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DIST. 9 REGION

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CONT. No. 90-36

W. O. No.

STR. SITE No.

HWY. No. 417

LOCATION Hwy 417 E' Graham Cr. South
Culvert (Structure #6)

No. of PAGES -

OVERSIZE DRAWINGS TO BE INCLUDED WITH THIS REPORT.

REMARKS:

RAN

ENGINEERING MATERIALS OFFICE
FOUNDATION DESIGN SECTION

CONT. 90-36

WP 120-87-09

DIST 9

HWY 417

STR SITE 3-537

Graham Creek Structure South Section
Structure #6

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FOUNDATION INVESTIGATION REPORT
For
Graham Creek Structure South Section
Structure #6
WP 120-87-09, Site 3-537
Hwy. 417, District 9, Ottawa

INTRODUCTION

This report summarizes the results obtained from a Foundation Investigation implemented at the aforementioned site. The proposed culvert is to be located immediately south of the existing Graham Creek culvert. This report is applicable to the structure foundations, approaches and related earthworks.

SITE DESCRIPTION AND GEOLOGY

The site is located immediately south and adjacent to the existing Graham Creek culvert that underpasses the existing Hwy. 417 in the City of Nepean, Ottawa-Carleton Municipality. The northly flowing waters of Graham Creek meander in a valley that is approximately 20 metres wide. The creek channel is approximately 6 metres in width and the water depth varies from 0.5 metre to 1 metre. The side slopes of the valley are roughly 2H:1V and covered with vegetation, grassland and trees. The slopes appear to be stable.

The surrounding terrain is generally flat and consists primarily of grassland. On the west side of the valley the land is presently used for agriculture.

Physiographically, the site lies in the area known as the Ottawa Valley Clay Plains founded in the Lowlands of the St. Lawrence. The deposit consists of clay plains interrupted by ridges of rock or sand. Fault scarps are also evident within the area, an illustration of the numerous normal faults that dominate the region.

The bedrock in the area is of the Gull River Formation of the Middle Ordovician Period. It consists of interbedded silty dolostone, shaley limestone and fine grained quartz sandstone. The overburden was deposited during and immediately

following the Wisconsin glaciation at which time the area was depressed from the effect of the glaciation. Following the retreat of the glacier, the brackish waters of the Champlain Sea flooded the area and then gradually receded as the land rebounded with the deposition of sediments to its present level.

FIELD INVESTIGATION

The fieldwork for the investigation was carried out between 88 07 21 and 88 07 28 and consisted of four sampled boreholes accompanied by two dynamic cone penetration tests. Continuous flight hollow stem auger equipment and washboring techniques were used to advance the boreholes in the overburden. Subsoil samples were retrieved at selected intervals by a split spoon sampler in accordance with the Standard Penetration Test (ASTM D1586). The samples were identified in the field and then returned to the laboratory for applicable testing. Bedrock was proven at BH #6-2 using conventional rock coring methods.

Water levels were obtained in the open boreholes until approximate stabilized levels were observed.

Survey information related to location and elevation of boreholes was provided by Eastern Region Surveys and Plans.

LABORATORY ANALYSES

To identify the behaviour, gradation and properties of the soil, various laboratory testing were performed. These tests included:

- 1) Atterberg Limit Tests
- 2) Grain Size Analyses
- 3) Natural Moisture Contents
- 4) Direct Shear Tests

Laboratory test results have been summarized and are included in the Appendix of this report.

SUBSURFACE CONDITIONS

Underlying a thin deposit of clayey silt (2.3 m) that was encountered at the eastern ridge of the Graham Creek valley (BH 6-1), the main deposit at the site consists of a significant thickness of a cohesionless sand. This deposit extends from the surface of the creek's channel to a minimum thickness of 16.4 metres. This sand layer contains traces of silt and gravel and also random zones of silty sand. Its relative density ranges from loose to very dense, but generally it can be classified as compact to dense. Underlying the sand layer is a heterogeneous mixture of sand, gravel and boulders (glacial till) that in turn overlies the bedrock composed of interbedded limestone and silty dolostone. The vertical extent of the till deposit was not established across the site but is 4.9 m in thickness in the area of BH 6-2.

The boundaries between the various soil types, in situ and laboratory test results as well as stabilized ground water levels, are shown on the attached Record of Borehole Sheets in the Appendix. A plan of the site illustrating the locations and elevations of the boreholes and subsoil stratigraphical sections are also provided on Dwg. 1208709-A. The plan includes locations and stratigraphical profiles of boreholes advanced in conjunction with structure 14 (culvert replacement).

A detailed description of the subsurface conditions encountered is given below.

Clayey Silt, some sand, trace gravel

Encountered at the eastern ridge of the Graham Creek valley and extending to a thickness of 2.3 m at BH 6-1, exists a layer of a cohesive clayey silt mixed with some sand and a trace of gravel. The deposit is brown in colour and possesses inclusions of organics of varying concentrations. This presence of organics influences the behaviour of the deposit as indicated by Atterberg Limits obtained on samples of the deposit. A summary of the indices of the basic cohesive material matrix is provided in Table 1 below and the results are plotted on Figure 1. Grain size distribution curves for the material as determined by mechanical analyses is given on Figure 2.

Table 1

	<u>Range</u>
Natural Moisture Content (w%)	16-21
Liquid Limit (w _L %)	33.5-35
Plastic Limit (w _p %)	21-25.5

It is evident from the results that the deposit is predominantly of low plasticity ranging from a clayey silt to an organic silt depending on the organic content. 'N' values obtained from the Standard Penetration Test indicate that the deposit has a consistency ranging from stiff to hard.

Sand

The predominant deposit at the site consists of a poorly graded cohesionless sand that extends for a minimum thickness of 16.4 m. This sand layer contains traces of gravel and silt and at random elevations, zones of silty sand are present. Minor variations in gravel content also exist at lower elevations within the deposit, perhaps an indication of the contact with the underlying deposit of the heterogeneous mixture of sand, gravel and boulders (glacial till). Typical grain size distribution curves are plotted in envelope form on Figure 3.

The relative density of the cohesionless deposit varies from very loose to very dense with 'N' values obtained from the Standard Penetration Test ranging from 2 blows/0.3 m to 103 blows/.15 m. Generally, the upper 4-5 metres of the deposit is compact while the relative density of this deposit below this level is dense to very dense.

Direct shear tests were performed on selected samples of the deposit in the laboratory to determine the angle of internal friction. Results revealed values ranging from 30 to 35°.

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

Underlying the predominant deposit of sand exists a heterogeneous mixture of sand, gravel and boulders of glacial origin. This stratum was not explored to its vertical extent over the entire site but a thickness of 4.9 metres exists in the area of BH 6-2. Rock Coring methods were required to penetrate the larger sizes of the deposit. The elevation of the surface of this deposit varies from 47.2 m to 40.0 m. A grain size distribution curve of a sample of this material, excluding boulder sizes, is provided on Figure 4.

Bedrock

The glacial till deposit is underlain by bedrock of the Gull River Formation and was proven at BH 6-2 by obtaining 1.6 metres of rock core samples. The bedrock consists of a silty to argillaceous dolostone which is a clastic sedimentary rock. Detailed descriptions of the bedrock are attached in the Appendix, entitled "Description of Rock Core".

Core recoveries and rock quality designations (RQD) were determined in situ and also in the laboratory to evaluate the competence and integrity of the rock. Core recoveries ranged from 85 to 94% and RQD's ranged from 45 to 55%. Based on these results and thorough visual laboratory examination, the rock can be classified as medium strong to strong rock and unweathered.

Groundwater Conditions

Observation of the groundwater level was carried out by measuring the water level in the open boreholes. Measurements revealed stabilized levels at an elevation ranging from 60.4 to 60.8 m which coincides with the water level in the flowing creek.

DISCUSSION AND RECOMMENDATIONS

It is proposed to replace and extend the existing Graham Creek Culvert that transmits the waters of Graham Creek at the Hwy. 417 crossing. The existing culvert is a 5.5 m x 2.4 m x 123 m reinforced concrete box culvert. It is conceived that both the culvert replacement and extension will be reinforced concrete box frame structures.

This report provides recommendations pertaining to the culvert extension and associated retaining walls. The approximate 50 m length extension will be aligned along the same centre-line as the existing culvert which corresponds to the approximate alignment of the existing creek channel. The proposed Hwy. 417 EB and 416S to 417E ramp will overpass the culvert at a grade of 70 m which translates into fills up to 5.0 metres beyond the existing river valley and 9.0 metres at the creek channel.

The major geotechnical related areas of discussion contained in this report are:

- 1) Structure Foundations
- 2) Stability and Settlement of Approaches
- 3) Lateral Earth Pressures
- 4) Construction Considerations

STRUCTURE FOUNDATIONS

The proposed concrete culvert structure and associated retaining walls may be founded on spread footings located within the sand layer that predominates the site. For purposes of the O.H.B.D.C., the following design values are recommended at the elevation provided.

