

MEMORANDUM

To: Mr. B. S. Davis,
Bridge Engineer,
Bridge Division,
Admin. Bldg.

Attention: Mr. S. McCombie

FROM: Foundation Section,
Materials & Testing Div.,
Room 107, Lab. Bldg.

DATE: January 4, 1968

IN REPLY TO JAN - 8 1968

OUR FILE REF.

SUBJECT:

FOUNDATION INVESTIGATION REPORT
For
Proposed Underpass at the Crossing
Of Gravel Road Revision and King's
Highway 401, Lots 18 & 19, Con. 3 EBR
Twp. Rochester, County Essex
District No. 1 (Chatham)
W.J. 67-F-106 -- W.P. 146-66-01

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

We believe that the factual data and recommendations contained therein, will prove adequate for your design requirements. Should additional information be required, please feel free to contact our Office.

AGS/mdeF
Attach.

cc: Messrs. B. R. Davis (2)
H. A. Tregaskes
D. W. Farren
W. Zonnenberg
P. C. Brown
J. Roy
A. P. Watt
B. A. Singh

Foundations Files
Gen. Files ✓

A. G. Sternac
A. G. Sternac
PRINCIPAL FOUNDATION ENGINEER

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FOUNDATION INVESTIGATION REPORT
For
Proposed Underpass at the Crossing
Of Gravel Road Revision and King's
Highway 401, Lots 18 & 19, Con.3 EBR
Twp. Rochester, County Essex
District No. 1 (Chatham)
W.J. 67-F-106 -- W.P. 146-66-01

1. INTRODUCTION:

The Foundation Section was requested to carry out a subsurface investigation for the proposed underpass at the crossing of Highway 401 and Gravel Road Revision, 2.1 miles east of Belle River Road Interchange 5 in the Twp. of Rochester. The request was contained in a memo from the Bridge Division (Mr. A. P. Watt, Regional Bridge Location Engineer), dated November 6, 1967. An investigation was subsequently carried out by this Section to determine the subsoil conditions at the site.

This report contains the results of the investigation, together with recommendations pertaining to the foundations of the new structure and the stability of the approach embankments.

2. DESCRIPTION OF SITE AND GEOLOGY:

The site is located in the Twp. of Rochester, Essex County, some 17 miles east of Windsor along Highway 401. At this location the Hwy. 401 grade is about 3 to 4 feet above the surrounding ground surface. Drainage ditches are located some 2 to 3 feet below average ground level on either side of the highway. The grade of the existing County Road is at about the same elevation as the surrounding ground level. The surrounding area is generally flat-lying farmland.

Physiographically, the area belongs to the "Essex Clay Plain" sub-region and consists of an extensive deposit of lacustrine clay overlying a glacial till sheet.

3. FIELD AND LABORATORY WORK:

Five sampled boreholes, each with an accompanying dynamic cone penetration test, were carried out during the course of the field investigation using a Penn. Drill auger machine.

Samples were recovered at required depths in a 2" O.D. split-spoon sampler which was hammered into the soil; or, in 2" I.D. Shelby tubes which were hydraulically and/or manually pushed into the cohesive soil. The method of driving the split-spoon sampler conformed to the specifications for the Standard Penetration Test. The same method was used to advance the dynamic cone penetration tests. Field vane tests were carried out in the cohesive portions of the overburden, where possible, to determine the undrained shear strength of the stratum. Detailed logs of the borings were made in order to describe the drilling and sampling techniques, soil types encountered, and groundwater conditions.

The locations and elevations of all borings, surveyed by personnel from the London Region Engineering Surveys, are shown on Drawing 67-F-106A, together with the estimated stratigraphical profile.

All samples were subjected to a careful visual examination in the laboratory prior to testing. The following engineering properties of the overburden were determined from tests carried out on representative samples:

- Bulk Densities
- Natural Moisture Contents
- Atterberg Limits
- Grain-Size Distributions
- Undrained Shear Strengths
- Consolidation Characteristics

The results of these tests are plotted on the Record of Borelog sheets contained in Appendix I of this report.

cont'd. /3 ...

4. SUBSOIL CONDITIONS:

4.1) General:

The predominant stratum across the site is a hard to stiff clayey silt, over 100 feet in thickness, which is underlain by a very dense stratum of glacial till (sandy silt with some gravel and clay). The boundaries of the various deposits, as determined in the boreholes, are shown on the accompanying borehole sheets. The stratigraphical profile, shown on Drawing 67-F-106A, is inferred from the borehole data.

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

4.2) Clayey Silt:

Underlying a surficial mantle of topsoil, some 6 to 9 inches thick, is the predominant stratum across the site, a grey clayey silt with occasional silty clay and silty sand seams and traces of sand and gravel. The thickness of this stratum, established in boreholes 1 and 5, is 107 feet. The upper 15 to 20 feet of the stratum is mottled grey-brown in colour and is fissured, indicating desiccation. Occasional seams of silty sand or sand, up to 4 to 6 inches in thickness, were encountered throughout the stratum.

The engineering properties of the stratum, as determined from field and laboratory tests, are as follows:

cont'd. /4 ...

4. SUBSOIL CONDITIONS: (cont'd.) ...

4.2) Clayey Silt: (cont'd.) ...

		<u>Desiccated Crust</u>		<u>Lower Zone</u>	
		<u>Range</u>	<u>(Average)</u>	<u>Range</u>	<u>(Average)</u>
Bulk Density	(PCF)	128 to 131	(130)	123 to 131	(128)
Natural Moisture Content	(%)	16 to 26	(20)	18 to 26	(22)
Liquid Limit	(%)	33 to 41	(37)	30 to 37	(33)
Plastic Limit	(%)	18 to 21	(19)	16 to 19	(18)
Undrained Shear Strength	(PSF)	1800 to 3200	(2500)	1000 to 1750	(1500)
"N" Values	(Blows/ft.)	20 to 70	(50)	16 to 20	(18)

The Atterberg Limits are also plotted on the Plasticity Chart in the Appendix, and the results indicate that in general, the clayey silt is inorganic and of low plasticity, being occasionally of intermediate plasticity in the upper desiccated zone. The undrained shear strength testing carried out is also summarized on the Undrained Shear Strength vs. Elevation profile given in the Appendix. Based on this, it is concluded that the consistency of the clayey silt ranges from hard within the desiccated zone to stiff to very stiff below the crust. A few laboratory tests indicate a firm consistency; however, it is felt that the low undrained shear strength values obtained from these tests, reflect sampling disturbances. The standard penetration resistance 'N' values recorded, corroborate the general consistency pattern given above.

Typical grain-size distribution curves obtained from selected samples of this deposit, are shown in the Appendix of this report. In addition, the results of consolidation tests carried out on two representative samples of the deposit, are shown as Void Ratio versus Logarithm of Pressure plots in the Appendix. These tests

cont'd. /5 ...

4. SUBSOIL CONDITIONS: (cont'd.) ...

4.2) Clayey Silt: (cont'd.) ...

indicate the deposit to be preconsolidated to a pressure of about 1 t.s.f. in excess of the existing effective overburden pressure at about elevation 550. The degree of preconsolidation in the upper desiccated zone is estimated to be higher than 1 t.s.f.

4.3) Silty Sand:

A stratum of grey silty sand some 6 feet thick, was encountered at a depth of about 31 feet at Boreholes 1 and 2. A grain-size distribution curve for a sample from this stratum is given in the Appendix; this test indicates the soil to be a silty sand with a trace of clay. 'N' values in the stratum ranged between 39 and 150 blows per foot, indicating a dense to very dense relative density.

4.4) Sandy Silt with some Clay and Gravel (Glacial Till):

Underlying the clayey silt stratum, a deposit of grey sandy silt with some gravel and traces of clay (glacial till) was encountered at Boreholes 1 and 5 at a depth of 107 feet below ground level - i.e., at about elevation 494, and is inferred to have been encountered at Borehole 3 at about elevation 496 during the course of a penetration test carried out in the borehole after sampling to a depth of 93 feet. The borings were terminated either within or above the glacial till, and thus the thickness of the stratum was not determined. The 'N' values in this stratum were over 100 blows per foot, indicating a very dense relative density.

