

No. 2253 -

REMARKS: _____

CONT 75-07

MINISTRY OF TRANSPORTATION AND COMMUNICATIONS, ONTARIO

MEMORANDUM

30M15-4

TO: Mr. G.C.E. Burkhardt, (2)
Regional Structural Planning Eng.,
Central Region,
90 Floral Pkwy., Downsview.

FROM: Foundations Office,
Design Services Branch,
West Bldg., Downsview.

ATTENTION:

DATE: February 9, 1973.

FILE REF.

IN REPLY TO FEB 14 1973

SUBJECT:

FOUNDATION INVESTIGATION REPORT
For
Proposed Extension to the Bridge Structure
At the Crossing of Hwy. 401 and
Lynde Creek
Twp. of Whitby, County of Ontario
District #6, Site 22-150
W.O. 72-11123 -- W.P. 44-71-04

Attached we are forwarding to you our detailed foundation investigation report on the subsoil conditions existing at the above-mentioned site.

We believe that the factual data and recommendations contained therein will prove adequate for your design requirements. Should additional information be required, please do not hesitate to contact our Office.

AGS/ao
Atch.

cc: E. J. Orr
B. R. Davis
A. Rutka
R. S. Pillar
H. Greenland
B. J. Giroux
C. Mirza
G. A. Wrong
B. A. Singh

A. G. Stermac
A. G. Stermac,
PRINCIPAL FOUNDATIONS ENGINEER.

Foundations Files
Documents

CONT 75-07

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FOUNDATION INVESTIGATION REPORT
For
Proposed Extension to the Bridge Structure
At the Crossing of Hwy. 401 and
Lynde Creek
Twp. of Whitby - County of Ontario
W.O. 72-11123 --- W.P. 44-71-04

1. INTRODUCTION:

In order to accommodate six lane traffic it is proposed to widen Hwy. #401 from the Rouge River, County of Ontario, easterly to the City of Oshawa. As part of this reconstruction the existing bridge structure at Hwy. 401 and Lynde Creek crossing in the Twp. of Whitby, County of Ontario, will be widened in a southerly direction. The Foundations Office was requested, in a memo from Mr. G.C.E. Burkhardt, Regional Structural Planning Engineer, dated October 26, 1972, to carry out a subsurface investigation at the above-mentioned site. Subsequently, an investigation was carried out by this Office to determine the subsoil, bedrock and groundwater conditions at this site.

This report contains the results of the investigation, together with recommendations pertaining to the foundations for the widening of the existing bridge structure, as well as stability and settlement considerations of the approach embankments.

2. DESCRIPTION OF THE SITE AND GEOLOGY:

The site is situated at the crossing of Hwy. 401 and Lynde Creek in the Township of Whitby. It is about 1-1/2 miles west of the Town of Whitby and about 150 ft. north of and parallel to the existing C.N.R. line. The existing bridge is a 50 ft. wide single span structure.

The area is flat to undulating in relief and physiographically

is referred to as "The Iroquois Plain." The old shoreline of glacial lake Iroquois is well marked by bluffs of gravel bars, offshore deposits of sands and the rest of it is a "mosaic" of till plains, drumlins, and silty lacustrine deposits. The overburden deposits are underlain by shale bedrock.

3. FIELD AND LABORATORY WORK:

Four sampled boreholes, each accompanied by a dynamic cone penetration test, were put down at this site. The borings were advanced by means of a C.M.E. auger machine adapted for soil sampling.

Samples of the subsoil were recovered at required depths in a 2" O.D. split-spoon sampler which was hammered into the soil in accordance with the specifications for the Standard Penetration Test. The same method was used to advance the dynamic cone penetration tests.

The location and elevations of all the borings were surveyed in the field by personnel from the Foundations Office; they are shown on Drawing 72-11123A, together with an estimated stratigraphical profile across the site.

All samples were visually examined and identified in the field and subsequently in the laboratory. Following this, laboratory testing was carried out on selected representative samples to determine the various physical properties; namely,

- Atterberg Limits
- Natural Moisture Contents
- Bulk Densities
- Grain-Size Distributions

The results of the laboratory testing are plotted on the Record of Borelog sheets and summarized on Fig. 1 and 2 in the Appendix of the report.

4. SUBSOIL CONDITIONS:

4.1) General:

The predominant material across the site is a deposit of loose silt to silty sand with some gravel and organics with layers

of clayey silt. The thickness of this deposit ranges from 15.5 to 17 feet below the top of the creek bank. This material is underlain by a 10 to 11.5 foot thick deposit of compact to very dense gravel with silty sand and some clay. The overburden material is underlain by shale bedrock.

The boundaries of the various deposits are shown on the accompanying borelog sheets. The stratigraphical profile plotted on Drawing No. 72-11123A, is inferred from this boring data.

From ground surface downwards, the various soil types and bedrock encountered are as follows:

4.2) Silt to Silty Sand with Some Gravel and Organics with Layers of Clayey Silt:

This deposit in all four boreholes is composed of silt to silty to silty sand and some gravel with organic inclusions mainly composed of decayed wood. Further, there are numerous 6 to 8 inch thick layers of soft to stiff clayey silt throughout the deposit. It is believed that this material has been deposited in the flood plain of Lynde Creek. Typical grain size distribution curves for samples obtained from this deposit are shown in envelope form on Figure #1 appended to this report.

Standard penetration testing was carried out within this deposit. This testing gave 'N' values which varied from 2 to 15 blows/ft., being generally less than 5 blows/ft. Based on these results it is estimated that the relative density of the major granular portion of the deposit ranges from loose to compact.

4.3) Gravel and Silty Sand with Trace of Clay:

Underlying the upper flood plain deposit is a stratum of gravel and silty sand with a trace of clay. The stratum varies from 10 to 11.5 feet in thickness. Grain-size distribution curves for samples of this material are plotted in envelope form on Fig. #2 appended to this report.

