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STR. SITE No. 37-1173

HWY. No. 400/407

LOCATION Bridge #9

Hwy 400 SBL

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OVERSIZE DRAWINGS TO BE INCLUDED WITH THIS REPORT.

REMARKS:

G.I.-30 SEPT. 1976



Ministry of
Transportation and
Communications

cont 90-18

FOUNDATION DESIGN SECTION

**foundation
investigation and
design report**

ENGINEERING MATERIALS OFFICE
FOUNDATION DESIGN SECTION

WP 137-87-06

DIST 6

HWY 400/407 IC

STR SITE 37-1173

BRIDGE #9

CONT. 90-18

Hwy. 400 S.B.L.

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FOUNDATION INVESTIGATION REPORT

FOR

Bridge #9

Hwy. 400 S.B.L.

W.P. 137-87-06, Site 37-1173

Hwy. 400/407 IC, Dist. 6, Toronto

INTRODUCTION

This report summarizes the foundation investigation for the proposed new bridge for Hwy. 400 S.B.L. The report is applicable to the proposed structure, the retaining walls and the approaches within 100 m of the abutments.

SITE DESCRIPTION

The site is located at the proposed Hwy. 400/407 interchange, approximately 0.9 km south of Hwy. 7.

This area is basically a glacial till plain with low local relief except for the existing Hwy. 400 embankment and ditches. The natural ground elevation is at elev. 192.5± m while the Hwy. 400 embankment is at elev. 194.5± m. The till deposits are interbedded with some continuous lacustrine layers and frequent random discontinuous silt to sand pockets. Bedrock was not encountered during the investigation but is reported to be composed of shale with limestone laminations and located below elev. 120± m.

To the east of Hwy. 400, land use is agricultural; to the west, there is a drive-in theatre and the Toronto Star property.

INVESTIGATION PROCEDURES

A foundation investigation for this site was conducted between 87 10 19 and 87 11 27. Continuous-flight auger machines equipped with 82 mm I.D. hollow-stem augers and solid-stem augers, and N and B casing were used.

The investigation for the entire interchange consisted of:

- 54 boreholes
- and
- 28 piezometer installations

The portion of the investigation directly related to the Bridge #9 site consisted of:

- 13 sampled boreholes accompanied by dynamic cone penetration tests, and
- 2 sampled boreholes

These site specific boreholes are identified as BH #9-1, #9-2, #9-3, #9-4, #9-5, #9-6, #9-7, #9-8, #9-9, #9-10, #9-11, #11-5, #12-3, #12-4 and #12-5. They extended for depths ranging from 9.6 m to 39.5 m. All boreholes were terminated in overburden.

Survey details were provided by the Central Region Surveys and Plans Section.

The sampling program consisted of split spoon samples collected at 0.8 m to 3.0 m intervals. They provided Standard Penetration Test (N) values for assessment of the in situ state of compaction of the non-cohesive materials, and for an indication of shear strengths of cohesive materials. These samples also provided material for identification purposes.

The laboratory testing program for representative samples consisted of:

- grain size analyses
- natural moisture content determinations
- Atterberg Limit determinations

SUBSURFACE CONDITIONS

The Record of Borehole Sheets in the Appendix illustrate the subsurface conditions at the borehole locations. The locations and elevations of the boreholes, along with stratigraphical profiles based on the borehole data are shown on Drawing No. 1378706 A, B & C.

The existing Hwy. 400 embankment is composed of compact sand fill extending from the road surface (elev. 194.5± m) to the surface of the native overburden (elev. 192.5± m). The upper portions of this fill are the granular sub-base for the pavement structure.

The native overburden consists of the following generalized layers, in sequence, from the surface down:

<u>Elevation (m)</u>		<u>Material</u>
<u>From</u>	<u>To</u>	
192.5	190	Clayey Silt (Glacial Till)
190	179	Silt/Clayey Silt with random silt and sand pockets (Glacial Till with Lacustrine Interbeds)
179	157	Silty Clay to Clay with thin silt seams (Lacustrine)
157	undetermined	Sandy Silt to Silty Sand (Lacustrine)

The properties of the glacial till deposits are variable across the site in both the horizontal and vertical dimensions, and the boundaries between the soil strata are transitional.

Sand (Fill)

This non-cohesive material is fill for the existing Hwy. 400 embankment. It has been described as sand, but is a typical granular sub-base material.

At the Bridge #9 site, it was encountered at BH #9-1, #9-2, #9-5, #9-6, #9-8, #9-9, #9-10 and #12-5 where it extended, from the surface, for thicknesses ranging from 0.9 m to 3.4 m.

Based on the results of Dynamic Cone Penetration Tests and Standard Penetration Tests for the Bridge #9 site, the material is considered to be in a compact state.

Clayey Silt (Glacial Till)

This cohesive material has been described as clayey silt, some sand, trace gravel.

At the Bridge #9 site the material was encountered at all boreholes. At BH #9-1, #9-2, #9-5, #9-6, #9-8, #9-9, #9-10 and #12-5 it underlies sand fill. At all other boreholes it is the surface material. Thicknesses of this deposit ranged from 1.3 m to 4.3 m at the borehole locations. At BH #9-1, #9-2, #9-8, #9-9 and #12-5, the upper 0.3 m to 1.9 m of this deposit contained organics.

Based on the results of Standard Penetration Tests (N = 8 to 37), for the Bridge #9 site, the material is in a firm to hard state.

Typical properties of the material, as determined by laboratory tests of representative samples from the entire interchange site, are summarized as follows:

	<u>Range</u>	<u>Average</u>
Water Content (w)	9.0-15.5%	13.0%
Liquid Limit (w_L)	17.0-23.5%	20.8%
Plastic Limit (w_p)	10.0-12.5%	11.4%

Figure 1 illustrates a typical plasticity envelope for this material, based on representative samples from the entire interchange site.

Figure 2 illustrates a typical grain size distribution for this material, based on representative samples from the entire interchange site.

Silt/Clayey Silt (Glacial Till)

The silt/clayey silt (glacial till) deposit has been described as silt/clayey silt, some sand, trace gravel, with random silt and sand pockets and occasional boulders. The main component of this deposit varies randomly from non-plastic silt (ML), to slightly plastic silt (CL-ML), to clayey silt (CL). Within this deposit there are frequent random discontinuous pockets of silts and sands, typically 1 m thick. A semi-continuous layer of lacustrine silt to sand, varying in thickness from 1.1 m to 3.6 m was encountered at elev. 189± m.

At the Bridge #9 site, this material was encountered at all borehole locations where it extended for thicknesses varying from over 7.2 m to 11.0 m.

Based on 'N' values which ranged from 9 to over 100 for Bridge #9, the denseness of this deposit can be described as loose to very dense (for the non-cohesive zones) while the consistency is stiff to hard (for the cohesive zones). Generally, the deposit may be considered to be dense to very dense (non-cohesive component) or hard (cohesive component).

Typical properties of the basic cohesive material matrix, as determined by laboratory tests of representative samples from the entire interchange site, are summarized as follows:

	<u>Range</u>	<u>Average</u>
Water Content (w)	6.5-23.0%	12.1%
Liquid Limit (w_L)	13.5-32.5%	19.8%
Plastic Limit (w_p)	9.0-17.5%	12.6%

Figure 3 illustrates a typical plasticity envelope for this material, based on representative samples from the entire interchange site.

Figure 4 illustrates a typical gran size distribution for this material based on representative samples from the entire interchange site.

Silty Clay to Clay (Lacustrine)

The silty clay to clay (lacustrine) deposit has been described as silty clay to clay, with thin silt seams. The thickness of this deposit was explored at the Bridge #9 site, at BH #9-4 and #12-3 where its thickness ranged from 21.4 m to 23.0 m. Within this deposit there are occasional sand pockets, generally up to 1.5 m thick. However, at BH #11-5 and #12-5 the sand layers are more extensive and up to 5.2 m in thickness.

Based on 'N' values ranging from 20 to over 100 at the Bridge #9 site, the consistency of this deposit ranges from stiff to hard, but is generally hard. The sand pockets are generally very dense.

Typical properties of the material, as determined by laboratory tests of representative samples from the entire site, are summarized as follows:

	<u>Range</u>	<u>Average</u>
Water Content (w)	12.0-24.0%	17.1%
Liquid Limit (w_L)	26.0-61.5%	35.6%
Plastic Limit (w_p)	11.5-21.0%	16.0%

Figure 5 illustrates a typical plasticity envelope for this material, based on representative samples from the entire interchange site.

Figure 6 illustrates a typical grain size distribution for this material, based on representative samples from the entire interchange site.

Sandy Silt to Silty Sand (Lacustrine)

This non-cohesive material has been described as sandy silt to silty sand.

Based on BH #9-4 and #12-3, the material underlies the silty clay to clay deposit at elevation 157± m. Its thickness was not determined. The material is in a very dense state with N values in excess of 100.

Groundwater

The groundwater was measured in open boreholes and also in piezometer installations (at various locations across the site for this project and related projects) that measured groundwater conditions in isolated zones at approximately 3 m, 6 m, 9 m, 12 m, 15 m, and 18 m below the surface. Based on these measurements, the groundwater elevation is generally between elev. 190 m and 192 m. However, the measurements of some of the piezometers over 12 m deep have required a considerable period of time to stabilize (in the order of weeks), indicating that there are zones of

very low permeability within the silt/clayey silt (glacial till) deposit and silty clay to clay (lacustrine) deposit. Although the initial readings in these zones measured groundwater at elevations ranging from 187.5 m to 189.5 m, the depth to groundwater has slowly been decreasing with time and had not completely stabilized by January 6, 1988.

There are pockets of silt and sand within the overburden which are water bearing and exhibit a tendency to flow or boil under conditions of unbalanced hydrostatic head.

DISCUSSION

The recommendations in this report apply to the structure, the retaining walls, and the approaches within 100 m of the abutments.

Bridge #9 is for Hwy. 400 S.B.L. A 5-span structure with related retaining walls is proposed. This structure will be at Level 3 of this 4 level interchange. The proposed deck elevation is $200 \pm$ m, which is $7.5 \pm$ m above the the existing natural ground surface. Cuts for Level 1 of this interchange will be to elevation $183 \pm$ m.

STRUCTURE FOUNDATIONS

The survey locations of Bridge #9 footings are referenced to Bridge #9 PCL chainage. There is an inconsistency in station designations between the plan and profile. Bridge #9 PCL chainage may be either 21+ or 31+.

There are some uncertainties in the footing locations in the present proposal. Consequently, the recommendations for structure foundations are subject to revision when the proposal has been finalized and fully detailed.

In addition, there is a possibility of footing interference with other interchange footings. The effect of footing interference cannot be fully assessed until footing locations are finalized, but deep foundations may be required for footings that are affected.

The following interchange footings may interfere with Bridge #9 footings.

Bridge #9 Footing	Location	Possible Interference Footings
North Centre Pier	Sta. 21 + 174 \pm and elev. 185 \pm m	<ul style="list-style-type: none">- Bridge #7 West Abutment at Sta. 19 + 141+ (Bridge #7 PCL chainage) and elev. 187\pm m.- Bridge #8 West Abutment at Sta. 19 + 115\pm (Bridge #8 PCL chainage) and elev. 187\pm m.- Bridge #11 West Centre Pier at Sta. 1 + 751\pm (Bridge #11 PCL chainage) and elev. 191 \pm m.- Bridge #12 Centre Pier at Sta. 1 + 390\pm (Bridge #12 PCL chainage) and elev. 184\pm m
North Pier	Sta. 21 + 206 \pm and elev. 189 \pm m	<ul style="list-style-type: none">- Bridge #7 West Abutment at Sta. 19 + 141\pm (Bridge #7 PCL chainage) and elev. 187\pm m.- Bridge #12 North Pier at Sta. 1 + 340\pm (Bridge #12 PCL chainage) and elev. 190\pm m.

The spread footing recommendation in this report apply only to footings in which the underside of the footing is a minimum of 3 m from a slope. Otherwise a reduction in bearing capacity may be necessary.

The abutments and related retaining structures may be founded on spread footings on compacted Granular 'A' pads constructed in accordance with the geometry illustrated in Figure 13.

The following chart indicates recommended elevations for the base of the granular pad, and O.H.B.D.C. bearing capacities for footings on compacted granular pads for each abutment and its related retaining structures. If the assumed highest possible footing elevation is incorrect, these recommendations will require revision.

Footing Element	Location	Assumed Highest Footing Elev.	Recommended Base of Granular 'A' Pad	Factored Bearing Capacity at U.L.S.	Bearing Capacity at S.L.S Type II
South Abutment and Retaining Structures	Sta. 21 + 034 \pm	194 \pm m	190 m	900 kPa	350 kPa
North Abutment and Retaining Structures	Sta. 21 + 223 \pm	194 \pm m	190 m	900 kPa	350 kPa

The piers may be founded on spread footings on native overburden.

The following chart indicates recommended footing elevations and O.H.B.D.C. bearing capacities for spread footings at each pier. If the assumed highest possible footing elevation is incorrect, these recommendations will require revision.

Footing Element	Location	Assumed Highest Footing Elev.	Recommended Footing Elev.	Factored Bearing Capacity at U.L.S.	Bearing Capacity at S.L.S. Type II
South Pier	Sta. 21 + 062±	187± m	186.5 m	525 kPa	350 kPa
South Centre Pier	Sta. 21 + 118±	184± m	184 m	1000 kPa	*
North Centre Pier	Sta. 21 + 174±	185± m	185 m	1000 kPa	*
North Pier	Sta. 21 + 206±	189± m	189 m or 187 m	450 kPa 750 kPa	300 kPa 500 kPa

Consideration should also be given to the application of earth reinforcement principles for the retaining structures. Both 'Reinforced Earth', which uses metal strips within the embankment to provide lateral resistance to prefabricated concrete panels, and 'Geo-crete Products Ltd.' which applies the same concept but substitutes geo-grids for metal strips, may provide more economical alternatives than conventional cantilever walls, for retaining structures in a fill situation. Anchored walls should be considered as an alternative for retaining structures in a cut situation. The alternatives should be evaluated and the least expensive option should be adopted.

If more details are required regarding these alternatives, this office can provide details.

Earth Pressure

Backfill to structures should consist of granular material in accordance with Ministry of Transportation Standard Special Provision #121 (83 10).

Computation of earth pressures should be in accordance with Section 6-6.1.2.1 of the O.H.B.D.C. The active condition will govern earth pressure design for the yielding condition while the at-rest condition will govern earth pressure design for the unyielding condition. The following properties for backfill are recommended for design:

<u>Material</u>	<u>ϕ</u>	<u>γ</u>	<u>K_A</u>	<u>K_0</u>
Granular 'A'	35°	22.8 kN/m ³	0.27	0.43
Granular 'B'	30°	21.2 kN/m ³	0.33	0.50

Lateral Resistance

Sliding resistance between concrete and foundation soil should be calculated in accordance with Section 6-7.3.3.2 of the O.H.B.D.C. assuming an unfactored ϕ value of 30° for noncohesive foundation soils or an unfactored adhesion value of 75 kPa for cohesive foundation soils. In view of the variable nature of the foundation soils, both the noncohesive and cohesive conditions should be considered for calculation of sliding resistance, and the worst case should be adopted in the design.

Sliding resistance of footings can be supplemented by keying into the soil, in which case the passive resistance below the frost penetration depth can be considered in the design. In this case, keys should be formed against undisturbed native overburden. Alternatively, soil anchors could be considered to resist lateral loads. If this option is considered, pre-contract soil anchor testing would be required to determine design anchor bond stresses.

The resistance to lateral load for piles should be calculated in accordance with Section 6-8.3.8 of the O.H.B.D.C. The horizontal component of battered piles may be used to resist lateral loads.

Frost Protection

A minimum earth cover of 1.2 m, or equivalent, to the base of footings or pile caps is required for frost protection.

Slope Stability

For fills above the prevailing groundwater elevation, temporary slopes will be stable at 1.5H:1V, and permanent slopes will be stable at 2H:1V, for embankments up to 9 m high.

The proposal for this interchange requires cuts in the order of 9 m deep. This cut will expose numerous random pockets and some distinct zones of fine-grained granular soils that are susceptible to disturbance when the water table is lowered. Therefore slope protection and drainage measures will be required to ensure their long-term surficial stability. These measures are required to lower the groundwater table below the frost penetration depth to prevent the softening of material due to freeze-thaw cycles, and to dissipate excess pore water pressures that could contribute to surficial slope failures.

Four cut geometry-surface treatment-drainage conditions variations, for a 9 m deep cut, have been analysed utilizing Bishop's effective stress method.

- (1) An analysis assuming a 2H:1V slope (Figure 7), resulted in a factor of safety of less than unity.
- (2) An analysis assuming a 2H:1V slope treated with a 1.2 m thick granular blanket (Figure 8), resulted in a marginal but unacceptable factor of safety.
- (3) An analysis assuming a 2.5H:1V slope treated with a 0.6 m thick granular blanket and a 1.2 m deep toe drain (Figure 9), resulted in an acceptable factor of safety.
- (4) An analysis assuming a 2H:1V slope with a 1.2 m wide bench located at a depth of 4.5 m from the top of the cut, a 1.2 m deep bench drain and a 1.2 m deep toe drain, and 0.6 m thick granular blankets on both the upper and lower slopes (Figure 10), resulted in an acceptable factor of safety.

Based on these analyses, cut slopes deeper than 4.5 m, should be constructed in accordance with the treatments described in either #3 or #4. These alternatives are illustrated in Figure 11. For cuts less than 4.5 m deep, the slope treatment should consist of a 2H:1V slope treated with a 0.6 m thick granular blanket and a 1.2 m deep toe drain. This recommended cut slope treatment is illustrated in Figure 12. The granular blanket should consist of free-draining material such as Ministry of Transportation Granular 'A'. Alternatively, Granular 'B' with appropriate gradation limits would be suitable. If Granular 'B' is proposed, typical gradations of the material should be submitted to this office for assessment. The drain trenches should be lined with a suitable geotextile filter fabric, such as Class 1 non-woven geotextile with EOS of 75 to 150 um. The perforated pipes should be 150 mm minimum diameter and should be surrounded by a minimum of 150 mm of granular backfill. The drains should be connected to an appropriate permanent drainage system. In addition all slopes should be provided with an interceptor ditch at the top of the slope.

Normal slope vegetation should be established as soon as possible after completion of the cut in order to control surficial erosion.

Settlement

Total and differential settlements will be negligible for structure foundations and embankments constructed in accordance with the recommendations provided.