<u>Structure</u>	<u>Recommended Footing El. (m)</u>	<u>Bearing Capacity at S.L.S. Type II (kPa)</u>	<u>Factored Bearing Capacity at U.L.S. (kPa)</u>
Concrete Culvert	<59.0	250	450
Retaining Walls	<59.0	250	450
	59.0-62.0	175	375

A footing width (B) of 6.0 m was used in the calculation of the capacities.

The underside of all footings should be provided with a minimum 1.80 metres of earth cover for frost protection. In addition, to protect the footings against scour, a properly designed rip-rap, meeting the hydrological requirements at the site, should be placed at the culvert channel inlet.

Settlement of the foundation subsoil as a result of the applied footing pressure will be elastic in nature - i.e. take place during or immediately following the construction period. The magnitude of this settlement is anticipated to be within 25 mm, provided the subsoil is not loosened by construction or related activities. It is recommended that a working slab be placed to protect the footing founding soil within 4 hours of exposure.

Sliding resistance between the concrete and the foundation soil should be calculated in accordance with Section 6.7.3.3.2 of the O.H.B.D.C. assuming an unfactored coefficient of friction of 0.6. If additional resistance to lateral forces is required, please contact this office. Shear keys in the native subsoil can be used to increase resistance.

STABILITY AND SETTLEMENT OF APPROACH FILLS

Stability computations were carried out to evaluate the effect of the approach fills to the overall stability both in the longitudinal and transverse directions. Bishop's total stress analysis was implemented incorporating a minimum factor of safety of 1.3. The properties of the fill material and subsoil and the surface geometries used in these computations are shown on Figure 5. The proposed fill height is in the order of 5 m above the existing ground surface at the ridges of the creek valley and up to 9 m within the valley. Based on the analyses, the following conclusions have been derived:

- 1) Due to the competent nature of the subsoil, no deep seated failures are anticipated for fills constructed with standard 2H:1V slopes.
- 2) Fills up to 8 metres above the original ground surface will maintain internal stability provided they are constructed with standard 2H:1V slopes.

- 3) A nominal 2 m berm will be required for fills exceeding 8 metres in height above the original ground surface. Berms should be constructed with a nominal slope such that surface run-off does not pond on the berm.

Any softened and/or organic soil should be removed within the planned limits of the fill prior to its placement.

Settlement of the native subsoil as a result of the approach embankment loading will be elastic in nature and within a magnitude of 25 mm. In addition, settlement of the fill under its own weight can be expected. In general, the following settlements within the fill can be expected:

Height of Fill (H_{FILL}) (m)	Total Settlement (S_T)
0-7	$0.5\% \times H_{FILL}$
7-10	$0.75\% \times H_{FILL}$
10-12	$1\% \times H_{FILL}$

Cohesive soils will settle with time and consequently it is recommended that cohesive fills be placed as far in advance of the roadway paving as scheduling permits.

LATERAL EARTH PRESSURES ON CULVERT/RETAINING WALLS

To prevent hydrostatic pressure build-up, backfill to culvert walls and retaining walls should consist of Granular 'A' or Granular 'B'. Design parameters of the soil are given below:

	Granular 'A'	Granular 'B'
Angle of Internal Friction (ϕ)	35°	30°
Unit Weight (kN/m^3), γ	22.8	21.2
Coefficient of Active Earth Pressure (K_a)	0.27	0.33
Coefficient of Earth Pressure at Rest (K_o)	0.43	0.5

Lateral earth pressures should be computed in accordance with Section 6.6.1.2.1 of the O.H.B.D.C.. The active condition (K_A) will govern earth pressure design if the structure is yielding while the at rest condition (K_0) will govern for an unyielding structure. Weep holes should be designed to drain accumulation of water in the backfill.

CONSTRUCTION CONSIDERATIONS

- 1) Temporary excavation cuts for foundation elements should be sloped at slopes no steeper than 2H:1V in view of the high water table.
- 2) Temporary diversion of the Graham Creek waters will be required during construction.
- 3) Footing excavations will extend some 2 metres below the groundwater level. This may cause the base of the excavation to "boil" due to unbalanced hydrostatic water pressure head within the sand stratum.

Consequently, a dewatering scheme will be required for the construction of the footings. Possible schemes are summarized below.

- a) Dewatering may be achieved by using perimeter ditches within a gravity system to drain the accumulated water. An illustration of this scheme is provided on Figure 6 in the appendix.
- b) Alternatively, dewatering may be achieved by carrying out the excavation from within an enclosure formed of interlocking steel sheeting (cofferdam). In order to prevent 'boiling' at the base of the excavation, it is recommended that the sheeting be driven to a depth below the footing base equal to the unbalanced hydrostatic head existing above this level. (see Figure 7).

The scheme that proves to be more economical and practically feasible should be adopted.

4) Backfill to the culvert should be constructed in accordance with appropriate O.P.S.D. Standards (O.P.S.D. 803 series). The backfill should be constructed in 300 mm lifts on alternating sides of the culvert so that the maximum differential in backfill at any time does not exceed 300 mm. Excessive vibratory equipment loadings should be prevented from inducing undue lateral pressures on the culvert walls.

MISCELLANEOUS

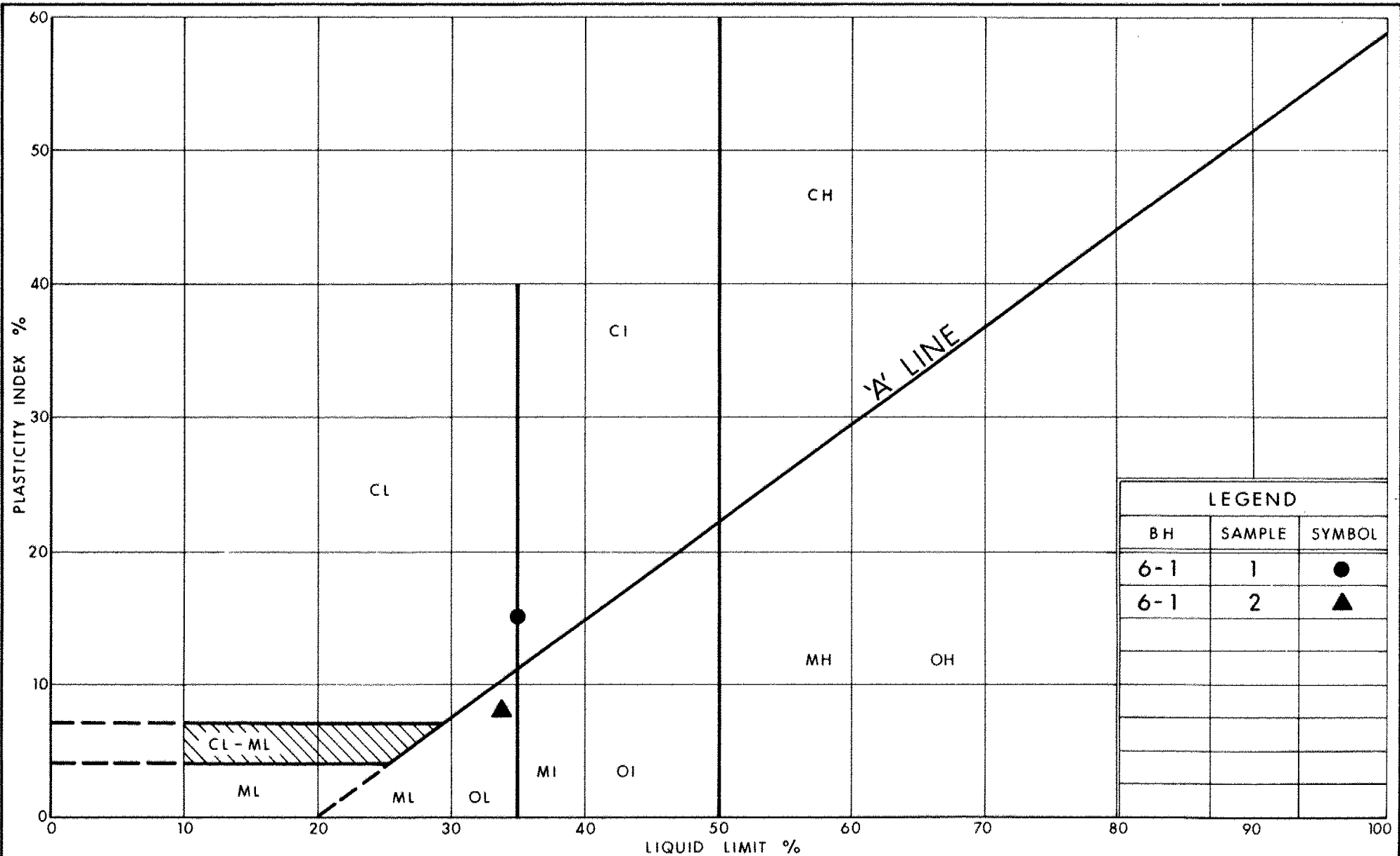
The fieldwork for this investigation was carried out under the supervision of J. Fellenius, Student Engineer and T. Sangiuliano, Foundation Engineer, utilizing equipment owned and operated by Marathon Drilling Co. and Johnston Drilling Co. This report was written by T. Sangiuliano and reviewed by Mr. M.S. Devata, Chief Foundation Engineer.



