

GEOCRES No. 40P9-38DIST. 2 REGION W.P. No. 535-91-00CONT. No. W. O. No. STR. SITE No. HWY. No. 6LOCATION culvert ExtensionSta. 17+144No of PAGES -

OVERSIZE DRAWINGS TO BE INCLUDED WITH THIS REPORT.

REMARKS:



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FOUNDATION DESIGN SECTION

**foundation
investigation and
design report**

ENGINEERING MATERIALS OFFICE
FOUNDATION DESIGN SECTION

WP 535-91-00 DIST 31
HWY 6 STR SITE -

Hwy. 6 (Hanlon Expressway)
Culvert Extension Sta. 17 + 144

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GEOCRES 40P9-38

DATE MAY 11 1995

FOUNDATION INVESTIGATION REPORT

FOR:

Hwy.6 (Hanlon Expressway) culvert extension Sta. 17+144

WP 535-91-00

District 31, London

INTRODUCTION

This report contains the results of a foundation investigation carried out at the above mentioned site. The field work was carried on 94 12 12 and consisted one borehole at the location of the culvert extension.

The boreholes was advanced to a depth of 7.5 m below the existing ground level using 82 mm ID continuous flight augers together with a BQ core barrel.

SITE DESCRIPTION

The site is located approximately 0.5 km north of the intersection of Hwy. 24 (Wellington St.) and Hwy. 6 in the City of Guelph, Wellington County. Hwy.6 has four lanes separated by a median. The existing culvert runs underneath Hwy 6. north and south bound lanes.

The terrain at the site is rolling with open fields immediately east and west with residential homes and industrial lands at a distance away. To the west, running parallel to the roadway is an open channel carrying the city's storm sewer refuse. The existing culvert which is to be lengthened drains into this open channel.

Physiographically the site is located within the region known as the "Guelph Drumlin Field". The drumlins in this area are not closely spaced with intervening low lying grounds between the drumlins. As a result, the dominant soil materials are the unstratified, unsorted drumlin tills consisting of a heterogeneous mixture of gravels, sands and silts.

Overburden in the site area is underlain by dolostone of the Guelph and Amabel formation with a depth of usually less than 5 metres.

INVESTIGATION PROCEDURE

GENERAL

Soil and rock data and inherent properties were obtained by conducting both an insitu field investigation and laboratory analysis. Details of the field investigation together with preliminary logsheets are provided below, however laboratory testing was not completed at this time.

FIELD INVESTIGATION

The fieldwork for this project was conducted on 94 12 13 and consisted of one borehole placed at the approximate location of the 5 m extension at the crest of the slope near the west outlet. The boring was advanced to depth of 6 metres. The boring was advanced using a conventional truck mounted Central Mining Equipment (CME) 55 Drill unit. Solid stem augering techniques were used to penetrate the overburden at the site.

Disturbed subsoil samples were retrieved in the overburden using a 50 mm Diameter Split Spoon Sampler driven in accordance with the Standard Penetration Test (SPT - ASTM D1586). The samples were generally retrieved at 0.76 m intervals. Bedrock underlying the overburden was cored to 2.2 metres in depth using conventional rock coring techniques. A BQ core barrel within BW casing was used in the coring process.

Rock core samples were measured in the field and transported to the laboratory where they were examined by a Ministry Petrographer.

Groundwater levels were determined by monitoring the water level in the open borehole throughout the duration of the field investigation. The borehole was backfilled upon completion of the fieldwork.

The survey related to the location and elevation of the borehole was provided by Southwestern Region Surveys and Plans.

Grain size analysis laboratory tests were carried out on select soil samples. Laboratory test results are given in the following section of this report and are illustrated on Figure 1 and on borehole log included in the appendix.