The 'N' values in this deposit ranged from 13 to over 100 blows per foot, indicating a relative density varying from compact to very dense.

4.4) Shale Bedrock:

Underlying the gravel and silty sand stratum is shale bedrock. The bedrock was proven in B.H.'s #1 and 2 by obtaining BXL size rock core samples. The upper 7.5 feet of the bedrock appeared to be in a weathered condition. Below this upper zone the shale is relatively sound as evidenced by the high percentage of rock core recovered.

5. GROUNDWATER CONDITIONS:

The groundwater level conditions across the site, during the period of the investigation (Nov. 1972) were observed by taking readings in the open boreholes. The results of the readings are shown on the Borelog sheets, as well as on Drawing No. 72-11123A.

The observations indicate that the groundwater level is located at elevation 251.4 ft. which corresponded to the water level in the creek during the time of the investigations.

6. DISCUSSION AND RECOMMENDATIONS:

6.1) General:

It is proposed to widen the existing single-span structure at the crossing of Hwy. 401 and Lynde Creek in the Town of Whitby. The widening will be 12 ft. on the south side of Hwy. 401, to accommodate future traffic lanes. It is understood that the existing profile grade of Hwy. 401 will be maintained (elevations 261 to 262). The maximum height of the widened portion of the approach fills will be in the order of 10 ft. above the existing ground surface in the transverse direction.

The subsoil at the site consists of a 15.5 to 17 foot thick flood plain deposit composed of a loose to compact silt to silty sand with trace of gravel and organic inclusions with layers of clayey silt. This deposit is underlain by a 10 to 11.5 foot thick stratum of compact to very dense gravel and silty sand with a trace of clay. The overburden is underlain by weathered to sound shale bedrock.

6.2) Structure Foundations:

According to available information (design drawings for this structure) it appears that the existing abutments are founded on spread footings located at the following elevations in the gravel and silty sand stratum.

East Abutment - 236.4 ft.
West Abutment - 236.5 ft.

It is recommended that the proposed south extension of the structure abutments can be founded on spread footings located at the aforementioned elevations. The footing extensions can be designed using an allowable bearing pressure of 3.0 t.s.f.

Since the closed type abutment extensions will be designed as a rigid frame a coefficient of earth pressure at rest (K_0) of 0.5 should be assumed for the granular material placed behind the abutments. In computing the sliding resistance between the base of the foundation extensions and the granular subsoil a coefficient of frictional resistance of 0.7 can be used.

The extension excavations will extend up to 15 feet below the creek water level. Since the subsoil is basically granular in nature, a positive dewatering scheme will be necessary for the construction of the foundation extensions. One method would be to employ a cofferdam incorporating interlocking steel sheeting driven to bedrock. Any seepage into the sheeted enclosure could be controlled using conventional pumping techniques.

The granular subsoil beneath the extensions will settle due to the imposed foundation footing pressure. These settlements will be elastic in nature; i.e., take place during or immediately following placement of the full structural load. It is estimated that the magnitude of these settlements should not exceed 1 inch provided the foundation subsoil is not loosened during the construction period. However, it is recommended that a construction joint should be provided between the existing abutment foundation and the extension in order to accommodate any possible differential settlement.

6.3) Approach Fill Embankments:

The existing embankments will be extended approximately

12 feet in a southerly direction. These extensions will require that up to 10 feet of fill will have to be placed on the south side of the existing approaches.

In order to maintain a smooth transition from the existing to the new fill sections, it is recommended that:

- a) All topsoil and organic material be stripped from the existing fill sections prior to placing future fill, and
- b) the future fill be 'keyed' into the existing approaches as per current M.T.C. methods.

If these measures are adopted, no stability problems are anticipated for the extensions, provided standard 2:1 slopes are employed. The subsoil will settle due to the embankment loading of the widened portion; it is estimated that this settlement could be of the order of 3 to 4 inches. In order to minimize the differential settlement between the existing and widened embankment sections it would be desirable to construct the extensions well in advance (3 to 6 months) of the final paving operations.

Visual observations made during the period of the investigation indicate that there is a low lying flooded area south of Hwy. #401 on the west side of Lynde Creek. In view of this it is our recommendation that a granular type of material should be used as fill in this area. Further, consideration should be given to raising the grade in this general area in order to prevent any future ponding.

7. MISCELLANEOUS:

The field work, performed during the period of November 22 to December 4, 1972, was carried out under the immediate supervision of Mr. V. Korlu, Project Foundations Engineer, who also prepared this report.

The equipment was owned and operated by Master Soil Investigation Ltd., Toronto.

This project was carried out under the general supervision of Mr. M. Devata, Supervising Foundations Engineer, who also reviewed this report.

V. Korlu
V. Korlu, P. Eng.



M. Devata
M. Devata, P. Eng.

VK/ao

February 8, 1973.

APPENDIX I

DESIGN SERVICES BRANCH

FOUNDATIONS OFFICE

RECORD OF BOREHOLE NO 1

JOB 72-11123

LOCATION 15, 939, 540 N 1, 141, 630 E

ORIGINATED BY VK

W.P. 44-71-04

BORING DATE Nov. 20, 1972

COMPILED BY OJ

DATUM Geodetic

BOREHOLE TYPE Auger, BXL Rock Core & Cone Penetration Test

CHECKED BY

SOIL PROFILE			SAMPLES			ELEV. SCALE	DYNAMIC PENETRATION RESISTANCE BLOWS / FOOT					LIQUID LIMIT — w_L PLASTIC LIMIT — w_p WATER CONTENT — w			BULK DENSITY γ P.C.F.	REMARKS
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	BLOWS/FOOT		20	40	60	80	100	w_p	w	w_L		
255.9	Ground Level															
0.0	Silt to silty sand with trace of gravel and organics - firm to stiff clayey silt layers		1	SS	2	250										W.L. 251.4
			2	SS	3											1 46 46 7
			3	SS	3											
	loose		4	SS	11											5 52 36 7
240.4			5	SS	12	240										
15.5	Gravel and silty sand with trace of clay. Dense to very dense		6	SS	44											
			7	SS	158											
229.9			8	SS	190	230										
26.0	Shale bedrock (weathered)		9	SS	100	230										
224.4			10	RC	83	Rec.										
31.5	(sound)		11	RC	95	Rec.										
			12	RC	100	Rec.										
214.4																
41.5	End of Borehole					210										