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APPENDIX



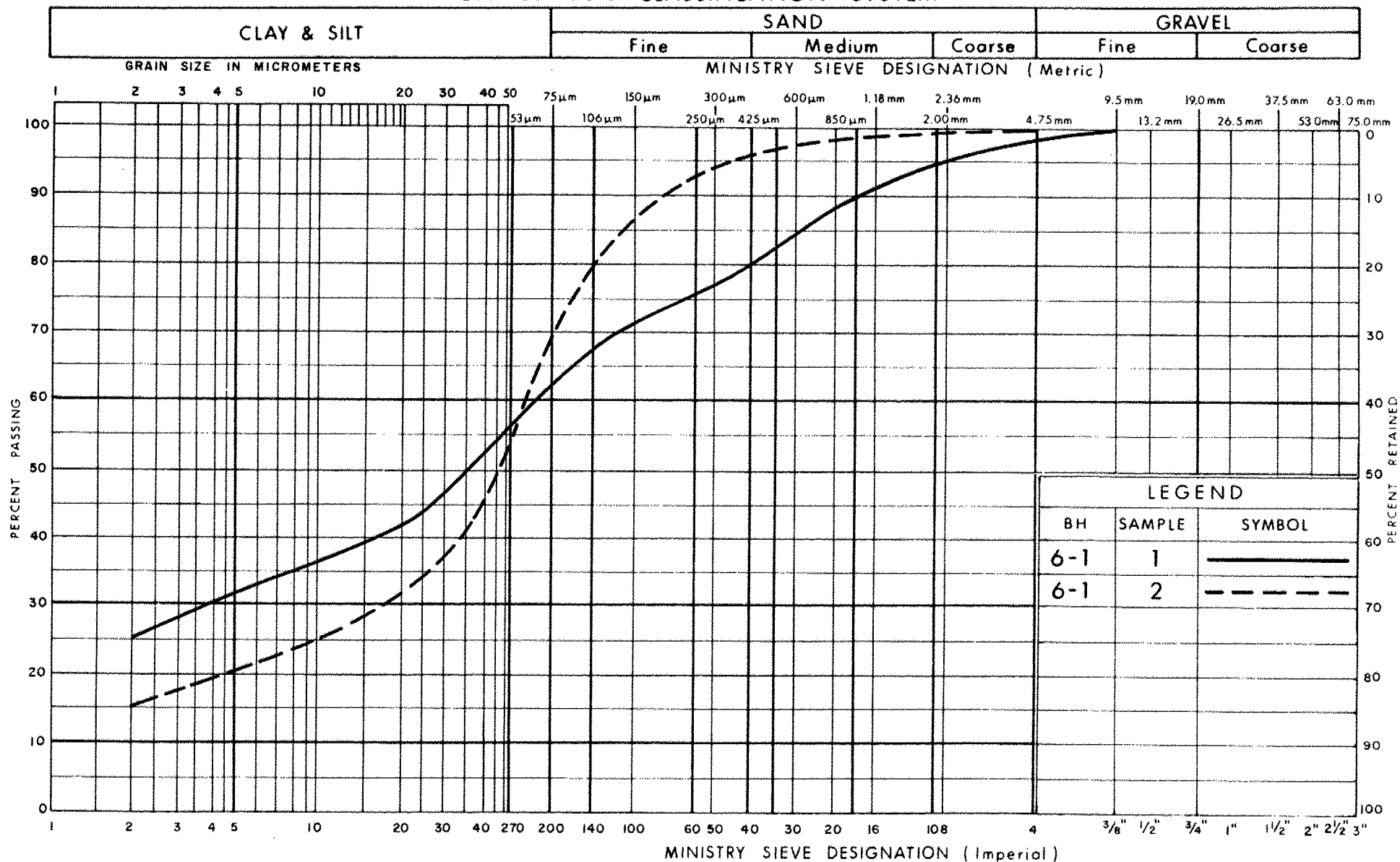
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PLASTICITY CHART
CLAYEY SILT, SOME SAND, TRACE GRAVEL
OCC ZONES OF ORGANICS

FIG No 1

W P 120-87-09

UNIFIED SOIL CLASSIFICATION SYSTEM



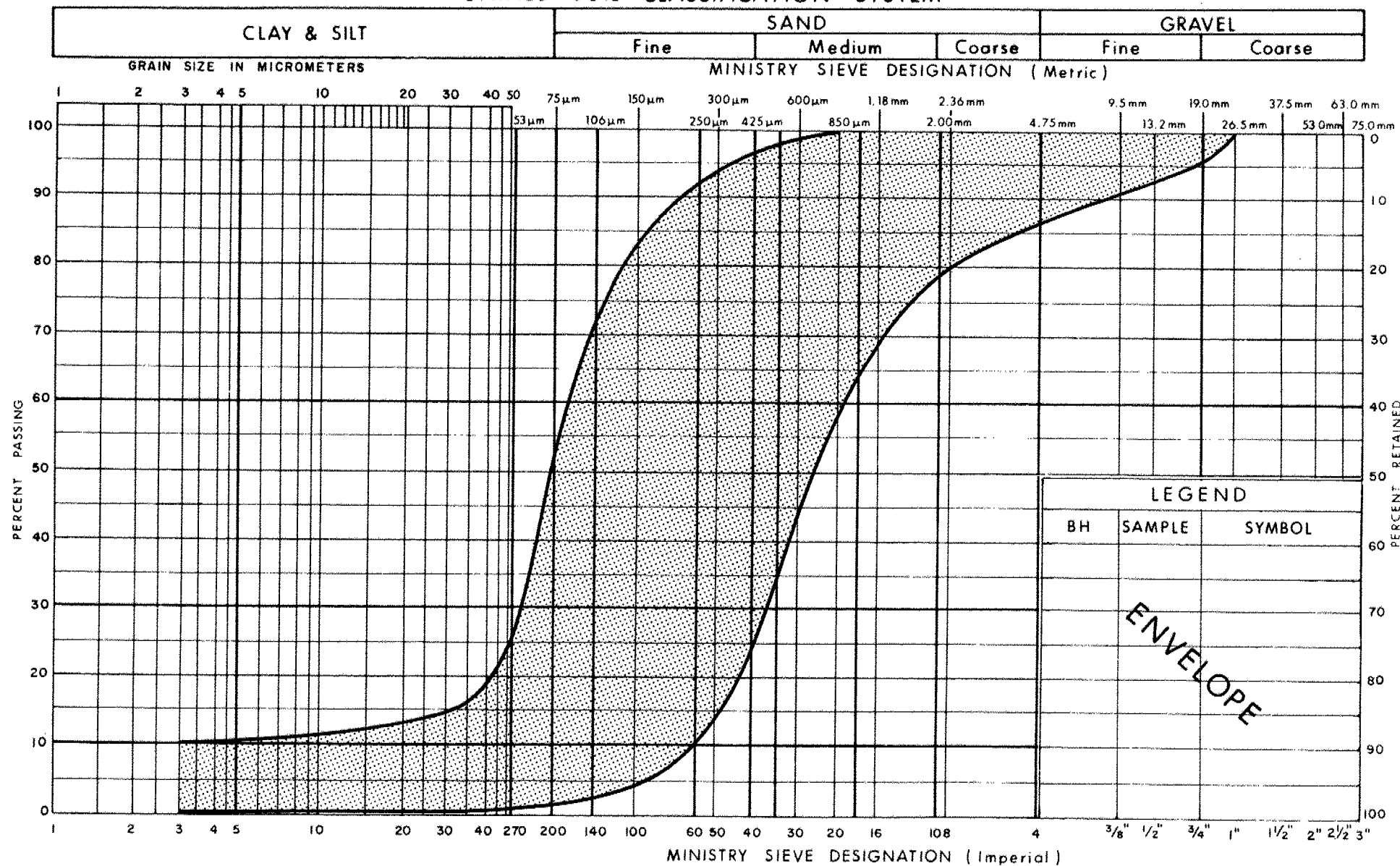
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GRAIN SIZE DISTRIBUTION
CLAYEY SILT, SOME SAND, TRACE GRAVEL
 OCC ZONES OF ORGANICS