SUBSURFACE CONDITIONS

GENERAL

The subsoil conditions across the site consisted of 3.6 m of a Heterogeneous Mixture of Gravel, Sand and Silt (Glacial Till). This layer contained varying sized chunks of gravel throughout. Underlying this Till was a 1.6 m thick Sand with Gravel. The above overburden rests on a Dolostone Bedrock found at a depth of 6.0 m. A boulder was encountered prior to reaching the bedrock surface.

Hand augering and probing at the base of the existing culvert indicates the presence of a 20 - 30 cm thick concrete apron which extends out to the fence line, approximately 5 - 6 m in length. Underlying this apron was a coarse bouldery till. While the founding elevation of the proposed culvert could not be provided at the time this report was written, it is assumed that the invert elevation of the existing culvert found to be approx. 313 m will be approximately the same as the proposed extension. In addition, probing and hand augering the near by open channel

indicated it rests on bedrock with a thin layer of sand.

The plan and location of the boring is shown on Drawing No. 5359100 - A in the attached appendix. The obtained field laboratory tests are plotted on the record of borehole sheets also in the appendix of this report. A brief description of the different soil types are given below.

Heterogeneous Mixture of Gravel, Sand and Silt (Glacial Till)

A 3.7 m thick layer of Heterogeneous Mixture of Gravel, Sand and Silt (Glacial Till) was encountered from the surface. A greater percentage of boulders and gravel was found within this layer near the bottom 1 m. Results of the grain size distribution tests carried out on select samples are shown on Figure 1 in the appendix. The material contained 53 % gravel, 38 % sand, 7 % silt and 2 % clay.

In this stratum the 'N' values ranged from 45 to 120 blows/0.3 m, having a Dense to Very Dense state of denseness.

Sand with Gravel

A Sand with Gravel layer was encountered to rest between the stratum above and the bedrock below. This layer was found to be 1.6 m thick.

The 'N' values were 31 and 11 blows/0.3 m, indicating a Compact state of denseness. These values may be somewhat high and low, primarily due to the presence of bedrock immediately below and the presence of groundwater within this layer causing disturbance during sampling.

Bedrock

The above strata are directly underlain by Dolostone bedrock of the Guelph Formation. While the Bedrock was encountered at depth of 6 metres, a 1.3 m thick boulder was found resting above. Detailed descriptions of the rock are attached in the appendix.

Rock core penetration rates were generally rapid which is indicative of the weaker nature of this sedimentary rock. Core recoveries (CR) and rock quality designation (RQD) were determined in situ and also in the laboratory to evaluate the competence and integrity of the rock. Recoveries were generally high, however the rock was very broken with low RQD's. The 1.5 m thick rock core retrieved has a 100 % recovery and a 19 % rock quality designation. These values may be artificially low due to the nature of the rock and the size of rock core taken.

Groundwater conditions

The groundwater level was found to rest within the Sand with Gravel layer approximately at the same elevation as that of the near by open channel with an elevation of 312.8 m.

Groundwater levels in generally are subject the seasonal fluctuations and hence can vary from the values given in this report.

DISCUSSION AND RECOMMENDATIONS

It is proposed to extend the existing steel pipe culvert 5 m with a concrete box culvert having a 4.0 m span and 2.5 m height.

The founding elevation of the proposed extension being at the same depth as that of the existing culvert would place it. The existing culvert appears to be in good condition, being a corrugated steel pipe grouted outside replacing an old wood truss structure.

Based on the review of the expected founding elevation, together with the subsurface soil and bedrock data the culvert would be placed within the bouldery granular till material immediately underlying the existing culvert. It is understood that the design bearing pressure at the founding elevation are 400 kPa at ULS and 250 kPa at SLS Type II. If the founding elevation of the proposed extension reaches beyond the surficial granular till the Sand with Gravel layer may be encountered. If locally the bedrock surface is encountered near the founding elevation of the culvert foundations it is recommended that the overburden material be excavated and replaced with mass concrete.

Earth pressure should be computed as per Section 6.7 of the bridge design code and an unyielding foundation condition may be assumed for the computations. The Granular 'A' or 'B' backfill should be in accordance with the current MTO Standards. The following parameters are recommended for the granular backfill.