5. GROUNDWATER CONDITIONS:

Groundwater level observations were carried out during the period of the investigation, in piezometers installed in two of the boreholes and in the open holes at the other boring locations. These observations, which are recorded on the borehole logs, are also summarized on Drawing No. 67-F-106A. The groundwater level in the open boreholes was encountered at about a 2 to 4 feet depth below

cont'd. /6 ...

5. GROUNDWATER CONDITIONS: (cont'd.) ...

ground surface. The groundwater level in the piezometers was, however, at depths greater than 20 ft. below ground surface. It is considered that these relatively low readings were due to the fact that insufficient time was available following installation of the piezometers, for the groundwater level to reach its equilibrium level. This occurrence is not uncommon for soils with low permeability such as the clayey silt stratum.

As discussed above, the upper 15 to 20 ft. of the clayey silt stratum has been desiccated due to seasonal fluctuations in the groundwater level. This depth below ground surface would, therefore, be a good indication of the groundwater level during the drier periods of the year.

6. DISCUSSION AND RECOMMENDATIONS:

6.1) General:

It is proposed to construct an underpass structure to carry Gravel Road Revision over Highway 401 in the Twp. of Rochester. Present proposals call for a four-span (35'-61.5'-61.5'-35') structure with approach fills having a maximum height of about 22 feet above the existing ground surface.

Subsoil at the site consists of a deep deposit (107 feet thickness) of hard to stiff clayey silt, the upper 15 to 20 feet of which has been desiccated. The clayey silt stratum is underlain by a very dense glacial till (sandy silt with some gravel and traces of clay).

6.2) Structure Foundations:

Since the upper 20 feet of the subsoil consists of a hard to very stiff clayey silt, conditions are favourable for spread footing support. In the case of the proposed piers, it is recommended that the footings be founded at or below elevation 593, and be designed for an allowable bearing pressure of 2.5 t.s.f.

cont'd. /7 ...

6. DISCUSSION AND RECOMMENDATIONS: (cont'd.) ...

6.2) Structure Foundations: (cont'd.) ...

The proposed abutments may be constructed within the approach fills; two alternate methods are given for the foundation support of the abutments:

a) The abutments can be supported on spread footings founded on a compacted granular (G.B.C. Class 'A') material using a safe bearing pressure of 2.0 t.s.f. The granular fill should extend to a horizontal distance of at least 10 feet from the footing edges in the plane of the footing tops. This portion of the fill should be constructed with slopes of 2:1. The remainder of the fill should be completed to about profile grade for a distance of about 50 feet behind the abutments before re-excavating for the construction of the abutment footings. Prior to construction of the granular fill, all organic topsoil should be removed from beneath the plan limits of the fill area.

b) The abutments can be supported on 12-3/4" O.D. tubular pipe piles driven closed end about 10 feet into the upper desiccated zone of the clayey silt stratum - i.e., to a pile tip elevation of about 590. Such piles driven to elevation 590 can be designed for an allowable load of 20 tons per pile. Care should be taken to ensure that no bouldery fill is placed at the locations through which piles have to be driven.

Several structures have, in the past, been constructed by the Department in this area. These structures were designed to tolerate the following maximum differential settlements:

- | | |
|---|----------------------|
| -- between the end piers and the abutments
(located within the approach fills) | -- 1 to 1-1/2 inches |
| -- between the end piers and centre piers | -- 1/2 to 1 inch |

cont'd. /8 ...

6. DISCUSSION AND RECOMMENDATIONS: (cont'd.) ...

6.2) Structure Foundations: (cont'd.) ...

At the proposed structure location, it is estimated that, in general, the differential settlements will also be of the same order of magnitude. Settlement computations carried out, however, indicate that the differential settlement between the abutments and end piers could be expected to be as much as 2 inches rather than the 1-1/2 inch maximum quoted on the preceding page. Consideration should be given to reducing the differential settlement between the abutments and end piers by constructing the approach embankments well in advance of the construction of the structure foundations. For example, if the embankments were constructed 6 months prior to the construction of the foundations, about 25 to 30 percent of the total consolidation settlement of the foundation subsoil will take place during this period. The differential settlement between the end piers and abutments would consequently be reduced from 2 inches to about 1-1/2 inches.

No major dewatering problems are anticipated during construction of the footings in view of the relatively impermeable nature of the subsoil. Seepage into excavations could be handled by pumping from sump pits. Care should be taken to prevent undue softening of the subsoil at and below foundation level, however, and in this regard it is recommended that a thin mat of lean concrete be poured once excavations reach footing level.

6.3) Approach Embankments:

The proposed approach embankments will be of the order of 20 to 22 feet above existing ground surface. No stability problems are anticipated for embankments constructed of properly compacted fill and with standard 2:1 side slopes.

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7. SUMMARY:

A foundation investigation for the proposed underpass structure at the crossing of Gravel Road Revision and Hwy. 401 is reported.

Subsoil at the site consists of a deep deposit of hard to stiff clayey silt, the upper 20 feet of which has been desiccated. The clayey silt stratum is underlain by a very dense glacial till stratum at a depth of about 107 feet.

Piers can be founded on spread footings at or below elevation 593 with a safe bearing pressure of 2.5 t.s.f.

The abutments constructed within the approach fills, can be founded: (a) within a zone of properly compacted granular fill at an allowable bearing pressure of 2.0 t.s.f., or (b) on 12-3/4" O.D. tubular piles driven to about elevation 590 and designed for a safe design load of 20 tons per pile.

The settlements of the structure foundations are discussed in the section, "Discussion and Recommendations".

No major dewatering problems are anticipated for the pier footing excavations.

No stability problems are anticipated for the approach fills with standard 2:1 slopes.

8. MISCELLANEOUS:

The field work was carried out between November 21 and 30, 1967, and was supervised by Mr. F. B. Schnabel, Project Foundation Engineer. The preparation of this report was undertaken by Mr. C. Mirza, Project Foundation Engineer.

The investigation was carried out under the general supervision of Mr. M. Devata, Supervising Foundation Engineer, who also reviewed this report.

Equipment used was owned and operated by Dominion Soil Investigation Limited, Toronto.

APPENDIX I

RECORD OF BOREHOLE NO. 1

DEPARTMENT OF HIGHWAYS - ONTARIO

MATERIALS & TESTING DIVISION

FOUNDATION SECTION

JOB 67-F-106

LOCATION Gravel Rd. Rev. Sta. 14 + 05 0.0. 18' Lt.

ORIGINATED BY CM

W P 146-66-01

REPORTING DATE November 24 - 30, 1967

COMPILED BY CM

DATUM Geodetic

BOREHOLE TYPE Penn. Drill - Auger

CHECKED BY

SOIL PROFILE		SAMPLES			DYNAMIC PENETRATION RESISTANCE BLOWS / FOOT		LIQUID LIMIT — WL PLASTIC LIMIT — WP WATER CONTENT — W		BULK DENSITY P.C.F.	REMARKS	
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	BLOWS / FOOT	SHEAR STRENGTH P.S.F. + Field Vane • Quick Triax. x Lab. Vane o Unconfined	WATER CONTENT %				
600.8	Ground Level					20 40 60 80 100	15 30 40			Gr.Sa.Si.Cl	
0.0	Mottled Brown		1	TW	17						
			2	SS	19						
	Clayey silt.		3	SS	56						
			4	SS	28						
583.8			5	SS	21						
17.0	Hard to stiff		6	TW	PM				129		
	Grey		7	TW	PM				131		
569.8			8	TW	PM				137	0.59 (41)	
31.0	Sandy silt.		9	SS	117						
563.8	Very dense. Grey		10	SS	59						
37.0	Occ. silty clay and sandy silt seams.		11	TW	PM				133		
	Trace sand, gravel		12	TW	PM						
			13	TW	PM				127	0.15 48 37	
			14	TW	PM						
			15	SS	-						
493.8			16	SS	101						

DYNAMIC PENETRATION RESISTANCE
BLOWS / FOOT

20 40 60 80 100

SHEAR STRENGTH P.S.F.
+ Field Vane • Quick Triax.
x Lab. Vane o Unconfined

500 1000 1500 2000 2500

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DEPARTMENT OF HIGHWAYS - ONTARIO

MATERIALS & TESTING DIVISION

JOB 67-F-106

LOCATION Gravel Rd. Rev. Sta. 14 + 39; o.s. 20' Rt.