Dewatering

As the groundwater elevation is at 190 m to 191 m, both a temporary (during construction) dewatering scheme and a permanent drainage system will be required.

The temporary dewatering scheme should lower the prevailing groundwater table a minimum of 1 m below excavations and should be designed to prevent disturbance of the foundation soil or cut slopes. The dewatering scheme should also take into consideration the presence of silt and sand pockets within the overburden. These materials are susceptible to disturbance under conditions of unbalanced hydrostatic head.

Although the dewatering of some shallow excavations may be possible by an oversized perimeter ditch/sump pumping system, the deep cut will probably require a larger scale scheme, such as excavating a pilot trench, to facilitate dewatering while the required cut geometry is constructed. A typical design would involve construction of a pilot trench prior to the excavation of the proposed cut geometry. The pilot trench would be excavated below the prevailing cut excavation level and would be located, in plan, at the central portion of the proposed cut.

The slope drainage system should be connected to an appropriate permanent drainage system.

Consideration should be given to establishing the existing groundwater conditions in the area surrounding the site, and the effects of both temporary dewatering and permanent drainage, particularly in those areas where there is a potential for claims.

Construction Considerations

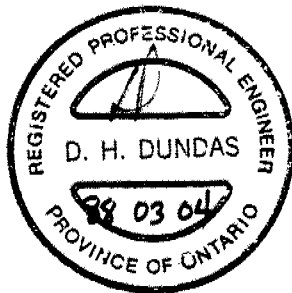
The bearing surfaces of spread footing excavations should be protected by a 15 cm pad of mass concrete within 4 hours of exposure.

MISCELLANEOUS

The field work for this project was carried out under the supervision of D. Dundas, Senior Foundations Engineer, T. Sangiuliano, Foundations Engineer, K. Zasitko, Foundation Field Technician, and M. Schnarr, Engineering Student.

The equipment used was owned and operated by Dominion Soil Investigation Inc., Malone's Soil Samples and Master Soil Investigation Ltd.

The report was written by D. Dundas, and reviewed by M. Devata, Chief Foundations Engineer (East).



D. H. Dundas

D. H. Dundas, P. Eng.

Sr. Foundations Engineer

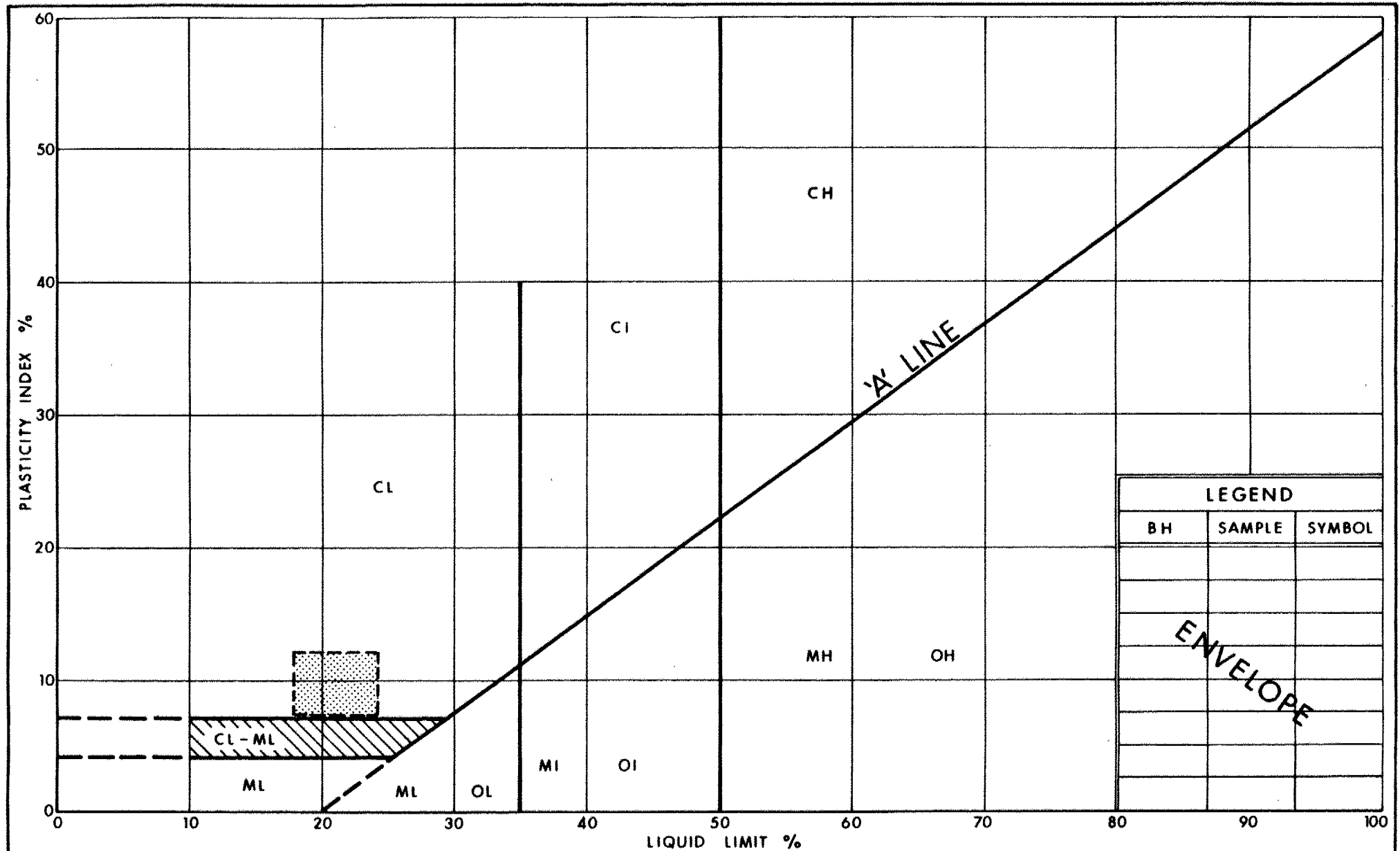
M. S. Devata

M. S. Devata, P. Eng.

Chief Foundations Engineer

(East)

APPENDIX



LEGEND		
BH	SAMPLE	SYMBOL



Ministry of
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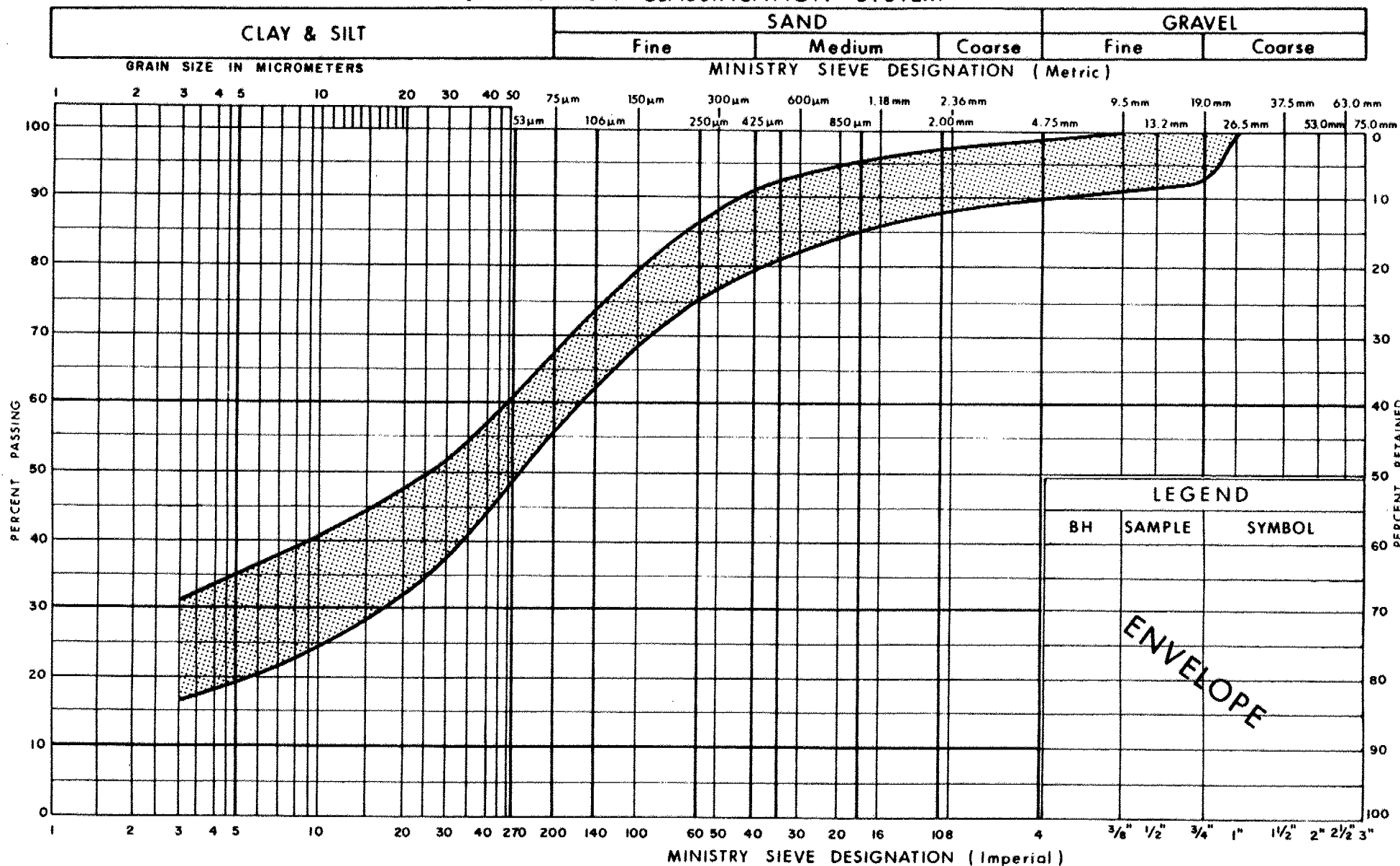
Ontario

PLASTICITY CHART CLAYEY SILT (Glacial Till)

FIG No 1

W P 137-87-06

UNIFIED SOIL CLASSIFICATION SYSTEM



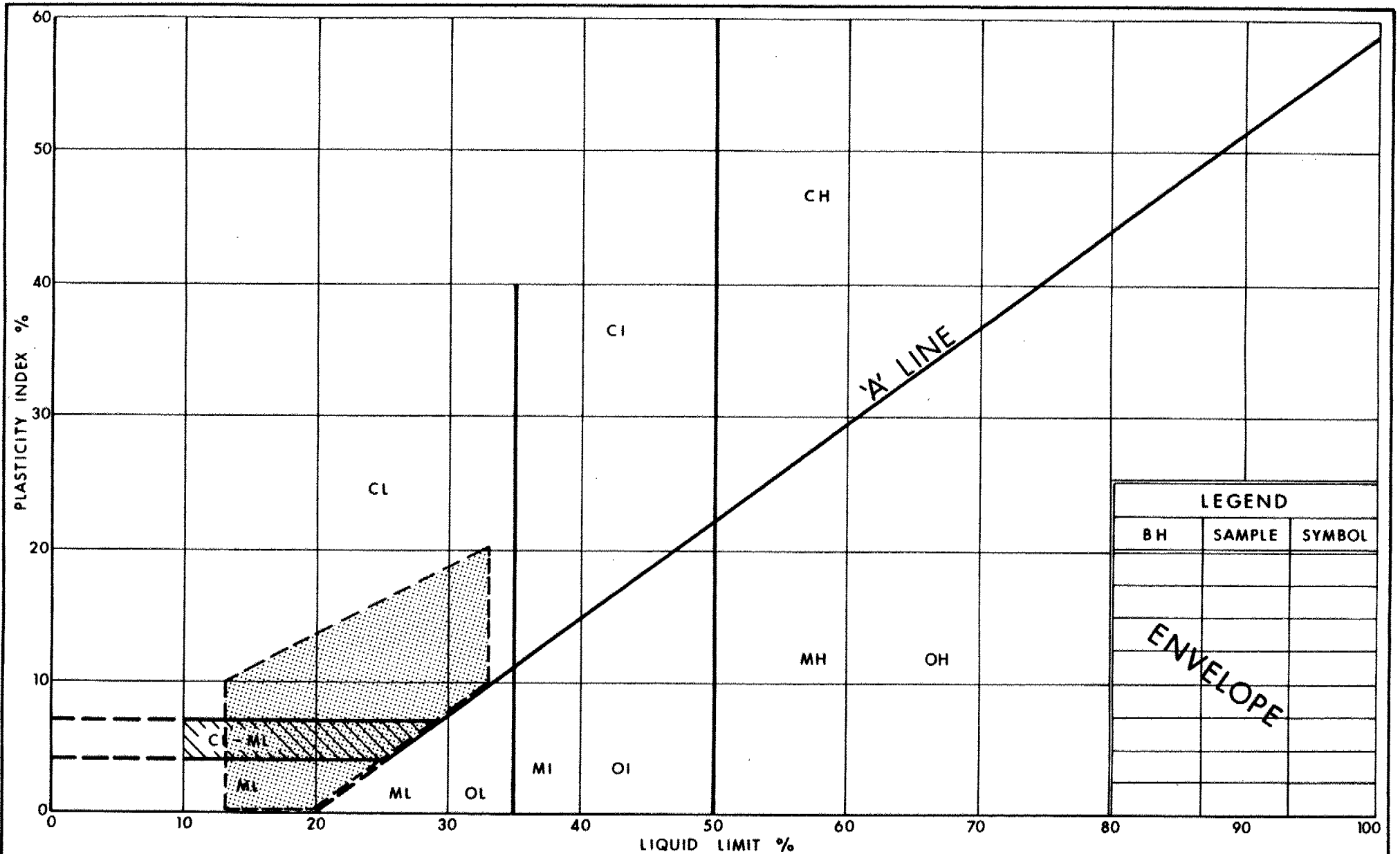
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GRAIN SIZE DISTRIBUTION
CLAYEY SILT (Glacial Till)

FIG No 2

W P 137-87-06



LEGEND		
BH	SAMPLE	SYMBOL



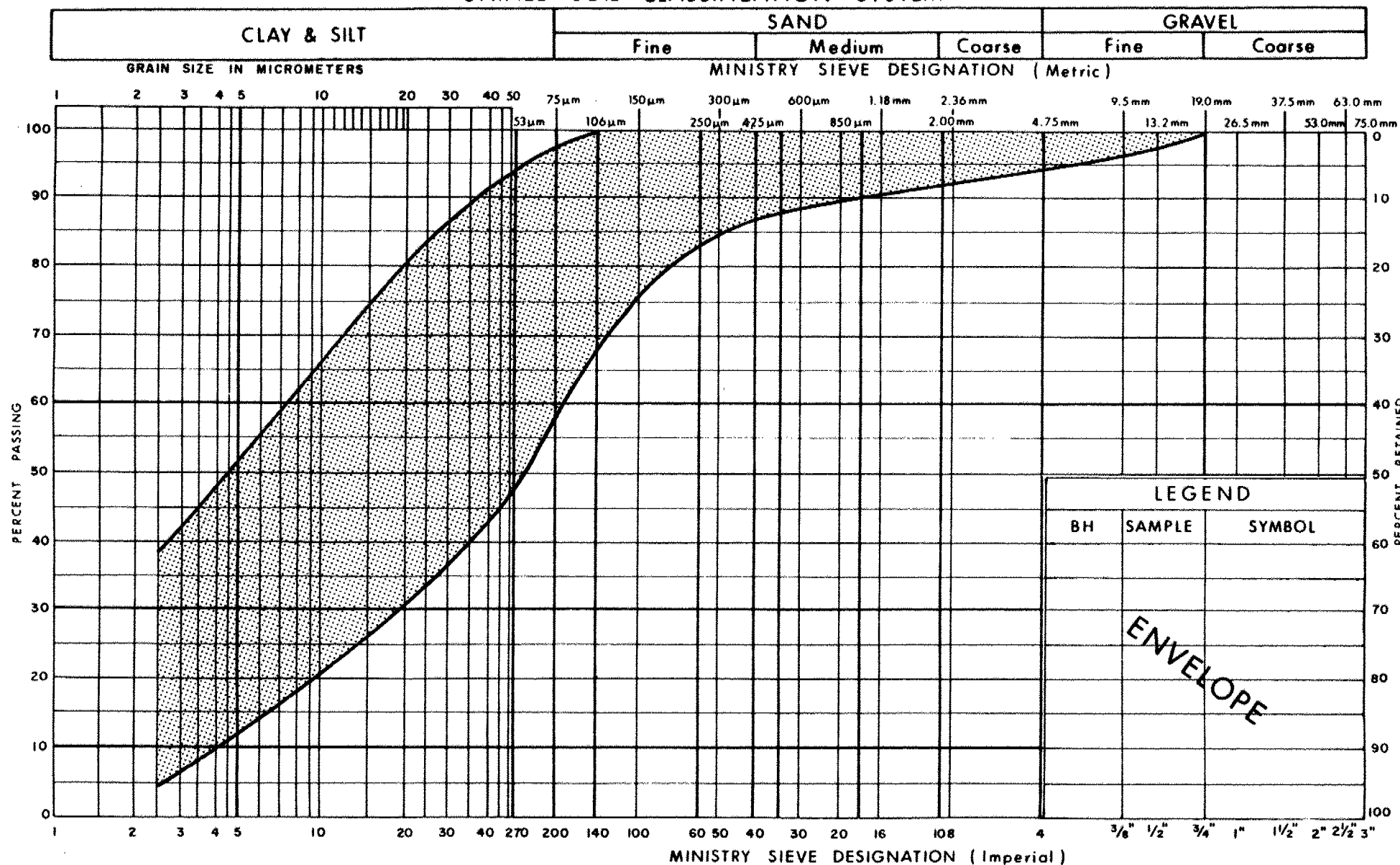
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PLASTICITY CHART SILT / CLAYEY SILT (Glacial Till)

