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# **FOUNDATION INVESTIGATION REPORT**

**CONTRACT NO. 94-84**



Ministry of  
Transportation

Ontario

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Note: For purposes of the contract, this report supersedes all other Foundation Reports prepared by, or for the Ministry in connection with the above mentioned projects.

## EXPLANATION OF TERMS USED IN REPORT

2

**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
$\sigma$	kPa	TOTAL NORMAL STRESS
$\sigma'$	kPa	EFFECTIVE NORMAL STRESS
$\tau$	kPa	SHEAR STRESS
$\sigma_1, \sigma_2, \sigma_3$	kPa	PRINCIPAL STRESSES
$\epsilon$	%	LINEAR STRAIN
$\epsilon_1, \epsilon_2, \epsilon_3$	%	PRINCIPAL STRAINS
E	kPa	MODULUS OF LINEAR DEFORMATION
G	kPa	MODULUS OF SHEAR DEFORMATION
$\mu$	1	COEFFICIENT OF FRICTION

### MECHANICAL PROPERTIES OF SOIL

$m_v$	kPa <sup>-1</sup>	COEFFICIENT OF VOLUME CHANGE
$C_c$	1	COMPRESSION INDEX
$C_s$	1	SWELLING INDEX
$C_\alpha$	1	RATE OF SECONDARY CONSOLIDATION
$c_v$	m <sup>2</sup> /s	COEFFICIENT OF CONSOLIDATION
H	m	DRAINAGE PATH
$T_v$	1	TIME FACTOR
U	%	DEGREE OF CONSOLIDATION
$\sigma'_{v0}$	kPa	EFFECTIVE OVERBURDEN PRESSURE
$\sigma'_p$	kPa	PRECONSOLIDATION PRESSURE
$\tau_f$	kPa	SHEAR STRENGTH
$c'$	kPa	EFFECTIVE COHESION INTERCEPT
$\phi'$	-°	EFFECTIVE ANGLE OF INTERNAL FRICTION
$c_u$	kPa	APPARENT COHESION INTERCEPT
$\phi_u$	-°	APPARENT ANGLE OF INTERNAL FRICTION
$\tau_R$	kPa	RESIDUAL SHEAR STRENGTH
$\tau_r$	kPa	REMOULDED SHEAR STRENGTH
$S_t$	1	SENSITIVITY = $\frac{c_u}{\tau_r}$

### PHYSICAL PROPERTIES OF SOIL

$\rho_s$	kg/m <sup>3</sup>	DENSITY OF SOLID PARTICLES	e	1, %	VOID RATIO	$e_{min}$	1, %	VOID RATIO IN DENSEST STATE
$\gamma_s$	kN/m <sup>3</sup>	UNIT WEIGHT OF SOLID PARTICLES	n	1, %	POROSITY	$I_D$	1	DENSITY INDEX = $\frac{e_{max} - e}{e_{max} - e_{min}}$
$\rho_w$	kg/m <sup>3</sup>	DENSITY OF WATER	w	1, %	WATER CONTENT	D	mm	GRAIN DIAMETER
$\gamma_w$	kN/m <sup>3</sup>	UNIT WEIGHT OF WATER	$S_r$	%	DEGREE OF SATURATION	$D_n$	mm	n PERCENT - DIAMETER
P	kg/m <sup>3</sup>	DENSITY OF SOIL	$w_L$	%	LIQUID LIMIT	$C_u$	1	UNIFORMITY COEFFICIENT
$\gamma$	kN/m <sup>3</sup>	UNIT WEIGHT OF SOIL	$w_p$	%	PLASTIC LIMIT	h	m	HYDRAULIC HEAD OR POTENTIAL
$\rho_d$	kg/m <sup>3</sup>	DENSITY OF DRY SOIL	$w_s$	%	SHRINKAGE LIMIT	q	m <sup>3</sup> /s	RATE OF DISCHARGE
$\gamma_d$	kN/m <sup>3</sup>	UNIT WEIGHT OF DRY SOIL	$I_p$	%	PLASTICITY INDEX = $w_L - w_p$	v	m/s	DISCHARGE VELOCITY
$\rho_{sat}$	kg/m <sup>3</sup>	DENSITY OF SATURATED SOIL	$I_L$	1	LIQUIDITY INDEX = $\frac{w - w_p}{I_p}$	i	1	HYDRAULIC GRADIENT
$\gamma_{sat}$	kN/m <sup>3</sup>	UNIT WEIGHT OF SATURATED SOIL	$I_C$	1	CONSISTENCY INDEX = $\frac{w_L - w}{I_p}$	k	m/s	HYDRAULIC CONDUCTIVITY
$\rho'$	kg/m <sup>3</sup>	DENSITY OF SUBMERGED SOIL	$e_{max}$	1, %	VOID RATIO IN LOOSEST STATE	j	kN/m <sup>3</sup>	SEEPAGE FORCE
$\gamma'$	kN/m <sup>3</sup>	UNIT WEIGHT OF SUBMERGED SOIL						

## FOUNDATION INVESTIGATION REPORT

For

Culvert Replacement

W.P. 331- 89-00

Queen Elizabeth Way

Fifty Road to Casablanca Boulevard

Stoney Creek and Grimsby

### 1.0 INTRODUCTION

This report presents the results of a foundation investigation carried out at 18 proposed culvert replacement sites in the City of Stoney Creek and Town of Grimsby, Ontario. The investigation was carried out in accordance with our proposal dated 94/08/06. Authorization to carry out the work was provided by the Foundation Design Section, Ministry of Transportation, Ontario (MTO).

This report contains factual information pertaining to the subsurface condition.

### 2.0 SITE DESCRIPTION AND GEOLOGY

Eighteen (18) culvert replacement sites are located along the Queen Elizabeth Way (QEW) from Fifty Road in Stoney Creek to approximately 1 km east of Casablanca Boulevard in Grimsby. The terrain surrounding the sites is generally flat and consists of mixed residential, agricultural and industrial land uses. The existing ground surface generally slopes downward gently from south to north, towards Lake Ontario.

At the time of the investigation, the QEW is a four-lane divided highway with gravel shoulders. A North Service Road and South Service Road is located parallel to the QEW on the north and south sides, respectively. Both the North and South Service Roads are two-lane paved roads with gravel shoulders.

Drainage of the existing QEW is provided by highway ditches located on both the north and south sides and in between the QEW and the two service roads. The culverts investigated during this study facilitate drainage of these ditches beneath the QEW towards the north into Lake Ontario. At each culvert location beneath the QEW, there is an additional two separate culverts constructed beneath the North Service Road and the South Service Road.

The existing culverts beneath the QEW and the existing culverts beneath the two service roads consist of either a concrete box culvert or a Corrugated Steel Pipe (CSP) culvert).

Physiographically, the sites lie in the area known as the Halton Till Plain, which consists of glacial till with clayey silt to silty clay size particles and little to no cobbles and boulders. Bedrock underlying the overburden consists of Ordovician shale of the Queenston Formation throughout the study area.

### **3.0 PROCEDURE**

#### **3.1 Field Investigation**

Prior to the onset of the drilling investigation, the necessary utility check clearances were obtained by our site personnel. Traffic control for this project was provided by Barricade Traffic Services Inc., who were coordinated by MTO.

The field work for this investigation was carried out between August 16 and 25, 1994. Three (3) boreholes were put down at each of the culvert locations. The test locations are indicated on Drawings 3318900-A to 3318900-D (Refer to Sheets 91A to D in the Contract Drawings). One dynamic cone penetration test was also conducted at each culvert location.

All boreholes were put down using either a track-mounted or truck-mounted power auger drill suitable equipped for soil and bedrock sampling. Continuous flight solid stem augers and NQ-sized rock coring techniques (where required) were employed during the course of the investigation to advance the boreholes.

The overburden soils encountered were sampled by means of a split spoon sampler during the performance of Standard Penetration Tests (SPT) (ASTM D 1586). Where soft to firm cohesive soils were encountered, field vane tests were conducted at selected locations. Sampling was generally conducted on a near continuous basis (intervals of 0.76 m) at the top 4.6 m of the borehole. Below this depth, sampling was conducted in intervals of about 1.5 m.

Water levels, where observed, were obtained in the open boreholes upon completion of the drilling. All boreholes were backfilled with auger cuttings and sealed with a minimum 500 mm thick bentonite layer at the ground surface. Boreholes put down at the median where the surface consists of asphaltic concrete were surfaced with a minimum of 50 mm of cold mix asphalt.

### **3.2 Survey**

The borehole and cone penetration test locations and ground surface elevations were surveyed by Jacques Whitford Environment Limited (JWEL) personnel after completion of the field work. The elevations were referenced to the existing culvert invert elevations shown on the site plans, provided by MTO. The elevations are assumed to be referenced to the Geodetic datum.

### **3.3 Laboratory Testing**

To identify the properties of the samples collected during the field investigation, the following laboratory tests were carried out on selected samples:

- Detailed visual classification,
- Natural moisture content,
- Sieve and hydrometer analyses,
- Atterberg Limits determination,
- Natural unit weight determination

## **4.0 RESULTS OF THE INVESTIGATION**

The subsurface conditions observed in the boreholes are presented in detail on the Record of Boreholes provided in Appendix .

A brief discussion of the observed subsurface conditions is provided below. Specific details of the subsurface materials at a particular culvert location should be obtained from the Record of Boreholes.

### **4.1 W.P. 331-89-00**

#### **4.1.1 Topsoil**

Topsoil was encountered at the ground surface in most boreholes except the boreholes located in the median of the QEW. The thickness of the topsoil ranges from 50 mm to 600 mm.

#### **4.1.2 Asphaltic Concrete**

Asphaltic concrete was encountered at the ground surface in Boreholes 135-41-2, 136-04-2, 136-14-2 and 136-15-2 (QEW median locations). The thickness of the asphaltic concrete ranged from 50 mm to 100 mm at the time of the investigation with an average thickness of about 75 mm.

#### **4.1.3 Sand, Silt and Gravel (Fill) / Silt (Fill)**

A loose to compact mixture of sand, silt and gravel (fill) layer was encountered at the ground surface or underlying the asphaltic concrete in all QEW median boreholes. The thickness of the fill layer ranged from 0.5 m to 2.6 m. The SPT conducted in this fill layer yielded N values ranging from 6 to 20. In general, this material was observed to be compact. Based on visual identification and laboratory tests, this fill can be classified as inorganic and cohesionless.



A compact silt (fill) with varying amounts of sand, clay and gravel was encountered underlying the sand, silt and gravel (fill) mentioned above, in Boreholes 135-40-2, 136-01-2, 136-05-2, 136-07-2, and 136-12-2. The thickness of the fill layer ranged from 0.9 m to 1.5 m. The SPT conducted in this fill layer yielded N values ranging from 9 to 25. The visual observations and laboratory test results indicate that this material is cohesionless.

The results of laboratory testing carried out on selected samples of both fill material types are provided on the Record of Boreholes, on Figures 5 and 7 in Appendix and are summarized below:

Property	Range	# Tests	Average
Moisture Content (%)	4-18	16	10
Grain Size			
% Gravel	0-42	4	18
% Sand	4-45	4	28
% Silt	13-76	4	43
% Clay	0-20	4	11
Liquid Limit (%)	24-39	3	30
Plastic Limit (%)	16-22	3	18
Plasticity Index (%)	7-17	3	12

#### 4.1.4 Heterogeneous Mixture of Silt and Clay, some Sand, trace Gravel (Glacial Till)

A heterogeneous mixture of silt and clay, some sand, trace gravel (glacial till) was encountered in all boreholes except Boreholes 136-10-2, 136-11-2, 136-12-1 and 136-12-2. The glacial till was observed at the ground surface or it was underlying the fill or topsoil. Where present, the glacial till surface was encountered at elevations ranging from El. 79.3 m to El. 84.3 m (depths of 0 m to 2.6 m).

The SPT conducted in the glacial till layer yielded N values ranging from 4 to over 100. All boreholes were terminated within the glacial till deposit with the exception of Boreholes 135-41-3, 136-08-3 to 136-13-3, and 136-16-1 to 136-16-3, which encountered shale bedrock.

The results of laboratory testing on selected SPT samples of this till material are provided on the Record of Boreholes, on Figures 1 to 4 and 8 in Appendix 1, and are summarized below:

Property	Range	# Test	Average
Moisture Content (%)	4-37	184	14
Grain size			
% Gravel	0-9	32	2
% Sand	10-56	32	18
% Silt and Clay	39-90	32	80
% Silt	34-73	32	55
% Clay	5-41	32	25
Liquid Limit (%)	23-39	31	32
Plastic Limit (%)	10-20	31	16
Plasticity Index (%)	10-22	31	16

Based on the above testing and visual identification, this till material can generally be classified as an inorganic, cohesive silt and clay of low to medium plasticity. Seams of cohesionless materials, generally consisting of sands and gravels, are noted at random depths and locations throughout the deposit. Grain size analysis of glacial till samples is limited to the maximum size of the SPT sampling methods that were employed (38 mm). Cobbles and/or boulders can be encountered in a glacial till deposit. Large cobbles or boulders were not detected in any of the boreholes put down as part of this investigation.

Vane shear testing was not possible due to the stiffness of this material. Based on laboratory observations and SPT correlations, the till is typically in the very stiff to hard range.

#### 4.1.5 Bedrock

Bedrock was encountered underlying the glacial till in Boreholes 135-41-3, 136-08-3 to 136-13-3, and 136-16-1 to 136-16-3, and sampled by coring in NQ-size in Boreholes 136-10-1 and 136-11-1. In the other boreholes, the bedrock could be penetrated by solid stem augers. The bedrock surface at these locations was encountered between El. 75.0 m and El. 83.4 m (depths of 0.2 m to 6.1 m). The bedrock is a reddish brown to grey, weathered to unweathered shale of the Queenston Formation. The bedrock is of poor to good quality (RQD of the unweathered shale ranging from 65% to 88%). Core recoveries varied between 97% and 100%. The average RQD over 5.8 m of rock cored was 74%, indicating an overall rock mass quality of fair.

#### 4.1.6 Groundwater

Groundwater was encountered in Boreholes 135-40-3, 136-02-3, 136-04-2, 136-05-3, 136-06-3, 136-11-3, 136-12-2, 136-13-3, 136-16-2 and 136-16-3 as noted on the Borehole Records. Groundwater levels at these locations ranged between El. 75.1 m and El. 81.3 m, or from 1.9 m to 7.7 m below ground surface immediately prior to backfilling. Groundwater was not encountered in other boreholes. Artesian conditions were not encountered in any of the boreholes.

The groundwater levels noted on the Borehole Records were recorded immediately after drilling. Due to the relatively low permeability of the overburden soils, these groundwater levels may not represent the static water levels which would approximately correspond to an adjacent creek level draining into Lake Ontario. Groundwater levels are subject to seasonal fluctuations.

## 5.0 MISCELLANEOUS

The field work for this investigation was carried out under the supervision of R. Rintjema, P. Eng., N. Lobo and C. Reynolds. Drilling equipment was provided by Master Soil Investigation Ltd. and Eastern Soil Investigation Ltd.

The report was prepared by C. Kwok and T. Olson, Project Engineer, and approved G. Kack, Project Manager.

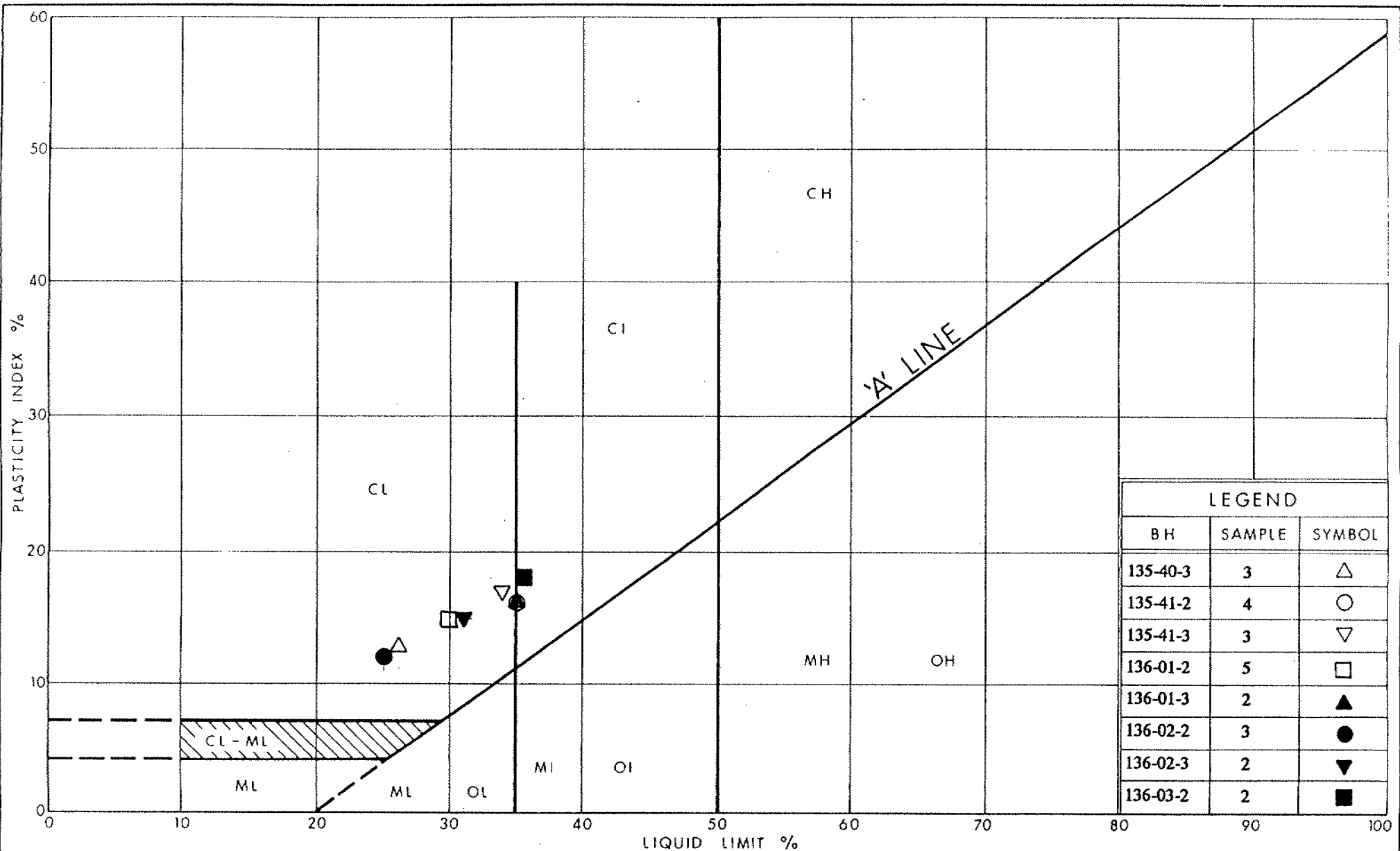
Note: The preceding report is a copy of the factual information from the Foundation Investigation and Design Report prepared by Jacques Whitford Environment Ltd. (consulting geotechnical engineers for this project), under the technical supervision of the MTO Foundation Design Section.



D. Dundas, P. Eng.

Sr. Foundation Engineer

**APPENDIX**

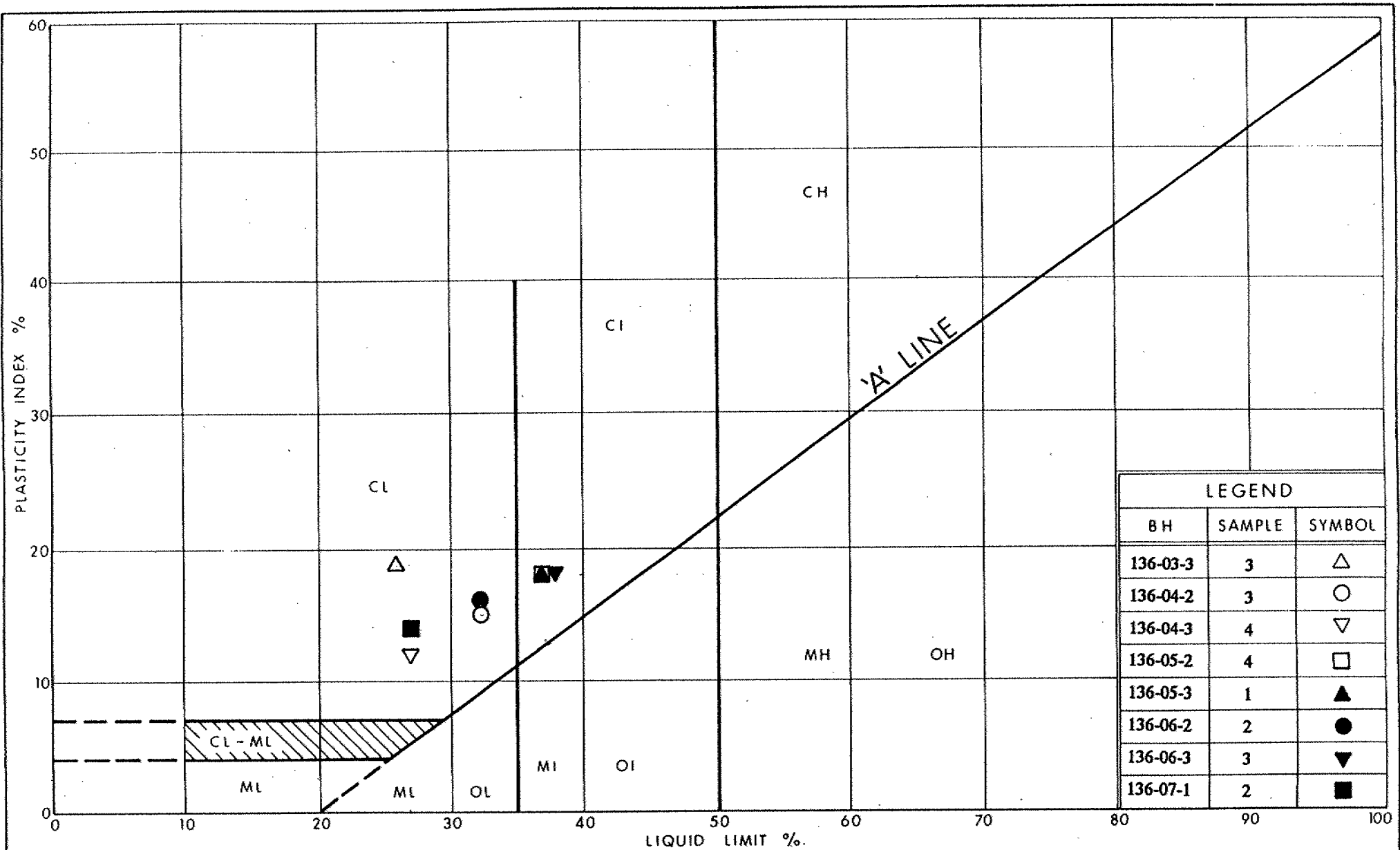


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**PLASTICITY CHART**  
**HET MIXTURE OF SILT & CLAY, SOME SAND,**  
**TRACE GRAVEL (Glacial Till)**

**FIG No 1**

**W P 331-89-00**

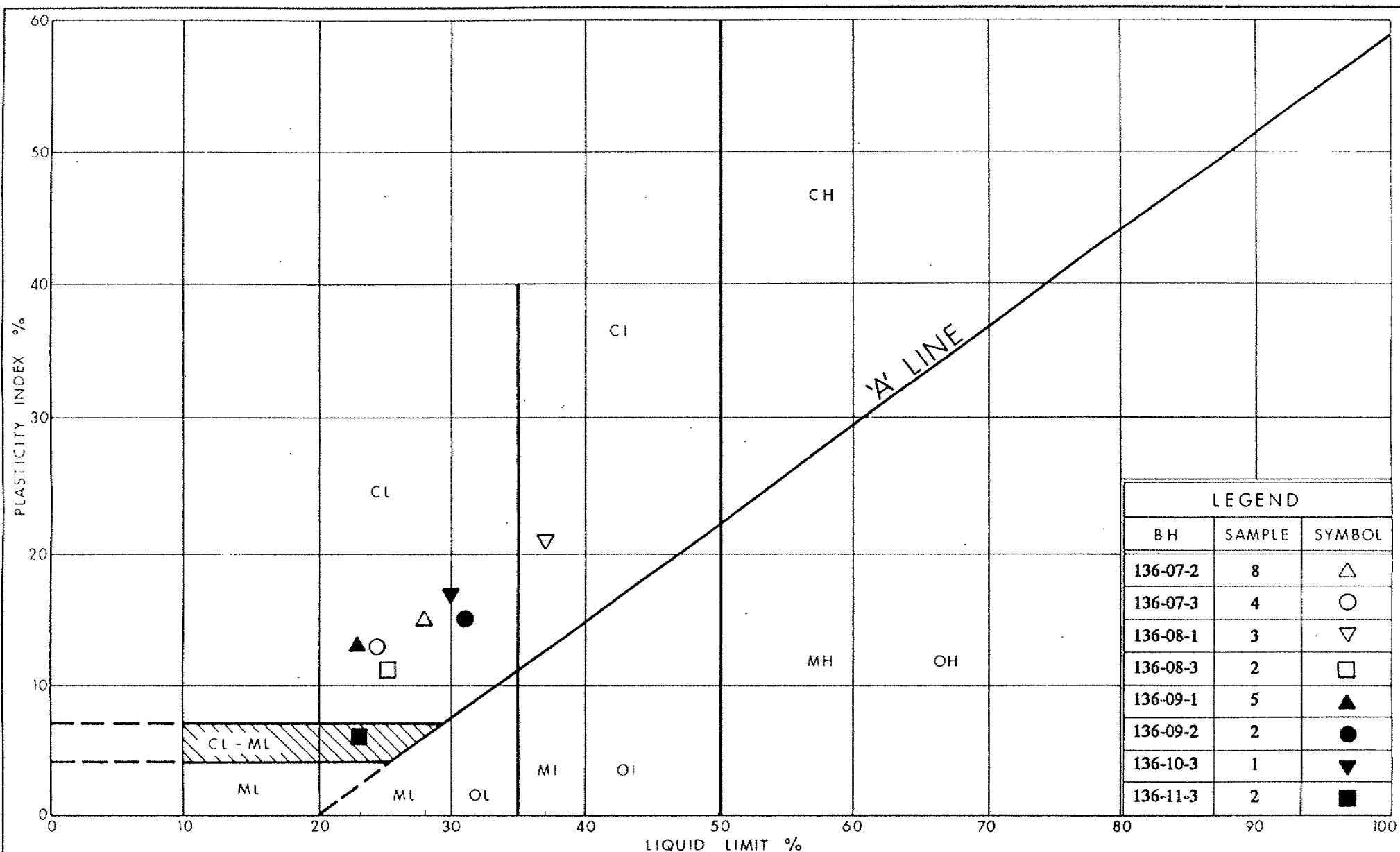


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**PLASTICITY CHART**  
**HET MIXTURE OF SILT & CLAY, SOME SAND,**  
**TRACE GRAVEL (Glacial Till)**

**FIG No 2**

**W P 331-89-00**



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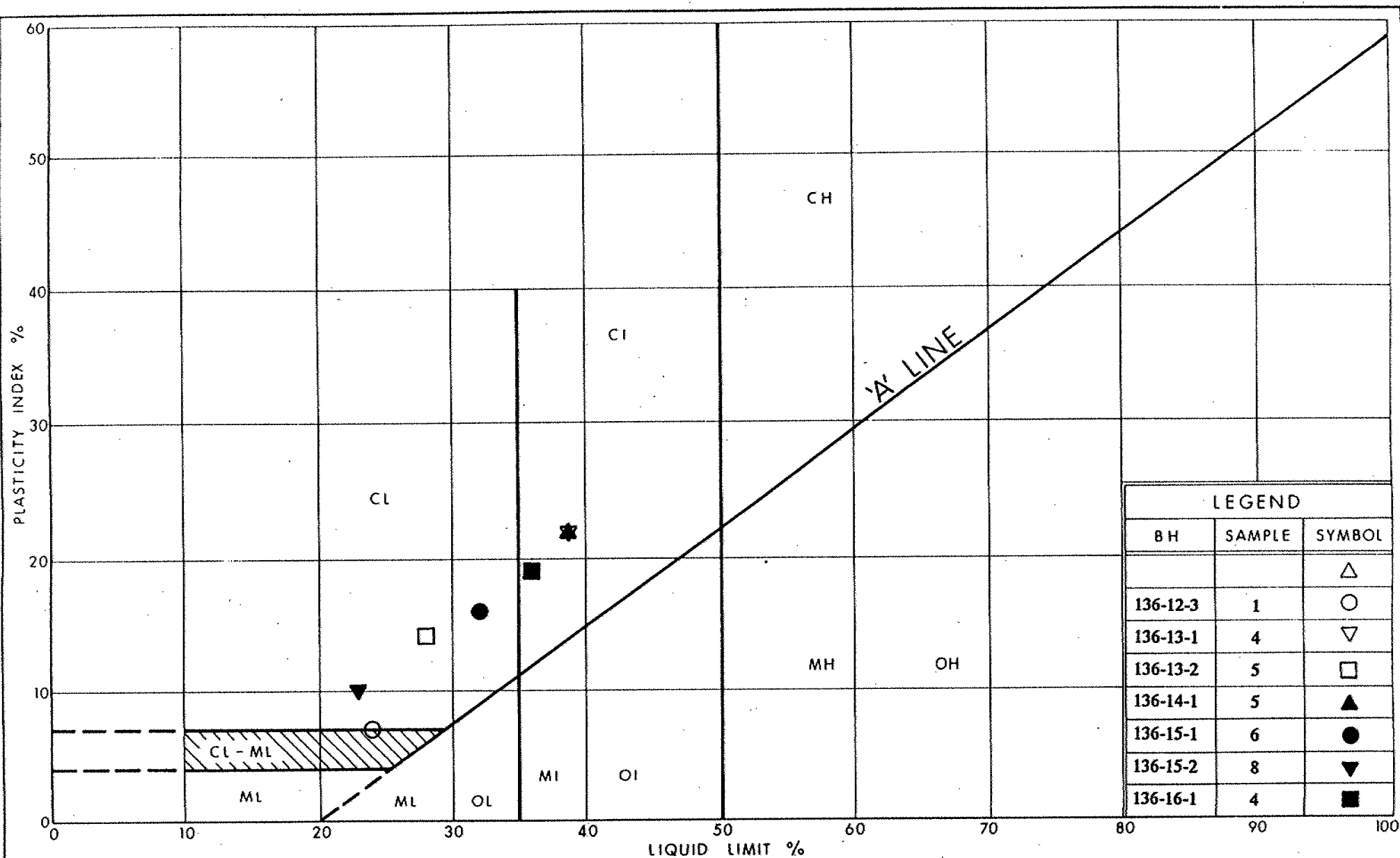
Ontario

