW	PH			can't push vane +			
6.5	Het. Mixture Clayey Silt, Sand & Gravel Stiff Glacial Till						68	100/0.25 m	o-H		36 29 25 10
66.1			5	SS	12						
8.6	End of Borehole Refusal to Augering Probable Bedrock										

+3, ×5 : Numbers refer to Sensitivity

20 / 15 ◇ 5 / 10 (%) STRAIN AT FAILURE

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HIGHWAY ENGINEERING DIVISION - ENGINEERING MATERIALS OFFICE - SOIL MECHANICS SECTION

RECORD OF BOREHOLE No 104 METRIC

W P 134-74-01 LOCATION Coords. N 4 890 260.0; E 233 803.8 ORIGINATED BY MM
DIST 8 HWY 14 BOREHOLE TYPE Hollow Stem Augers COMPILED BY MM
DATUM Geodetic DATE 1979 05 08 CHECKED BY RS

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES 'N' VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH kPa (o UNCONFINED, + FIELD VANE, ● QUICK TRIAXIAL, × LAB VANE)	PLASTIC LIMIT Wp / NATURAL MOISTURE CONTENT W / LIQUID LIMIT WL / WATER CONTENT (%)	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
75.2	Water Surface										
0.0	Water										
							74				
72.6	Bay Bottom										
2.6	Organic Clay Very Soft to Soft										
							72				
70.6											
4.6	Clay Firm to Stiff		1	SS	7		70	+ 7			
			2	TW	PH			+ 4			
67.5			3	SS	2		68	+ 9			
7.7	Het. Mixture Clayey Silt, Sand & Gravel Glacial Till Stiff		4	SS	5						
	Hard		5	SS	4		66	+ can't push vane			
			6	SS	82			+ can't push vane			
63.8			7	SS	50/	0.05 m	64				
11.4	Refusal to Augering Probable Bedrock End of Borehole										

+3, ×5 : Numbers refer to Sensitivity

20 / 15 ◇ 5 / 10 (%) STRAIN AT FAILURE

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HIGHWAY ENGINEERING DIVISION - ENGINEERING MATERIALS OFFICE - SOIL MECHANICS SECTION

RECORD OF BOREHOLE No 105 METRIC

W P 134-74-01 LOCATION Coords. N 4 890 295.7; E 233 757.0 ORIGINATED BY MM
DIST 8 HWY 14 BOREHOLE TYPE Hollow Stem Augers and Cone Test COMPILED BY MM
DATUM Geodetic DATE 1979 03 07 CHECKED BY RS

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES 'N' VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH kPa (o UNCONFINED, + FIELD VANE, ● QUICK TRIAXIAL, × LAB VANE)	PLASTIC LIMIT Wp / NATURAL MOISTURE CONTENT W / LIQUID LIMIT Wl / WATER CONTENT (%)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
74.7	Ground Surface										
0.0	Sandy Gravel Trace of Silt Occasional Cobbles & Boulders Compact to Dense		1	SS	27		74		o		79 18 (3)
70.7			2	SS	42		72				
4.0	Clay Stiff		3	SS	3		70	+10 + 7			
67.1			4	TW	PH		68	× 2 + 9 + 5	o	15.7	
7.6	Het. Mixture Silt, Sand & Gravel, Hard Cobbles		5	TW	PH		66				
65.6	Glacial Till										
9.1	Limestone Bedrock Sound		6	BX RC	Rec. 100%		64	100/0.15 m			RQD 73%
62.6			7	BX RC	Rec. 100%						RQD 83%
12.1	End of Borehole										

+³, ×⁵ : Numbers refer to Sensitivity

20 / 15 ◇ 5 / 10 (%) STRAIN AT FAILURE

Ontario Ministry of Transportation and Communications

HIGHWAY ENGINEERING DIVISION - ENGINEERING MATERIALS OFFICE - SOIL MECHANICS SECTION

RECORD OF BOREHOLE No 106 METRIC

W P 134-74-01 LOCATION Coords. N 4 890 293.5; E 233 743.5 ORIGINATED BY MM

DIST 8 HWY 14 BOREHOLE TYPE Hollow Stem Augers and Cone Test COMPILED BY MM

DATUM Geodetic DATE 1979 03 06 CHECKED BY [illegible]

ELEV / DEPTH	SOIL PROFILE DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	TYPE	'N' VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE) (20 40 60 80 100)	PLASTIC LIMIT Wp / NATURAL MOISTURE CONTENT W / LIQUID LIMIT WL — WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
76.3	Ground Surface										
0.0	Sandy Gravel Trace of Silt Occasional Cobbles Compact to Very Dense		1	SS	20	▼	76	Augered	○		66 27 (7)
			2	SS	100		74	100/0.25 m			
70.5			3	SS	44		72				
5.8	Clay Stiff		4	SS	5		70	+8 +6			
			5	TW	PH		68	×4 +10 +5	○	16.2	
66.9			6	TW	PH						
9.4 65.9	Het. Mix. Silt, Sand & Gravel, Glacial Till Hard						66				
10.4	Limestone Bedrock Sound		7	BX RC	Rec. 100%						RQD 70%
			8	BX RC	Rec. 100%		64				RQD 85%
62.8											
13.5	End of Borehole										

+3, ×5 : Numbers refer to Sensitivity

20 / 15 ◇ 5 / 10 (%) STRAIN AT FAILURE

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HIGHWAY ENGINEERING DIVISION - ENGINEERING MATERIALS OFFICE - SOIL MECHANICS SECTION

RECORD OF BOREHOLE No 107 METRIC

W P 134-74-01 LOCATION Coords. N 4 890 239.5; E 233 768.0 ORIGINATED BY DM
DIST 8 HWY 14 BOREHOLE TYPE Hollow Stem Augers and Cone Test COMPILED BY MM
DATUM Geodetic DATE 1979 03 05 CHECKED BY RC

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES 'N' VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (o UNCONFINED, • QUICK TRIAXIAL, + FIELD VANE, × LAB VANE; 20 40 60 80 100)	PLASTIC LIMIT Wp / NATURAL MOISTURE CONTENT W / LIQUID LIMIT Wl; WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
74.7	Ice Surface										
0.0	Ice										
	Water										
0.7	Trace Organics		1	SS	6		74				0m 2% 41 31 19 9
	Sandy Gravel Trace of Silt Compact to Dense		2	SS	22						
			3	SS	37		72				
			4	SS	Bouncing		70				
69.2											
5.5	Clay		5	SS	4		68				
	Stiff							+95			
			6	SS	2			+7			
65.4							66				
9.3	Het. Mix. Clayey Silt Sand and Gravel Hard		7	TW	PM						26 36 28 10
63.7	Glacial Till		8	SS	121		64	100/0.18 m			35 29 26 10
11.0	Limestone Bedrock		9	BXL RC	Rec 100%						RQD 70%
62.8	Sound										
11.9	End of Borehole										

+³, ×⁵ : Numbers refer to Sensitivity

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

Ministry of Transportation and Communications
Ontario

HIGHWAY ENGINEERING DIVISION - ENGINEERING MATERIALS OFFICE - SOIL MECHANICS SECTION

RECORD OF BOREHOLE No 108 METRIC

W P 134-74-01 LOCATION Coords. N 4 890 237.0; E 233 757.0 ORIGINATED BY MM
DIST 8 HWY 14 BOREHOLE TYPE Hollow Stem Augers and Cone Test COMPILED BY MM
DATUM Geodetic DATE 1979 03 12 CHECKED BY RS

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES 'N' VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (o UNCONFINED, + FIELD VANE, ● QUICK TRIAXIAL, × LAB VANE)	PLASTIC LIMIT Wp / NATURAL MOISTURE CONTENT W / LIQUID LIMIT WL / WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
74.7	Ice Surface										
0.0 / 74.0	Ice						74				
0.7	Water										
1.0	Sandy Gravel Trace of Silt Numerous Cobbles and Boulders Compact to Dense		1	SS	25				o		74 22 (4)
			2	SS	25		72	100/0.23 m	o		
68.8			3	SS	45		70				
5.9	Clay Stiff		4	SS	8		68	+ 7			
66.4			5	TW	PH			+ 8		16.1	
8.3	Het. Mixture Clayey Silt, Sand & Gravel (Glacial Till) Firm — Hard		6	SS	7		66				
63.9			7	SS	105/	0.15 m	64		o H		35 32 23 10
10.8	End of Borehole Refusal to Augering Probable Bedrock										

+3, ×5 : Numbers refer to Sensitivity

15 20 10 5 (%) STRAIN AT FAILURE

Ontario Ministry of Transportation and Communications

HIGHWAY ENGINEERING DIVISION - ENGINEERING MATERIALS OFFICE - SOIL MECHANICS SECTION

RECORD OF BOREHOLE No 109 METRIC

W P 134-74-01 LOCATION Coords. N 4 890 156.5; E 233 786.5 ORIGINATED BY MM

DIST 8 HWY 14 BOREHOLE TYPE Hollow Stem Augers and Cone Test COMPILED BY MM

DATUM Geodetic DATE 1979 02 26 CHECKED BY JS

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES 'N' VALUES	GROUND WATER CONDITIONS	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
74.7	Ice Surface						
0.0	Ice						
0.6	Water						
72.8	Bay Bottom						
1.9	Sandy Gravel Trace Silt Dense to Very Dense		1	SS	43		
			2	SS	56		68 25 (7)
69.5							
5.2	Clay Very Stiff		3	SS	11		
67.5							
7.2	Heterogeneous Mixture Clayey Silt, Sand and Gravel Hard Glacial Till		4	SS	22		
			5	SS	18		32 31 22 15
			6	SS	27		
61.4	Cobbles and Boulders		7	NX RC	Rec	50%	
13.3	Limestone Bedrock Fractured		8	BX RC	Rec	95%	RQD 0% RQD 40%
	Sound		9	BX RC	Rec	97%	RQD 90%
58.2							
16.5	End of Borehole						

DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100

SHEAR STRENGTH kPa
o UNCONFINED + FIELD VANE
● QUICK TRIAXIAL x LAB VANE
20 40 60 80 100

PLASTIC LIMIT Wp NATURAL MOISTURE CONTENT W LIQUID LIMIT Wl
WATER CONTENT (%) 20 40 60

UNIT WEIGHT γ

ELEVATION SCALE 74 72 70 68 66 64 62 60

+ > 95

100/0.18 m

+3, x5 : Numbers refer to Sensitivity

20 15 10 5 (%) STRAIN AT FAILURE

Ministry of Transportation and Communications
Ontario

HIGHWAY ENGINEERING DIVISION - ENGINEERING MATERIALS OFFICE - SOIL MECHANICS SECTION

RECORD OF BOREHOLE No 110 METRIC

W P 134-74-01 LOCATION Coords. N 4 890 154.0; E 233 775.0 ORIGINATED BY OJ

DIST 8 HWY 14 BOREHOLE TYPE Hollow Stem Augers and Cone Test COMPILED BY MM

DATUM Geodetic DATE 1979 08 05 CHECKED BY [illegible]

SOIL PROFILE ELEV/DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	TYPE	'N' VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (o UNCONFINED, + FIELD VANE, ● QUICK TRIAXIAL, x LAB VANE) (20 40 60 80 100)	PLASTIC LIMIT Wp / NATURAL MOISTURE CONTENT W / LIQUID LIMIT Wl — WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
74.7	Ice Surface										
0.0	Ice						74				
0.7 / 73.1	Water / Bay Bottom										
1.6	Sandy Gravel, Trace of Silt, Compact to Very Dense		1	SS	28		72		o		47 47 (6)
								122/0.15 m			
69.5			2	SS	66		70				
5.2	Clay, Very Stiff		3	SS	9						
67.5							68	+ >95			
7.2	Heterogeneous Mixture Clayey Silt, Sand and Gravel, Glacial Till, Very Stiff to Hard		4	SS	5						
			5	SS	9		66		o		22 36 30 12
			6	SS	25		64				
			7	SS	104/	0.13 m	62		o H		39 31 20 10
61.5											
13.2	Limestone Bedrock Sound		8	BXL RC	Rec 97%						RQD 72%
			9	BXL RC	Rec 96%		60				RQD 87%
			10	BXL RC	Rec 100%						RQD 84%
57.8							58				
16.9	End of Borehole										

+3, x5 : Numbers refer to Sensitivity

15 ◇ 20 / 10 5 (%) STRAIN AT FAILURE

Ontario Ministry of Transportation and Communications

HIGHWAY ENGINEERING DIVISION - ENGINEERING MATERIALS OFFICE - SOIL MECHANICS SECTION

RECORD OF BOREHOLE No 111 METRIC

W P 134-74-01 LOCATION Coords. N 4 890 074.5; E 233 806.0 ORIGINATED BY MM

DIST 8 HWY 14 BOREHOLE TYPE Hollow Stem Augers and Cone Test COMPILED BY MM

DATUM Geodetic DATE 1979 02 23 CHECKED BY RC

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	TYPE	'N' VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED, ● QUICK TRIAXIAL, + FIELD VANE, × LAB VANE) (20 40 60 80 100)	PLASTIC LIMIT Wp / NATURAL MOISTURE CONTENT W / LIQUID LIMIT WL / WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
74.7	Ice Surface										
0.0 / 74.1	Ice						74				
0.6 / 72.3	Water Bay Bottom										
2.4 / 70.9	Organic Clay, Trace of Sand and Gravel Very Soft		1	SS	Own	Wt.	72				
3.8	Fine to Med. Sand		2	SS	35		70				
	Sandy Gravel Trace Silt Dense to Very Dense		3	SS	67				○		73 22 (5)
67.4							68				
7.3	Clay		4	TW	PH			+15 × 130		16.7	
	Stiff		5	SS	1		66	7			
	Soft										
63.3			6	TW	PH		64		a	23.5	
11.4	Silty Sand Dense										
	Het. Mix. Clayey Silt Sand and Gravel, Hard (Glacial Till)		7	SS	37		62		○H		38 29 23 10
			8	SS	21				aH		16 38 37 9
	With Cobbles and Boulders		9	BX RC	Rec 10%		60				RQD 0%
58.6											
16.1	Limestone Bedrock Sound		10	BX RC	Rec 97%		58				RQD 66%
			11	BX RC	Rec 100%						RQD 90%
55.6							56				
19.1	End of Borehole										

+³, ×⁵ : Numbers refer to Sensitivity

20 / 15 ◇ 5 / 10 (%) STRAIN AT FAILURE

Ministry of Transportation and Communications
Ontario

HIGHWAY ENGINEERING DIVISION - ENGINEERING MATERIALS OFFICE - SOIL MECHANICS SECTION

RECORD OF BOREHOLE No 112 METRIC

W P 134-74-01 LOCATION Coords. N 4 890 071.0 E 233 793.2 ORIGINATED BY MM
DIST 8 HWY 14 BOREHOLE TYPE Hollow Stem Augers and Cone Test COMPILED BY MM
DATUM Geodetic DATE 1979 02 21 CHECKED BY [illegible]

ELEV / DEPTH	SOIL PROFILE DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	TYPE	'N' VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE
74.7	Ice Surface						
0.0 / 74.1	Ice						74
0.6	Water						
72.3	Bay Bottom						72
2.4	Pockets or Layers of Gravel, Some Sand Some Silt and Organic Clay Loose		1	SS	5		
			2	SS	8		70
			3	SS	2		68
67.4							
7.3	Clay Soft		4	SS	2		
			5	SS	2		66
	Clayey Silt Soft		6	TW	PH		64
63.2							
11.5	Gravel, Some Sand Some Silt, Trace Clay Dense		7	SS	36		62
61.3							
13.4	Het. Mixture Clayey Silt, Sand and Gravel Hard (Glacial Till)		8	SS	47		
			9	SS	50/	0.08 m	60
58.1			10	BX RC	Rec.	100%	
16.6	Limestone Bedrock Sound		11	BX RC	Rec.	97%	58
			12	BX RC	Rec.	100%	
			13	BX RC	Rec.	93%	56
55.2							
19.5	End of Borehole						

DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100

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

PLASTIC LIMIT W_p | NATURAL MOISTURE CONTENT W | LIQUID LIMIT W_L
WATER CONTENT (%) 20 40 60

UNIT WEIGHT γ kN/m³

REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
Om 3%
47 29 19 5
52 23 16 9
10 28 52 10
RQD 20%
RQD 67%
RQD 47%
RQD 59%

+3, ×5 : Numbers refer to Sensitivity

15 20 10 5 (%) STRAIN AT FAILURE

Ministry of Transportation and Communications
Ontario

HIGHWAY ENGINEERING DIVISION - ENGINEERING MATERIALS OFFICE - SOIL MECHANICS SECTION

RECORD OF BOREHOLE No 113 METRIC

W P 134-74-01 LOCATION Coords. N 4 889 988.0; E 233 835.7 ORIGINATED BY BL
DIST 8 HWY 14 BOREHOLE TYPE Hollow Stem Augers and Diamond Drilling With BX Casing COMPILED BY MM
DATUM Geodetic DATE 1979 05 09 CHECKED BY RS

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES 'N' VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE) (20 40 60 80 100)	PLASTIC LIMIT Wp / NATURAL MOISTURE CONTENT W / LIQUID LIMIT WL — WATER CONTENT (%)	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
75.2	Water Surface										
0.0	Water						74				
							72				
							70				
69.4	Bay Bottom										
5.8	Sandy Gravel Trace of Silt Occasional Cobbles Dense to Very Dense		1	SS	54		68				
			2	SS	44						
66.1							66	+ 4			
19.1	Clay Grey Soft to Stiff		3	SS	2						
			4	SS	2		64	2 +			
63.1											
12.1	End of Borehole * Note: Boring Terminated Because of Adverse Weather Conditions Borehole Continued on B.H. #113A	*									