FIG No 3

W P 137-87-06

UNIFIED SOIL CLASSIFICATION SYSTEM

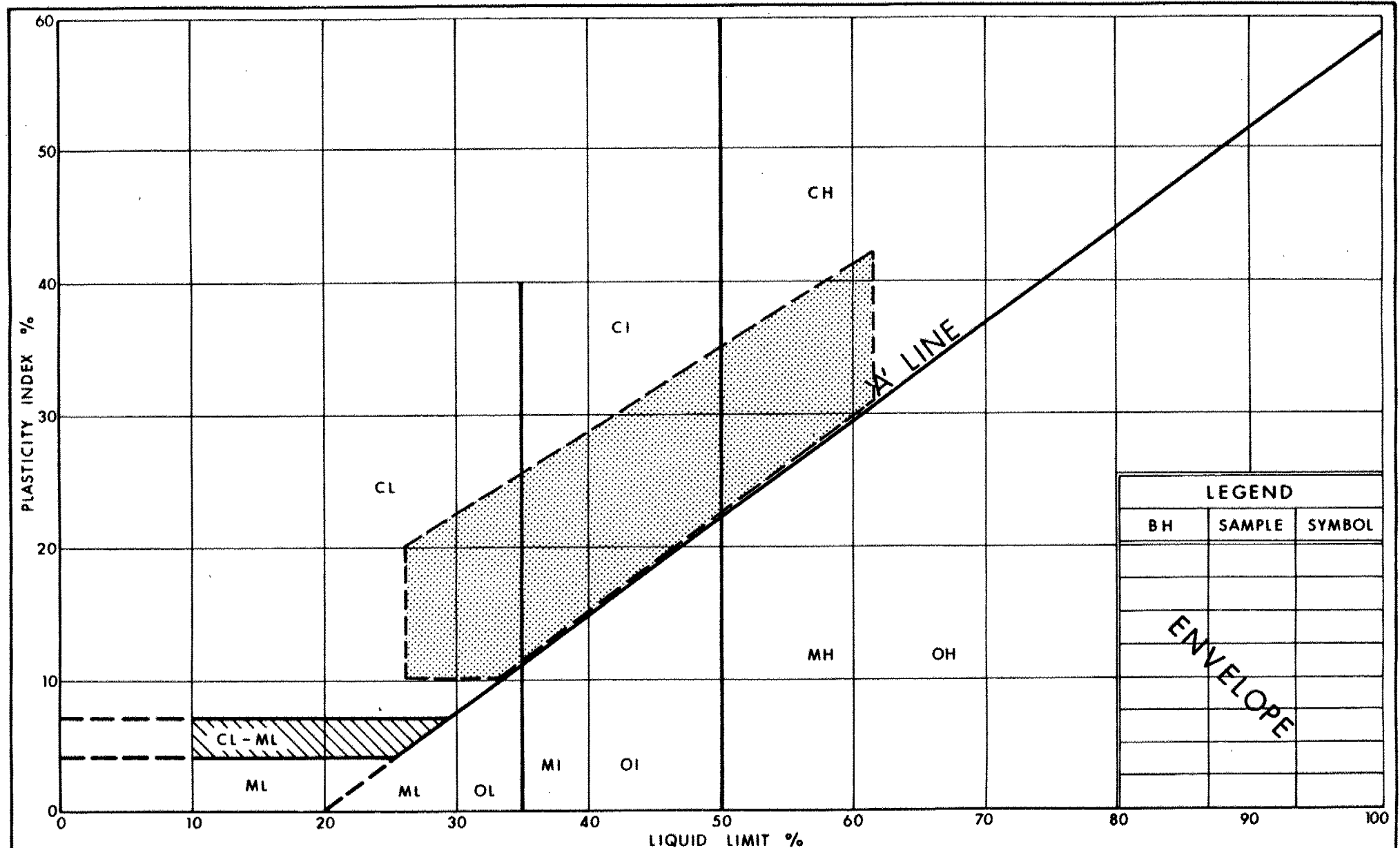


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GRAIN SIZE DISTRIBUTION
SILT/CLAYEY SILT (Glacial Till)

FIG No 4

W P 137-87-06



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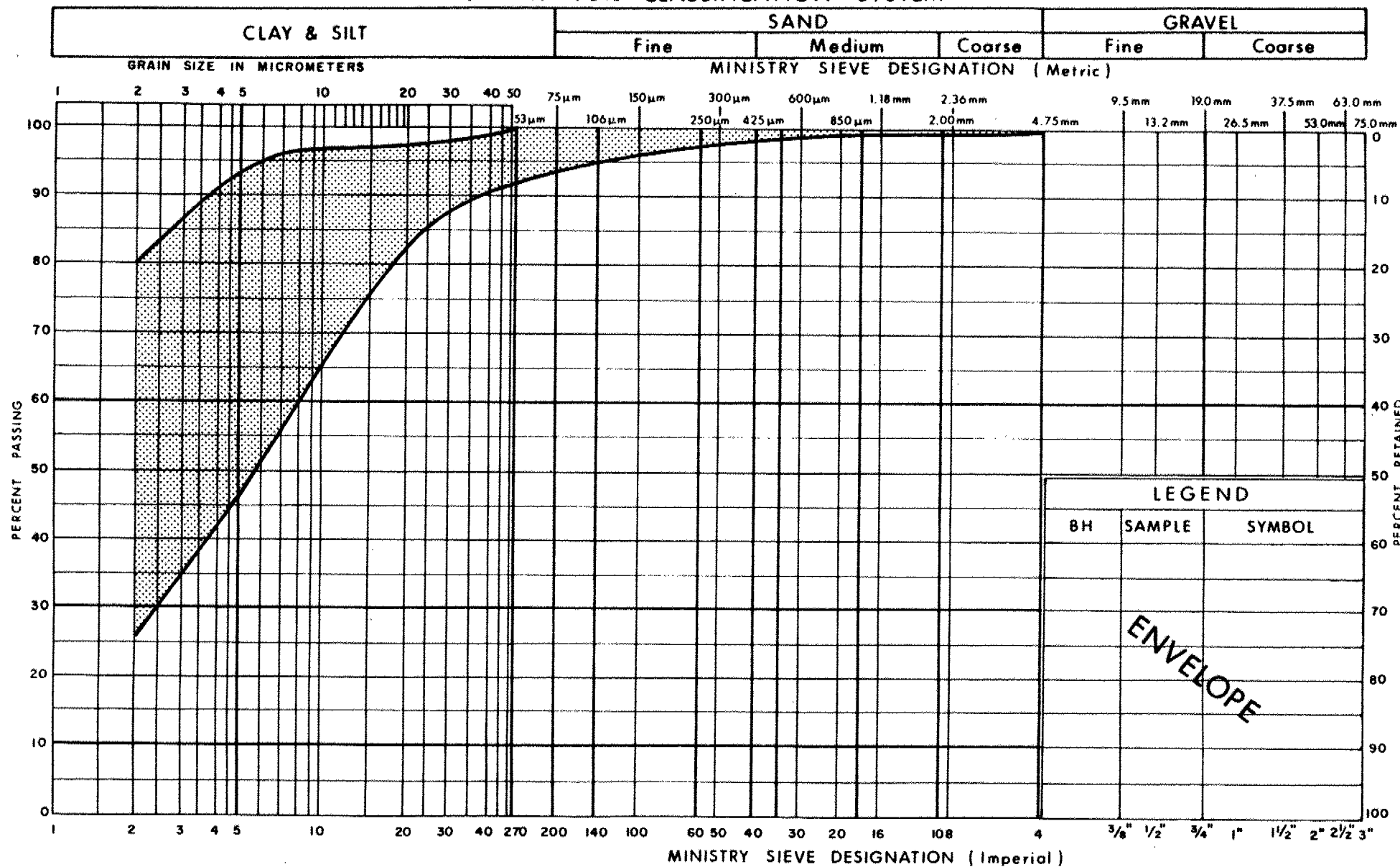
Ontario

PLASTICITY CHART SILTY CLAY TO CLAY (LACUSTRINE)

FIG No 5

W P 137-87-06

UNIFIED SOIL CLASSIFICATION SYSTEM



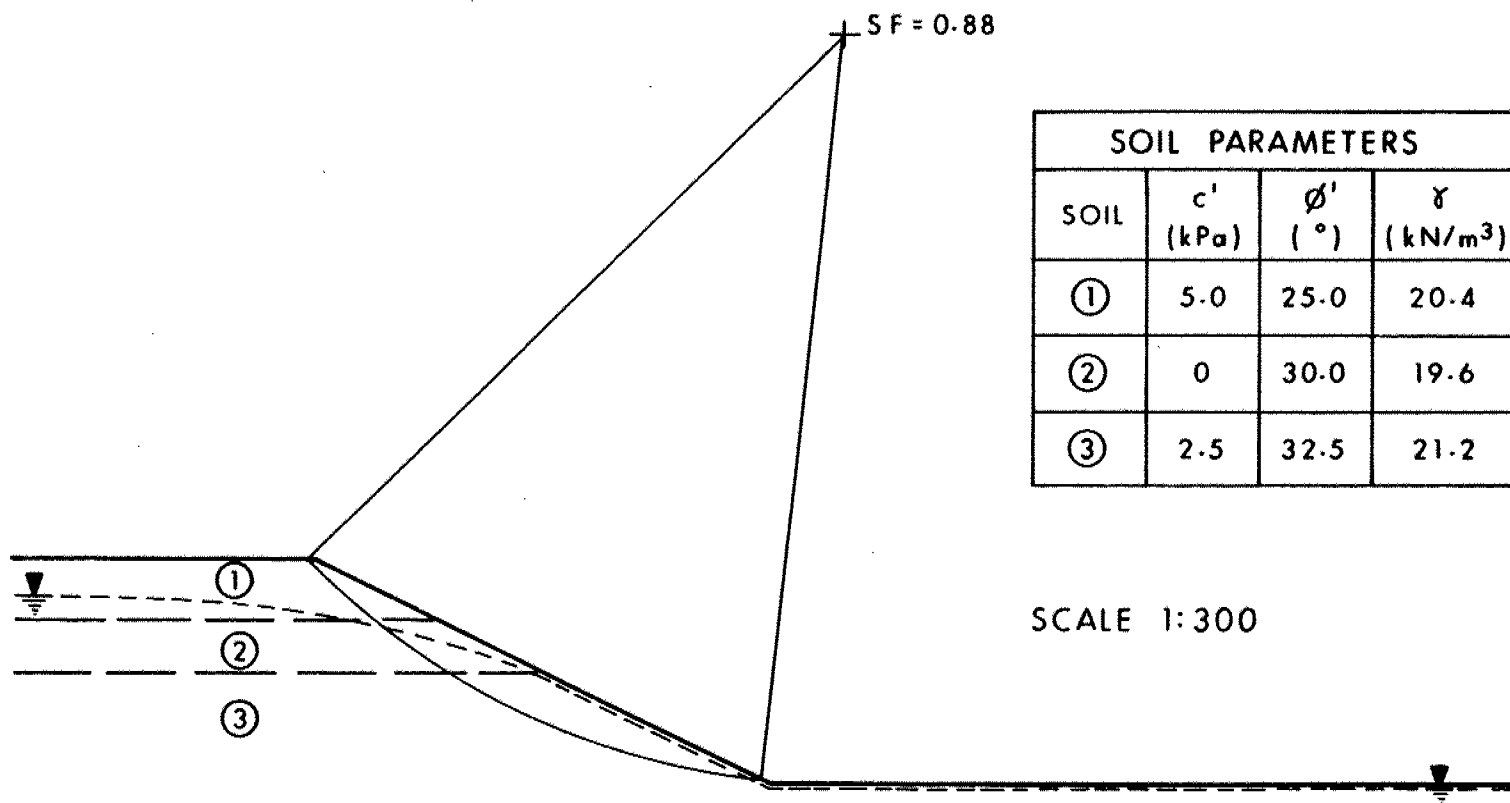
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GRAIN SIZE DISTRIBUTION

SILTY CLAY TO CLAY (LACUSTRINE)

FIG No 6

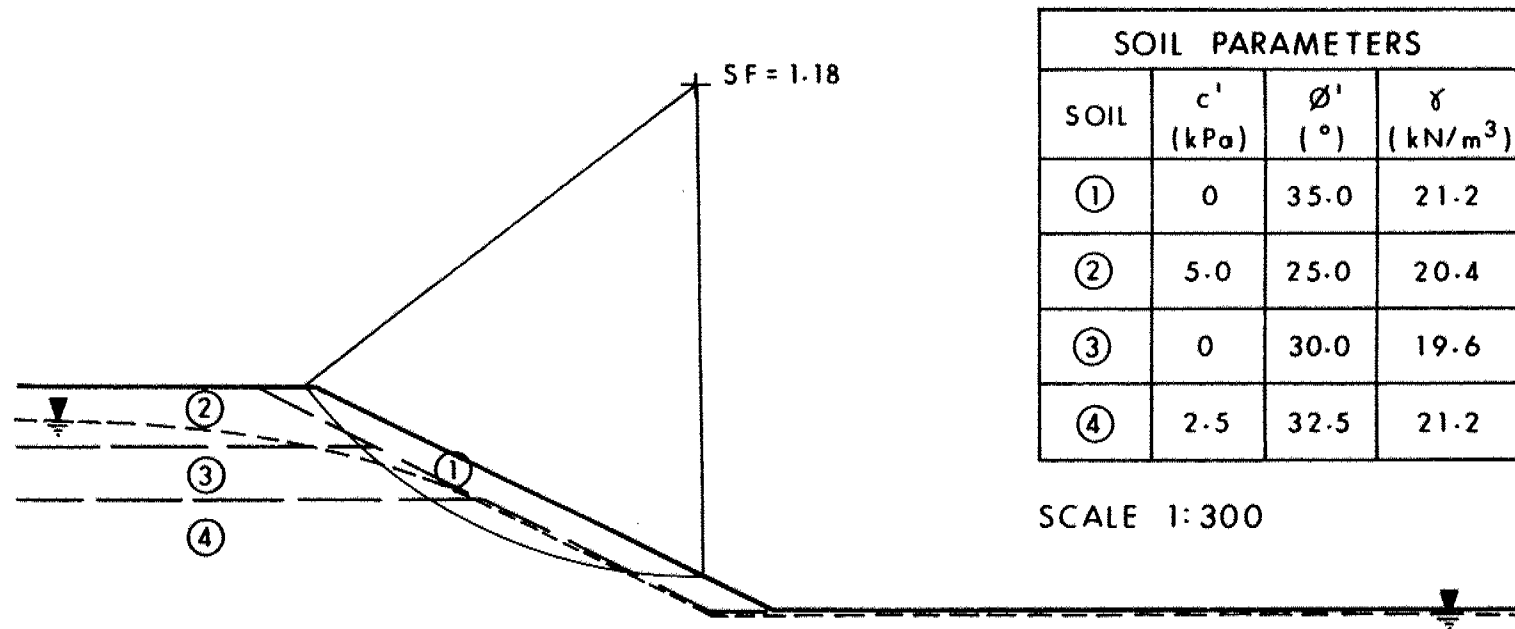
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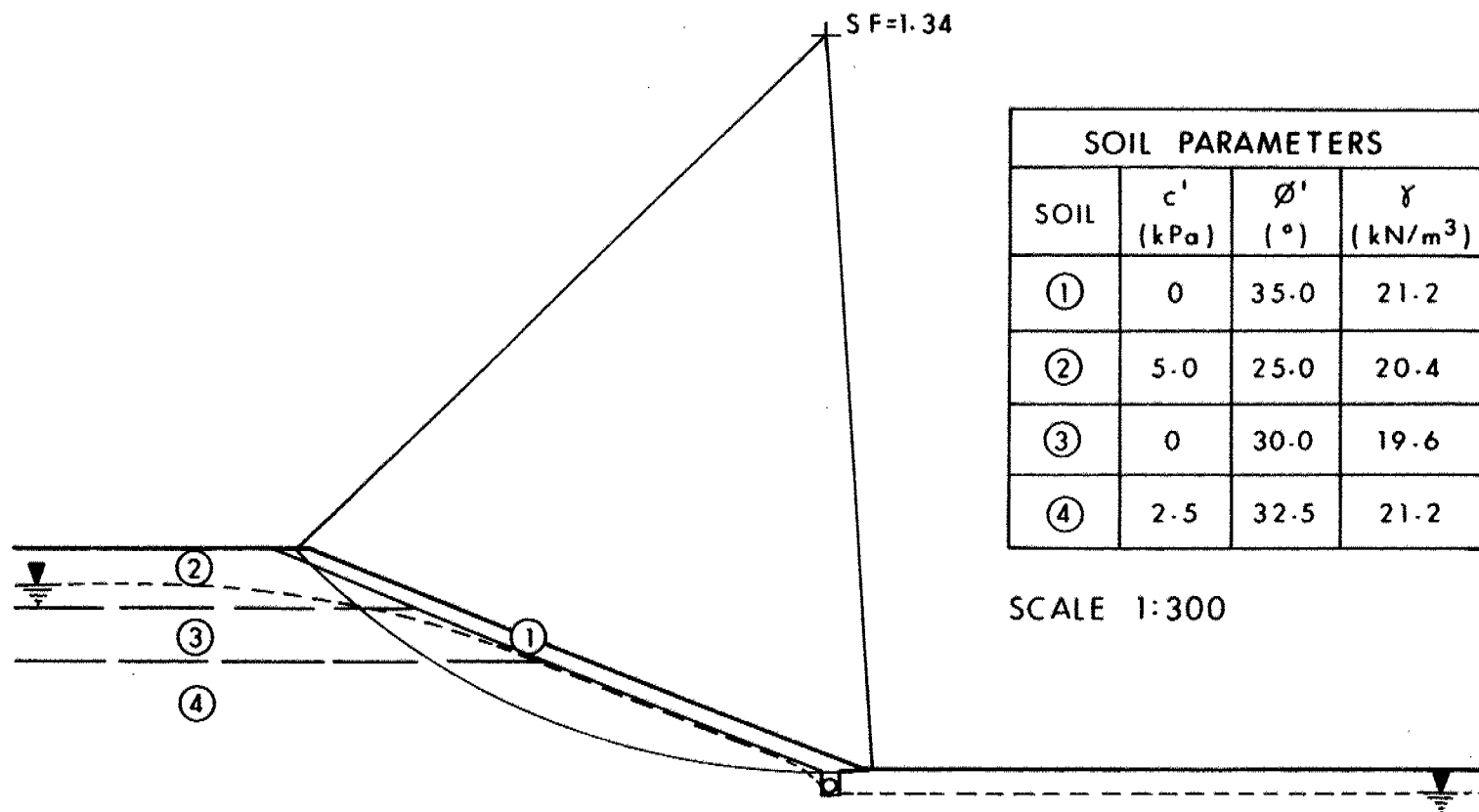
EFFECTIVE STRESS ANALYSIS (2H:1V SLOPE)