OFFICE REPORT SOIL EXPLORATION

DESIGN SERVICES BRANCH

FOUNDATIONS OFFICE

RECORD OF BOREHOLE NO 1A

JOB 72 1123

LOCATION 15, 939, 546 N 1, 141, 612 E

ORIGINATED BY VK

W.P. 44-71-04

BORING DATE Dec. 1, 1972

COMPILED BY OJ

DATUM Geodetic

BOREHOLE TYPE Auger, Cone, Vane

CHECKED BY

SOIL PROFILE			SAMPLES			ELEV SCALE	DYNAMIC PENETRATION RESISTANCE BLOWS / FOOT					LIQUID LIMIT — w_L PLASTIC LIMIT — w_p WATER CONTENT — w			BULK DENSITY γ	REMARKS
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	BLOWS/FOOT		20	40	60	80	100	w_p	w	w_L		
258.0	Ground Level															
0.0	Silt to silty sand with trace of gravel and organics - soft to stiff Clayey silt layers		1	TW	PM										119	
			2	TW	PM	250										
			3	TW	PM										119	
			4	SS	5											
241.0	(loose to compact)															
17.0	Gravel and Silty Sand		5	SS	13	240										
236.0	Compact															
22.0	End of Borehole															
23.5	End of Cone Test															
						230										

OFFICE REPORT SOIL EXPLORATION

DESIGN SERVICES BRANCH

FOUNDATIONS OFFICE

RECORD OF BOREHOLE NO 2

JOB 72-11123

LOCATION 15, 939, 513 N 1, 141, 703 E

ORIGINATED BY VK

W.P. 41-71-04

BORING DATE Nov. 22, 1972

COMPILED BY OJ

DATUM Geodetic

BOREHOLE TYPE Auger, Cone, Vane

CHECKED BY

SOIL PROFILE			SAMPLES			ELEV SCALE	DYNAMIC PENETRATION RESISTANCE					LIQUID LIMIT — w_L			BULK DENSITY	REMARKS
ELEV DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	BLOWS/FOOT		BLOWS / FOOT					PLASTIC LIMIT — w_p				
257.3	Ground Level						20	40	60	80	100	WATER CONTENT — w				
							SHEAR STRENGTH P.S.F.					w_p — w — w_L				
							○ UNCONFINED + FIELD VANE					WATER CONTENT %			γ	
							● QUICK TRIAXIAL x LAB VANE					10 20 30			P.C.F.	GR SA SI CL
							400 800 1200 1600 2000									
0.0	Silt to silty sand with trace of gravel and organics. Soft to firm Clayey silt layers Loose		1	SS	3	250										

OFFICE REPORT SOIL EXPLORATION

DESIGN SERVICES BRANCH

FOUNDATIONS OFFICE

RECORD OF BOREHOLE NO 2A

JOB 72-11123

LOCATION 15, 939, 508 N

1, 141, 722 E

ORIGINATED BY VK

W.P. 44-71-04

BORING DATE Dec. 4, 1972

COMPILED BY OJ

DATUM Geodetic

BOREHOLE TYPE Auger, Cone, Vane Tests

CHECKED BY

SOIL PROFILE			SAMPLES			ELEV. SCALE	DYNAMIC PENETRATION RESISTANCE BLOWS / FOOT					LIQUID LIMIT — w_L PLASTIC LIMIT — w_P WATER CONTENT — w			BULK DENSITY γ	REMARKS
ELEV. DEPTH	DESCRIPTION	STRAT. PLT.	NUMBER	TYPE	BLOWS/FOOT		20	40	60	80	100	w_p	w	w_L		
260.0	Ground Level															
0.0	Silt to silty sand with trace of gravel and organics		1	SS	6											
			2	TW	PM											
	Soft to firm Clayey silt layers (loose to compact)		3	SS	15	250										
			4	TW	PM											
243.0			5	SS	7											
17.0	Gravel and silty sand		6	SS	17	210										
238.7	Compact to very dense		7	SS	100/1"											
21.3	End of Borehole															
231.3																
28.7	End of Cone Test					230										

OFFICE REPORT SOIL EXPLORATION

DESIGN SERVICES BRANCH

FOUNDATIONS OFFICE

RECORD OF BOREHOLE NO 3

JOB 72-11123

LOCATION Co-ords. 15,939,658 N; 1,141,533 E.

ORIGINATED BY L.J.H.

W.P. 14-71-04

BORING DATE Aug. 2 - 7, 1973

COMPILED BY I.J.H.

DATUM Geodetic

BOREHOLE TYPE NX/BX Casing and Washboring, Cone

CHECKED BY

SOIL PROFILE			SAMPLES			ELEV. SCALE	DYNAMIC PENETRATION RESISTANCE BLOWS / FOOT					LIQUID LIMIT — w_L PLASTIC LIMIT — w_P WATER CONTENT — w			BULK DENSITY γ	REMARKS
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	BLOWS/FOOT		20	40	60	80	100	w_P	w	w_L		
252.2	Ground Level															
0.0	Silty sand, some gravel and organics, clayey silt layers. Very Loose to Compact		2	SS	1/6"	250										35 56 (7)
211.2	Grey		3	SS	2/10"											21 57 21 1
11.0	Gravel and silty sand, trace of clay.		4	SS	27											
			5	SS	6	240										
			6	SS	66											35 37 23 5
	Loose to Very Dense		7	SS	109											
227.2	Grey		8	SS	75/70"	230										36 34 25 5
225.2	Weathered Shale, Grey		9	SS	100/3"											
27.0	Shale Bedrock		10	RC	100%	220										
215.2			11	RC	100%											
37.0	End of Borehole					210										

DESIGN SERVICES BRANCH

FOUNDATIONS OFFICE

RECORD OF BOREHOLE NO 4

 JOB 72-11123 LOCATION Co-ords. 15,939,611N; 1,141,401 E.