ORIGINATED BY CM

W.P. 146-66-01

BORING DATE November 28 - 30, 1967

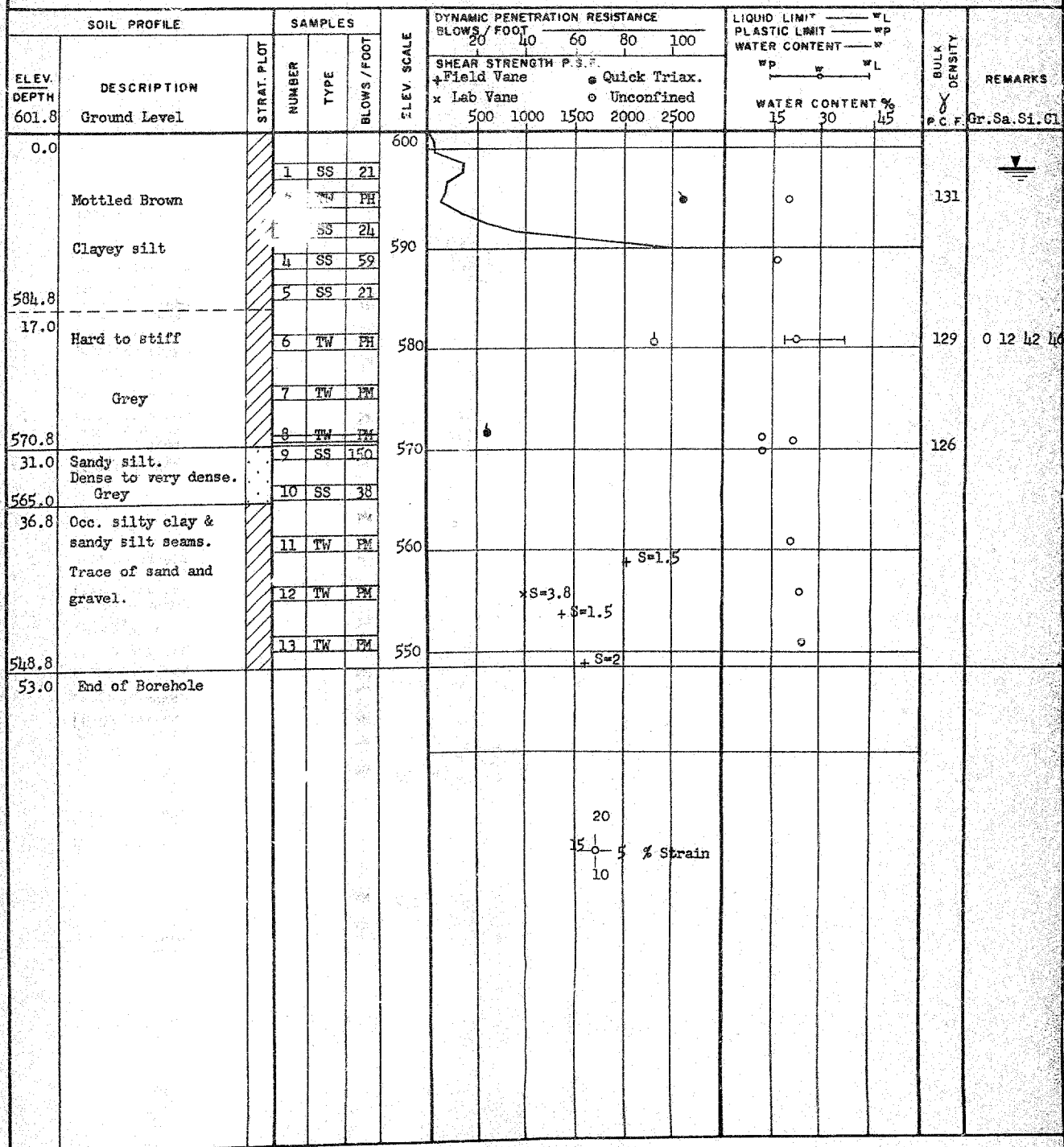
COMPILED BY CM

DATUM Geodetic

BOREHOLE TYPE Penn Drill - Auger

CHECKED BY *SL*

FOUNDATION SECTION



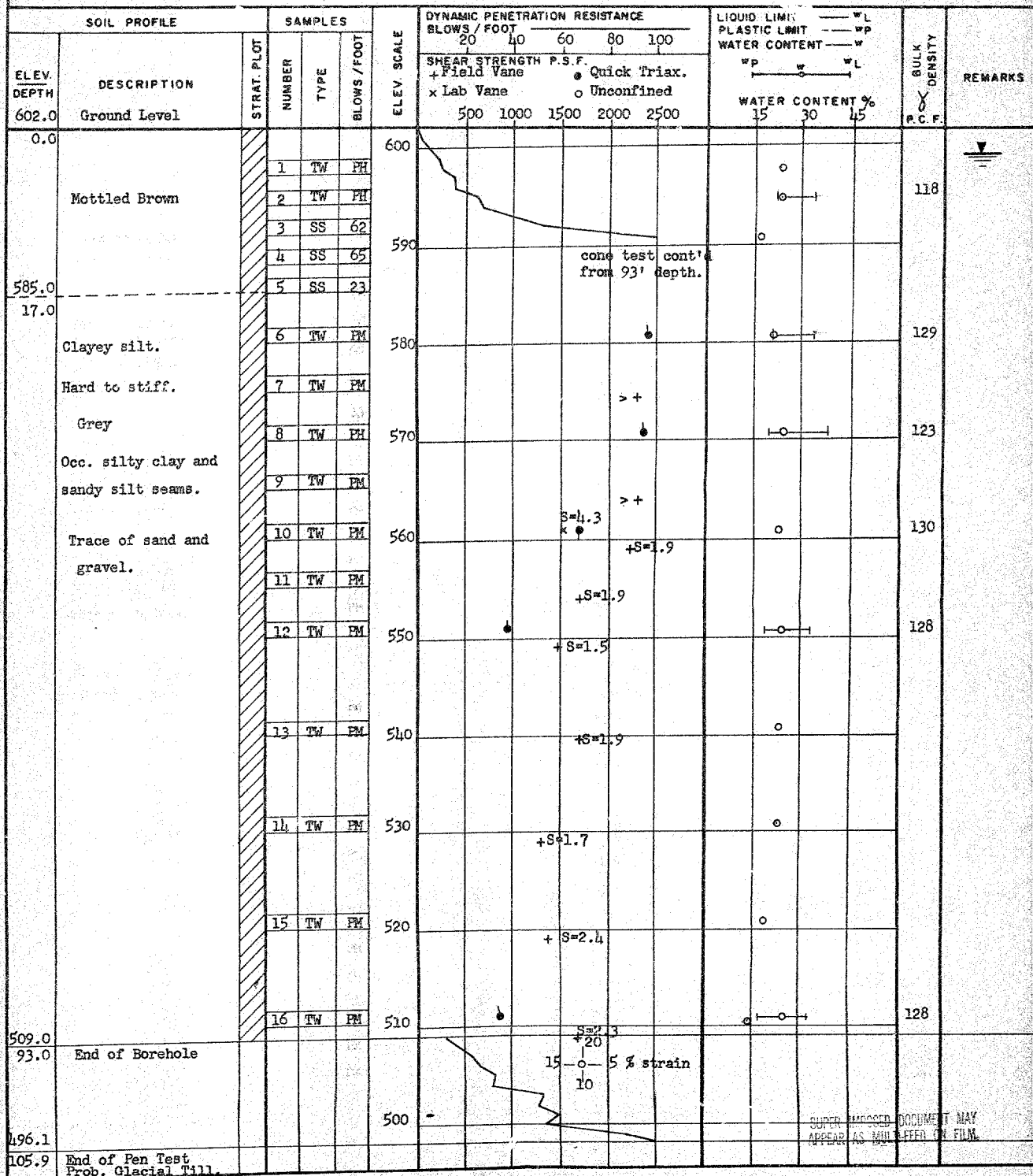
DEPARTMENT OF HIGHWAYS - ONTARIO

RECORD OF BOREHOLE NO. 3

FOUNDATION SECTION

MATERIALS & TESTING DIVISION

JOB 67-F-106 LOCATION Gravel Rd. Rev. Sta. 15 + 00; o.s. 18' Lt. ORIGINATED BY CM
W.P. 146 -66-01 BORING DATE November 21 - 22, 1967 COMPILED BY CM
DATUM Geodetic BOREHOLE TYPE Penn Drill - Auger CHECKED BY [Signature]



MATERIALS & TESTING DIVISION

JOB 67-F-106

LOCATION Gravel Rd. Rev. Sta. 15 + 62, o.s. 20th Rt.

FOUNDATION SECTION

W P 146-66-01

BORING DATE November 27, 1967

ORIGINATED BY CM

DATUM Geodetic

BOREHOLE TYPE Pen Drill - Auger

COMPILED BY CM

DATUM Geodetic

BOREHOLE TYPE Pen Drill - Auger

CHECKED BY KK.

SOIL PROFILE			SAMPLES			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	ELEV. SCALE	SHEAR STRENGTH P.S.F. + Field Vane • Quick Triax. x Lab. Vane o Unconfined			WATER CONTENT %							
601.8	Ground Level						500	1000	1500	2000	2500	15	30	45			
0.0	Mottled Brown		1	SS	20	600										131	
			2	TW	PM												
			3	SS	73												
			4	SS	52												
586.8			5	TW	PH						3120						133
15.0	Clayey silt. Hard to stiff. Grey occ. silty clay seams trace of sand and gravel.		6	TW	PH		580										
			7	TW	PM												129
			8	TW	PM												
			9	TW	PM		570										130
			10	TW	PM												
			11	TW	PM		560										