Fig 7

WP 137-87-06

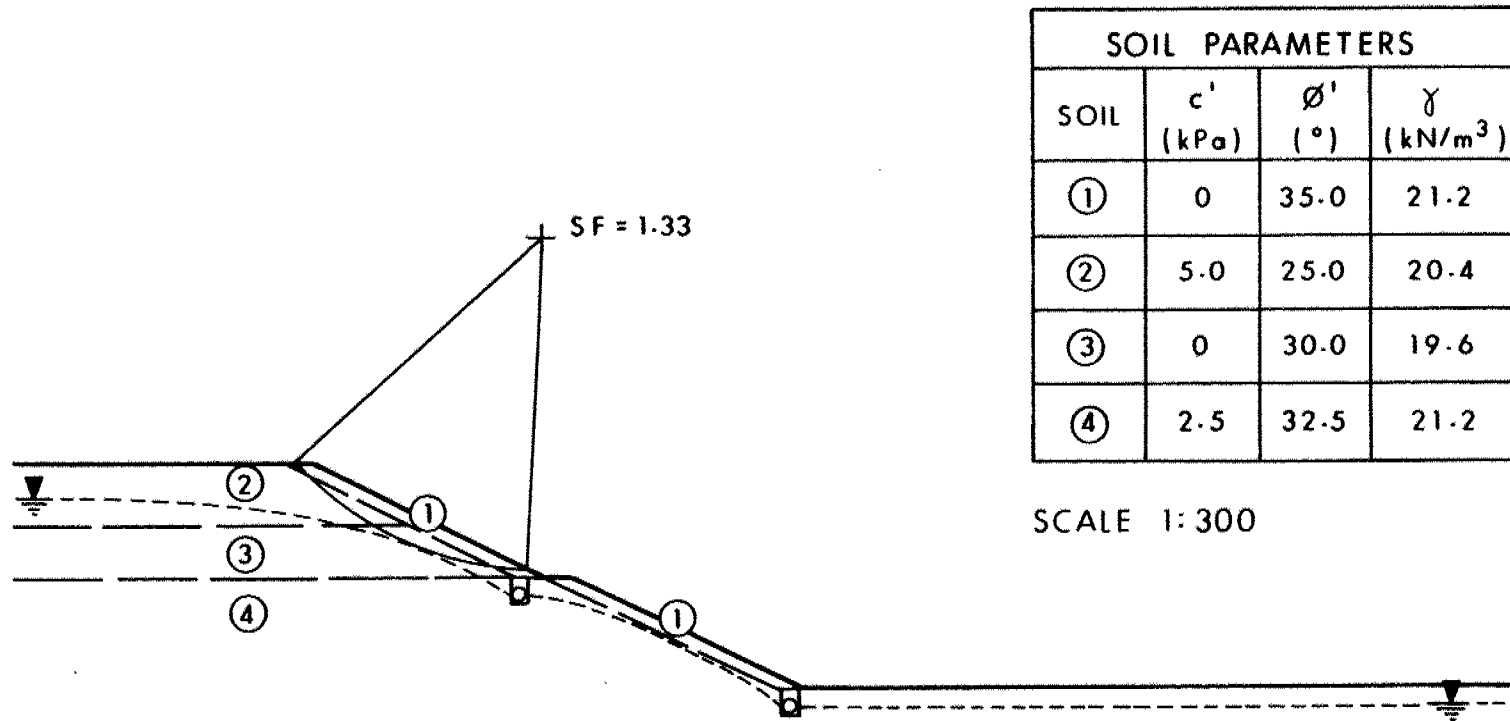


EFFECTIVE STRESS ANALYSIS (2H:1V SLOPE)
WITH 1.2m THICK GRANULAR BLANKET



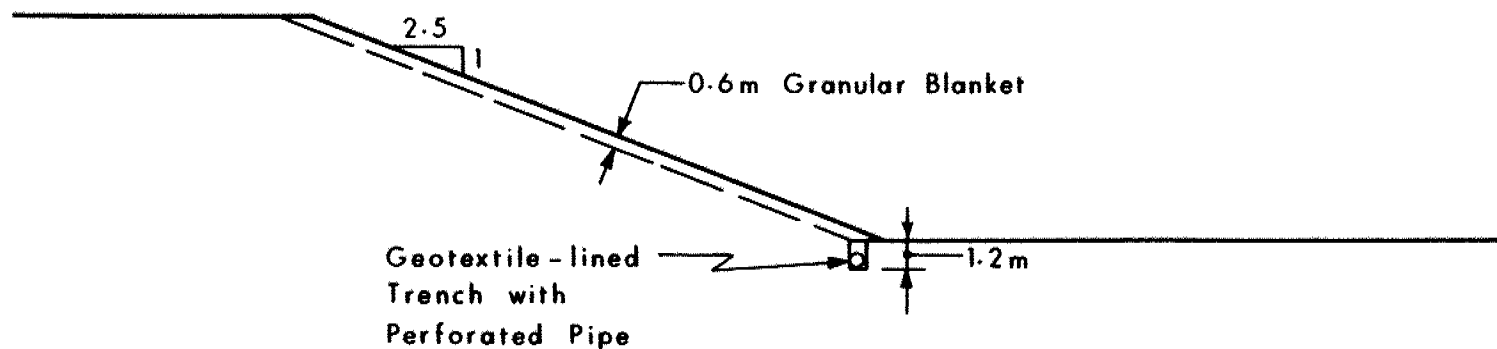
EFFECTIVE STRESS ANALYSIS (2.5H:1V SLOPE)

WITH 0.6m THICK GRANULAR BLANKET AND TOE DRAIN

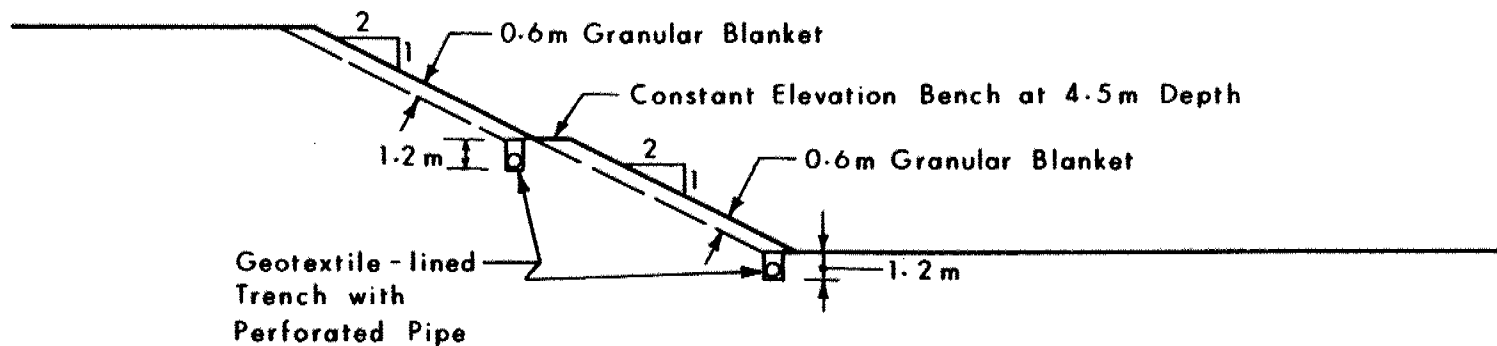


EFFECTIVE STRESS ANALYSIS (2H:1V SLOPE)
WITH 0.6m THICK GRANULAR BLANKET AND BENCH AND TOE DRAINS

Alternative No 1



Alternative No 2

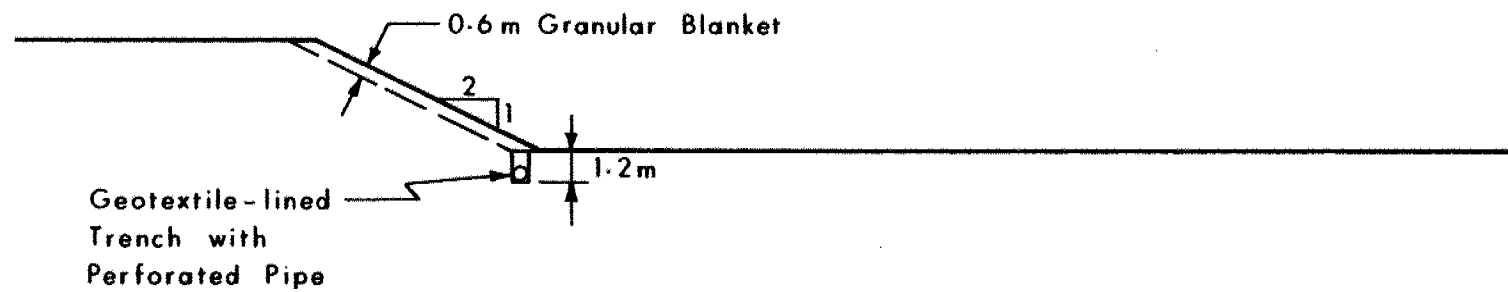


SCALE 1:300

RECOMMENDED CUT SLOPE TREATMENT FOR CUTS OVER 4.5m DEEP

Fig 11

WP 137-87-06

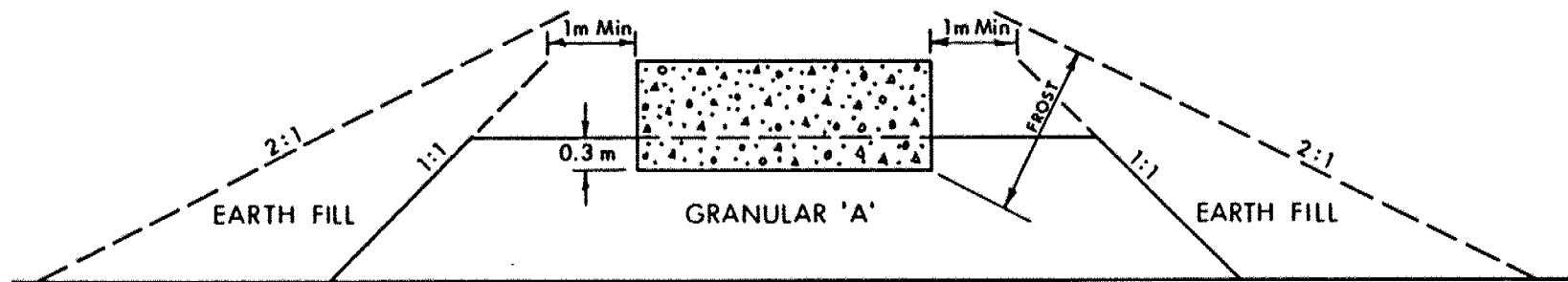


SCALE 1:300

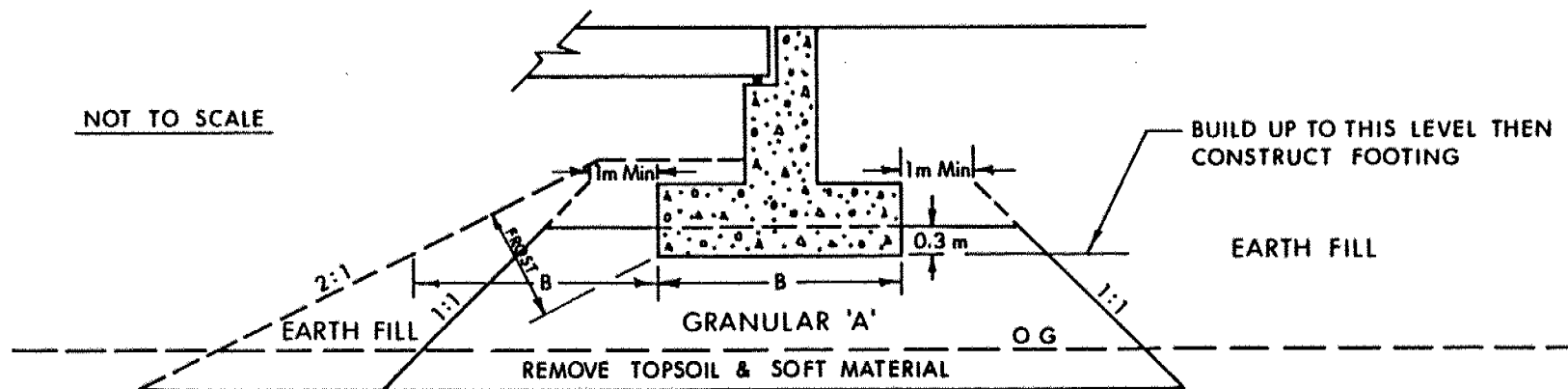
RECOMMENDED CUT SLOPE TREATMENT FOR CUTS UNDER 4.5 m DEEP

Fig 12

WP 137-87-06



X SECTION



LONGITUDINAL SECTION

NOTES:

- 1 - REMOVE TOPSOIL &/OR SOFT SUBSOIL UNDER AREA OF COMPACTED GRANULAR 'A' & EARTH FILL.
- 2 - PLACE GRANULAR 'A' & EARTH FILL TO BOTTOM OF FOOTING LEVEL, COMPACTED ACCORDING TO CURRENT M T C STANDARDS.
- 3 - CONSTRUCT CONCRETE FOOTING.
- 4 - PLACE REMAINDER OF GRANULAR 'A' & EARTH FILL AS REQUIRED.



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ABUTMENT ON COMPACTED FILL
SHOWING GRANULAR 'A' CORE

FIG No 13

W P 137-87-06

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

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

STRESS AND STRAIN

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

MECHANICAL PROPERTIES OF SOIL

m_v	kPa ⁻¹	COEFFICIENT OF VOLUME CHANGE
C_c	1	COMPRESSION INDEX
C_s	1	SWELLING INDEX
C_α	1	RATE OF SECONDARY CONSOLIDATION
c_v	m ² /s	COEFFICIENT OF CONSOLIDATION
H	m	DRAINAGE PATH
T_v	1	TIME FACTOR
U	%	DEGREE OF CONSOLIDATION
σ'_{vo}	kPa	EFFECTIVE OVERBURDEN PRESSURE
σ'_p	kPa	PRECONSOLIDATION PRESSURE
τ_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_f	1	SENSITIVITY = $\frac{c_u}{\tau_r}$

PHYSICAL PROPERTIES OF SOIL

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



Ministry of
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Ontario

RECORD OF BOREHOLE No 9-1

METRIC

W P 137-87-06 LOCATION Co-ords. N 4 848 844.3; E 301 782.9 ORIGINATED BY MS
DIST 6 HWY 400/407 BOREHOLE TYPE Cone Test, H-S Auger, Tricone COMPILED BY MS
DATUM Geodetic DATE 87 10 29-30 CHECKED BY DD

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20 40 60 80 100	20 40 60					
194.3	Ground Surface						194							GR SA SI CL
0.0	Sand					**								
193.4	Compact (Fill)		1	SS	30									
0.9			2	SS	13									
	With Organics		3	SS	16		192							0 9 63 28
	Clayey Silt		4	SS	17									
	Some Sand		5	SS	12		190							
	Trace Gravel		6	SS	29									
189.7	Stiff to Very Stiff (Glacial Till)		7	SS	34									14 32 41 13
4.6			8	SS	54		188							0 3 89 8
	Silt to Sandy Silt		9	SS	59									
	Dense to Very Dense (Lacustrine)		10	SS	100/23 cm		186							
	Silt/Clayey Silt		11	SS	88		184							0 14 53 33
	Some Sand		12	SS	100		182							
	Trace Gravel		13	SS	100/25 cm									
	Random Silt and Sand Pockets						180							
	Occ. Boulders													
	Dense to Very Dense/ Hard (Glacial Till)													
179.4	Silty Clay to Clay		14	SS	48									0 1 33 66
14.9														
178.6														
15.7	End of Borehole													
	* With Thin Silt Seams Hard (Lacustrine)													
	** Groundwater Elevation Not Determined													

OFFICE REPORT ON SOIL EXPLORATION

+3, x5: Numbers refer to
Sensitivity

20
15
10
5 (%) STRAIN AT FAILURE



Ministry of
Transportation and
Communications
Ontario

RECORD OF BOREHOLE No 9-2

METRIC

W P 137-87-06 LOCATION Co-ords. N 4 848 853.7; E 301 799.0 ORIGINATED BY TS
DIST 6 HWY 400/407 BOREHOLE TYPE Cone Test, H-S Auger COMPILED BY TS
DATUM Geodetic DATE 87 11 02 - 04 CHECKED BY DD

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20 40 60 80 100	SHEAR STRENGTH					
194.3	Ground Surface							○ UNCONFINED + FIELD VANE	20 40 60					GR SA SI CL
0.0	Asphalt							● QUICK TRIAXIAL x LAB VANE						
193.4	Sand, Compact, (Fill)		1	SS	9									
0.9			2	SS	19									
	With Organics		3	SS	17									0 13 59 28
	Clayey Silt		4	SS	10									
	Some Sand		5	SS	14									2 34 (64)
	Trace Gravel		6	SS	20									
189.1	Stiff to Very Stiff (Glacial Till)		7	SS	14									
5.2			8	SS	10									2 18 (80)
	Silt		9	SS	84									0 5 83 12
	Compact to Very Dense (Lacustrine)		10	SS	40									1 14 80 5
	Silt/Clayey Silt		11	SS	43									
	Some Sand		12	SS	80									0 14 57 29
	Trace Gravel													
	Random Silt and Sand Pockets													
	Occ. Boulders													
	Compact to Very Dense Stiff to Hard (Glacial Till)													
180.6			13	SS	68									0 5 53 42
13.7			14	SS	94									
	Silty Clay to Clay With Thin Silt Seams Hard (Lacustrine)		15	SS	100									
175.6			16	SS	100/28 cm									3 5 48 44
18.7	End of Borehole													

+3, x5: Numbers refer to
Sensitivity

20
15 5 (%) STRAIN AT FAILURE
10

RECORD OF BOREHOLE No 9-3

METRIC

W P 137-87-06 LOCATION Co-ords. N 4 848 855.5; E 301 765.5 ORIGINATED BY MS
 DIST 6 HWY 400/407 BOREHOLE TYPE Cone Test, H-S Auger COMPILED BY MS
 DATUM Geodetic DATE 87 10 29 & 87 11 24 CHECKED BY DD