 W.P. 44-71-04 BORING DATE Aug. 7 - 8, 1973

 DATUM Geodetic BOREHOLE TYPE NX/BX Casing & Washboring, Conc

 ORIGINATED BY L.H.

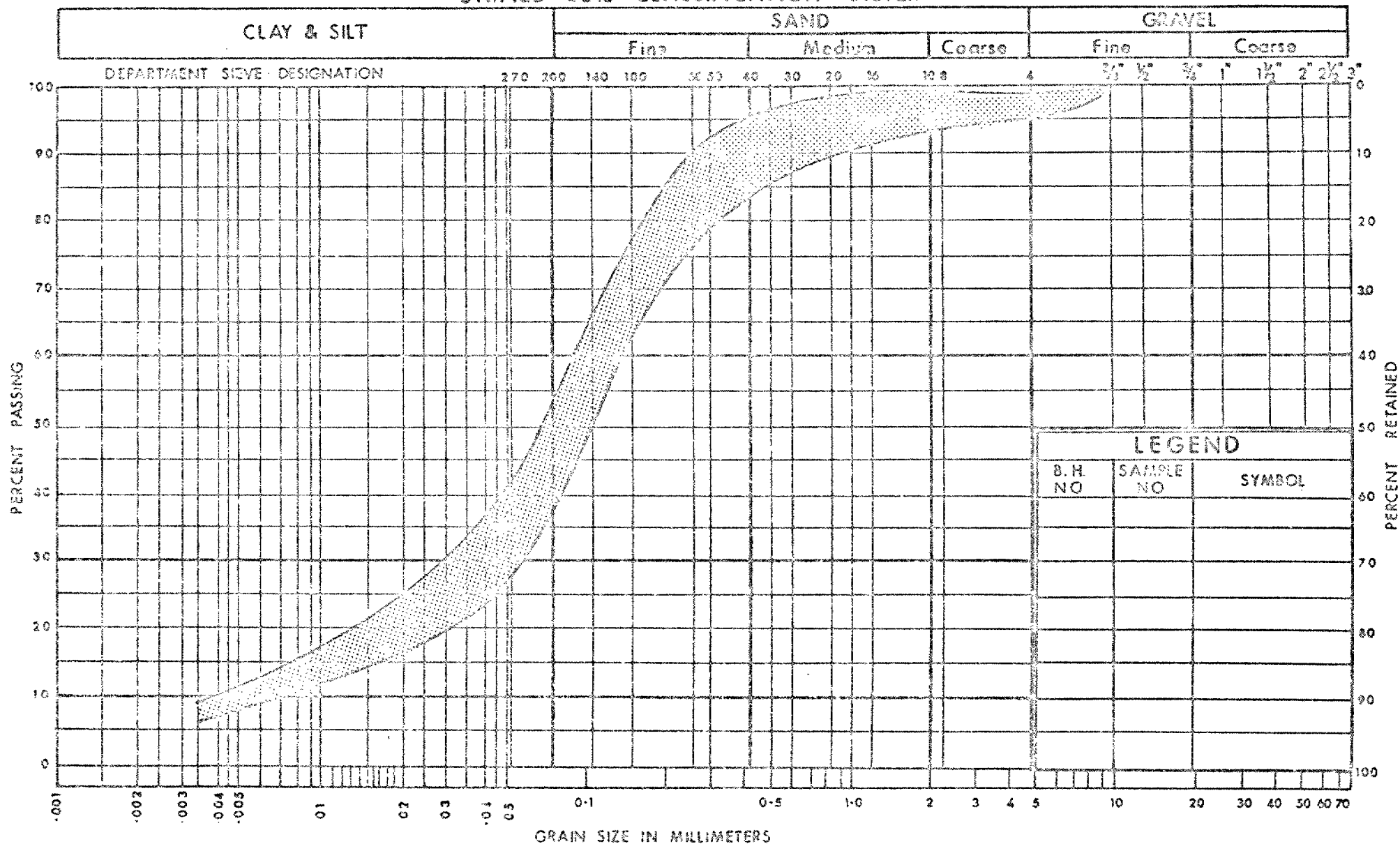
 COMPILED BY L.H.

 CHECKED BY L.H.

SOIL PROFILE			SAMPLES			ELEV. SCALE	DYNAMIC PENETRATION RESISTANCE BLOWS / FOOT					LIQUID LIMIT W_L PLASTIC LIMIT W_P WATER CONTENT W			BULK DENSITY γ P.C.F.	REMARKS
ELEV. DEPTH	DESCRIPTION	STRAT. PLT	NUMBER	TYPE	BLOWS / FOOT		20	40	60	80	100	W_p	W	W_L		
254.2	Ground Level															
0.0	Silty sand to sandy silt, traces of gravel & organics		1	SS	3	250										1 250.4
	clayey silt layers.		2	SS	7											3 25.13
242.7	Very Loose to Dense Grey		3	SS	1											12 67 18 3
11.5	Gravel and silty sand and trace of clay.		4	SS	11	210										39 46 (15)
			5	SS	5											25 45 24 6
	Loose to Very Dense		6	SS	70											
			7	SS	37											14 49 30 7
	Grey		8	SS	24	230										
225.2	Shale Bedrock		9	RC	10	220										
222.2																
32.0	End of Borehole															