+3, ×5 : Numbers refer to Sensitivity

15 20 10 5 (%) STRAIN AT FAILURE

Ontario

HIGHWAY ENGINEERING DIVISION - ENGINEERING MATERIALS OFFICE - SOIL MECHANICS SECTION

RECORD OF BOREHOLE No 113 A METRIC

W P 134-74-01 LOCATION Coords. N 4 889 989.0; E 233 852.4 ORIGINATED BY MM

DIST 8 HWY 14 BOREHOLE TYPE Hollow Stem Augers and BXL Rock Core COMPILED BY MM

DATUM Geodetic DATE 1979 05 10 CHECKED BY

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES 'N' VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE) / WATER CONTENT (%) (PLASTIC LIMIT Wp, NATURAL MOISTURE CONTENT W, LIQUID LIMIT Wl)	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
75.2	Water Surface									
0.0	Water						74			
							72			
69.4	Bay Bottom						70			
5.8	Sandy Gravel * Trace Silt Occasional Cobbles Dense to Very Dense						68			
66.1										
19.1	Clay * Grey Soft to Stiff						66			
62.8										
12.4	Het. Mix. Clayey Silt Sand and Gravel Glacial Till Hard		5	SS	61		64			
	Cobbles & Boulders		6	SS	50/	0.08 m	62			
59.1			7	SS	60/	0.10 m	60			
16.1	Limestone Bedrock Fractured		10				58			
			11							
			12							
	Sound		13							
55.9										
19.3	End of Borehole									
	* Note: These Descriptions 0-12.4 m Based on B.H. 113 and Nature of Augering Operation		8	BXL RC	Rec. 30%			See Below for Details of Sample No. 8, 9, 10, 11, 12, & 13		RQD 0%
			9	BXL RC	Rec. 100%					RQD 20%
			10	BXL RC	Rec. 20%					RQD 0%
			11	BXL RC	Rec. 95%					RQD 68%
			12	BXL RC	Rec. 100%					RQD 0%
			13	BXL RC	Rec. 100%					RQD 80%

+3, ×5 : Numbers refer to Sensitivity

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

Ontario

HIGHWAY ENGINEERING DIVISION - ENGINEERING MATERIALS OFFICE - SOIL MECHANICS SECTION

RECORD OF BOREHOLE No 114 METRIC

W P 134-74-01 LOCATION Coords. N 4 889 984.6; E 233 810.6 ORIGINATED BY MM

DIST 8 HWY 14 BOREHOLE TYPE Hollow Stem Augers COMPILED BY MM

DATUM Geodetic DATE 1979 05 08 CHECKED BY [illegible]

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE) (20 40 60 80 100)	PLASTIC LIMIT Wp / NATURAL MOISTURE CONTENT W / LIQUID LIMIT Wl — WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES						
75.2	Water Surface										
0.0	Water						74				
							72				
69.7	Bay Bottom						70				
	Occ. Cobbles & Boulders										
5.5	Organic Clay										
68.4	Very Soft to Soft										
6.8	Sandy Gravel		1	SS	28		68				
	Trace of Silt										
	Compact		2	SS	29				○		
	Occasional Cobbles										
66.0							66				
9.2	Silty Clay		3	SS	5			+5			
	With Sand and Gravel										
	Firm		4	SS	3		64	+ 3			
63.0											
12.2	Het. Mixture Clayey Silt, Sand & Gravel Stiff — — — Hard		5	SS	12				○		
	(Glacial Till)		6	SS	50/	0.05 m	62				
59.0											
16.2	Refusal to Augering Probable Bedrock End of Borehole		7	SS	85/	0.08 m	60				

+3, ×5 : Numbers refer to Sensitivity

15 20 5 10 (%) STRAIN AT FAILURE

Ontario Communications

HIGHWAY ENGINEERING DIVISION - ENGINEERING MATERIALS OFFICE - SOIL MECHANICS SECTION

RECORD OF BOREHOLE No 115 METRIC

W P 134-74-01 LOCATION Coords. N 4 889 908.0; E 233 843.5 ORIGINATED BY MM

DIST 8 HWY 14 BOREHOLE TYPE Hollow Stem Augers and Cone Test COMPILED BY MM

DATUM Geodetic DATE 1979 03 01 CHECKED BY RS

SOIL PROFILE ELEV/DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	TYPE	'N' VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE 20 40 60 80 100	PLASTIC LIMIT Wp / NATURAL MOISTURE CONTENT W / LIQUID LIMIT Wl — WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
74.7	Ice Surface										
0.0	Ice										
0.4	Water						74				
70.5	Bay Bottom						72				
4.2	Organic Clay Very Soft to Soft		1	SS	1		70		w=225%		
			2	SS	1		68	+ 2			
			3	SS	1			+ 2			
			4	TW	PH		66	×2 + 2	w=178% w_L=303% w_p=95% I_p=208%	11.4	
			5	SS	1		64	+ 2			
61.8			6	SS	1						
12.9	Silty Sand Compact With Cobbles and Gravel		7	SS	5		62	+ 2	w=115%		
			8	SS	10/ Rec	0.08 m 60%	60	100/0.23 m			
58.7			9	BXL RC							RQD 0%
16.0	End of Borehole										

+³, ×⁵ : Numbers refer to Sensitivity

15 20 10 5 (%) STRAIN AT FAILURE

Ontario Communications

HIGHWAY ENGINEERING DIVISION - ENGINEERING MATERIALS OFFICE - SOIL MECHANICS SECTION

RECORD OF BOREHOLE No 117 METRIC

W P 134-74-01 LOCATION Coords. N 4 889 824.5; E 233 862.0 ORIGINATED BY MM

DIST 8 HWY 14 BOREHOLE TYPE Hollow Stem Augers and Cone Test COMPILED BY MM

DATUM Geodetic DATE 1979 03 01 CHECKED BY JPS

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES 'N' VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH kPa (○ UNCONFINED, ● QUICK TRIAXIAL, + FIELD VANE, × LAB VANE)	WATER CONTENT (%) (PLASTIC LIMIT W_P, NATURAL MOISTURE CONTENT W, LIQUID LIMIT W_L)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
74.7	Ice Surface										
0.0 / 74.0	Ice						74				
0.7	Water						72				
70.8	Bay Bottom										
3.9	Organic Clay Very Soft to Soft		1	SS	1		70	+ 4			
			2	TW	PM		68	+ 3	w_n = 267% w_L = 357% w_p = 75% I_p = 262%	10.6	
			3	SS	3			+ 2			
			4	SS	4		66	+ 2	w = 293%		
			5	SS	Own Wt.		64	+ 2			
			6	TW	PM		62	+ 3	w = 171%		
59.8			7	SS	Own Wt.			+8			
14.9	Gravel, Some Sand Trace Silt Very Dense		8	SS	85		60	120/0.15 m	0		62 32 (6)
58.2											
16.5	End of Borehole Refusal to Augering Probable Bedrock										

+³, ×⁵ : Numbers refer to Sensitivity

20 / 15 ◇ 5 / 10 (%) STRAIN AT FAILURE

Ontario Ministry of Transportation and Communications

HIGHWAY ENGINEERING DIVISION - ENGINEERING MATERIALS OFFICE - SOIL MECHANICS SECTION

RECORD OF BOREHOLE No 117A METRIC

W P 134-74-01 LOCATION Coords. N 4 889 826.0; E 233 855.0 ORIGINATED BY OM

DIST 8 HWY 14 BOREHOLE TYPE Cone Test COMPILED BY MM

DATUM Geodetic DATE 79 03 02 CHECKED BY KS

ELEV / DEPTH	DESCRIPTION *	STRAT PLOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: 'N' VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE)	PLASTIC LIMIT Wp / NATURAL MOISTURE CONTENT W / LIQUID LIMIT Wl — WATER CONTENT (%)	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
74.7	Ice Surface										
74.2 / 0.5	Ice						74				
	Water						72				
71.0	Bay Bottom										
3.7	Organic Clay Very Soft to Firm						70				
							68				
							66				
							64				
							62				
59.8							60	100/0.18 m			
14.9 / 59.0	Gravel, Some Sand, Trace Silt, V. Dense										
15.7	End of Cone Test										

* Note: Description Inferred From B.H. 117 & 118

+3, ×5 : Numbers refer to Sensitivity

20 / 15 ◇ 5 / 10 (%) STRAIN AT FAILURE

Ministry of Transportation and Communications
Ontario

HIGHWAY ENGINEERING DIVISION - ENGINEERING MATERIALS OFFICE - SOIL MECHANICS SECTION

RECORD OF BOREHOLE No 118 METRIC

W P 134-74-01 LOCATION Coords. N 4 889 821.5; E 233 848.4 ORIGINATED BY MM
DIST 8 HWY 14 BOREHOLE TYPE Hollow Stem Augers COMPILED BY MM
DATUM Geodetic DATE 1979 02 28 CHECKED BY CS

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	TYPE	'N' VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE)	PLASTIC LIMIT Wp / NATURAL MOISTURE CONTENT W / LIQUID LIMIT WL — WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
74.7	Ice Surface										
0.0	Ice						74				
0.5	Water										
71.7	Bay Bottom						72				
3.0	Fill		1	SS	8				○		43 49 (8)
	Sandy Gravel to Gravelly Sand Some Silt		2	SS	6		70				
			3	SS	17						
	Occasional Cobbles and Occasional Pockets of Organic Material		4	SS	8		68		○		29 59 (12)
			5	SS	20						
			6	SS	22		66				
			7	SS	18				○		29 57 (14)
60.2			8	SS	58		64				
14.5	Clayey Silt to Silt of Slight Plasticity Loose, Trace Sand		9	SS	4				⊢○		0 7 75 18
58.7							62				
16.0	Gravel, Some Sand Trace of Silt, Dense		10	SS	Bouncing						
57.9							60				
16.8	Limestone Bedrock Sound		11	BX RC	Rec 90%						RQD 87%
			12	BX RC	Rec 100%		58				RQD 89%
54.8											
19.9	End of Borehole						56				

+3, ×5 : Numbers refer to Sensitivity

20 / 15 ◇ 5 / 10 (%) STRAIN AT FAILURE

Ontario Ministry of Transportation and Communications

HIGHWAY ENGINEERING DIVISION - ENGINEERING MATERIALS OFFICE - SOIL MECHANICS SECTION

RECORD OF BOREHOLE No 118A METRIC

W P 134-74-01 LOCATION Coords. N 4 889 817.5; E 233 851.3 ORIGINATED BY DM

DIST 8 HWY 14 BOREHOLE TYPE Cone Test COMPILED BY MM

DATUM Geodetic DATE 1979 03 02 CHECKED BY RS

ELEV / DEPTH	DESCRIPTION *	STRAT PLOT
74.7	Ice Surface	
74.2	Ice	
0.5	Water	
71.1	Bay Bottom	
3.6	Fill Sandy Gravel to Gravelly Sand Some Silt	
64.8		
9.9	Organic Clay Firm	
61.2		
13.5	Gravel Some Sand Compact to Dense	
58.0		
16.7	End of Cone Test Probable Bedrock * Note Description Inferred From B.H. 117 & 118	

SAMPLES: NUMBER | TYPE | 'N' VALUES

GROUND WATER CONDITIONS

ELEVATION SCALE: 74, 72, 70, 68, 66, 64, 62, 60

DYNAMIC CONE PENETRATION RESISTANCE PLOT: 20 40 60 80 100

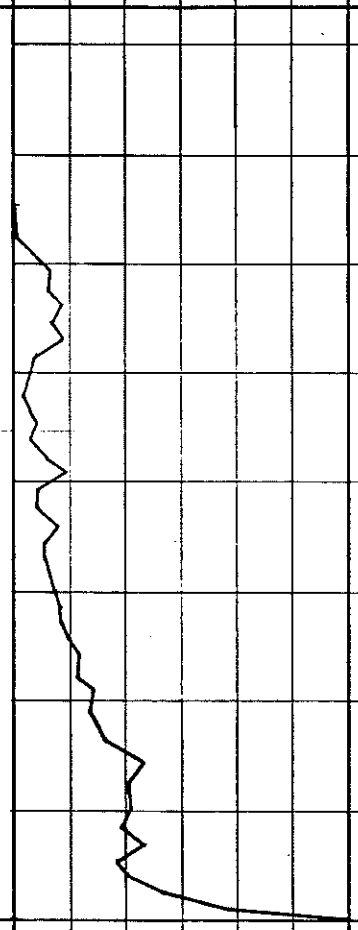
SHEAR STRENGTH
o UNCONFINED + FIELD VANE
● QUICK TRIAXIAL × LAB VANE

PLASTIC LIMIT W_P | NATURAL MOISTURE CONTENT W | LIQUID LIMIT W_L

WATER CONTENT (%)

UNIT WEIGHT γ

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



$+^3$, $\times^5$: Numbers refer to Sensitivity

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

Transportation and Communications
Ontario

HIGHWAY ENGINEERING DIVISION - ENGINEERING MATERIALS OFFICE - SOIL MECHANICS SECTION

RECORD OF BOREHOLE No 119 , METRIC

W P 134-74-01 LOCATION Coords. N 4 889 742.0; E 233 880.8 ORIGINATED BY DM

DIST 8 HWY 14 BOREHOLE TYPE Hollow Stem Augers and Cone Test COMPILED BY MM

DATUM Geodetic DATE 1979 02 28 CHECKED BY JS

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: 'N' VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH kPa (○ UNCONFINED, ● QUICK TRIAXIAL, + FIELD VANE, × LAB VANE)	PLASTIC LIMIT Wp / NATURAL MOISTURE CONTENT W / LIQUID LIMIT Wl — WATER CONTENT (%)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
74.7	Ice Surface										
0.0 / 74.1	Ice						74				
0.6	Water										
72.1	Bay Bottom						72				
2.6	Organic Clay Soft to Firm		1	SS	1		70		$w = 334\%$ $w_L = 358\%$ $w_p = 91\%$ $I_p = 267\%$	10.9	Om 27%
			2	TW	PM		68	+ 2			
			3	SS	1		66	+ 2			
			4	SS	1			+ 2			
			5	SS	1		64	+ 2			
			6	SS	1		62	+ 3			
			7	TW	PM			+3	$w = 110\%$ $w_L = 148\%$ $w_p = 55\%$	13.8	Om 16%
59.8							60				
14.9	Clayey Silt to Silt of Slight Plasticity Trace of Sand Loose		8	SS	1			+3			0 6 83 11
			9	SS	3		58				0 11 74 15
56.9											
17.8	End of Borehole Refusal to Augering Probable Bedrock										

$+^3$, $\times^5$: Numbers refer to Sensitivity

20 / 15 ◇ 5 / 10 (%) STRAIN AT FAILURE

Ministry of Transportation and Communications
Ontario

HIGHWAY ENGINEERING DIVISION - ENGINEERING MATERIALS OFFICE - SOIL MECHANICS SECTION

RECORD OF BOREHOLE No 120

METRIC

W P 134-74-01 LOCATION Coords. N 889 738.5; E 233 866.5 ORIGINATED BY MM

DIST 8 HWY 14 BOREHOLE TYPE Hollow Stem Augers and Cone Test COMPILED BY MM

DATUM Geodetic DATE 1979 02 27 CHECKED BY

ELEV / DEPTH	SOIL PROFILE: DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	TYPE	'N' VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH kPa: o UNCONFINED, • QUICK TRIAXIAL, + FIELD VANE, × LAB VANE	PLASTIC LIMIT Wp / NATURAL MOISTURE CONTENT W / LIQUID LIMIT WL / WATER CONTENT (%)	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
74.7	Ice Surface										
0.0 / 74.0	Ice						74				
0.7	Water						72				
71.0	Bay Bottom										
3.7	Fill Occasional Cobbles Layers of Fine to Medium Sand and Sandy Gravel Trace Silt and Organic Clay		1	SS	16		70				34 60 (6)
			2	SS	6		68				
			3	SS	9						
			4	SS	4		66				
			5	SS	10		64				15 78 (7)
61.9			6	SS	27		62				69 29 (2)
12.8	Organic Clay Firm		7	SS	4				w=99%		
59.0			8	SS	4		60	+3			
15.7	Clayey Silt to Silt of Slight Plasticity Trace Clay, Trace Sand Loose		9	SS	4		58				0 10 80 10
57.0								30/0.03 m			
17.7	Limestone Bedrock Sound		10	BXL RC	Rec	100%	56				RQD 86%
53.7			11	BXL RC	Rec	87%	54				RQD 81%
21.0	End of Borehole										

+3, ×5 : Numbers refer to Sensitivity

15 20/10 5 (%) STRAIN AT FAILURE

Ministry of Transportation and Communications
Ontario

HIGHWAY ENGINEERING DIVISION - ENGINEERING MATERIALS OFFICE - SOIL MECHANICS SECTION

RECORD OF BOREHOLE No 121 METRIC

W P 134-74-01 LOCATION Coords. N 4 889 659.0; E 233 899.3 ORIGINATED BY DM

DIST 8 HWY 14 BOREHOLE TYPE Hollow Stem Augers and Cone Test COMPILED BY MM

DATUM Geodetic DATE 1979 02 28 CHECKED BY

ELEV / DEPTH	DESCRIPTION	NUMBER	TYPE	'N' VALUES	GROUND WATER CONDITIONS	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
74.7	Ice Surface					
72.4	Ice					
0.5	Water					
70.7	Bay Bottom					
4.0	Organic Clay With Sand Soft to Stiff	1	SS	1		
		2	SS	1		
		3	TW	PM		
		4	SS	1		
		5	SS	2		
		6	SS	2		
		7	SS	1		
		8	SS	1		
		9	TW	1		
56.7						
18.0	Silt of Slight Plasticity, Loose, Trace Clay Trace Sand Cobbles	10	SS	4		
55.5		11	BXL RC	Rec	66%	RQD 0%
19.2	Bedrock	12	BXL RC	Rec	100%	RQD 80 %
	Limestone Sound	13	BXL RC	Rec	100%	RQD 80%
		14	BXL RC	Rec	50%	RQD 43%
52.0						
22.7	End of Borehole					

DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100

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

PLASTIC LIMIT W_P NATURAL MOISTURE CONTENT W LIQUID LIMIT W_L
WATER CONTENT (%) 20 40 60

ELEVATION SCALE 74 72 70 68 66 64 62 60 58 56 54

+4 +2 ×3 +3 +2 +2 +2 +2 +3 +2 50/0.03 m

w 171 %
w 169 %
w 125 %

UNIT WEIGHT γ kN/m³: 11.8

+³, ×⁵ : Numbers refer to Sensitivity

15 20 10 5 (%) STRAIN AT FAILURE

Ministry of Transportation and Communications
Ontario

HIGHWAY ENGINEERING DIVISION - ENGINEERING MATERIALS OFFICE - SOIL MECHANICS SECTION

RECORD OF BOREHOLE No 122 METRIC

W P 134-74-01 LOCATION Coords.N 4 889 656.0; E 233 886.5 ORIGINATED BY DM
DIST 8 HWY 14 BOREHOLE TYPE Hollow Stem Augers and Cone Test COMPILED BY MM
DATUM Geodetic DATE 1979 03 01 CHECKED BY RS