**PLASTICITY CHART**  
**HET MIXTURE OF SILT & CLAY, SOME SAND,**  
**TRACE GRAVEL (Glacial Till)**

**FIG No 3**

**W P 331-89-00**



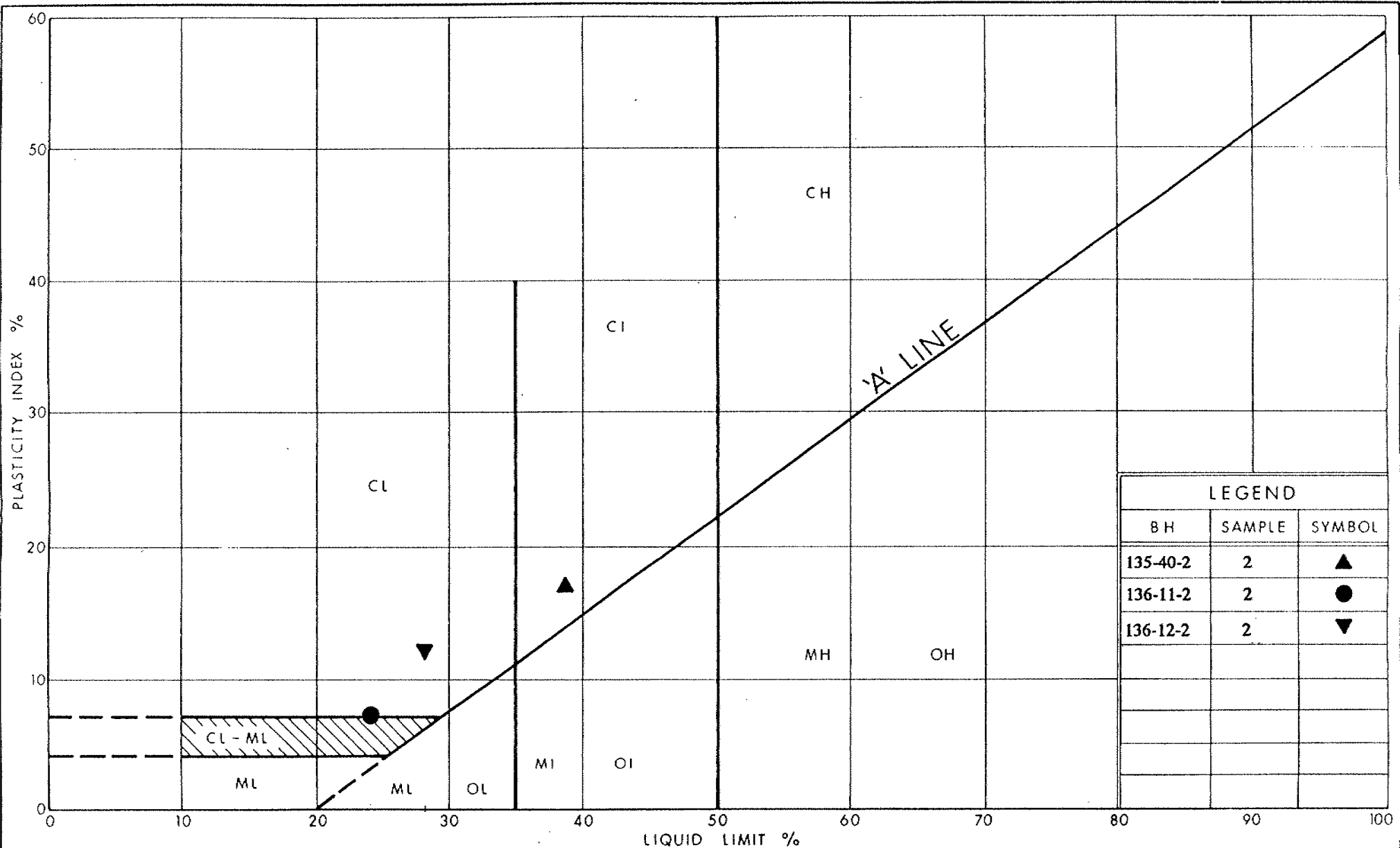


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**PLASTICITY CHART**  
**HET MIXTURE OF SILT & CLAY, SOME SAND,**  
**TRACE GRAVEL (Glacial Till)**

**FIG No 4**

**W P 331-89-00**



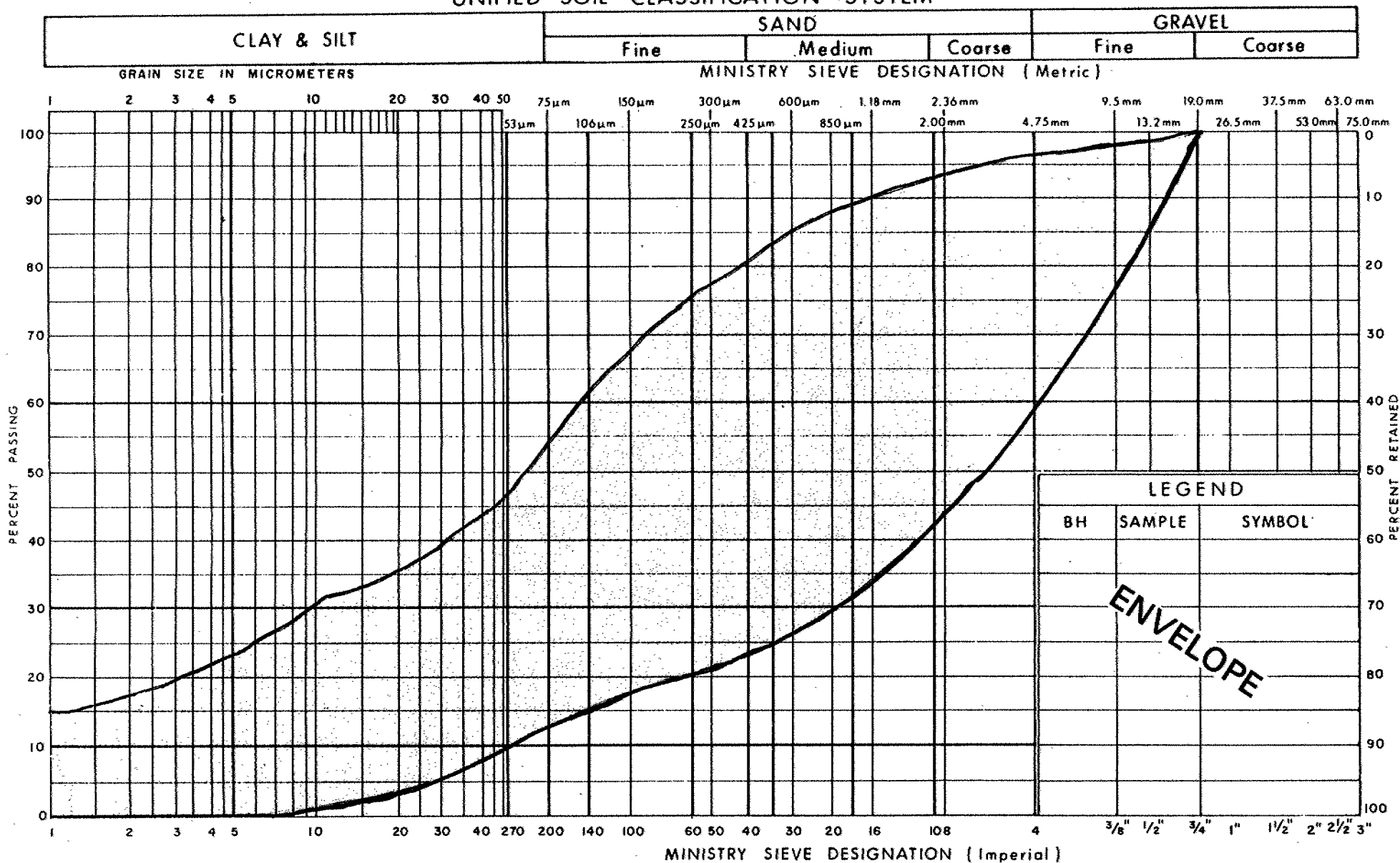
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Transportation

# PLASTICITY CHART MIXTURE OF SILT, CLAY, SAND & GRAVEL (FILL)

FIG No 5

W P 331-89-00

## UNIFIED SOIL CLASSIFICATION SYSTEM



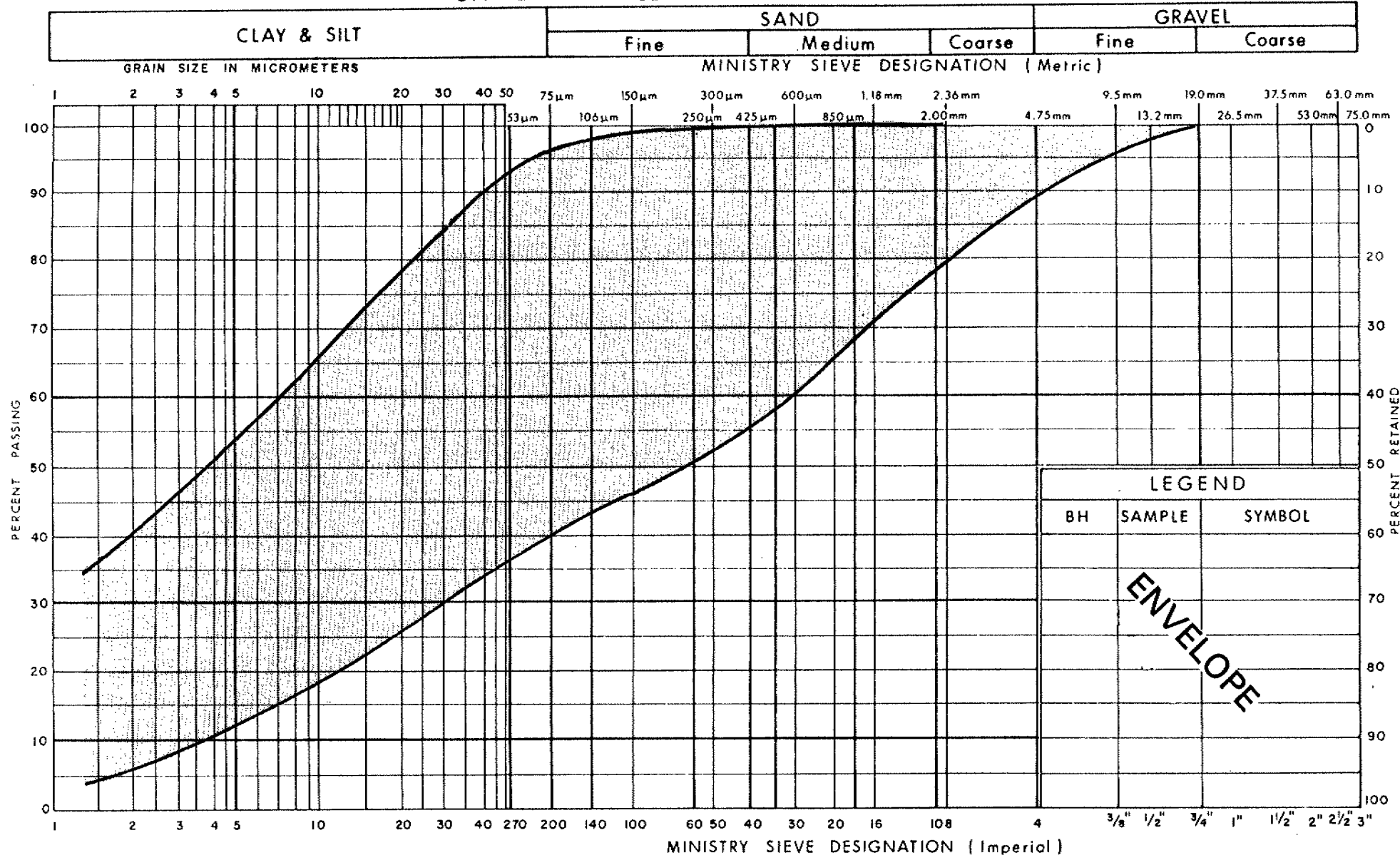
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## GRAIN SIZE DISTRIBUTION FILL

FIG No 7

W P 331-89-00

## UNIFIED SOIL CLASSIFICATION SYSTEM



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Transportation

**GRAIN SIZE DISTRIBUTION**  
**HET MIXTURE OF SILT & CLAY, SOME SAND,**  
**TRACE GRAVEL (Glacial Till)**

FIG No 8

W P 331-89-00

RECORD OF BOREHOLE No 135-40-1

1 OF 1

METRIC

W.P. 331-89-00 LOCATION WC 135-40; Sta. 31+688, O-S 25m Lt. ORIGINATED BY IK  
DIST 4 HWY QEW BOREHOLE TYPE Solid Stem COMPILED BY IK  
DATUM SEE TEXT DATE 94.08.24 & 94.08.24 CHECKED BY TO

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT $\gamma$ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES		20	40	60	80	100		
81.8	Ground Surface												
0.0	Topsoil		1	SS	12								
81.4													
0.5	Het. mixture of Silt and Clay, some sand, trace gravel  (Glacial Till)  Very Stiff to Hard  Brown Grey		2	SS	37	81							
			3	SS	21	80						24.2	
			4	SS	10	79							
			5	SS	13	78							
			6	SS	22	77							
						76							
75.1			7	SS	35								
6.7	END OF BOREHOLE  Borehole dry upon completion												

RECORD OF BOREHOLE No 135-40-2

1 OF 1

METRIC

W.P. 331-89-00 LOCATION WC 135-40; Sta. 31+688, O-S 4m Rt. ORIGINATED BY IK  
DIST 4 HWY OEW BOREHOLE TYPE Solid Stem, Cone Test COMPILED BY IK  
DATUM SEE TEXT DATE 94.08.10 & 94.08.10 CHECKED BY TO

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W <sub>P</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20	40					
83.5	Ground Surface													
0.0	Mixture of Sand, Silt and Clay, trace gravel. (Fill) Stiff		1	AS										
			2	SS	12									
82.0														
1.5	Het. mixture of Silt and Clay, some sand, trace gravel  (Glacial Till)  Very Stiff to Hard  Brown		3	SS	21									
			4	SS	30									
			5	SS	26									
			6	SS	29									
			7	SS	34									
			8	SS	37									
			9	SS	49									
75.3														
8.2	END OF BOREHOLE  Borehole dry upon completion													

RECORD OF BOREHOLE No 135-40-3

1 OF 1

METRIC

W.P. 331-89-00 LOCATION WC 135-40; Sta. 31+688, O-S 28m Rt. ORIGINATED BY IK  
DIST 4 HWY QEW BOREHOLE TYPE Solid Stem COMPILED BY IK  
DATUM SEE TEXT DATE 94.08.11 & 94.08.11 CHECKED BY TO

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT $\gamma$ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			20	40	60	80	100		
82.0	Ground Surface					82							
0.0	Het. mixture of Silt and Clay, some sand, trace gravel  (Glacial Till)  Very Stiff to Hard       Brown Grey		1	SS	18								
			2	SS	29	81							
			3	SS	19	80							
			4	SS	20								
			5	SS	21	79							
			6	SS	24	78							
			7	SS	34	77							
			8	SS	30	76							
75.3	END OF BOREHOLE												
6.7													

## RECORD OF BOREHOLE No 135-41-1

1 OF 1

## METRIC

W.P. 331-89-00

LOCATION WC 135-41; Sta. 32+102, O-S 30m Lt.

ORIGINATED BY JK

**DIST** 4

HWY QEW

BOREHOLE TYPE Solid Stem

COMPILED BY IK

DATUM SEE TEXT

DATE 94.08.23 & 94.08.23

CHECKED BY \_\_\_\_\_ TO \_\_\_\_\_

[illegible]

\*<sup>3</sup>, ×<sup>3</sup>: Numbers refer to Sensitivity



RECORD OF BOREHOLE No 135-41-2

1 OF 1

METRIC

W.P. 331-89-00 LOCATION WC 135-41; Sta. 32+102, O-S 3m Rt. ORIGINATED BY IK  
DIST 4 HWY QEW BOREHOLE TYPE Solid Stem, Cone Test COMPILED BY IK  
DATUM SEE TEXT DATE 94.08.10 & 94.08.10 CHECKED BY TO

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT	NATURAL MOISTURE CONTENT	LIQUID LIMIT	UNIT WEIGHT $\gamma$ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			"N" VALUES	SHEAR STRENGTH kPa					
82.1	Ground Surface												
82.0	75mm ASPHALT												
0.1	Mixture of Sand, Silt and Gravel. (Fill)		1	AS									
81.2													
0.9	Het. mixture of Silt and Clay, some sand, trace gravel  (Glacial Till)  Very Stiff to Hard		2	SS	6								
			3	SS	29								
			4	SS	25								
			5	SS	25								
			6	SS	18								
			7	SS	24								
			8	SS	33								
			9	SS	25								
74.6													
7.6	END OF BOREHOLE  Borehole dry upon completion												

RECORD OF BOREHOLE No 135-41-3

1 OF 1

METRIC

W.P. 331-89-00 LOCATION WC 135-41; Sta. 32+102, O-S 36m Rt. ORIGINATED BY IK  
DIST 4 HWY QEW BOREHOLE TYPE Solid Stem COMPILED BY IK  
DATUM SEE TEXT DATE 94.08.11 & 94.08.11 CHECKED BY TO

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT $\gamma$ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20	40	60	80	100		
80.5	Ground Surface													
80.4	50mm Topsoil		1	SS	8									
0.1	Het. mixture of Silt and Clay, some sand, trace gravel  (Glacial Till)  Very Stiff to Hard		2	SS	27									
			3	SS	33									
			4	SS	24									
			5	SS	27									
			6	SS	32									
75.0														
5.6	Shale Bedrock Poor to Fair		7	SS	50	100mm								
73.8														
6.7	END OF BOREHOLE  Borehole dry upon completion													

RECORD OF BOREHOLE No 136-01-1

1 OF 1

METRIC

W.P. 331-89-00 LOCATION WC 136-01; Sta. 10+419, O-S 23m Lt. ORIGINATED BY IK  
DIST 4 HWY QEW BOREHOLE TYPE Solid Stem COMPILED BY IK  
DATUM SEE TEXT DATE 94.08.23 & 94.08.23 CHECKED BY TO

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT $\gamma$ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20 40 60 80 100	20 40 60 80 100	20 40 60 80 100	20 40 60 80 100	20 40 60 80 100		
80.2	Ground Surface													
79.9	Topsoil		1	SS	13		80							
0.3	Het. mixture of Silt and Clay, some sand, trace gravel  (Glacial Till)  Very Stiff to Hard   Brown Grey  -grey shale seam (75mm)		2	SS	26		79						20.7	
			3	SS	35		78							
			4	SS	63		77							
			5	SS	68	283mm	76							
			6	SS	26		75							
			7	SS	29		74							
73.5	END OF BOREHOLE													
6.7	Borehole dry upon completion													

RECORD OF BOREHOLE No 136-01-2

1 OF 1

METRIC

W.P. 331-89-00 LOCATION WC 136-01; Sta. 10+419, O-S 4m Rt. ORIGINATED BY IK  
DIST 4 HWY QEW BOREHOLE TYPE Solid Stem, Cone Test COMPILED BY IK  
DATUM SEE TEXT DATE 94.08.11 & 94.08.11 CHECKED BY TO

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				PLASTIC LIMIT	NATURAL MOISTURE CONTENT	LIQUID LIMIT	UNIT WEIGHT $\gamma$ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20	40	60	80					
82.0	Ground Surface															
81.7	Mixture of Sand, Silt and Gravel (Fill)		1	SS	8											
80.3	Mixture of Silt and Sand, trace clay (Fill), loose		2	SS	9											
1.7	Het. mixture of Silt and Clay, some sand, trace gravel  (Glacial Till)  Very Stiff to Hard  Brown Grey		3	SS	33											
			4	SS	45											
			5	SS	59											
			6	SS	69											
			7	SS	35											
			8	SS	49											
			9	SS	36											
73.8	END OF BOREHOLE															
8.2	Borehole dry upon completion															

RECORD OF BOREHOLE No 136-01-3

1 OF 1

METRIC

W.P. 331-89-00 LOCATION WC 136-01; Sta. 10+419, O-S 22m Rt. ORIGINATED BY IK  
DIST 4 HWY QEW BOREHOLE TYPE Solid Stem COMPILED BY IK  
DATUM SEE TEXT DATE 94.08.11 & 94.08.11 CHECKED BY TO

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			UNIT WEIGHT γ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa					
							20	40	60	80	100		
							○ UNCONFINED      × FIELD VANE						
							● QUICK TRIAXIAL    × LAB VANE						
							20	40	60	80	100		
							WATER CONTENT (%)						
							wp	w	wL				
							10	20	30				
79.9	Ground Surface												
79.8	75mm Topsoil		1	SS	9								
0.1	Het. mixture of Silt and Clay, some sand, trace gravel		2	SS	4								
	(Glacial Till)		3	SS	26								0 16 51 33
	Very Stiff to Hard		4	SS	77	225mm							
	Brown Grey		5	SS	45								
			6	SS	54								

RECORD OF BOREHOLE No 136-02-1

1 OF 1

METRIC

W.P. 331-89-00 LOCATION WC 136-02; Sta. 10+622, O-S 23m Lt. ORIGINATED BY IK  
DIST 4 HWY QEW BOREHOLE TYPE Solid Stem COMPILED BY IK  
DATUM SEE TEXT DATE 94.08.23 & 94.08.23 CHECKED BY TO

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT $\gamma$ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES		20	40	60	80	100		
81.3	Ground Surface												
80.8	Topsoil		1	SS	14	81							
0.3	Het. mixture of Silt and Clay, some sand, trace gravel  (Glacial Till)  Very Stiff to Hard  Brown Grey		2	SS	27	80							
			3	SS	24	79							
			4	SS	38	78							
			5	SS	36	77							
			6	SS	26	76							
			7	SS	22	75							
74.6	END OF BOREHOLE												
6.7	Borehole dry upon completion												

RECORD OF BOREHOLE No 136-02-2

1 OF 1

METRIC

W.P. 331-89-00 LOCATION WC 136-02; Sta. 10+822, O-S 3m Rt. ORIGINATED BY IK  
DIST 4 HWY QEW BOREHOLE TYPE Solid Stem, Cone Test COMPILED BY IK  
DATUM SEE TEXT DATE 94.08.11 & 94.08.11 CHECKED BY TO

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT & kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20	40	60	80	100		
82.2	Ground Surface													
0.0	Mixture of Sand, Silt and Gravel (Fill), compact		1	SS	7		82							
81.6														
0.6	Het. mixture of Silt and Clay, some sand, trace gravel  (Glacial Till)  Very Stiff to Hard		2	SS	8		81							
			3	SS	32		80							
			4	SS	34		79							
			5	SS	31		78							
			6	SS	43		77							
			7	SS	42		76							
			8	SS	30		75							
			9	SS	30									
74.6														
7.6	END OF BOREHOLE  Borehole dry upon completion													

x<sup>3</sup>, x<sup>2</sup>: Numbers refer to  
Sensitivity

20  
15  
10

(%) STRAIN AT FAILURE

RECORD OF BOREHOLE No 136-02-3

1 OF 1

METRIC

W.P. 331-89-00 LOCATION WC 136-02; Sta. 10+622, O-S 23m Rt. ORIGINATED BY IK  
DIST 4 HWY QEW BOREHOLE TYPE Solid Stem COMPILED BY IK  
DATUM SEE TEXT DATE 94.08.11 & 94.08.11 CHECKED BY TO

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W <sub>P</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	*N* VALUES			SHEAR STRENGTH kPa	WATER CONTENT (%)					
81.5	Ground Surface													
0.0	Topsoil		1	SS	7									
81.1														
0.4	Het. mixture of Silt and Clay, some sand, trace gravel  (Glacial Till)  Very Stiff to Hard       Brown Grey		2	SS	30									0 17 54 29
			3	SS	35									
			4	SS	45									
			5	SS	38									
			6	SS	38									
74.8			7	SS	27									
6.7	END OF BOREHOLE													



RECORD OF BOREHOLE No 136-03-1

1 OF 1

METRIC

W.P. 331-88-00 LOCATION WC 136-03; Sta. 10+825, O-S 22m Lt. ORIGINATED BY IK  
DIST 4 HWY QEW BOREHOLE TYPE Solid Stem COMPILED BY IK  
DATUM SEE TEXT DATE 94.08.23 & 94.08.23 CHECKED BY TO

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT γ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa						
						20 40 60 80 100 ○ UNCONFINED × FIELD VANE ● QUICK TRIAXIAL × LAB VANE					PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT W <sub>p</sub> — W — W <sub>L</sub> WATER CONTENT (%) 10 20 30			
81.8	Ground Surface													
81.8	Topsoil		1	SS	2									
0.3	Het. mixture of Silt and Clay, some sand, trace gravel  (Glacial Till)  Very Stiff to Hard   Brown Grey		2	SS	13									
			3	SS	34									
			4	SS	26									
			5	SS	26									
			6	SS	28									
75.1			7	SS	30									
6.7	END OF BOREHOLE  Borehole dry upon completion													

RECORD OF BOREHOLE No 136-03-2

1 OF 1

METRIC

W.P. 331-89-00 LOCATION WC 136-03; Sta. 10+825, O-S 3m Rt. ORIGINATED BY IK  
DIST 4 HWY QEW BOREHOLE TYPE Solid Stem, Cone Test COMPILED BY IK  
DATUM SEE TEXT DATE 94.08.11 & 94.08.11 CHECKED BY TO

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		UNIT WEIGHT $\gamma$ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa	WATER CONTENT (%)		
82.3	Ground Surface										
0.0	Mixture of Sand, Silt and Gravel. (Fill), compact		1	AS							
81.5											
0.8	Het. mixture of Silt and Clay, some sand, trace gravel  (Glacial Till)  Very Stiff to Hard    Brown Grey   -100mm sand seam		2	SS	15						5 13 48 34
			3	SS	36						
			4	SS	45						
			5	SS	55						
			6	SS	36						
			7	SS	30						
			8	SS	28						
			9	SS	33						
74.1											
8.2	END OF BOREHOLE  Borehole dry upon completion										

RECORD OF BOREHOLE No 136-03-3

1 OF 1

METRIC

W.P. 331-89-00 LOCATION WC 136-03; Sta. 10+825, O-S 22m Rt. ORIGINATED BY IK  
DIST 4 HWY QEW BOREHOLE TYPE Solid Stem COMPILED BY IK  
DATUM SEE TEXT DATE 94.08.11 & 94.08.11 CHECKED BY TO

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT $\gamma$ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20 40 60 80 100	20 40 60 80 100	20 40 60 80 100	20 40 60 80 100	20 40 60 80 100		
81.6	Ground Surface													
81.5	Topsoil		1	SS	14		81							
0.1	Het. mixture of Silt and Clay, some sand, trace gravel  (Glacial Till)  Very Stiff to Hard		2	SS	36		80						21.0	0 15 55 30
			3	SS	45		79							
			4	SS	50		78							
			5	SS	31		77							
			6	SS	29		76							
			7	SS	27		75							
74.9	END OF BOREHOLE													
6.7	Borehole dry upon completion													

RECORD OF BOREHOLE No 136-04-1

1 OF 1

METRIC

W.P. 331-89-00 LOCATION WC 136-04; Sta. 11+101, O-S 23m Lt. ORIGINATED BY IK  
DIST 4 HWY QEW BOREHOLE TYPE Solid Stem COMPILED BY IK  
DATUM SEE TEXT DATE 94.08.23 & 94.08.23 CHECKED BY TO

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT $\gamma$ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20	40	60	80	100		
81.6	Ground Surface													
81.3	Topsoil		1	SS	5									
0.3	Het. mixture of Silt and Clay, some sand, trace gravel  (Glacial Till)  Very Stiff to Hard  Brown Grey		2	SS	26									
			3	SS	49									
			4	SS	41									
			5	SS	28									
			6	SS	43									
			7	SS	20									
74.9	END OF BOREHOLE												22.8	
6.7	Borehole dry upon completion													

RECORD OF BOREHOLE No 136-04-2

1 OF 1

METRIC

W.P. 331-89-00 LOCATION WC 136-04; Sta. 11+101, O-S 3m Rt. ORIGINATED BY IK  
DIST 4 HWY QEW BOREHOLE TYPE Solid Stem, Cone Test COMPILED BY IK  
DATUM SEE TEXT DATE 94.08.11 & 94.08.11 CHECKED BY TO

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT w <sub>p</sub>	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w <sub>L</sub>	UNIT WEIGHT γ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	*N* VALUES			SHEAR STRENGTH kPa	WATER CONTENT (%)					
82.7	Ground Surface													
82.8	75mm ASPHALT													
0.1	Brown Sand and Gravel (Fill)		1	SS	7									
82.2	Het. mixture of Silt and Clay, some sand, trace gravel		2	SS	7									
0.5	(Glacial Till)		3	SS	22									
	Very Stiff to Hard		4	SS	32									
	Brown Grey		5	SS	28									
			6	SS	50									
			7	SS	48									
			8	SS	34									
75.1			9	SS	36									
7.6	END OF BOREHOLE													

# RECORD OF BOREHOLE No 136-04-3

1 OF 1

**METRIC**

W.P. 331-89-00

LOCATION WC 136-04; Sta. 11+101, O-S 23m Rt.

