

DOCUMENT MICROFILMING IDENTIFICATION

G.I.-30 SEPT. 1976

GEOCRES No. 30M11-186

DIST. 6 REGION

W.P. No. 33-76-18

CONT. No. 81-96

W. O. No.

STR. SITE No. 37-519

HWY. No.

LOCATION Black Creek Bridge
at Weshen Rd.

No of PAGES -

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OVERSIZE DRAWINGS TO BE INCLUDED WITH THIS REPORT.

REMARKS:

CONT
81-96



Golder Associates
CONSULTING GEOTECHNICAL ENGINEERS



Golder Associates
CONSULTING GEOTECHNICAL ENGINEERS



FOUNDATION INVESTIGATION AND REPORT

BLACK CREEK BRIDGE AT WESTON ROAD
WP 33-76-18 SITE 37-519
NORTHWEST METRO ARTERIAL ROAD

DISTRICT 6

TORONTO

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December, 1979

791-1298

GEOG. 30M11-186

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Abstract

A subsurface investigation was carried out by Golder Associates for the Ministry of Transportation and Communications, at the site of a proposed bridge structure on Weston Road at the Black Creek. The proposed bridge will likely be either a rigid box type structure, or a single, simply supported span, and will incorporate a hydraulic drop and transition structure.

In summary the borings indicate that fill materials and recent alluvium overlie glacial deposits of competent clayey silt, interstadial sand, and clayey silt till. Groundwater levels in the upper, pervious fill and alluvial materials generally coincide with the water level in Black Creek, while the interstadial sand strata exhibits a subartesian water condition.

It is recommended that the proposed structure be supported on shallow spread footings or a raft type foundation. General recommendations are also presented for geotechnical design aspects of the channel lining, transition and drop structures.

1. INTRODUCTION

As part of the proposed Northwest Metro Arterial Roadway project (NWMA), Golder Associates have been authorized by the Hon. James Snow, on behalf of the Ministry of Transportation and Communications, to undertake a subsurface investigation for a proposed bridge/culvert and hydraulic transition structure to carry the reconstructed Weston Road over the existing Black Creek in Toronto, Ontario.

The details of the project were provided in a copy of a memorandum, dated August 20, 1979, from Mr. A.S.P. Ma of the Ministry, addressed to Mr. M. Devata of the Ministry, and on a Fenco Consultants Ltd. unnumbered, undated preliminary plan and section for the project.

The purpose of the investigation was to determine the subsurface conditions at the site, and based on our interpretation of these conditions, to provide engineering recommendations for the geotechnical design of the proposed structure.

The field investigation was carried out and this report was prepared in accordance with our proposal letter dated October 12, 1979 and Consultant's Agreement No. 4243-9079-94.

2. PREVIOUS INVESTIGATIONS

Two previous investigations were carried out in the vicinity of the present project as part of a study for adjacent structures of the NWMA. The investigations comprised preliminary borings undertaken by the Ministry followed by a more detailed programme carried out by Golder Associates. The factual borehole and laboratory data obtained from both of these previous investigations are summarized in Golder Associates' report 781308 and were considered

in the preparation of this report. In particular, the data obtained from Borehole 1 (which was put down during the preliminary Ministry study) is directly applicable to the present project since the borehole is located at the northwest corner of the proposed structure.

3. SITE AND PROJECT DESCRIPTION

The site is located in a fully urban area in the Borough of York, near the intersection of Weston Road and Humber Boulevard (refer to Sheet 1 - Borehole Location and Soil Strata).

The surrounding land use is primarily residential except for some small commercial buildings on the north side of Weston Road. Railway lines for both the CN and CP cross the Black Creek valley immediately north of the project. An existing structure with a 33 ft. wide hydraulic opening carries Weston Road over the Black Creek. The creek flows in an open "natural" channel to the north (upstream) of the existing structure and a 40 ft. wide concrete lined channel to the south. At present, the west wall of the channel is flared slightly at the bridge to accommodate the difference between the bridge opening and downstream channel width.

The proposed structure will form part of the Northwest Metro Arterial Roadway system, and will have a 36 to 40 ft. wide opening to increase hydraulic capacity. Upstream of the structure the flow from the existing open channel will be directed beneath the bridge by a transition structure having flared vertical wing walls, and an 8 ft. drop section. Downstream of the bridge, a transition to the existing lined channel will be constructed. At this time, it is proposed to retain the east wall of the existing lined channel and reconstruct the west wall to obtain the required channel width.

4. SUBSURFACE CONDITIONS

4.1 Site Geology

From a review of selected geological references, the site falls within the physiographic region known as the South Slope of the Oakridges Interlobate Moraine. This area is characteristically underlain by glacial tills of the Pleistocene Epoch, with some interstadial deposits of sand. Shale bedrock of the Dundas formation underlies the area at considerable depth.

Recent accumulations of alluvium and fill may be expected within the Black Creek valley and in the vicinity of the existing road and bridge structures.

4.2 Soil Stratigraphy

The detailed stratigraphy encountered in each of the borings is given on the accompanying Record of Borehole sheets. A stratigraphic section showing the inferred subsurface conditions across the site is given on Sheet 1.

Boreholes 201 to 203 were carried out under the full time supervision of a member of our engineering staff as part of the present investigation, while the data for Borehole 1 was obtained from previous borings undertaken by the Ministry. It should be noted that the boundaries shown between the various strata are based on non-continuous sampling and typically represent a transition between the soil types rather than an exact plane of geologic change.

The inferred upper and lower boundaries of the various strata are illustrated on the accompanying Summary of Engineering Properties (Figure 1), along with the results of laboratory analyses. In summary, the site is underlain by

fill and recent alluvial materials beneath which a till-like, competent clayey silt stratum is encountered. A relatively thin deposit of interstadial dense sand overlying hard glacial till was found at depth beneath the clayey silt.

Fill Materials: Fill materials were encountered in all boreholes from grade to depths of 7 to 15 ft. Two main types of fill material were encountered.

In Boreholes 201 and 202, essentially granular fill was encountered from grade to a depth of 7 ft. The material is relatively "clean" and generally comprises fine-medium sand with some silt and gravel and a trace of clay. Occasional pieces of building rubble such as brick fragments were also noted in some samples. The fill is generally compact with 'N' values ranging from 10 to 22 blows/ft.

Fill materials of an essentially random composition were encountered beneath the granular fill in Borehole 202 to a depth of 15 ft. and from grade to 7 ft. and 10 ft. depths in Boreholes 1 and 203 respectively. In Boreholes 202 and 203, the fill consisted of silty fine sand with varying amounts of gravel and clay, and contained some organic matter and building rubble throughout. 'N' values of 5 to 74 blows/ft. were recorded during sampling. It is suspected that the higher values are the result of coarse gravel or brick fragments, and the fill is actually in a loose state throughout. In Borehole 1, the fill material is reported to consist of firm/loose clayey silt and silty sand.

Recent Alluvium: Underlying the fill materials in Boreholes 201 to 203, alluvial material, probably deposited by the Black Creek, was encountered to depths of 18 to 22 ft. below grade, respectively. This stratum consists of loose to compact fine-medium sands, with a trace to some clay, silt and gravel. The material is grey to brown in colour and has

occasional dark grey to black zones of organic staining. Faint laminated and cross bedded structures were noted in some of the samples.

Upper Sandy Silt: In Borehole 203 only, a layer of dense sandy silt was sampled from 20 to 21.5 ft. However, based on the rate of advance of the augers, and the appearance of the auger cuttings brought to the ground surface, it is thought that this stratum extends from about 18 to 23 ft. depth. A standard penetration resistance value of 38 blows/ft. was recorded during sampling, suggesting that the material is in a dense state. No layering or other depositional structures were noted in the sample obtained.

Upper Clayey Silt: This stratum was found at depths of 7, 19, 22 and 23 ft. in Boreholes 1, 201, 202 and 203 respectively. This stratum was not fully penetrated by Boreholes 202 and 203 (terminated at a depth of about 41 ft. below grade) but was found to extend to depths of 64 and 43 ft. in Boreholes 1 and 201 respectively.

The material contains a trace to some sand and gravel and is well graded and till-like (see figure 3 for gradation analyses). Occasional thin seams of sand were noted throughout, and in particular, a zone of silty fine sand to sandy silt was noted in the 25 to 26.5 ft. sample from Boreholes 1 and 202. The soil also exhibited a faintly laminated structure in some samples.

The material is generally stiff to very hard, except in the upper portion of Borehole 1, where it reportedly has a firm consistency. Laboratory testing by the Ministry indicates an undrained shear strength of about 600 lb/sq.ft. in the firm zone, while field vane tests in this zone indicate an undrained shear strength in excess of 2000 lb/sq.ft.

The liquid limit of the material varies between about 20 and 26 per cent and the plasticity index is about 7 to 10. The measured water content of the soil is approximately 25 per cent in the firm zone of Borehole 1 and is generally between 12 and 16 per cent in other areas. Based on the relatively low natural water content and liquidity indices, it is anticipated that this stratum will be of very low compressibility.

Middle Silt Stratum: A deposit of very stiff to hard silt containing a trace to some clay and occasional sand seams was encountered between depths of about 43 and 65 ft. in Borehole 201 (see Figure 4 for gradation analysis). The upper portions of this stratum have the highest clay content and are slightly cohesive while below approximately 50 ft. depth, the silt is essentially non-cohesive. The natural water content is generally between 15 and 22 per cent.

A zone of soil of a similar description was noted in the Ministry's boring (Borehole 1) in the 45 to 46.5 ft. sample (Sample 14).

Lower Sand Stratum: In Boreholes 1 and 201, a sand stratum was encountered from about 64 to 68 ft. and 65.5 to 80 ft. depths respectively. In the Ministry boring, the material is described as a fine-medium sand, although no grading analyses were performed. In Borehole 201, the soil graded with depth from a silty fine to a fine-medium sand with a trace of silt (see Figure 2 for gradation analysis).

The sand is compact to dense with 'N' values of 26 to 40 blows/ft. recorded during sampling. It is anticipated that the material is actually in a very dense state, but was loosened during sampling by upward groundwater movement and/or the wash boring procedure (see Appendix A).

Glacial Till: Glacial till was found from 68 and 80 ft. depths to the base of Boreholes 1 and 201 repectively. It was not penetrated in any of the borings for this investigation.

The till generally comprises clayey silt, with some sand and gravel throughout (see Figure 5 for gradation analysis). It has a hard consistency with 'N' values of 30 to 39 blows/ft. and a low plasticity with liquid and plastic limits of 11 and 20 per cent respectively. Natural water content of the strata is uniformly low at 12 and 13 per cent.

4.3 Groundwater Conditions

Following completion of each of the boreholes, standpipes were installed to allow monitoring of groundwater levels across the site. The details of standpipe installation are given on the accompanying Record of Borehole sheets.