OFFICE REPORT ON SOIL EXPLORATION

UNIFIED SOIL CLASSIFICATION SYSTEM

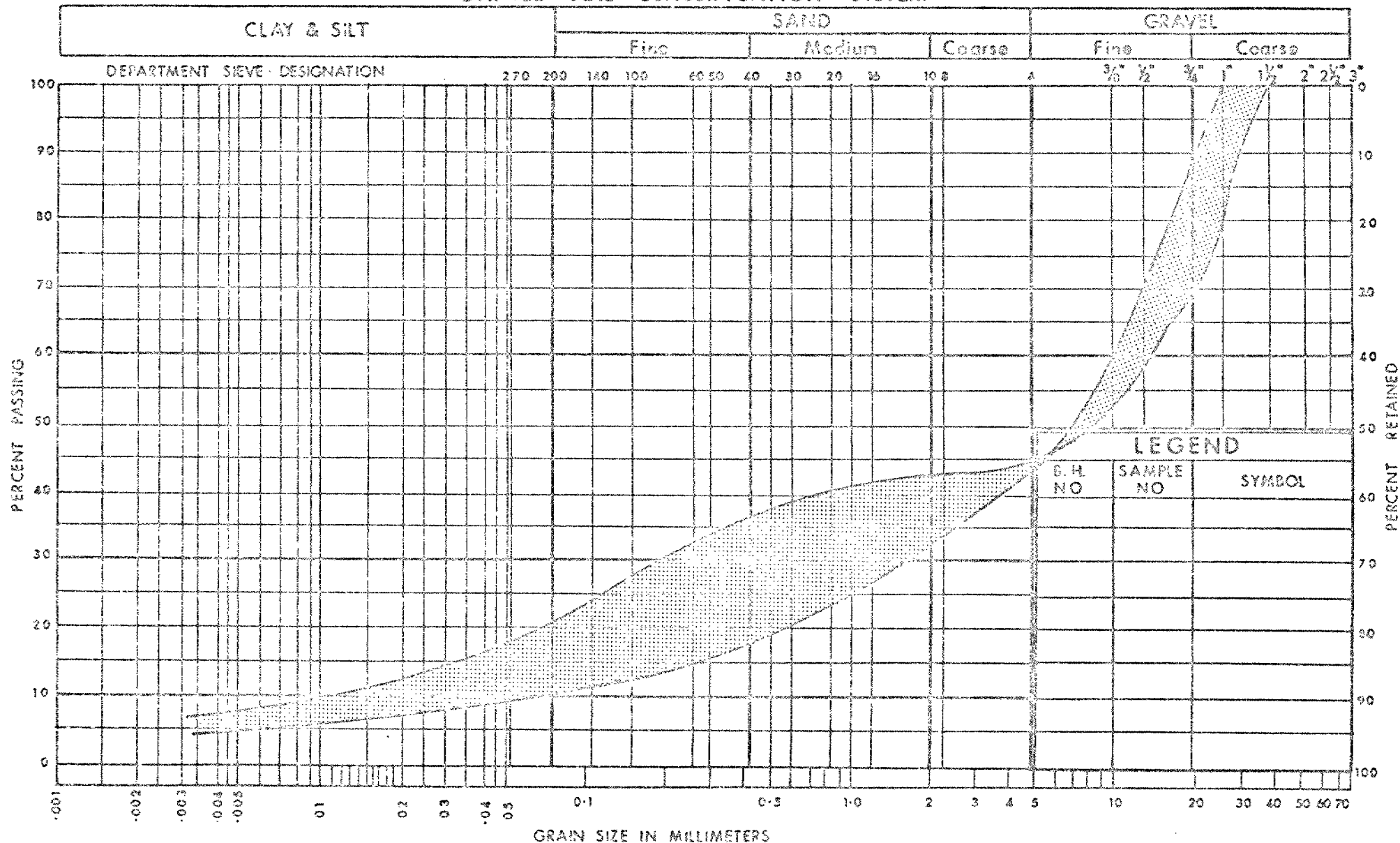


DEPARTMENT
OF
TRANSPORTATION AND COMMUNICATIONS
DESIGN SERVICES
BRANCH

GRAIN SIZE DISTRIBUTION
SILT TO SILTY SAND
TRACE OF GRAVEL & ORGANICS

W.P. No. 44-71-04
JOB No. 72-11123
FIG.1

UNIFIED SOIL CLASSIFICATION SYSTEM



DEPARTMENT
OF
TRANSPORTATION AND COMMUNICATIONS

DESIGN SERVICES
BRANCH

GRAIN SIZE DISTRIBUTION
GRAVEL
AND SILTY SAND, TRACE OF CLAY

W.P. No. 44-71-04
JOB No. 72-11123
FIG. 2

ABBREVIATIONS & SYMBOLS USED IN THIS REPORTPENETRATION RESISTANCE

'N'-STANDARD PENETRATION RESISTANCE : - THE NUMBER OF BLOWS REQUIRED TO ADVANCE A STANDARD SPLIT SPOON SAMPLER 12 INCHES INTO THE SUBSOIL, DRIVEN BY MEANS OF A 140 POUND HAMMER FALLING FREELY A DISTANCE OF 30 INCHES.

DYNAMIC PENETRATION RESISTANCE : - THE NUMBER OF BLOWS REQUIRED TO ADVANCE A 2 INCH, 60 DEGREE CONE, FITTED TO THE END OF DRILL RODS, 12 INCHES INTO THE SUBSOIL, THE DRIVING ENERGY BEING 350 FOOT POUNDS PER BLOW.