FIG No 2

W P 120-87-09

UNIFIED SOIL CLASSIFICATION SYSTEM



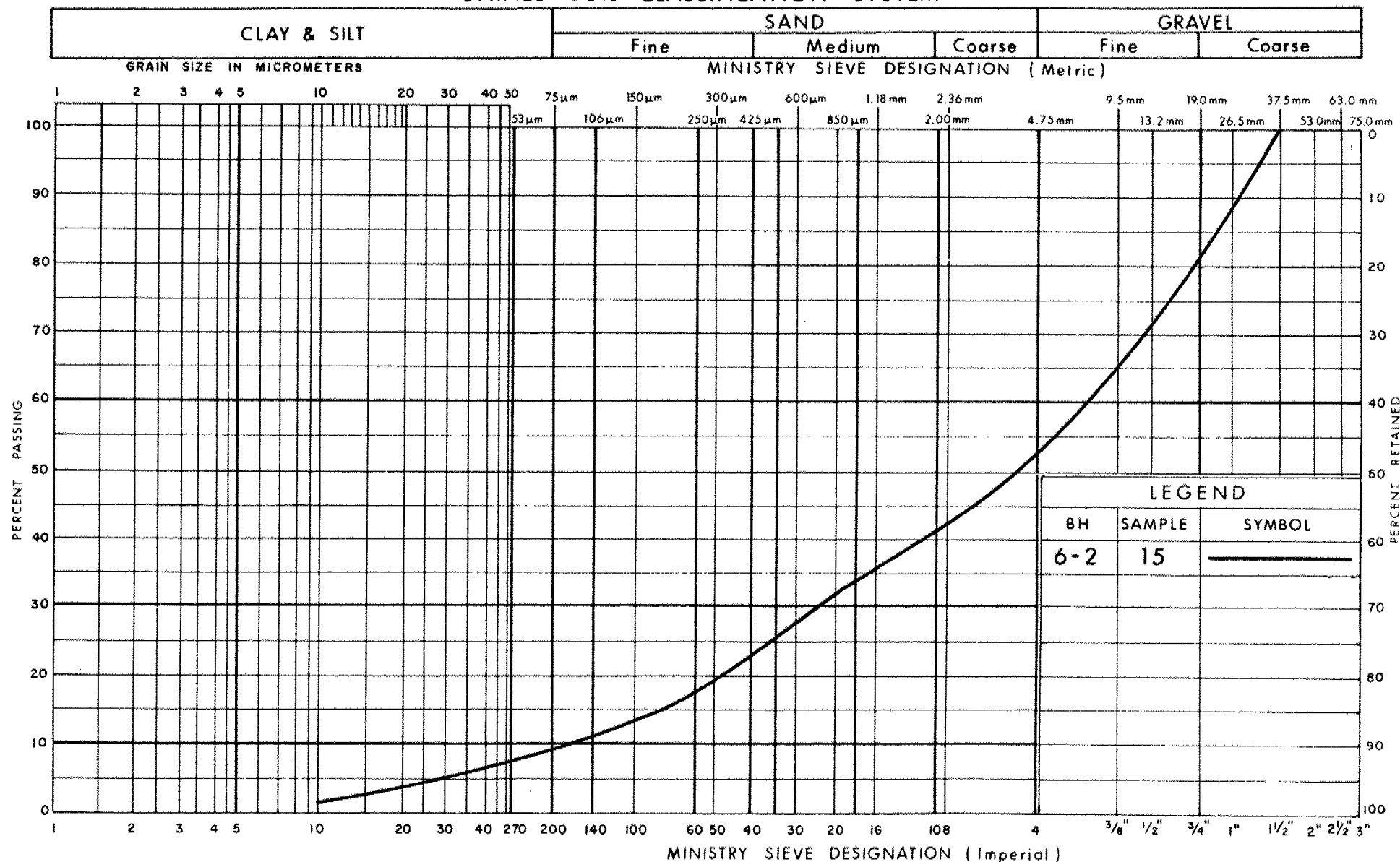
Ministry of
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GRAIN SIZE DISTRIBUTION
SAND, TRACE OF SILT, TRACE OF GRAVEL
OCC SILTY SAND ZONES

FIG No 3

W P 120-87-09

UNIFIED SOIL CLASSIFICATION SYSTEM


 Ministry of
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Ontario

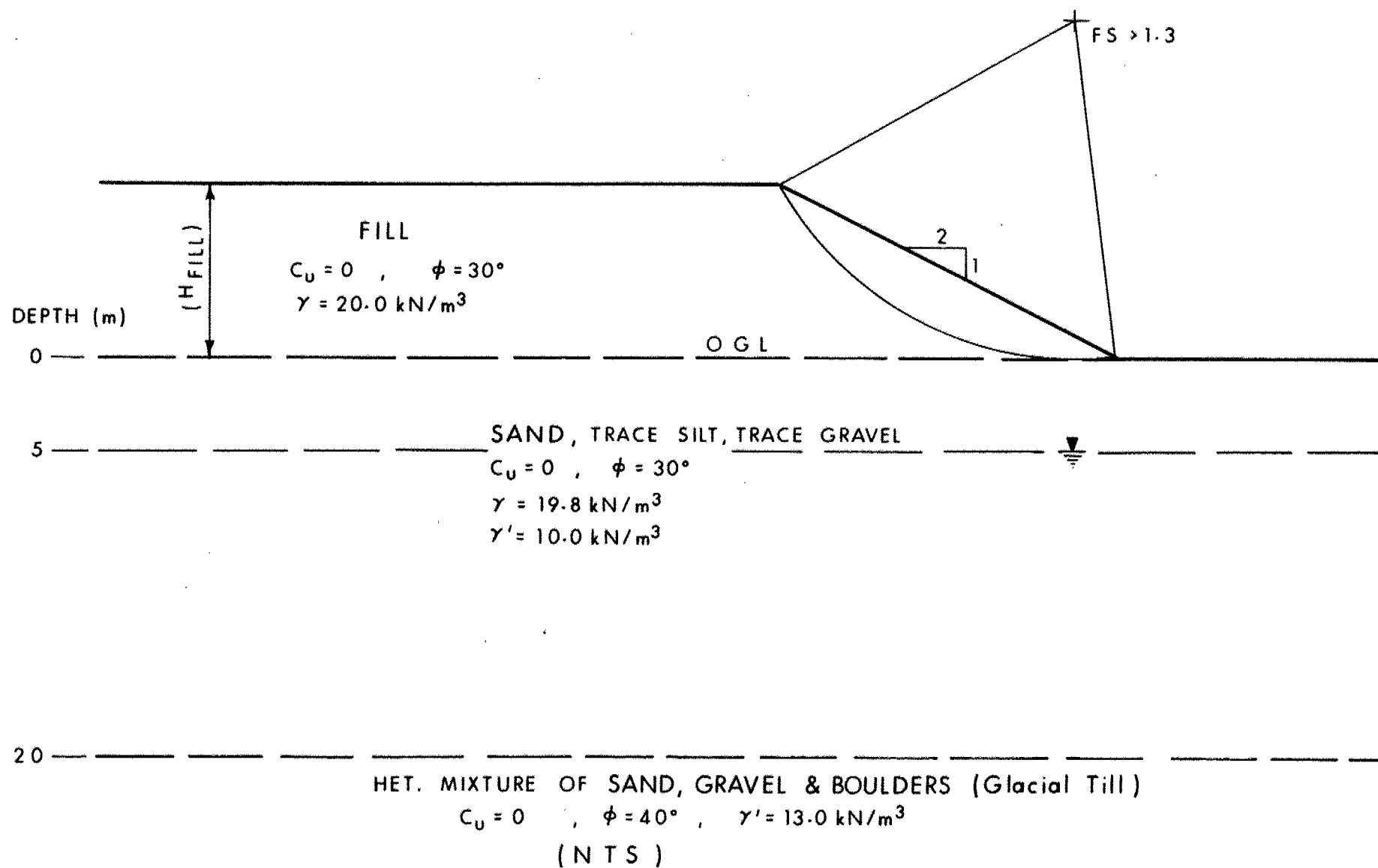
GRAIN SIZE DISTRIBUTION

HET MIXTURE OF

SAND, GRAVEL & BOULDERS (Glacial Till)