The water level in the standpipe installed in Borehole 203, with its tip in the clayey silt to sandy silt stratum, was at about 14 ft. depth after five days. The standpipe in Borehole 202, with its tip at about 15 ft. depth in the alluvial materials, was dry after five days. A water level at about 1.5 ft. below grade was recorded in the standpipe installed in the lower sand stratum in Borehole 201.

It is expected that the water level in the upper pervious deposits of fill, alluvium and sandy silt will generally coincide with the water level in the adjacent Black Creek.

Although not penetrated in this investigation, previous borings to the east of the site indicate that a sand stratum with artesian water conditions is found below the glacial till.

5. DISCUSSION AND RECOMMENDATIONS

The following discussion and recommendations are based on our understanding that:

- (i) By necessity of maintaining adequate cover for frost protection, the invert of the footings/pile caps for the bridge abutments will be at a maximum elevation of 323 ft.
- (ii) The bridge structure will likely be either a single span simply supported on each abutment or a rigid box type structure.

5.1 Bridge Foundations

5.1.1 Spread Footings

The bridge abutments may be founded on shallow spread footings placed on the generally hard upper clayey silt stratum. An allowable bearing pressure of 6 ksf may be used for the design of footings placed on this stratum below approximately elevation 323 ft. Based on the available laboratory data, it is anticipated that total settlement of footings founded on undisturbed, hard clayey silt and designed using the allowable bearing pressure will be relatively small; generally less than about 1/2 in. Nonetheless, spread footings are not recommended for use in conjunction with a rigid frame type structure, since differential settlements may exceed tolerable structural limits.

In the event that spread footings are used, some sub-excavation should be anticipated within the river channel, since alluvial deposits may be slightly deeper in this area. In order to allow construction of footings under "dry"

conditions, a suitable river diversion will be required to prevent entry of surface (river) water into the excavation. Some groundwater seepage may also be expected to enter excavations carried through the pervious alluvial materials. This will require suitable shoring of the excavation, and control of groundwater inflow by a method such as pumping from sumps. No heave or loosening of the clayey silt founding stratum is expected as a result of groundwater seepage. It should be noted, however, that the clayey silt is susceptible to disturbance due to construction activities, particularly in the presence of water.

To ensure that the footings are placed on competent, undisturbed material, it is recommended that the base of all footing excavations should be inspected by a qualified geotechnical engineer immediately prior to placing of concrete.

5.1.2 Slab-Type Foundations

If the bridge is constructed as a rigid box, the base component of the box, which would also serve as a channel bottom liner, could be designed as a structural foundation slab or mat. In this case, the slab would be founded on the upper clayey silt stratum. A soil pressure of 6 ksf could also be used for design purposes, although due to the large area of the slab, the actual soil contact pressure would be less, probably on the order of 0.5 to 1.0 ksf.

5.1.3 Pile Foundations

At present, it appears that a piled foundation would be necessary only if a rigid frame type structure is proposed. In this case, a piled foundation would be required to ensure that differential and total settlements would be within tolerable structural limits.

It is understood that an extensive pile driving and loading test programme has been carried out by the Ministry in the immediate vicinity as part of the NWMA project. Sub-surface conditions in the test area are generally similar to those encountered in the present investigation. Should it be decided to pursue a piling alternative, we would be pleased to review the existing pile load testing data and, based on this data, provide recommendations regarding appropriate pile type, lengths and allowable loadings.

5.2 Channel Lining

The clayey silt stratum will provide a suitable foundation base for a separate concrete slab-type channel lining beneath the bridge. A compacted base of 12 to 18 in. of well graded granular material, such as M.T.C. Granular 'A' should be provided over the native soils. Any alluvium, fill or other deleterious materials should be subexcavated and replaced with select, compacted granular material. Adequate protection, in the form of a cut-off wall into the underlying clayey silt or other water-tight seal, should be provided to prevent scour and seepage beneath the concrete liner.

5.3 Retaining Walls/Bridge Abutments

Cantilever type retaining walls may be founded on conventional spread footings using the capacities and founding elevations previously recommended for the bridge structure.

The lateral earth loads on the retaining walls will depend on the type and method of the placement of the back-fill materials.

The following recommendations are made in respect to the design of the retaining walls and abutments:

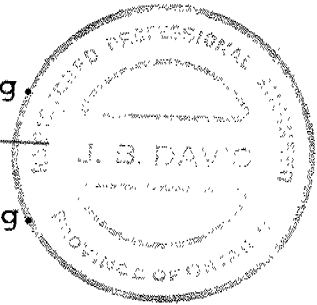
- (i) Select granular fill, such as M.T.C. Granular 'B' should be used as backfill behind the structures. The select fill should be placed in the wedge-shaped zone defined by a 45 degree line extending up and back from the rear of the structure's footings.
- (ii) The existing soil, which will be left in place behind the select granular fill, is assumed to consist primarily of non-cohesive alluvium or fill materials. There materials should require little or no additional compaction, hence it is assumed that they will contribute no additional lateral earth loads. This assumption should be verified by review of the intended construction procedure, and through field inspection at the time of construction.
- (iii) The granular fill should be compacted in thin lifts to 95 per cent of the standard Proctor dry density. Heavy compaction equipment should not be used behind the wall within a lateral distance equal to the current height of the fill above the wall footing.
- (iv) Provided the above criteria are satisfied, a coefficient of active earth pressure K_a of 0.3 may be used in computing lateral earth pressures, if an outward deflection of approximately 1/2 per cent of the wall height can be tolerated. If no outward wall deflection may be allowed, then at-rest coefficient of earth pressure, K_0 , equal to 0.5, should be used in calculating the lateral earth pressures. A coefficient of friction of 0.35 may be assumed between the clayey/sandy silt and concrete wall footing. A bulk unit weight of 130 lb/cu.ft. may be assumed for the select granular backfill.
- 130 x 1.5
90 x 1.4
65
35
40% increase

- (v) An adequate drainage system should be provided behind the wall to prevent build-up of hydrostatic forces. The drainage system should be fitted with a properly designed filter to prevent clogging of the pipes and should be protected against freezing. Provision should be made to allow cleaning or rodding of the pipes should they become clogged.

GOLDER ASSOCIATES

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APPENDIX A
FIELD WORK

December, 1979

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FIELD WORK

A previous study was carried out in the vicinity by Golder Associates (report no. 781300, January, 1979). This study summarized the results of a series of borings undertaken by both the Ministry and Golder Associates. Of these borings, Borehole No. 1 (which was put down under the direction of the Ministry staff) is considered directly applicable to the present project, and is incorporated into this report.

The present drilling programme consists of three boreholes numbered 201 to 203, inclusive which were put down between October 24 and October 27, 1979, using a bombardier mounted CME 55 power auger operated by Eastern Soil Investigations Ltd. Boreholes 202 and 203 were put down using 4-1/2 in. diameter solid stem augers, while Borehole 1 was advanced with 7 in. diameter hollow stem augers. No undue difficulties were encountered during the drilling, except in the water bearing sand stratum found at depth in Borehole 1. The sub-artesian water conditions in this stratum caused the sand to "blow" inside the augers, requiring they be washed out with a chopping bit prior to sampling. In all, a total of approximately 174.5 ft. of sampled borings were put down during the present investigation.

Soil samples were generally taken at about 2.5 to 5 ft. intervals, using a standard 2 in. O.D. split spoon sampler, which was advanced by a 140 lb. weight falling freely 30 in. to determine 'N' or standard penetration resistance values.

Details of the drilling and sampling operations are summarized on the Record of Borehole sheets.

A filtered standpipe was sealed into each of Boreholes 201 to 203 to allow monitoring of water levels within the various strata. (Details of standpipe installations are given on the Record of Borehole sheets.)

A dynamic cone penetration test was performed immediately adjacent each borehole, by driving an uncased AW size drillrod into the subsoil with a 140 lb. hammer falling freely for 30 in. A standard 60 degree, 2 in. diameter cone was fitted to the bottom of the drillrods. The total length of dynamic penetration tests was 64 ft. In each case, the driving was terminated when the resistance exceeded 100 blows/ft.

The field work was supervised throughout by a member of our technical staff, who located the borings in the field, directed the drilling and sampling operations and logged the samples obtained.

The final location of the boreholes with respect to NWMA chainages and Geodetic ground elevations, were determined by survey personnel from the Ministry of Transportation and Communications. The grid location of the boreholes was interpolated from this data.

APPENDIX B
LABORATORY ANALYSES

December, 1979

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LABORATORY ANALYSES

Following field identification and logging, all samples obtained during the investigation were placed in appropriate containers and brought to our laboratory where they were examined in detail by the project engineer and classified by visual and tactile methods. Selected samples were then submitted for laboratory testing based on the requirements of the project. Where practicable, the results from previous analyses were incorporated into the study.

Grain size distribution and Atterberg limit determinations were performed on selected samples and the results are presented on Figures 2 to 6 and summarized on the "Summary of Engineering Properties" sheet (Figure 1). The natural water content of selected samples was determined and is plotted on the Record of Borehole sheets and the "Summary of Engineering Properties" sheet.

EXPLANATION OF TERMS USED IN REPORT

'N' VALUE: AN INDICATOR OF SUBSOIL QUALITY. IT IS OBTAINED FROM THE STANDARD PENETRATION TEST (CSA STD. A119.1). SPT 'N' VALUE IS THE NUMBER OF BLOWS REQUIRED TO CAUSE A STANDARD 2 INCH O.D. SPLIT-BARREL SAMPLER TO PENETRATE 12 INCHES INTO UNDISTURBED GROUND IN A BOREHOLE WHEN DRIVEN BY A HAMMER WEIGHING 140 POUNDS, FALLING FREELY A DISTANCE OF 30 INCHES. FOR PENETRATIONS OF LESS THAN 12 INCHES 'N' VALUES ARE INDICATED AS THE NUMBER OF BLOWS FOR THE PENETRATION ACHIEVED. 'N' VALUES CORRECTED FOR OVERBURDEN PRESSURE ARE DENOTED THUS N_c .

DYNAMIC CONE PENETRATION TEST (CSA STD. A119.3): CONTINUOUS PENETRATION OF A CONICAL STEEL POINT (2" O.D. 60 CONE ANGLE) DRIVEN BY 350 FT-LB IMPACTS ON 'A' SIZE DRILL RODS. THE RESISTANCE TO CONE PENETRATION IS MEASURED AS THE NUMBER OF BLOWS FOR EACH 12 INCH ADVANCE OF THE CONICAL POINT INTO THE UNDISTURBED GROUND.

SOIL QUALITY: SOILS ARE DESCRIBED BY THEIR COMPOSITION AND CONSISTENCY OR DENSITY.