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES 'N' VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH (o UNCONFINED, ● QUICK TRIAXIAL, + FIELD VANE, × LAB VANE)	PLASTIC LIMIT Wp / NATURAL MOISTURE CONTENT W / LIQUID LIMIT WL — WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
74.7	Ice Surface										
72.9	Ice						74				
0.5	Water										
71.6	Bay Bottom						72				
3.1	Fill										
	Gravelly Sand to Sandy Gravel Trace Silt Trace Clay With Decayed Wood Chips		1	SS	5		70				56 31 11 2
			2	SS	22		68				
			3	SS	16						45 34 8 13
			4	SS	5		66				
	Sand Fine to Medium		5	SS	6		64				
			6	SS	15		62				
			7	SS	11		60				
58.5			8	SS	23			Note: Cone Test From B.H. 122A			49 47 (4)
16.2	End of Borehole Probable Boulders										

+3, ×5 : Numbers refer to Sensitivity

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

Ontario Transportation and Communications

HIGHWAY ENGINEERING DIVISION - ENGINEERING MATERIALS OFFICE - SOIL MECHANICS SECTION

RECORD OF BOREHOLE No 122A METRIC

W P 134-74-01 LOCATION Coords. N 4 889 654.6; E 233 880.8 ORIGINATED BY DM

DIST 8 HWY 14 BOREHOLE TYPE Hollow Stem Augers and Cone Test COMPILED BY MM

DATUM Geodetic DATE 1979 03 01 CHECKED BY

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: 'N' VALUES	GROUND WATER CONDITIONS
74.7	Ice Surface					
0.0 / 74.2	Ice					
0.5	Water					
71.6	Bay Bottom					
3.1	Fill					
	Gravelly Sand to Sandy Gravel Trace of Silt		1	SS	5	
68.6						
6.1	End of Borehole					
	Refusal to Augering Boulder					
59.3						
15.4	End of Cone Test					

ELEVATION SCALE: 74, 72, 70, 68, 66, 64, 62, 60

DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100

SHEAR STRENGTH
o UNCONFINED + FIELD VANE
● QUICK TRIAXIAL × LAB VANE

PLASTIC LIMIT Wp — NATURAL MOISTURE CONTENT W — LIQUID LIMIT W_L

WATER CONTENT (%)

100/0.18 m

UNIT WEIGHT γ

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

$+^3$, $\times^5$: Numbers refer to Sensitivity

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

Ministry of Transportation and Communications
Ontario

HIGHWAY ENGINEERING DIVISION - ENGINEERING MATERIALS OFFICE - SOIL MECHANICS SECTION

RECORD OF BOREHOLE No 124 METRIC

W P 134-74-01 LOCATION Coords. N 4 889 581.0; E 233 903.0 ORIGINATED BY MM
DIST 8 HWY 14 BOREHOLE TYPE Diamond Drilling With BX Casing COMPILED BY MM
DATUM Geodetic DATE 1979 05 14 CHECKED BY RS

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: 'N' VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE) / WATER CONTENT (%) (PLASTIC LIMIT Wp — NATURAL MOISTURE CONTENT W — LIQUID LIMIT WL)	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
75.2	Water Surface									
0.0	Water						74			
							72			
							70			
							68			
66.9	Bay Bottom -- Cobbles and Boulders						66			
8.3	Organic Clay Very Soft to Soft		1	SS	Own	Wt.	64			
							62			
59.4							60			
15.8	Cobbles and Boulders Some Sand		2	BXL RC	Rec	50%				
58.0	Compact		3	BXL RC	Rec	10%				
			4	BXL RC	Rec	30%				
17.2	End of Borehole									

+3, ×5 : Numbers refer to Sensitivity

20
15 ⊹ 5 (%) STRAIN AT FAILURE
10

Ministry of Transportation and Communications
Ontario

HIGHWAY ENGINEERING DIVISION - ENGINEERING MATERIALS OFFICE - SOIL MECHANICS SECTION

RECORD OF BOREHOLE No 124 A METRIC

W P 134-74-01 LOCATION Coords. N 4 889 584.5; E 233 898.4 ORIGINATED BY MM
DIST 8 HWY 14 BOREHOLE TYPE Diamond Drilling With BX Casing and AX Casing COMPILED BY MM
DATUM Geodetic DATE 1979 05 17 CHECKED BY

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES 'N' VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE) / WATER CONTENT (%) (PLASTIC LIMIT W_P — NATURAL MOISTURE CONTENT W — LIQUID LIMIT W_L)	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
0.0 75.2	Water Surface									
	Water						74			
							72			
							70			
							68			
66.0	Bay Bottom									
9.2	Cobbles and Boulders						66			
	Organic Clay Very Soft to Soft						64			
							62			
60.8							60			BX Casing
14.4	Cobbles and Boulders		1	BXL RC	Rec	50%				
			2	BXL RC	Rec	90%				
	Some Sand		3	AXL RC	Rec	40%	58			AX Casing
56.4	Compact		4	AXL RC	Rec	15%				
18.8	Fractured		5	AXL RC	Rec	70%	56			RQD 35%
	Limestone Bedrock Sound		6	AXL RC	Rec	98%				RQD 97%
54.1										
21.1	End of Borehole									

+3, ×5 : Numbers refer to Sensitivity

20 / 15 ◇ 5 / 10 (%) STRAIN AT FAILURE

Ministry of Transportation and Communications
Ontario

HIGHWAY ENGINEERING DIVISION - ENGINEERING MATERIALS OFFICE - SOIL MECHANICS SECTION

RECORD OF BOREHOLE No 125 METRIC

W P 134-74-01 LOCATION Coords. N 4 889 498.0; E 233 938.5 ORIGINATED BY MM
DIST 8 HWY 14 BOREHOLE TYPE Diamond Drilling With BX Casing COMPILED BY MM
DATUM Geodetic DATE 1979 05 15 CHECKED BY

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES 'N' VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
75.2	Water Surface							
0.0	Water						74 / 72 / 70 / 68 / 66 / 64	
66.9	Bay Bottom							
8.3	Cobbles and Boulders Organic Clay Very Soft to Soft							
64.8			1	SS	50/	0.08 m		
10.4	Limestone Bedrock Sound		2	BXL RC	Rec 100%			RQD 95%
63.2								
12.0	End of Borehole							

DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100
SHEAR STRENGTH o UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE
PLASTIC LIMIT Wp | NATURAL MOISTURE CONTENT W | LIQUID LIMIT W_L — WATER CONTENT (%)
UNIT WEIGHT γ

RECORD OF BOREHOLE No 127 METRIC

W P 134-74-01 LOCATION Coords. N 4 889 429.3; E 233 944.0 ORIGINATED BY MM
DIST 8 HWY 14 BOREHOLE TYPE Hollow Stem Augers and BXL Rock Core & Cone Test COMPILED BY MM
DATUM Geodetic DATE 1979 05 11 CHECKED BY

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES 'N' VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
75.2	Water Surface							
0.0	Water						74 / 72	
72.4	Bay Bottom							
2.8	Cobbles & Boulders ~~~ Sandy Silt With Organics, Trace of Gravel, Very Loose		1	SS	1			
70.9								
4.3	Limestone Bedrock Fractured		2	BXL RC	Rec 90%			RQD 45%
70.0								
5.2	End of Borehole							

50/0.21 m

DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100
SHEAR STRENGTH o UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE
PLASTIC LIMIT Wp | NATURAL MOISTURE CONTENT W | LIQUID LIMIT W_L — WATER CONTENT (%)
UNIT WEIGHT γ

$+^3$, $\times^5$: Numbers refer to Sensitivity

$\frac{20}{15 \diamond 5}$ (%) STRAIN AT FAILURE
10

Ministry of Transportation and Communications
Ontario

HIGHWAY ENGINEERING DIVISION - ENGINEERING MATERIALS OFFICE - SOIL MECHANICS SECTION

RECORD OF BOREHOLE No 128 METRIC

W P 134-74-01 LOCATION Coords. N 4 889 437.3; E 233 935.0 ORIGINATED BY MM
DIST 8 HWY 14 BOREHOLE TYPE Diamond Drilling With BX Casing COMPILED BY MM
DATUM Geodetic DATE 1979 05 14 CHECKED BY RS

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES 'N' VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE)	PLASTIC LIMIT Wp / NATURAL MOISTURE CONTENT W / LIQUID LIMIT Wl — WATER CONTENT (%)	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
75.2	Water Surface										
0.0	Water						74				
72.7	Bay Bottom										
2.5	Cobbles & Boulders										
	Sandy Silt With Organics Trace of Gravel		1	BXL RC	Rec	10%	72				
70.3	Very Loose										
4.9	Limestone Bedrock		2	BXL RC	Rec	100% RQD 30%					
	Fractured		3	BXL RC	Rec RQD	90% 55%	70				Packer Test A
	Sound		4	BXL RC	Rec RQD	100% 95%	68				Packer Test B
67.0											
8.2	End of Borehole										

Packer Test A (Elevation 70.2 to 68.6)

Pressure 70 kPa

Time	Flow Litres Per Minute
1 min.	13.6
2 min.	15.4
5 min.	18.6
10 min.	20.8
15 min.	20.8

Packer Test B (Elevation 68.6 to 67.0)

Pressure 70 kPa

Time Min.	Flow Litres Per Minute
1 min.	0.5
2 min.	0.5
5 min.	0.5
10 min.	0.5

Pressure 140 kPa

Time Min.	Flow Litres Per Minute
1 min.	0.5
2 min.	0.5
5 min.	0.5
10 min.	0.5

+3, ×5 : Numbers refer to Sensitivity

20 / 15 ◇ 5 / 10 (%) STRAIN AT FAILURE

Ontario Transportation and Communications

HIGHWAY ENGINEERING DIVISION - ENGINEERING MATERIALS OFFICE - SOIL MECHANICS SECTION

RECORD OF BOREHOLE No 129 METRIC

W P 134-74-01 LOCATION Coords. N 4 889 422.0; E 233 974.5 ORIGINATED BY MM

DIST 8 HWY 14 BOREHOLE TYPE Diamond Drilling With BX Casing COMPILED BY MM

DATUM Geodetic DATE 1979 05 14 CHECKED BY

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES 'N' VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH (o UNCONFINED, • QUICK TRIAXIAL, + FIELD VANE, x LAB VANE) / WATER CONTENT (%) (PLASTIC LIMIT Wp, NATURAL MOISTURE CONTENT W, LIQUID LIMIT WL)	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
75.2	Water Surface					▼				
0.0	Water						74			
72.9	Bay Bottom									
2.3	Cobbles and Boulders									
2.9	Sandy Silt With Organics, Trace of Gravel, Very Loose		1	SS	1					
	Refusal to Driving Casing									
	Probable Bedrock									
	End of Borehole									

RECORD OF BOREHOLE No 302 METRIC

W P 134-74-01 LOCATION COORDS: N 4 890 406.0; E 233 748.0 ORIGINATED BY BRL

DIST 8 HWY 14 BOREHOLE TYPE Hollow Stem Auger & Cone Test COMPILED BY BRL

DATUM Geodetic DATE 79 05 08 CHECKED BY

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES 'N' VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (o UNCONFINED, • QUICK TRIAXIAL, + FIELD VANE, x LAB VANE) / WATER CONTENT (%) (PLASTIC LIMIT Wp, NATURAL MOISTURE CONTENT W, LIQUID LIMIT WL)	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
76.2	Ground Surface					▼				
0.0	Fill, Gravelly Sand With Pockets of Organic Silt		1	SS	8		76	o		42 43 (15)
	Sanitary Land Fill Metal, Plastic, and Mortar Refuse		2	SS	1					
			3	SS	12		74			
			4	SS	8					
			5	SS	24		72			
	Sandy Gravel, Trace of Silt		6	SS	30			o		46 45 (9)
70.4										
5.8	Clay, Stiff to Very Stiff		7	SS	5		70	+		
67.7			8	SS	4		68			
8.5	Glacial Till, Hard							131/0.31 m		
67.1										
9.1	End of Borehole Refusal to Auger Probable Bedrock									

+3, x5 : Numbers refer to Sensitivity

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

Ontario Ministry of Transportation and Communications

HIGHWAY ENGINEERING DIVISION - ENGINEERING MATERIALS OFFICE - SOIL MECHANICS SECTION

RECORD OF BOREHOLE No 304 METRIC

W P 134-74-01 LOCATION COORDS: N 4 890 416.0; E 233 722.3 ORIGINATED BY BRL

DIST 8 HWY 14 BOREHOLE TYPE Hollow Stem Augers COMPILED BY BRL

DATUM Geodetic DATE 79 05 08 CHECKED BY RS

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES 'N' VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH kPa	WATER CONTENT (%) Wp W WL	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
76.2	Ground Surface										
0.0	Fill, Gravelly Sand, Some Silt, Trace Clay With Pockets of Organic Silt		1	SS	8	▼	76		o		25 42 23 10
	Sanitary Land Fill; Plastic, Metal, Wood, and Mortar Debris		2	SS	8						
			3	SS	2		74				
			4	SS	13						
	Sandy Gravel, Trace of Silt		5	SS	34		72		o		
71.2			6	SS	35			Cannot Push Vane			
5.0	Clay, Stiff to Very Stiff		7	SS	11		70	+2			
68.3											
7.9	Glacial Till, Hard		8	SS	50/	0.15m	68				
67.4											
8.8	Refusal to Auger Probable Bedrock										

RECORD OF BOREHOLE No306 METRIC

W P 134-74-01 LOCATION COORDS: N 4 890 414.4; E 233 713.7 ORIGINATED BY BRL

DIST 8 HWY 14 BOREHOLE TYPE Hollow Stem Auger & Cone Test COMPILED BY BRL

DATUM Geodetic DATE 79 05 09 CHECKED BY RS

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES 'N' VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH kPa	WATER CONTENT (%) Wp W WL	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
75.9	Ground Surface										
0.0	Fill Gravelly Sand, Some		1	SS	9	▼			o		
74.4	Silt, Trace Clay										
1.5	Organic Silt, Trace of		2	SS	2				o		
73.5	Sand, Soft						74				
2.4	Fill		3	SS	35						
	Gravelly Sand to Sandy Gravel, Some Silt, Trace Clay		4	SS	16				o		22 61 14 3
			5	SS	41		72				
70.9			6	SS	55				o		
5.0	Clay, Very Stiff		7	SS	16						
69.5							70	→100			
6.4	End of Borehole										

+3, ×5 : Numbers refer to Sensitivity

15 20 10 5 (%) STRAIN AT FAILURE

Ministry of Transportation and Communications
Ontario

HIGHWAY ENGINEERING DIVISION - ENGINEERING MATERIALS OFFICE - SOIL MECHANICS SECTION

RECORD OF BOREHOLE No 309 METRIC

W P 134-74-01 LOCATION COORDS: N 4 890 429.2; E 233 711.5 ORIGINATED BY BRL
DIST 8 HWY 14 BOREHOLE TYPE Hollow Stem Auger & Cone Test COMPILED BY BRL
DATUM Geodetic DATE 79 05 08 CHECKED BY RS

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES 'N' VALUES	GROUND WATER CONDITIONS
76.2	Ground Surface					
0.0	Fill					
	Gravelly Sand, Some Silt, Trace Clay		1	SS	19	▼
			2	SS	8	
73.9						
2.3	Organic Clay With Wood Debris, Firm to Stiff		3	SS	2	
			4	SS	2	
72.5						
3.7	Fill, Gravelly Sand to Some Sandy Gravel, Some Silt, Trace Clay		5	SS	19	
			6	SS	37	
71.2						
5.0	Clay, Very Stiff to Stiff					
			7	SS	9	
68.3						
7.9	Glacial Till, Hard		8	SS	17	
67.7						
8.5	Refusal to Auger Probable Bedrock End of Borehole					

ELEVATION SCALE: 76, 74, 72, 70, 68

DYNAMIC CONE PENETRATION RESISTANCE PLOT: 20 40 60 80 100
SHEAR STRENGTH kPa
○ UNCONFINED + FIELD VANE
● QUICK TRIAXIAL × LAB VANE
20 40 60 80 100
+3, +5, +7, +6, 80/0.28

PLASTIC LIMIT W_P NATURAL MOISTURE CONTENT W LIQUID LIMIT W_L
WATER CONTENT (%) 20 40 60

UNIT WEIGHT γ

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

RECORD OF BOREHOLE No 310 METRIC

W P 134-74-01 LOCATION COORDS: N 4 890 445.5; 233 715.5 ORIGINATED BY BRL
DIST 8 HWY 14 BOREHOLE TYPE Hollow Stem Auger and Cone Test COMPILED BY BRL
DATUM Geodetic DATE 79 05 09 CHECKED BY RS

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES 'N' VALUES	GROUND WATER CONDITIONS
76.3	Ground Level					
0.0	Fill					
	Sandy Gravel, Some Silt, Trace Clay		1	SS	26	▼
	Sanitary Land Fill, Metal, Glass, and Wood Debris		2	SS	7	
			3	SS	11	
73.2						
3.1	Organic Clay, Trace of Sand, Firm		4	SS	3	
72.4						
3.9	Fill, Sandy Gravel, Trace Silt, Trace Clay		5	SS	30	
71.5						
4.8	Clay, Very Stiff		6	SS	19	
			7	SS	10	
68.4						
7.8	Glacial Till, Hard		8	SS	22	
67.8						
8.5	Refusal to Auger Probable Bedrock End of Borehole					

ELEVATION SCALE: 76, 74, 72, 70, 68

DYNAMIC CONE PENETRATION RESISTANCE PLOT: 20 40 60 80 100
SHEAR STRENGTH kPa
○ UNCONFINED + FIELD VANE
● QUICK TRIAXIAL × LAB VANE
20 40 60 80 100
+100, +100, 135, 75/0.18m