FIG No 4

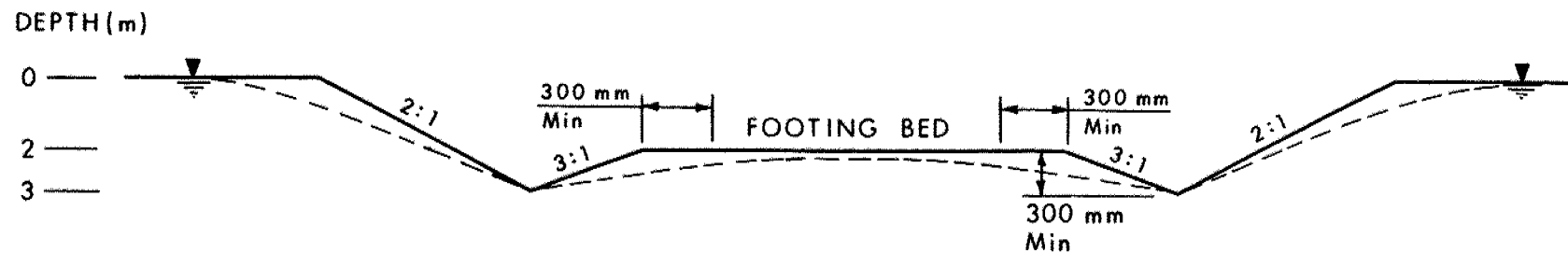
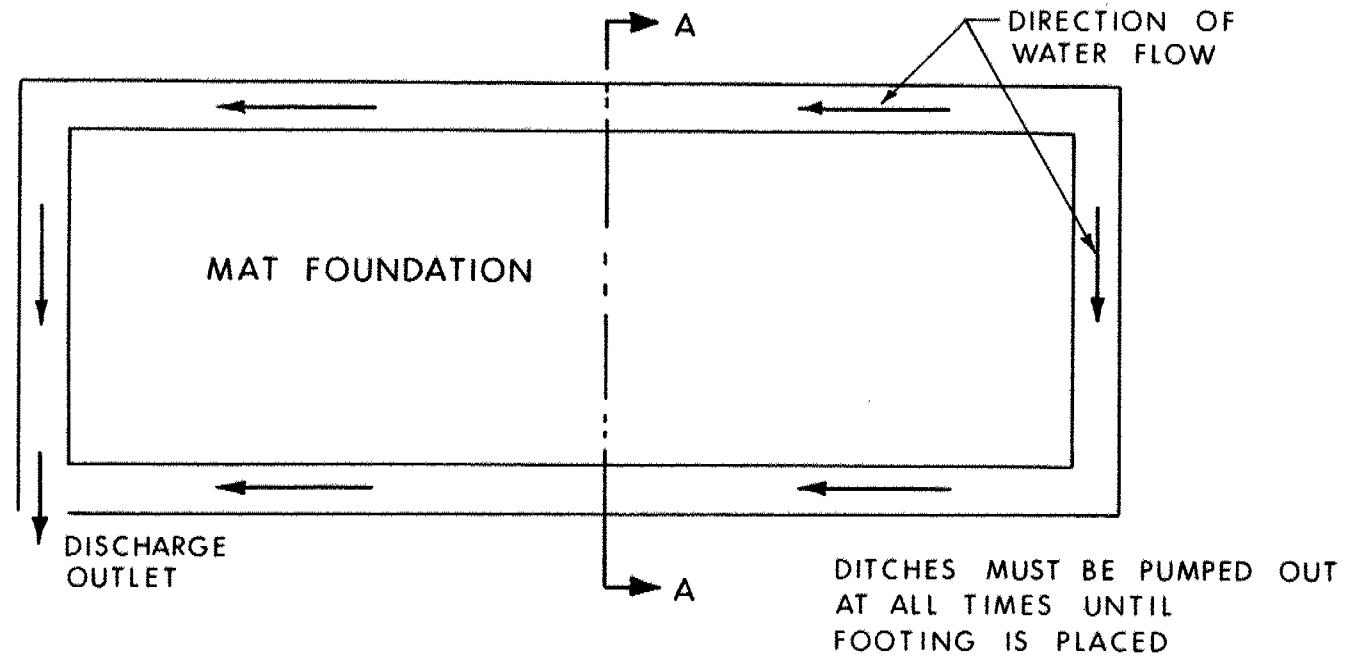
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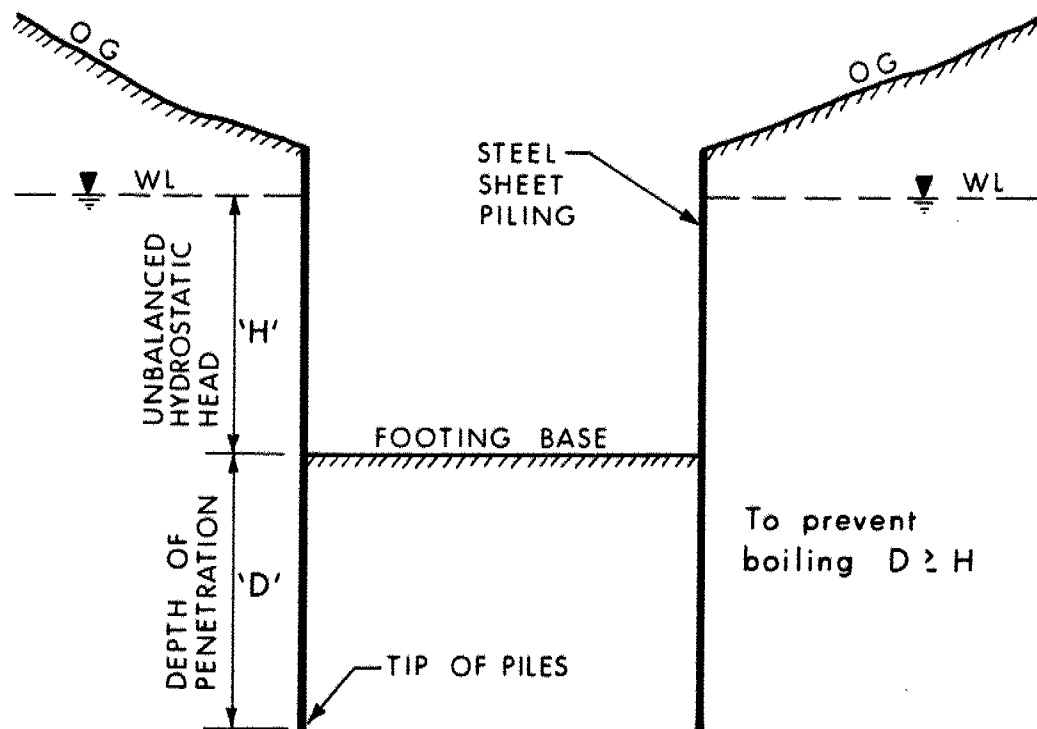
BISHOP'S TOTAL STRESS ANALYSIS (Height of Fill $\leq 8 \text{ m}$)

W P 120-87-09

FIG 5



SECTION A-A
(NTS)
DEWATERING SCHEME - PERIMETER DITCHES



COFFERDAM CONSTRUCTION

WP 120-87-09

FIG 7

DESCRIPTION OF ROCK CORE - WP 120-87-09

CORE RECOVERY				CORE DESCRIPTION	
HOLE #	DEPTH (m)	%CR*	%RQD*	DEPTH (m)	DESCRIPTION
6-2	15.24-18.29	8	NA	15.24-21.83	OVERBURDEN, foreign and locally derived bedrock material.
	18.29-21.34	NOT	CORED	21.83-22.96	SILTY DOLOSTONE, medium grey; fine grained, thick bedded; medium strong to strong rock; slightly weathered to unweathered; close spaced fractures: horizontal, smooth, undulating, slightly open to closed
	21.34-21.95	48	19		
	21.95-23.16	85	55		
	23.16-23.57	94	45	22.96-23.57	ARGILLACEOUS DOLOSTONE, dark grey; thin bedded; slightly weathered to unweathered; medium strong rock; close to very close spaced fractures: horizontal, planar, slightly open to closed.

NOTE: Depths are approximated in zones of poor core recovery.

*CR = CORE RECOVERY

*RQD = ROCK QUALITY DESIGNATION

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

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

STRESS AND STRAIN

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

MECHANICAL PROPERTIES OF SOIL

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

RECORD OF BOREHOLE No 6-1

METRIC

W P 120-87-09 LOCATION Co-Ords N 5 022 702.0; E 358 757.4 ORIGINATED BY JBF
 DIST 9 HWY 417 BOREHOLE TYPE H-S Augers "B" Casing, Washboring & Cone Test COMPILED BY TS
 DATUM Geodetic DATE 88 07 21 CHECKED BY

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 SHEAR STRENGTH kPa ○ 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							
65.9	Ground Surface											
0.0	Clayey Silt Some Sand, trace Gravel Brown, stiff to hard		1	SS	30							1 35 39 25
63.6	Occ.Zones of Organics		2	SS	14							1 29 55 15
2.3			3	SS	11							
			4	SS	8							8 68 14 10
			5	SS	17							
			6	SS	19							
	Brown Grey Sand		7	SS	27							0 96 (4)
	Trace Silt, Trace Gravel		8	SS	18							
	Loose to Very Dense		9	SS	32							0 83 (17)
			10	SS	41							
			11	SS	56							
47.2	Het.mixture of sand, Gravel, Boulders (Glacial Till)		12	SS	76							0 96 (4)
18.7			13	RC	-							
46.1												
19.8	END OF BOREHOLE											
	* Water Level Not Established											

OFFICE REPORT ON SOIL EXPLORATION

RECORD OF BOREHOLE No 6-2

METRIC

W P 120-87-09 LOCATION Co-Ords N 5 022 707.2; E 358 733.3 ORIGINATED BY JF
 DIST 9 HWY 417 BOREHOLE TYPE Washboring, "N"-Casing & BXL Rock Core COMPILED BY TS
 DATUM Ceodetic DATE 88 07 25 to 28 CHECKED BY

OFFICE REPORT ON SOIL EXPLORATION

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					
61.4	Ground Surface																GR SA SI CL
0.0																	
			1	SS	9		60										10 85 (5)
			2	SS	7												
			3	SS	23												
	Sand		4	SS	28		58										6 91 (3)
	Trace Silt		5	SS	25												
			6	RC	-												
	Trace Gravel		7	SS	39		56										
	Loose to Very Dense		8	SS	35												2 71 (27)
			9	SS	55		54										
			10	SS	69		52										0 92 (8)
			11	SS	71		50										
			12	SS	59		48										
			13	SS	75/	15cm	46										
44.3																	
17.1	Het. mixture of Sand, Gravel and Boulders (Glacial Till)		14	RC	-		44										
							42										
39.6			15	SS	100		40										47 43 (10)
21.8	Bedrock		16	RC	REC	48%											ROD = 19%
	Dolostone		17	BXL RC	REC 85%												ROD = 55%
37.8	Unweathered		18	RC	REC	94%	38										ROD = 45%
23.6	END OF BOREHOLE																