CONSISTENCY: COHESIVE SOILS ARE DESCRIBED ON THE BASIS OF THEIR UNDRAINED SHEAR STRENGTH AS FOLLOWS:

S_u (PSF)	0 - 250	250 - 500	500 - 1000	1000 - 2000	2000 - 4000	> 4000
	VERY SOFT	SOFT	FIRM	STIFF	VERY STIFF	HARD

DENSENESS: COHESIONLESS SOILS ARE DESCRIBED ON THE BASIS OF SPT 'N' VALUES AS FOLLOWS:

'N' (BLOW/FT)	0 - 5	5 - 10	10 - 30	30 - 50	> 50
	VERY LOOSE	LOOSE	COMPACT	DENSE	VERY DENSE

ROCK QUALITY: 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 DRILLED IN THAT CORING RUN.

MODIFIED RECOVERY: SUM OF THOSE NATURALLY FRACTURED CORE PIECES, 4" 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	2"	2" - 12"	1' - 3'	3' - 10'	> 10'
JOINTING	VERY CLOSE	CLOSE	MOD. CLOSE	WIDE	VERY WIDE
BEDDING	VERY THIN	THIN	MEDIUM	THICK	VERY THICK

ABBREVIATIONS & SYMBOLS

LABORATORY TESTING

TRIAxIAL TESTS ARE DESCRIBED IN TERMS OF WHETHER THEY ARE CONSOLIDATED (C) OR NOT (U) ISOTROPICALLY (I) OR NOT (A) AND SHEARED DRAINED (D) OR UNDRAINED (U) WITH PORE PRESSURE MEASUREMENTS (BAR OVER SYMBOLS) EG. $\bar{C}U$ = CONSOLIDATED ISOTROPIC UNDRAINED TRIAXIAL WITH PORE PRESSURE MEASUREMENT UNLESS OTHERWISE SPECIFIED IN REPORT ALL TESTS ARE IN COMPRESSION

FIELD SAMPLING

S S SPLIT SPOON
W S WASH SAMPLE
S T SLOTTED TUBE SAMPLE
B S BLOCK SAMPLE
C S CHUNK SAMPLE
T W THINWALL OPEN
T P THINWALL PISTON
O S OSTERBERG SAMPLE
F S FOIL SAMPLE
R C ROCK CORE
P H T.W. ADVANCED HYDRAULICALLY
P M T.W. ADVANCED MANUALLY

EARTH PRESSURE TERMS

μ COEFFICIENT OF FRICTION
 δ ANGLE OF WALL FRICTION
 k_o COEFFICIENT OF EARTH PRESSURE AT REST
 k_A COEFFICIENT OF ACTIVE EARTH PRESSURE
 k_P COEFFICIENT OF PASSIVE EARTH PRESSURE
 i ANGLE OF INCLINATION OF SURCHARGE
 w SLOPE ANGLE-BACKFACE OF WALL
 β ANGLE OF SLOPE
 N_1, N_q, N_c BEARING CAPACITY FACTORS
 D_f DEPTH OF FOOTING
B, L FOOTING DIMENSIONS

INDEX PROPERTIES

γ UNIT WEIGHT OF SOIL (BULK DENSITY)
 γ_w UNIT WEIGHT OF WATER
 γ_d UNIT DRY WEIGHT OF SOIL (DRY DENSITY)
 γ' UNIT WEIGHT OF SUBMERGED SOIL
 G_s SPECIFIC GRAVITY OF SOLIDS
 e VOIDS RATIO
 e_o INITIAL VOIDS RATIO
 e_{max} e IN LOOSEST STATE
 e_{min} e IN DENSEST STATE
 D_r RELATIVE DENSITY = $\frac{e_{max} - e}{e_{max} - e_{min}}$
 n POROSITY
 w WATER CONTENT
 w_L LIQUID LIMIT
 w_P PLASTIC LIMIT
 w_S SHRINKAGE LIMIT
 I_P PLASTICITY INDEX = $w_L - w_P$
 I_L LIQUIDITY INDEX = $\frac{w - w_P}{I_P}$
 I_c CONSISTENCY INDEX = $\frac{w_L - w}{I_P}$
 A_c ACTIVITY = $\frac{I_P \text{ of soil}}{I_P \text{ of } 2\mu m \text{ Soil Fraction}}$
 Om ORGANIC MATTER CONTENT
 S_r DEGREE OF SATURATION
 S SENSITIVITY = $\frac{S_u \text{ (undisturbed)}}{S_u \text{ (remoulded)}}$

STRENGTH PARAMETERS

ϕ ANGLE OF SHEARING RESISTANCE
 τ_f PEAK SHEAR STRENGTH
 τ_R RESIDUAL SHEAR STRENGTH
 c COHESION INTERCEPT
 $\sigma_1, \sigma_2, \sigma_3$ NORMAL PRINCIPAL STRESSES
 u PORE WATER PRESSURE
 u_e EXCESS u
 r_u PORE PRESSURE RATIO
 q_u UNCONFINED COMPRESSIVE STRENGTH
 σ_u UNDRAINED SHEAR STRENGTH
 ϵ LINEAR STRAIN
 γ SHEAR STRAIN
 ν POISSON'S RATIO
 E MODULUS OF ELASTICITY
 G MODULUS OF SHEAR DEFORMATION
 k_s MODULUS OF SUBGRADE REACTION
 m, n STABILITY COEFFICIENTS
 A, B PORE PRESSURE COEFFICIENTS

HYDRAULIC TERMS

h HYDRAULIC HEAD OR POTENTIAL
 q RATE OF DISCHARGE
 v VELOCITY OF FLOW
 i HYDRAULIC GRADIENT
 j SEEPAGE FORCE PER UNIT VOLUME
 η COEFFICIENT OF VISCOSITY
 k COEFFICIENT OF HYDRAULIC CONDUCTIVITY
 k_h k IN HORIZONTAL DIRECTION
 k_v k IN VERTICAL DIRECTION
 m_v COEFFICIENT OF VOLUME CHANGE
 c_v COEFFICIENT OF CONSOLIDATION
 C_c COMPRESSION INDEX
 C_r RECOMPRESSION INDEX
 d DRAINAGE PATH DISTANCE
 T_v TIME FACTOR
 U DEGREE OF CONSOLIDATION
 O_r OVERCONSOLIDATION RATIO (OCR)

NOTE: EFFECTIVE STRESS PARAMETERS ARE DENOTED BY USE OF APOSTROPHE ABOVE THE SYMBOL, THUS:
 ϕ' = EFFECTIVE ANGLE OF SHEARING RESISTANCE;
 σ' = EFFECTIVE NORMAL STRESS



Ministry of
Transportation and
Communications

HIGHWAY ENGINEERING DIVISION-ENGINEERING MATERIALS OFFICE-SOIL MECHANICS SECTION

RECORD OF BOREHOLE No 1 (ORIGINATED BY M.T.C.)

W.P. 33-76-13,14 LOCATION Co-ords N 872 522 E 1 005 223 ORIGINATED BY B.L.
DIST 6 HWY N.W.M.A BOREHOLE TYPE Hollow Stem Auger COMPILED BY B.L.
DATUM Geodetic DATE March 23, 1977 CHECKED BY

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 ^o VALUES			20	40	60	80	100					
344.6	GROUND LEVEL																
0.0	Fill:																
	Clayey Silt And Silty		1	SS	9												
	Sand		2	SS	6												
337.6																	
7.0	Clayey Silt:		3	SS	6												
	Some Sand And A Trace		4	SS	5												
	Of Gravel.		5	TW	PH												
	Very Stiff		6	SS	39												
			7	SS	33												
			8	SS	39												
			9	SS	41												
	Sandy Silt		10	SS	45												
	Trace Of Clay																
			11	SS	37												
			12	SS	38												
			13	SS	26												
	Silt: Some		14	SS	26												
	Sand & Clay		15	SS	31												
			16	SS	26												
	Stiff		17	TW	PH												
280.6																	
64.0	Sand: Fine To Medium		18	SS	26												
276.6	Compact																
68.0	Glacial Till																
273.1			19	SS	37												
71.5	End Of Borehole																

+3, x5: Numbers refer to
Sensitivity

20
12 5 (%) STRAIN AT FAILURE
10



RECORD OF BOREHOLE No 201

W P 33-76-18 LOCATION STA. 152+08.42' LT. (15,872,405 N., 1,005,252 E.) ORIGINATED BY W.W.
 DIST 6 HWY NWMA BOREHOLE TYPE HOLLOW STEM AUGER & CONE TEST COMPILED BY M.H.W.
 DATUM GEODETIC DATE OCTOBER 24-26, 1979 CHECKED BY W.B.

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						
349.9	GROUND SURFACE													GR SA SI CL
0.0	Fill, fine to medium sand, some silt and gravel, brick fragments		1	SS	22		(FEET)							
342.9	Compact to loose Brown		2	SS	10									
7.0	Sand, fine to medium, some silt, trace clay and organic matter (Recent alluvium)		3	SS	8		340							
	Loose Brown Grey		4	SS	4									
330.9			5	SS	4		330							
19.0			6	SS	45		320							
	Clayey Silt, trace to some sand and gravel faintly laminated (Till- Like)		7	SS	37									7 32 44 17
	Hard Grey		8	SS	27		310							
			9	SS	35									
306.9			10	SS	52		300							
43.0			11	SS	37									0 5 86 9
	Silt, trace to some clay, trace fine sand in layers		12	SS	27		290							
	Hard Grey		13	TW	PH									
			14	CS	PH		280							
284.4			15	SS	40									
65.5	Silty fine sand Dense Grey		16	SS	40		270							
	Clayey silt till		17	SS	30									1 87 9 3
	Sand, fine to medium, trace to some silt		18	SS	30		260							
269.9	Dense Grey		19	SS	32									7 34 43 16
80.0	Clayey Silt, trace to some sand and gravel (Glacial Till)		20	SS	39		250							
258.4	Hard Grey													
91.5	END OF BOREHOLE													

+3, x5: Numbers refer to
Sensitivity

20
15 5 (%) STRAIN AT FAILURE
10

OFFICE REPORT ON SOIL EXPLORATION

79/1-1295

Ministry of
Transportation and
Communications

HIGHWAY ENGINEERING DIVISION-ENGINEERING MATERIALS OFFICE-SOIL MECHANICS SECTION

RECORD OF BOREHOLE No 202

W P 33-76-18 LOCATION STA. 152+72.57' LT. (15,872,396 N., 1,005,183 E.) ORIGINATED BY W.W.
 DIST 6 HWY NWMA BOREHOLE TYPE SOLID STEM AUGER & CONE TEST COMPILED BY MHW
 DATUM GEODETIC DATE OCTOBER 26, 1979 CHECKED BY DUB