PLASTIC LIMIT W_P NATURAL MOISTURE CONTENT W LIQUID LIMIT W_L
WATER CONTENT (%) 20 40 60
W=126%

UNIT WEIGHT γ

REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
42 30 18 10
63 27 (10)

$+^3$, $\times^5$: Numbers refer to Sensitivity

20
15 ⊹ 5 (%) STRAIN AT FAILURE
10

Ontario Transportation and Communications

HIGHWAY ENGINEERING DIVISION - ENGINEERING MATERIALS OFFICE - SOIL MECHANICS SECTION

RECORD OF BOREHOLE No 314 METRIC

W P 134-74-01 LOCATION COORDS: N 4 890 463.0; 233 727.6 ORIGINATED BY BRL

DIST 8 HWY 14 BOREHOLE TYPE Hollow Stem Augers and Cone Test COMPILED BY BRL

DATUM Geodetic DATE 79 05 09 CHECKED BY

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES 'N' VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE
77.4	Ground Surface						
0.0	Fill						
	Sandy Gravel, Some Silt, Trace Clay		1	SS	14		
75.8							76
1.6	Clayey Silt, Some Sand		2	SS	6		
			3	SS	5		
	Sanitary Land Fill		4	SS	5		
73.6							74
3.8	Sandy Gravel to Gravelly Sand, Trace Silt, Trace Clay		5	SS	66		
			6	SS	81		
70.8							72
			7	SS	53		
6.6	Clay, Very Stiff						
			8	SS	9		70
68.8							
8.6	Glacial Till, Hard		9	SS	100/	0.09 m	68
68.1							
9.3	Refusal to Auger Probable Bedrock End of Borehole						

DYNAMIC CONE PENETRATION RESISTANCE PLOT: 20 40 60 80 100

SHEAR STRENGTH kPa: ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE

20 40 60 80 100

100

100

100/0.28m

PLASTIC LIMIT W_P NATURAL MOISTURE CONTENT W LIQUID LIMIT W_L

WATER CONTENT (%) 20 40 60

UNIT WEIGHT γ

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

RECORD OF BOREHOLE No 320 METRIC

W P 134-74-01 LOCATION COORDS: N 4 890 497.5; E 233 719.8 ORIGINATED BY BRL

DIST 8 HWY 14 BOREHOLE TYPE Hollow Stem Auger and Cone Test COMPILED BY BRL

DATUM Geodetic DATE 79 05 09 CHECKED BY

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES 'N' VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE
76.0	Ground Surface						
0.0	Fill						
	Silty Clay, Some Sand		1	SS	4		
			2	SS	5		
	Organic Clay, Firm		3	SS	74		74
73.5							
73.0	Gravelly Sand, S. Silt		4	SS	32		
3.0	Heterogeneous Mixture Clayey Silts, Sand and Gravel (Glacial Till), Hard		5	SS	56		
			6	SS	60/	0.10m	72
			7	SS	50/	0.13m	70
68.6							
7.4	Refusal to Auger Probable Bedrock End of Borehole						

DYNAMIC CONE PENETRATION RESISTANCE PLOT: 20 40 60 80 100

SHEAR STRENGTH kPa: ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE

130/0.23m

150/0.24m

PLASTIC LIMIT W_P NATURAL MOISTURE CONTENT W LIQUID LIMIT W_L

WATER CONTENT (%) 20 40 60

UNIT WEIGHT γ

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

0 28 47 25

$+^3$, $\times^5$: Numbers refer to Sensitivity

15 $\frac{20}{10}$ 5 (%) STRAIN AT FAILURE

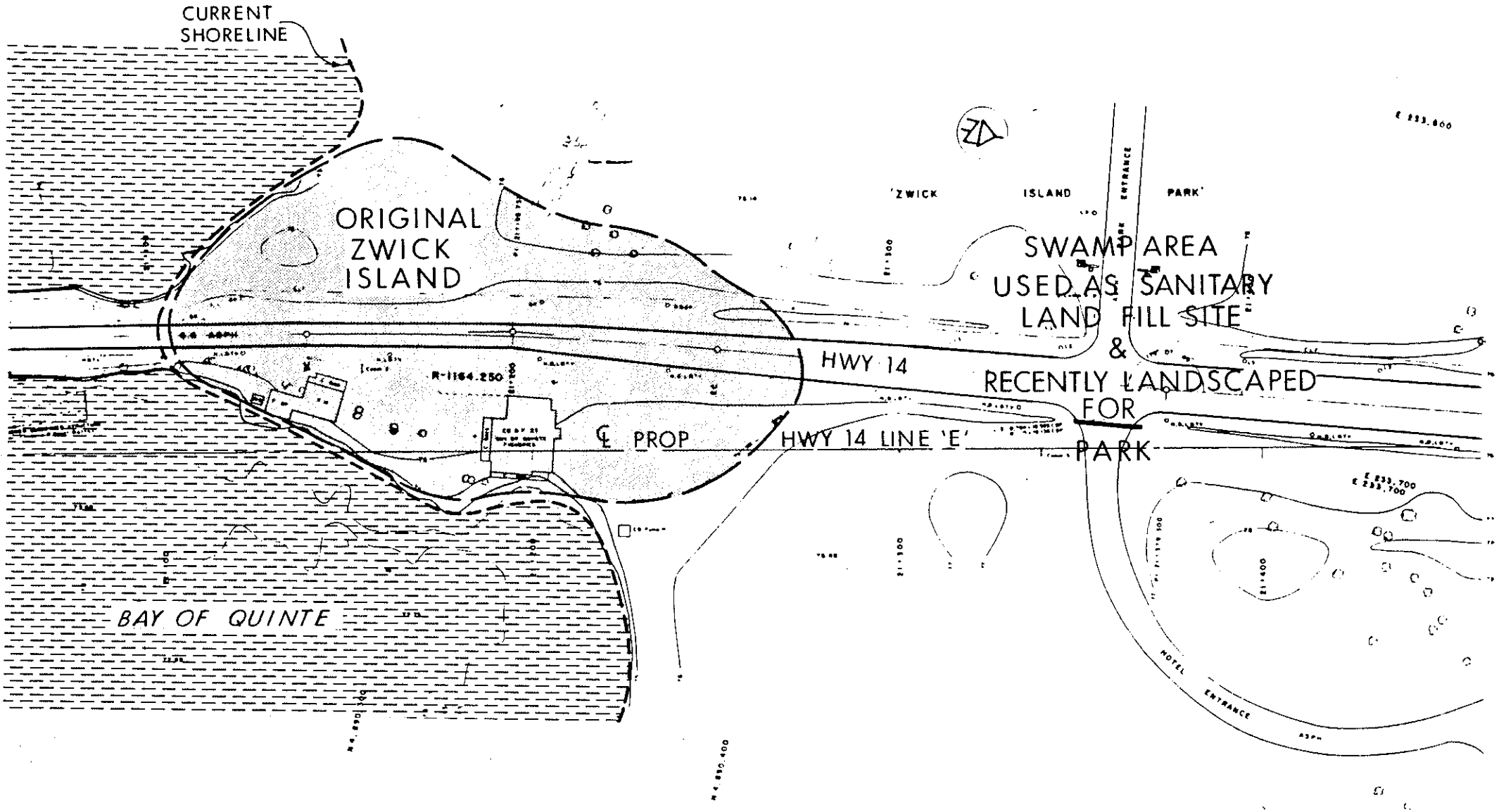
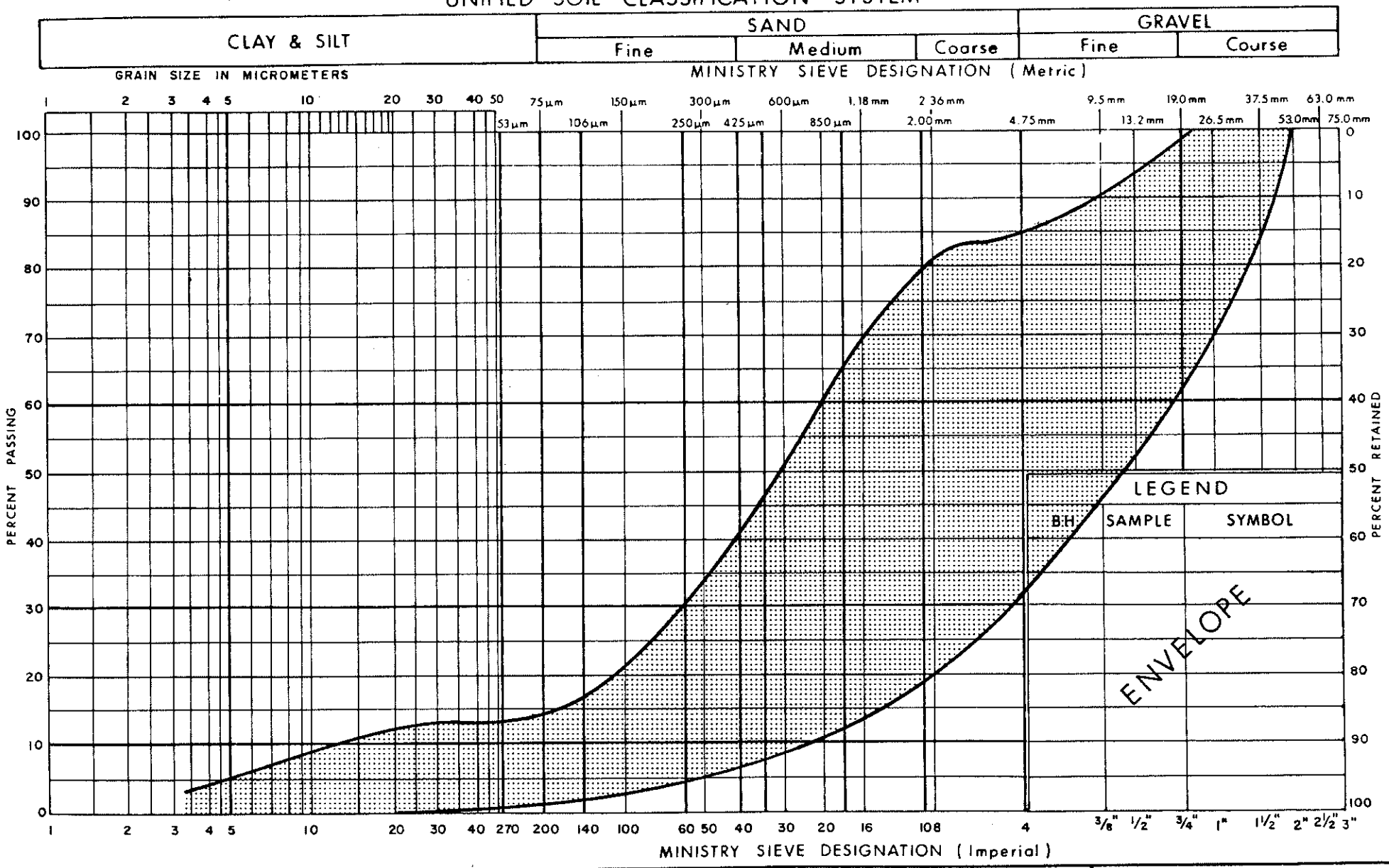


FIG 1 LOCATION OF ORIGINAL ZWICK ISLAND

WP 134-74-01

UNIFIED SOIL CLASSIFICATION SYSTEM



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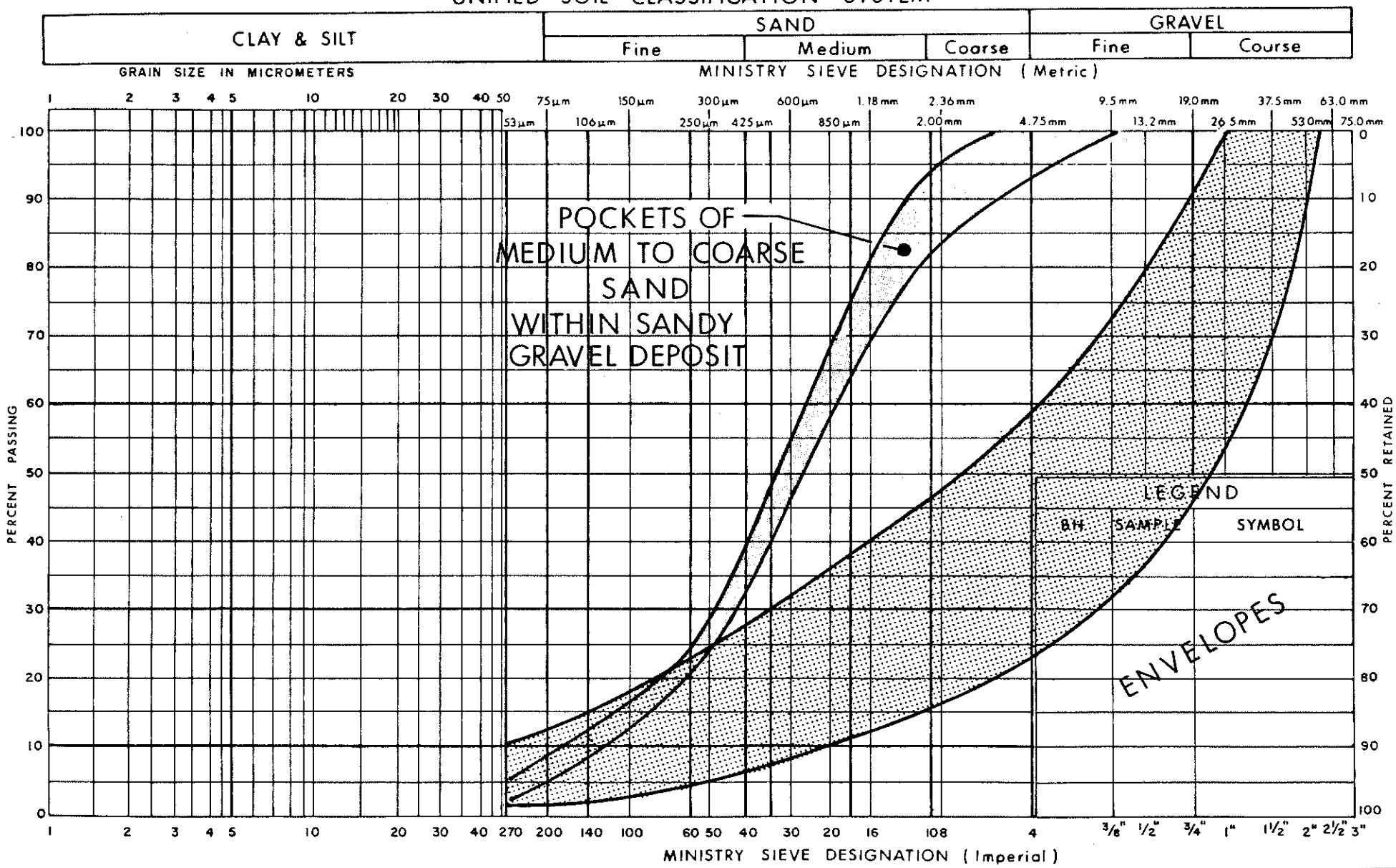
Ontario

GRAIN SIZE DISTRIBUTION
FILL
GRAVELLY SAND TO SANDY GRAVEL
TRACE TO SOME SILT, TRACE OF CLAY

FIG No 2
W P 134 - 74 - 01

UNIFIED SOIL CLASSIFICATION SYSTEM



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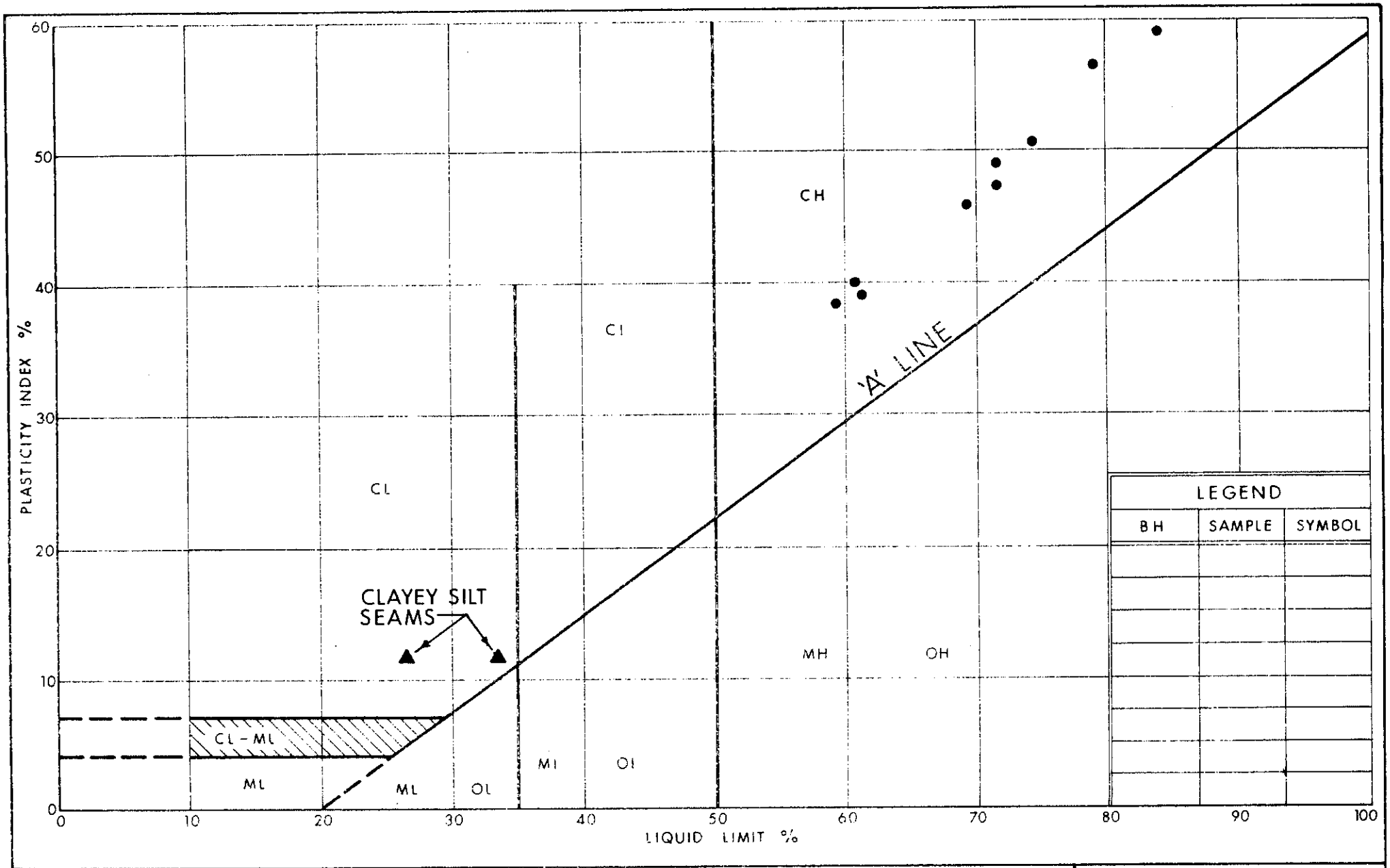
Ontario