ORIGINATED BY IK

DIST 4

HWY      QEW

**BOREHOLE TYPE** Solid Stem

COMPILED BY IK

DATUM SEE TEXT

DATE 94.08.12 & 94.08.12

CHECKED BY \_\_\_\_\_ TO \_\_\_\_\_

[illegible]

$\times^3, \times^3$ : Numbers refer to Sensitivity

RECORD OF BOREHOLE No 136-05-1

1 OF 1

METRIC

W.P. 331-89-00 LOCATION WC 136-05; Sta. 11+262, O-S 22m Lt. ORIGINATED BY IK  
DIST 4 HWY QEW BOREHOLE TYPE Solid Stem COMPILED BY IK  
DATUM SEE TEXT DATE 94.08.23 & 94.08.23 CHECKED BY TO

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT γ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20	40	60	80	100		
81.7	Ground Surface													
81.2	Topsoil		1	SS	11									
0.3	Het. mixture of Silt and Clay, some sand, trace gravel  (Glacial Till)  Very Stiff to Hard   Brown Grey		2	SS	47		81							
			3	SS	60		80							
			4	SS	47		79							
			5	SS	39		78							
			6	SS	24		77							
							76							
76.0			7	SS	33		75							
6.7	END OF BOREHOLE  Borehole dry upon completion													

x<sup>3</sup>, x<sup>3</sup>: Numbers refer to  
Sensitivity

20  
15  
10

(%) STRAIN AT FAILURE

RECORD OF BOREHOLE No 136-05-2

1 OF 1

METRIC

W.P. 331-89-00 LOCATION WC 136-05; Sta. 11+262, O-S 3m Rt. ORIGINATED BY IK  
DIST 4 HWY QEW BOREHOLE TYPE Solid Stem, Cone Test COMPILED BY IK  
DATUM SEE TEXT DATE 94.08.11 & 94.08.12 CHECKED BY TO

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20 40 60 80 100	20 40 60 80 100					
82.9	Ground Surface													
82.9	Brown Sand (Fill)		1	SS	23									
0.3	Brown Silt (Fill), some sand, trace clay and gravel		2	SS	14									
	Compact													
81.1	Het. mixture of Silt and Clay, some sand, trace gravel		3	SS	34									
1.8	(Glacial Till)		4	SS	32									
	Very Stiff to Hard		5	SS	28									
			6	SS	52									
			7	SS	37									
			8	SS	28									
			9	SS	42									
74.7	END OF BOREHOLE													
8.2	Borehole dry upon completion													



RECORD OF BOREHOLE No 136-05-3

1 OF 1

METRIC

W.P. 331-89-00 LOCATION WC 136-05; Sta. 11+262, O-S 22m Rt. ORIGINATED BY IK  
DIST 4 HWY QEW BOREHOLE TYPE Solid Stem COMPILED BY IK  
DATUM SEE TEXT DATE 94.08.12 & 94.08.12 CHECKED BY TO

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT w <sub>p</sub>	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w <sub>L</sub>	UNIT WEIGHT γ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa							WATER CONTENT (%)
								20 40 60 80 100	20 40 60 80 100						
82.2	Ground Surface							○ UNCONFINED    × FIELD VANE							
82.1	75mm Topsoil		1	SS	12		82							0 15 59 26	
0.1	Het. mixture of Silt and Clay, some sand, trace gravel  (Glacial Till)  Very Stiff to Hard   - seams of silty sand   Brown Grey		2	SS	25		81								
			3	SS	34		80								
			4	SS	50		79								
			5	SS	46		78								
			6	SS	32		77								
			7	SS	32		76								
75.5															
6.7	END OF BOREHOLE														

RECORD OF BOREHOLE No 136-06-1

1 OF 1

METRIC

W.P. 331-89-00 LOCATION WC 136-06; Sta. 11+446, O-S 23m Lt. ORIGINATED BY IK  
DIST 4 HWY QEW BOREHOLE TYPE Solid Stem COMPILED BY IK  
DATUM SEE TEXT DATE 94.08.23 & 94.08.23 CHECKED BY TO

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT $\gamma$ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa						
								20 40 60 80 100						
81.8	Ground Surface													
81.8	Topsoil		1	SS	6									
0.3	Het. mixture of Silt and Clay, some sand, trace gravel		2	SS	35									
	(Glacial Till)		3	SS	34									
	Very Stiff to Hard		4	SS	54									
			5	SS	47									
			6	SS	32									
			7	SS	31									
75.1														
6.7	END OF BOREHOLE													
	Borehole dry upon completion													

RECORD OF BOREHOLE No 136-06-2

1 OF 1

METRIC

W.P. 331-89-00 LOCATION WC 136-06: Sta. 11+448, O-S 3.0m Rt. ORIGINATED BY IK  
DIST 4 HWY QEW BOREHOLE TYPE Solid Stem, Cone Test COMPILED BY IK  
DATUM SEE TEXT DATE 94.08.11 & 94.08.11 CHECKED BY TO

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT w <sub>p</sub>	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w <sub>L</sub>	UNIT WEIGHT γ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa	WATER CONTENT (%)					
82.9	Ground Surface													
0.0	Mixture of Sand, Silt and Gravel (Fill), compact		1	SS	11									
82.3	Het. mixture of Silt and Clay, some sand, trace gravel (Glacial Till)  Very Stiff to Hard		2	SS	10									
			3	SS	20									
			4	SS	28									
			5	SS	27									
			6	SS	40									
			7	SS	45									
			8	SS	38									
			9	SS	31									
75.3														
7.6	END OF BOREHOLE  Borehole dry upon completion													

x<sup>3</sup>, x<sup>3</sup>: Numbers refer to Sensitivity 20 15 10 (% STRAIN AT FAILURE

RECORD OF BOREHOLE No 136-06-3

1 OF 1

METRIC

W.P. 331-89-00 LOCATION WC 136-06; Sta. 11+446, O-S 23m Rt. ORIGINATED BY JK  
DIST 4 HWY QEW BOREHOLE TYPE Solid Stem COMPILED BY JK  
DATUM SEE TEXT DATE 94.08.12 & 94.08.12 CHECKED BY TO

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT γ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20	40	60	80	100		
82.1	Ground Surface													
82.0	Topsoil		1	SS	2		82							
0.1	Het. mixture of Silt and Clay, some sand, trace gravel		2	SS	25		81							
	(Glacial Till)		3	SS	31		80							
	Very Stiff to Hard		4	SS	70	290mm	79							
			5	SS	35		78							
	Brown Grey		6	SS	50	125mm	77							
			7	SS	28		76							
75.4	END OF BOREHOLE													
6.7														

RECORD OF BOREHOLE No 136-07-1

1 OF 1

METRIC

W.P. 331-89-00 LOCATION WC 136-07; Sta. 11+656, O-S 22m Lt. ORIGINATED BY IK  
DIST 4 HWY QEW BOREHOLE TYPE Solid Stem COMPILED BY IK  
DATUM SEE TEXT DATE 94.08.17 & 94.08.17 CHECKED BY TO

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				UNIT WEIGHT $\gamma$ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20 40 60 80 100	20 40 60 80 100	20 40 60 80 100	20 40 60 80 100		
82.5	Ground Surface												
82.4	50mm Topsoil		1	SS	3								
0.1	Het. mixture of Silt and Clay, some sand, trace gravel  (Glacial Till)  Very Stiff to Hard		2	SS	20								
			3	SS	23								
			4	SS	50	100mm							
			5	SS	38								
			6	SS	40								
			7	SS	31								
75.8													
6.7	END OF BOREHOLE  Borehole dry upon completion												

RECORD OF BOREHOLE No 136-07-2

1 OF 1

METRIC

W.P. 331-89-00 LOCATION WC 136-07; Sta. 11+656, O-S 3m Rt. ORIGINATED BY JK  
DIST 4 HWY QEW BOREHOLE TYPE Solid Stem, Cone Test COMPILED BY JK  
DATUM SEE TEXT DATE 94.08.12 & 94.08.12 CHECKED BY TO

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W <sub>P</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	*N* VALUES			SHEAR STRENGTH kPa	WATER CONTENT (%)					
83.1	Ground Surface													
0.0	Mixture of Sand, Silt and Gravel (Fill), compact		1	SS	10									
82.4														
0.7	Brown Silt (Fill), sandy and clayey, trace gravel, compact		2	SS	12									
81.6														
1.6	Het. mixture of silt and clay, some sand, trace gravel  (Glacial till)  Very stiff to hard  Brown Grey		3	SS	27									
			4	SS	34									
			5	SS	63									
			6	SS	55									
			7	SS	48									
			8	SS	46									
			9	SS	68									
74.9														
8.2	END OF BOREHOLE  Borehole dry upon completion													

RECORD OF BOREHOLE No 136-07-3

1 OF 1

METRIC

W.P. 331-89-00 LOCATION WC 136-07; Sta. 11+656, O-S 23m Rt. ORIGINATED BY IK  
DIST 4 HWY QEW BOREHOLE TYPE Solid Stem COMPILED BY IK  
DATUM SEE TEXT DATE 94.08.12 & 94.08.12 CHECKED BY TO

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa						
82.4	Ground Surface													
82.3	Topsoil		1	SS	6									
0.1	Het. mixture of Silt and Clay, some sand, trace gravel  (Glacial Till)  Very Stiff to Hard  Brown Grey		2	SS	21								23.0	
			3	SS	52									
			4	SS	31									5 24 56 15
			5	SS	31									
			6	SS	38									
			7	SS	28									
75.7														
6.7	END OF BOREHOLE  Borehole dry upon completion													

RECORD OF BOREHOLE No 136-08-1

1 OF 1

METRIC

W.P. 331-89-00 LOCATION WC 136-08; Sta. 11+853, O-S 23m Lt. ORIGINATED BY IK  
DIST HWY QEW BOREHOLE TYPE Solid Stem COMPILED BY IK  
DATUM SEE TEXT DATE 94.08.17 & 94.08.17 CHECKED BY TO

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W <sub>P</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT $\gamma$ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20 40 60 80 100	20 40 60 80 100					
82.9	Ground Surface													
0.0	Topsoil		1	SS	3									
82.3														
0.6	Het. mixture of Silt and Clay, some sand, trace gravel  (Glacial Till)  Very Stiff to Hard   Brown Grey		2	SS	26		82							
			3	SS	35		81							1 15 55 29
			4	SS	42		80							
			5	SS	57		79							
			6	SS	71		78							
							77							
76.2			7	SS	46									
6.7	END OF BOREHOLE  Borehole dry upon completion													



RECORD OF BOREHOLE No 136-08-2

1 OF 1

METRIC

W.P. 331-89-00 LOCATION WC 136-08; Sta. 11+853, O-S 3m Rt. ORIGINATED BY IK  
DIST HWY QEW BOREHOLE TYPE Solid Stem, Cone Test COMPILED BY IK  
DATUM SEE TEXT DATE 94.08.12 & 94.08.12 CHECKED BY TO

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 <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa		w <sub>p</sub>	w	w <sub>L</sub>		
								○ UNCONFINED ● QUICK TRIAXIAL	* FIELD VANE × LAB VANE					
83.4	Ground Surface							20 40 60 80 100						
0.0	Mixture of Sand, Silt and Gravel (Fill), loose		1	SS	8									
82.5														
0.9	Het. mixture of Silt and Clay, some sand, trace gravel  (Glacial Till)  Very Stiff to Hard		2	SS	5									
			3	SS	34									
			4	SS	48									
			5	SS	60									
			6	SS	36									
			7	SS	44									
			8	SS	30									
			9	SS	65									
75.8														
7.6	END OF BOREHOLE  Borehole dry upon completion													

RECORD OF BOREHOLE No 136-08-3

1 OF 1

METRIC

W.P. 331-89-00 LOCATION WC 136-08; Sta. 11+853, O-S 23m Rt. ORIGINATED BY IK  
DIST HWY QEW BOREHOLE TYPE Solid Stem COMPILED BY IK  
DATUM SEE TEXT DATE 94.08.12 & 94.08.12 CHECKED BY TO

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			UNIT WEIGHT  γ  kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa					WATER CONTENT (%)
82.5	Ground Surface							20 40 60 80 100		PLASTIC LIMIT	NATURAL MOISTURE CONTENT	LIQUID LIMIT	
82.2	Topsoil							20 40 60 80 100		W <sub>p</sub>	W	W <sub>L</sub>	
0.3	Het. mixture of Silt and Clay, some sand, trace gravel  (Glacial Till)  Very Stiff to Hard		1	SS	25		82						
			2	SS	44		81						9 22 54 15
			3	SS	67	125mm	80						
			4	SS	72		79						
			5	SS	47		78						
			6	SS	50	125mm	77						
77.0													
5.5	Shale, Bedrock												
76.3	Poor to Fair		7	SS	50	75mm							
6.2	END OF BOREHOLE												
	Borehole dry upon completion												

RECORD OF BOREHOLE No 136-09-1

1 OF 1

METRIC

W.P. 331-89-00 LOCATION WC 136-09: Sta. 12+059, O-S 34m Lt. ORIGINATED BY IK  
DIST 4 HWY QEW BOREHOLE TYPE Solid Stem COMPILED BY IK  
DATUM SEE TEXT DATE 94.08.17 & 94.08.17 CHECKED BY TO

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20	40	60	80					
82.8	Ground Surface															
82.8	Topsoil		1	SS	8											
82.8	Het. mixture of Silt and Clay, some sand, trace gravel		2	SS	54											
	(Glacial Till)															
	Very Stiff to Hard		3	SS	36											
	Brown		4	SS	66											
			5	SS	44											
			6	SS	51											
77.6																
5.3	Shale															
	Bedrock															
	Poor to Fair															
76.6			7	SS	50	75mm										
6.2	END OF BOREHOLE															
	Borehole dry upon completion															

RECORD OF BOREHOLE No 136-09-2

1 OF 1

METRIC

W.P. 331-89-00 LOCATION WC 136-09; Sta. 12+059, O-S 3m Rt. ORIGINATED BY IK  
DIST HWY QEW BOREHOLE TYPE Solid Stem, Cone Test COMPILED BY IK  
DATUM SEE TEXT DATE 94.08.12 & 94.08.12 CHECKED BY TO

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			UNIT WEIGHT γ <sub>s</sub> kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	*N* VALUES			20 40 60 80 100	PLASTIC LIMIT	NATURAL MOISTURE CONTENT	LIQUID LIMIT	
83.7	Ground Surface							SHEAR STRENGTH kPa ○ UNCONFINED × FIELD VANE ● QUICK TRIAXIAL × LAB VANE	WP	W	WL	
0.0	Mixture of Sand, Silt and Gravel (Fill), compact.		1	SS	14		83	20 40 60 80 100				0 11 56 33
82.8												
0.9	Het. mixture of Silt and Clay, some sand, trace gravel  (Glacial Till)  Very Stiff to Hard  Brown		2	SS	13		82					
			3	SS	29							
			4	SS	35		81					
			5	SS	95		80					
			6	SS	70		79					
78.6			7	SS	91		78					
5.2	Shale  Bedrock  Poor to Fair		8	SS	100	75mm	77					
76.4			9	SS	100	63mm						
7.3	END OF BOREHOLE  Borehole dry upon completion											

RECORD OF BOREHOLE No 136-09-3

1 OF 1

METRIC

W.P. 331-89-00 LOCATION WC 136-09; Sta. 12+059, O-S 24m Rt. ORIGINATED BY IK  
DIST HWY QEW BOREHOLE TYPE Solid Stem COMPILED BY IK  
DATUM SEE TEXT DATE 94.08.15 & 94.08.15 CHECKED BY TO

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				UNIT WEIGHT $\gamma$ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20 40 60 80 100	20 40 60 80 100	20 40 60 80 100	20 40 60 80 100		
83.3	Ground Surface												
0.0	Topsoil		1	SS	6		83						
82.6													
0.8	Het. mixture of Silt and Clay, some sand, trace gravel		2	SS	27		82						
	(Glacial Till)		3	SS	50								
	Very Stiff to Hard		4	SS	74		81						
80.3	Brown												
3.1	Shale		5	SS	50	125mm	80						
	Bedrock		6	SS	50	100mm	79						
	Poor to Fair						78						
							77						
76.6			7	SS	50	25mm							
6.7	END OF BOREHOLE												
	Borehole dry upon completion												

$\times^3, \times^3$ : Numbers refer to Sensitivity 20 15 10 (% STRAIN AT FAILURE

RECORD OF BOREHOLE No 136-10-1

1 OF 1

METRIC

W.P. 331-89-00 LOCATION WC 136-10; Sta. 12+347, O-S 24m Lt. ORIGINATED BY JK  
DIST 4 HWY QEW BOREHOLE TYPE Solid Stem, N-Casing, Rock Coring COMPILED BY JK  
DATUM SEE TEXT DATE 94.08.18 & 94.08.18 CHECKED BY TO

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT $\gamma$ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	*N* VALUES			20	40	60	80	100		
83.5	Ground Surface													
83.4	Topsoil		1	SS	4		83							
0.1	Het. mixture of silt and clay, some sand, trace gravel (Glacial Till), Very Stiff to Hard, brown		2	SS	80		82							
82.1	Shale		3	SS	50	150mm	81							
1.5	Bedrock		4	SS	50	150mm	80							
	Poor to Fair		5	NQ RC	REC 97%		79							RQD = 65%
			6	NQ RC	REC 100%		78							RQD = 73%
77.4	END OF BOREHOLE													
6.1														

RECORD OF BOREHOLE No 136-10-2

1 OF 1

METRIC

W.P. 331-89-00 LOCATION WC 136-10; Sta. 12+347, O-S 3m Rt. ORIGINATED BY IK  
DIST 4 HWY QEW BOREHOLE TYPE Solid Stem, Cone Test COMPILED BY IK  
DATUM SEE TEXT DATE 94.08.16 & 94.08.16 CHECKED BY TO

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT w <sub>p</sub>	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w <sub>L</sub>	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20	40						60
84.4	Ground Surface		1	SS	9		84								
0.0	Mixture of Sand, Silt and Gravel (Fill) Compact		2	SS	20		83								
83.4			3	SS	100	250mm	82								
1.1	Shale		4	SS	60	125mm	81								
	Bedrock		5	SS	50	25mm	80								
	Poor to Fair		6	SS	60	50mm	79								
			7	SS	60	63mm	78								
			8	SS	65	25mm	77								
76.8			9	SS	70	25mm									
7.7	END OF BOREHOLE														
	Borehole dry upon completion														

RECORD OF BOREHOLE No 136-10-3

1 OF 1

METRIC

W.P. 331-89-00 LOCATION WC 136-10; Sta. 12+347, O-S 30m Rt. ORIGINATED BY IK  
DIST 4 HWY QEW BOREHOLE TYPE Solid Stem COMPILED BY IK  
DATUM SEE TEXT DATE 94.08.15 & 94.08.15 CHECKED BY TO

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT $\gamma$ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20	40	60	80	100		
83.0	Ground Surface													
0.0	Het. mixture of Silt and Clay,		1	SS	9									0 23 73 5
82.6	some sand, trace gravel		2	SS	50	50mm								
0.5	(Glacial Till), very stiff to hard, brown		3	SS	50	100mm								
	Shale		4	SS	50	125mm								
	Bedrock		5	SS	50	25mm								
	Poor to Fair		6	SS	50	25mm								
			7	SS	50	125								
76.3	END OF BOREHOLE													
6.7	Borehole dry upon completion													

\*<sup>3</sup>, X<sup>3</sup>: Numbers refer to Sensitivity 20 15 10 (%) STRAIN AT FAILURE



RECORD OF BOREHOLE No 136-11-1

1 OF 1

METRIC

W.P. 331-89-00 LOCATION WC 136-11; Sta. 12+675, O-S 25m Lt. ORIGINATED BY IK  
DIST 4 HWY QEW BOREHOLE TYPE Solid Stem, N-Casing, Rock Coring COMPILED BY IK  
DATUM SEE TEXT DATE 94.08.17 & 94.08.18 CHECKED BY TO

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT WP	NATURAL MOISTURE CONTENT W	LIQUID LIMIT WL	UNIT WEIGHT γ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)				
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			"N" VALUES	SHEAR STRENGTH kPa												
						○ UNCONFINED    × FIELD VANE ● QUICK TRIAXIAL    × LAB VANE					WATER CONTENT (%)									
						20	40	60	80	100	20	40	60	80	100	10	20	30		
83.3	Ground Surface																			
83.0	Topsoil		1	SS	5															
81.8	Het. mixture of Silt and Clay, some sand, trace gravel (Glacial Till), very stiff to hard, brown		2	SS	22															
81.5	Shale		3	SS	50	100mm														
	Bedrock		4	SS	50	750mm														
	Fair to Good																			
			5	NQ RC	REC 97%															RQD = 88%
			6	NQ RC	REC 100%															RQD = 70%
77.1																				
6.2	END OF BOREHOLE																			

RECORD OF BOREHOLE No 136-11-2

1 OF 1

METRIC

W.P. 331-89-00 LOCATION WC 136-11; Ste. 12+675, O-S 3m Rt. ORIGINATED BY IK  
DIST HWY QEW BOREHOLE TYPE Solid Stem, Cone Test COMPILED BY IK  
DATUM SEE TEXT DATE 94.08.16 & 94.08.16 CHECKED BY TO

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W <sub>P</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			"N" VALUES	SHEAR STRENGTH kPa					
84.8	Ground Surface												
0.0	Mixture of Sand, Silt and Gravel (Fill), trace clay, compact		1	SS	10								
			2	SS	10								
82.8			3	SS	15								
2.0	Shale		4	SS	60	125mm							
	Bedrock												
	Poor to Fair		5	SS	60	50mm							
			6	SS	60	63mm							
			7	SS	60	63mm							
			8	SS	60	60mm							
77.1			9	SS	60	50mm							
7.7	END OF BOREHOLE												
	Borehole dry upon completion												

RECORD OF BOREHOLE No 136-11-3

1 OF 1

METRIC

W.P. 331-89-00 LOCATION WC 136-11; Sta. 12+676, O-S 32m Rt. ORIGINATED BY IK  
DIST 4 HWY QEW BOREHOLE TYPE Solid Stem COMPILED BY IK  
DATUM SEE TEXT DATE 94.08.15 & 94.08.15 CHECKED BY TO

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT $\gamma$ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES		20	40	60	80	100		
84.5	Ground Surface												
84.3	Topsoil		1	SS	7								
0.2	Het. mixture of Silt and Clay, some sand, trace gravel (Glacial Till), very stiff to hard		2	SS	50	75mm							3 21 63 13
83.0	Shale		3	SS	50	75mm							
1.6	Bedrock		4	SS	50	25mm							
	Poor to Fair		5	SS	50	25mm							
			6	SS	50	25mm							
			7	SS	50	100mm							
77.8	END OF BOREHOLE												

RECORD OF BOREHOLE No 136-12-1

1 OF 1

METRIC

W.P. 331-89-00 LOCATION WC 136-12; Sta. 12+885, O-S 36m Lt. ORIGINATED BY JK  
DIST HWY QEW BOREHOLE TYPE Solid Stem COMPILED BY JK  
DATUM SEE TEXT DATE 94.08.17 & 94.08.17 CHECKED BY TO

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT $\gamma$ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES		20	40	60	80	100		
83.0	Ground Surface												
82.8	Topsoil		1	SS	37								
0.2	Shale		2	SS	50	100mm							
	Bedrock		3	SS	50	100mm							
	Poor to Fair		4	SS	50	100mm							
			5	SS	50	40mm							
			6	SS	50	40mm							
76.8			7	SS	50	125m							
6.2	END OF BOREHOLE												
	Borehole dry upon completion												

# RECORD OF BOREHOLE No 136-12-2

1 OF 1

METRIC

W.P. 331-89-00 LOCATION WC 136-12; Sta. 12+885, O-S 3m Rt. ORIGINATED BY JK  
DIST 4 HWY QEW BOREHOLE TYPE Solid Stem, Cone Test COMPILED BY JK  
DATUM SEE TEXT DATE 94.08.17 & 94.08.17 CHECKED BY TO

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W <sub>P</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT & kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa	WATER CONTENT (%)					
84.5	Ground Surface													
0.0	Mixture of Sand, Silt and Gravel (Fill), compact		1	SS	20									
83.7														
0.8	Clayey Silt (Fill), trace sand, very stiff, brown		2	SS	25									
82.9														
1.7	Shale		3	SS	35									
	Bedrock		4	SS	70	100mm								
	Poor to Fair		5	SS	60	25mm								
			6	SS	70	125mm								
			7	SS	60	100mm								
			8	SS	60	50mm								
76.8			9	SS	60	50mm								
7.7	END OF BOREHOLE													

RECORD OF BOREHOLE No 136-12-3

1 OF 1

METRIC

W.P. 331-89-00 LOCATION WC 136-12; Sta. 12+885, O-S 26m Rt. ORIGINATED BY IK  
DIST HWY QEW BOREHOLE TYPE Solid Stem COMPILED BY IK  
DATUM SEE TEXT DATE 94.08.15 & 94.08.15 CHECKED BY TO

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W <sub>P</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20	40	60	80	100					
83.7	Ground Surface		1	SS	12												
0.0	Het. mixture of Silt and Clay, some sand, trace gravel (Glacial Till) Very Stiff to Hard		2	SS	76												
82.2																	
1.5	Shale		3	SS	50	75mm											
	Bedrock																
	Poor to Fair		4	SS	50	10mm											
			5	SS	50	10mm											
			6	SS	50	10mm											
77.5																	
6.3	END OF BOREHOLE																
	Borehole dry upon completion																

RECORD OF BOREHOLE No 136-13-1

1 OF 1

METRIC

W.P. 331-89-00 LOCATION WC 136-13; Sta. 13+085, O-S 32m Lt. ORIGINATED BY IK  
DIST 4 HWY QEW BOREHOLE TYPE Solid Stem COMPILED BY IK  
DATUM SEE TEXT DATE 94.08.17 & 94.08.17 CHECKED BY TO

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT $\gamma$ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20	40	60	80	100		
82.5	Ground Surface													
82.2	Topsoil		1	SS	6		82							
0.3	Het. mixture of Silt and Clay, some sand, trace gravel  (Glacial Till)  Very Stiff to Hard  Brown		2	SS	20		81							
			3	SS	13		80							
			4	SS	15		79							
			5	SS	32		78							
78.3			6	SS	33		77							
4.3	Shale  Bedrock  Poor to Fair													
76.3			7	SS	50	100mm								
6.2	END OF BOREHOLE  Borehole dry upon completion													

\*<sup>3</sup>, x<sup>3</sup>: Numbers refer to Sensitivity  
20  
15  
10 (%) STRAIN AT FAILURE

RECORD OF BOREHOLE No 136-13-2

1 OF 1

METRIC

W.P. 331-89-00 LOCATION WC 136-13; Sta. 13+085, O-S 3m Lt. ORIGINATED BY JK  
DIST HWY OEW BOREHOLE TYPE Solid Stem, Cone Test COMPILED BY JK  
DATUM SEE TEXT DATE 94.08.12 & 94.08.12 CHECKED BY TO

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W <sub>P</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20	40						60
83.7	Ground Surface														
0.0	Silty Sand (Fill), some gravel, compact Brown		1	SS	9										
82.6			2	SS	13										
1.1	Het. mixture of Silt and Clay, some sand, trace gravel  (Glacial Till)  Very Stiff to Hard		3	SS	17										
			4	SS	20										
			5	SS	25										
			6	SS	39										
79.0			7	SS	70	38mm									
4.7	Shale  Bedrock  Poor to Fair		8	SS	100	75mm									
			9	SS	100	75mm									
76.2															
7.6	END OF BOREHOLE  Borehole dry upon completion														



# RECORD OF BOREHOLE No 136-13-3

1 OF 1

METRIC

W.P. 331-89-00 LOCATION WC 136-13; Ste. 13+085, O-S 47m Rt. ORIGINATED BY IK  
 DIST HWY QEW BOREHOLE TYPE Solid Stem COMPILED BY IK  
 DATUM SEE TEXT DATE 94.08.15 & 94.08.15 CHECKED BY TO