553.8																	
48.0	End of Borehole					550											
						</											

DEPARTMENT OF HIGHWAYS - ONTARIO

RECORD OF BOREHOLE NO. 5

FOUNDATION SECTION

MATERIALS & TESTING DIVISION

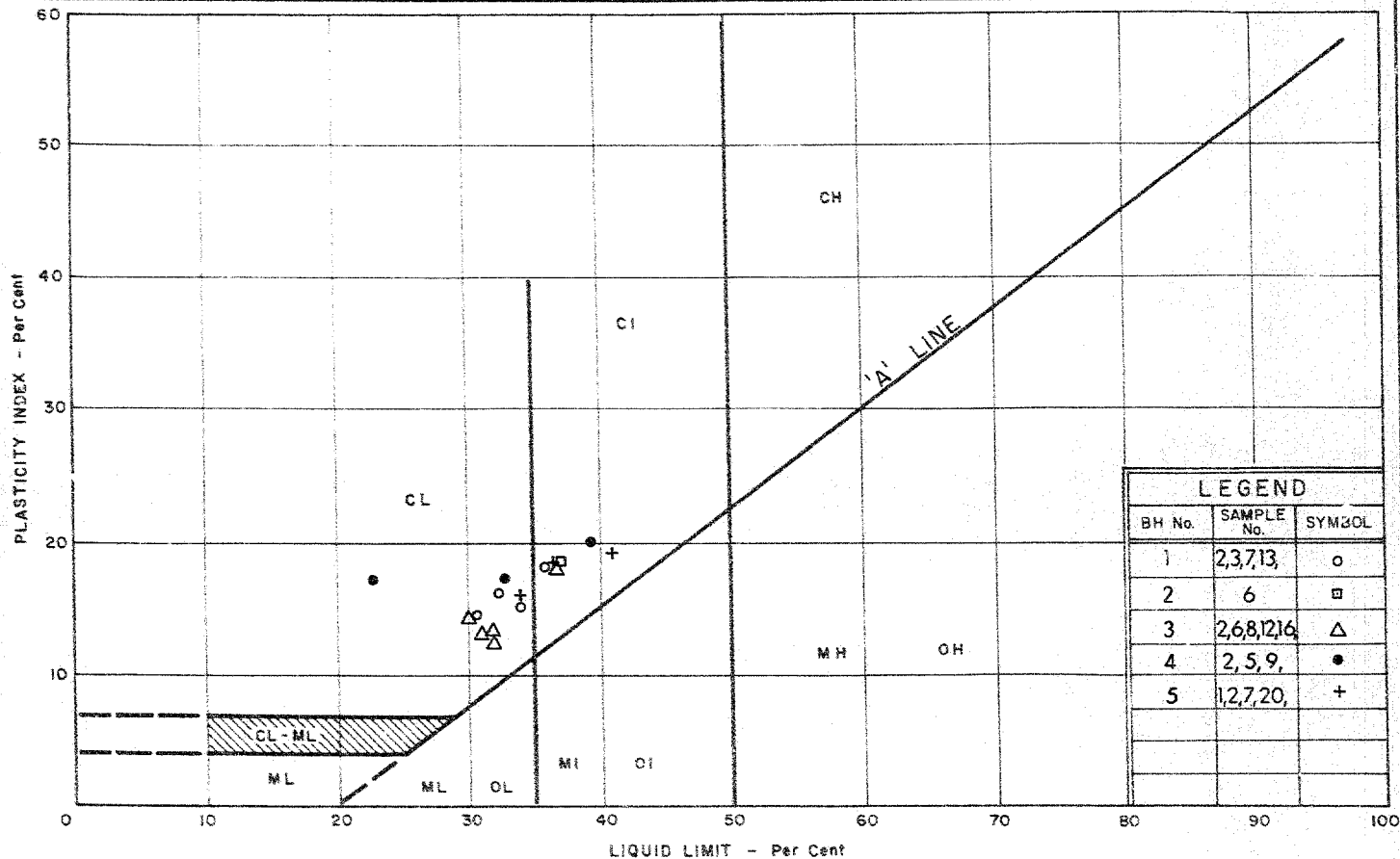
JOB 67-F-106 LOCATION Gravel Rd. Rev. Sta. 15 + 97; o.s. 18' Lt. ORIGINATED BY CM
W.P. 146-66-01 BORING DATE November 22, - 27, 1967 COMPILED BY CM
DATUM Geodetic BOREHOLE TYPE Penn Drill - Auger CHECKED BY [Signature]

SOIL PROFILE		STRAT. PLT	SAMPLES			ELEV. SCALE	DYNAMIC PENETRATION RESISTANCE BLOWS / FOOT				LIQUID LIMIT — WL PLASTIC LIMIT — WP WATER CONTENT — W			BULK DENSITY P.C.F.	REMARKS
ELEV. DEPTH	DESCRIPTION		NUMBER	TYPE	BLOWS / FOOT		20	40	60	80	100	WP	WL		
600.9	Ground Level														
0.0			1	TW	PM									129	
	Mottled Brown		2	TW	PH									128	
			3	SS	66										
585.9			4	SS	48										
15.0	Clayey silt. Hard to stiff. occ. silty clay & sandy silt seams. Trace sand and gravel.		5	TW	PM									132	
			6	TW	PM										
			7	TW	PM									127	
			8	TW	PM										
			9	TW	PM									127	
			10	TW	PM										
			11	TW	PM										
			12	TW	PM										
			13	TW	PM										
			14	TW	PM									128	
			15	TW	PM										
			15A	TW	lost										
			15B	TW	lost										
			16	SS	17										
			17	TW	PM										
			17A	TW	lost										
			18	SS	20										
			19	TW	PM										
			20	TW	PM									124	
493.9															
491.9	Sandy silt, some clay & gr. (glac. till) v. dense														
109.0	End of borehole. grey														