GRAIN SIZE DISTRIBUTION
SANDY GRAVEL
TRACE TO SOME SILT, TRACE OF CLAY

FIG No 3
W P 134 - 74 - 01



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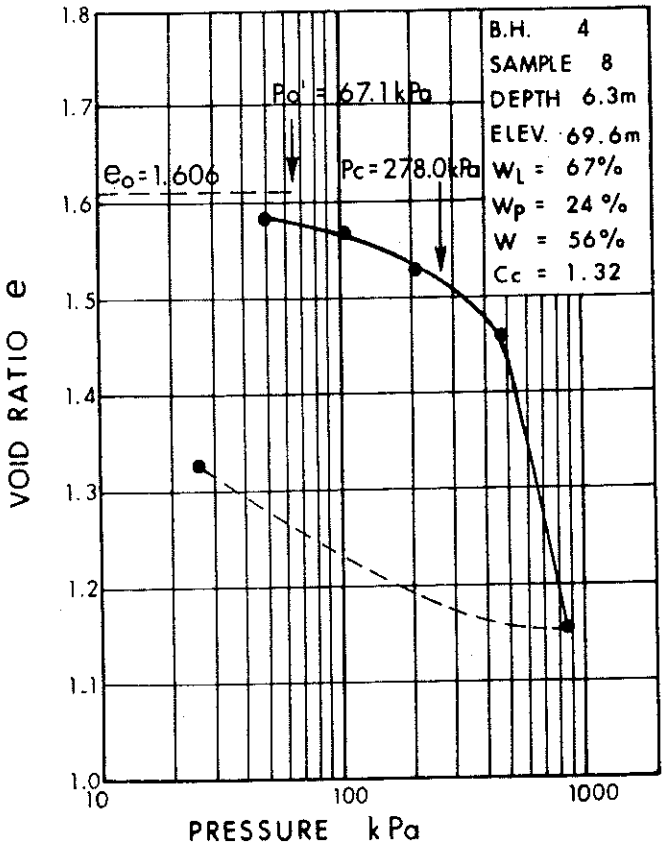
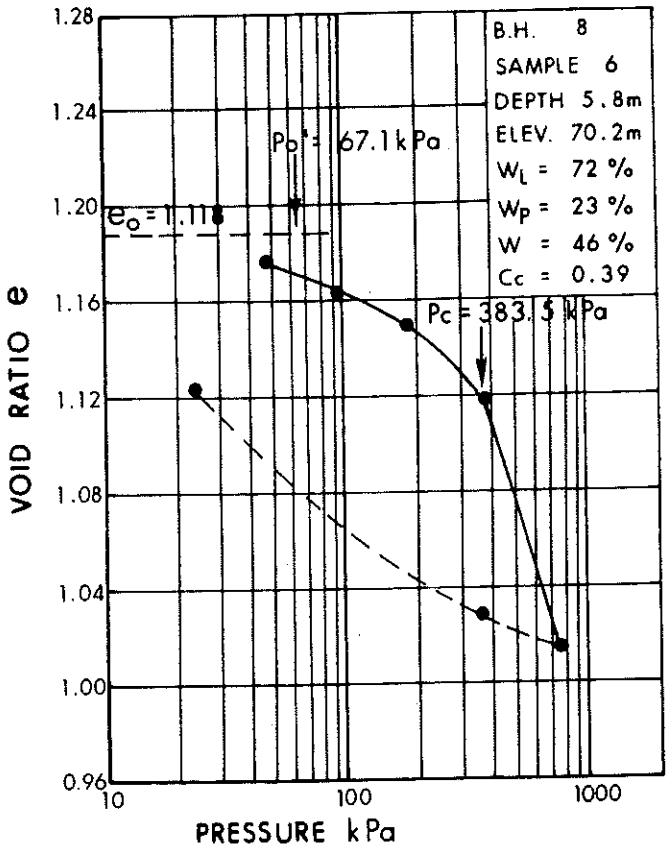
PLASTICITY CHART
CLAY

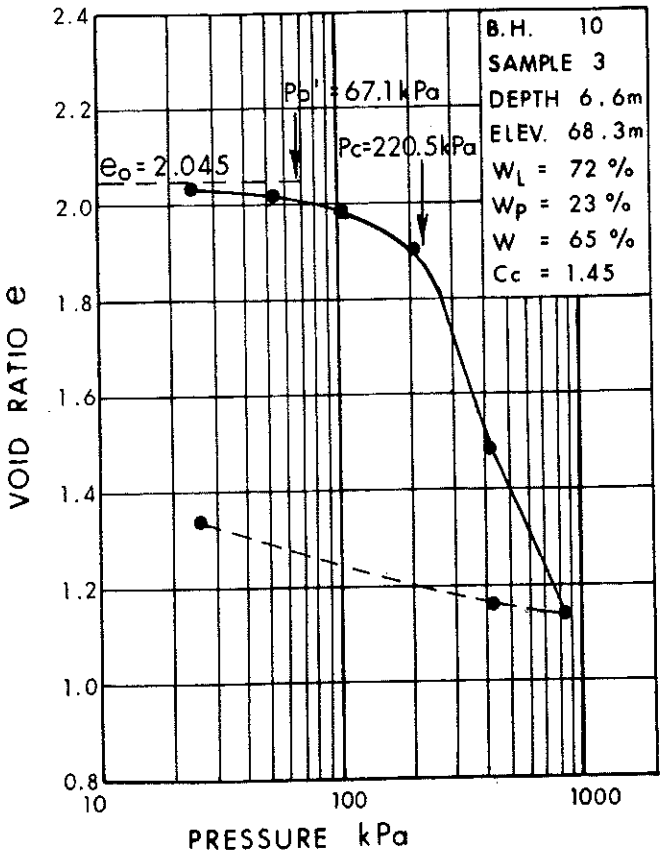
FIG No 4
W P 134 - 74 - 01

VOID RATIO - PRESSURE CURVES

WP 134 - 74 - 01







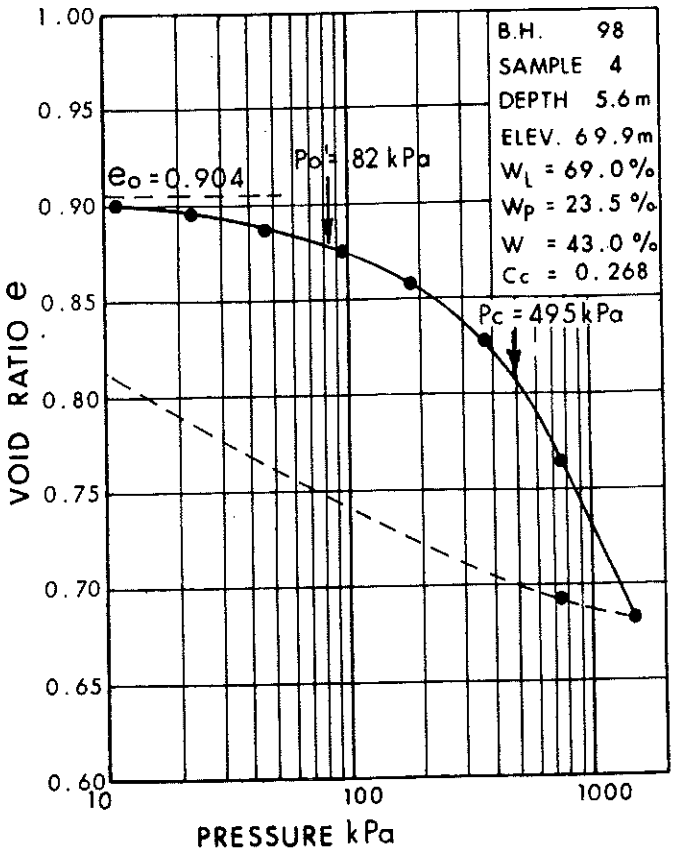
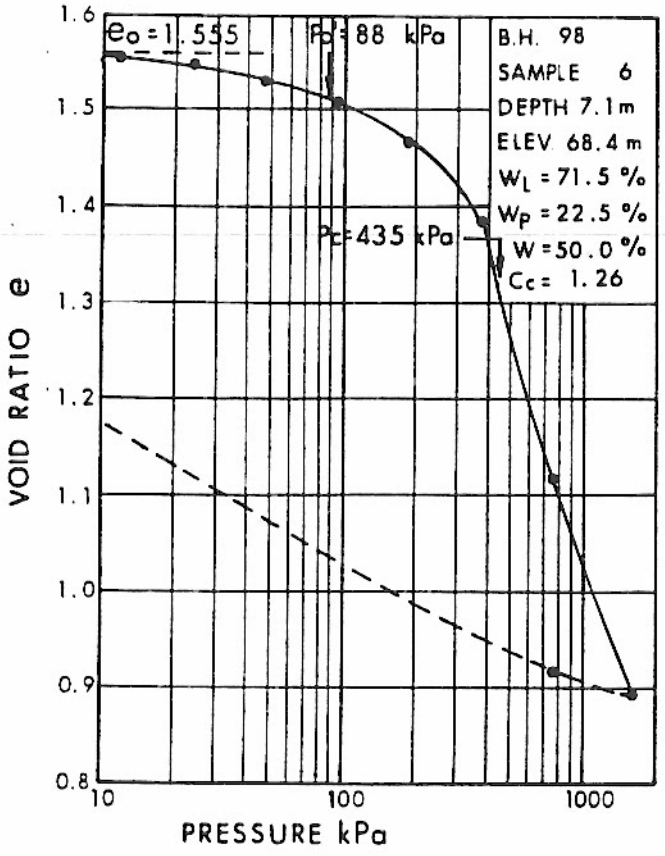
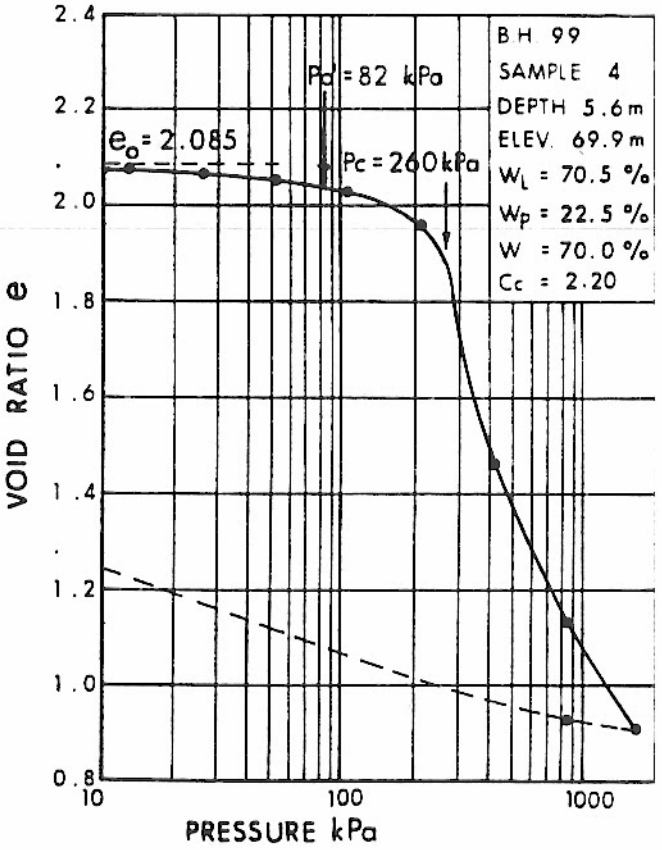


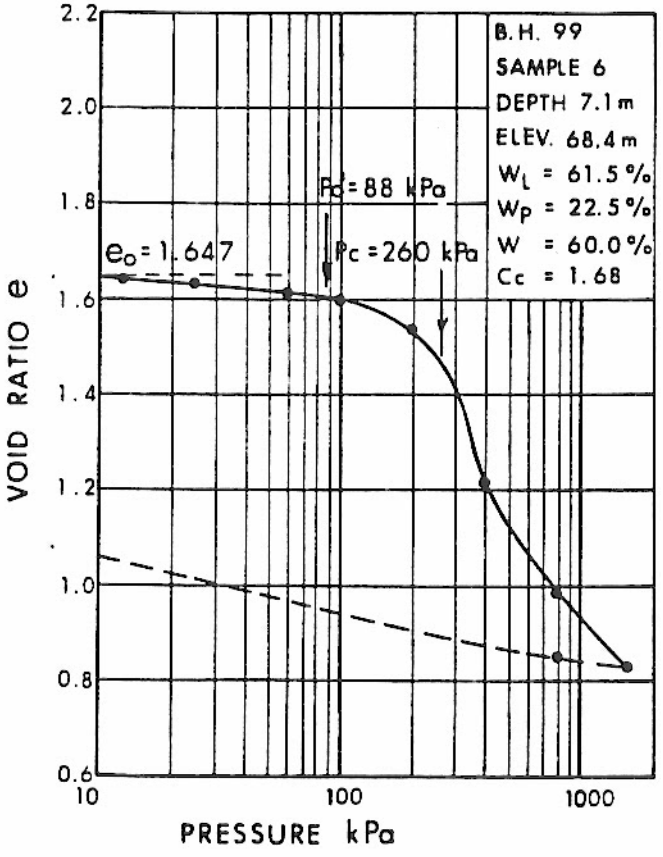
FIG. 5

VOID RATIO – PRESSURE CURVES

WP 134 - 74 - 01







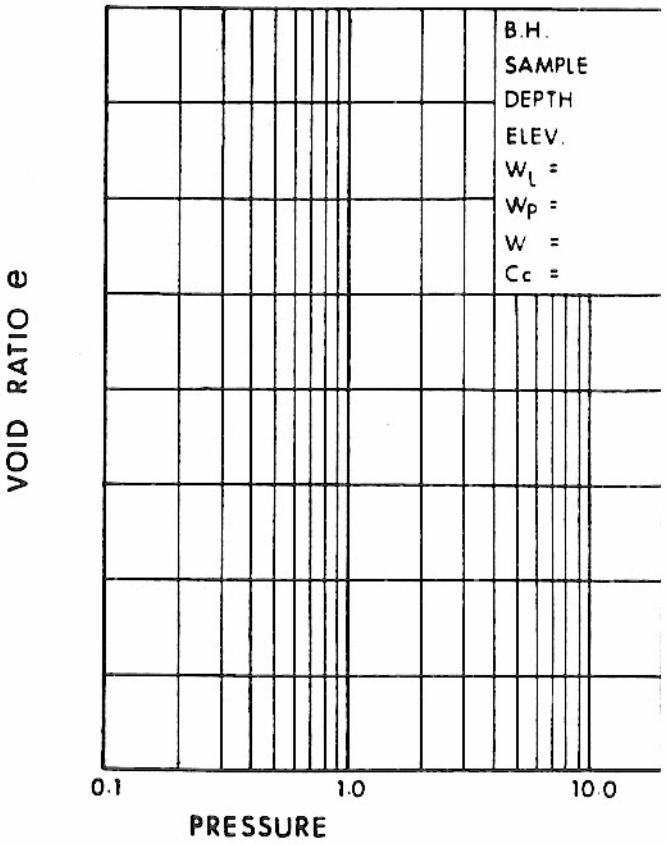
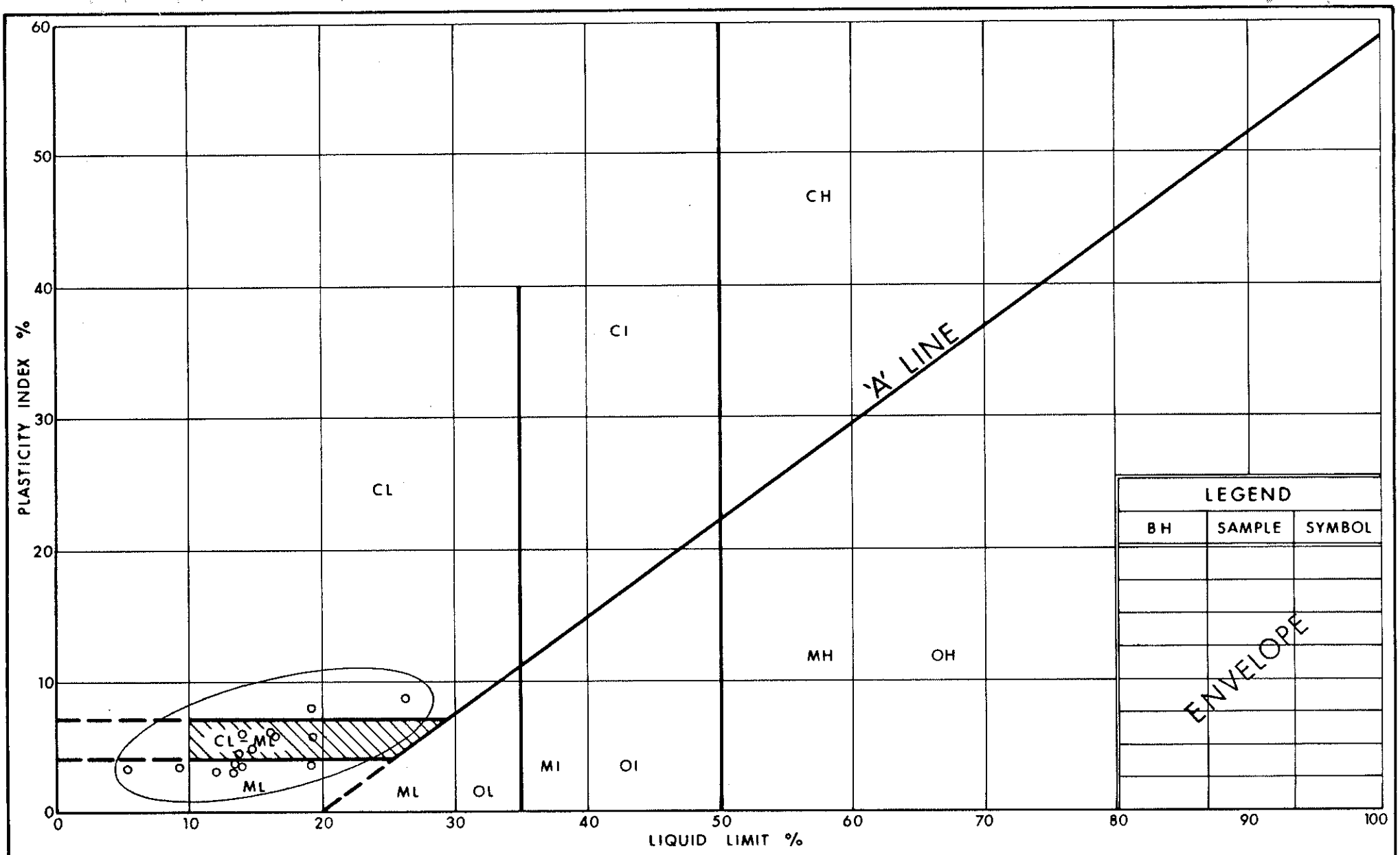