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 SHEAR STRENGTH ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB VANE	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
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE							
191.6	Ground Surface										
0.0	Clayey Silt Some Sand Trace Gravel Very Stiff (Glacial Till)		1	SS	22						
189.6			2	SS	65						0 1 96 3
2.0	Silt Very Dense (Lacustrine)		3	SS	66						0 6 87 7
	Silt/Clayey Silt Some Sand Trace Gravel Random Silt and Sand Pockets Occ. Boulders Very Dense/Hard (Glacial Till)		4	SS	100/25 cm						
			5	SS	92/28 cm						1 18 51 30
182.0			6	SS	59						
9.6	End of Borehole										

RECORD OF BOREHOLE No 9-4

METRIC

W P 137-87-06 LOCATION Co-ords. N 4 848 889.0; E 301 763.0 ORIGINATED BY DD
DIST 6 HWY 400/407 BOREHOLE TYPE Cone Test, H-S Auger, Tricone COMPILED BY DD
DATUM Geodetic DATE 87 10 29 & 87 11 19 - 24 CHECKED BY DD

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20 40 60 80 100	20 40 60					
191.8	Ground Surface													
0.0	Clayey Silt Some Sand Trace Gravel Very Stiff (Glacial Till)		1	SS	18		190							3 17 37 43
189.4			2	SS	15		188							1 22 69 8
2.4	Silt to Sandy Silt Compact to Dense (Lacustrine)		3	SS	32		186							0 40 54 6
	Silt/Clayey Silt Some Sand Trace Gravel Random Silt and Sand Pockets Occ. Boulders Compact to Very Dense Very Stiff to Hard (Glacial Till)		4	SS	100/25 cm		184							1 15 63 21
			5	SS	80		182							
			6	SS	88		180							
			7	SS	101/28 cm		178							
			8	SS	102/28 cm		176							
			9	SS	90/10 cm		174							
180.4			10	SS	76		172							
11.4			11	SS	55		170							
			12	SS	51		168							
	Silty Clay to Clay With Thin Silt Seams		13	SS	100		166							
	Hard (Lacustrine)		14	SS	50		164							
			15	SS	85		162							
			16	SS	72									
			17	SS	100									
			18	SS	94									
			19	SS	100/25 cm									
			20	SS	100									
			21	SS	97									
			22	SS	66									
161.6														
30.2														

Continued

+3, x5: Numbers refer to
Sensitivity

20
15 5 (%) STRAIN AT FAILURE
10

Continued

RECORD OF BOREHOLE No 9-4 Continued METRIC

W P 137-87-06 LOCATION Co-ords. N 4 848 889.0; E 301 763.0 ORIGINATED BY DD
 DIST 6 HWY 400/407 BOREHOLE TYPE Cone Test, H-S Auger, Tri-Cone COMPILED BY MS
 DATUM Geodetic DATE 87 10 29 & 87 11 19 - 24 CHECKED BY DD

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT Y	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES		20	40	60	80	100					
161.6	Continued															
30.2	Silty Clay to Clay With Thin Silt Seams Hard (Lacustrine)		23	SS	84	160										
157.4						158										
34.4	Sandy Silt to															
156.6	Silty Sand *		24	SS	120	8 cm										
35.2	End of Borehole															
	* Very Dense (Lacustrine)															

+³, x⁵: Numbers refer to
Sensitivity

20
15 5 (%) STRAIN AT FAILURE
10



RECORD OF BOREHOLE No 9-5

METRIC

W P 137-87-06 LOCATION Co-ords. N 4 848 893.0; E 301 774.5 ORIGINATED BY TS
DIST 6 HWY 400/407 BOREHOLE TYPE Cone Test, H-S Auger, Tricone COMPILED BY TS
DATUM Geodetic DATE 87 10 28 - 30 CHECKED BY DD

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20 40 60 80 100	20 40 60					
194.4	Ground Surface						194							GR SA SI CL
0.0	Sand Compact (Fill)					*	194							
192.9							192							
1.5	Clayey Silt Some Sand Trace Gravel Very Stiff (Glacial Till)		1	SS	16		192							
			2	SS	21		190							
190.1			3	SS	24		190							
4.3	Silt Compact (Lacustrine)		4	SS	13		188							0 14 73 13
			5	SS	35		188							0 17 65 18
	Silt/Clayey Silt Some Sand Trace Gravel Random Silt and Sand Pockets Occ. Boulders Compact to Very Dense, Stiff to Hard (Glacial Till)		6	SS	36		186							
			7	SS	25		186							
			8	SS	70		184							6 13 57 24
			9	SS	75		184							
			10	SS	56		182							
			11	SS	101		182							2 5 48 45
180.1			12	SS	100		180							
14.3			13	SS	100		180							0 5 56 39
			14	SS	100		178							
			15	SS	100/28 cm		178							
			16	SS	49		176							0 0 20 80
	Silty Clay to Clay With Thin Silt Seams Hard (Lacustrine)		17	SS	62		176							
			18	SS	44		174							
			19	SS	71		174							
			20	SS	50		172							
169.6			21	SS	80		170							
24.8	End of Borehole													
	* Groundwater Elevation Not Determined													

+³, x⁵: Numbers refer to
Sensitivity

20
15 5 (%) STRAIN AT FAILURE
10

RECORD OF BOREHOLE No 9-6

METRIC

W P 137-87-06 LOCATION Co-ords. N 4 848 955.0; E 301 763.1 ORIGINATED BY TS
DIST 6 HWY 400/407 BOREHOLE TYPE Cone Test, H-S Auger COMPILED BY TS
DATUM Geodetic DATE 87 10 26 - 27 CHECKED BY DD

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100		
194.6	Ground Surface													
0.0	Sand Compact (Fill)		1	SS	22		194							
191.2			2	SS	31		192							
3.4	Clayey Silt *		3	SS	24		190							
189.9			4	SS	19		188							1 20 70 9
4.7	Silt to Sandy Silt Compact (Lacustrine)		5	SS	90		186							
	Silt/Clayey Silt Some Sand Trace Gravel Random Silt and Sand Pockets Occ. Boulders Compact to Very Dense/ Very Stiff to Hard (Glacial Till)		6	SS	100	30 cm	184							1 22 60 17
			7	SS	100	25 cm	182							1 5 50 44
			8	SS	100	25 cm	180							0 6 53 41
181.2			9	SS	116	25 cm	178							1 4 49 46
13.4			10	SS	84		176							0 4 49 47
	Silty Clay to Clay With Thin Silt Seams Hard (Lacustrine)		11	SS	112	23 cm	174							0 6 50 44
			12	SS	125	25 cm	172							
			13	SS	121	23 cm								
			14	SS	110	23 cm								
			15	SS	100	28 cm								
	Sand		16	SS	101	23 cm								2 60 20 18
			17	SS	100	15 cm								1 4 49 46
			18	SS	120	13 cm								
171.5			19	SS	141	23 cm								
23.1	End of Borehole													
	* Some Sand Trace Gravel Very Stiff (Glacial Till)													



RECORD OF BOREHOLE No 9-7

METRIC

W P 137-87-06 LOCATION Co-ords. N 4 848 952.5; E 301 751.0 ORIGINATED BY MS
DIST 6 HWY 400/407 BOREHOLE TYPE Cone Test, H-S Auger COMPILED BY MS
DATUM Geodetic DATE 87 10 30 & 87 11 20 CHECKED BY DD

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			20	40	60	80	100			
191.9	Ground Surface													GR SA SI CL
0.0	Clayey Silt Some Sand Trace Gravel Very Stiff (Glacial Till)		1	SS	18									
189.9			2	SS	15									
2.0	Silt Compact (Lacustrine)		3	SS	100									1 19 69 11
			4	SS	92									
	Silt/Clayey Silt Some Sand Trace Gravel Random Silt and Sand Pockets Occ. Boulders Compact to Very Dense/ Stiff to Hard (Glacial Till)		5	SS	52									1 21 65 13
			6	SS	97									0 6 54 40
			7	SS	69									1 4 51 44
180.0			8	SS	60									
11.9			9	SS	84									0 0 29 71
	Silty Clay to Clay With Thin Silt Seams Hard (Lacustrine)		10	SS	100									
			11	SS	82									8 20 38 34
173.2			12	SS	100									
18.7	End of Borehole													

+3, x5: Numbers refer to
Sensitivity

20
15 5 (%) STRAIN AT FAILURE
10



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RECORD OF BOREHOLE No 9-8

METRIC

W P 137-87-06 LOCATION Co-ords. N 4 849 040.7; E 301 747.0 ORIGINATED BY TS
DIST 6 HWY 400/407 BOREHOLE TYPE Cone Test, H-S Auger COMPILED BY TS
DATUM Geodetic DATE 87 10 26-27 CHECKED BY DD

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT Y	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20 40 60 80 100	20 40 60					
194.6	Ground Surface													
0.0	Sand Compact (Fill)					*	194							
193.1	With Organics		1	SS	14		192							
1.5	Clayey Silt Some Sand Trace Gravel Stiff (Glacial Till)		2	SS	14		190							
190.0	Silt to Sandy Silt Compact to Very Dense (Lacustrine)		3	SS	52		188							5 38 46 11
4.6	Silt/Clayey Silt Some Sand Trace Gravel Random Silt and Sand Pockets Occ. Boulders Compact to Very Dense/ Very Stiff to Hard (Glacial Till)		4	SS	28		186							1 9 78 12
			5	SS	22		184							1 35 (64)
			6	SS	50		182							
			7	SS	58		180							1 6 (93)
			8	SS	72		178							
			9	SS	100		176							0 5 53 42
			10	SS	94		174							0 0 21 79
			11	SS	66		172							
			12	SS	73		170							
			13	SS	35									
			14	SS	33									
180.1	Silty Clay to Clay With Thin Silt Seams Very Stiff to Hard (Lacustrine)		15	SS	25									
14.5			16	SS	27									
			17	SS	45									
			18	SS	120	25 cm								
			19	SS	61									
			20	SS	100	28 cm								
			21	SS	105									
169.8	End of Borehole		22	SS	108	28 cm								
24.8	* Groundwater Elev. Not Determined													

+3, x5: Numbers refer to
Sensitivity

20
15 5 (%) STRAIN AT FAILURE
10

OFFICE REPORT ON SOIL EXPLORATION

RECORD OF BOREHOLE No 9-9

METRIC

W P 137-87-06 LOCATION Co-ords. N 4 849 061.7; E 301 764.0 ORIGINATED BY DD
DIST 6 HWY 400/407 BOREHOLE TYPE Cone Test, H-S Auger, Tricone COMPILED BY MS
DATUM Geodetic DATE 87 11 02 - 04 CHECKED BY DD

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT Y	REMARKS & GRAIN SIZE DISTRIBUTION (%)			
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40						60	80	100
								SHEAR STRENGTH							WATER CONTENT (%)		
							○ UNCONFINED + FIELD VANE					● QUICK TRIAXIAL x LAB VANE					
194.6	Ground Surface																
0.0	Asphalt													GR SA SI CL			
193.4	Sand, Compact (Fill)		1	SS	10												
1.2	With Organics		2	SS	11												
	Clayey Silt		3	SS	14												
	Some Sand		4	SS	13												
	Trace Gravel		5	SS	14												
190.3	Stiff (Glacial Till)		6	SS	40												
4.3	Silt to Sandy Silt Dense (Lacustrine)		7	SS	33									8 29 60 3			
			8	SS	36									0 3 91 6			
	Silt/Clayey Silt Some Sand Trace Gravel Random Silt and Sand Pockets Occ. Boulders Dense to Very Dense/ Hard (Glacial Till)		9	SS	63												
			10	SS	100	23 cm											
			11	SS	90												
			12	SS	52												
180.9	Sand		13	SS	59												
13.7	Silty Clay to Clay With Thin Silt Seams Very Stiff to Hard (Lacustrine)		14	SS	48									8 6 56 30			
			15	SS	19									0 0 91 9			
	Silt		16	SS	120	30 cm								0 0 87 13			
			17	SS	100	28 cm											
172.9			18	SS	100	23 cm											
21.7	End of Borehole																

RECORD OF BOREHOLE No 9-10

METRIC

W P 137-87-06 LOCATION Co-ords. N 4 849 071.3; E 301 740.9 ORIGINATED BY TS
DIST 6 HWY 400/407 BOREHOLE TYPE Cone Test, H-S Auger, Tricone COMPILED BY TS
DATUM Geodetic DATE 87 10 30 CHECKED BY DD

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20 40 60 80 100	PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L		
194.6	Ground Surface												
0.0	Sand					*	194						
193.7	Compact (Fill)		1	SS	8								
0.9	Clayey Silt Some Sand Trace Gravel Stiff to Hard (Glacial Till)		2	SS	13		192						
			3	SS	8								
			4	SS	25								
			5	SS	37								
190.0	Silt Dense to Very Dense (Lacustrine)		6	SS	48		190						
4.6			7	SS	67								
			8	SS	103	28 cm	188						
	Silt/Clayey Silt Some Sand Trace Gravel Random Silt and Sand Pockets Occ. Boulders Very Dense/Hard (Glacial Till)		9	SS	100	25 cm	186						
			10	SS	115	23 cm							
			11	SS	120	20 cm	184						
182.0	End of Borehole		12	SS	70								
12.6	* Groundwater Elevation Not Determined												

OFFICE REPORT ON SOIL EXPLORATION

RECORD OF BOREHOLE No 9-11

METRIC

W P 137-87-06 LOCATION Co-ords. N 4 848 825.0; E 301 771.0 ORIGINATED BY MS
DIST 6 HWY 400/407 BOREHOLE TYPE Cone Test, H-S Auger, Tricone COMPILED BY MS
DATUM Geodetic DATE 87 10 30 & 87 11 18 CHECKED BY DD

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20 40 60 80 100	20 40 60					
191.5	Ground Surface													
0.0	Clayey Silt Some Sand Trace Gravel Very Stiff to Hard (Glacial Till)		1	SS	26		190							
189.4			2	SS	37									
2.1			3	SS	57									
	Silt to Silty Sand Compact to Very Dense (Lacustrine)		4	SS	24		188						0 38 60 2	
			5	SS	100	25 cm							0 67 32 1	
			6	SS	100	23 cm								
			7	SS	100	28 cm	186						0 10 86 4	
			8	SS	105	25 cm								
	Silt/Clayey Silt Some Sand Trace Gravel Random Silt and Sand Pockets Occ. Boulders Very Dense/Hard (Glacial Till)		9	SS	100		184						1 15 57 27	
			10	SS	95	25 cm	182							
			11	SS	117	28 cm	180						2 19 61 18	
178.7			12	SS	108	25 cm								
12.8	Silty Clay to Clay With Thin Silt Seams Hard (Lacustrine)		13	SS	100		178							
176.3	Gravel		14	SS	126	25 cm								
15.2	End of Borehole													



Ministry of
Transportation and
Communications
Ontario

RECORD OF BOREHOLE No 11-5

METRIC

W P 137-87-06 LOCATION Co-ords. N 4 849 007.0; E 301 735.5 ORIGINATED BY MS
DIST 6 HWY 400/407 BOREHOLE TYPE H-S Auger COMPILED BY MS
DATUM Geodetic DATE 87 11 24 - 26 CHECKED BY MS

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES		20	40	60	80	100					
192.0	Ground Surface															GR SA SI CL
0.0	Clayey Silt Some Sand Trace Gravel Very Stiff (Glacial Till)		1	SS	24											
189.0			2	SS	34											0 22 73 5
3.0	Silt Dense (Lacustrine)		3	SS	100											0 10 71 19
	Silt/Clayey Silt Some Sand Trace Gravel Random Silt and Sand Pockets Occ. Boulders Dense to Very Dense/ Hard (Glacial Till)		4	SS	60	10 cm										
			5	SS	90	8 cm										1 27 59 13
			6	SS	90	15 cm										
181.0	Boulder		7	SS	120	0 cm										
11.0			8	SS	60	10 cm										1 92 5 2
			9	SS	100	20 cm										1 92 6 1
	Sand Very Dense		10	SS	100											
173.4	Silty Clay to Clay		11	SS	100											
18.6	End of Borehole * With Thin Silt Seams Hard (Lacustrine)															

+3, x5: Numbers refer to
Sensitivity

20
15 5 (%) STRAIN AT FAILURE
10



Ministry of
Transportation and
Communications

RECORD OF BOREHOLE No 12-3

METRIC

W P 137-87-06 LOCATION Co-ords. N 4 849 060.0; E 301 717.5 ORIGINATED BY KZ
DIST 6 HWY 400/407 BOREHOLE TYPE Cone Test, H-S Auger, Tricone COMPILED BY KZ
DATUM Geodetic DATE 87 11 16 - 18 CHECKED BY MS

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20 40 60 80 100	20 40 60					
193.5	Ground Surface													GR SA SI CL
0.0	Clayey Silt Some Sand Trace Gravel Very Stiff to Hard (Glacial Till)		1	SS	30		192							10 31 39 20
190.8			2	SS	16									0 11 87 2
2.7	Silt Dense to Very Dense (Lacustrine)		3	SS	15		190							
			4	SS	9									
			5	SS	40		188							
			6	SS	43									
			7	SS	63		186							1 21 64 14
	Silt/Clayey Silt Some Sand Trace Gravel Random Silt and Sand Pockets Occ. Boulders Loose to Very Dense/ Stiff to Hard (Glacial Till)		8	SS	72									4 29 52 15
			9	SS	88		184							
			10	SS	90	15 cm								
			11	SS	115	25 cm	182							
			12	SS	80		180							1 3 (96)
179.8			13	SS	30									
13.7	Silty Clay to Clay With Thin Silt Seams Very Stiff to Hard (Lacustrine)		14	SS	63		178							0 7 (93)
			15	SS	105		176							
			16	SS	107		174							
			17	SS	41		172							
			18	SS	64		170							
			19	SS	67		168							
			20	SS	61		166							
			21	SS	52		164							
			22	SS	28									
			23	SS	20									
163.3														
30.2														

Continued

+3, x5: Numbers refer to
Sensitivity

20
15 5 (%) STRAIN AT FAILURE
10

Continued

RECORD OF BOREHOLE No 12-3 Continued METRIC

W P 137-87-06 LOCATION Co-ords. N 4 849 060.0; E 301 717.5 ORIGINATED BY KZ
 DIST 6 HWY 400/407 BOREHOLE TYPE Cone Test, H-S Auger, Tricone COMPILED BY KZ
 DATUM Geodetic DATE 87 11 16 - 18 CHECKED BY MS

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100					
163.3 30.2	Continued		24	SS	23		162										
	Silty Clay to Clay With Thin Silt Seams Very Stiff to Hard (Lacustrine)		25	SS	26		160										
158.4 35.1			26	SS	40		158										
	Sandy Silt to Silty Sand Dense to Very Dense (Lacustrine)		27	SS	210	15 cm	156										
			28	SS	105	25 cm											
154.0 39.5	End of Borehole		29	SS	102	20 cm											