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE (FEET)	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						
349.6	GROUND SURFACE													GR SA SI CL
0.0	Fill, fine to medium sand, some gravel, some silt		1	SS	21									
342.6	Compact Brown		2	SS	17									
7.0	Fill, fine silty sand, trace gravel, trace organic matter		3	SS	5									
334.6	Loose Grey brown		4	SS	7									
15.0	Sand, fine to medium, trace to some gravel, trace clay, trace organic matter (Recent alluv.)		5	SS	22									
327.6	Compact Brown to grey		6	SS	29									
22.0	Silty fine sand --- Dense Grey		7	SS	92									
	Clayey Silt, trace to some sand & gravel, faintly laminated, occasional thin seams of fine sand (Till-Like)		8	SS	54									
	Hard Grey		9	SS	90									
308.1			10	SS	65									
41.5	END OF BOREHOLE													

OFFICE REPORT ON SOIL EXPLORATION

+3, x5; Numbers refer to
Sensitivity

20
15 \div 5 (%) STRAIN AT FAILURE
10

791-1298

Ministry of
Transportation and
Communications
Ontario

HIGHWAY ENGINEERING DIVISION-ENGINEERING MATERIALS OFFICE-SOIL MECHANICS SECTION

RECORD OF BOREHOLE No 203

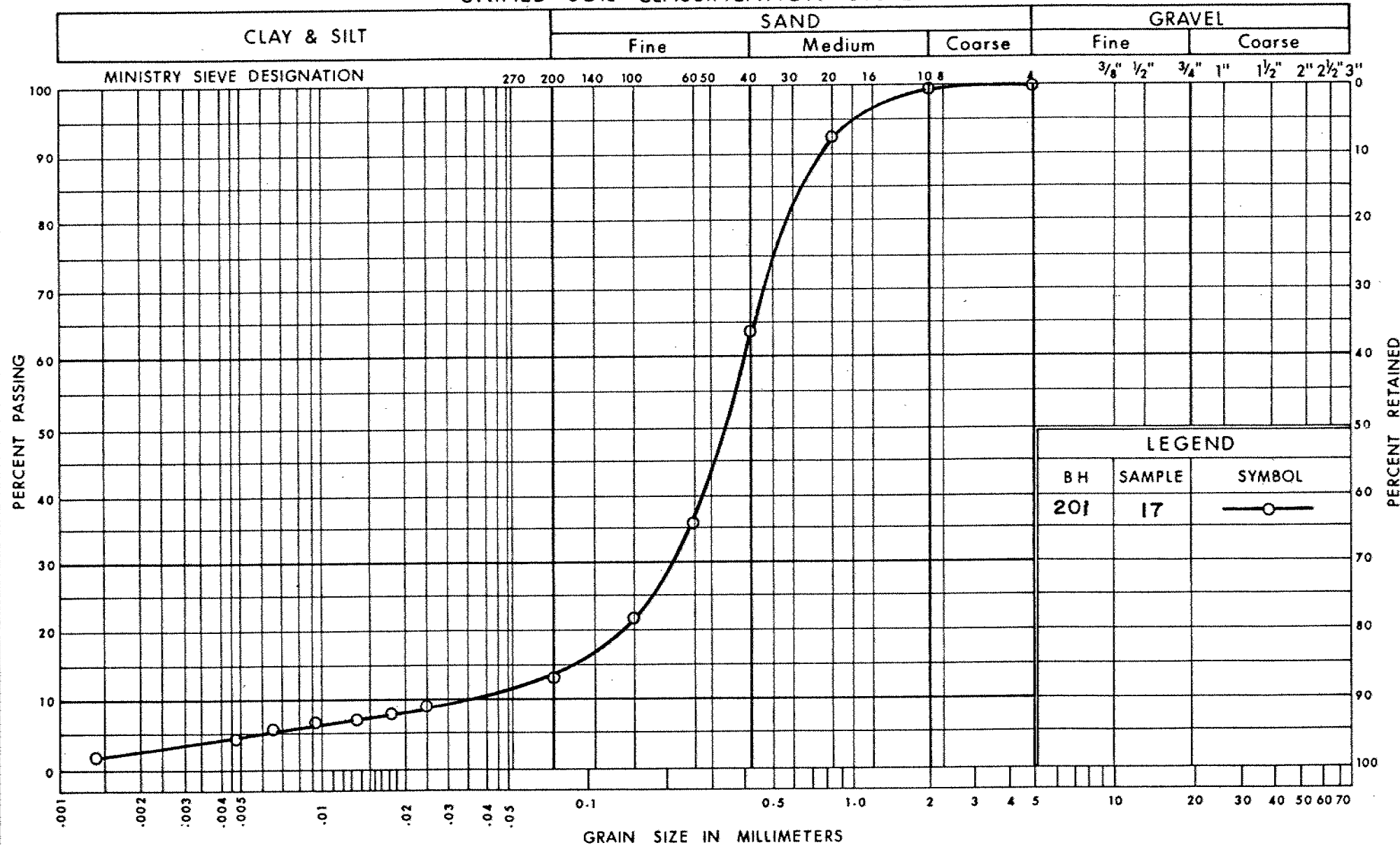
W P 33-76-18 LOCATION STA. 151+90.97 RT. (15,872,535N., 1,005,308E.) ORIGINATED BY W.W.
 DIST 6 HWY NWMA BOREHOLE TYPE SOLID STEM AUGER & CONE TEST COMPILED BY MHW
 DATUM GEODETIC DATE OCTOBER 27, 1979 CHECKED BY DB

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE (FEET)	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 (%) 10 20 30	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES										
349.2	GROUND SURFACE														
0.0	Fill, fine silty sand, trace to some gravel, some debris trace organic matter and brick fragments		1	SS	39										
			2	SS	74										
			3	SS	31										
339.2	Compact to dense Brown		4	SS	37										
10.0	Sand, fine to medium, some silt, trace of gravel & organic matter (Recent alluvium)		5	SS	14										
331.2	Loose to compact Grey brown		6	SS	7										
18.0	Sandy silt														
326.2	Dense Grey		7	SS	38										
23.0	Clayey Silt, trace to some sand & gravel (Till-Like)		8	SS	58										
	Hard Grey		9	SS	30										
			10	SS	57										
307.7			11	SS	24										
41.5	END OF BOREHOLE														

OFFICE REPORT ON SOIL EXPLORATION

+3, x5: Numbers refer to
Sensitivity20
15 → 5 (%) STRAIN AT FAILURE
10

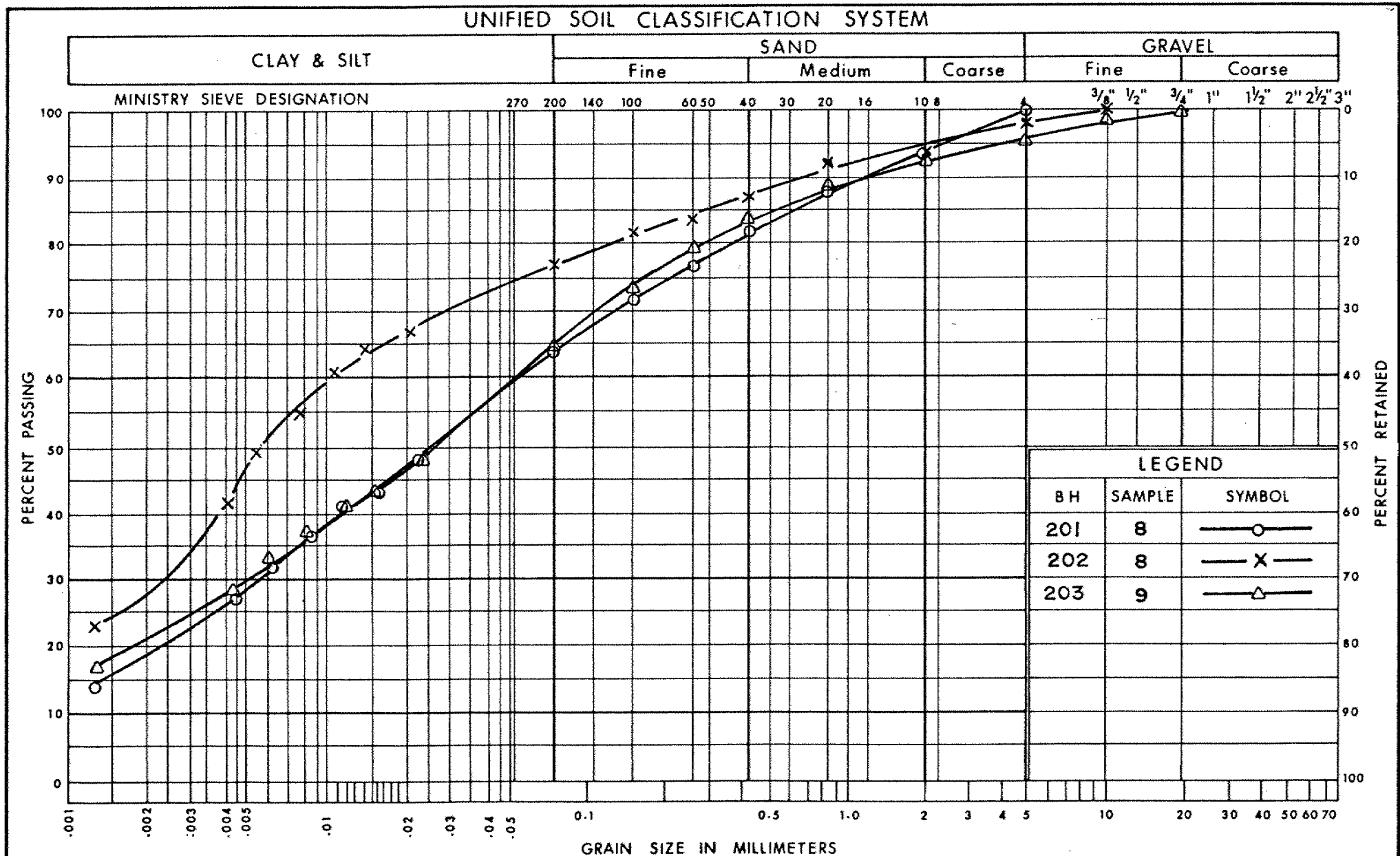
UNIFIED SOIL CLASSIFICATION SYSTEM



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Ontario
ENGINEERING SERVICES BRANCH