DESCRIPTION OF SOIL

THE CONSISTENCY OF COHESIVE SOILS AND THE RELATIVE DENSITY OR DENSENESS OF COHESIONLESS SOILS ARE DESCRIBED IN THE FOLLOWING TERMS:-

<u>CONSISTENCY</u>	<u>c LB./SQ. FT.</u>	<u>DENSENESS</u>	<u>'N' BLOWS / FT.</u>
VERY SOFT	0 - 250	VERY LOOSE	0 - 4
SOFT	250 - 500	LOOSE	4 - 10
FIRM	500 - 1000	COMPACT	10 - 30
STIFF	1000 - 2000	DENSE	30 - 50
VERY STIFF	2000 - 4000	VERY DENSE	> 50
HARD	> 4000		

TERMS TO BE USED IN DESCRIBING SOILS:-

TRACE < 10% , SOME 10-25% , WITH 25-40% , > 40% SILTY, SANDY, GRAVELLY, CLAYEY ETC.

TYPE OF SAMPLE

S.S.	SPLIT SPOON	T.W.	THINWALL OPEN
W.S.	WASHED SAMPLE	T.P.	THINWALL PISTON
S.T.	SLOTTED TUBE SAMPLE	O.S.	OESTERBERG SAMPLE
A.S.	AUGER SAMPLE	F.S.	FOIL SAMPLE
C.S.	CHUNK SAMPLE	R.C.	ROCK CORE

P.H. SAMPLE ADVANCED HYDRAULICALLY

P.M. SAMPLE ADVANCED MANUALLY

SOIL TESTS

U	UNCONFINED COMPRESSION	L.V.	LABORATORY VANE
UU	UNCONSOLIDATED UNDRAINED TRIAXIAL	F.V.	FIELD VANE
CU	CONSOLIDATED ISOTROPIC UNDRAINED TRIAXIAL	C	CONSOLIDATION
CID	" " DRAINED "	S	SENSITIVITY
CAU	" ANISOTROPIC UNDRAINED "		
CAD	" " DRAINED "		

ABBREVIATIONS & SYMBOLS USED IN THIS REPORT

SOIL PROPERTIES

γ	UNIT WEIGHT OF SOIL (BULK DENSITY)
γ_s	UNIT WEIGHT OF SOLID PARTICLES
γ_w	UNIT WEIGHT OF WATER
γ_d	UNIT DRY WEIGHT OF SOIL (DRY DENSITY)
γ'	UNIT WEIGHT OF SUBMERGED SOIL
G	SPECIFIC GRAVITY OF SOLID PARTICLES $G = \frac{\gamma_s}{\gamma_w}$
e	VOID RATIO
n	POROSITY
w	WATER CONTENT
S_r	DEGREE OF SATURATION
w_L	LIQUID LIMIT
w_p	PLASTIC LIMIT
I_p	PLASTICITY INDEX
w_s	SHRINKAGE LIMIT
I_L	LIQUIDITY INDEX $= \frac{w - w_p}{I_p}$
I_C	CONSISTENCY INDEX $= \frac{w_L - w}{I_p}$
e_{max}	VOID RATIO IN LOOSEST STATE
e_{min}	VOID RATIO IN DENSEST STATE
I_D	DENSITY INDEX $= \frac{e_{max} - e}{e_{max} - e_{min}}$
	RELATIVE DENSITY D_r IS ALSO USED
h	HYDRAULIC HEAD OR POTENTIAL
q	RATE OF DISCHARGE
v	VELOCITY OF FLOW
i	HYDRAULIC GRADIENT
k	COEFFICIENT OF PERMEABILITY
j	SEEPAGE FORCE PER UNIT VOLUME
m_v	COEFFICIENT OF VOLUME CHANGE $= \frac{-\Delta e}{(1+e)\Delta \sigma'}$
c_v	COEFFICIENT OF CONSOLIDATION
C_c	COMPRESSION INDEX $= \frac{\Delta e}{\Delta \log_{10} \sigma'}$
T_v	TIME FACTOR $= \frac{c_v t}{d^2}$ (d, DRAINAGE PATH)
U	DEGREE OF CONSOLIDATION
τ_f	SHEAR STRENGTH
c'	EFFECTIVE COHESION
ϕ'	EFFECTIVE ANGLE OF SHEARING RESISTANCE, OR FRICTION
c_u	APPARENT COHESION
ϕ_u	APPARENT ANGLE OF SHEARING RESISTANCE, OR FRICTION
μ	COEFFICIENT OF FRICTION
S_t	SENSITIVITY

GENERAL

π	= 3.1416
e	BASE OF NATURAL LOGARITHMS 2.7183
$\log_e a$ OR $\ln a$	NATURAL LOGARITHM OF a
$\log_{10} a$ OR $\log a$	LOGARITHM OF a TO BASE 10
t	TIME
g	ACCELERATION DUE TO GRAVITY
V	VOLUME
W	WEIGHT
M	MOMENT
F	FACTOR OF SAFETY

STRESS AND STRAIN

u	PORE PRESSURE
σ	NORMAL STRESS
σ'	NORMAL EFFECTIVE STRESS ($\bar{\sigma}$ IS ALSO USED)
τ	SHEAR STRESS
ϵ	LINEAR STRAIN
γ	SHEAR STRAIN
ν	POISSON'S RATIO (μ IS ALSO USED)
E	MODULUS OF LINEAR DEFORMATION (YOUNG'S MODULUS)
G	MODULUS OF SHEAR DEFORMATION
K	MODULUS OF COMPRESSIBILITY
η	COEFFICIENT OF VISCOSITY