3145
+S=2.0
+S=2.1
+S=2.0
+S=3.3
+S=2.0
+S=1.9
+S=1.7
+S=1.9
+S=2.1
+S=2.4
15 10 5 % Strain

WATER CONTENT %
15 30 45

SUPERIMPOSED DOCUMENT MAY
APPEAR AS MULTIPLIED ON
HLM



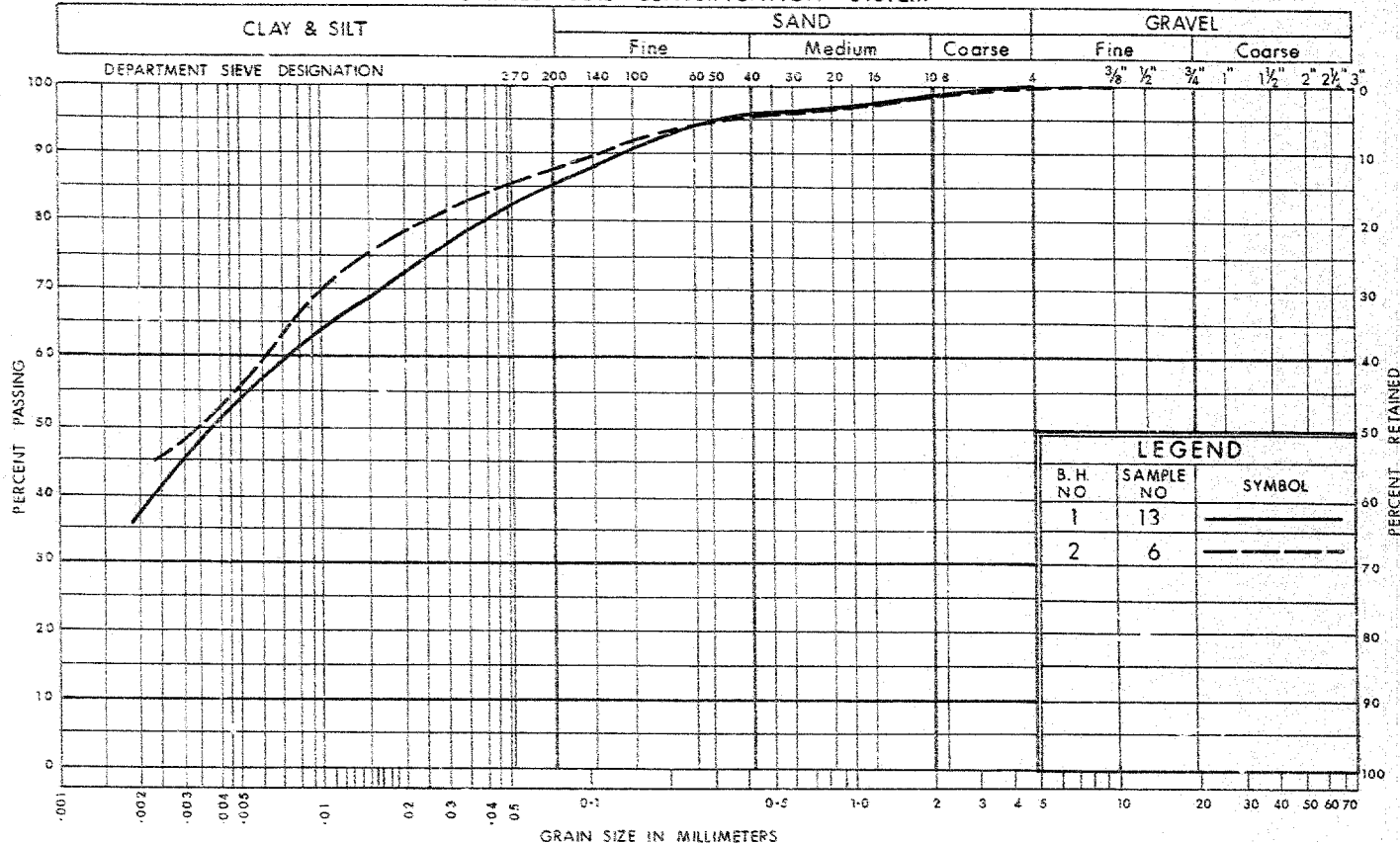
DEPARTMENT OF HIGHWAYS
MATERIALS and
TESTING
DIVISION

PLASTICITY CHART CLAYEY SILT SILTY CLAY

W.P. No. 146 - 66 - 01

JOB No. 67 - F - 106

UNIFIED SOIL CLASSIFICATION SYSTEM



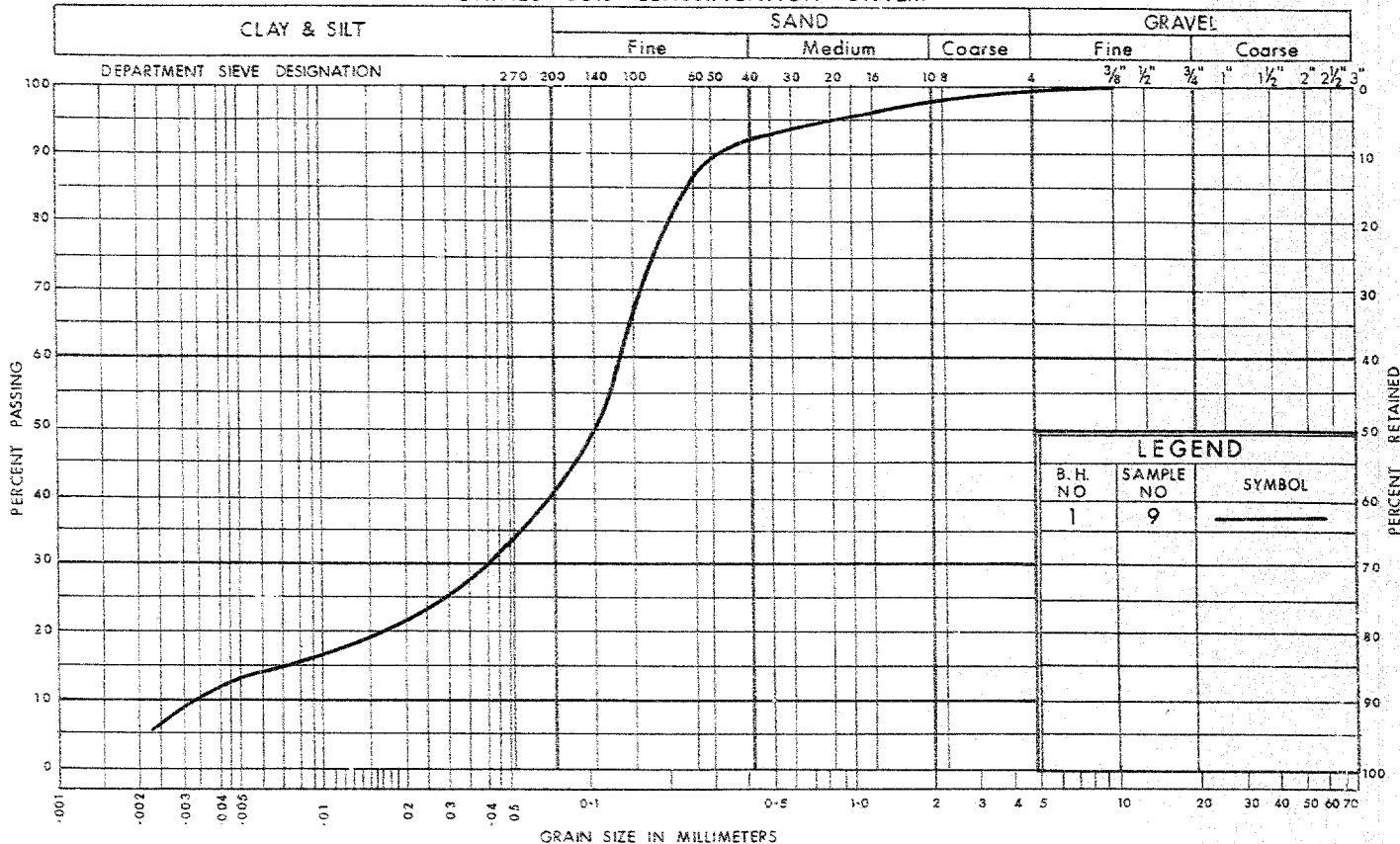
DEPARTMENT OF HIGHWAYS
MATERIALS and
TESTING
DIVISION