FIG. 6

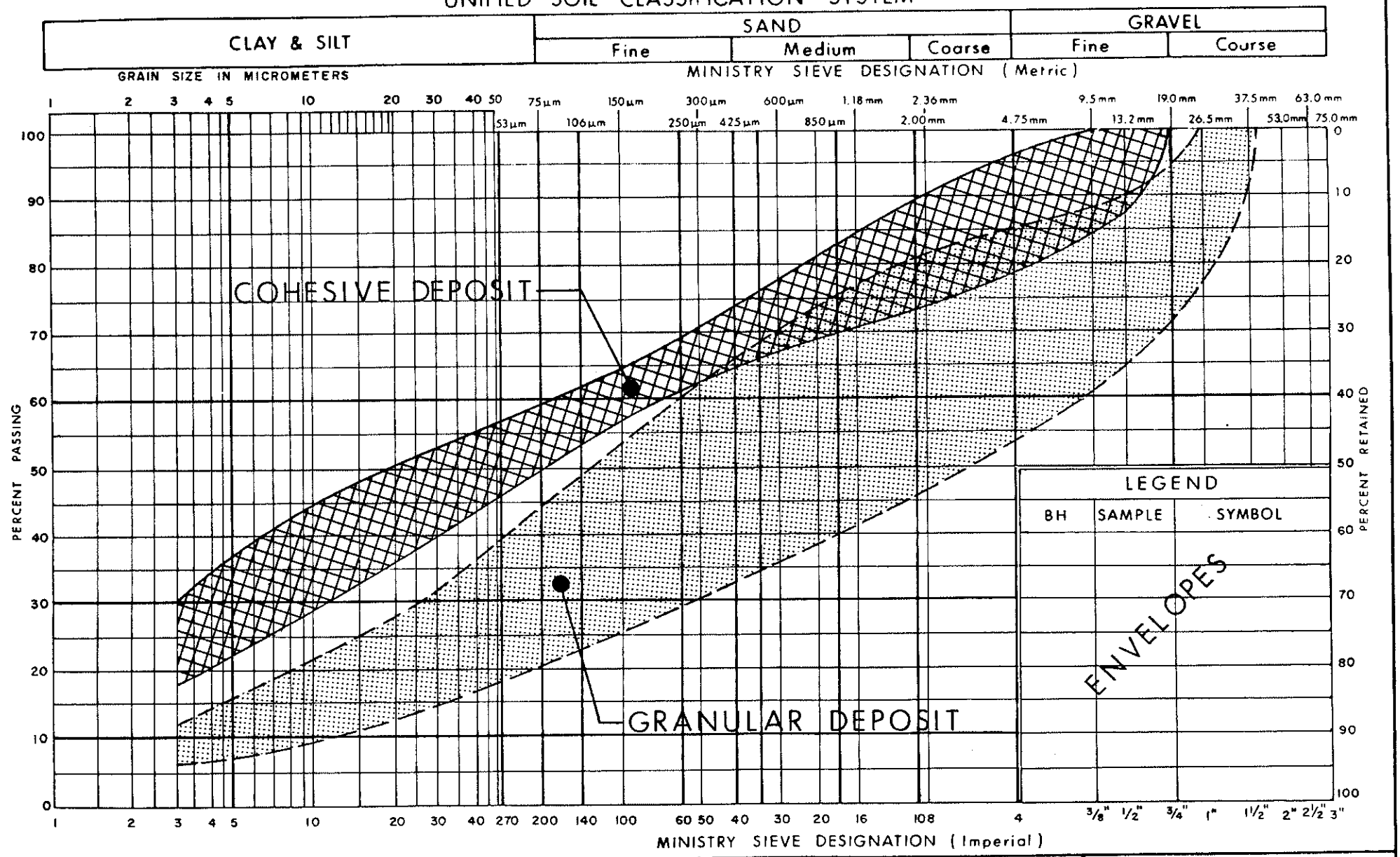


Ministry of Transportation and Communications
Ontario
ENGINEERING SERVICES BRANCH

PLASTICITY CHART
GLACIAL TILL (cohesive portion)

FIG No 7
W P 134-74-01

UNIFIED SOIL CLASSIFICATION SYSTEM



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Ontario

GRAIN SIZE DISTRIBUTION

GLACIAL TILL

FIG No 8

W P 134-74-01

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 475 J 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:

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

ABBREVIATIONS AND SYMBOLS

FIELD SAMPLING

S S	SPLIT SPOON	T P	THINWALL PISTON
W S	WASH SAMPLE	O S	OSTERBERG SAMPLE
S T	SLOTTED TUBE SAMPLE	R C	ROCK CORE
B S	BLOCK SAMPLE	P H	T W ADVANCED HYDRAULICALLY
C S	CHUNK SAMPLE	P M	T W ADVANCED MANUALLY
T W	THINWALL OPEN	F S	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_f	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_R	kPa	RESIDUAL SHEAR STRENGTH
τ_r	kPa	REMOULDED SHEAR STRENGTH
S_t	1	SENSITIVITY = $\frac{c_u}{\tau_r}$

PHYSICAL PROPERTIES OF SOIL

ρ_s	kg/m^3	DENSITY OF SOLID PARTICLES
γ_s	kN/m^3	UNIT WEIGHT OF SOLID PARTICLES
ρ_w	kg/m^3	DENSITY OF WATER
γ_w	kN/m^3	UNIT WEIGHT OF WATER
ρ	kg/m^3	DENSITY OF SOIL
γ	kN/m^3	UNIT WEIGHT OF SOIL
ρ_d	kg/m^3	DENSITY OF DRY SOIL
γ_d	kN/m^3	UNIT WEIGHT OF DRY SOIL
ρ_{sat}	kg/m^3	DENSITY OF SATURATED SOIL
γ_{sat}	kN/m^3	UNIT WEIGHT OF SATURATED SOIL
ρ'	kg/m^3	DENSITY OF SUBMERGED SOIL
γ'	kN/m^3	UNIT WEIGHT OF SUBMERGED SOIL

e	1,%	VOID RATIO
n	1,%	POROSITY
w	1,%	WATER CONTENT
S_r	%	DEGREE OF SATURATION
w_L	%	LIQUID LIMIT
w_p	%	PLASTIC LIMIT
w_S	%	SHRINKAGE LIMIT
I_p	%	PLASTICITY INDEX = $w_L - w_p$
I_L	1	LIQUIDITY INDEX = $\frac{w - w_p}{I_p}$
I_C	1	CONSISTENCY INDEX = $\frac{w_L - w}{I_p}$
e_{max}	1,%	VOID RATIO IN LOOSEST STATE

e_{min}	1,%	VOID RATIO IN DENSEST STATE
I_D	1	DENSITY INDEX = $\frac{e_{max} - e}{e_{max} - e_{min}}$
D	mm	GRAIN DIAMETER
D_n	mm	n PERCENT - DIAMETER
C_U	1	UNIFORMITY COEFFICIENT
h	m	HYDRAULIC HEAD OR POTENTIAL
q	m^3/s	RATE OF DISCHARGE
v	m/s	DISCHARGE VELOCITY
i	1	HYDRAULIC GRADIENT
k	m/s	HYDRAULIC CONDUCTIVITY
j	kN/m^3	SEEPAGE FORCE

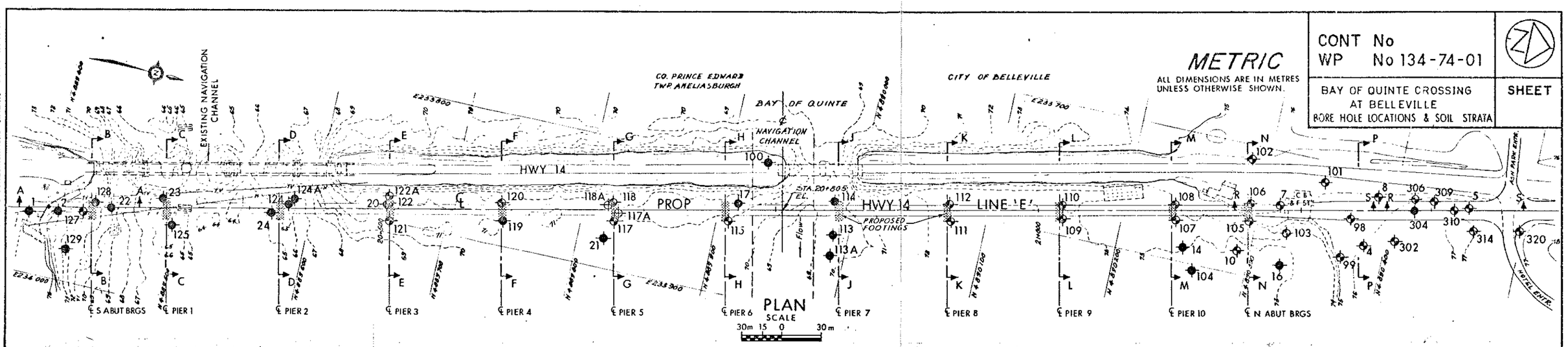
MINISTRY OF TRANSPORTATION AND COMMUNICATIONS ONTARIO DS-ER 15M 79 01

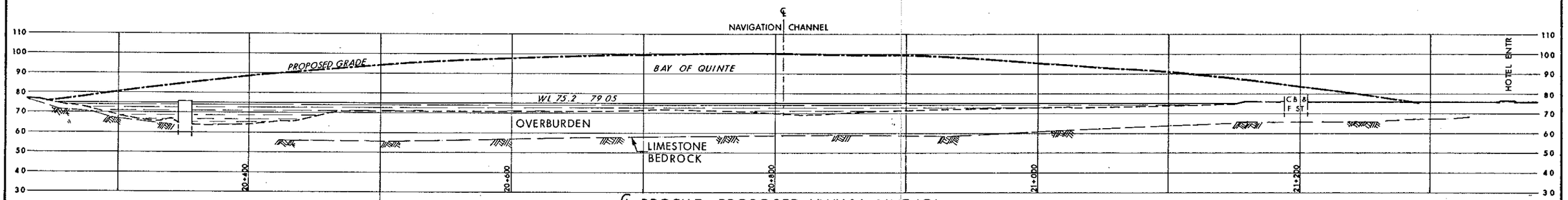
CONT No
WP No 134-74-01

BAY OF QUINTE CROSSING AT BELLEVILLE
BORE HOLE LOCATIONS & SOIL STRATA

SHEET

METRIC
ALL DIMENSIONS ARE IN METRES UNLESS OTHERWISE SHOWN.



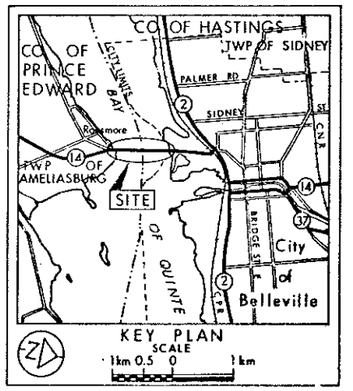


℄ PROFILE - PROPOSED HWY 14 LINE 'E'
SCALE
HOR 30m 15 0 30m
VERT 20m 10 0 20m

DATE OF INVESTIGATION 1977 05 & 06

BORE HOLE LOCATION			
No	ELEVATION	CO-ORDINATES NORTH	CO-ORDINATES EAST
1	77.1	4 889 389.0	233 952.5
2	75.1	4 889 410.0	233 947.5
4	75.9	4 890 383.5	233 756.0
5	76.4	4 890 456.0	233 711.0
7	75.9	4 890 315.0	233 740.6
8	76.0	4 890 387.0	233 717.3
10	74.9	4 890 291.0	233 780.6
14	74.9	4 890 249.2	233 787.1
16	74.9	4 890 324.0	233 785.5
17	74.9	4 889 913.0	233 828.2
20	74.9	4 889 655.2	233 888.2
21	74.9	4 889 819.5	233 876.1
22	74.9	4 889 449.7	233 936.0
23	74.9	4 889 487.1	233 920.2
24	74.9	4 889 569.2	233 913.0
98	75.5	4 890 370.0	233 738.7
99	75.2	4 890 368.0	233 768.5
100	77.5	4 889 928.0	233 793.3
101	76.2	4 890 344.2	233 715.6
102	76.3	4 890 287.0	233 710.0
103	74.7	4 890 324.2	233 759.0
104	75.2	4 890 260.0	233 803.8
105	74.7	4 890 295.7	233 757.0
106	76.3	4 890 293.5	233 743.5
107	74.7	4 890 239.5	233 768.0
108	74.7	4 890 237.0	233 757.0
109	74.7	4 890 156.5	233 786.5
110	74.7	4 890 154.0	233 775.0
111	74.7	4 890 074.5	233 806.0
112	74.7	4 890 071.0	233 793.2

BORE HOLE LOCATION			
No	ELEVATION	CO-ORDINATES NORTH	CO-ORDINATES EAST
113	75.2	4 889 988.0	233 835.7
113A	75.2	4 889 989.0	233 852.4
114	75.2	4 889 984.6	233 810.6
115	74.7	4 889 908.7	233 843.5
117	74.7	4 889 824.5	233 862.0
117A	74.7	4 889 826.0	233 855.0
118	74.7	4 889 821.5	233 848.4
118A	74.7	4 889 817.5	233 851.3
119	74.7	4 889 742.0	233 880.8
120	74.7	4 889 738.5	233 866.5
121	74.7	4 889 659.0	233 899.3
122	74.7	4 889 656.0	233 886.5
122A	74.7	4 889 654.6	233 880.8
124	75.2	4 889 581.0	233 903.0
124A	75.2	4 889 584.5	233 898.4
125	75.2	4 889 498.0	233 938.5
127	75.2	4 889 429.3	233 942.0
128	75.2	4 889 437.3	233 935.0
129	75.2	4 889 422.0	233 974.5
302	76.2	4 890 406.0	233 748.0
304	76.2	4 890 416.0	233 722.3
306	75.9	4 890 414.4	233 713.7
309	76.2	4 890 429.2	233 711.5
310	76.3	4 890 445.5	233 715.5
314	77.4	4 890 463.0	233 727.6
320	76.0	4 890 497.5	233 719.8



LEGEND

- Bore Hole
- Dynamic Cone Penetration Test (Cone)
- Bore Hole & Cone
- N Blows/0.3m (Std Pen Test, 475 J/blow)
- CONE Blows/0.3m (60° Cone, 475 J/blow)
- W L at time of investigation