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT γ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES		20	40	60	80	100		
82.8	Ground Surface												
0.0	Het. mixture of Silt and Clay, some sand, trace gravel  (Glacial Till)  Very Stiff to Hard  Brown Grey		1	SS	4								
			2	SS	4								
			3	SS	18								
			4	SS	50								
79.6			5	SS	50	50mm							
3.3	Shale		6	SS	50	135mm							
	Bedrock												
	Poor to Fair												
76.2			7	SS	50	75mm							
6.7	END OF BOREHOLE												

RECORD OF BOREHOLE No 136-14-1

1 OF 1

METRIC

W.P. 331-89-00 LOCATION WC 136-14; Sta. 13+278, O-S 30m Lt. ORIGINATED BY IK  
DIST HWY QEW BOREHOLE TYPE Solid Stem COMPILED BY IK  
DATUM SEE TEXT DATE 94.08.16 & 94.08.16 CHECKED BY TO

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			UNIT WEIGHT γ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa				
								○ UNCONFINED 20 40 60 80 100	✕ FIELD VANE 20 40 60 80 100	● QUICK TRIAXIAL 20 40 60 80 100		
82.6	Ground Surface											
82.6	Topsoil		1	SS	4							
0.1	Het. mixture of Silt and Clay, some sand, trace gravel		2	SS	26							
	(Glacial Till)		3	SS	37							
	Very Stiff to Hard		4	SS	13							
	Brown		5	SS	12							
			6	SS	12							
			7	SS	38							
75.9	END OF BOREHOLE											
6.7	Borehole dry upon completion											

# RECORD OF BOREHOLE No 136-14-2

1 OF 1

METRIC

W.P. 331-89-00 LOCATION WC 136-14; Sta. 13+278, O-S 3m Lt. ORIGINATED BY IK  
 DIST HWY QEW BOREHOLE TYPE Solid Stem, Cone Test COMPILED BY IK  
 DATUM SEE TEXT DATE 94.08.13 & 94.08.13 CHECKED BY TO

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT w <sub>p</sub>	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w <sub>L</sub>	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			"N" VALUES	SHEAR STRENGTH kPa					
83.7	Ground Surface												
83.6	100mm Asphalt												
0.1	Mixture of Sand, Silt and Gravel (Fill), loose, brown		1	SS	9								
82.6			2	SS	8								
1.1	Het. mixture of Silt and Clay, some sand, trace gravel (Glacial Till)		3	SS	19								
	Very Stiff to Hard		4	SS	29								
	Brown		5	SS	18								
			6	SS	8								
			7	SS	7								
			8	SS	130								
			9	SS	37								
76.1													
7.6	END OF BOREHOLE												
	Borehole dry upon completion												

# RECORD OF BOREHOLE No 136-14-3

1 OF 1

**METRIC**

W.P. 331-89-00

**LOCATION** WC 136-14; Sta. 13+278, O-S 34m Rt.

ORIGINATED BY IK

**DIST** 4

HWY            QEW

BOREHOLE TYPE Solid Stem

COMPILED BY IK

DATUM SEE TEXT

DATE 94.08.15 & 94.08.16

**CHECKED BY** \_\_\_\_\_ **TO** \_\_\_\_\_

SOIL PROFILE						DYNAMIC CONE PENETRATION RESISTANCE PLOT							UNIT WEIGHT $\gamma$ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER TYPE "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	RESISTANCE PLOT					WATER CONTENT (%)			
83.0	Ground Surface													
82.9	Topsail		1 SS 10		83									
0.3	Het. mixture of Silt and Clay, some sand, trace gravel  (Glacial Till)  Very Stiff to Hard   Brown Grey		2 SS 27		82									
			3 SS 31		81									
			4 SS 25		80									
			5 SS 15		79									
			6 SS 12		78									
					77									
76.3			7 SS 45											
6.7	END OF BOREHOLE  Borehole dry upon completion													

$\times^3, \times^3$ : Numbers refer to Sensitivity

RECORD OF BOREHOLE No 136-15-1

1 OF 1

METRIC

W.P. 331-89-00 LOCATION WC 136-15: Sta. 13+499, O-S 23m Lt. ORIGINATED BY IK  
DIST HWY QEW BOREHOLE TYPE Solid Stem COMPILED BY IK  
DATUM SEE TEXT DATE 94.08.16 & 94.08.16 CHECKED BY TO

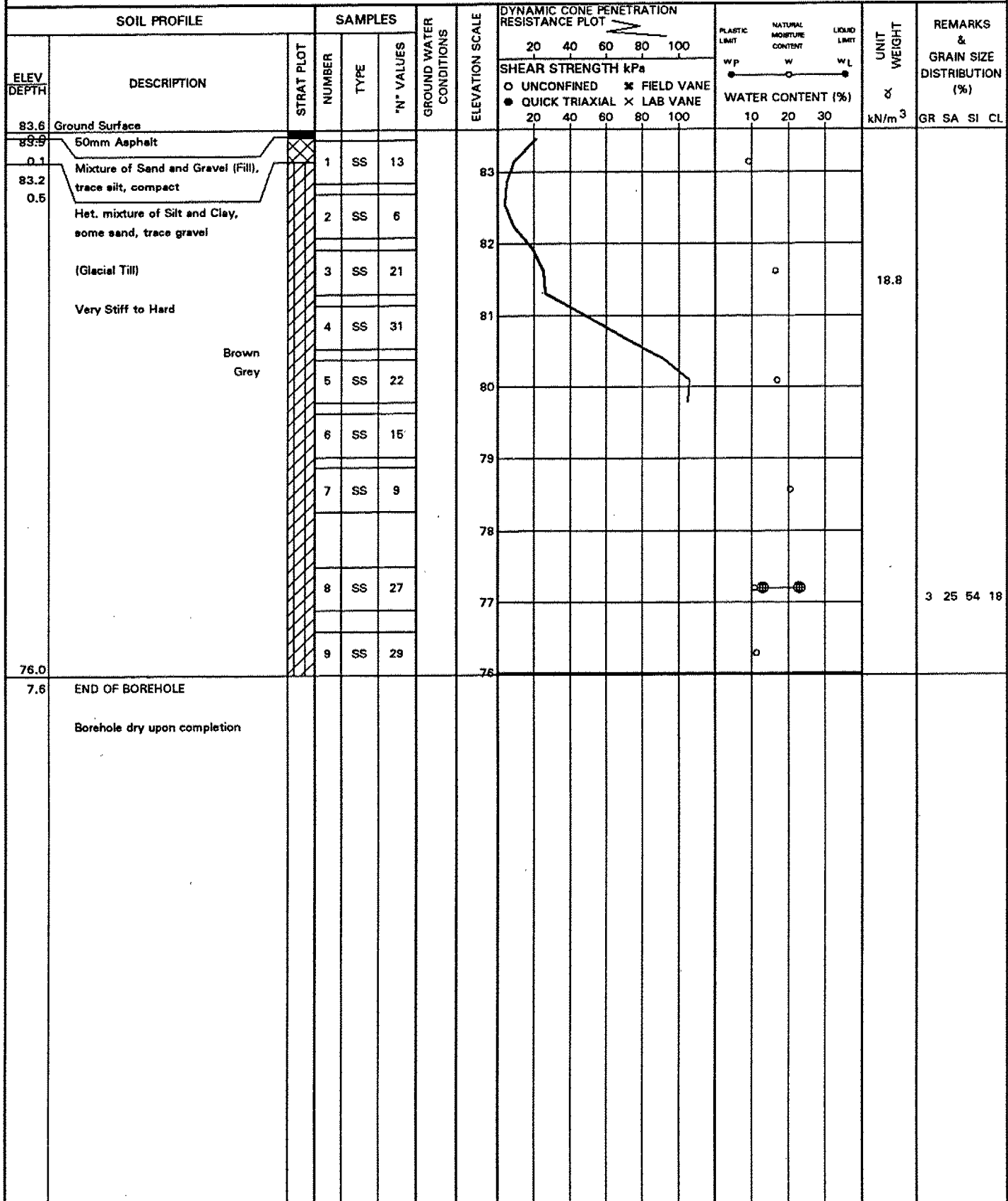
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT w <sub>p</sub>	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w <sub>L</sub>	UNIT WEIGHT γ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa						
82.6	Ground Surface							20 40 60 80 100						
82.6	Topsoil		1	SS	9									
0.1	Het. mixture of Silt and Clay, some sand, trace gravel		2	SS	32									
	(Glacial Till)													
	Very Stiff to Hard		3	SS	28									
			4	SS	17									
	Brown Grey		5	SS	11									
			6	SS	11									
			7	SS	41									
75.9	END OF BOREHOLE													
6.7	Borehole dry upon completion													

RECORD OF BOREHOLE No 136-15-2

1 OF 1

METRIC

W.P. 331-89-00 LOCATION WC 136-15; Sta. 13+499, O-S 3m Lt. ORIGINATED BY IK  
DIST 4 HWY QEW BOREHOLE TYPE Solid Stem, Cone Test COMPILED BY IK  
DATUM SEE TEXT DATE 94.08.12 & 94.08.12 CHECKED BY TO



RECORD OF BOREHOLE No 136-15-3

1 OF 1

METRIC

W.P. 331-89-00 LOCATION WC 136-15; Sta. 13+499, O-S 21m Rt. ORIGINATED BY IK  
DIST HWY QEW BOREHOLE TYPE Solid Stem COMPILED BY IK  
DATUM SEE TEXT DATE 94.08.15 & 94.08.15 CHECKED BY TO

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT Wp	NATURAL MOISTURE CONTENT W	LIQUID LIMIT Wl	UNIT WEIGHT γ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20 40 60 80 100	20 40 60 80 100					
82.5	Ground Surface													
0.1	Topsoil		1	SS	7		82							
	Het. mixture of Silt and Clay, some sand, trace gravel		2	SS	35		81							
	(Glacial Till)		3	SS	28		80							
	Very Stiff to Hard		4	SS	24		79							
	Brown Grey		5	SS	14		78							
			6	SS	23		77							
75.8			7	SS	46		76							
6.7	END OF BOREHOLE													
	Borehole dry upon completion													

RECORD OF BOREHOLE No 136-16-1

1 OF 1

METRIC

W.P. 331-89-00 LOCATION WC 136-16; Sta. 13+817, O-S 27m Lt. ORIGINATED BY IK  
DIST HWY QEW BOREHOLE TYPE Solid Stem COMPILED BY IK  
DATUM SEE TEXT DATE 94.08.16 & 94.08.18 CHECKED BY TO

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			UNIT WEIGHT $\gamma$ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa					
83.4	Ground Surface							20 40 60 80 100		PLASTIC LIMIT WP	NATURAL MOISTURE CONTENT W	LIQUID LIMIT WL	
82.8 0.2	Topsoil		1	SS	7		83						
	Mixture of Sand, Silt and Gravel (Fill), loose		2	SS	6		82						
82.0													
1.4	Het. mixture of Silt and Clay, some sand, trace gravel (Glacial Till) Very Stiff to Hard Grey		3	SS	28		81						
			4	SS	37		80						
			5	SS	58		79						
79.2			6	SS	55		78						
4.2	Shale												
	Bedrock												
	Poor to Fair												
77.2			7	SS	50	150mm							
6.3	END OF BOREHOLE												



RECORD OF BOREHOLE No 136-16-2

1 OF 1

METRIC

W.P. 331-89-00 LOCATION WC 136-16; Sta. 13+817, O-S 3m Lt. ORIGINATED BY IK  
DIST HWY QEW BOREHOLE TYPE Solid Stem, Cone Test COMPILED BY IK  
DATUM SEE TEXT DATE 94.08.12 & 94.08.12 CHECKED BY TO

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			UNIT WEIGHT $\gamma$ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20 40 60 80 100	PLASTIC LIMIT w <sub>p</sub>	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w <sub>L</sub>	
84.7	Ground Surface											
0.0	Mixture of Sand, Silt and Gravel (Fill)		1	SS	19		84					
	Loose to Compact		2	SS	10							
			3	SS	6		83					
82.2			4	SS	15		82					
2.6	Het. mixture of Silt and Clay, some sand, trace gravel		5	SS	50							
	(Glacial Till)		6	SS	60	125mm	81					
	Very Stiff to Hard		7	SS	60	125mm	80					
	Grey											
78.7			8	SS	80	10mm	79					
6.1	Shale						78					
	Bedrock											
	Poor to Fair		9	SS	60	25mm	77					
76.5												
8.2	END OF BOREHOLE											

x<sup>3</sup>, x<sup>3</sup>: Numbers refer to Sensitivity 20 15 10 (%) STRAIN AT FAILURE

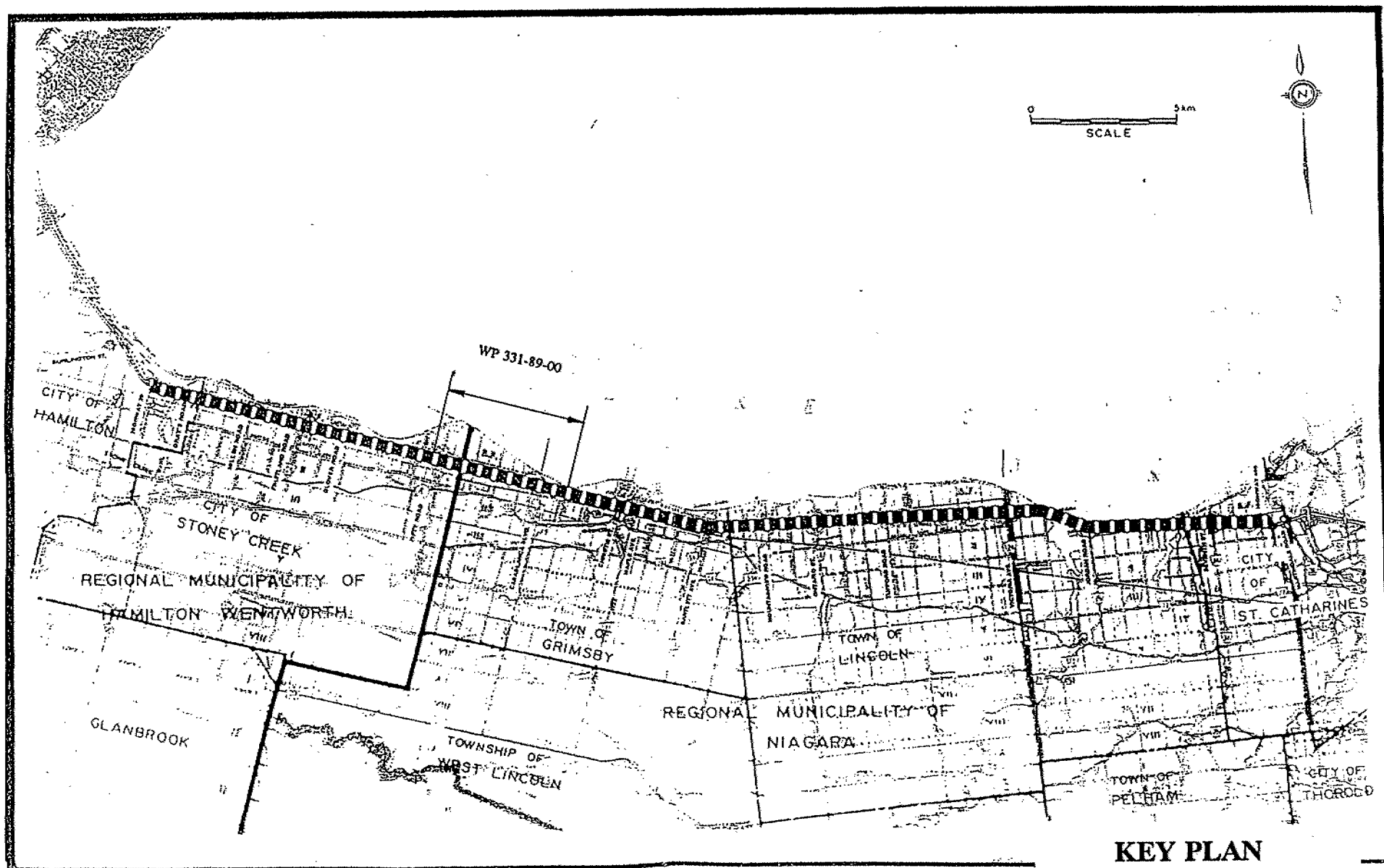
RECORD OF BOREHOLE No 136-16-3

1 OF 1

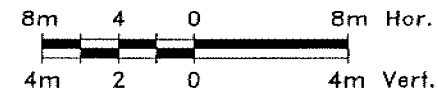
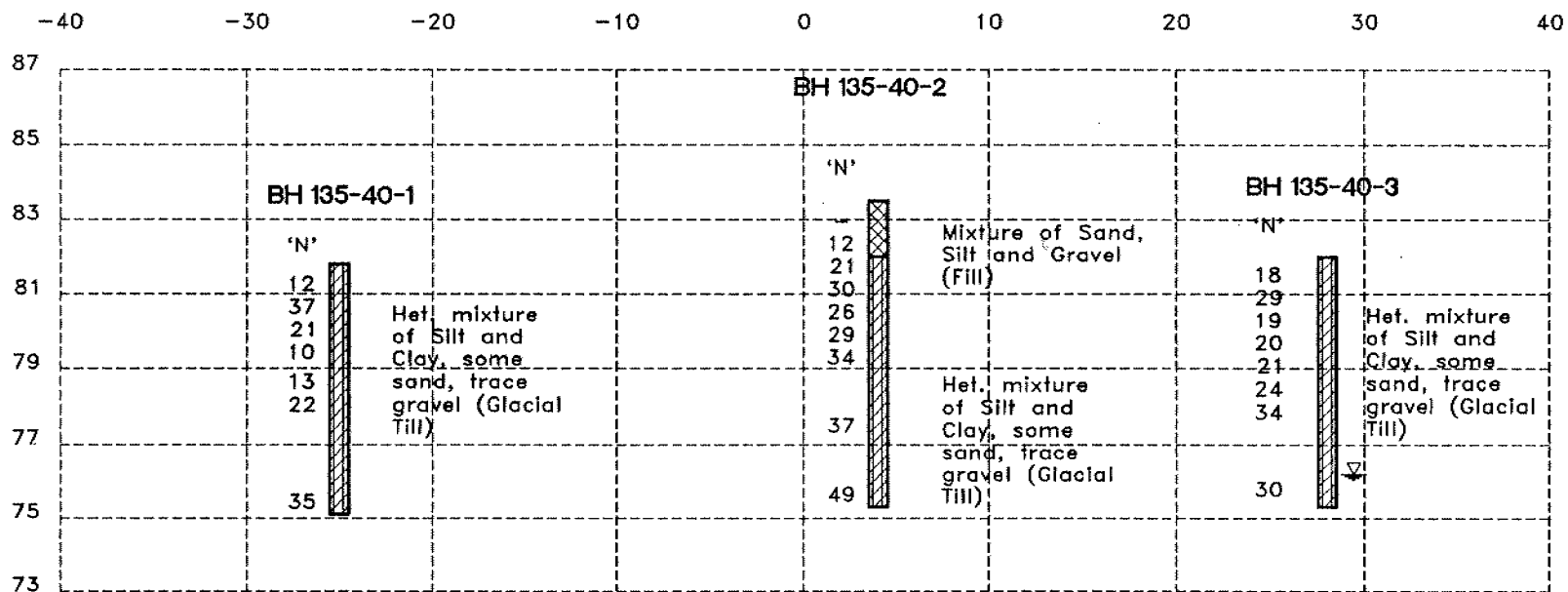
METRIC

W.P. 331-89-00 LOCATION WC 136-16; Sta. 13+817, O-S 29m Rt. ORIGINATED BY IK  
DIST HWY GEW BOREHOLE TYPE Solid Stem COMPILED BY IK  
DATUM SEE TEXT DATE 94.08.16 & 94.08.16 CHECKED BY TO

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT $\gamma$ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20 40 60 80 100	20 40 60 80 100	20 40 60 80 100	20 40 60 80 100	20 40 60 80 100		
83.2	Ground Surface													
83.1	Topsoil		1	SS	8		83							
0.1	Silty Sand (Fill), some gravel Loose Brown		2	SS	7		82							
81.7	Het. mixture of Silt and Clay, some sand, trace gravel (Glacial Till) Very Stiff to Hard Brown		3	SS	22		81							
1.5			4	SS	60		80							
79.9	Shale		5	SS	100	250mm	79							
3.3	Bedrock		6	SS	100	/0mm	78							
	Poor to Fair													
77.1			7	SS	50	80mm								
6.2	END OF BOREHOLE													



**KEY PLAN  
FIGURE 1**



WC 135-40 -  $\xi$  PROFILE STATION 31+688

Job No.:  
WP 331-89-00

Dwg. No.:  
3318900-E

Date:  
94/09/06

Dwn. by:  
TA

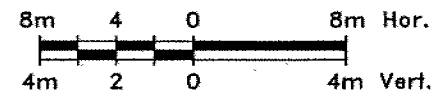
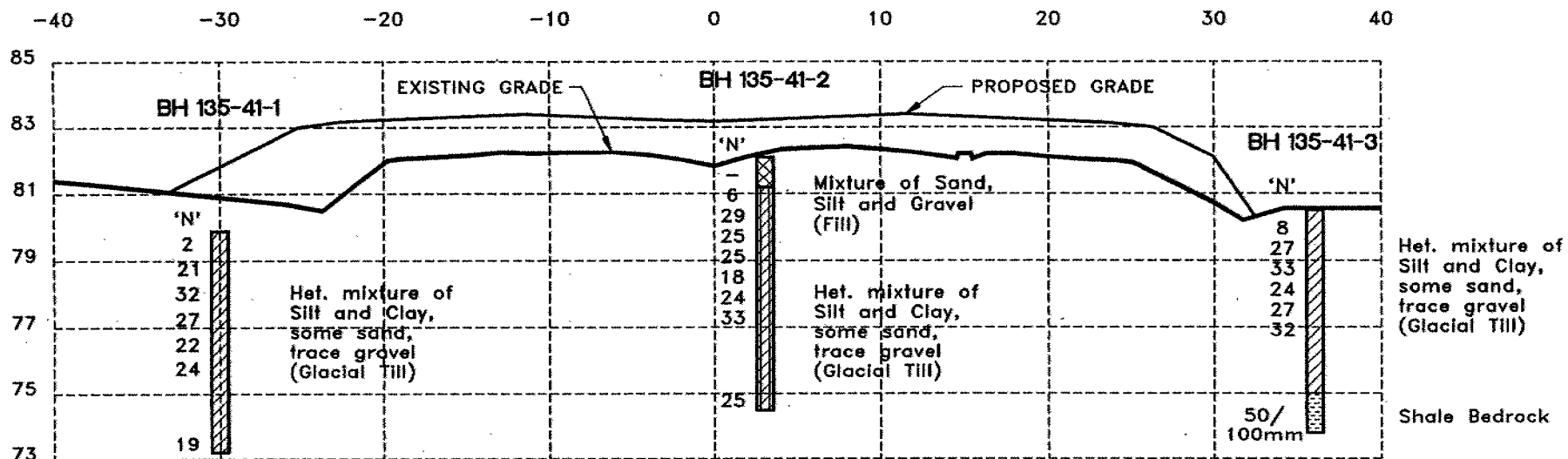
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TO



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3318900-E



WC 135-41 - C PROFILE STATION 32+102

Job No.:  
WP 331-89-00

Dwg. No.:  
3318900-F

Date:  
94/09/06

Dwn. by:  
TA

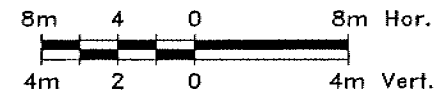
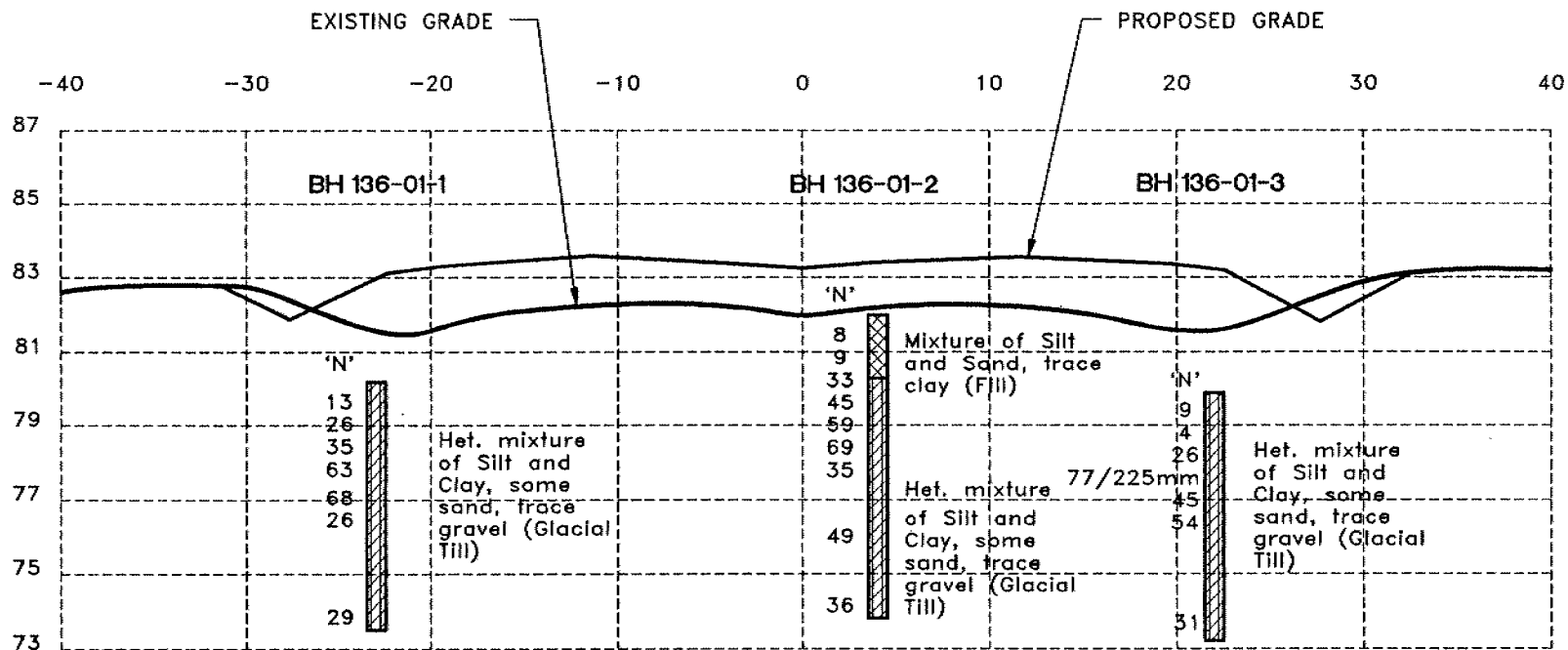
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TO



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3318900-F



WC 136-01 - C PROFILE STATION 10+419

Job No.:  
WP 331-89-00

Dwg. No.:  
3318900-G

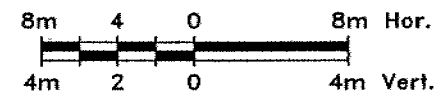
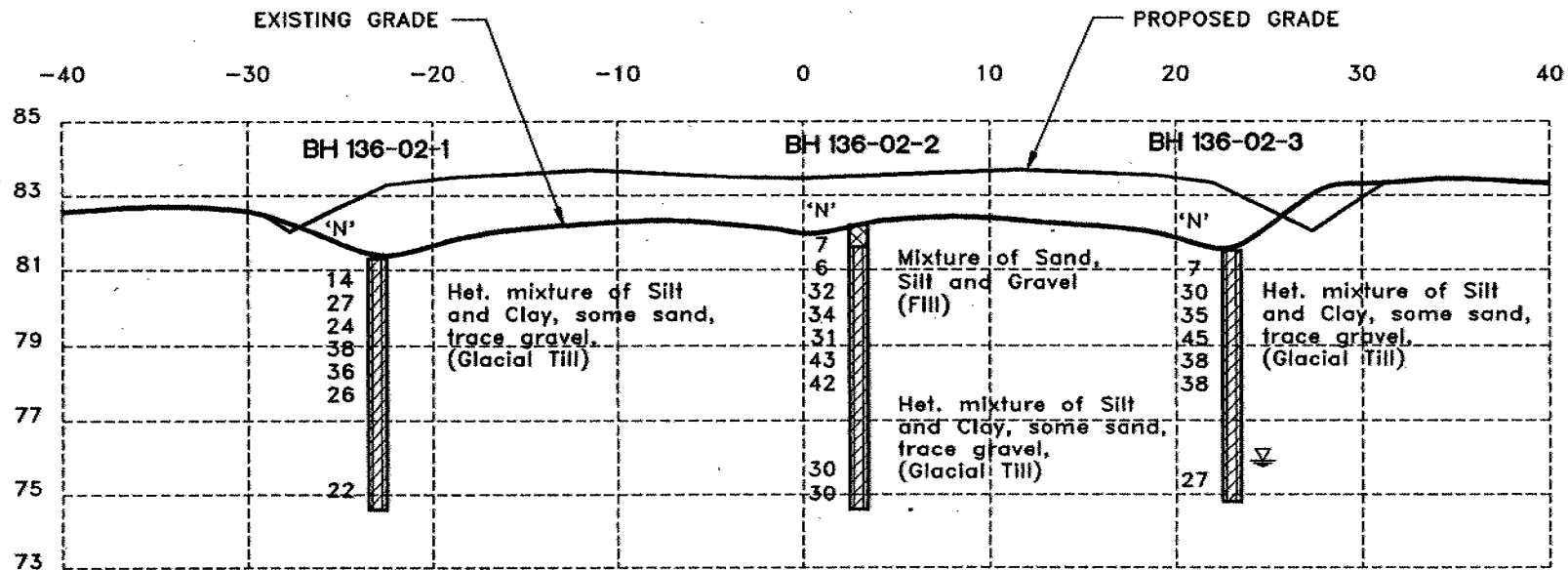
Date:  
94/09/06