EARTH PRESSURE

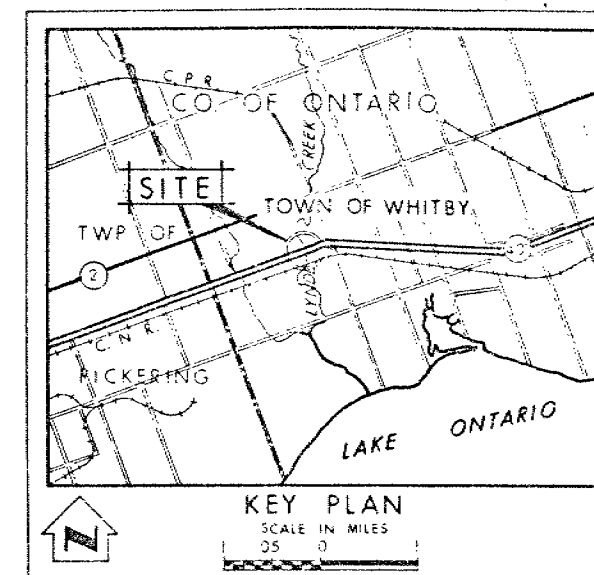
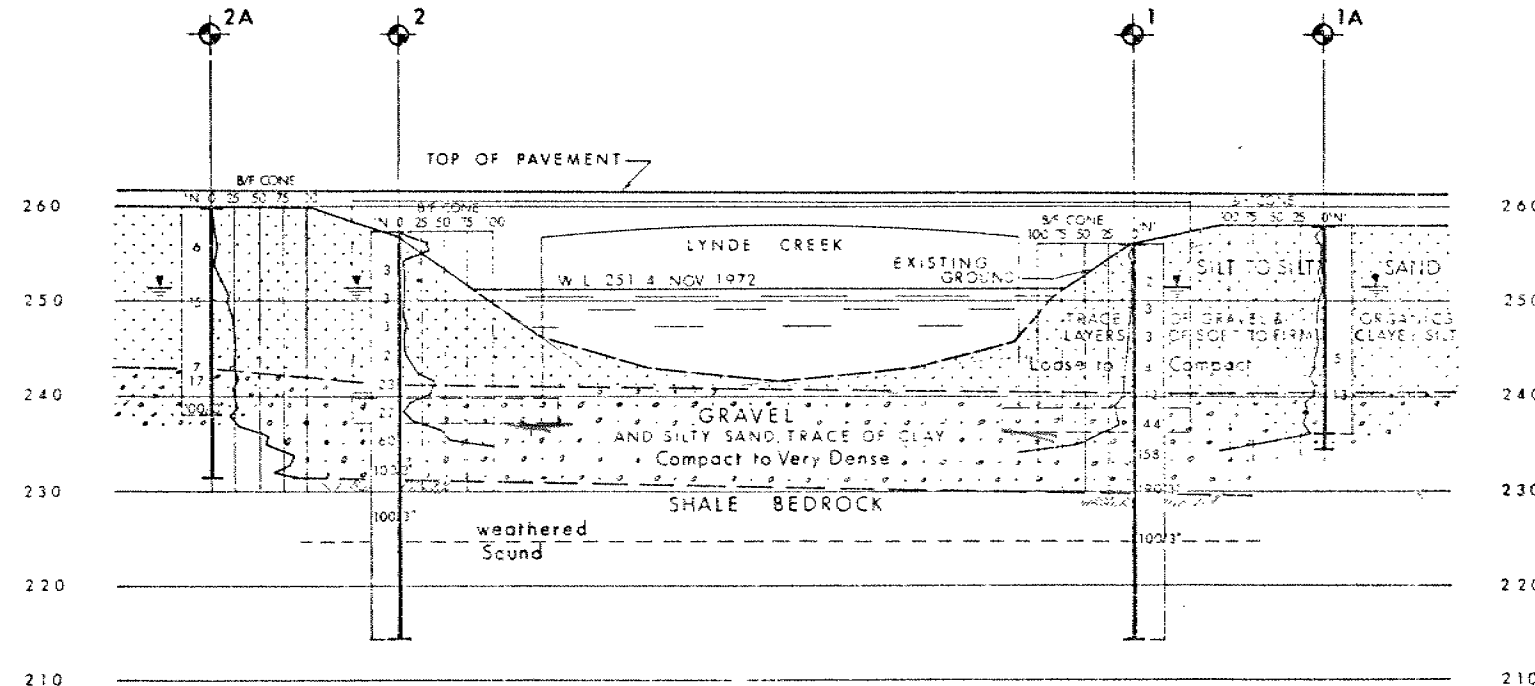
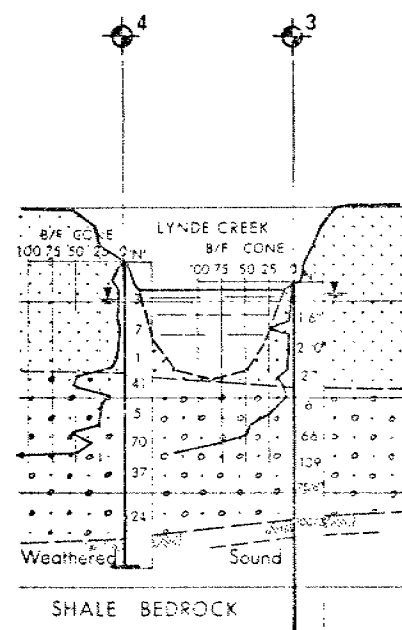
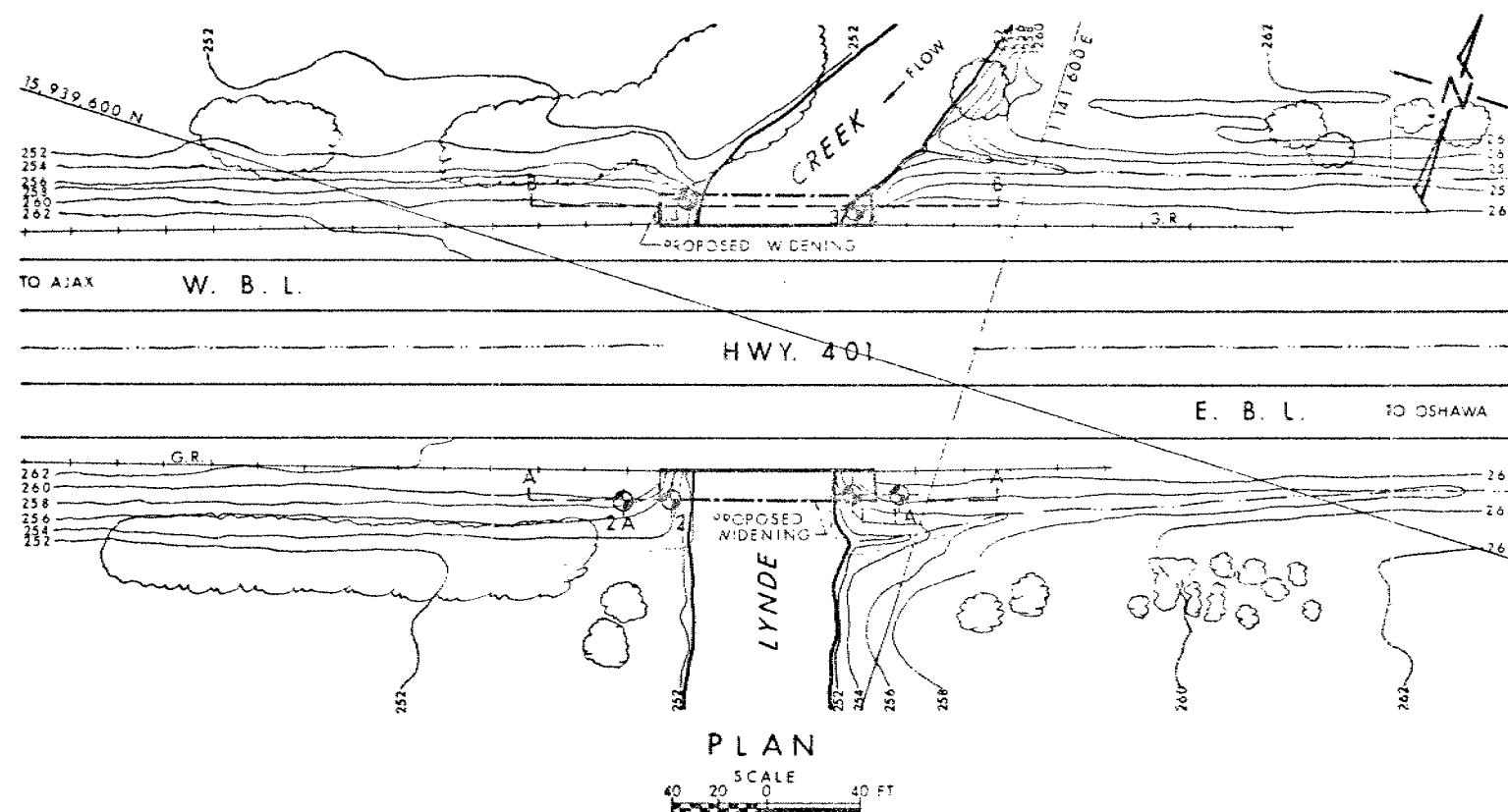
d	DISTANCE FROM TOP OF WALL TO POINT OF APPLICATION OF PRESSURE
δ	ANGLE OF WALL FRICTION
K	DIMENSIONLESS COEFFICIENT TO BE USED WITH VARIOUS SUFFIXES IN EXPRESSIONS REFERRING TO NORMAL STRESS ON WALLS
K_0	COEFFICIENT OF EARTH PRESSURE AT REST