	Granular 'A'	Granular 'B'
Angle of Internal Friction	35°	30°
Unit Weight (kN/m ³)	22.8	21.2

The earth pressure should be computed as per Section 6.1.2.2. of the O.H.B.D.C. assuming 'at rest' conditions.

An unfactored coefficient of friction value of $\tan 30^\circ$ may be assumed for the estimate of sliding resistance.

OTHER CONSIDERATIONS

The backfill operations should be carried out simultaneously on both sides of the proposed culvert.

The concrete for the culvert foundation should be placed in a dry base condition. During construction the bottom slab will be located below the ground water level, requiring a dewatering scheme. The presence of the Sand with Gravel layer and the permeable nature of the bedrock could make dewatering more difficult. Provisions should also be made for the creek diversion. Steps should be taken to prevent any surface water flow in to the excavations. It is recommended

that the base placed on bedrock be cleaned with any spongy areas or weathered rock observed in the channel bed removed.

The frost protection requirements in this area is in the order of 1.5 m of earth cover.

The culvert outlet should be treated with rock protection as per O.P.S.D. 810.01 type 'A'.

No major stability problems are anticipated for the excavation in the overburden material with 2H:1V side slopes.

Miscellaneous

The fieldwork for this investigation was carried out under the supervision of M. Michalek, Foundation Engineer. The equipment was owned and operated by London Soils Investigations Ltd., London.

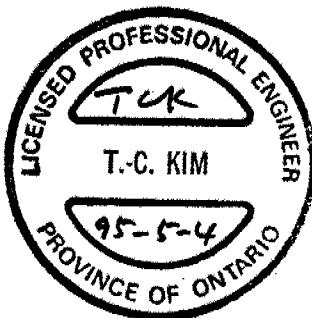
This report was written by M. Michalek, Foundation Engineer under the general supervision of T. C. Kim, Senior Foundation Engineer