Dwn. by:  
TA

Appd.:  
TO



Jacques Whitford



WC 136-02 - C PROFILE STATION 10+622

Job No.:  
WP 331-89-00

Dwg. No.:  
3318900-H

Date:  
94/09/06

Dwn. by:  
TA

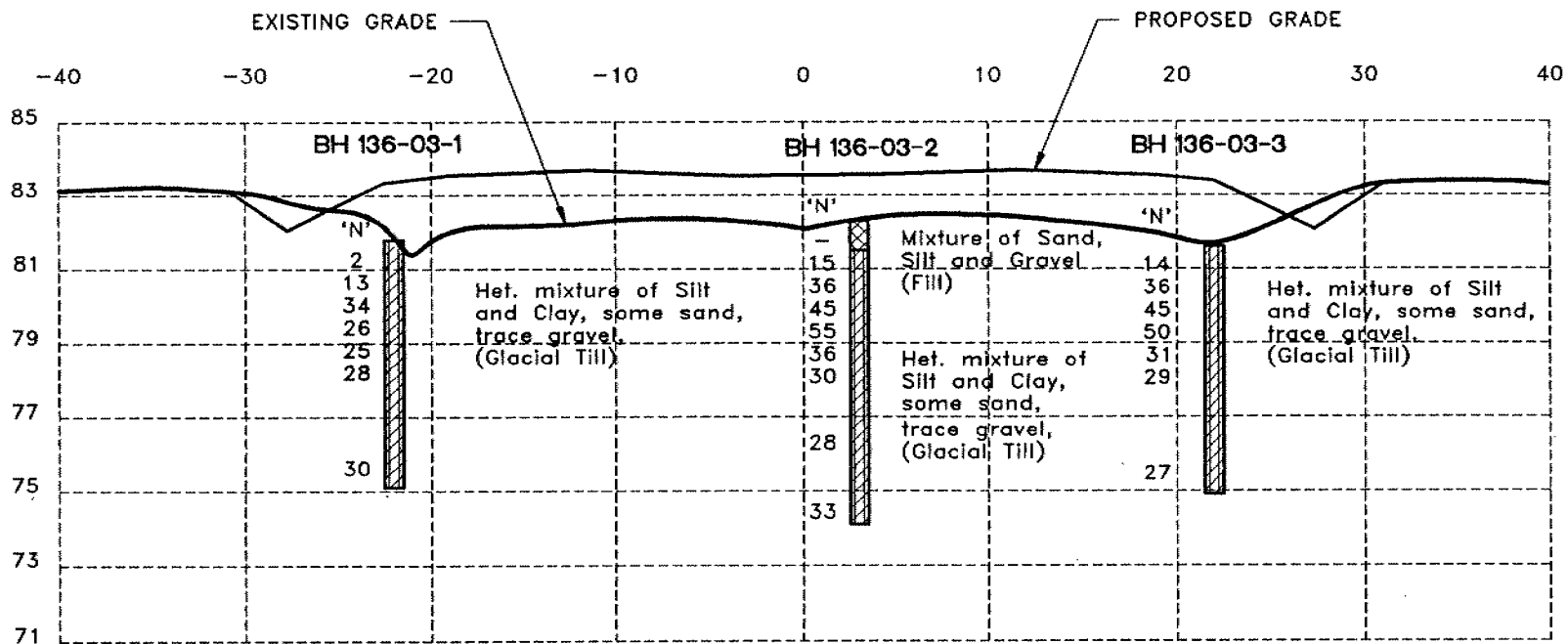
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TO



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3318900-H



WC 136-03 - C PROFILE STATION 10+825

Job No.:  
WP 331-89-00

Dwg. No.:  
3318900-1

Date:  
94/09/06

Dwn. by:  
TA

Appd.:  
TO

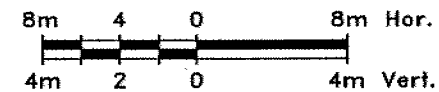
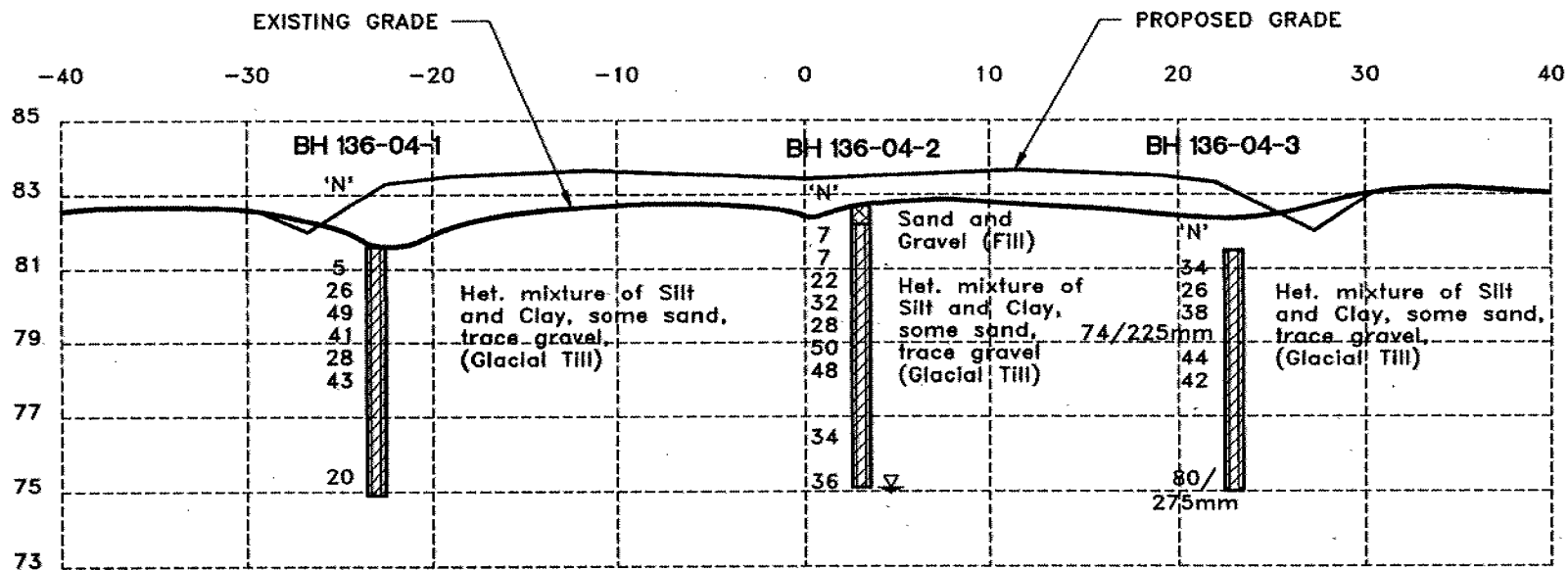


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3318900-1





WC 136-04 - C PROFILE STATION 11+101

Job No.:  
WP 331-89-00

Dwg. No.:  
3318900-J

Date:  
94/09/06

Dwn. by:  
TA

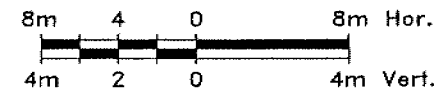
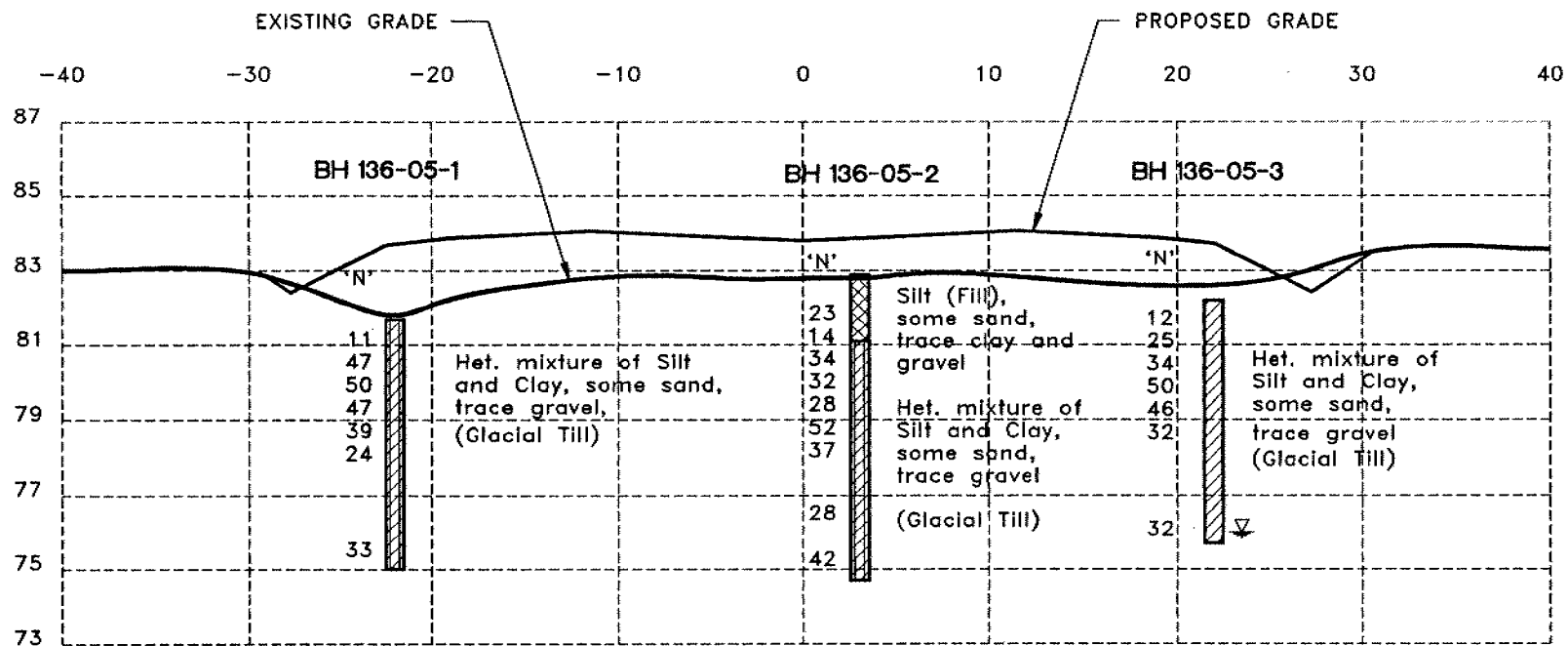
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3318900-J



WC 136-05 -  $\zeta$  PROFILE STATION 11+262

Job No.:  
WP 331-89-00

Dwg. No.:  
3318900-K

Date:  
94/09/06

Dwn. by:  
TA

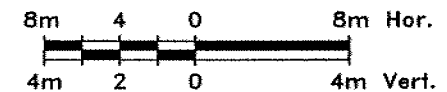
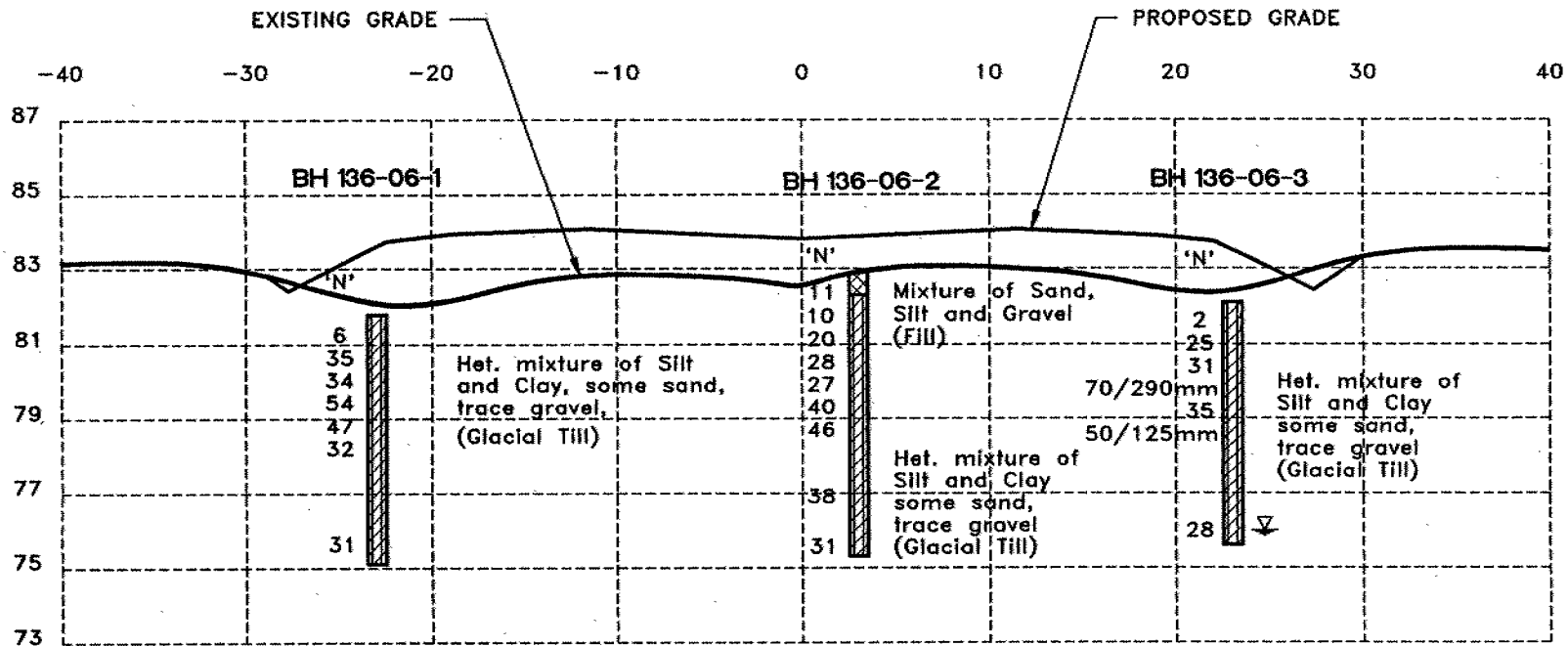
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TO



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Whitford

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3318900-K



WC 136-06 - C PROFILE STATION 11+446

Job No.:  
WP 331-89-00

Dwg. No.:  
3318900-L

Date:  
94/09/06

Dwn. by:  
TA

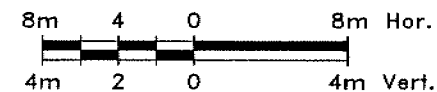
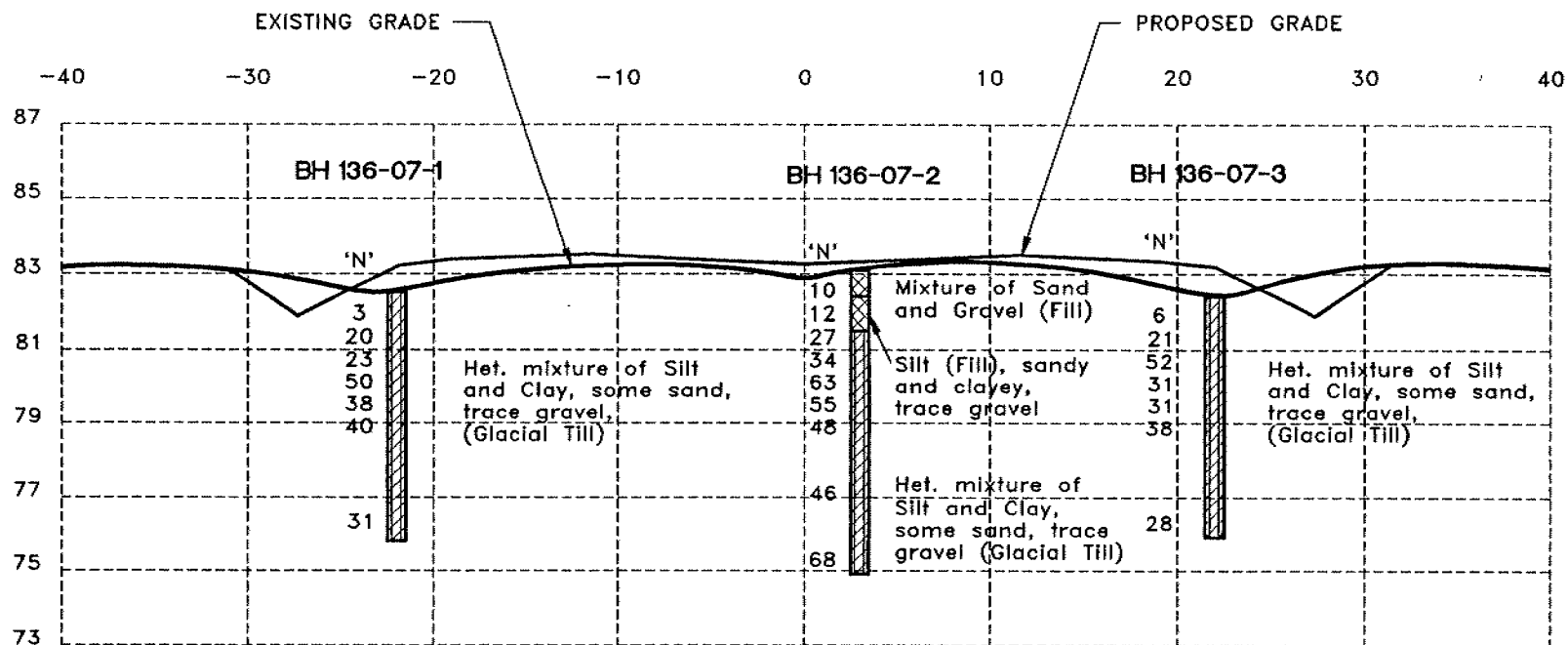
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TO



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3318900-L



WC 136-07 - C PROFILE STATION 11+656

Job No.:  
WP 331-89-00

Dwg. No.:  
3318900-M

Date:  
94/09/06

Dwn. by:  
TA

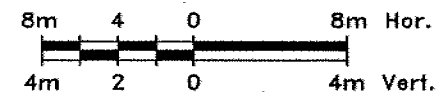
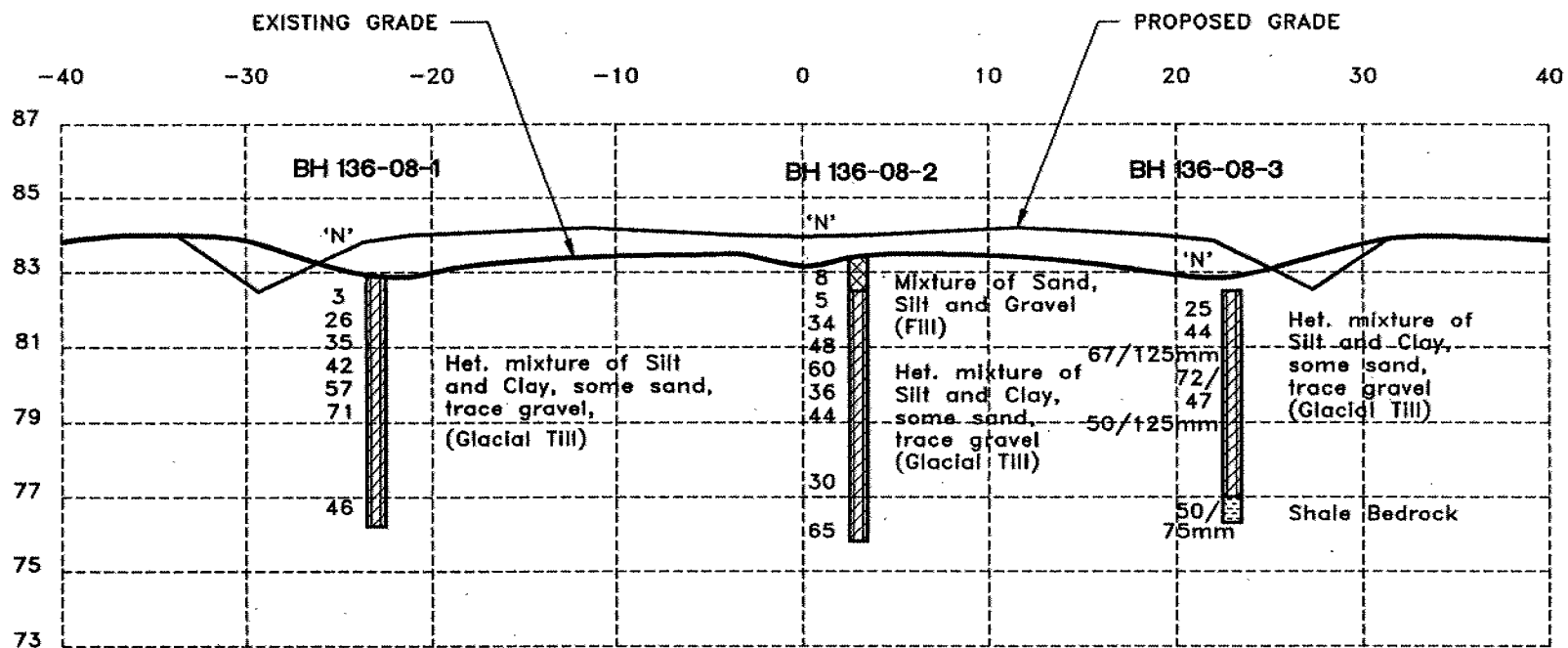
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Whitford

202

3318900-M



WC 136-08 - C PROFILE STATION 11+853

Job No.:  
WP 331-89-00

Dwg. No.:  
3318900-N

Date:  
94/09/06

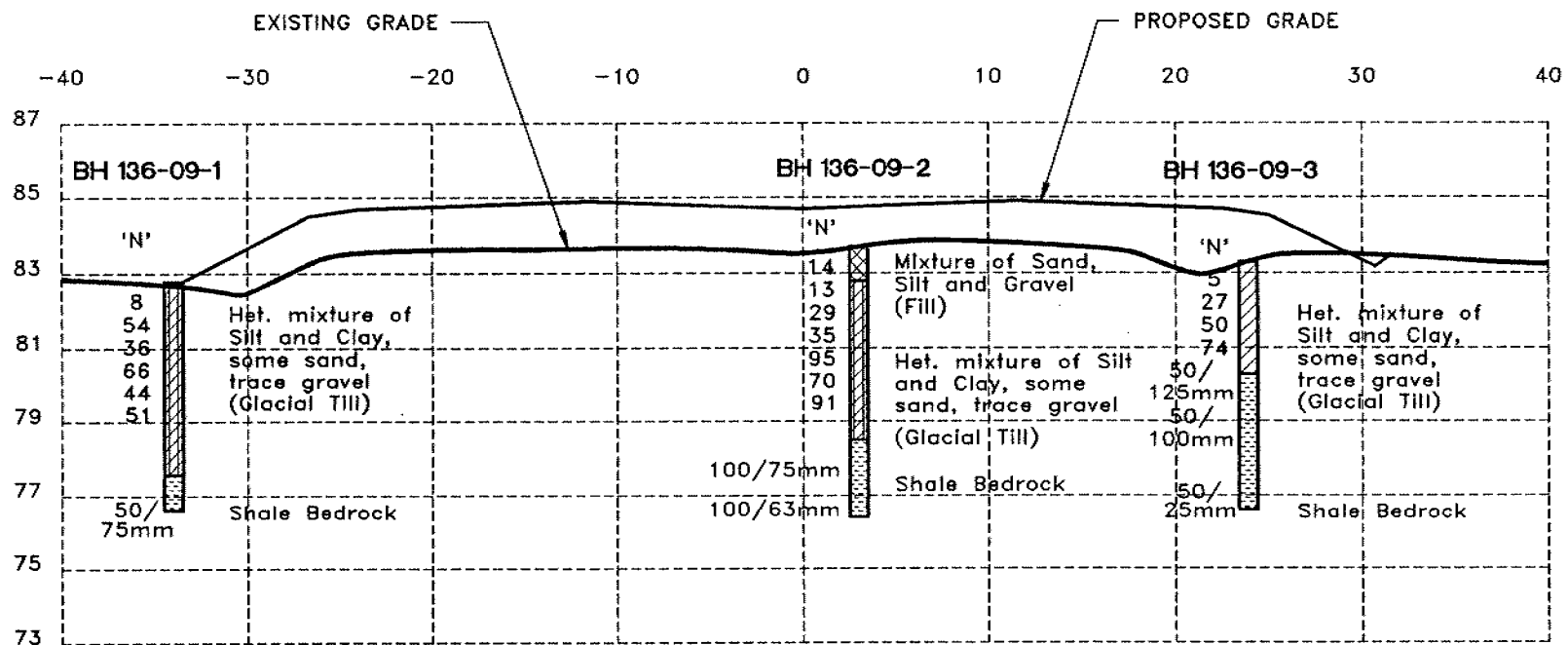
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TA

Appd.:  
TO



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Whitford

3318900-N



WC 136-09 - C PROFILE STATION 12+059

Job No.:

WP 331-89-00

Dwg. No.:

3318900-0

Date:

94/09/06

Dwn. by:

TA

Appd.:

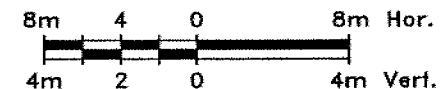
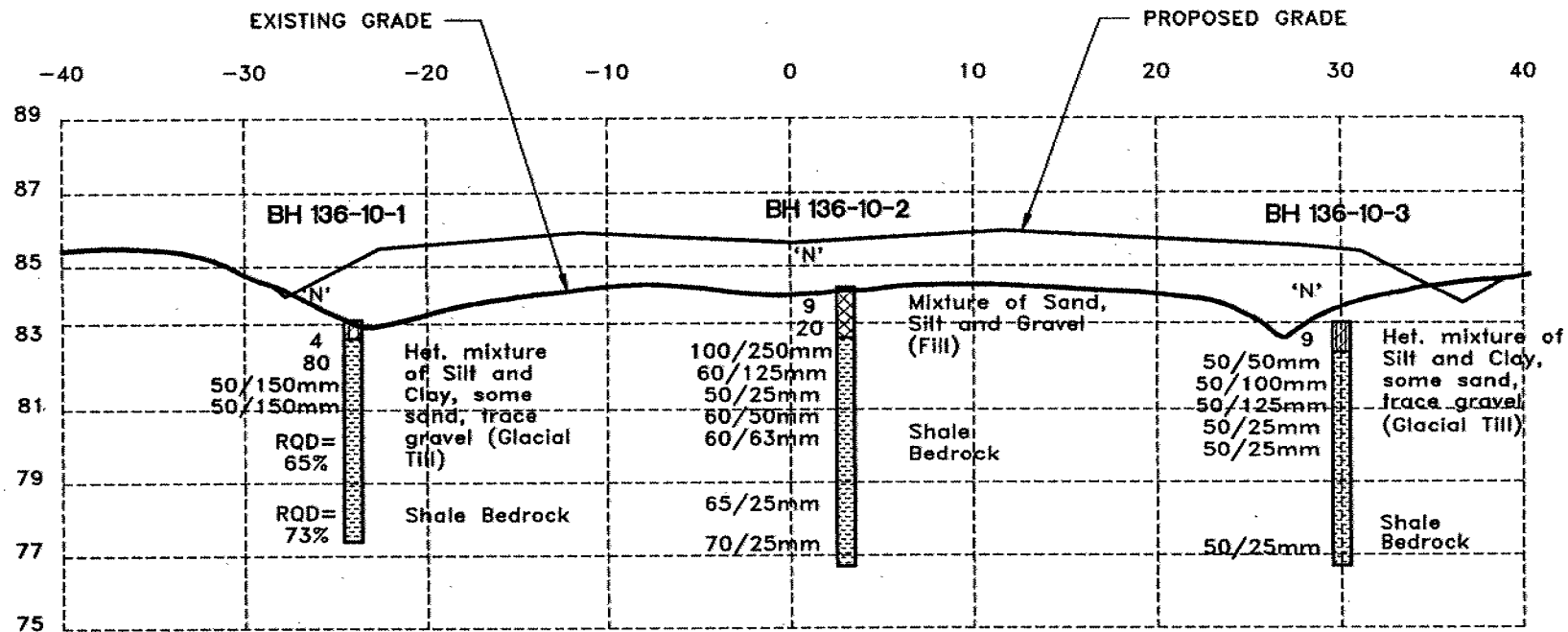
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Jacques Whitford