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

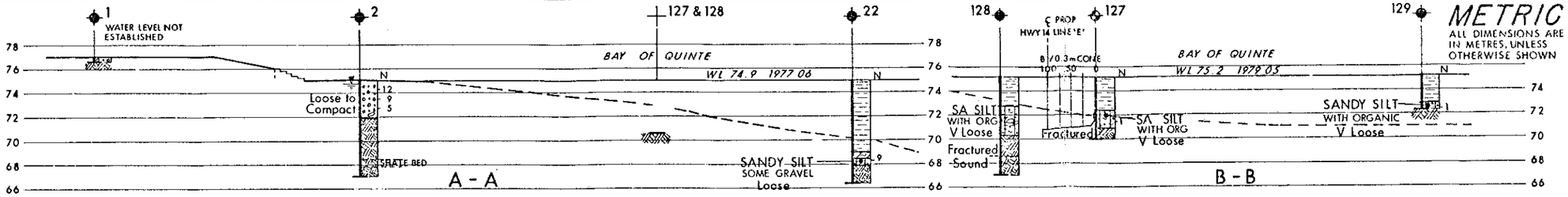
REVISIONS		
DATE	BY	DESCRIPTION

Geocres No 31 C-135

REF No. STRUCTURAL DWG 28-28-1; 1979 01

HWY No 14 LINE 'E'			DIST 8
SUBM'D MM	CHECKED	DATE 1979 08 03	SITE 28-28
DRAWN R S	CHECKED	APPROVED	DWG 1347401-A

MINISTRY OF TRANSPORTATION AND COMMUNICATIONS, ONTARIO 08-MT-308M 6-78

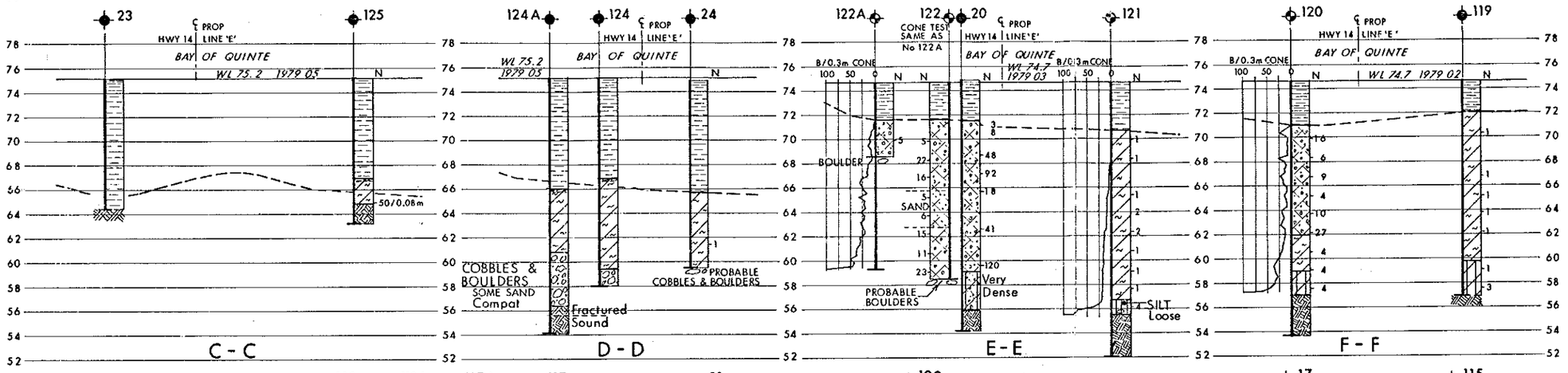


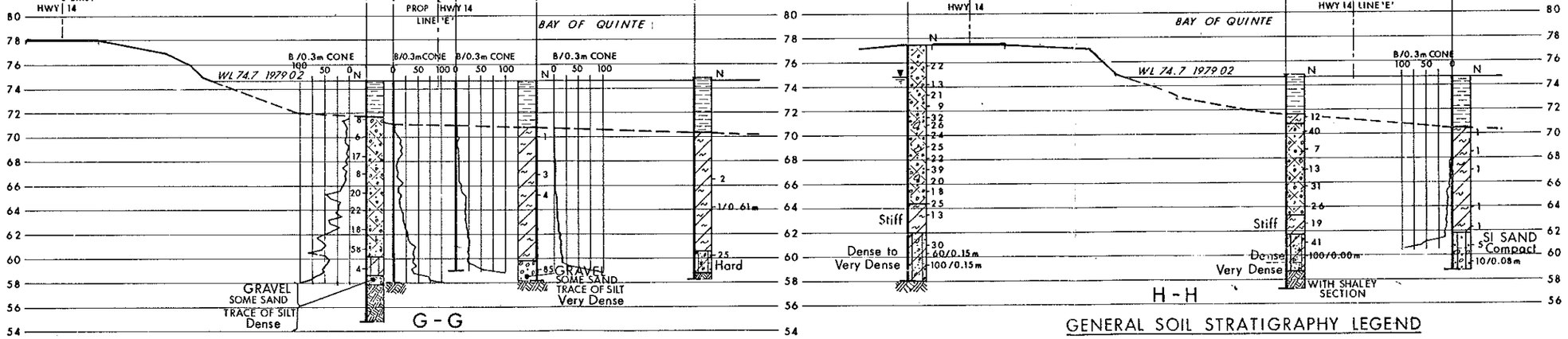
METRIC
ALL DIMENSIONS ARE IN METRES, UNLESS OTHERWISE SHOWN

CONT No
WP No 134 - 74 - 01

BAY OF QUINTE CROSSING AT BELLEVILLE
BORE HOLE LOCATIONS & SOIL STRATA

SHEET





SECTIONS
SCALE
5m 4 3 2 1 0 5m

SEE DWG 1347401 - A

KEY PLAN
SCALE

LEGEND

- Bore Hole
- Dynamic Cone Penetration Test (Cone)
- Bore Hole & Cone
- N Blows/0.3m (Std Pen Test, 475 J/blow)
- CONE Blows/0.3m (60° Cone, 475 J/blow)
- W L at time of investigation
  1977 05 & 06
  1979 02 to 05
  W L NOT Established for Bore Hole No 1
- — — Bottom of Bay from Contours.

No	ELEVATION		

GENERAL SOIL STRATIGRAPHY LEGEND

- WATER
- ORGANIC CLAY — Very Soft to Firm
- CLAY — Firm to Stiff
- FILL — GRAVELLY SAND TO SANDY GRAVEL
- CLAYEY SILT TO SILT — OF SLIGHT PLASTICITY, TRACE OF SAND, Loose
- SANDY GRAVEL — SOME SILT, TRACE OF CLAY, Compact to Very Dense
- GLACIAL TILL
- LIMESTONE BEDROCK — Sound
- PROBABLE BEDROCK

NOTE:
SEE BORE HOLE LOGS FOR COMPLETE SOIL DETAILS.

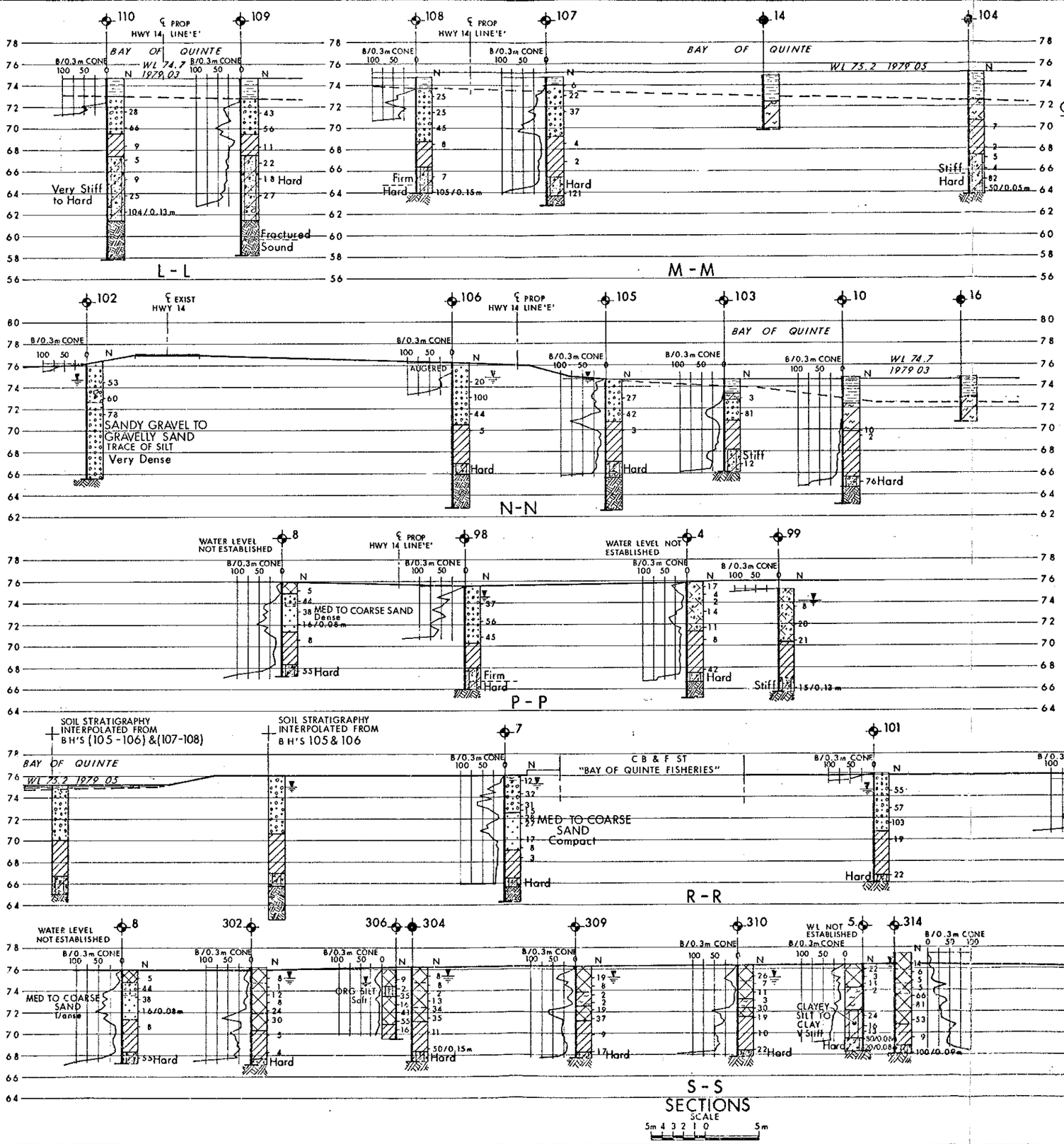
NOTE
The boundaries between soil strata have been established only at Bore Hole locations. Between Bore Holes the boundaries are assumed from geological evidence.

REVISIONS			
	DATE	BY	DESCRIPTION

Geocres No 31C - 135

HWY No 14 LINE 'E'			DIST 8
SUBM'D M M	CHECKED	DATE 1979 08 03	SITE 28 - 28
DRAWN R S	CHECKED	APPROVED	DWG 1347401 - B

MINISTRY OF TRANSPORTATION AND COMMUNICATIONS, ONTARIO 08-MT-308M 6-78



METRIC

ALL DIMENSIONS ARE IN METRES UNLESS OTHERWISE SHOWN.

CONT No
WP No 134-74-01

BAY OF QUINTE CROSSING
AT BELLEVILLE
BORE HOLE LOCATIONS & SOIL STRATA

SHEET

GENERAL SOIL STRATIGRAPHY LEGEND

- WATER
- ORGANIC CLAY — Very Soft to Firm
- CLAY — Firm to Very Stiff
- FILL — GRAVELLY SAND TO SANDY GRAVEL
- FILL — SAND, GRAVEL, CLAYEY SILT & SANITARY LANDFILL
- SANDY GRAVEL — Compact to Very Dense
- GLACIAL TILL
- LIMESTONE BEDROCK — Sound
- PROBABLE BEDROCK

NOTE:
SEE BORE HOLE LOGS FOR COMPLETE SOIL DETAILS

SEE DWG 1347401-A

KEY PLAN
SCALE

LEGEND

- Bore Hole
- Dynamic Cone Penetration Test (Cone)
- Bore Hole & Cone
- N — Blows/0.3m (Std Pen Test, 475 J/blow)
- CONE — Blows/0.3m (60° Cone, 475 J/blow)
- W L at time of investigation
  1977 05 & 06
  1979 02 to 05
  W L NOT Established for Bore Holes No 4, 5 & 8
- Bottom of Bay from Contours

No	ELEVATION		

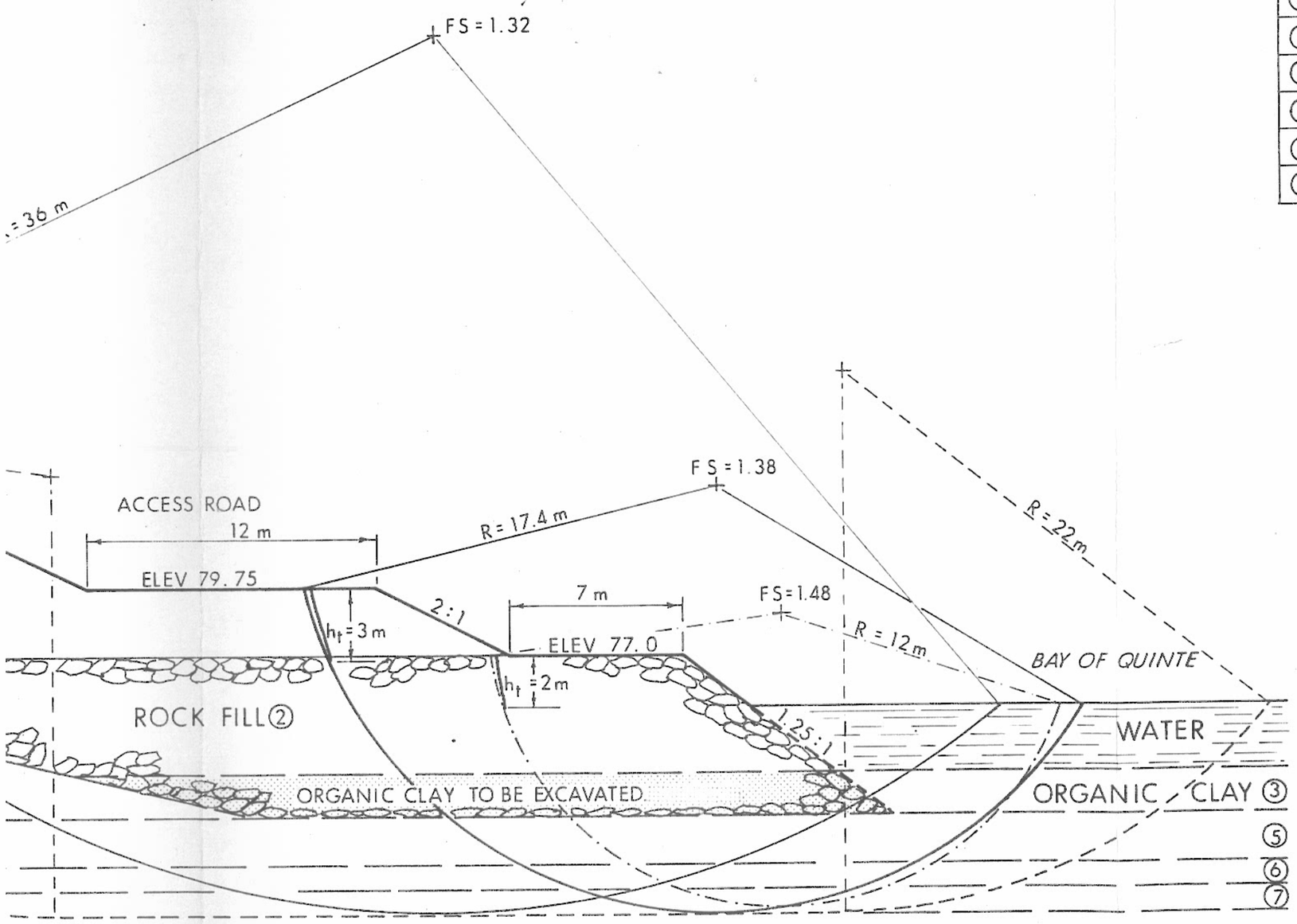
NOTE
The boundaries between soil strata have been established only at Bore Hole locations. Between Bore Holes the boundaries are assumed from geological evidence.

REVISIONS		
DATE	BY	DESCRIPTION

Geocres No 31C-135

HWY No 14 LINE 'E'		DIST 8
SUBM'D M.M. CHECKED M.M.	DATE 1979 08 03	SITE 28-28
DRAWN R.S. CHECKED T.J.	APPROVED	DWG 1347601-C

ASSUMED SUBSOIL PROPERTIES					
No	SOIL TYPE	COHESION kPa	ANGLE OF INTERNAL FRICTION ϕ	UNIT WEIGHT kN/m^3	SUBMERGED UNIT WEIGHT kN/m^3
①	EARTH FILL	0	30	22.0	12.0
②	ROCK FILL	0	35	22.0	12.0
③	ORGANIC CLAY	5	0	11.0	1.0
④	SANDY GRAVEL	0	30	22.0	12.0
⑤	CLAY	80	0	15.7	5.9
⑥	CLAY	60	0	15.7	5.9
⑦	CLAY	20	0	15.7	5.9



METHOD F.S. = 1.29

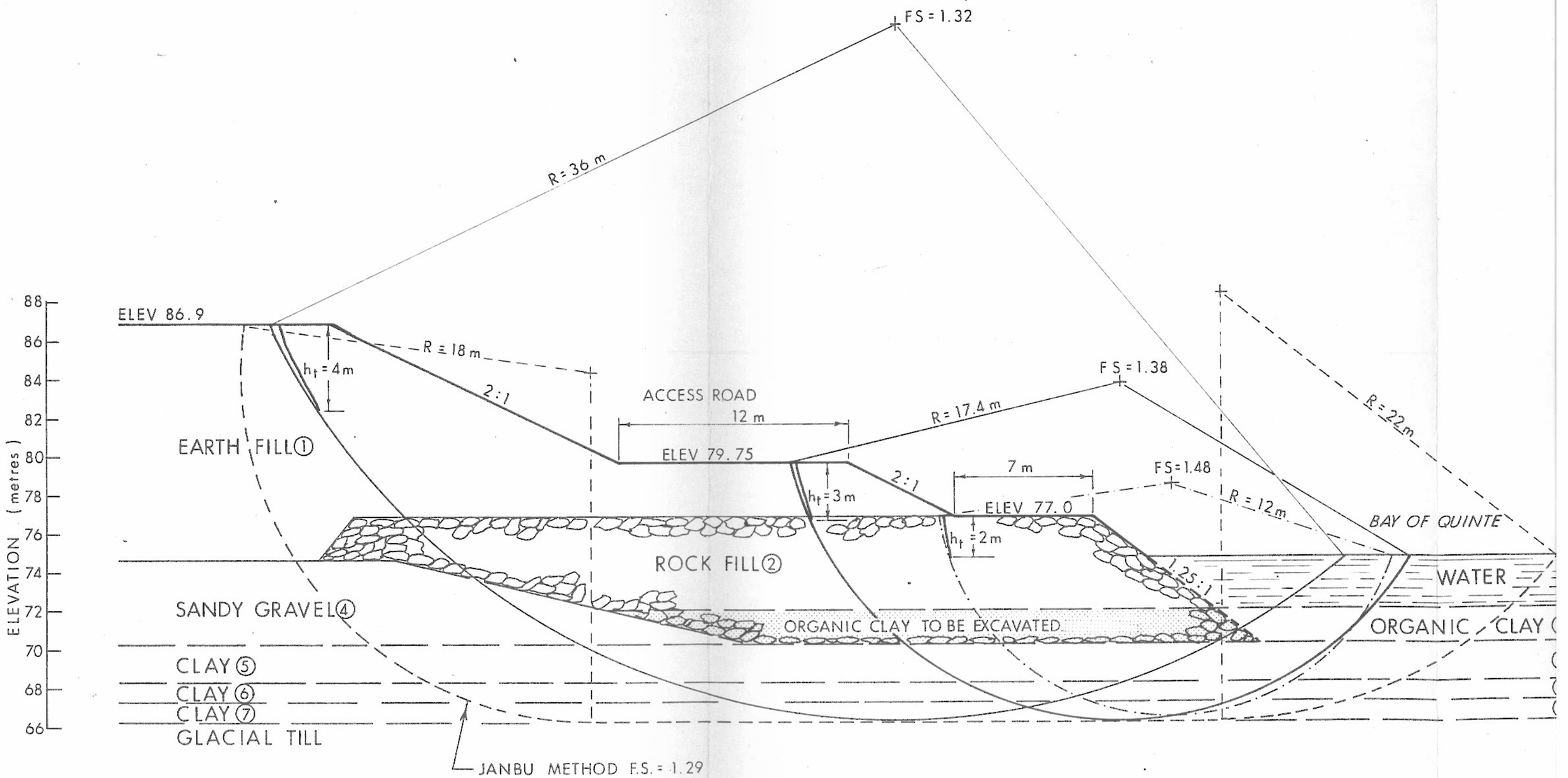
SECTION ALONG ℄ PROP HWY 14 LINE 'E'
NORTH ABUTMENT

NTS

TOTAL STRESS ANALYSIS
CRITICAL CIRCLES & FACTOR OF SAFETY
WITH ASSUMED STRATIGRAPHY & SOIL PROPERTIES
ACCESS RD ON UPPER BERM