RECORD OF BOREHOLE No 6-3

METRIC

W P 120-87-09 LOCATION Co-Ords N 5 022 721.6; E 358 699.2 ORIGINATED BY JBF
 DIST 9 HWY 417 BOREHOLE TYPE Hollow Stem Augers, Washboring COMPILED BY TS
 DATUM Geodetic DATE 88 07 21-22 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 γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			VALUES	20					
62.0	Ground Surface												GR SA SI CL
0.0			1	SS	2								0 59 31 10
			2	SS	5								0 98 (2)
			3	SS	20								0 98 (2)
			4	SS	22								1 97 (2)
			5	SS	44								0 49 50 1
			6	SS	47								17 74 (9)
			7	SS	89								
			8	SS	94								
			9	SS	72								
			10	SS	103/	15cm							
			11	SS	124								
40.2			12	SS	113								
21.8	END OF BOREHOLE												

OFFICE REPORT ON SOIL EXPLORATION

+3, x5: Numbers refer to Sensitivity

20
15 5 (%) STRAIN AT FAILURE
10

RECORD OF BOREHOLE No 6-4

METRIC

W P 120-87-09 LOCATION Co-Ords N 5 022 729.9; E 358 737.4 ORIGINATED BY JBF
 DIST 9 HWY 417 BOREHOLE TYPE Hollow Stem Augers, Washboring & Cone Test COMPILED BY TS
 DATUM Geodetic DATE 88 07 22 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 γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			'N' VALUES	20					
65.7	Ground Surface												
0.0													
			1	SS		19							
			2	SS		73							
			3	SS		37							
			4	SS		16							
			5	SS		38							
			6	SS		60							
			7	SS		53							
			8	SS		36							
53.1													
12.6	END OF BOREHOLE												
	* Water Level not established												

OFFICE REPORT ON SOIL EXPLORATION

RECORD OF BOREHOLE No 14-1

METRIC

W P 120-87-03 LOCATION Co-Ords N 5 022 737.7; E 358 692.0 ORIGINATED BY JBF
 DIST 9 HWY 417 BOREHOLE TYPE Hollow Stem Augers, Washboring & Cone Test COMPILED BY JBF
 DATUM Geodetic DATE 88 07 21 CHECKED BY

OFFICE REPORT ON SOIL EXPLORATION

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20 40 60 80 100	WATER CONTENT (%)					
66.1	Ground Surface													
0.0	Mixture of Sand, Silt and Gravel		1	SS	5									
	(Fill)		2	SS	17									
	Brown loose to Compact		3	SS	27									9 59 24 8
61.5			4	SS	44									5 88 (7)
4.6	Brown Grey		5	SS	62									19 73 (8)
	Sand		6	SS	95									0 90 (10)
	Trace Silt		7	SS	46									2 91 (7)
	Trace Gravel		8	SS	49									
	Compact to Very Dense		9	SS	16									
			10	SS	18									
			11	SS	31									0 98 (2)
			12	SS	55									
			13	SS	53									
			14	SS	120/	25cm								
46.3			15	SS	73									
19.8	Het. Mixture of Sand, Gravel, Boulders (Glacial Till)													
44.3	Grey, very dense													
21.8	END OF BOREHOLE													

RECORD OF BOREHOLE No 14-2

METRIC

W P 120-87-03 LOCATION Co-Ords N 5 022 758.9; E 358 645.1 ORIGINATED BY TS
 DIST 9 HWY 417 BOREHOLE TYPE Cone Test, H-S Auger, B-Casing, Washbore & BXL Rock Core COMPILED BY TS
 DATUM Geodetic DATE 88 07 22-23 CHECKED BY

OFFICE REPORT ON SOIL EXPLORATION

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT Y	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40					
65.6	Ground Surface													GR SA SI CL
0.0	Mixture of Clayey Silt and Gravel (Fill) Brown, compact		1	SS	18									2 72 19 7
			2	SS	15									6 70 20 4
60.6			3	SS	21									5 88 (7)
5.0	Sand	Brown Grey	4	SS	5									4 90 (6)
	Trace Silt		5	SS	12									1 90 (9)
	Trace Gravel		6	SS	23									1 90 (9)
	Compact		7	SS	25									
	To		8	SS	19									
	Very Dense		9	SS	30									
			10	SS	55									
			11	SS	38									
			12	SS	33									0 91 (9)
			13	SS	32									
			14	SS	36									
			15	SS	97									13 78 (9)
41.2			16	SS	54									
24.4	Het Mixture of Sand, Gravel and Boulders, Very Dense		17	RC	REC	100%								RQD = 41%
39.1	(Glacial Till)		18	BXL RC	REC 95%									RQD = 64%
26.5	Bedrock Dolostone Unweathered													
37.9	END OF BOREHOLE													
27.7	* Water Level not established. Hole caved in at 2.1m depth.													

+3, x5: Numbers refer to Sensitivity

20
15 5 (%) STRAIN AT FAILURE
10

RECORD OF BOREHOLE No 14-3

METRIC

W P 120-87-03 LOCATION Co-Ords N 5 022 791.6; E 358 619.6 ORIGINATED BY JBF
 DIST 9 HWY 417 BOREHOLE TYPE Hollow Stem Auger, Washboring, & Cone Test COMPILED BY JBF
 DATUM Geodetic DATE 88 07 23 CHECKED BY

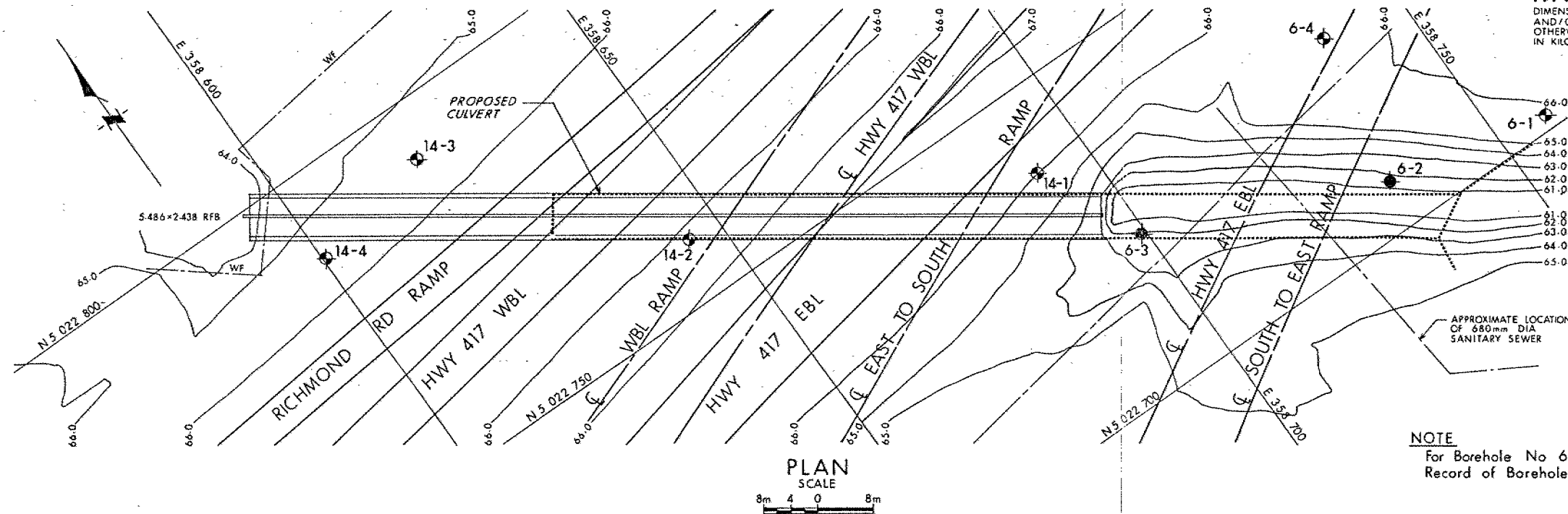
OFFICE REPORT ON SOIL EXPLORATION

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20 40 60 80 100	SHEAR STRENGTH kPa					
65.4	Ground Surface													
0.0	Mixture of Clayey Silt, Sand, and Gravel Brown, Very Stiff (Fill)	X	1	SS	27	*	64							
61.9			2	SS	17		62						6 48 32 14	
3.5	Sand trace Silt Occ. Gravelly Zones Compact to Very Dense Grey	.	3	SS	18		60						29 58 13 0	
			4	SS	30		58						0 89 (11)	
			5	SS	50		56							
			6	SS	19		54						0 94 (6)	
			7	SS	61									
52.8			8	SS	26									
12.6	END OF BOREHOLE						52							
							50							
							48							
							46							
43.8							44							
21.6	END OF CONE TEST													
	* Water level not established. Hole caved in at 4.6m depth													