GRAIN SIZE DISTRIBUTION
SAND, fine to medium

FIG No 2
W P 33-76-18

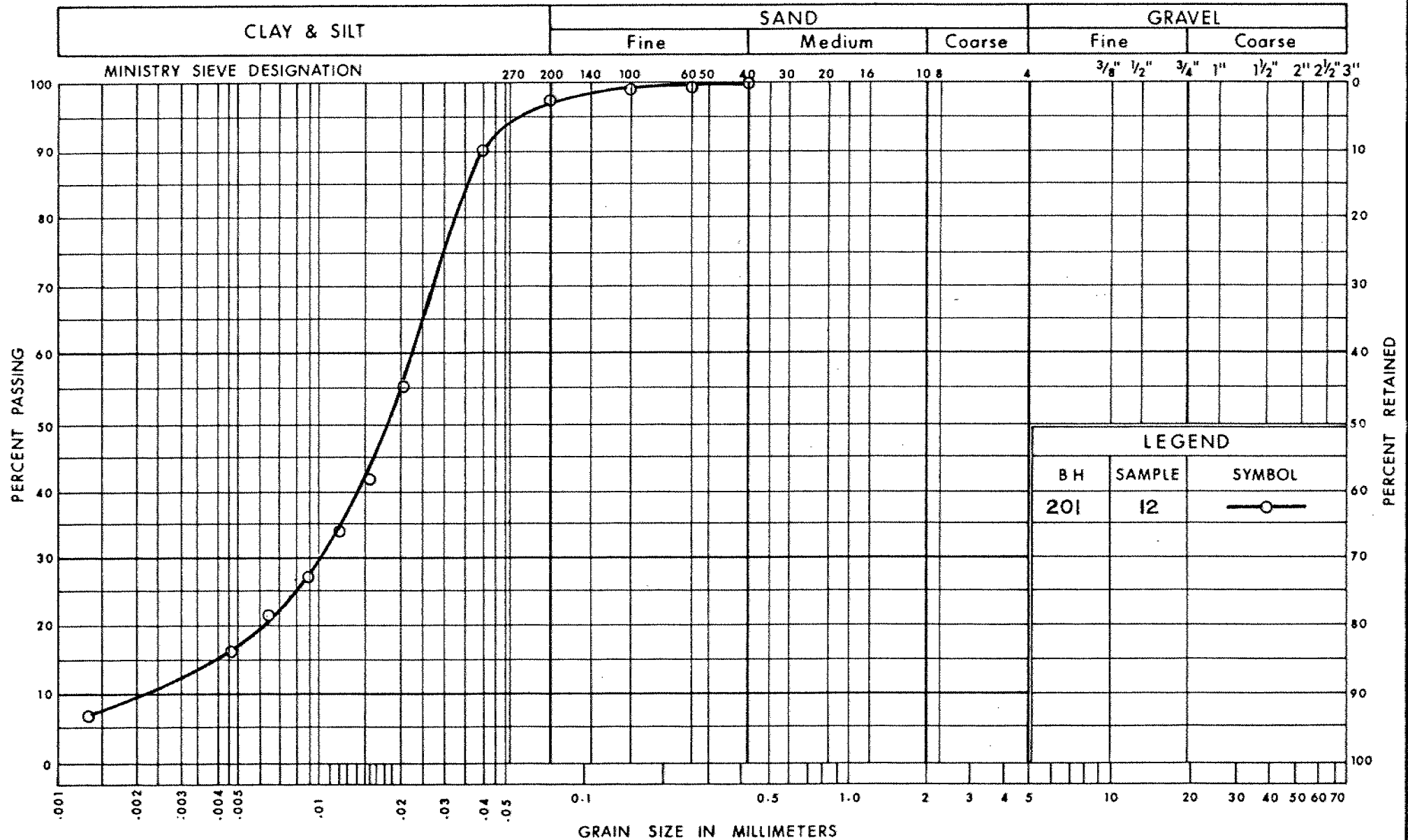


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GRAIN SIZE DISTRIBUTION CLAYEY SILT

FIG No 3
W P 33-76-18

UNIFIED SOIL CLASSIFICATION SYSTEM

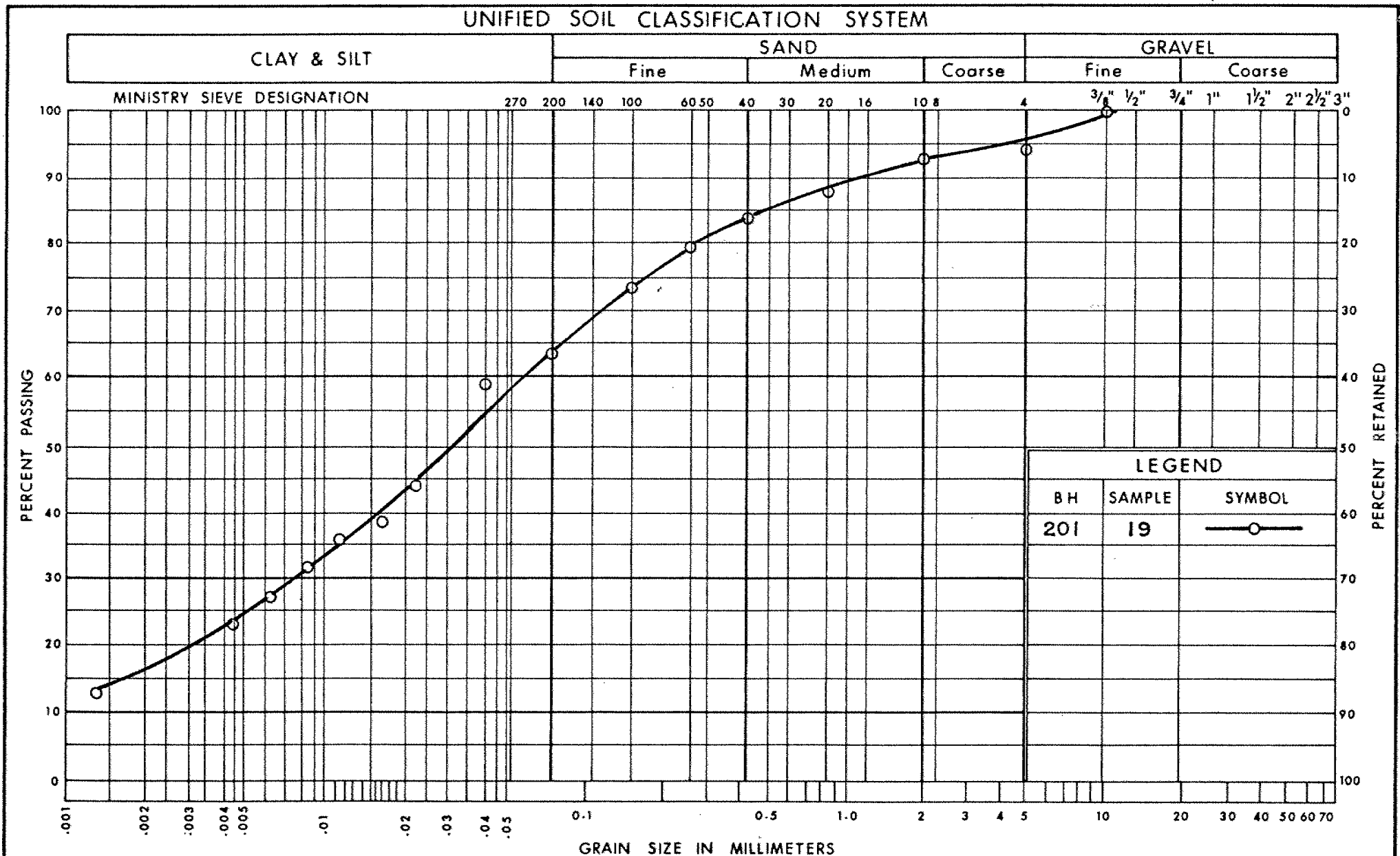


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GRAIN SIZE DISTRIBUTION

SILT

FIG No 4
W P 33-76-18



Ministry of
Transportation and
Communications

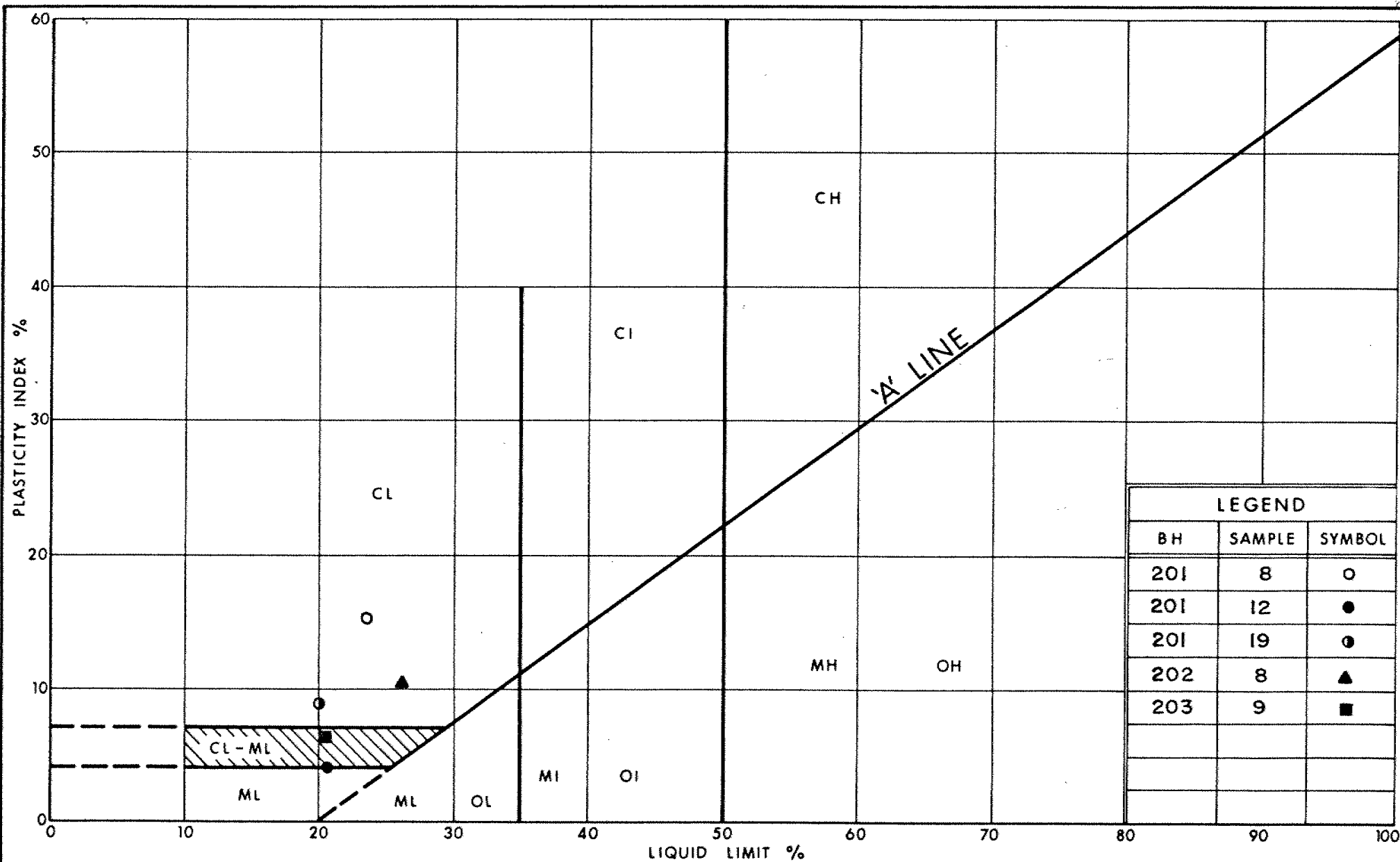
Ontario

ENGINEERING SERVICES BRANCH

GRAIN SIZE DISTRIBUTION LOWER CLAYEY SILT (GLACIAL TILL)