GRAIN SIZE DISTRIBUTION
CLAYEY SILT

W.P. No. 146 - 66 - 01

JOB No. 67 - F - 106

UNIFIED SOIL CLASSIFICATION SYSTEM



GRAIN SIZE IN MILLIMETERS

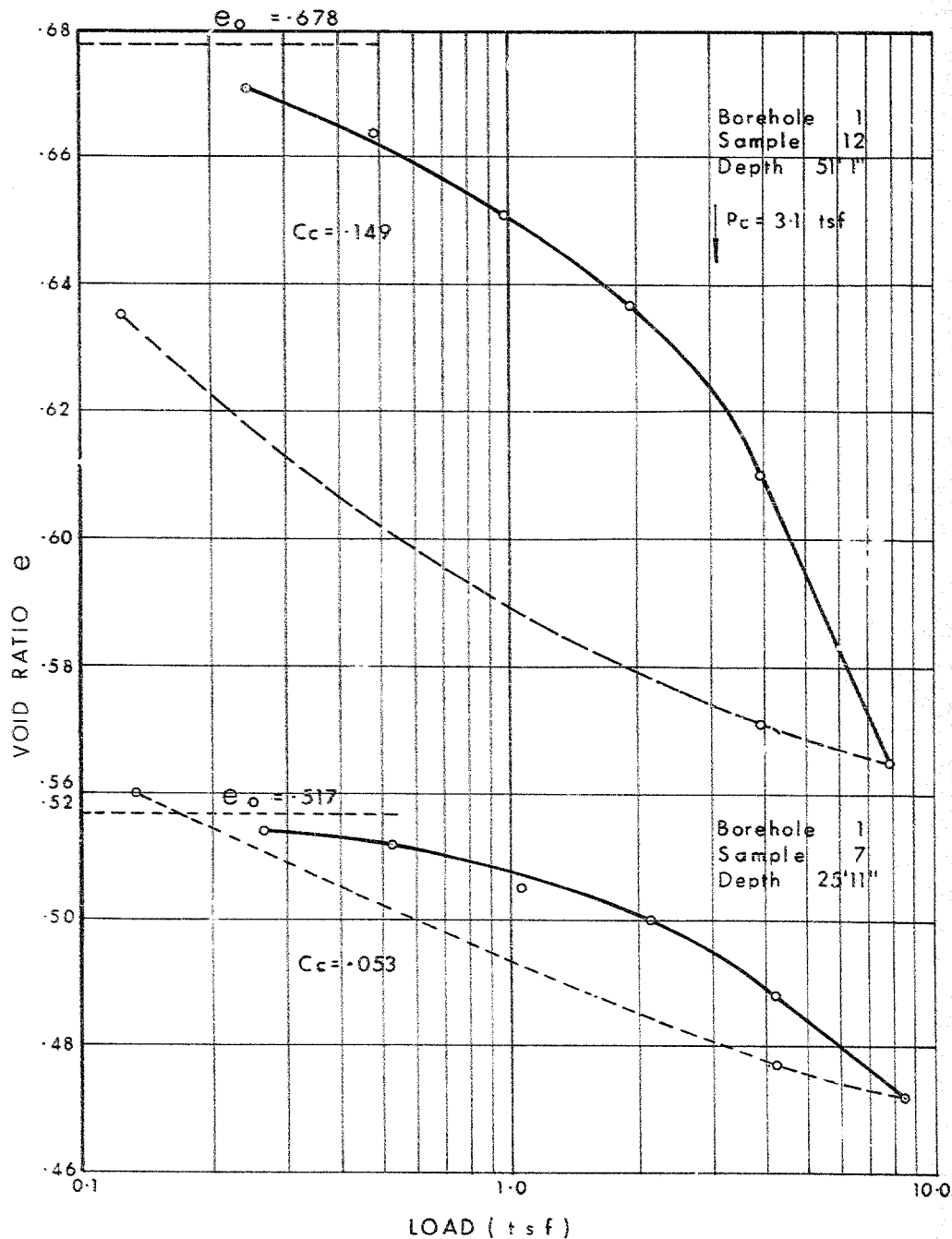


DEPARTMENT OF HIGHWAYS
MATERIALS and
TESTING
DIVISION

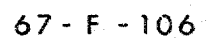
GRAIN SIZE DISTRIBUTION
SILTY SAND

W.P. No. 146-66-01
JOB No. 67-F-106

CONSOLIDATION CURVES



UNDRAINED SHEAR STRENGTH (p.s.f.)



ABBREVIATIONS USED IN THIS REPORT

PENETRATION RESISTANCE

STANDARD PENETRATION RESISTANCE 'N' - 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>'N' BLOWS / FT.</u>	<u>c LB. / SQ. FT.</u>	<u>DENSENESS</u>	<u>'N' BLOWS / FT.</u>
VERY SOFT	0 - 2	0 - 250	VERY LOOSE	0 - 4
SOFT	2 - 4	250 - 500	LOOSE	4 - 10
FIRM	4 - 8	500 - 1000	COMPACT	10 - 30
STIFF	8 - 15	1000 - 2000	DENSE	30 - 50
VERY STIFF	15 - 30	2000 - 4000	VERY DENSE	> 50
HARD	> 30	> 4000		

TYPE OF SAMPLE

S.S.	SPLIT SPOON	T.W.	THINWALL OPEN
W.S.	WASHED SAMPLE	T.P.	THINWALL PISTON
S.B.	SCRAPER BUCKET SAMPLE	O.S.	OESTERBERG SAMPLE
A.S.	AUGER SAMPLE	F.S.	FOIL SAMPLE
C.S.	CHUNK SAMPLE	R.C.	ROCK CORE
S.T.	SLOTTED TUBE SAMPLE		
	P.H.	SAMPLE ADVANCED HYDRAULICALLY	
	P.M.	SAMPLE ADVANCED MANUALLY	

SOIL TESTS

Q _u	UNCONFINED COMPRESSION	L.V.	LABORATORY VANE
Q	UNDRAINED TRIAXIAL	F.V.	FIELD VANE
Q _{cu}	CONSOLIDATED UNDRAINED TRIAXIAL	C	CONSOLIDATION
Q _d	DRAINED TRIAXIAL	S	SENSITIVITY

ABBREVIATIONS 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
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_r	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_t	SHEAR STRENGTH
c	EFFECTIVE COHESION INTERCEPT
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
$\log_e \sigma$ OR $\ln \sigma$	NATURAL LOGARITHM OF σ
$\log_{10} \sigma$ OR $\log \sigma$	LOGARITHM OF σ 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
$\bar{\sigma}$	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 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

MEMORANDUM

To: Mr. A. G. Sternac
Principal Foundation Engineer
Lab Building
D O W N S V I E W

From: A. P. Watt

Date: November 6, 1967

Our File Ref.