M. Michalek, P. Eng.
Foundation Engineer

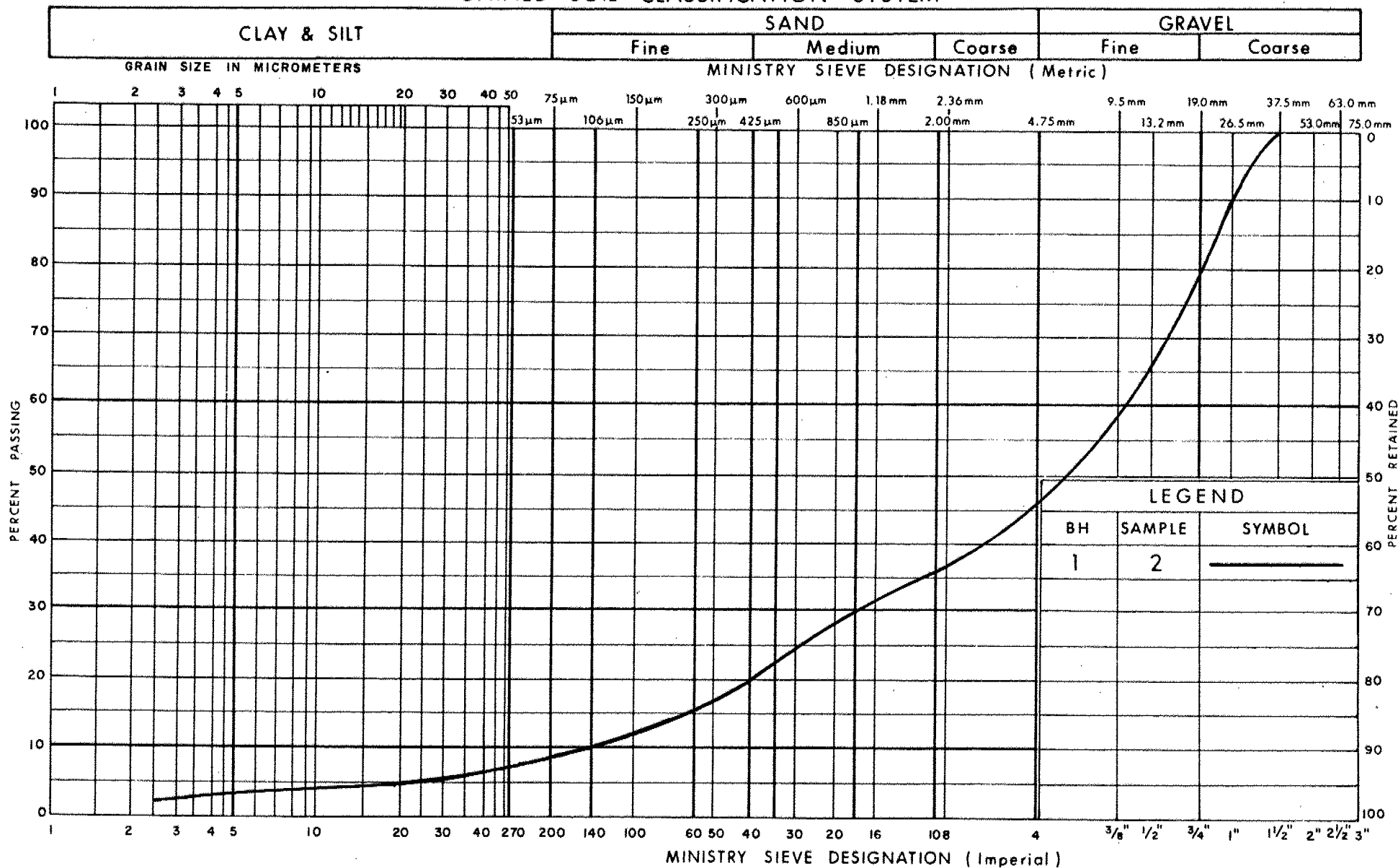


T. Kim, P. Eng.
Senior Foundation Engineer



APPENDIX

UNIFIED SOIL CLASSIFICATION SYSTEM



Ministry of
Transportation

GRAIN SIZE DISTRIBUTION
 HETEROGENEOUS MIXTURE OF
 GRAVEL, SAND & SILT (Glacial Till)

FIG No 1

W P 535-91 - 00

RECORD OF BOREHOLE No 1

1 OF 1

METRIC

W.P. 535-91-00 LOCATION Co-Ords: N 4 821 125; E 242 575 ORIGINATED BY M.M.
 DIST 31 HWY 6 BOREHOLE TYPE HS Auger, BQ Rock core COMPILED BY M.M.
 DATUM Geodetic DATE 94.12.12 CHECKED BY T.K.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100	W _p	W	W _L		
316.5	Ground Surface																
0.0	Heterogeneous Mixture of Gravel, Sand and Silt (Glacial Till) Brown, Dense to Very Dense		1	SS	46												
			2	SS	120												
			3	SS	120												
	Gravel, Boulders		4	SS	45												
312.8																	
3.7	Sand with Gravel Compact		5	SS	31												
			6	SS	11												
311.2																	
5.3	Boulder																
310.5																	
8.0	Dolomite Bedrock Weak, Slightly Weathered Note: RQD values are questionable due to the nature of the rock and the size of rock core taken.		7	RC	REC 100%												
309.0																	
7.5	End of Borehole																

ROCK CORE DESCRIPTION **WP 535-91-00**

Page 1 of 1

CORE RECOVERY					CORE DESCRIPTION	
BH#	RC#	DEPTH (m)	% CR*	% RQD*	DEPTH (m)	DESCRIPTION
1	7	6.02-7.54	100	18	6.02-7.54	DOLOSTONE (with stylolites, abundant stromatoporoids and corals, abundant small vugs, and larger vugs up to 2 cm in diameter commonly containing calcite crystals), very pale orange to pale yellowish brown; medium grained; weak; unweathered to slightly weathered; fractures close to extremely close spaced, flat to near vertical, undulating to planar, smooth to rough.