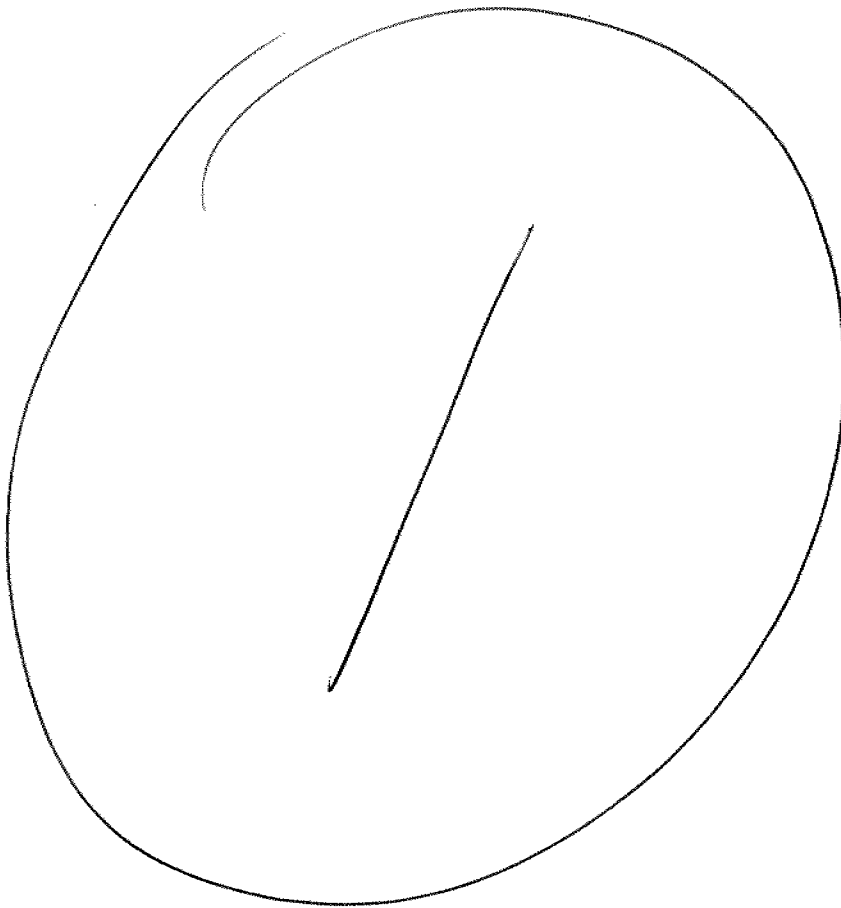
FIG No 5

W P 33-76-18

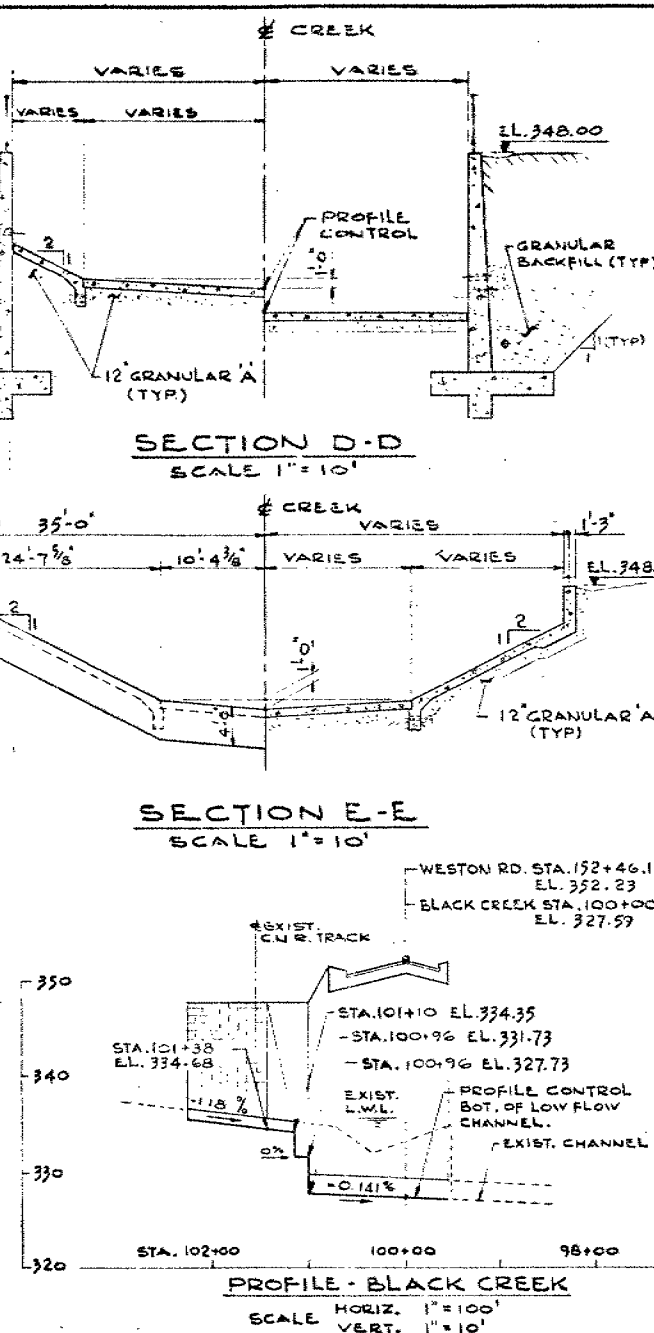
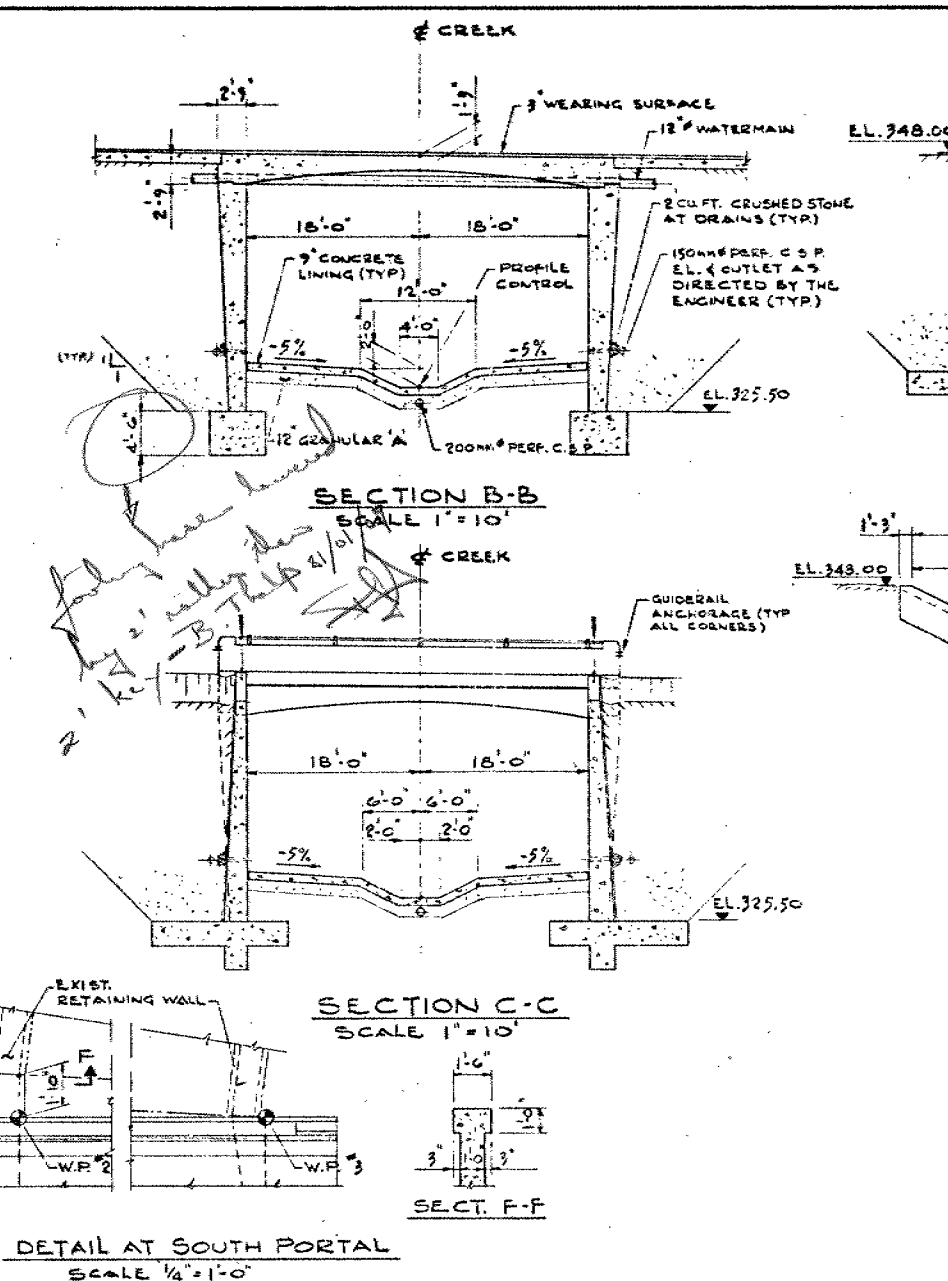
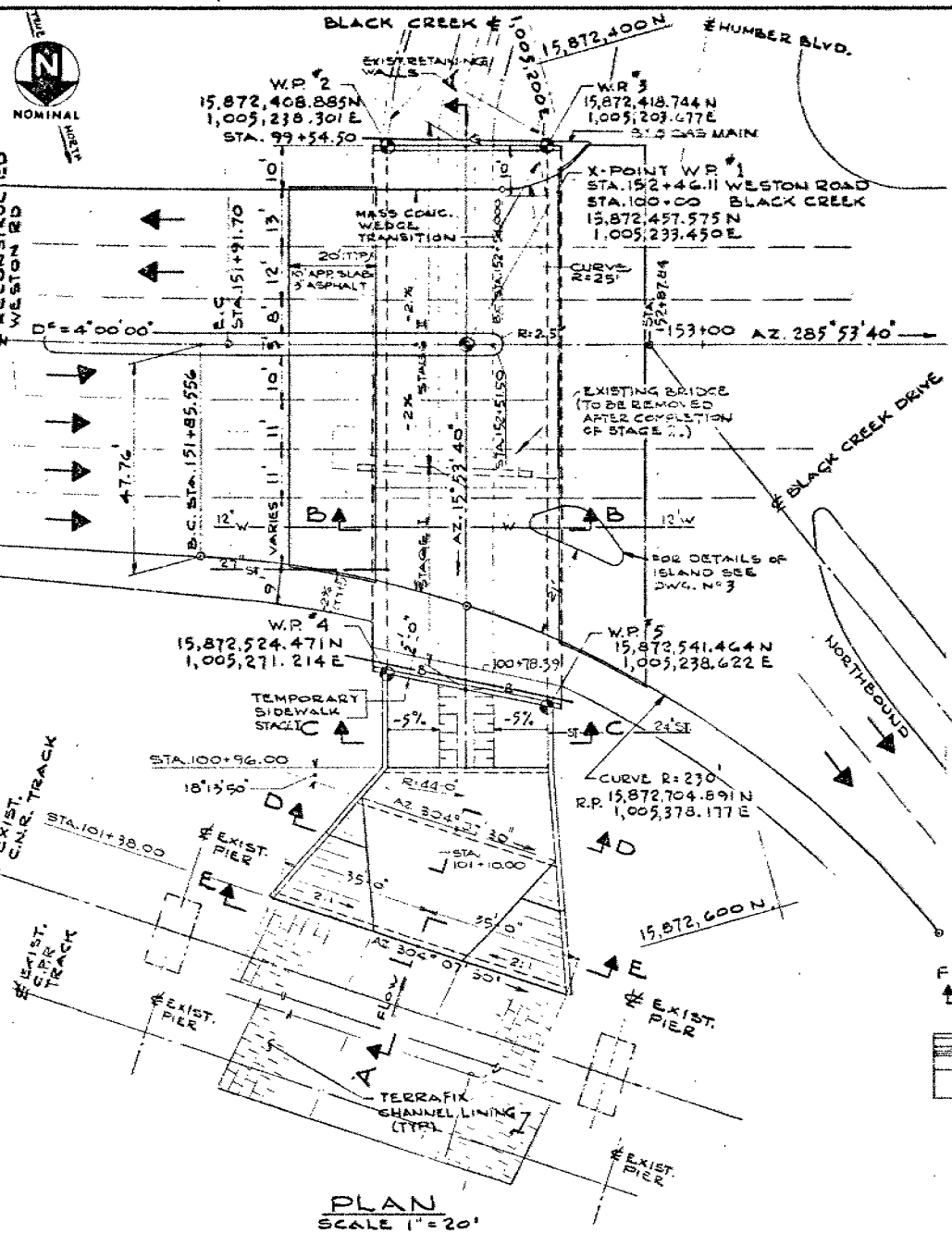