+3, x⁵: Numbers refer to
Sensitivity

20
15 5 (%) STRAIN AT FAILURE
10



Ministry of
Transportation and
Communications
Ontario

RECORD OF BOREHOLE No 12-4

METRIC

W P 137-87-06 LOCATION Co-ords. N 4 849 041.0; E 301 728.5 ORIGINATED BY MS
DIST 6 HWY 400/407 BOREHOLE TYPE H-S Auger COMPILED BY MS
DATUM Geodetic DATE 87 11 27 CHECKED BY MS

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20 40 60 80 100						
								SHEAR STRENGTH						
192.2	Ground Surface													GR SA SI CL
0.0	Clayey Silt Some Sand Trace Gravel (Glacial Till)						192							
190.7			1	SS	25		190							5 28 47 20
1.5			2	SS	110	25 cm	188							0 9 81 10
	Silt Very Dense (Lacustrine)		3	SS	60	8 cm	186							
	Silt/ Clayey Silt Some Sand Trace Gravel		4	SS	60	13 cm	184							2 35 53 10
	Random Silt and Sand Pockets Occ. Boulders		5	SS	105	30 cm	182							
	Compact to Very Dense/ Very Stiff to Hard (Glacial Till)		6	SS	60	13 cm	180							0 5 39 56
181.5			7	SS	67		178							0 2 84 14
10.7	Silty Clay to Clay With Thin Silt Seams		8	SS	29		176							0 6 50 44
	Very Stiff to Hard (Lacustrine)		9	SS	95		174							0 2 29 69
			10	SS	75									
			11	SS	70									
173.5			12	SS	83									
18.7	End of Borehole													

+3, x5: Numbers refer to 20
Sensitivity 15-5 (%) STRAIN AT FAILURE
10

OFFICE REPORT ON SOIL EXPLORATION

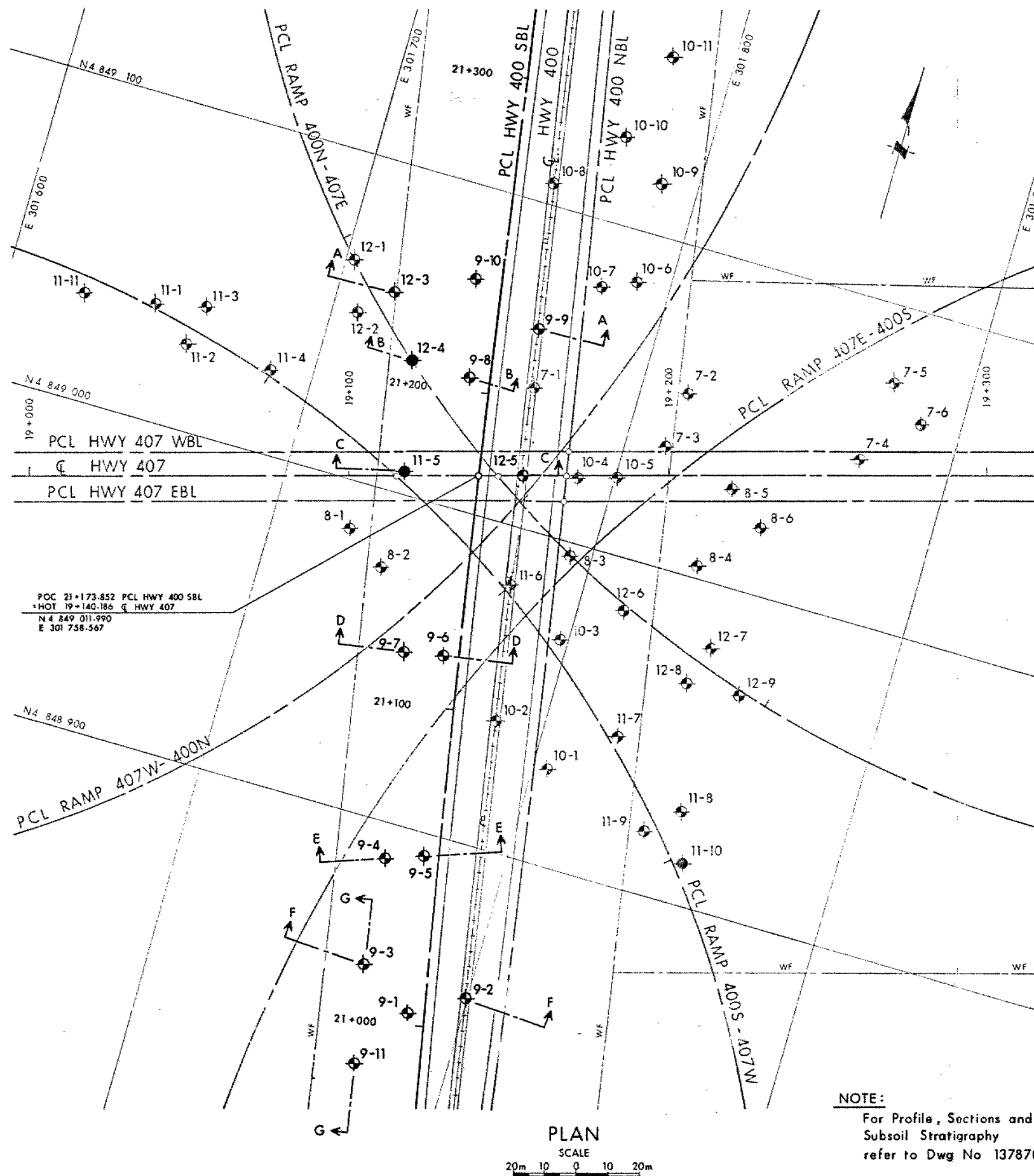


RECORD OF BOREHOLE No 12-5

METRIC

W P 137-87-06 LOCATION Co-ords. N 4 849 016.0; E 301 771.8 ORIGINATED BY MS
DIST 6 HWY 400/407 BOREHOLE TYPE Cone Test, H-S Auger, Tricone COMPILED BY MS
DATUM Geodetic DATE 87 11 02 - 04 CHECKED BY MS

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT Y	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20 40 60 80 100	20 40 60					
194.6	Ground Surface													
0.0	Asphalt													
193.1	Sand Compact (Fill)													
1.5	With Organics		1	SS	10									
	Clayey Silt													
	Some Sand		2	SS	18									
	Trace Gravel													
189.7	Stiff to Very Stiff (Glacial Till)		3	SS	16									
4.9	Silt Dense (Lacustrine)		4	SS	33									0 12 75 13
	Silt/ Clayey Silt													
	Some Sand		5	SS	81									1 8 78 13
	Trace Gravel		6	SS	71									
	Random Silt and Sand Pockets		7	SS	120	15 cm								
	Occ. Boulders													
	Dense to Very Dense/ Hard		8	SS	100	23 cm								2 15 56 27
	(Glacial Till)		9	SS	100	13 cm								1 7 68 24
180.3			10	SS	100	23 cm								
14.3			11	SS	86									2 10 47 41
			12	SS	100	23 cm								
			13	SS	115	23 cm								
	Silty Sand		14	SS	120	23 cm								0 59 39 2
			15	SS	120	20 cm								
	Very Dense		16	SS	100	8 cm								
			17	SS	100	13 cm								
	Silty Clay to Clay With Thin Silt Seams		18	SS	74	15 cm								1 6 66 27
	Hard (Lacustrine)		19	SS	100	28 cm								
169.9			20	SS	100	28 cm								
24.7	End of Borehole													



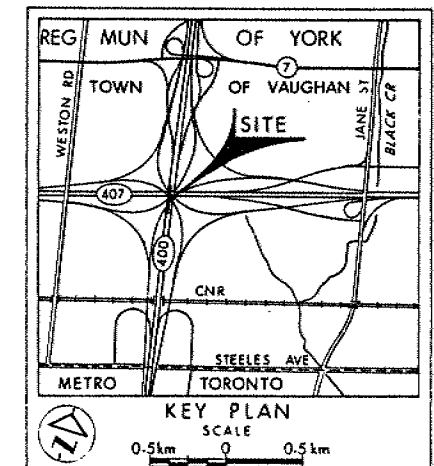
NOTE:

For Profile, Sections and
Subsoil Stratigraphy
refer to Dwg No 1378706-B & 1378706-C

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





CONT No
WP No 137-87-06

HWY 400 SBL
(BRIDGE - 9)
BORE HOLE LOCATIONS & SOIL STRATA



No	ELEVATION	CO-ORDINATES NORTH	EAST
7-1	194.6	4 849 043.3	301 767.3
7-2	192.6	4 849 055.0	301 814.5
7-3	192.6	4 849 037.0	301 812.0
7-4	192.3	4 849 050.0	301 871.5
7-5	192.3	4 849 076.0	301 875.5
7-6	192.3	4 849 066.0	301 887.5
8-1	192.8	4 848 985.0	301 724.0
8-2	192.2	4 848 976.0	301 737.0
8-3	194.6	4 848 995.7	301 793.0
8-4	192.6	4 849 004.0	301 832.0
8-5	192.5	4 849 030.0	301 836.0
8-6	192.4	4 849 021.0	301 848.0
9-1	194.3	4 848 844.3	301 782.0
9-2	194.3	4 848 853.7	301 799.0
9-3	191.6	4 848 855.5	301 765.5
9-4	191.8	4 848 889.0	301 763.0
9-5	194.4	4 848 893.0	301 774.5
9-6	194.6	4 848 955.0	301 763.0
9-7	191.9	4 848 952.5	301 751.0
9-8	194.6	4 849 040.7	301 747.0
9-9	194.6	4 849 061.7	301 764.0
9-10	194.6	4 849 071.3	301 740.0
9-11	191.5	4 848 825.0	301 771.0
10-1	194.0	4 848 929.9	301 804.0
10-2	194.5	4 848 939.9	301 784.0
10-3	194.6	4 848 969.8	301 797.3
10-4	194.6	4 849 020.0	301 788.0
10-5	192.6	4 849 023.5	301 800.5
10-6	192.8	4 849 084.0	301 789.9
10-7	194.5	4 849 079.7	301 779.9
10-8	194.4	4 849 106.9	301 755.5
10-9	192.1	4 849 116.0	301 788.0
10-10	194.3	4 849 127.0	301 773.0
10-11	191.8	4 849 155.0	301 780.5
11-1	192.8	4 849 036.0	301 646.0
11-2	191.6	4 849 026.5	301 659.0
11-3	193.4	4 849 039.5	301 662.0
11-4	193.1	4 849 026.0	301 686.0
11-5	192.0	4 849 007.0	301 735.0
11-6	194.6	4 848 982.0	301 777.5
11-7	192.1	4 848 945.5	301 823.0
11-8	192.4	4 848 928.5	301 848.5
11-9	192.2	4 848 919.5	301 839.0
11-10	192.0	4 848 913.0	301 853.0
11-11	192.9	4 849 033.0	301 623.0
12-1	193.3	4 849 066.5	301 702.5
12-2	193.4	4 849 051.0	301 708.0
12-3	193.5	4 849 060.0	301 717.5
12-4	192.2	4 849 041.0	301 728.5
12-5	194.6	4 849 016.0	301 771.8
12-6	192.4	4 848 984.0	301 814.0
12-7	192.4	4 848 980.0	301 843.5
12-8	192.7	4 848 967.5	301 839.0
12-9	192.3	4 848 968.5	301 856.0

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) |
|  | WL at time of investigation |

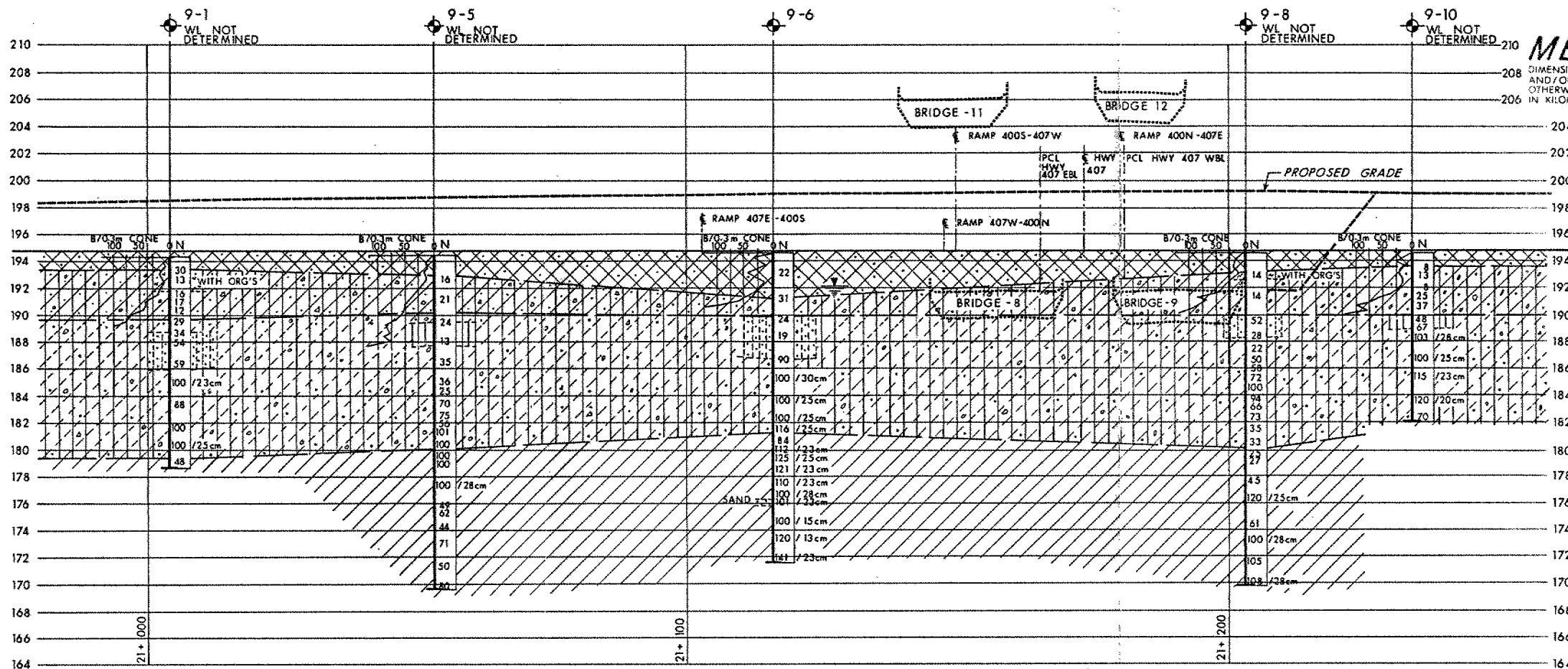
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==NOTE==

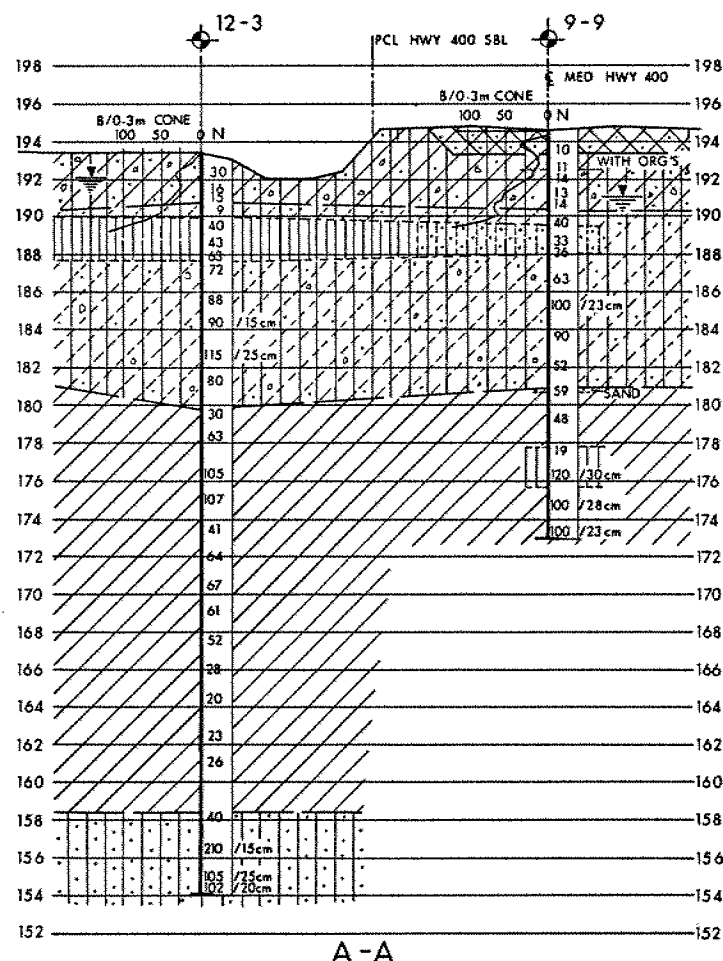
NOTE
The boundaries between soil strata have been established only at Bore Hole locations. Between Bore Holes the boundaries are assumed from geological evidence.