*CR = CORE RECOVERY

*RQD = ROCK QUALITY DESIGNATION

Note: Depths are approximated where core recovery is less than 100%
 Logged by: DAW, Soils and Aggregates Section

EXPLANATION OF TERMS USED IN REPORT

N VALUE: THE STANDARD PENETRATION TEST (SPT) N VALUE IS THE NUMBER OF BLOWS REQUIRED TO CAUSE A STANDARD 51mm O.D. SPLIT BARREL SAMPLER TO PENETRATE 0.3m INTO UNDISTURBED GROUND IN A BOREHOLE WHEN DRIVEN BY A HAMMER WITH A MASS OF 63.5kg, FALLING FREELY A DISTANCE OF 0.76m. FOR PENETRATIONS OF LESS THAN 0.3m N VALUES ARE INDICATED AS THE NUMBER OF BLOWS FOR THE PENETRATION ACHIEVED. AVERAGE N VALUE IS DENOTED THUS \bar{N} .

DYNAMIC CONE PENETRATION TEST: CONTINUOUS PENETRATION OF A CONICAL STEEL POINT (51mm O.D. 60° CONE ANGLE) DRIVEN BY 475 J IMPACT ENERGY ON 'A' SIZE DRILL RODS. THE RESISTANCE TO CONE PENETRATION IS MEASURED AS THE NUMBER OF BLOWS FOR EACH 0.3m ADVANCE OF THE CONICAL POINT INTO THE UNDISTURBED GROUND.

SOILS ARE DESCRIBED BY THEIR COMPOSITION AND CONSISTENCY OR DENSENESS.

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

c_u (kPa)	0 - 12	12 - 25	25 - 50	50 - 100	100 - 200	> 200
	VERY SOFT	SOFT	FIRM	STIFF	VERY STIFF	HARD

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

N (BLOWS/0.3m)	0 - 5	5 - 10	10 - 30	30 - 50	> 50
	VERY LOOSE	LOOSE	COMPACT	DENSE	VERY DENSE

ROCKS ARE DESCRIBED BY THEIR COMPOSITION AND STRUCTURAL FEATURES AND / OR STRENGTH.

RECOVERY: SUM OF ALL RECOVERED ROCK CORE PIECES FROM A CORING RUN EXPRESSED AS A PERCENT OF THE TOTAL LENGTH OF THE CORING RUN.

MODIFIED RECOVERY: SUM OF THOSE INTACT CORE PIECES, 100mm+ IN LENGTH EXPRESSED AS A PERCENT OF THE LENGTH OF THE CORING RUN. THE ROCK QUALITY DESIGNATION (RQD), FOR MODIFIED RECOVERY, IS:

RQD (%)	0 - 25	25 - 50	50 - 75	75 - 90	90 - 100
	VERY POOR	POOR	FAIR	GOOD	EXCELLENT

JOINTING AND BEDDING:

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

ABBREVIATIONS AND SYMBOLS

FIELD SAMPLING

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

STRESS AND STRAIN

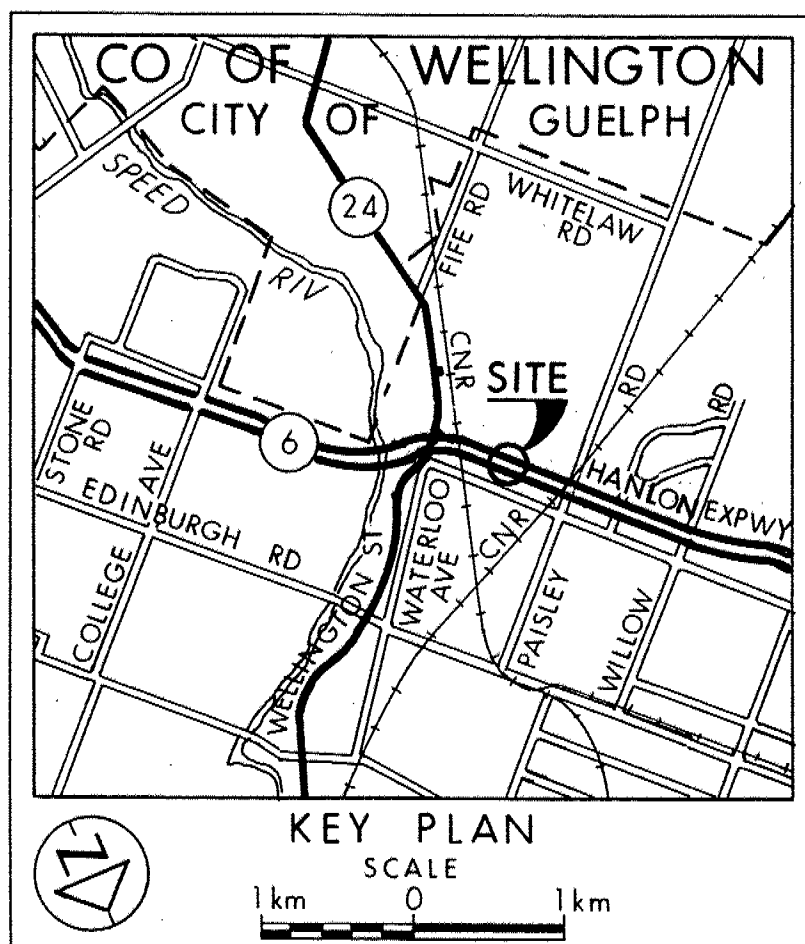
u_w	kPa	PORE WATER PRESSURE
r_u	1	PORE PRESSURE RATIO
σ	kPa	TOTAL NORMAL STRESS
σ'	kPa	EFFECTIVE NORMAL STRESS
τ	kPa	SHEAR STRESS
$\sigma_1, \sigma_2, \sigma_3$	kPa	PRINCIPAL STRESSES
ϵ	%	LINEAR STRAIN
$\epsilon_1, \epsilon_2, \epsilon_3$	%	PRINCIPAL STRAINS
E	kPa	MODULUS OF LINEAR DEFORMATION
G	kPa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

MECHANICAL PROPERTIES OF SOIL

m_v	kPa ⁻¹	COEFFICIENT OF VOLUME CHANGE
C_c	1	COMPRESSION INDEX
C_s	1	SWELLING INDEX
C_α	1	RATE OF SECONDARY CONSOLIDATION
c_v	m ² /s	COEFFICIENT OF CONSOLIDATION
H	m	DRAINAGE PATH
T_v	1	TIME FACTOR
U	%	DEGREE OF CONSOLIDATION
σ'_{v0}	kPa	EFFECTIVE OVERBURDEN PRESSURE
σ'_p	kPa	PRECONSOLIDATION PRESSURE
τ_f	kPa	SHEAR STRENGTH
c'	kPa	EFFECTIVE COHESION INTERCEPT
ϕ'	-°	EFFECTIVE ANGLE OF INTERNAL FRICTION
c_u	kPa	APPARENT COHESION INTERCEPT
ϕ_u	-°	APPARENT ANGLE OF INTERNAL FRICTION
τ_R	kPa	RESIDUAL SHEAR STRENGTH
τ_r	kPa	REMOULDED SHEAR STRENGTH
S_t	1	SENSITIVITY = $\frac{c_u}{\tau_r}$