35MM

DRAWING



MINISTRY OF TRANSPORTATION AND COMMUNICATIONS ONTARIO 3115 DENNIS 4-75



DIST. No 6
CONT No
WP No 33-76-18

NORTH WEST METRO ARTERIAL
WESTON ROAD BRIDGE

GENERAL ARRANGEMENT

FENCO
FENCO CONSULTANTS LTD.

KEY PLAN

GENERAL NOTES

CLASS OF CONCRETE - 30 MPa
REINFORCING STEEL - GRADE 400
CLEAR COVER TO REINFORCING STEEL -
SURFACES IN CONTACT WITH EARTH
DECK SLAB TOP
DECK SLAB SOFFIT & SIDEWALKS
BARRIER WALL SEE DWG. NO. 8

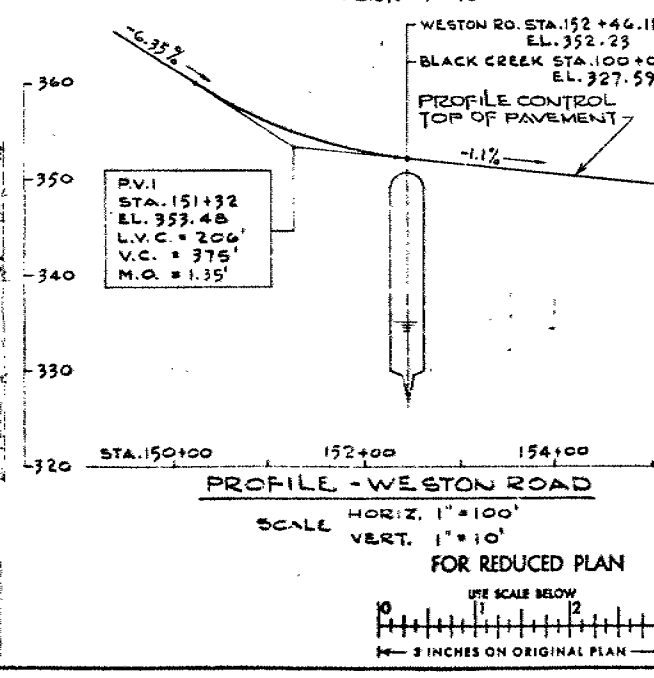
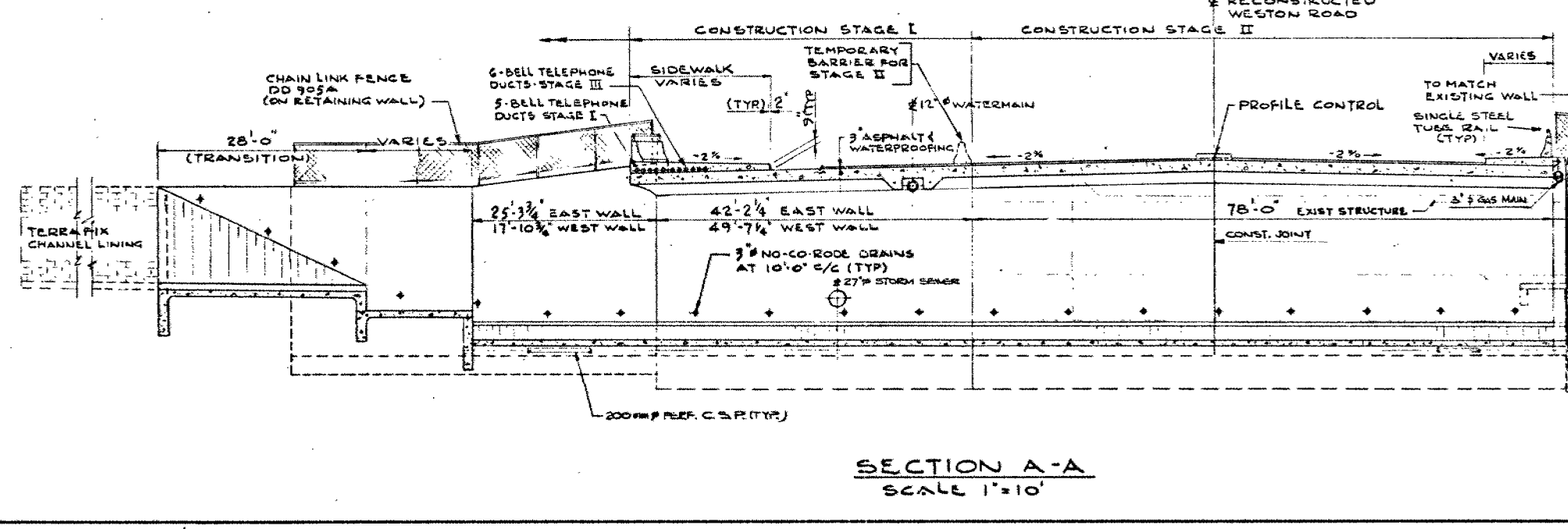
CONCRETE QUANTITIES

CONCRETE QUANTITIES LISTED BELOW
FOR THE APPROPRIATE LUMP SUM:-
TENDER ITEMS:-
CONCRETE IN RIGID FRAME, WALLS,
DECK, AND RETAINING WALLS = 1019 C.Y.
CONCRETE IN CHANNEL LINING = 269 C.Y.
CONCRETE IN BARRIER WALLS = 7 C.Y.
CONCRETE IN APPROACH SLABS = 142 C.Y.

* TO ACHIEVE THE MINIMUM CLEAR COVER OF 2"
SPECIFIED, THE TOP LAYER SHALL BE PLACED
WITH A CLEAR COVER OF 2 1/2" TOLERANCE.

STAGES
FOR DETAILS OF CONSTRUCTION STAGES
SEE DWG. NO. 10.

- LIST OF DRAWINGS:**
- 8589-1K-1 GENERAL ARRANGEMENT
 - 2 BOREHOLE LOCATIONS AND SOIL STRATA
 - 3 FOUNDATION LAYOUT
 - 4 RIGID FRAME
 - 5 RIGID FRAME-DETAILS
 - 6 RETAINING WALLS
 - 7 CONCRETE LINING
 - 8 BARRIER WALL ON SIDEWALK
 - 9 RAILING FOR BARRIER WALL
 - 10 STAGING AND SHORING
 - 11 20FT. APPROACH SLAB
 - 12 AS CONSTRUCTED ELEV. & DIM.
 - 13 SCREEN ELEVATIONS
 - 14 STANDARD I
 - 15 STANDARD II