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

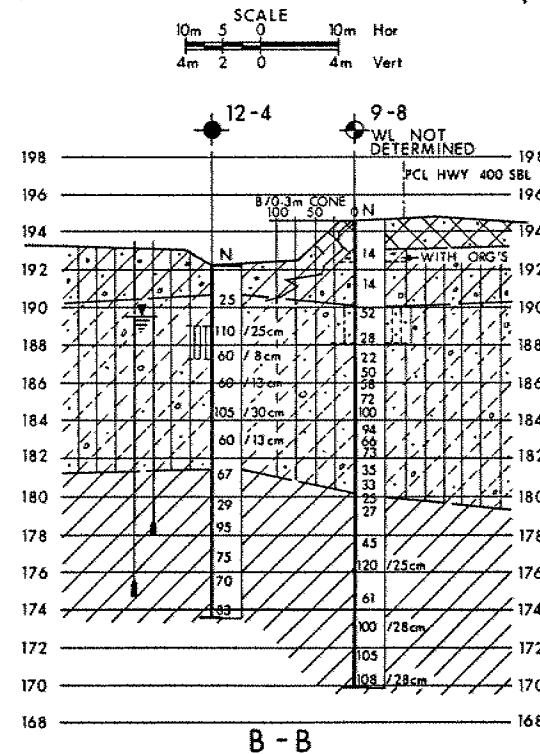
REV				
DATE	BY	DESCRIPTION		
Geacres No 30M13-71				
HWY No 400 & 407				DIST 6
SUBMIT DD	CHECKED	DATE 1988 02 22	SITE 37-1173	
DRAWN DT	CHECKED	DWG 1378706-A		



PROFILE CONTROL LINE HWY 400 SBL (BRIDGE - 9)

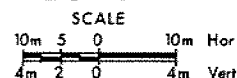


A-A



B-B

SECTIONS



SOIL STRATIGRAPHY LEGEND

	SAND (FILL) Compact		SANDY SILT TO SILTY SAND Dense to Very Dense (LACUSTRINE)
	CLAYEY SILT SOME SAND, TRACE GRAVEL Firm to Hard (GLACIAL TILL)		SILT Compact to Very Dense (LACUSTRINE)
	SILT / CLAYEY SILT SOME SAND, TRACE GRAVEL RANDOM SILT & SAND POCKETS OCCASIONAL BOULDERS Loose to Very Dense / Stiff to Hard (GLACIAL TILL)		SILT TO SANDY SILT Compact to Very Dense (LACUSTRINE)
	SILTY CLAY TO CLAY WITH THIN SILT SEAMS Very Stiff to Hard (LACUSTRINE)		SAND Very Dense

Note:
For Plan Refer to
Dwg No 1378706-A

CONT No
WP No 137-87-06

HWY 400 SBL
(BRIDGE - 9)
BORE HOLE LOCATIONS & SOIL STRATA

SHEET

SEE DWG 1378706-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)
- WL at time of investigation
87 10 and 87 11
- WL in Piezometer
- Piezometer

No	ELEVATION	CO-ORDINATES NORTH	EAST
9-1	194.3	4 848 844.3	301 782.9
9-2	194.3	4 848 853.7	301 799.0
9-3	191.6	4 848 855.5	301 765.5
9-4	191.8	4 848 889.0	301 763.0
9-5	194.4	4 848 893.0	301 774.5
9-6	194.6	4 848 955.0	301 763.1
9-7	191.9	4 848 952.5	301 751.0
9-8	194.6	4 849 040.7	301 747.0
9-9	194.6	4 849 061.7	301 764.0
9-10	194.6	4 849 071.3	301 740.9
11-5	191.5	4 848 825.0	301 771.0
12-3	193.5	4 849 060.0	301 717.5
12-4	192.2	4 849 041.0	301 728.5
12-5	194.6	4 849 016.0	301 771.8

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

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

REV.			
DATE	BY	DESCRIPTION	

Geacres No 30M13-71

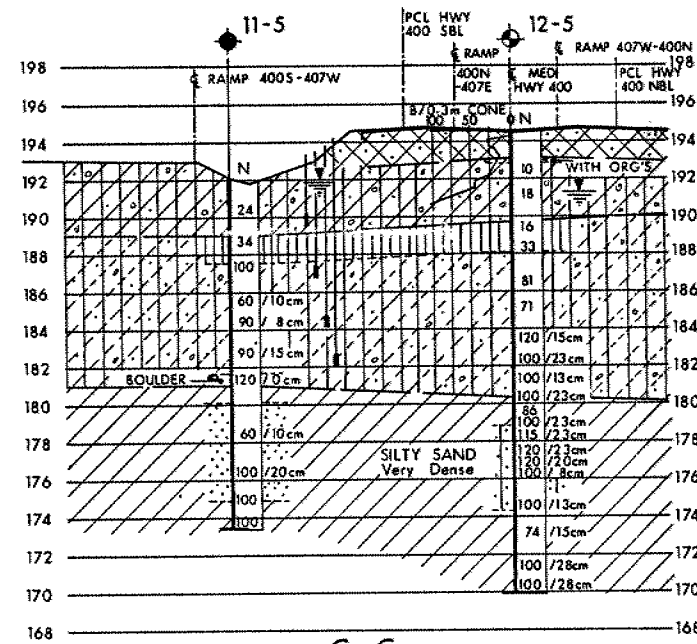
HWY No 400 & 407		DIST 6
SUBMND DD	CHECKED	DATE 88 03 07
DRAWN DT	CHECKED	APPROVED
		SITE 37-1173
		DWG 1378706-B

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

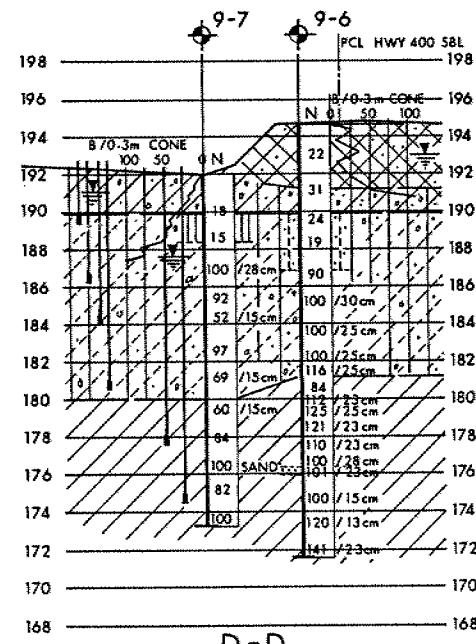
CONT No
WP No 137-87-06

HWY 400 SBL
(BRIDGE-9)
BORE HOLE LOCATIONS & SOIL STRATA

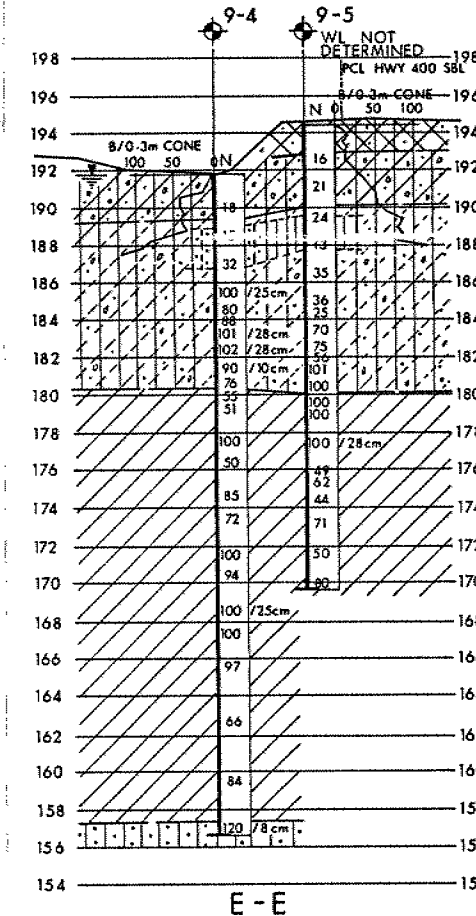
SHEET



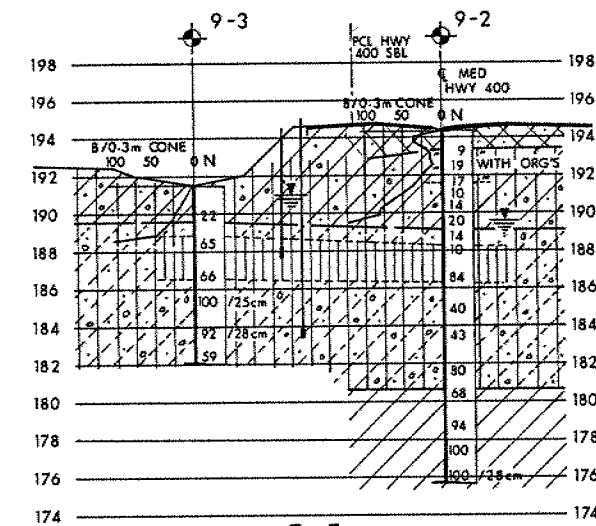
C-C



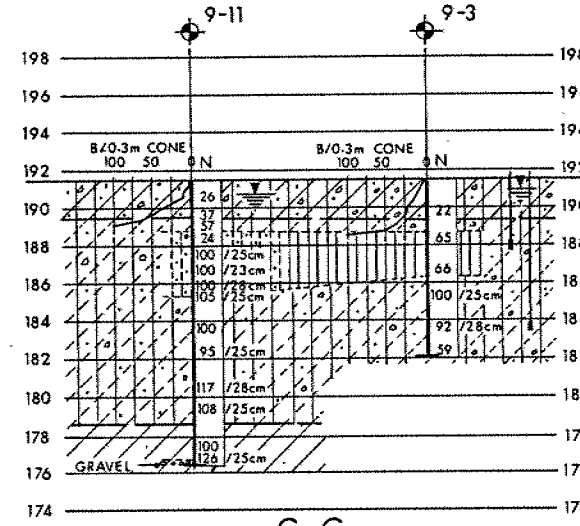
D-D



E-E



F-F



G-G

SECTIONS

SCALE
10m 5 0 10m Hor
4m 2 0 4m Vert

SOIL STRATIGRAPHY LEGEND

	SAND (FILL) Compact		SANDY SILT TO SILTY SAND Dense to Very Dense (LACUSTRINE)
	CLAYEY SILT SOME SAND, TRACE GRAVEL Firm to Hard (GLACIAL TILL)		SILT Compact to Very Dense (LACUSTRINE)
	SILT/CLAYEY SILT SOME SAND, TRACE GRAVEL RANDOM SILT & SAND POCKETS OCCASIONAL BOULDERS Loose to Very Dense/ Stiff to Hard (GLACIAL TILL)		SILT TO SANDY SILT Compact to Very Dense (LACUSTRINE)
	SILTY CLAY TO CLAY WITH THIN SILT SEAMS Very Stiff to Hard (LACUSTRINE)		SAND Very Dense

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)
- WL at time of investigation
87 10 and 87 11
- WL in Piezometer
- Piezometer

No	ELEVATION	CO-ORDINATES NORTH	EAST
9-2	194.3	4 848 853.7	301 799.0
9-3	191.6	4 848 855.5	301 765.5
9-4	191.8	4 848 889.0	301 763.0
9-5	194.4	4 848 893.0	301 774.5
9-6	194.6	4 848 955.0	301 763.1
9-7	191.9	4 848 952.5	301 751.0
9-11	191.5	4 848 825.0	301 771.0
11-5	192.0	4 849 007.0	301 735.5
12-5	194.6	4 849 016.0	301 771.8

NOTE

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

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

Note:
For Plan Refer to
Dwg No 1378706-A

REV	DATE	BY	DESCRIPTION

Geocres No 30M13-71

HWY No 400 & 407	DIST 6
SUBWD DD CHECKED	DATE 88 03 07
DRAWN DT CHECKED	SITE 37-1173
	DWG 1378706-C

memorandum



To: G. Al-Bazi
Design Engineer
Structural Office

Date: 1989 07 17

From: Foundation Design Section
Room 315, Central Building

RE: Final Design Review
Bridge #9
Hwy. 400 S.B.L.
W.P. 137-87-06, Site 37-1173
Hwy. 400/407 IC, District 6, Toronto

We have reviewed the final drawings and documents for this project and our comments are as follows:

Drawing No. 1: General Arrangement

- On the Elevation at Pier #3, it is unclear if frost protection, or a granular blanket has been provided as the south end of the footing is drawn above the ground line.
- The drain trenches for slope protection should be lined with geotextiles as indicated on page 13 of the Foundation Report for this project. There is also a requirement for bench drains as illustrated in Figure 11 of the Foundation Report.

Drawing No. 13: Piers

On the Elevation for Pier #3, ^{on Drawing #13} the top of footing has been indicated as 188.0 which is inconsistent with Drawing #1 and Drawing #6.


Special Provisions

- The Special Provision for Unwatering Structure Excavations should indicate that the soil is susceptible to boiling and disturbance under conditions of unbalanced hydrostatic head and that it is the responsibility of the contractor to lower the groundwater elevation a minimum of 0.5m below any excavation and to construct the footings without disturbing the foundation soil. A drainage channel will be in place prior to this contract which may facilitate dewatering by perimeter ditching and sump pumping. Another alternative would be well points. However, the Special Provision should indicate that the proposed method is the responsibility of the contractor and should be submitted for review.
- An additional Special Provision should be included advising the contractor that hard and very dense ground containing cobbles and boulders, and in general difficult excavating conditions, are anticipated at this site.

.../2

- A Special Provision is required for Reinforced Earth Walls detailing materials and construction. Please submit for our review.

If there are any questions, please advise.


D.H. Dundas, P. Eng.
Sr. Foundation Engineer

for

M. Devata, P. Eng.
Chief Foundation Engineer

MD/DHD/jb

memorandum



Tel: (416) 235-4959

To: Mr. R.A. Jeffries
Structural Supervisor
Structural Section
Central Region

Date: 88 10 04

Re: Highway 400/407 Interchange
Bridge #9, Hwy 400 SBL
W.P. 137-87-06, Site 37-1173
District 6, Toronto



This memo will confirm the following:

a) Re: Berms at North and South Abutments

The 3 meter width of berm is considered excessive and will be reduced to 2 meters. (A marked-up print of preliminary drawing P1 is attached as well as correspondence from the Foundation Office.)

b) Re: Proposed 0.3m Grade Revision

Please forward written confirmation and vertical curve data in regards to the new grade.

A handwritten signature in cursive script that reads "J. Brown".

J. Brown
Project Engineer

JB/sl

c.c. M. Gergely

D. Dundas

memorandum



Tel: 3731

To: G. Al-Bazi
Design Engineer
Structural Office
3501 Dufferin Street

From: Foundation Design Section
Room 315, Central Building

RE: Preliminary Drawing Review
Bridge #9
Hwy. 400 S.B.L.
W.P. 137-87-06, Site 37-1173
Hwy. 400/407 IC, District 6, Toronto

Date: 1988 08 29

Further to your memo dated 88 05 30, we have reviewed the preliminary drawing for this project.

Our comments which were provided verbally in our meeting of 88 07 21, are as follows:

- 1) Recommended bearing capacities for each footing element are provided in the attached table.
- 2) For design purposes, it can be assumed that the unfactored frictional resistance is equivalent to $\tan 28^\circ$.
- 3) Within cuts, there should be no slope higher than 4.5 m that is not benched with a minimum 1.2 m bench. Bench and toe drains, as well as granular blankets are required for stability. From a geotechnical assessment, the 3 m wide berms illustrated on the preliminary drawing may be excessive. Details are provided in the Foundation Report for this project.

If there are any questions, please advise.

A handwritten signature in cursive script, reading "D. H. Dundas".

D.H. Dundas, P. Eng.
Sr. Foundation Engineer

DHD/mmj

Attach.

FOOTING	FOUNDATION TYPE	BASE OF FOOTING	BASE OF GRANULAR PAD	BEARING CAPACITY	
				Factored ULS	SLS Type II
South Abut. Sta. 31+013.852	spread ftg. on granular pad	190.0	188.0	900 kPa	350 kPa
South Pier Sta. 31+061.852	spread ftg. on native ground	182.7	N/A	1000 kPa	*
Centre Pier Sta. 31+117.852	spread ftg. on native ground	182.0	N/A	1000 kPa	*
North Pier Sta. 31+173.852	spread ftg. on native ground	185.0	N/A	1000 kPa	*
North Abut. Sta. 31+221.852	spread ftg. on granular pad	192.5	189.9	900 kPa	350 kPa

* will not govern design

memorandum



Tel: 235-3731

To: J. Brown
Project Engineer
Structural Office

Date: 1988 03 29

From: Foundation Design Section
Room 315, Central Building

RE: Bridge #9, Hwy. 400 S.B.L.
W.P. 137-87-06, Site 37-1173
Hwy. 400/407, District 6, Toronto

Further to your memo dated 88 03 25:

The recommendations provided in our memo dated 88 03 28, are applicable to the most recent footing locations.

At the south abutment (Sta. 31+013.852), we recommend a common footing elevation instead of stepping the footing. However, mass concrete may be utilized to pad above the recommended base if it will be more economical.

If there are any questions, please contact this office.

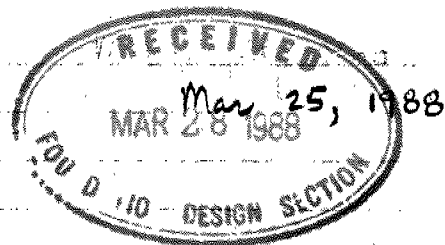
A handwritten signature in dark ink, appearing to read "D.H. Dundas".

D.H. Dundas, P. Eng.
Sr. Foundations Engineer
(East)

DHD/mj

Hwy 400 - 407 Interchange

Bridge #9, Hwy 400 SBL.



Proposed revisions to date (March 25, 1988)

1. Span Revisions

North
→

(a) Planning Report: 28m - 55.5m - 55m - 32m - 16m
(5 spans)

(b) Proposed revision: 48m - 56.0m - 56m - 48m
(4 spans)

- South end span increased to reduce the height of south abutment from 11.5m to 7.9m ±.
- North pier at station 31 + 205.852 deleted.
- North abutment on granular pad.

2. Grading Contour Revisions

- revised at both abutments to provide berms and also to clear underside of deck at south abutment.

3. Proposed Bottom of Footing Elevations

Support

Station

Bottom of Footing

South Abutment

31 + 013.852

(possibly stepped)

El. (west) 190.5; (east) 192.5

Pier #1

+ 061.852

184.0

??

Pier #2

+ 117.852

183.0

??

Pier #3

+ 173.852

(piers)

184.0

??