IN REPLY TO

SUBJECT:


W.P. 146-66-01, Bridge Site 6-258,
Township Road Underpass,
2.1 miles east of Belle River Road Interchange 5,
Highway 40,
District 1, Chatham.

Would you kindly arrange to have a foundation investigation conducted at the above location.

I have enclosed one copy of the site plan number E-4813-1 with the probable footing locations marked in red. This memorandum will also confirm giving Mr. Per Schnabel, Foundation Section, a copy of site plan E-4813-1 with the probable footing locations marked in red.

Attached please find a copy of the preliminary structure site report for your use.

Accommodation may be obtained in Belle River, Ontario



A. P. WATT
REGIONAL BRIDGE LOCATION ENGINEER

APW:gp
ENCL.

C.C. Mr. S. McCombie
Mr. R. Fitzgibbon

Department of Highways Ontario

Copy for the information of

A. Stermac

Mr. A. Watt,
Reg. Bridge Location Engineer,
London Regional Office,
London, Ontario.

Bridge Division,
Downsview, Ontario.

April 8, 1968.

Township Road Underpass
2.1 Mi. E. of Belle River Rd. - Interchange 5
W.P. 146-66-01, Site 6-258
Hwy. 401 (H.C. Freeway), Dist. 1

Attached herewith are prints of the preliminary Bridge
Plan Drawing B-6426-F1 for the above-mentioned structure.

The estimated cost of the proposed structure is \$91,850.00.
This cost includes tender, materials, engineering and sundry
construction.

Any comments or ~~revisions~~ you may have should be submitted
within three weeks.

CSG:ts
Attach.

C.S. Griebaki,
Bridge Design Engineer.

c.c. S. MacGhie
A. Stermac (2)
J. Anderson

67-F-106

NO COMMENTS

A.L.B.

17 APR 1968.

DEPARTMENT OF HIGHWAYS ONTARIO

MEMORANDUM

To: Mr. A. Stermac,
Principal Foundation Engineer,
Room 107, Lab. Building

From: Bridge Division,
Downsview, Ontario

ATTENTION:

DATE: August 13, 1968

OUR FILE REF:

IN REPLY TO

SUBJECT: Township Road Underpass
W.P. 146-66-01, Site 6-258
Highway 401, District No. 1

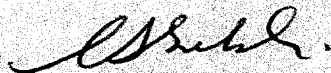
67-F-106

Attached herewith we are submitting the final bridge drawings which show the foundation design for this structure.

Kindly give us your comments at your earliest convenience.

CSG:rd

Attach.



C.S. Grebski,
Bridge Design Engineer

no comment

APR
14/8/68

M. Devata
Aug 14/68

#67-F-106

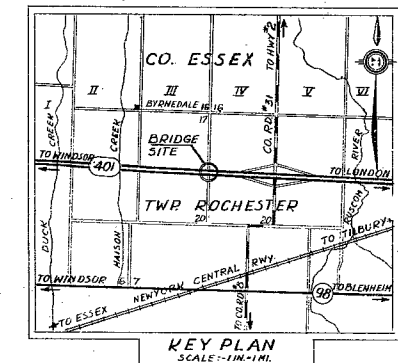
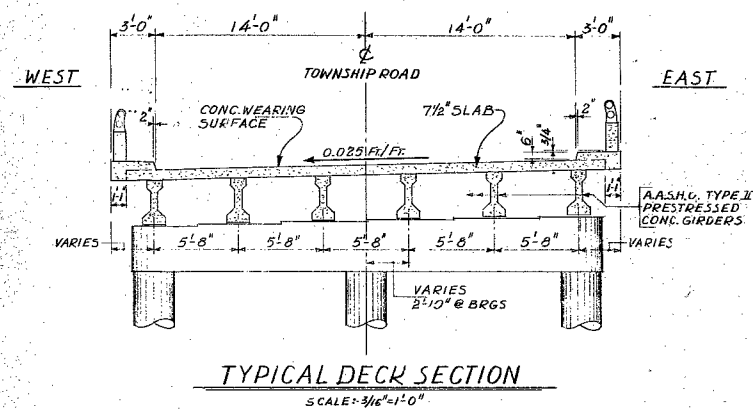
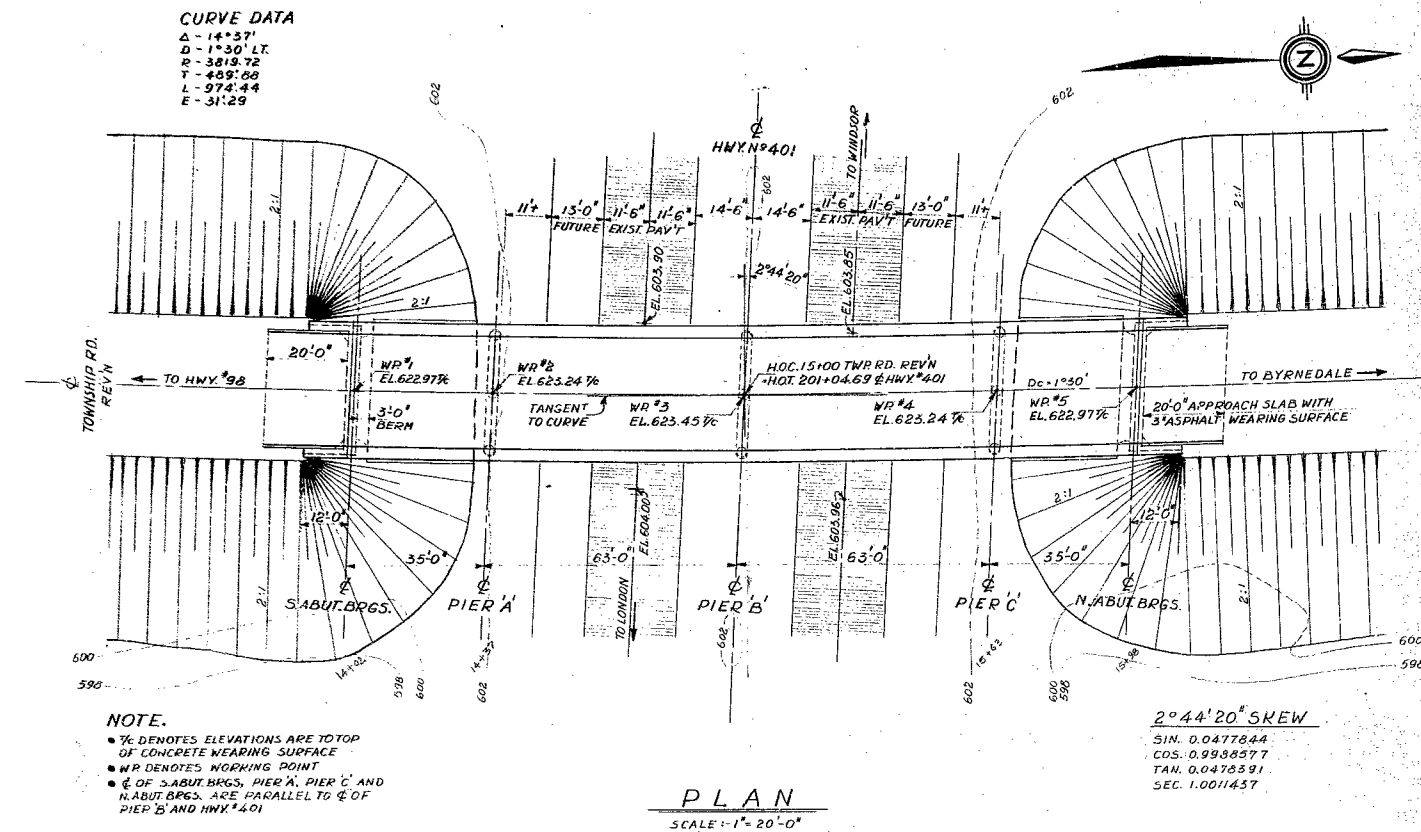
W.P. #146-66-01