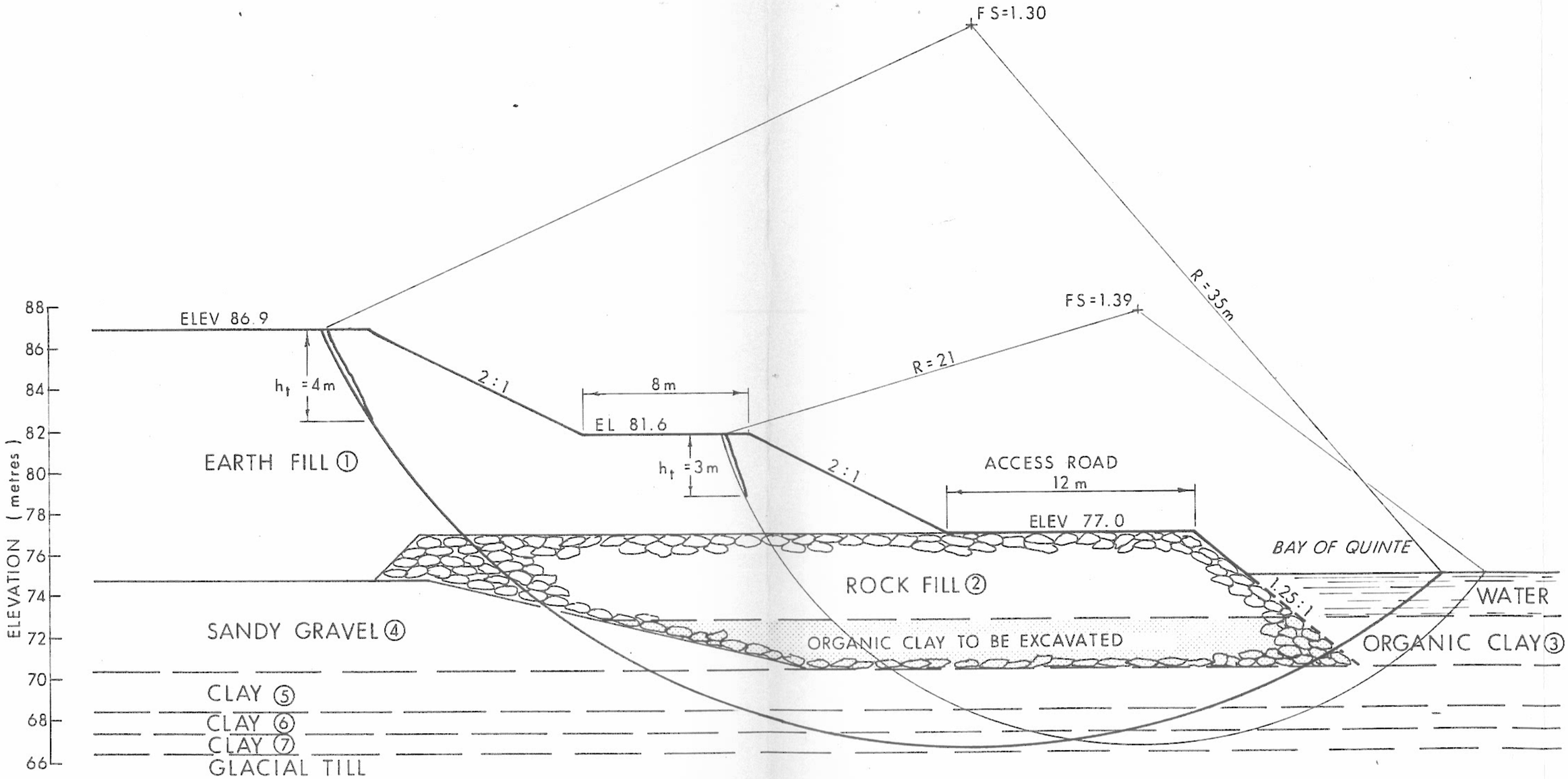
HWY 14 LINE 'E' & BAY OF QUINTE
BELLEVILLE

WP 134-74-01 DIST 8 FIG 9



SECTION ALONG ℄ PROP HWY 14 LINE 'E'
NORTH ABUTMENT

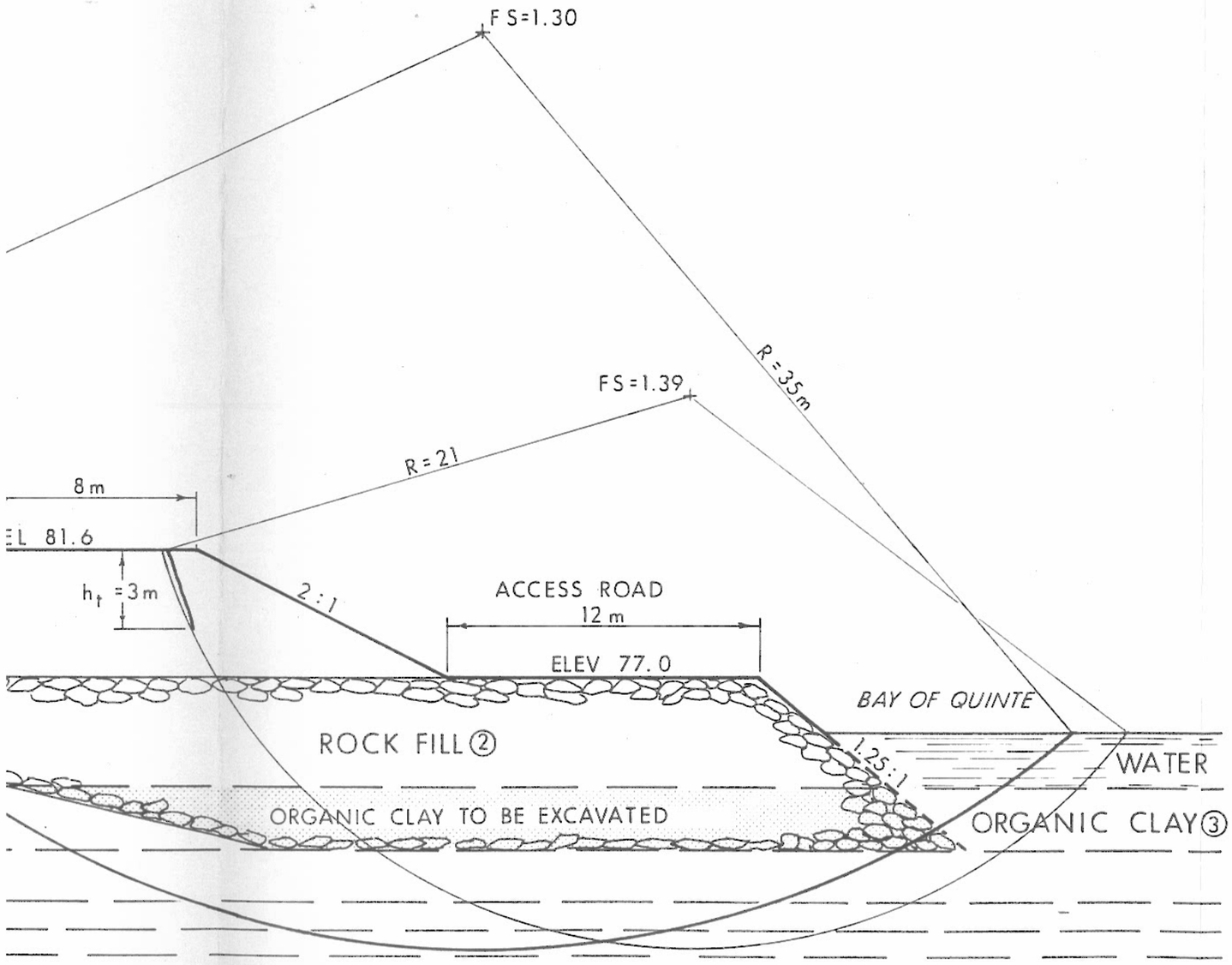
NTS



SECTION ALONG ℄ PROP HWY 14 LINE 'E'
NORTH ABUTMENT

NTS

ASSUMED SUBSOIL PROPERTIES					
No	SOIL TYPE	COHESION kPa	ANGLE OF INTERNAL FRICTION ϕ	UNIT WEIGHT kN/m^3	SUBMERGED UNIT WEIGHT kN/m^3
①	EARTH FILL	0	30	22.0	12.0
②	ROCK FILL	0	35	22.0	12.0
③	ORGANIC CLAY	5	0	11.0	1.0
④	SANDY GRAVEL	0	30	22.0	12.0
⑤	CLAY	80	0	15.7	5.9
⑥	CLAY	60	0	15.7	5.9
⑦	CLAY	20	0	15.7	5.9



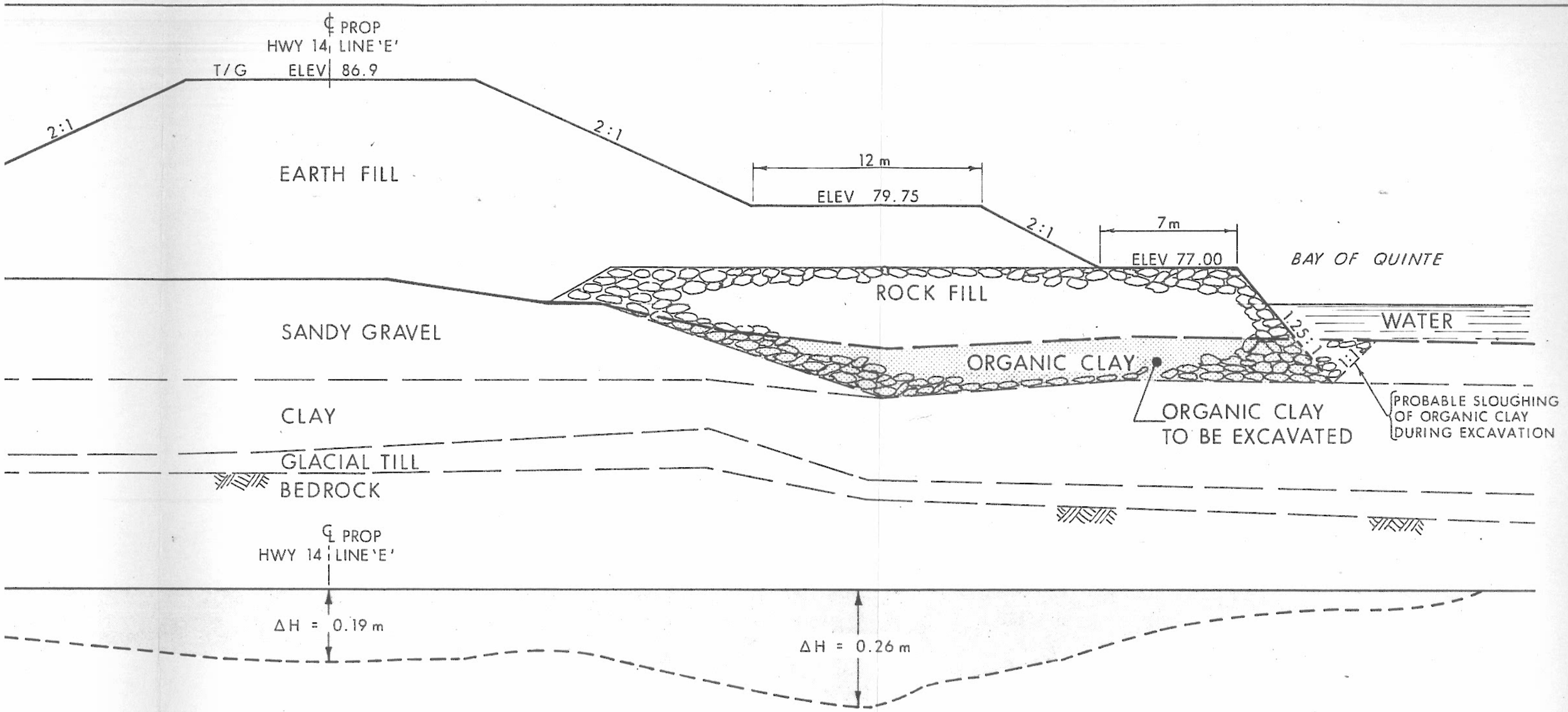
CTION ALONG ℄ PROP HWY 14 LINE 'E'
NORTH ABUTMENT

NTS

TOTAL STRESS ANALYSIS
CRITICAL CIRCLES & FACTOR OF SAFETY
WITH ASSUMED STRATIGRAPHY &
SOIL PROPERTIES
ACCESS RD ON LOWER BERM

HWY 14 LINE 'E' & BAY OF QUINTE
BELLEVILLE

WP 134-74-01 DIST 8 FIG 10



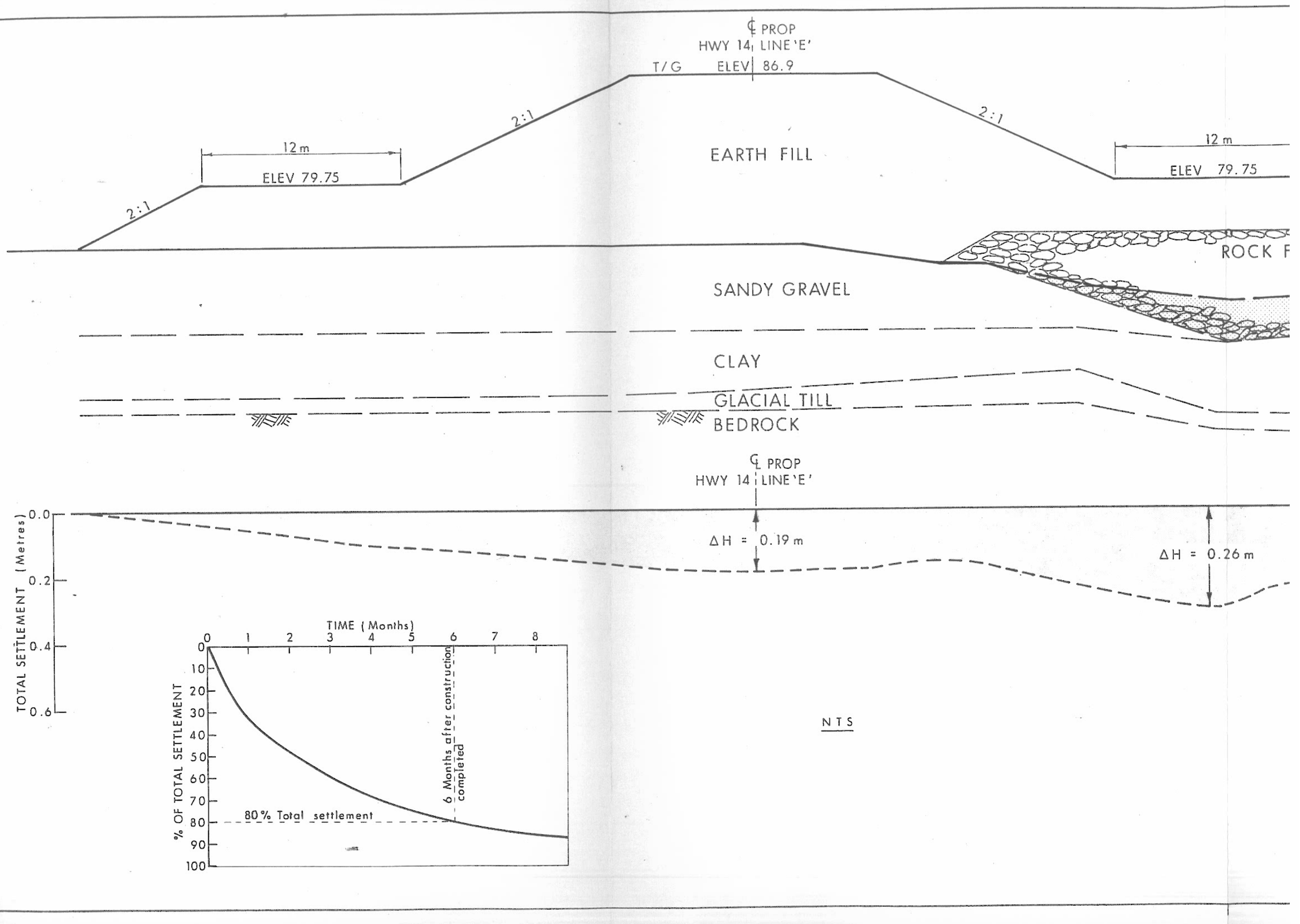
7 8

NTS

SETTLEMENT & ASSUMED STRATIGRAPHY SECTION AT NORTH ABUTMENT

HWY 14 LINE 'E' & BAY OF QUINTE
BELLEVILLE

WP 134 - 74 - 01 DIST 8 FIG 11


℄ PROP
HWY 14 LINE 'E'
T/G ELEV 86.9
2:1
2:1
12 m
ELEV 79.75
2:1
12 m
ELEV 79.75
EARTH FILL
ROCK F
SANDY GRAVEL
CLAY
GLACIAL TILL
BEDROCK
℄ PROP
HWY 14 LINE 'E'
ΔH = 0.19 m
ΔH = 0.26 m
TOTAL SETTLEMENT (Metres)
0.0
0.2
0.4
0.6
TIME (Months)
0 1 2 3 4 5 6 7 8
% OF TOTAL SETTLEMENT
0 10 20 30 40 50 60 70 80 90 100
6 Months after construction completed
80% Total settlement

NTS