84

3318900



WC 136-10 - C PROFILE STATION 12+347

Job No.:  
WP 331-89-00

Dwg. No.:  
3318900-P

Date:  
94/09/06

Dwn. by:  
TA

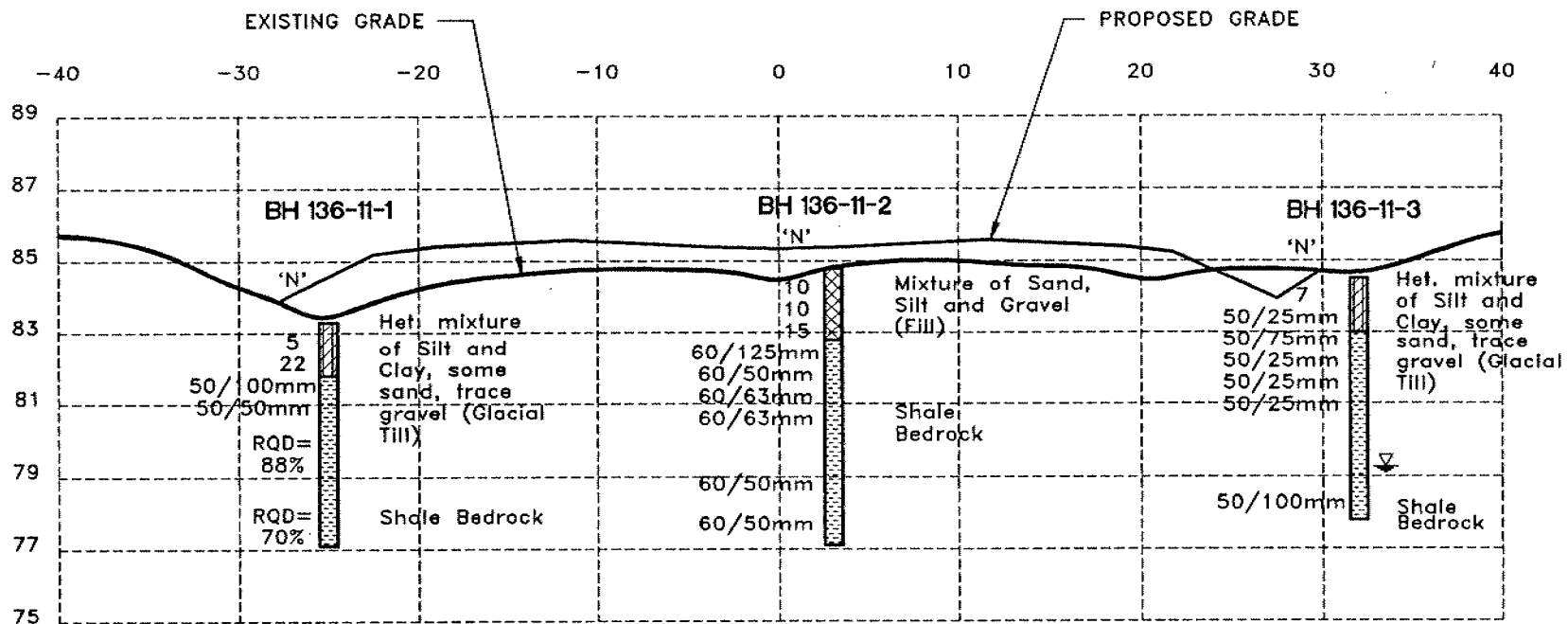
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TO



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Whitford

85

3318900-P



WC 136-11 - C PROFILE STATION 12+675

Job No.:  
WP 331-89-00

Dwg. No.:  
3318900-0

Date:  
94/09/06

Dwn. by:  
TA

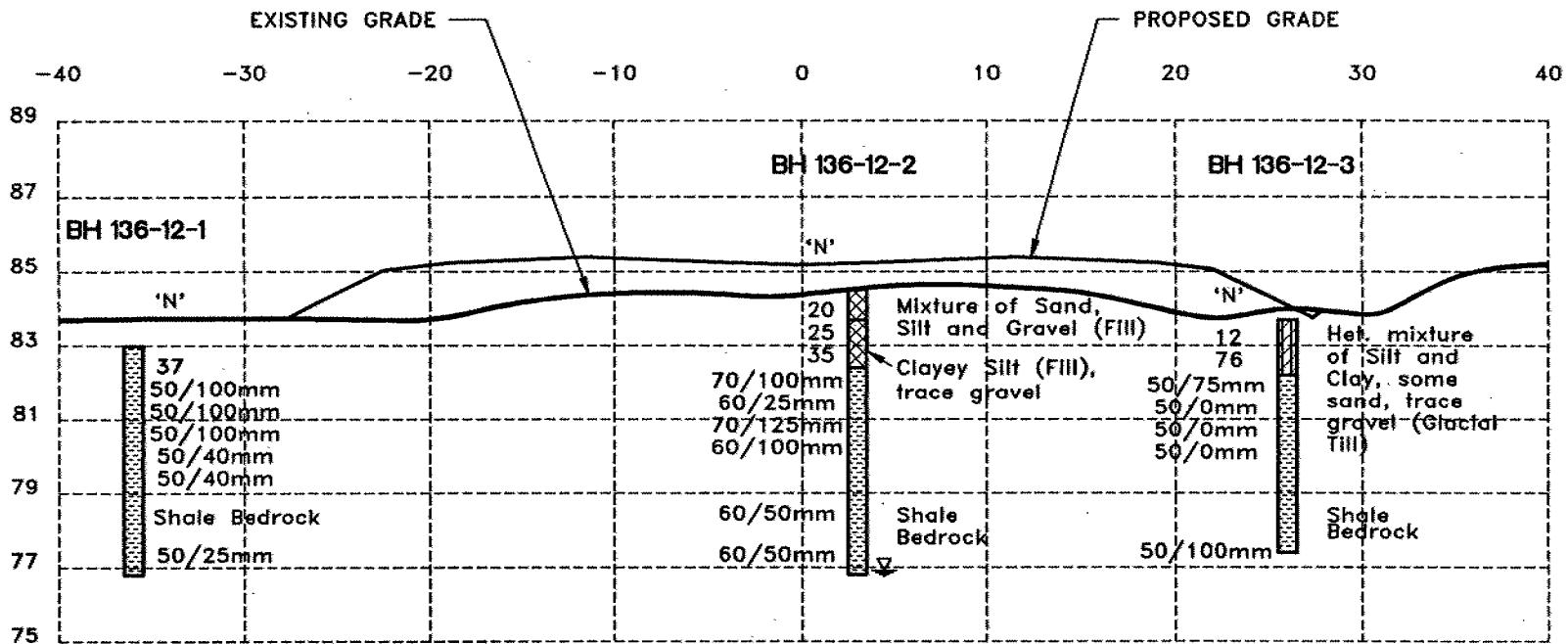
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WC 136-12 - C PROFILE STATION 12+885

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WP 331-89-00

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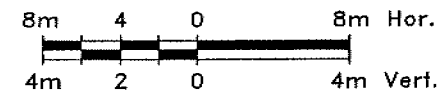
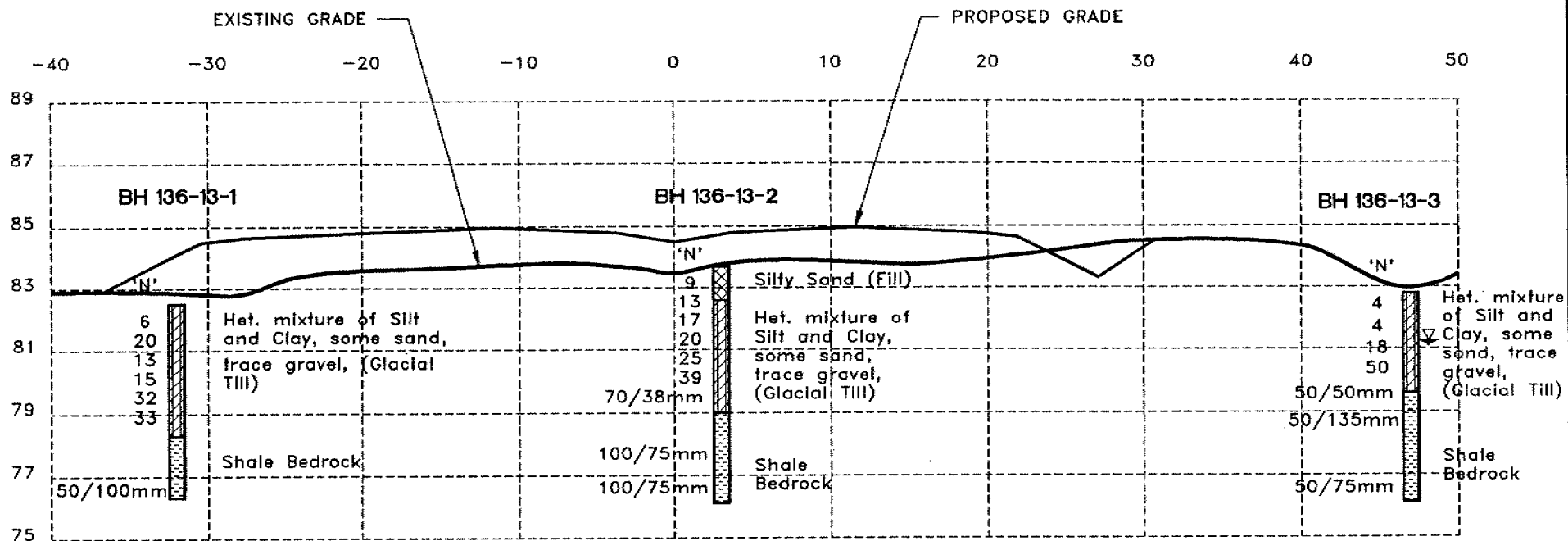
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Jacques  
Whitford



WC 136-13 -  $\zeta$  PROFILE STATION 13+085

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3318900-S

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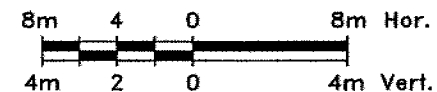
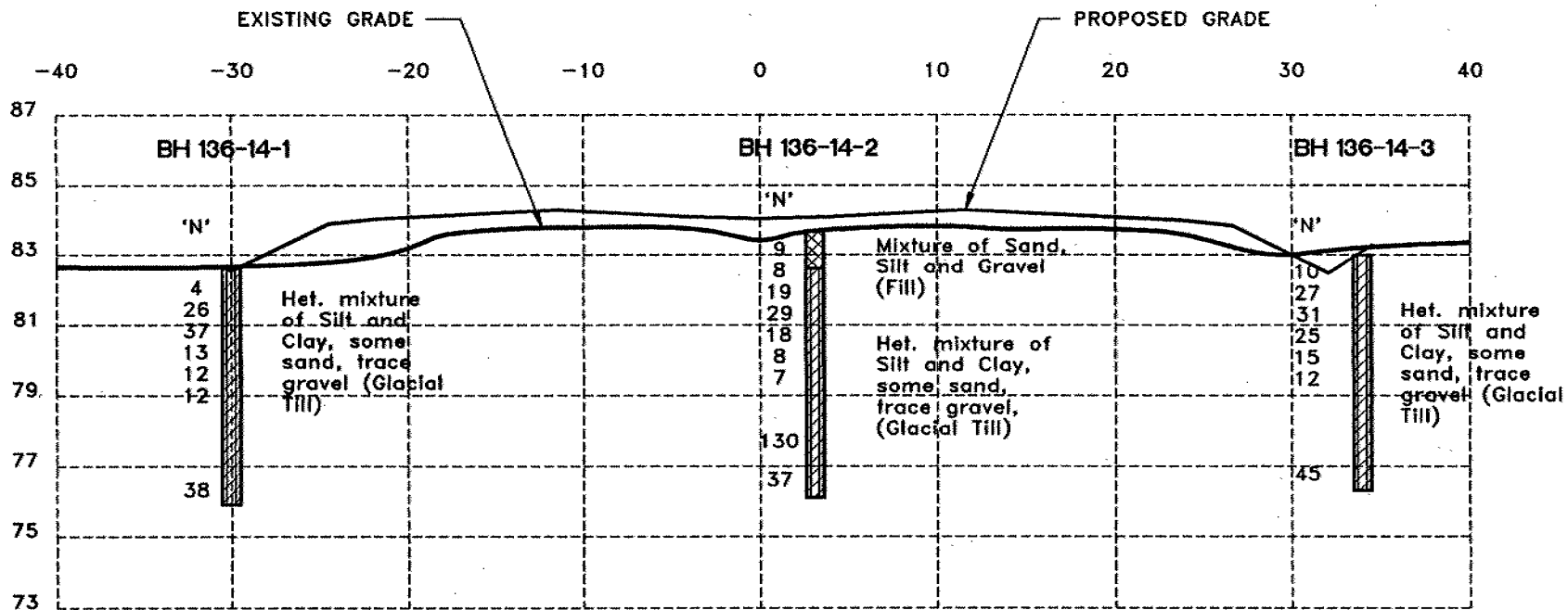
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Jacques Whitford

3318900-S



WC 136-14 - C PROFILE STATION 13+278

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3318900-T

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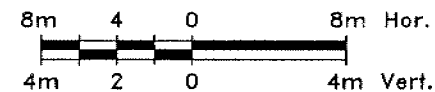
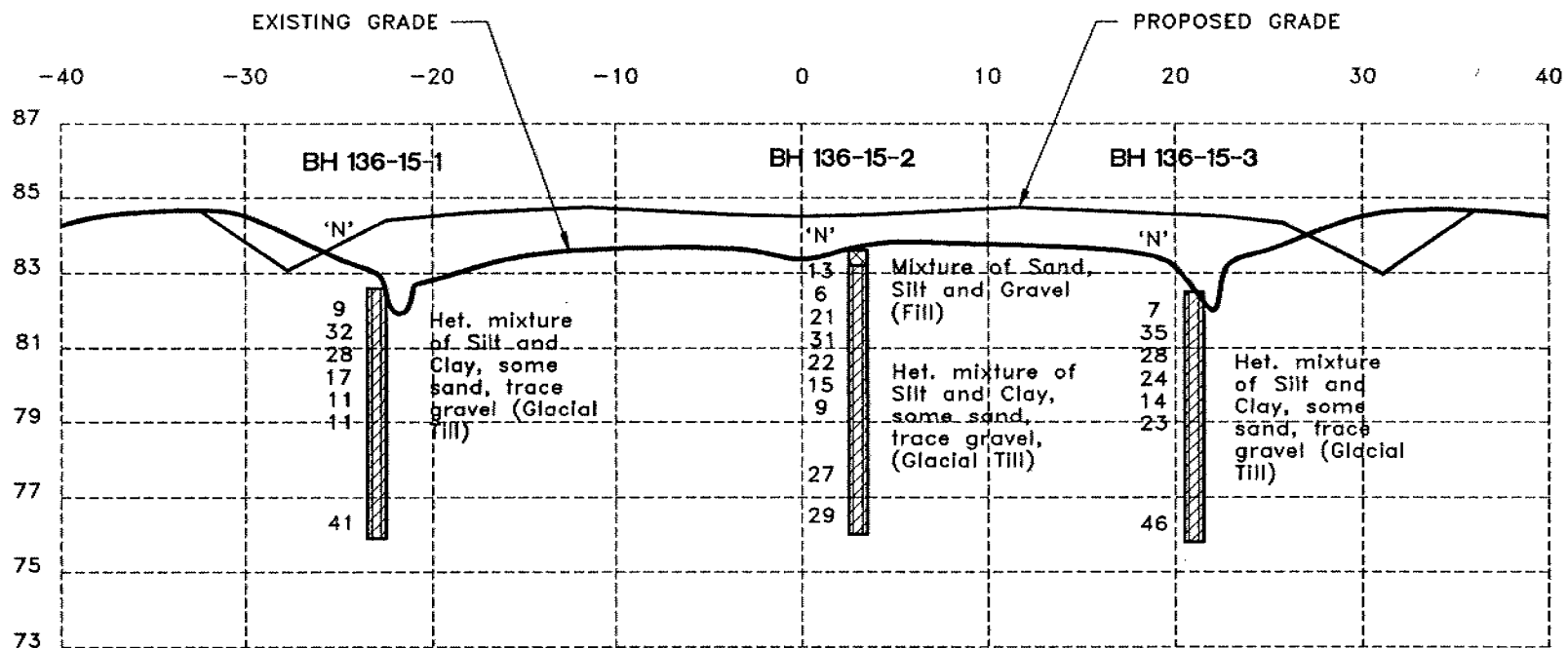
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Jacques Whitford 89

3318900-T



WC 136-15 - C PROFILE STATION 13+499

Job No.:  
WP 331-89-00

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3318900-U

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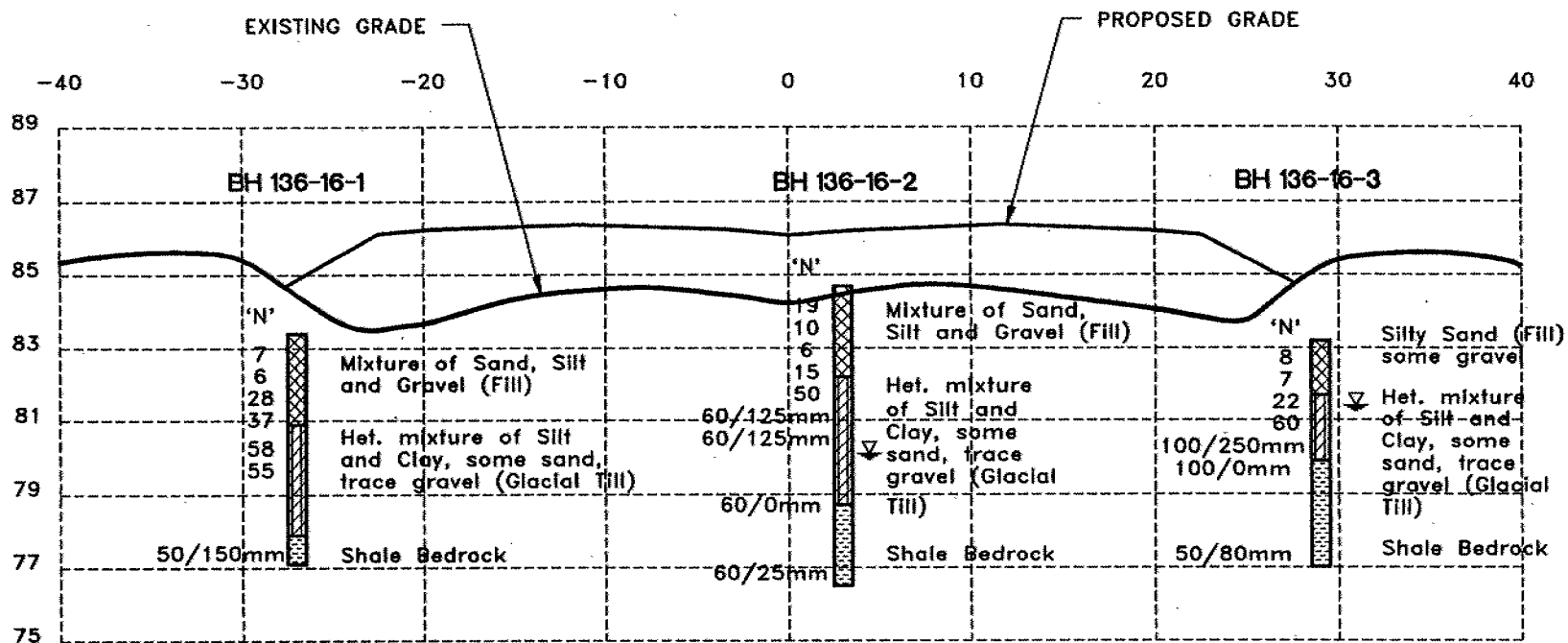
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3318900-U



WC 136-16 - E PROFILE STATION 13+817

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WP 331-89-00

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3318900-V

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94/09/06

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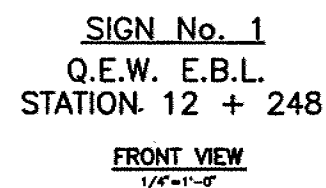
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Jacques  
Whitford

91

3318900-V



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REGIONAL MUNICIPALITY OF  
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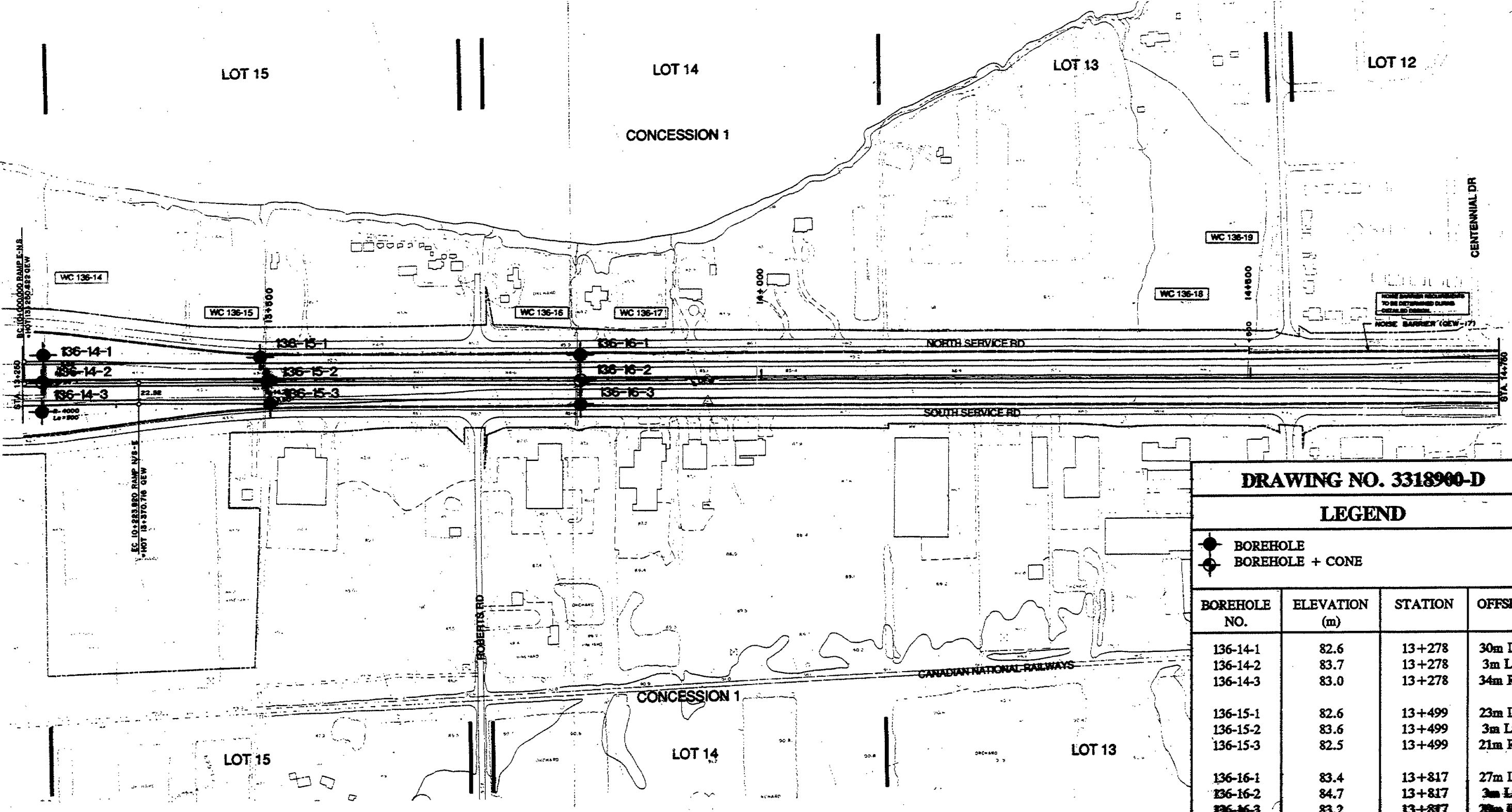
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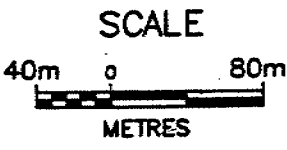


DRAWING NO. 3318900-D

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- BOREHOLE + CONE

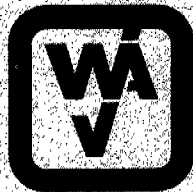
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136-14-2	83.7	13+278	3m Lt.
136-14-3	83.0	13+278	34m Rt.
136-15-1	82.6	13+499	23m Lt.
136-15-2	83.6	13+499	3m Lt.
136-15-3	82.5	13+499	21m Rt.
136-16-1	83.4	13+817	27m Lt.
136-16-2	84.7	13+817	3m Lt.
136-16-3	83.2	13+817	20m Rt.



LEGEND

- FLOODPLAIN LINE
- FILL LINE
- EXISTING PROPERTY
- PROPOSED CAH
- PROPERTY ACQUISITION

FILE COPY



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**Jacques Whitford  
Environment Limited**

Consulting Engineers  
and Scientists



Recycled Paper



**FOUNDATION INVESTIGATION REPORT**

**W.P. 331-89-00 & W.P. 333-89-00  
CULVERT REPLACEMENT  
QUEEN ELIZABETH WAY  
STONEY CREEK, GRIMSBY & ST. CATHERINES**

**MINISTRY OF TRANSPORTATION ONTARIO**

**SUBMITTED BY**

**JACQUES WHITFORD ENVIRONMENT LIMITED**

**85 CITIZEN COURT  
UNIT 18  
MARKHAM, ONTARIO L6G 1A7**

**PHONE: (416) 495-8614 FAX: (905) 479-9326**

*GEOCRES No's 30M3 - 203  
30M4 - 76*

**SEP 16 1994**

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### Appendix 1

Explanation of Terms Used in Report

Record of Boreholes

Figure 1 - 6 : Plasticity Chart

Figure 7 - 8 : Grain Size Distribution

### Appendix 2

Figure 1 Key Plan

Table 1 - Culvert Details

Table 2 - Report of Soil Chemistry Analysis

Drawing No. 3318900- A to D - Borehole Locations

Drawing No. 3338900- A and B - Borehole Locations

Drawing No. 3318900- E to V - Soil Strata Profile

Drawing No. 3338900- C and D - Soil Strata Profile

# **FOUNDATION INVESTIGATION REPORT**

**for**

**Culvert Replacement**

**W.P. 331-89-00  
Queen Elizabeth Way  
Fifty Road to Casablanca Boulevard  
Stoney Creek and Grimsby**

**and**

**W.P. 333-89-00  
Queen Elizabeth Way  
Jordan Road  
St. Catharines**

## **1.0 INTRODUCTION**

This report presents the results of a foundation investigation carried out at twenty (20) proposed culvert replacement sites in the City of Stoney Creek, Town of Grimsby and City of St. Catharines, Ontario. The investigation was carried out in accordance with our proposal dated 94/08/06. Authorization to carry out the work was provided by the Foundation Design Section, Ministry of Transportation, Ontario (MTO).

This report contains factual information together with discussion and recommendations pertaining to the subsurface conditions.

## **2.0 SITE DESCRIPTION AND GEOLOGY**

Eighteen (18) culvert replacement sites are located along the Queen Elizabeth Way (QEW) from Fifty Road in Stoney Creek to approximately 1 km east of Casablanca Boulevard in Grimsby. A key plan illustrating the site location is provided as Figure 1 in Appendix 2. Two (2) culvert replacement sites are located along the QEW at Jordan Road in St. Catharines. The terrain surrounding the sites is generally flat and consists of mixed residential, agricultural and industrial land uses. The existing ground surface generally slopes downward gently from south to north, towards Lake Ontario.

At the time of the investigation, the QEW is a four-lane divided highway with gravel shoulders. A North Service Road and South Service Road is located parallel to the QEW on the north and south sides, respectively. Both the North and South Service Roads are two-lane paved roads with gravel shoulders.

Drainage of the existing QEW is provided by highway ditches located on both the north and south sides and in between the QEW and the two service roads. The 20 culverts investigated during this study facilitate drainage of these ditches beneath the QEW towards the north into Lake Ontario. At each culvert location beneath the QEW, there is an additional two separate culverts constructed beneath the North Service Road and the South Service Road.

The 20 existing culverts beneath the QEW and the 40 existing culverts beneath the two service roads consist of either a concrete box culvert or a Corrugated Steel Pipe (CSP) culvert.

Physiographically, the sites in Stoney Creek and Grimsby lie in the area known as the Halton Till Plain, which consists of glacial till with clayey silt to silty clay size particles and little to no cobbles and boulders. The sites in St. Catharines lie in the glacial Lake Iroquois stratified sands and silts. Bedrock underlying the overburden consists of Ordovician shale of the Queenston Formation throughout the study area.

### **3.0 PROCEDURE**

#### **3.1 Field Investigation**

Prior to the onset of the drilling investigation, the necessary utility check clearances were obtained by our site personnel. Traffic control for this project was provided by Barricade Traffic Services Inc., who were coordinated by MTO.

The field work for this investigation was carried out between August 16 and 25, 1994. Three (3) boreholes were put down at each of the twenty (20) culvert locations. The test locations are indicated on Drawings 3318900-A to 3318900-D and 3338900-A and 3338900-B provided in Appendix 2. One dynamic cone penetration test was also conducted at each culvert location. Bedrock was proven by coring in NQ-size at two culvert locations (WC136-10 and WC136-11).

All boreholes were put down using either a track-mounted or truck-mounted power auger drill suitably equipped for soil and bedrock sampling. Continuous flight solid stem augers and NQ-sized rock coring techniques (where required) were employed during the course of the investigation to advance the boreholes. The boreholes were put down to depths of about 4 m to 5 m below the existing culvert founding levels, to total depths ranging from 6.1 m to 12.8 m.

The overburden soils encountered were sampled by means of a split spoon sampler during the performance of Standard Penetration Tests (SPT) (ASTM D1586). Where soft to firm cohesive soils were encountered, field vane tests were conducted at selected locations. Sampling was generally conducted on a near continuous basis (intervals of 0.76 m) at the top 4.6 m of the borehole. Below this depth, sampling was conducted in intervals of about 1.5 m.