METRIC

W P 120-87-03 LOCATION Co-Ords N 5 022 787.1; E 358 600.4 ORIGINATED BY TS
DIST 9 HWY 417 BOREHOLE TYPE Cone Test, H-S Auger, Washbore COMPILED BY JBF
DATUM Gendetic DATE 88 07 22 CHECKED BY _____

[illegible]



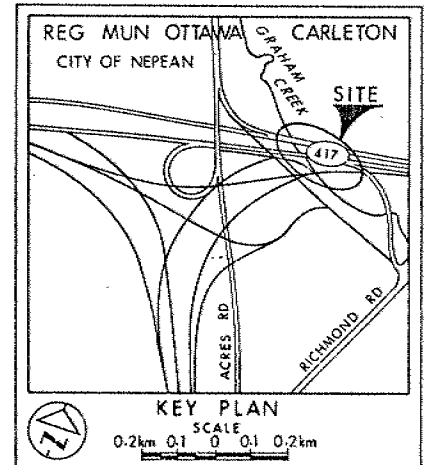
METRIC
DIMENSIONS ARE IN METRES
AND/OR MILLIMETRES UNLESS
OTHERWISE SHOWN. STATIONS
IN KILOMETRES + METRES.

CONT No
WP No 120-87-09

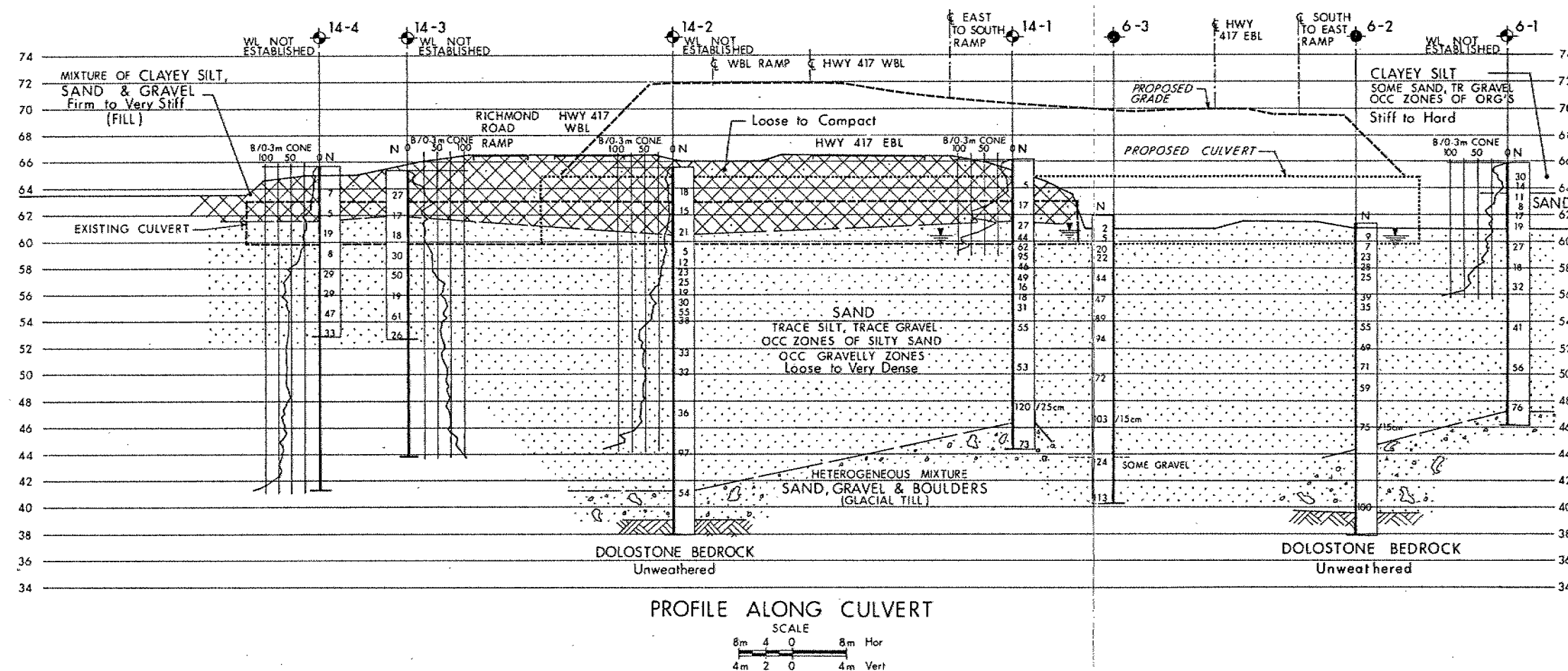
HWY 417 & GRAHAM CREEK
(SOUTH CULVERT) STR 6
BORE HOLE LOCATIONS & SOIL STRATA



SHEET



NOTE
For Borehole No 6-4 see
Record of Borehole Sheet

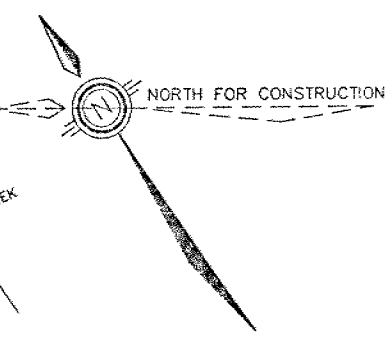
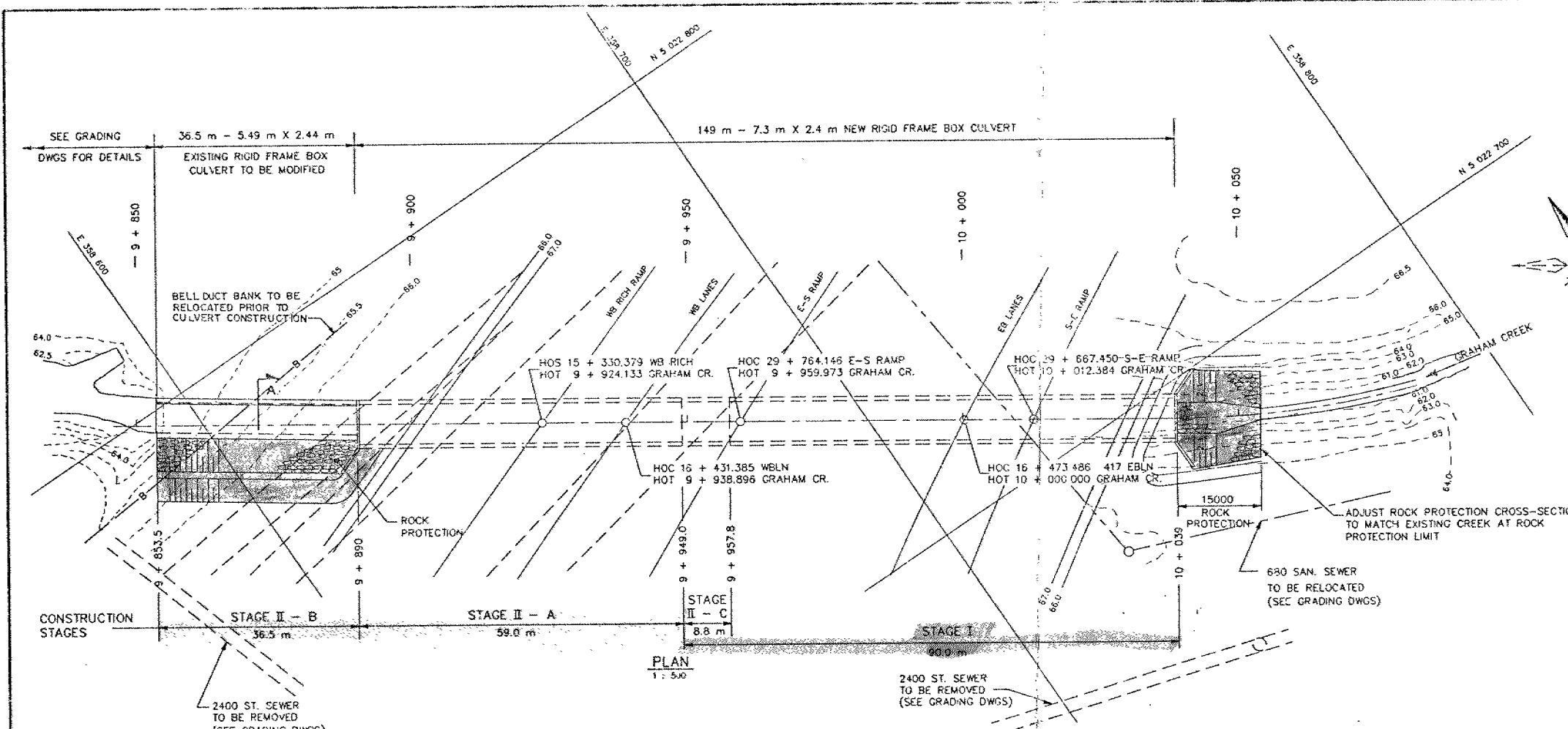