FOUNDATIONS

B	BREADTH OF FOUNDATION
L	LENGTH OF FOUNDATION
D	DEPTH OF FOUNDATION BENEATH GROUND
N	DIMENSIONLESS COEFFICIENT USED WITH A SUFFIX APPLYING TO SPECIFIC GRAVITY, DEPTH AND COHESION ETC. IN THE FORMULA FOR BEARING CAPACITY
k_s	MODULUS OF SUBGRADE REACTION

SLOPES

H	VERTICAL HEIGHT OF SLOPE
D	DEPTH BELOW TOE OF SLOPE TO HARD STRATUM
β	ANGLE OF SLOPE TO HORIZONTAL



LEGEND			
	Bore Hole		
	Cone Penetration Test		
	Bore Hole & Cone Test		
	Water Levels established at time of field investigation Nov & Dec. 72		
	Water Levels for Boreholes No. 3 & 4 established Aug. 1973.		
NO.	ELEVATION	CO-ORDINATES	
		NORTH	EAST
1	255.9	15,939,540	1,141,630
1A	253.0	15,939,546	1,141,612
2	257.3	15,939,513	1,141,703
2A	260.0	15,939,508	1,141,722
3	252.2	15,939,658	1,141,533
4	254.2	15,939,641	1,141,464

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

REVISIONS	DATE	BY	DESCRIPTION
1	2/2/73	W.S.	Boreholes 1, 2, 3 & 4 and Section B-B added

MINISTRY OF TRANSPORTATION AND COMMUNICATIONS—ONTARIO
DESIGN SERVICES BRANCH—FOUNDATIONS OFFICE

LYNDE CREEK

HIGHWAY NO. 401 DIST. NO. 6
CO. ONTARIO TOWN OF WHITBY
TWP. LOT 31 & 32, CON. 1

BORE HOLE LOCATIONS & SOIL STRATA

SUBMITTED BY: V.K. CHECKED BY: W.K. DATE: 4-4-74 DRAWN BY: V.K.
DRAWN BY: V.K. CHECKED BY: W.K. DATE: 7-11-73 72-11123A
DATE: 5 FEB 1973 SCALE: 1"=40' TITLE: BORE HOLE LOCATIONS & SOIL STRATA
APPROVED BY: [Signature] DATE: [Blank] DRAWN BY: [Blank]

REF. NO. B-4-17