All soil samples recovered together with bedrock core samples were stored in moisture-proof bags or core boxes, and were returned to our Markham laboratory for detailed classification and testing.

Water levels, where observed, were obtained in the open boreholes upon completion of the drilling. All boreholes were backfilled with auger cuttings and sealed with a minimum 500 mm thick bentonite layer at the ground surface. Boreholes put down at the median where the surface consists of asphaltic concrete were surfaced with a minimum of 50 mm of cold mix asphalt.

### **3.2 Survey**

The borehole and cone penetration test locations and ground surface elevations were surveyed by Jacques Whitford Environment Limited (JWEL) personnel after completion of the field work. The elevations were referenced to existing culvert invert elevations shown on the site plans, provided by MTO. These elevations are assumed to be referenced to the Geodetic datum. The borehole and elevation data is summarized on Drawings 3318900-A to 3318900-D, and 3338900-A and 3338900-B in Appendix 2.

### **3.3 Laboratory Testing**

To identify the properties of the samples collected during the field investigation, the following laboratory tests were carried out on selected samples:

- Detailed visual classification,
- Natural moisture content,
- Sieve and hydrometer analyses,
- Atterberg Limits determination,
- Natural unit weight determination.

#### **4.0 RESULTS OF THE INVESTIGATION**

The subsurface conditions observed in the boreholes are presented in detail on the Record of Boreholes provided in Appendix 1. An Explanation of Terms Used in Report is also provided in Appendix 1. Cross sections showing the soil profiles at each culvert location are provided in Appendix 2. The laboratory test results are summarized in the Record of Boreholes and also on Figures 1 to 8 in Appendix 1.

A brief discussion of the observed subsurface conditions is provided below. For the purpose of presentation, this discussion is broken down into two sections. Specific details of the subsurface materials at a particular culvert location should be obtained from the Record of Boreholes.

#### **4.1 W.P. 331-89-00**

##### **4.1.1 Topsoil**

Topsoil was encountered at the ground surface in most boreholes except the boreholes located in the median of the QEW. The thickness of the topsoil ranges from 50 mm to 600 mm.

##### **4.1.2 Asphaltic Concrete**

Asphaltic concrete was encountered at the ground surface in Boreholes 135-41-2, 136-04-2, 136-14-2 and 136-15-2 (QEW median locations). The thickness of the asphaltic concrete ranged from 50 mm to 100 mm at the time of the investigation with an average thickness of about 75 mm.

##### **4.1.3 Sand, Silt and Gravel (Fill) / Silt (Fill)**

A loose to compact mixture of sand, silt and gravel (fill) layer was encountered at the ground surface or underlying the asphaltic concrete in all QEW median boreholes. The thickness of the fill layer ranged from 0.5 m to 2.6 m. The SPT conducted in this fill layer yielded N values ranging from 6 to 20. In general, this material was observed to be compact. Based on visual identification and laboratory tests, this fill can be classified as inorganic and cohesionless.

A compact silt (fill) with varying amounts of sand, clay and gravel was encountered underlying the sand, silt and gravel (fill) mentioned above, in Boreholes 135-40-2, 136-01-2, 136-05-2, 136-07-2, and 136-12-2. The thickness of the fill layer ranged from 0.9 m to 1.5 m. The SPT conducted in this fill layer yielded N values ranging from 9 to 25. The visual observations and laboratory test results indicate that this material is cohesionless.

The results of laboratory testing carried out on selected samples of both fill material types are provided on the Record of Boreholes, on Figures 5 and 7 in Appendix 1, and are summarized below:

Property	Range	# Tests	Average
Moisture Content (%)	4-18	16	10
Grain Size			
% Gravel	0-42	4	18
% Sand	4-45	4	28
% Silt	13-76	4	43
% Clay	0-20	4	11
Liquid Limit (%)	24-39	3	30
Plastic Limit (%)	16-22	3	18
Plasticity Index (%)	7-17	3	12

#### 4.1.4 Heterogeneous Mixture of Silt and Clay, some Sand, trace Gravel (Glacial Till)

A heterogeneous mixture of silt and clay, some sand, trace gravel (glacial till) was encountered in all boreholes except Boreholes 136-10-2, 136-11-2, 136-12-1 and 136-12-2. The glacial till was observed at the ground surface or it was underlying the fill or topsoil. Where present, the glacial till surface was encountered at elevations ranging from El. 79.3 m to El. 84.3 m (depths of 0 m to 2.6 m).

The SPT conducted in the glacial till layer yielded N values ranging from 4 to over 100. All boreholes were terminated within the glacial till deposit with the exception of Boreholes 135-41-3, 136-08-3 to 136-13-3, and 136-16-1 to 136-16-3, which encountered shale bedrock.



The results of laboratory testing on selected SPT samples of this till material are provided on the Record of Boreholes, on Figures 1 to 4 and 8 in Appendix 1, and are summarized below:

Property	Range	# Test	Average
Moisture Content (%)	4-37	184	14
Grain size			
% Gravel	0-9	32	2
% Sand	10-56	32	18
% Silt and Clay	39-90	32	80
% Silt	34-73	32	55
% Clay	5-41	32	25
Liquid Limit (%)	23-39	31	32
Plastic Limit (%)	10-20	31	16
Plasticity Index (%)	10-22	31	16

Based on the above testing and visual identification, this till material can generally be classified as an inorganic, cohesive silt and clay of low to medium plasticity. Seams of cohesionless materials, generally consisting of sands and gravels, are noted at random depths and locations throughout the deposit. Grain size analysis of glacial till samples is limited to the maximum size of the SPT sampling methods that were employed (38 mm). Cobbles and/or boulders can be encountered in a glacial till deposit. Large cobbles or boulders were not detected in any of the boreholes put down as part of this investigation.

Vane shear testing was not possible due to the stiffness of this material. Based on laboratory observations and SPT correlations, the till is typically in the very stiff to hard range.

#### 4.1.5 Bedrock

Bedrock was encountered underlying the glacial till in Boreholes 135-41-3, 136-08-3 to 136-13-3, and 136-16-1 to 136-16-3, and sampled by coring in NQ-size in Boreholes 136-10-1 and 136-11-1. In the other boreholes, the bedrock could be penetrated by solid stem augers. The bedrock surface at these locations was encountered between El. 75.0 m and El. 83.4 m (depths of 0.2 m to 6.1 m). The bedrock is a reddish brown to grey, weathered to unweathered shale of the Queenston Formation. The bedrock is of poor to good quality (RQD of the unweathered shale ranging from 65% to 88%). Core recoveries varied between 97% and 100%. The average RQD over 5.8 m of rock cored was 74%, indicating an overall rock mass quality of fair.

#### **4.1.6 Groundwater**

Groundwater was encountered in Boreholes 135-40-3, 136-02-3, 136-04-2, 136-05-3, 136-06-3, 136-11-3, 136-12-2, 136-13-3, 136-16-2 and 136-16-3 as noted on the Borehole Records. Groundwater levels at these locations ranged between El. 75.1 m and El. 81.3 m, or from 1.9 m to 7.7 m below ground surface immediately prior to backfilling. Groundwater was not encountered in other boreholes. Artesian conditions were not encountered in any of the boreholes.

The groundwater levels noted on the Borehole Records were recorded immediately after drilling. Due to the relatively low permeability of the overburden soils, these groundwater levels may not represent the static water levels which would approximately correspond to an adjacent creek level draining into Lake Ontario. Groundwater levels are subject to seasonal fluctuations.

#### **4.2 W.P. 333-89-00**

##### **4.2.1 Topsoil**

Topsoil was encountered at the ground surface in all boreholes except the boreholes located in the median of the QEW. The thickness of the topsoil ranges from 100 mm to 300 mm.

##### **4.2.2 Fill**

A mixture of sand, silt and gravel (fill) layer was encountered at the ground surface in Boreholes 138-06-2 and 138-07-2. The thickness of the fill layer ranged from 0.2 m to 0.3 m. Based on visual identification and laboratory tests, this fill can be classified as inorganic and cohesionless.

A silt (fill) with some sand and clay was observed in Boreholes 138-06-01, 139-06-02, and 138-07-02. The thickness of the fill layer ranged from 3.0 m to 3.4 m. The SPT conducted in this fill layer yielded N values ranging from 7 to 30, indicating a relative density of loose to compact. Laboratory analysis carried out on a sample of the fill indicated a grain size distribution of 0% gravel, 10% sand, 76% silt and 14% clay. The moisture content of the fill ranged from 12% to 20% with an average of about 15%. Based on visual observation and laboratory tests, this material can be classified as inorganic and cohesionless.

#### **4.2.3 Silt**

A silt with some sand and clay was encountered underlying the fill or topsoil in all boreholes except Boreholes 138-07-2 and 138-07-3. Where present, the silt surface was encountered at elevations ranging from El. 82.3 m to El. 85.5 m (depths of 0.3 m to 3.0 m).

The SPT conducted in the silt layer yielded N values ranging from 3 to 26, indicating a relative density of loose to compact. Laboratory analyses carried out on a representative sample of the silt indicated a grain size distribution of 0% gravel, 18% sand, 71% silt and 11% clay. The moisture content of the silt ranged from 13% to 19%, with an average of about 17%. This material is classified as cohesionless. Non-cohesive deposits such as this silt material are susceptible to base disturbance or boiling if an unbalanced piezometric head is introduced during construction.

#### **4.2.4 Silt and Clay**

A lacustrine deposit of silt and clay with some sand was encountered underlying the fill or silt in the boreholes. The silty clay surface was encountered at elevations ranging from El. 79.2 m to El. 84.0 m.

Field vane tests indicated shear strengths exceeding 120 kPa. Based on laboratory observations and SPT correlations, the silt and clay has a general consistency in the stiff to very stiff range.

Laboratory analyses carried out on a representative sample of the silt and clay indicated a grain size distribution of 0% gravel, 34% sand, 53% silt and 13% clay. The moisture content of the silt and clay ranged from 12% to 28%, with an average of about 17%.

Based on the above testing and visual identification, this silt and clay material can generally be classified as inorganic, cohesive and of low plasticity.

#### **4.2.5 Groundwater**

Groundwater was encountered in all boreholes except Borehole 138-07-2, as noted in the Borehole Records, which caved in at 4.9 m. Groundwater levels at these locations ranged between El. 77.7 m and El. 81.5 m, or from 4.6 m to 9.2 m below ground surface prior to backfilling. Artesian conditions were not encountered in any of the boreholes.

The groundwater levels noted on the Borehole Records were recorded immediately after drilling. Due to the relatively low permeability of the overburden soils, these groundwater levels may not represent the static water levels which would approximately correspond to an adjacent creek level draining into Lake Ontario. Groundwater levels are subject to seasonal fluctuations.

## **5.0 DISCUSSION AND RECOMMENDATIONS**

### **5.1 Proposed Development**

It is understood that it is proposed to replace the existing culverts under the QEW with concrete culverts at the twenty sites investigated. Concrete box culverts are the anticipated culvert type. Open footing concrete culverts could also possibly be considered. The new concrete culvert at each site is proposed to be extended to connect to the existing culverts beneath the North Service Road and the South Service Road. The culvert extension is to allow reconstruction and widening of the QEW. It is understood that the finished road grades at the culvert locations are to be raised 1.5 m or less.

### **5.2 Geotechnical Assessment**

The subsurface profiles at the culvert sites below the culvert inverts can be generalized as follows:

W.P. 331-89-00	Very stiff to hard glacial till underlain by shale bedrock
W.P. 333-89-00	Loose to compact silt underlain by stiff to very stiff silt and clay

The proposed culverts at all culvert site locations may be placed at the founding level of the existing culverts. Settlement of the supporting soil beneath the culvert due to the anticipated culvert loading and adjacent fill placement is expected to be less than 25 mm.

It is expected that shoring will be required during construction of the culverts to minimize excavation and to facilitate traffic flow on the QEW.

This report contains our detailed recommendations for the proposed culvert structures at the culvert sites in W.P. 331-89-00 and 333-89-00 in the following areas:

- 1) Structure Foundations
- 2) Culvert Backfill
- 3) Temporary Shoring
- 4) Construction Considerations

### 5.3 Structure Foundations

#### 5.3.1 Construction Method

It is anticipated that construction of the proposed concrete culverts beneath QEW will use conventional excavation and temporary shoring techniques. Dewatering and/or temporary shoring may be required during excavation if open-footing culverts placed on native undisturbed soils are proposed. Bearing capacities and sliding resistances of the native soils are provided in Section 5.3.2.

If concrete box culverts are used, consideration could be given to sub-excavating the native soil for a depth of 500 mm beneath the culvert invert and replacing this sub-excavation with OPSS Granular A that is end dumped from the top of the excavation and not compacted. The use of this construction method could minimize the dewatering requirements thereby simplifying construction and reducing the overall project costs.

#### 5.3.2 Native Soil Support

##### W.P. 331-89-00

Concrete culvert structures may be founded directly on the very stiff to hard silt and clay glacial till, or on the shale bedrock, depending on the elevations of the bedrock surface relative to the proposed invert elevations. The approximate elevation of the culvert invert is summarized for each culvert on Table 1 provided in Appendix 2. The following design values are recommended for structure foundation design:

<u>Founding Stratum</u>	<u>Bearing Capacity at S.L.S.</u>	<u>Factored Bearing Capacity at U.L.S.</u>
Glacial Till	250 kPa	450 kPa
Shale Bedrock	300 kPa	550 kPa

Sliding resistance between the concrete and the foundation bearing surface should be calculated in accordance with Section 6-8.4.3 of the O.H.B.D.C. assuming the following unfactored coefficients of friction.

Concrete - Glacial Till	0.58
Concrete - Shale Bedrock	0.53

## W.P. 333-89-00

Concrete culvert structures may be founded within the native undisturbed silt or silt and clay depending on the proposed culvert inverts (see Table 1 in Appendix 2). The following design values are recommended for structure foundation design:

<u>Founding Stratum</u>	<u>Bearing Capacity at S.L.S.</u>	<u>Factored Bearing Capacity at U.L.S.</u>
Silt	175 kPa	275 kPa
Silt and Clay	150 kPa	250 kPa

Sliding resistance between the concrete and the foundation bearing surface should be calculated in accordance with Section 6-8.4.3 of the O.H.B.D.C. assuming the following unfactored coefficients of friction.

Concrete - Silt	0.53
Concrete - Silt and Clay	0.50

### **5.3.3 All Culvert Sites**

The following is applicable to all culvert sites in W.P. 331-89-00 and W.P. 333-89-00.

The above recommended U.L.S. capacities are applicable to footing widths (B) from 2.5 m to 6 m.

The underside of all footings should be provided with a minimum 1.2 m of earth cover for frost protection if open footing culverts are proposed. This earth cover has been taken into account for the bearing capacity recommendations provided above.

Settlement of the foundation soil as a result of the applied footing pressure is anticipated to be less than 25 mm, provided that the bearing surface is not disturbed by construction or related activities. All foundation bearing materials, including the glacial till, shale bedrock, silt and silt and clay are susceptible to wet weather conditions or construction activities. To prevent disturbance of the bearing surface, it is recommended that a 150 mm layer of lean concrete working slab be placed to protect the footing bearing surface within 4 hours of exposure.

#### 5.4 Culvert Backfill

The following is applicable to all culvert sites in W.P. 331-89-00 and W.P. 333-89-00.

To prevent hydrostatic pressure buildup, backfill against the culvert walls should consist of free draining materials such as OPSS Granular A or Granular B. Backfill requirements for culverts should be in accordance with OPSD 803 series.

Computation of earth pressures should be in accordance with Section 6-7 of the O.H.B.D.C.. The active earth pressure should be used if the structure is unyielding. For rigidly tied structures, the at-rest earth pressure should be used for design, unless enough deflection (approximately 0.05% of the wall height) is allowed to establish active conditions.

For a horizontal backfill the following soil parameters are recommended for design:

	<u>Granular A</u>	<u>Granular B</u>
Unit Weight ( $\text{kN/m}^3$ )	22.8	21.2
Effective Friction Angle, $\phi$	35°	30°
Coefficient of Active Earth Pressure, $K_a$	0.27	0.33
Coefficient of Earth Pressure at Rest, $K_o$	0.43	0.50

For W.P. 331-89-00, consideration can be given to using the excavated glacial till and shale bedrock as backfill above the water line. An effective friction angle of 28 degrees and a unit weight of  $20.8 \text{ kN/m}^3$  could be used for these materials.

The backfill should be constructed in 300 mm lifts on alternating sides of the culvert so that the maximum differential backfill height does not exceed 300 mm.

Compaction of the granular backfill located within a 1H:2V projection from the culvert invert should be carried out using hand-operated equipment to prevent overstressing the culvert walls.

## 5.5 Temporary Shoring

### 5.5.1 Lateral Earth Pressures

Temporary shoring will likely be required near the QEW median during construction to maintain traffic flow. The following lateral earth parameters for the native soils encountered at the sites are recommended for shoring design. The parameters are based on a horizontal surface behind the shoring.

	Silt and Clay Glacial Till (W.P. 331-89-00)	Silt Fill / Silt / Silt and Clay (W.P. 333-89-00)
Unit Weight ( $\text{kN/m}^3$ )	21.0	19.0
Effective Cohesion, $c'$ (kPa)	0	0
Effective Friction Angle, $\phi$	29°	28°
Coefficient of Active Earth Pressure, $K_a$	0.33	0.36
Coefficient of Earth Pressure at Rest, $K_0$	0.50	0.53

Earth pressure distribution behind a temporary shoring system is dependent on the type of shoring system. The following earth pressure distributions are recommended for calculations of commonly used temporary shoring systems:

- For a flexible cantilevered and tied back shoring system such as the anticipated system described above, it is recommended that a triangular pressure distribution based on Rankine coefficients of active and passive pressures be used for calculations.
- For strutted flexible walls, it is recommended that a rectangular earth pressure distribution of  $0.65K_a\gamma H$  be used for calculations.
  - where  $K_a$  = Coefficient of active earth pressure
  - $\gamma$  = Unit weight of soil behind shoring system
  - H = Height of shoring system

Based on the excavation depths and the soil conditions encountered, it is anticipated that conventional soldier piles with timber lagging system, supplemented by soil/rock anchors if required, will be the most likely shoring alternative.



## **5.5.2 Soil and Rock Anchors**

### **5.5.2.1 W.P. 331-89-00**

The following allowable bond stresses are recommended for tieback anchor design calculations for culvert sites in W.P. 331-89-00 (WC135-40, 135-41, 136-01 to 136-16 inclusive).

<u>Material</u>	<u>Allowable Bond Stress</u>
Silt and Clay Glacial Till	30 kPa
Shale Bedrock	200 kPa

Soil and rock anchors should be designed in accordance with current MTO standards. Refer to the Foundation Design Unit of the Pavements and Foundation Section for the appropriate Non Standard Special Provision for design purposes.

### **5.5.2.2 W.P. 333-89-00**

At culvert sites WC138-06 and 138-07 (W.P. 333-89-00), the subsurface profile consists of silt underlain by silt and clay. Anchors installed in these materials are not recommended. Anchors could either be extended to bedrock or not used.

## **5.6 Construction Considerations**

### **5.6.1 Open Cut Excavations**

#### **5.6.1.1 W.P. 331-89-00**

Temporary unshored excavations in the silt and clay glacial till may be undertaken using vertical side slopes up to a height of 1.2 m from the excavation bottom. The portion of the excavation higher than 1.2 m from the bottom should be undertaken using side slopes no steeper than 1H:1V up to a maximum total height of 7.0 m. Vertical side slopes may be utilized for temporary excavations within the shale bedrock.

#### **5.6.1.2 W.P. 333-89-00**

Temporary unshored excavations in the silt fill and the underlying native silt and silt and clay should be undertaken using side slopes no steeper than 1H:1V, up to a total height of 7.0 m, from the bottom of the excavation. In cohesionless deposits (silt fill and silt) where seepage is encountered, flatter side slopes may be required, or alternatively a shoring system may be utilized.

### 5.6.2 Dewatering

It is the responsibility of the contractor to lower the groundwater below the excavation base, and to construct the structure foundations in the dry conditions without disturbing the underlying foundation soils.

Based on the soil types and the groundwater conditions encountered during the investigation, the following dewatering methods may be considered.

- For unshored excavations, perimeter ditches within a gravity system in conjunction with a sump pump discharge system to drain accumulated water may be utilized.
- Dewatering may be achieved by pumping from inside a shored excavation.

Other dewatering alternatives may also be considered. The more economical and practically feasible dewatering alternative should be selected. As discussed in Section 5.3.1, consideration could be given to using precast concrete sections placed on Granular A to minimize the amount of dewatering required. Groundwater levels and the amount of inflow should be expected to fluctuate seasonally.

### 5.7 Soil Chemistry

Representative soil samples were submitted to Environment Protection Laboratories Inc. of Mississauga for pH, sulphate and chloride testing to assess the potential of sulphate attack on concrete and potential attack on exposed steel.

The results of the testing are summarized on Table 2 provided in Appendix 2.

## 6.0 MISCELLANEOUS

The field work for this investigation was carried out under the supervision of R. Rintjema, P.Eng., N. Lobo and C. Reynolds. Drilling equipment was provided by Master Soil Investigations Ltd. and Eastern Soil Investigation Ltd.

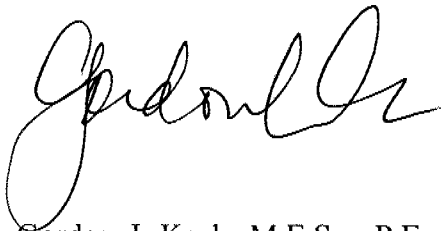
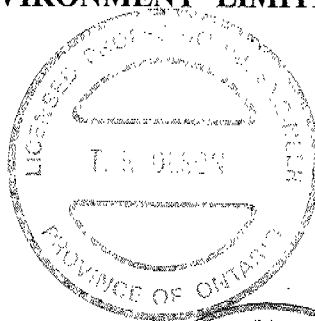
This report was prepared by C. Kwok and T. Olson, Project Engineer, and approved by G. Kack, Project Manager.

Respectfully submitted,

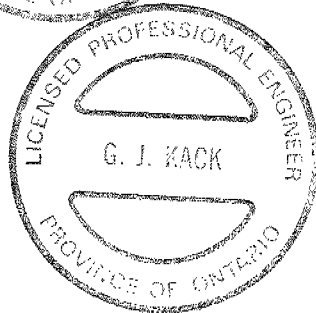
### JACQUES WHITFORD ENVIRONMENT LIMITED



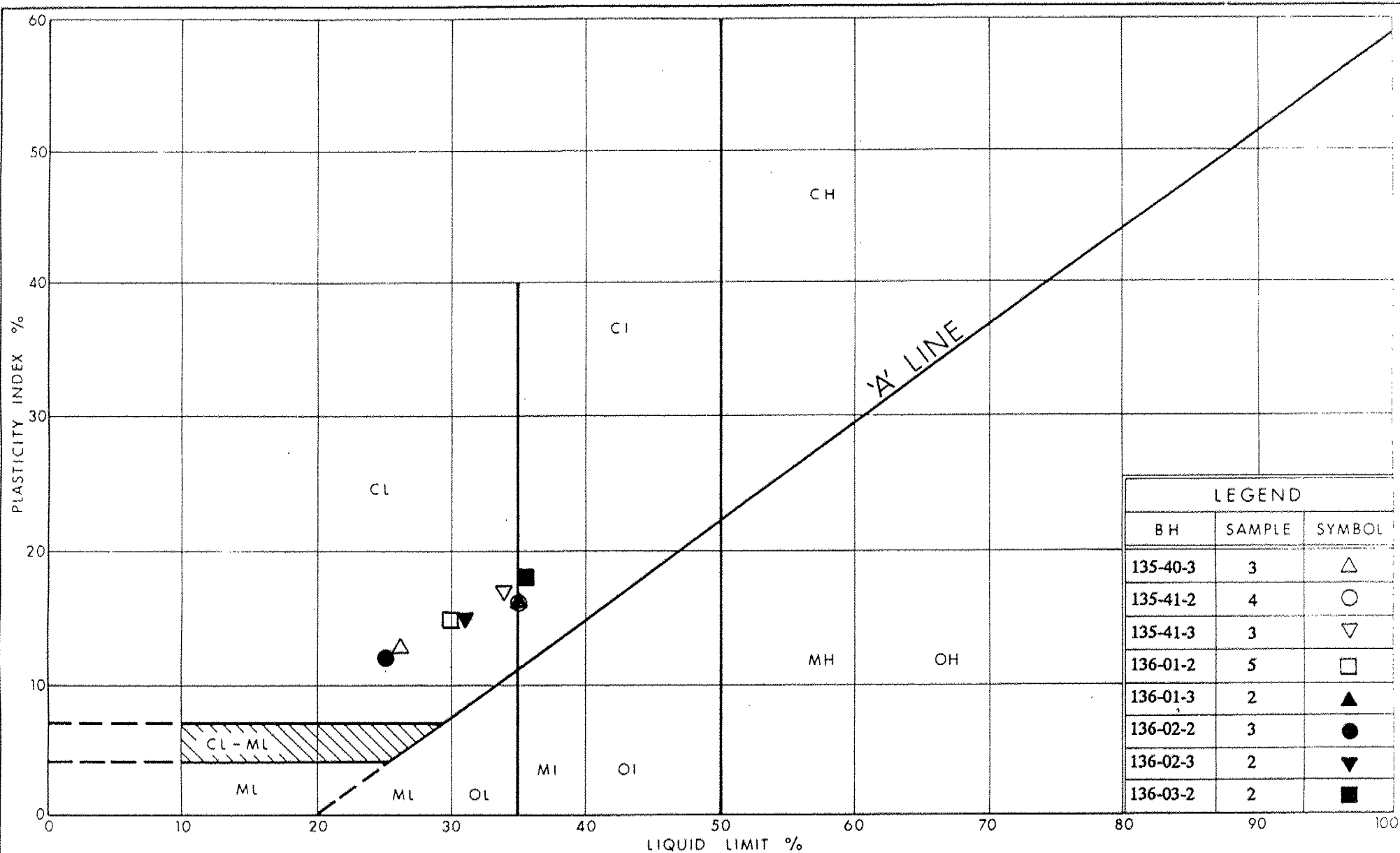
Timothy K. Olson, P.Eng.  
Project Engineer



Gordon J. Kack, M.E.Sc., P.Eng.  
Project Manager



## APPENDIX 1



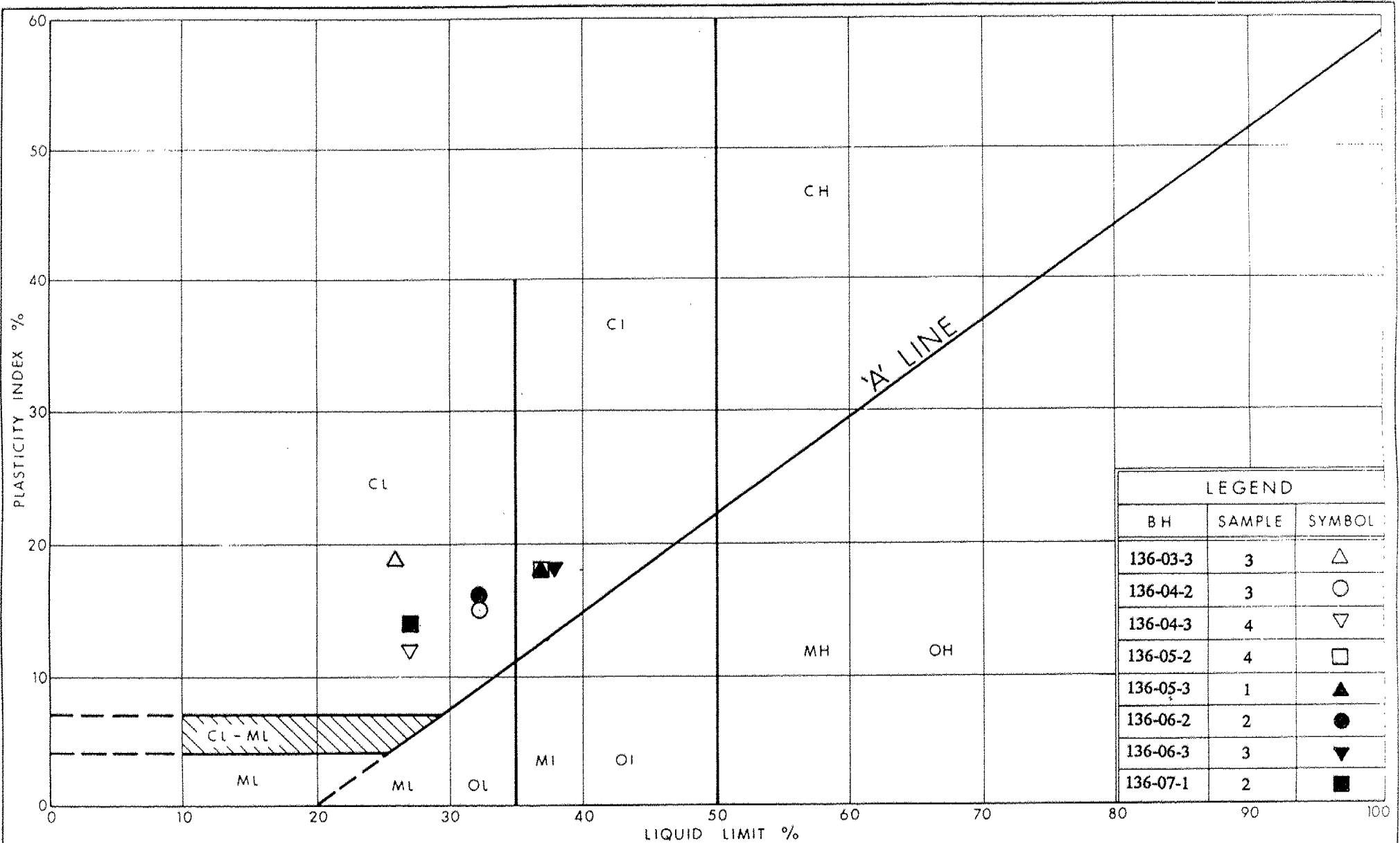
Ministry of  
Transportation

Ontario

PLASTICITY CHART  
HET MIXTURE OF SILT & CLAY, SOME SAND,  
TRACE GRAVEL (Glacial Till)