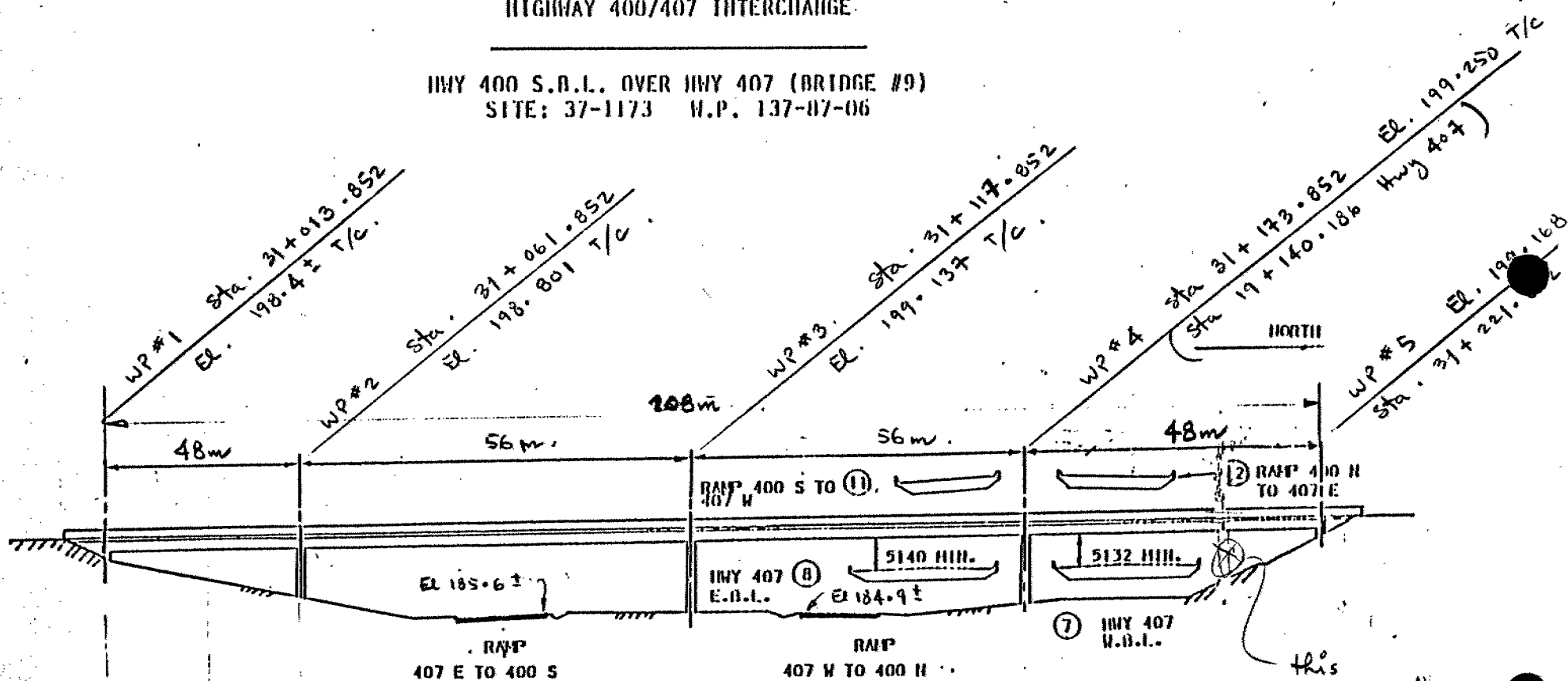
North Abutment

31 + 221.852

El. 192.6

STRUCTURAL DESIGN REPORT HIGHWAY 400/407 INTERCHANGE.

HWY 400 S.B.L. OVER HWY 407 (BRIDGE #9)
SITE: 37-1173 W.P. 137-07-06



NOTE:

ARE MEASURED ALONG P.C.L.
ALL DIMENSIONS ARE IN MILLIMETRES.

BRIDGE #9

Scale 1:400

(increasing chainage to right.)

(PROPOSED SPANS)

H.T.S.

GRADING OPTION B

North

Ramp 407E - 402.5

1400

02554
SKEP

BRIDGE #9

BRIDGE N° 10

CONFIDENTIAL

1980 25 ()
237000
(RET. WALL)
SO
A

sta 31 + 013.852
EQ 198.4 ±

314000

12.64215235

2675

3.0 SHED.

El 190.

199

8

7

6

5

4

3

2

1

El. 190

189

8

7

6

5

El 198.4±

South Abutment

sta 21+013.852

48m

(south end span)

2.2 deck

Ground Line
along east face.

El 194±

El. 192.5

Ground line
along west face.

1.2 frost

El 190.5

Footing possibly
stepped.

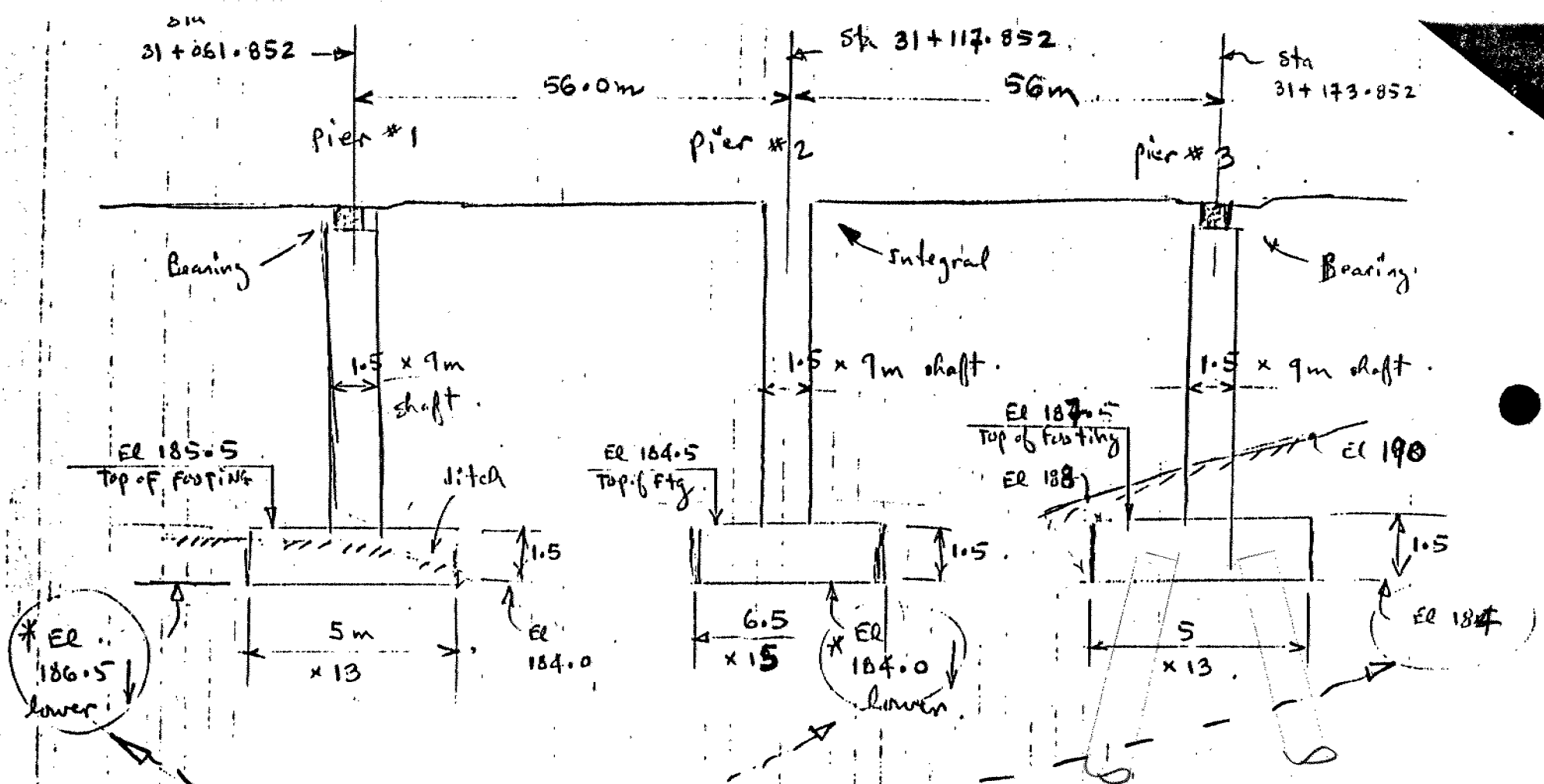
SOUTH ABUTMENT

North. →

ELEVATION.

(Abutment skew = 6° 25' 34")

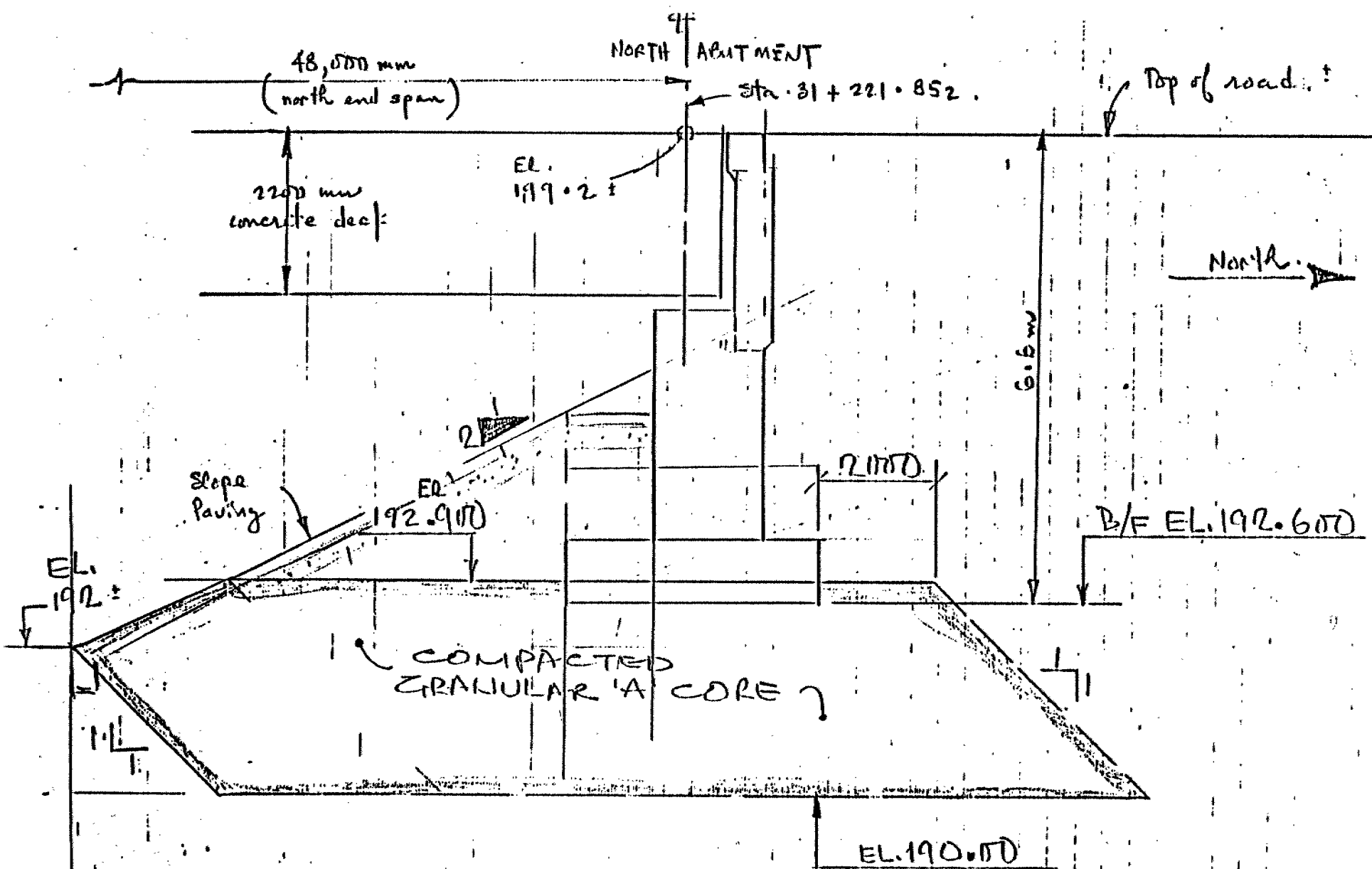
BRIDGE #9.



ELEVATION OF PIERS

BRIDGE #9

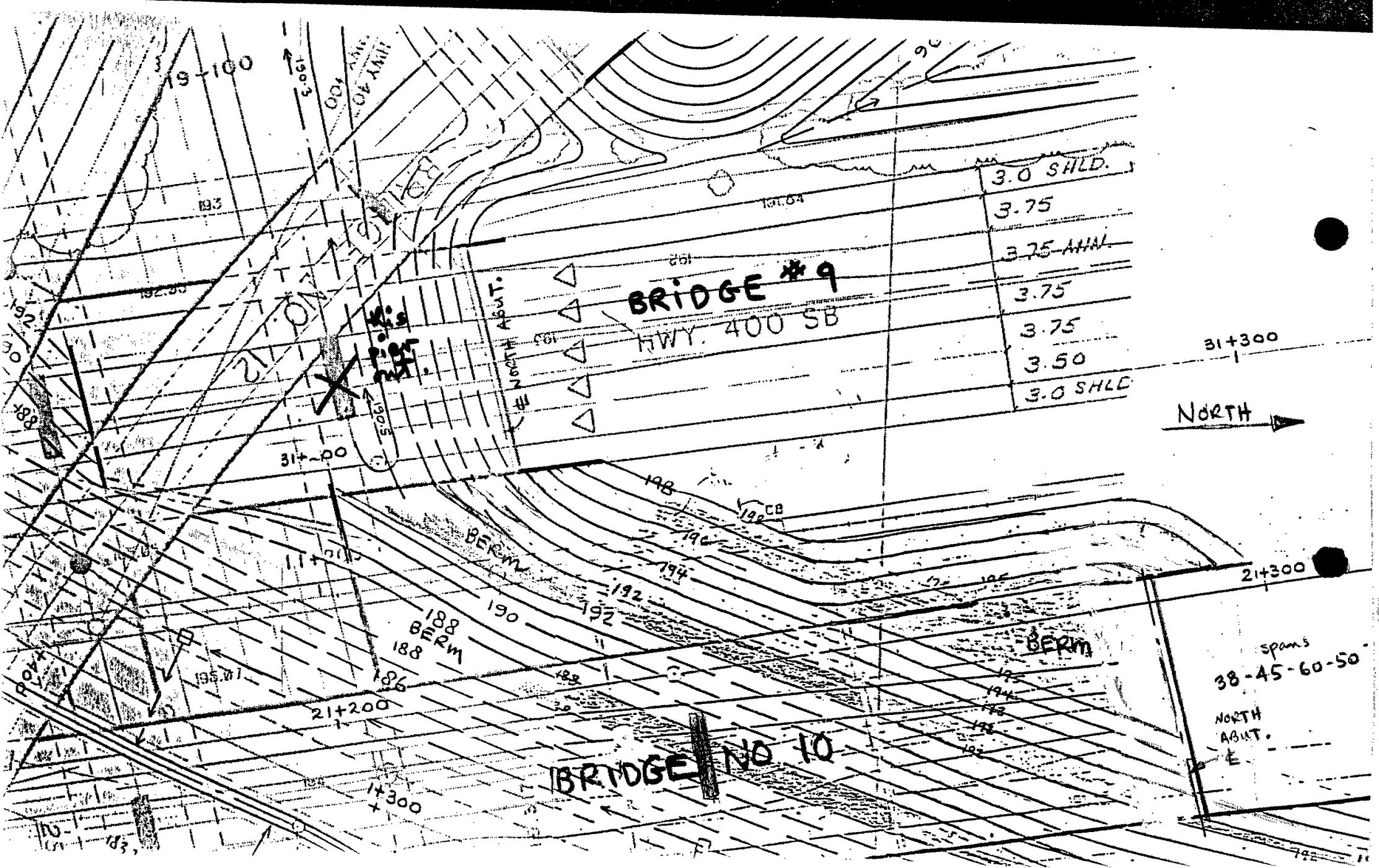
NORTH



GRANULAR PAD FOR NORTH ABUT.

BRIDGE #9, Hwy 400 SBLanes.

Scale 1:75



BRIDGE #9
HWY. 400 SB

3.0 SHLD.
3.75
3.75 AHW.
3.75
3.75
3.50
3.0 SHLD.

NORTH

BRIDGE NO 10

spans
38-45-60-50
NORTH
ABUT.
E

memorandum



To: J. Brown
Project Engineer
Structural Office

Date: 1988 03 28

From: Foundation Design Section
Room 315, Central Building

RE: Bridge #9, Hwy. 400 S.B.L.
W.P. 137-87-06, Site 37-1173
Hwy. 400/407, District 6, Toronto

Further to your memo dated 88 03 11:

(1) South Abutment Option 1

In Option 1, the south abutment is at Sta. 31 + 030.352. The elevation of the bottom of the footing is 190.0 m or below on the east half, and 187.0 m or below on the west half.

We recommend that the abutment at this location should be founded on spread footings on native soil at a common elevation of 187.0 m for the entire footing. A stepped footing was considered but at this location the elevation of suitable foundation material is lower at the east half than the west. However, mass concrete may be used to bring the entire footing level up from 187 m to 190 on the east side.

For footings on native soil, the following design values are recommended:

<u>Footing Elevation</u>	<u>Factored Bearing Capacity at U.L.S.</u>	<u>Bearing Capacity at S.L.S. Type II</u>
187.0 m	600 kPa	400 kPa

(2) South Abutment Option 2

In Option 2, the south abutment is at Sta. 31 + 015.352. The elevation of the bottom of the footing is 190.5 m or below.

We recommend that the abutment at this location could be founded on spread footings on either native soil or compacted granular.

For footings on native soil, the following design values are recommended:

<u>Footing Elevation</u>	<u>Factored Bearing Capacity at U.L.S.</u>	<u>Bearing Capacity at S.L.S. Type II</u>
188.0 m	525 kPa	350 kPa

.....2

For footings on compacted granular, the following design values are recommended for pads with minimum thickness of 2 m.

<u>Base of Pad Footing Elevation</u>	<u>Factored Bearing Capacity at U.L.S.</u>	<u>Bearing Capacity at S.L.S. Type II</u>
188.0 m	900 kPa	350 kPa

(3) North Abutment at Sta. 31 + 221.852

We have no comment regarding the design illustrated in your drawing for the north abutment.

(4) South Pier at Sta. 31 + 063.352

The grading required the base of the footing at Elev. 184.0 or below.

For footings on native soil, the following design values are recommended:

<u>Footing Elevation</u>	<u>Factored Bearing Capacity at U.L.S.</u>	<u>Bearing Capacity at S.L.S. Type II</u>
184.0 to 182.0 m	1000 kPa	will not govern design

(5) South Centre Pier at Sta. 31 + 118.852

The grading requires the base of the footing at Elev. 183.0 or below.

For footings on native soil, the following design values are recommended:

<u>Footing Elevation</u>	<u>Factored Bearing Capacity at U.L.S.</u>	<u>Bearing Capacity at S.L.S. Type II</u>
183.0 to 181.0 m	1000 kPa	will not govern design

If there are any questions, please contact this office.

D.H. Dundas

D.H. Dundas, P. Eng.
Sr. Foundations Engineer