LEGEND			
	Bore Hole		
	Dynamic Cone Penetration Test (Cone)		
	Bore Hole & Cone		
N	Blows/0.3m (Std Pen Test, 475 J/blow)		
CONE	Blows/0.3m (60° Cone, 475 J/blow)		
	WL at time of investigation 88.07		
No	ELEVATION	CO-ORDINATES	
		NORTH	EAST
6-1	65.9	5 022 702.0	358 757.4
6-2	61.4	5 022 707.2	358 733.3
6-3	62.0	5 022 721.6	358 699.2
6-4	65.7	5 022 729.9	358 737.4
14-1	66.1	5 022 737.7	358 692.0
14-2	65.6	5 022 758.9	358 645.1
14-3	65.4	5 022 791.6	358 619.0
14-4	65.6	5 022 787.1	358 600.4

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

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

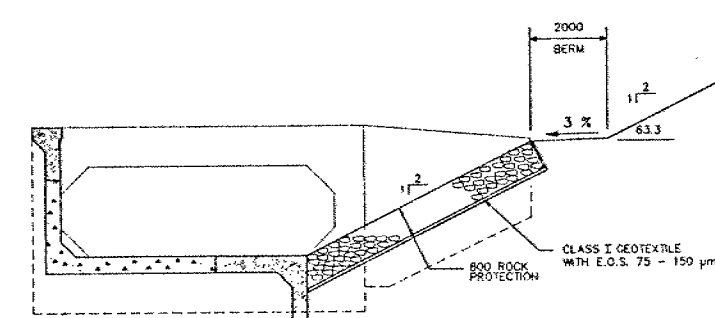
REV	DATE	BY	DESCRIPTION
Geocres No 31G5-149			
HWY No 417		DIST 9	
SUBMITT	CHECKED	DATE 88.11.03	SITE 3-537
DRAWN DT	CHECKED	APPROVED	DWG 1208709-A



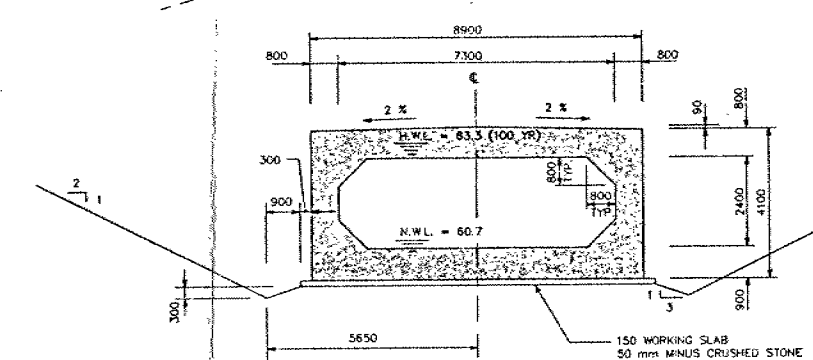
- GENERAL NOTES**
- DESIGNED IN ACCORDANCE WITH THE 1983 EDITION OF THE O.H.B.D.C. WITH THE EXCEPTION OF THE SHEAR PROVISIONS IN CLAUSE 8-8.2.7. SHEAR DESIGN BASED ON THE 1938 EDITION OF THE M.T.O. CONCRETE CULVERT DESIGN AND DETAILING MANUAL.
 - CLASS OF CONCRETE SHALL BE 30 MPa.
 - REINFORCING STEEL SHALL BE GRADE 400 UNLESS OTHERWISE SPECIFIED.
 - CLEAR COVER TO REINFORCING STEEL
 BOTTOM OF TOP SLAB 50 ± 10
 BOTTOM OF BOTTOM SLAB 100 ± 25
 REMAINDER 70 ± 20 UNLESS OTHERWISE NOTED.
 - ABBREVIATIONS USED IN REINFORCEMENT DETAILING:
 ALT DENOTES ALTERNATE
 IF DENOTES INSIDE FACE
 OF DENOTES OUTSIDE FACE
 EF DENOTES EACH FACE
 - ALL EXPOSED CONCRETE EDGES TO HAVE 25 mm x 25 mm CHAMFER.
 - CULVERT DESIGNED FOR 7.5 m FILL DEPTH.
 - STAGE NUMBERS SHOWN RELATE TO GRAHAM CREEK CULVERT CONSTRUCTION. REFER TO GRADING DRAWINGS FOR PROJECT STAGING.

who does this?

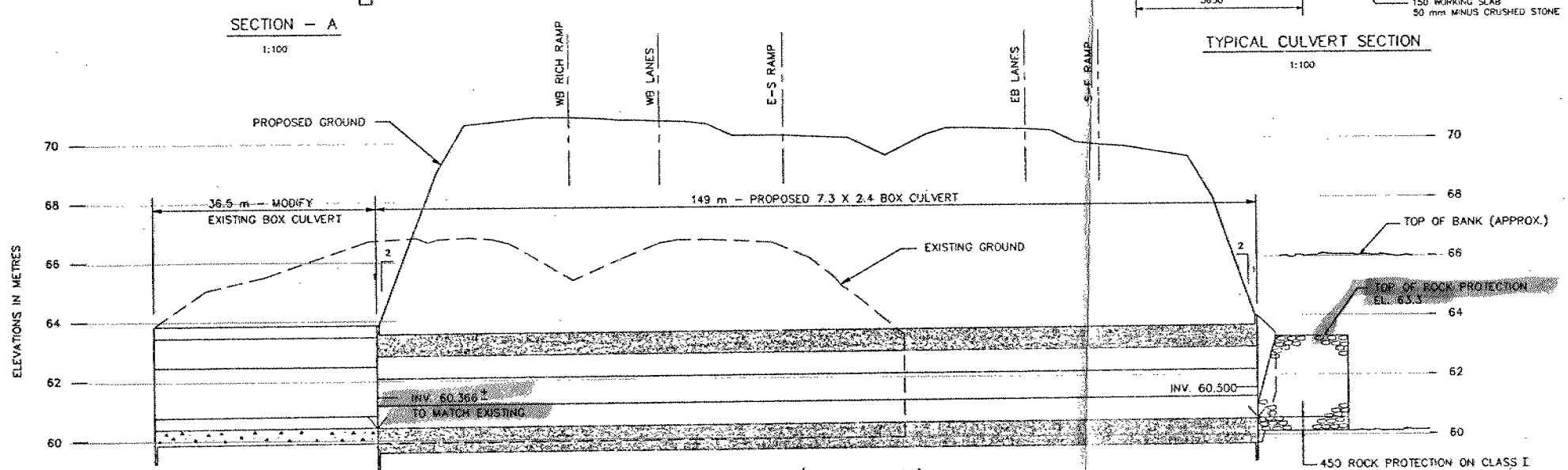
- CONSTRUCTION NOTES**
- BACKFILL SHALL BE PLACED SIMULTANEOUSLY BEHIND BOTH SIDES OF CULVERT KEEPING THE HEIGHT OF THE BACKFILL APPROXIMATELY THE SAME. AT NO TIME SHALL THE DIFFERENCE IN ELEVATION BE GREATER THAN 300 mm.
 - NO CONCRETE SHALL BE PLACED UNTIL DEPTH OF THE EXCAVATION AND THE CHARACTER OF THE FOUNDATION HAVE BEEN APPROVED BY THE ENGINEER.
 - WORKING SLAB SHALL BE PLACED WITHIN 4 HOURS OF EXPOSURE.
 - DEWATERING OF EXCAVATION SHALL BE BY PERIMETER DITCHES SLOPED TO A COMMON OUTLET. DITCHES MUST BE PUMPED OUT AT ALL TIMES UNTIL BOTTOM SLAB OF CULVERT IS PLACED.
 - EXCAVATED MATERIAL MAY BE REUSED FOR BACKFILLING CREEK DIVERSIONS (SUBJECT TO APPROVAL OF THE ENGINEER)



SECTION - A
1:100



TYPICAL CULVERT SECTION
1:100



LONGITUDINAL SECTION (ALONG C OF CULVERT)
HOR. 1: 500
VERT. 1: 100



DRAWING NOT TO BE SCALED
100 mm ON ORIGINAL DRAWING

LIST OF DRAWINGS

- GENERAL ARRANGEMENT
- BOREHOLE LOCATIONS AND SOIL STRATA
- CREEK DIVERSION - STAGE I
- CREEK DIVERSION - STAGE II
- STRUCTURAL DETAILS - STAGE I
- STRUCTURAL DETAILS - STAGE II - A & C
- STRUCTURAL DETAILS - STAGE II - B
- WINGWALL DETAILS
- BRIDGE DATE & SITE NUMBER DATA.
- QUANTITIES - STRUCTURES

DATE	BY	DESCRIPTION
DESIGN G.A.M.	CHK. M.L.T.	LOADING
DRAWN G.V.	CHK. M.L.T.	SITE No 03-537
		DATE DEC 1999
		DWG 1