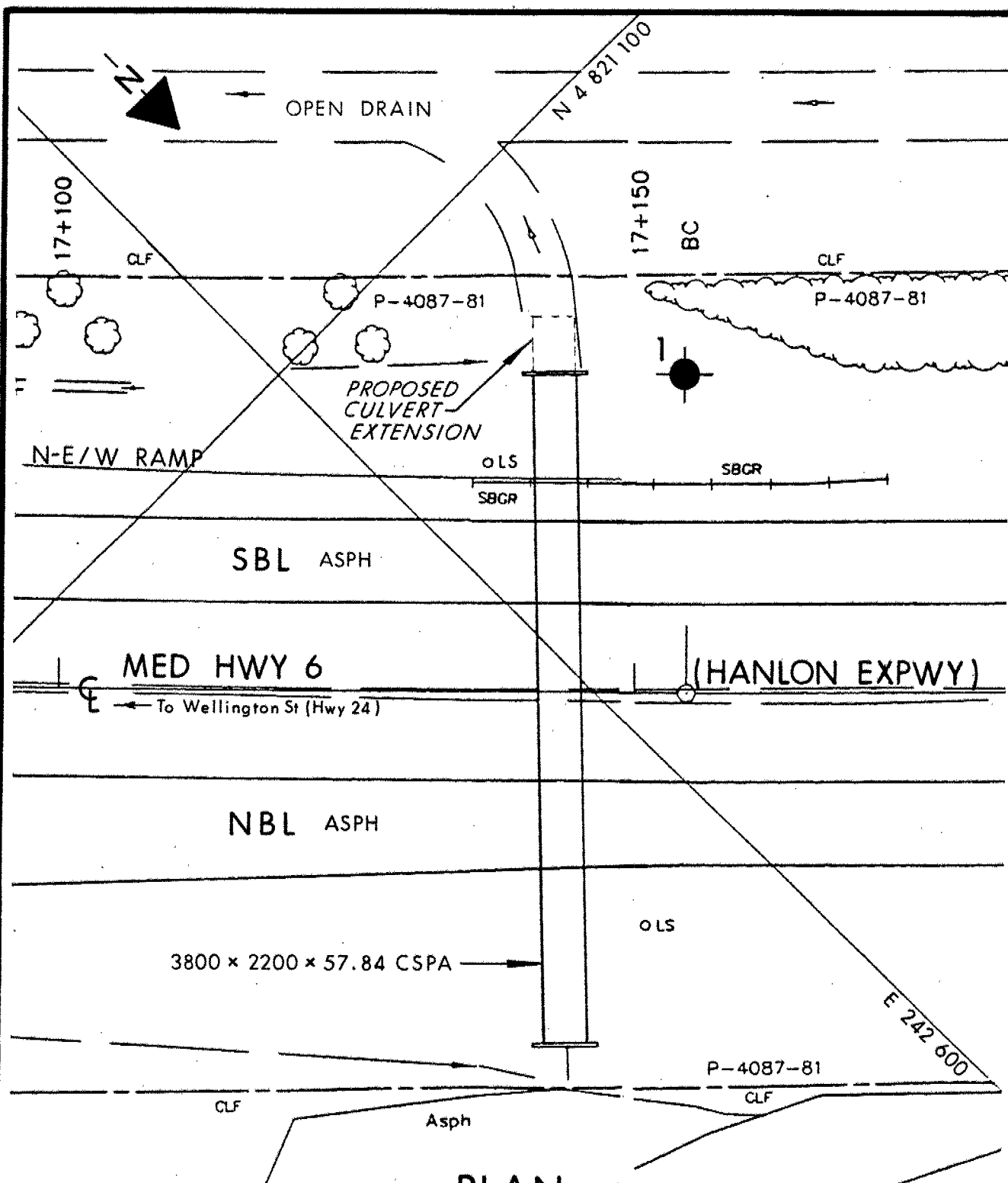
PHYSICAL PROPERTIES OF SOIL

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



Geocres No 40P9-38

WP 535-91-00



PLAN



LEGEND



NOTE

FOR SUBSOIL INFORMATION OF B.H. 1
REFER TO RECORD OF BOREHOLE SHEET.

Geocres No 40P9-38
WP 535-91-00
DIST 31
DWG 5359100-A
DATE 1995 03 15