HWY. #401

TWP. RD. UNDERPASS

2.1 MILES E. OF

BELLE R. ROAD



NOTES

CLASS OF CONCRETE

DECK, CURB AND PARAPET WALL 4000 p.s.i.
REMAINDER 3000 p.s.i. OR AS NOTED

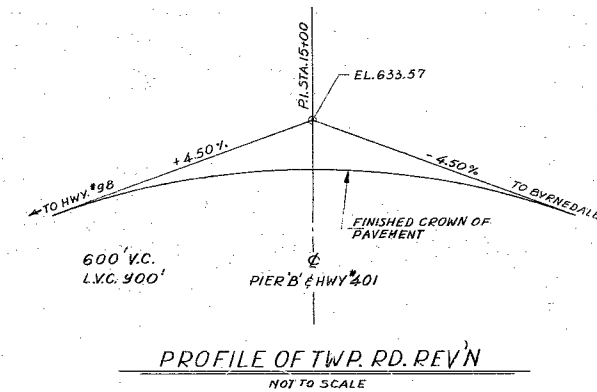
CLEAR COVER ON REINF. STEEL

FOOTINGS, ABUTMENTS, PIERS, DECK: TOP, BOTTOM,
3' 3' 2' 11/2" 1'
DIAPHRAGMS, CURBS, PARAPET WALLS, APPR. SLABS
1/2" 2' 1/2" 2'
AND/OR AS NOTED ON DRAWINGS

CONSTRUCTION NOTES

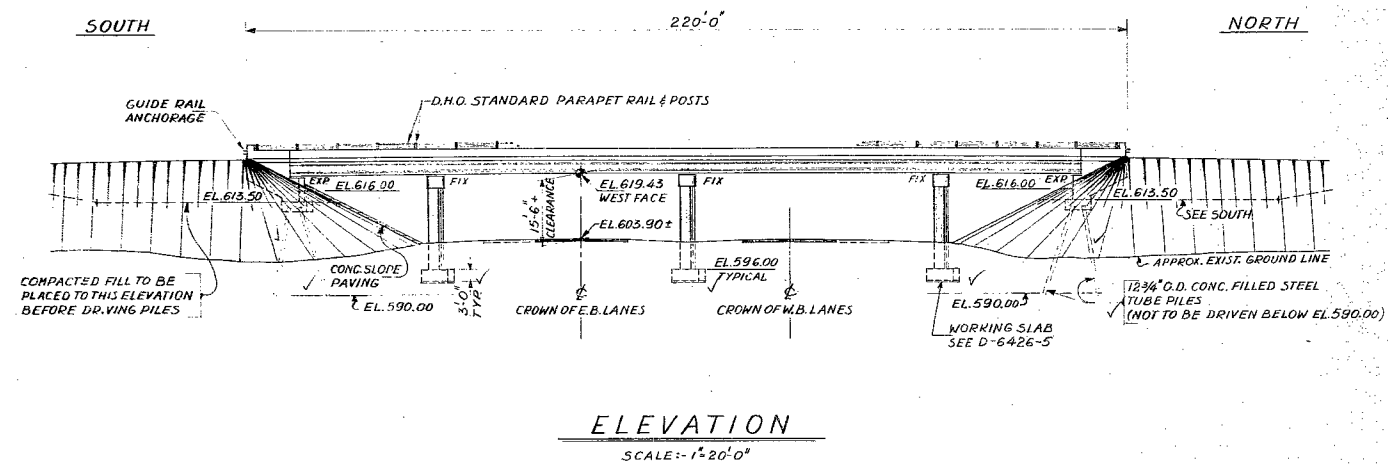
THE CONTRACTOR IS RESPONSIBLE FOR FINISHING THE BEARING SEATS DEAD LEVEL TO THE SPECIFIED ELEVATIONS WITH A TOLERANCE OF $\pm 1/8$ INCH.

NO CONCRETE SHALL BE PLACED ABOVE THE ABUTMENT BEARING SEATS UNTIL THE CONCRETE IN DECK HAS BEEN PLACED.



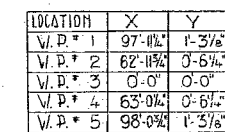
- ### LIST OF DRAWINGS

- D-6426 - 1 GENERAL LAYOUT
- 2- 2 BOREHOLE LOCATIONS & SOIL STRATA
 - 3- 3 FOUNDATION LAYOUT
 - 4- 4 ABUTMENTS
 - 5- 5 PIERS
 - 6- 6 PRESTRESSED GIRDERS & BEARINGS
 - 7- 7 DECK
 - 8- 8 PARAPET WALL DETAILS
 - 9- 9 APPROACH SLABS
 - 10- 10 STANDARD STEEL PARAPET RAIL
 - 11- 11 STANDARD DETAILS
 - 12- 12 DETAILS OF CONC. SLOPE PAVING

[illegible]

REVISIONS									
DATE	BY	DESCRIPTION							

DEPARTMENT OF HIGHWAYS ONTARIO BRIDGE DIVISION	
67-F-106	
<u>TOWNSHIP ROAD UNDERPASS</u> 2.1 MILES EAST OF BELLE RIVER ROAD-INTERCHANGE 5	
KING'S HIGHWAY No. 401 (M.C.FREEWAY) CO. E35EX TWP. ROCHESTER	DIST. No. 1 LOT 18619 CON. 3. E.B.R.
GENERAL LAYOUT	
APPROVED _____ BRIDGE ENGINEER	SITE No. 6-258 W.P. No. 146-66-01
DESIGN J.Sz./J.L.K. CHECK J.L.K. DRAWING J.Sz. CHECK J.L.K. DATE JULY 68 LOADING #520-44	CONTRACT Nos. _____ DRAWING No. D-6426-1



X MEASURED FROM V.P. #3 ON THE TG.

NOTES

DIMENSIONS ARE SIMILAR FOR ALL PIER FOOTINGS

DIMENSIONS AND PILE LAYOUT SIMILAR FOR BOTH ABUTMENT FOOTINGS

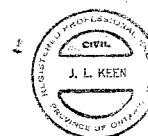
ABUTMENT PILE SPACING TO BE MEASURED AT UNDERSIDE OF FOOTING

ALL PILES ARE 12 3/4" O.D. AND 0.203" MIN. WALL THICKNESS.

TUBE PILES TO BE FILLED WITH 3000 P.S.I. CONCRETE AFTER INSTALLATION AND INSPECTION.

FOR PILE DRIVING, SEE STANDARD SHEETS DD-1218 AND DD-1219 OR DRGS D-6426-11

PILES SUPPLIED			
LOCATION	-Nº	LENGTH	TYPE
SOUTH ABUTMENT	14	23'✓	12¾" O.D.
NORTH ABUTMENT	14	23'✓	
DESIGN LOAD - 20 TONS PER PILE.			



REVISIONS		
DATE	BY	DESCRIPTION

DEPARTMENT OF HIGHWAYS ONTARIO
BRIDGE DIVISION

67-F-106

TOWNSHIP ROAD UNDERPASS

2.1 MILES EAST OF BELLE RIVER FORD- INTERCHANGE 5

KING'S HIGHWAY No. 401 (M.C. FREEWAY) DIST. No. 1

CO. ESSEX

TWP. ROCHESTER LOT 18 & 19 CON. 3 E.B.R.

FOUNDATION LAYOUT

<u>SITE No.</u> 6-258	<u>W.P. No.</u> 146-66-0
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APPROVED 6-258 148-88

BRIDGE ENGINEER				CONTRACT Nos.			
DESIGN	J. C. K.	CHECK	T. L. P.				

DESIGN	J. SZ	CHECK	J.L.R.	DATE			
DRAWING	J.P.M.	CHECK	J.SZ	DRAWING	D 0106	3	

DATE	JULY 68	LOADING	HS20-44	DRAWING No.	D-6426-3
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100