REVISIONS	DATE	BY	DESCRIPTION

DESIGN W.Y.C. CHECK R.C. LOADING OHBDC-A-70 DATE OCT/80
DRAWING W.R. CHECK T.P. SITE No 37-519 DWG 1
FENCO 8589-1K-1



DIST. No 6
CONT No
WP No 33-76-18

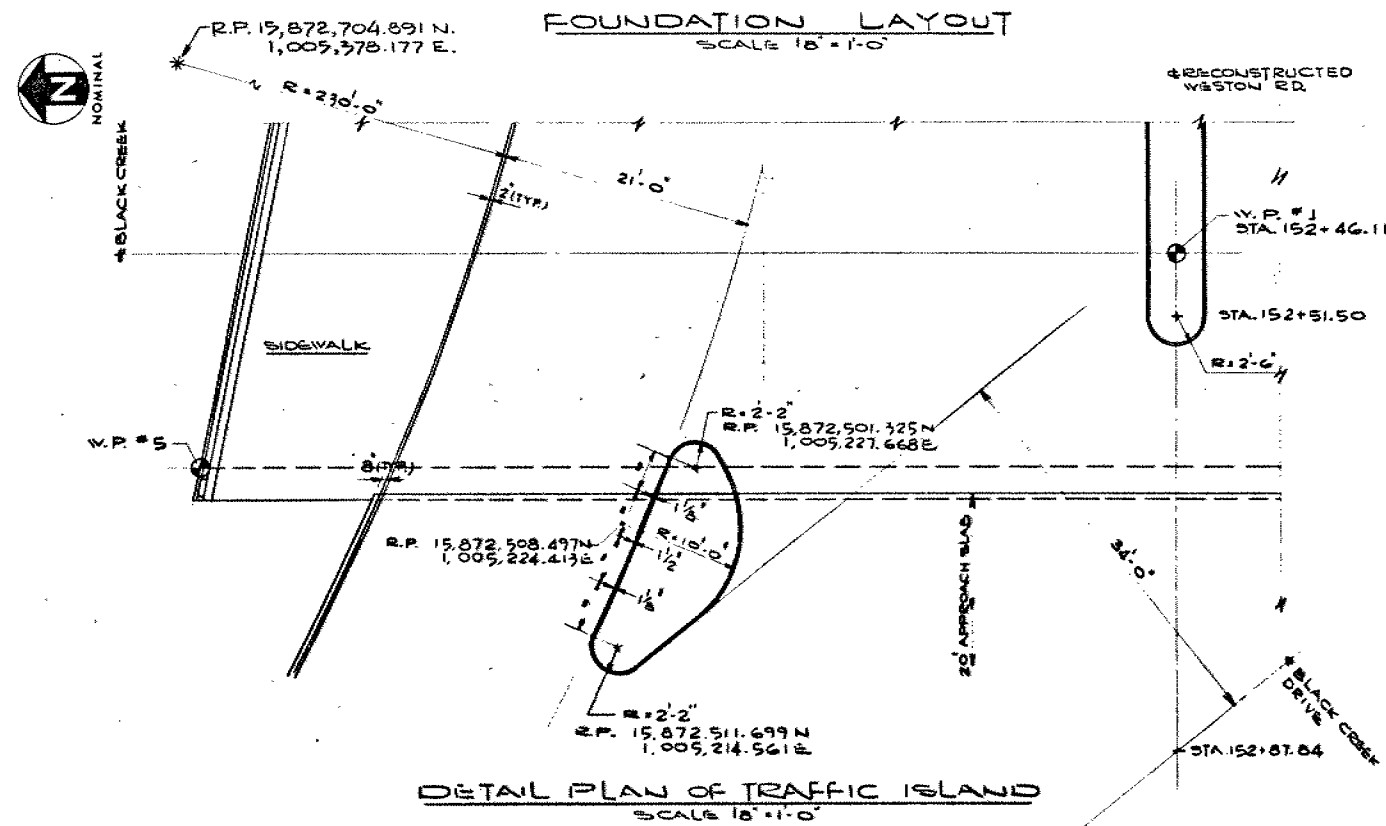
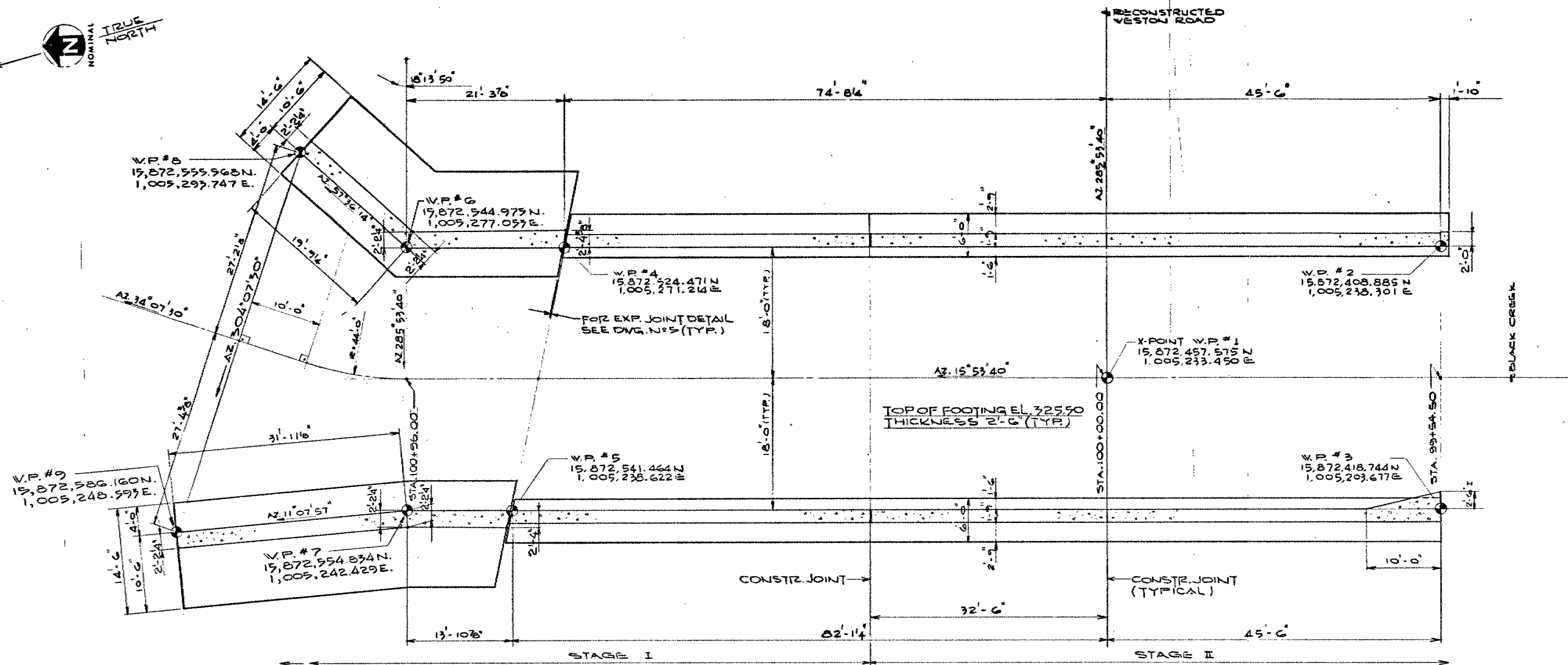


NORTH WEST METRO ARTERIAL
WESTON ROAD BRIDGE
FOUNDATION LAYOUT

SHEET

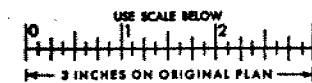
FENCO

FENCO CONSULTANTS LTD.



NOTE:
• FOR GENERAL NOTES, SEE DWG. NO. 1

FOR REDUCED PLAN



REVISIONS	DATE	BY	DESCRIPTION

DESIGN W.F.Y. CHECK J.C.D. LOADING ON BRIDGE 79 DATE OCT/80
DRAWING T.O. CHECK J.C.D. SITE NO 37-519 DWG 3

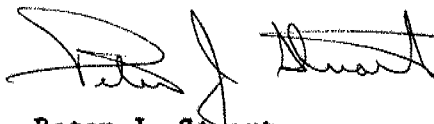
Mr. K.G. Bassi
Head, Operating Section
Structural Office
West Building

Pavement & Foundation Design Section
Room 313, Central Building

1981 01 12

Weston Road Bridge
W.P. 33-76-18, Site 37-519
N.W.M.A., Dist. 6, Toronto

There are no further comments or recommendations following
a review of the final structural drawings.



Peter J. Stuart
Foundations Engineer
For:
M. Devata
Senior Foundations Engineer

PJS:ea

memorandum



To: Mr. K. Bassi
Head, Operating Section
Structural Office
West Building

Date: 1980-09-22

Attention: Mr. W.L. Lin

From: Pavement & Foundation Design Section
Room 313, Central Building

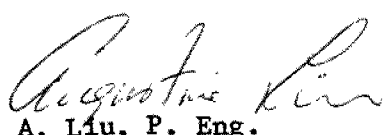
Re: Weston Rd. Bridge, N.W.M.A.
W.P. 33-76-18, Site 37-519
Black Creek Drive, District #6

In response to your request dated 1980-08-22, we have reviewed the preliminary bridge plan drawings 37-519-P1, which leads us to the following comments.

- 1) From the borehole records, it can be seen that all footings are founded on clayey silt. As clayey silt is susceptible to disturbance due to construction activities, particularly in the presence of water, a suitable river diversion scheme should be considered to prevent entry of surface (river) water into the excavation. If it is hydrologically feasible, the channel, in the vicinity of the site, can be divided in halves. The water can be diverted into one half of the channel while footings are being constructed on the other half, and vice versa.
- 2) A memo from Mr. B.T. Phalp, Supervising Engineer of Fenco confirmed that the following, which are not shown on the preliminary drawings submitted to us, but were agreed upon at a meeting held on August 28, 1980 have been incorporated in the design.
 - a) The sliding resistance was calculated using $C = 2000$ psf with a factor of safety of 1.5.
 - b) A 2'-0" x 2'-0" key was added.
 - c) The passive resistance was calculated from the top of the footing to the bottom of the key using the Rankine formula $\gamma Z + 2c$ (i.e. $\phi = 0$).

However, normal granular backfill, instead of bottom ash as suggested in the meeting was used as backfill. Bottom ash was suggested in order to reduce the active earth pressure. The writer called Mr. B.T. Phalp who said that by incorporating (a), (b), (c) above, no lightweight material is required in order to achieve the required factor of safety for stability.

AL:ea
cc: G. Burkhardt


A. Liu, P. Eng.
For: M. Devata
Senior Foundations Engineer

memorandum



To: Mr. G.C.E. Burkhardt
Head, Structural Section
Central Region

Date: 1979-12-07

From: Pavement & Foundation Design Section
Room 315, Central Building
Downsview

Re: Foundation Investigation Report For
Black Creek Structure at Weston Rd.
Hwy. NWMA, District #6 (Toronto)
W.P. 33-76-18, Site 37-519

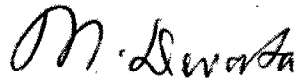
A subsurface investigation was carried out by Golder Associates, Consulting Geotechnical Engineers for the Ministry at the above mentioned site. The proposed bridge will likely be either a rigid box type structure, or a single, simply supported span and will incorporate a hydraulic drop and transition structure.

We have reviewed the foundation report prepared by Golder Associates and submit the following comments.

- 1) The subsurface investigation revealed that the site is underlain by fill materials and recent alluvium overlying glacial till consisting of competent clayey silt mixed with sand and gravel. In general, the ground water levels in the upper, pervious fill and alluvial materials corresponded very closely with the water level in the Black Creek. However, in certain locations the sand layer sandwiched within the glacial till stratum exhibited a subartesian water condition.
- 2) The new structure should be supported on shallow spread footings or a raft type foundation as suggested in the foundation report with an allowable bearing pressure of 3 t.s.f.
- 3) In our opinion spread footings should also be adopted even for a rigid frame type of structure since the differential settlements may not exceed one inch. In view of this, piling alternatives should not be considered.
- 4) General recommendations provided in the report with regard to geotechnical requirements of the channel lining, transition and drop structures are quite adequate for your design purposes.
- 5) The foundation material is susceptible to disturbance due to construction activities, particularly in the presence of water. To minimize such problems a lean concrete working slab should be placed once the footing excavation is completed.

...../2

Should you have any further queries with regard to this report,
please contact us.



M. Devata
Senior Foundations Engineer

MD:ea

Encl.

cc: R.D. Gunter
I.V. Oliver
D.E. Thrasher (2)
C. Grebski
B.J. Giroux
R. Hore
R. Fitzgibbon)
J. Anderson) memo only
T.J. Kovich)