FIG No 1

W P 331-89-00

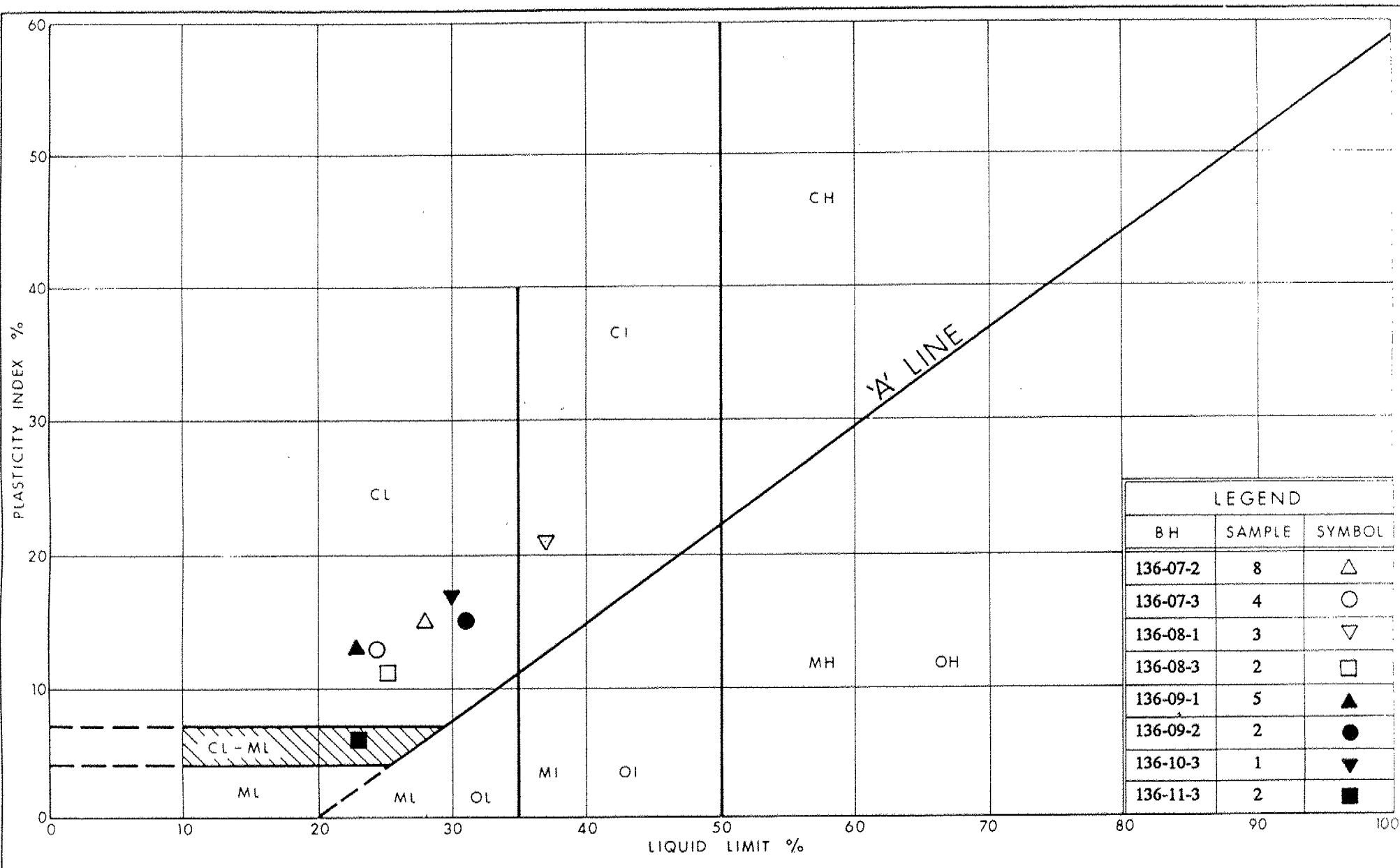


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Transportation  
Ontario

PLASTICITY CHART  
HET MIXTURE OF SILT & CLAY, SOME SAND,  
TRACE GRAVEL (Glacial Till)

FIG No 2

W P 331-89-00

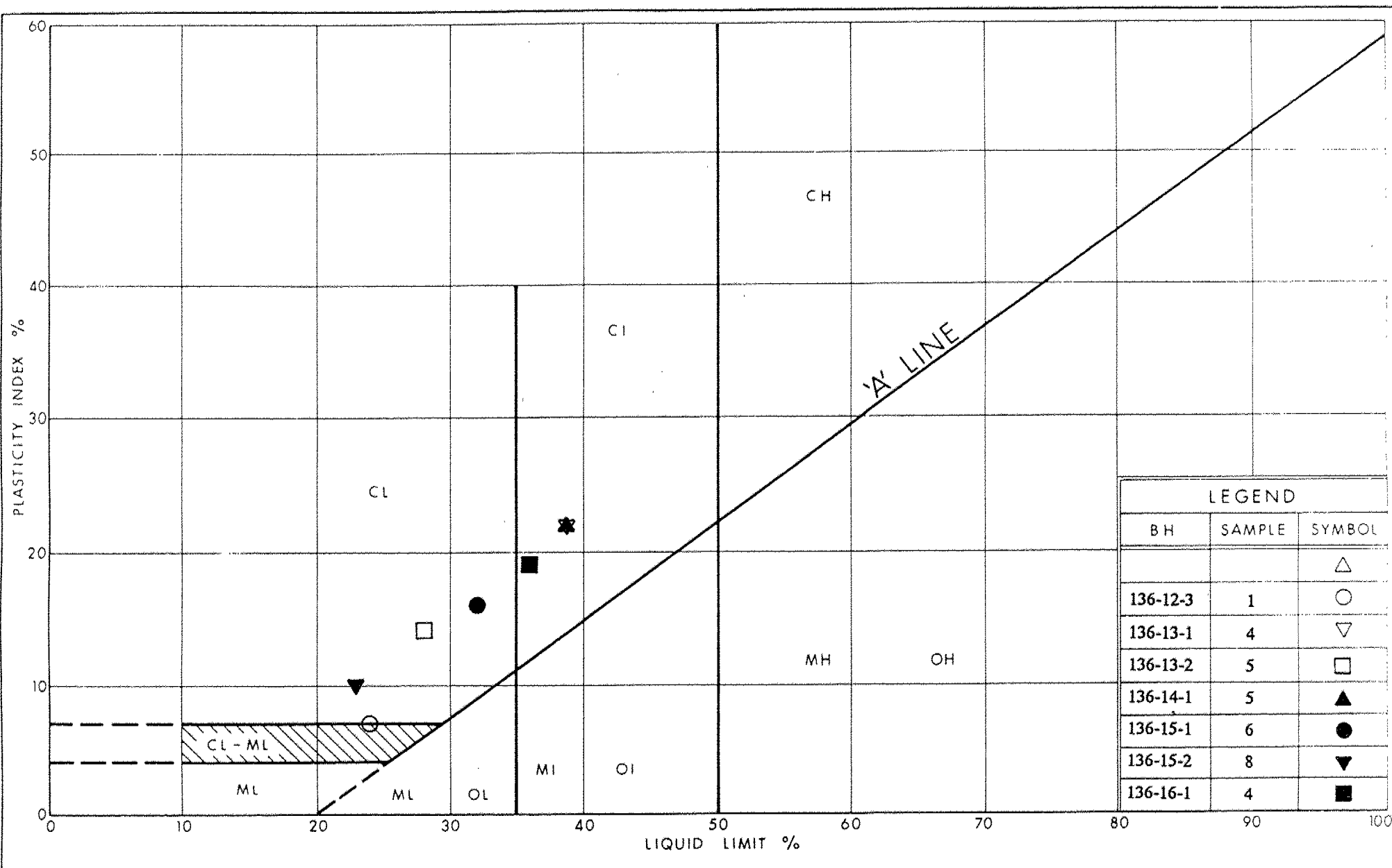


Ministry of  
Transportation

PLASTICITY CHART  
HET MIXTURE OF SILT & CLAY, SOME SAND,  
TRACE GRAVEL (Glacial Till)

FIG No 3

W P 331-89-00



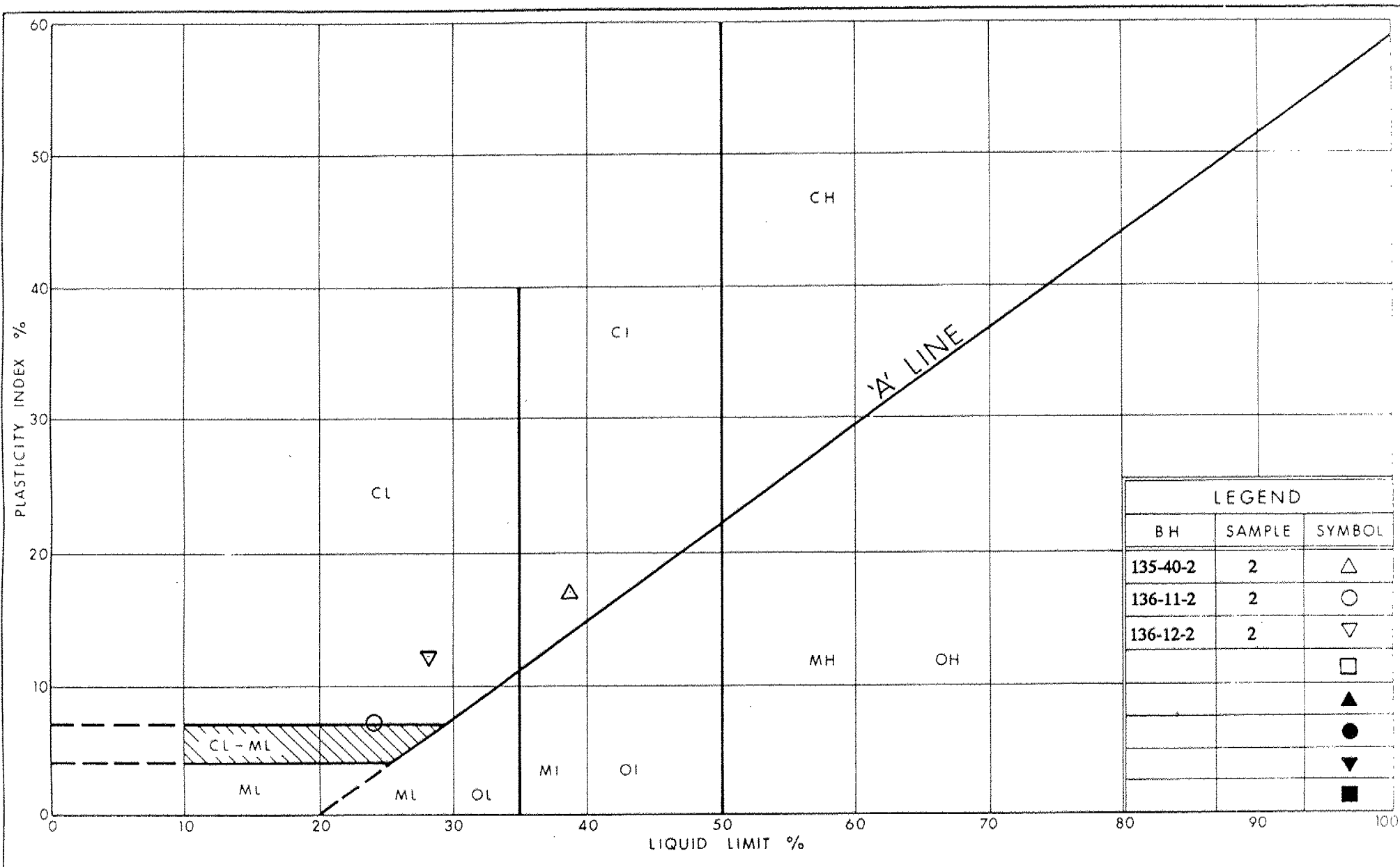
Ministry of  
Transportation  
Ontario

PLASTICITY CHART  
HET MIXTURE OF SILT & CLAY, SOME SAND,  
TRACE GRAVEL (Glacial Till)

FIG No 4

W P 331-89-00



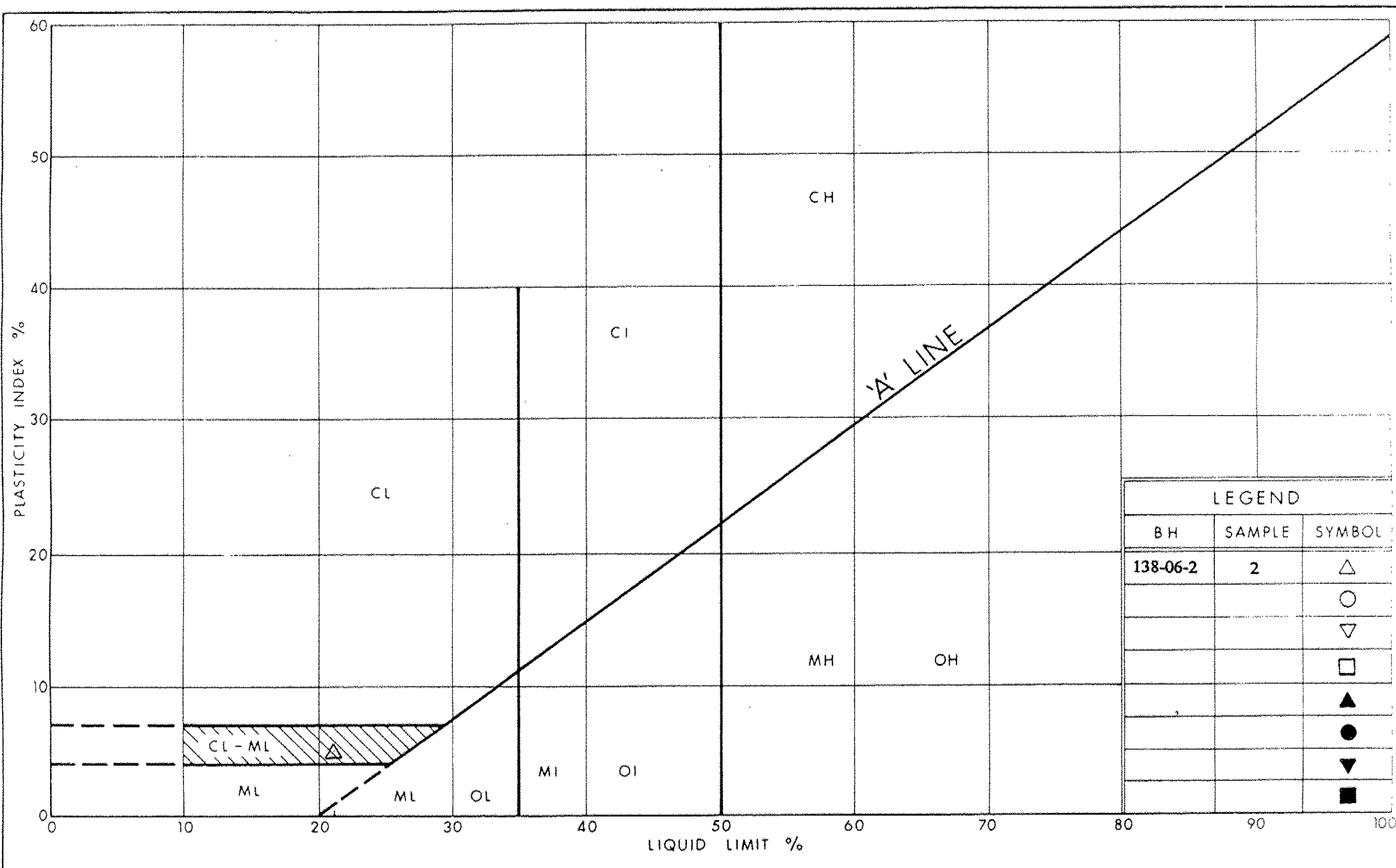


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Ontario

# PLASTICITY CHART MIXTURE OF SILT, CLAY, SAND & GRAVEL (FILL)

FIG No 5

W P 331-89-00



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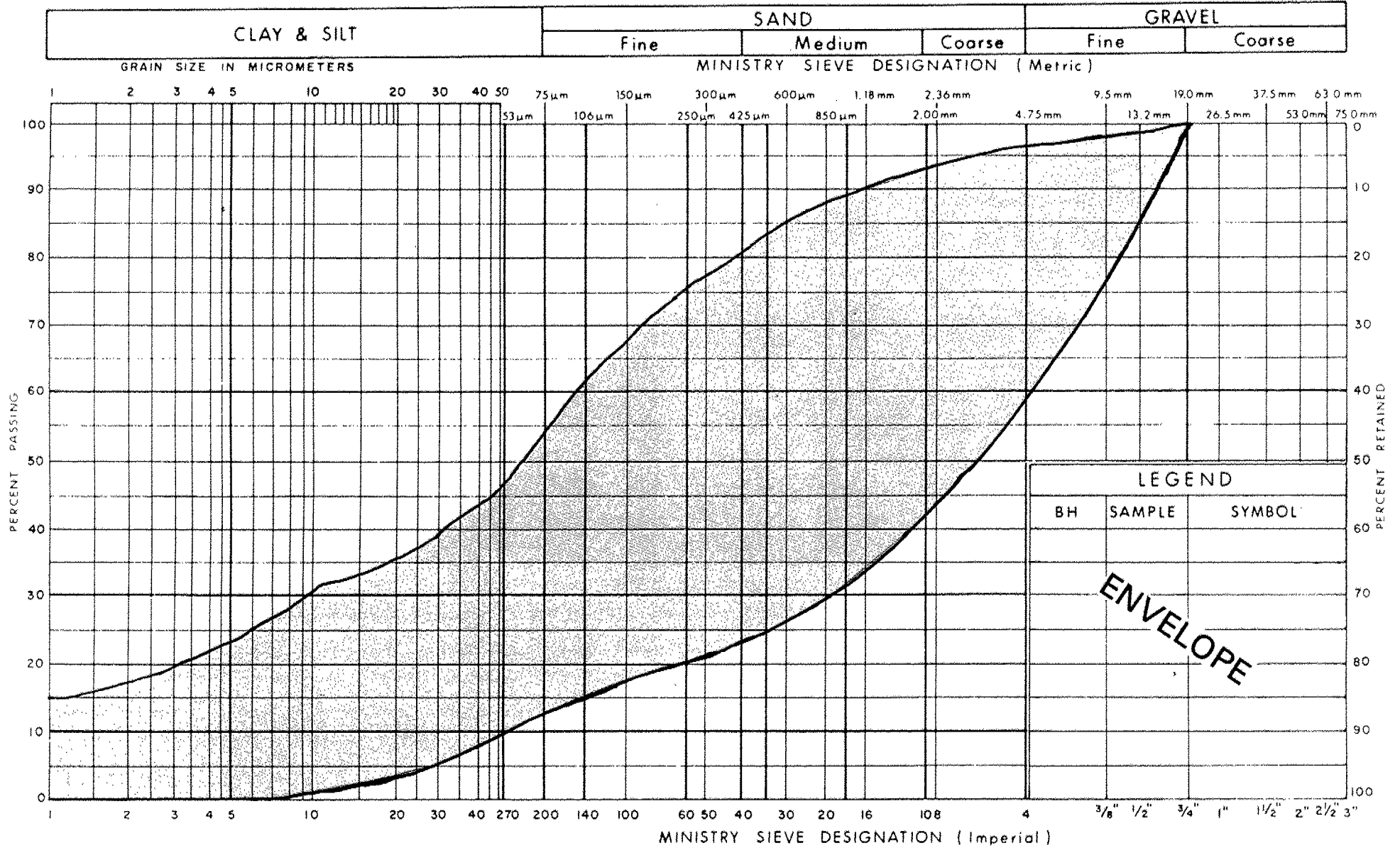
Ontario

# PLASTICITY CHART SILT (FILL), SOME SAND & CLAY

FIG No 6

W P 333-89-00

## UNIFIED SOIL CLASSIFICATION SYSTEM

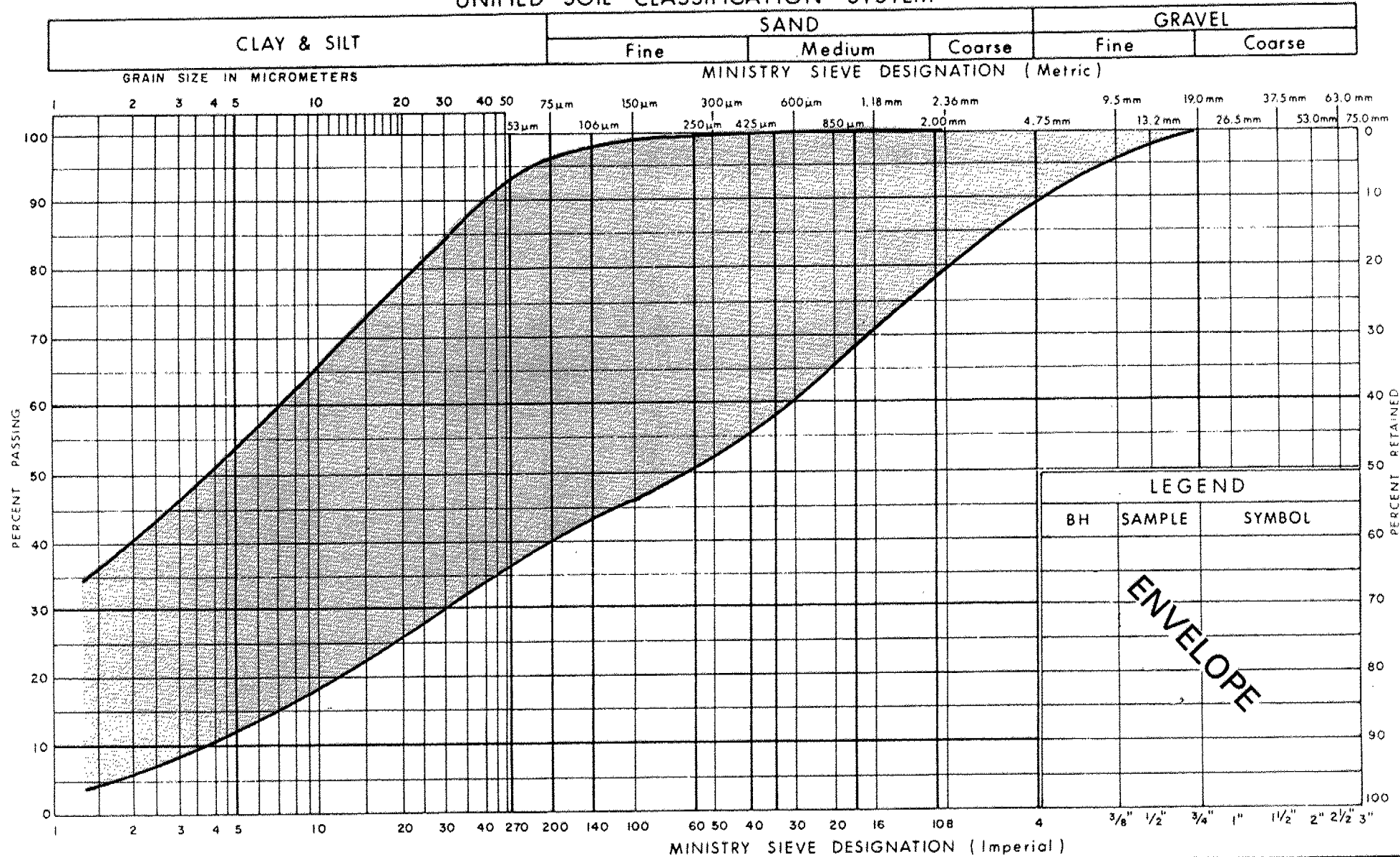


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## GRAIN SIZE DISTRIBUTION FILL

FIG No 7  
W P 331-89-00

## UNIFIED SOIL CLASSIFICATION SYSTEM



Ministry of  
Transportation

**GRAIN SIZE DISTRIBUTION**  
**HET MIXTURE OF SILT & CLAY, SOME SAND,**  
**TRACE GRAVEL (Glacial Till)**

FIG No 8

W P 331-89-00

# 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 31mm 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 (31mm 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

### MECHANICAL PROPERTIES OF SOIL

$m_v$	$kPa^{-1}$	COEFFICIENT OF VOLUME CHANGE
$C_c$	1	COMPRESSION INDEX
$C_s$	1	SWELLING INDEX
$C_\alpha$	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
$\sigma'_{vo}$	kPa	EFFECTIVE OVERBURDEN PRESSURE
$\sigma'_p$	kPa	PRECONSOLIDATION PRESSURE
$\tau_f$	kPa	SHEAR STRENGTH
$c'$	kPa	EFFECTIVE COHESION INTERCEPT
$\phi'$	-°	EFFECTIVE ANGLE OF INTERNAL FRICTION
$c_u$	kPa	APPARENT COHESION INTERCEPT
$\phi_u$	-°	APPARENT ANGLE OF INTERNAL FRICTION
$\tau_R$	kPa	RESIDUAL SHEAR STRENGTH
$\tau_r$	kPa	REMOULDED SHEAR STRENGTH
$S_t$	1	SENSITIVITY = $\frac{c_u}{\tau_r}$

### STRESS AND STRAIN

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

### PHYSICAL PROPERTIES OF SOIL

$\rho_s$	$kg/m^3$	DENSITY OF SOLID PARTICLES	e	1, %	VOID RATIO	$e_{min}$	1, %	VOID RATIO IN DENSEST STATE
$\gamma_s$	$kN/m^3$	UNIT WEIGHT OF SOLID PARTICLES	n	1, %	POROSITY	$I_D$	1	DENSITY INDEX = $\frac{e_{max} - e}{e_{max} - e_{min}}$
$\rho_w$	$kg/m^3$	DENSITY OF WATER	w	1, %	WATER CONTENT	D	mm	GRAIN DIAMETER
$\gamma_w$	$kN/m^3$	UNIT WEIGHT OF WATER	$S_r$	%	DEGREE OF SATURATION	$D_n$	mm	n PERCENT - DIAMETER
$\rho$	$kg/m^3$	DENSITY OF SOIL	$w_L$	%	LIQUID LIMIT	$C_u$	1	UNIFORMITY COEFFICIENT
$\gamma$	$kN/m^3$	UNIT WEIGHT OF SOIL	$w_p$	%	PLASTIC LIMIT	h	m	HYDRAULIC HEAD OR POTENTIAL
$\rho_d$	$kg/m^3$	DENSITY OF DRY SOIL	$w_s$	%	SHRINKAGE LIMIT	q	$m^3/s$	RATE OF DISCHARGE
$\gamma_d$	$kN/m^3$	UNIT WEIGHT OF DRY SOIL	$I_p$	%	PLASTICITY INDEX = $w_L - w_p$	v	m/s	DISCHARGE VELOCITY
$\rho_{sat}$	$kg/m^3$	DENSITY OF SATURATED SOIL	$I_L$	1	LIQUIDITY INDEX = $\frac{w - w_p}{I_p}$	i	1	HYDRAULIC GRADIENT
$\gamma_{sat}$	$kN/m^3$	UNIT WEIGHT OF SATURATED SOIL	$I_C$	1	CONSISTENCY INDEX = $\frac{w_L - w}{I_p}$	k	m/s	HYDRAULIC CONDUCTIVITY
$\rho'$	$kg/m^3$	DENSITY OF SUBMERGED SOIL	$e_{max}$	1, %	VOID RATIO IN LOOSEST STATE	j	$kN/m^2$	SEEPAGE FORCE
$\gamma'$	$kN/m^3$	UNIT WEIGHT OF SUBMERGED SOIL						

# RECORD OF BOREHOLE No 135-40-1

1 OF 1

METRIC

W.P. 331-89-00 LOCATION WC 135-40; Sta. 31 + 688, O-S 25m Lt. ORIGINATED BY IK  
DIST 4 HWY QEW BOREHOLE TYPE Solid Stem COMPILED BY IK  
DATUM SEE TEXT DATE 94.08.24 & 94.08.24 CHECKED BY TO

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT $\gamma$ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa						
81.8	Ground Surface							20 40 60 80 100						
0.0	Topsoil		1	SS	12			○ UNCONFINED    × FIELD VANE						
81.4								● QUICK TRIAXIAL    × LAB VANE						
0.5	Het. mixture of Silt and Clay, some sand, trace gravel  (Glacial Till)  Very Stiff to Hard  Brown Grey		2	SS	37		81	Wp    W    W <sub>L</sub>					24.2	
			3	SS	21		80							
			4	SS	10		79							
			5	SS	13		78							
			6	SS	22		77							
							76							
75.1			7	SS	35									
6.7	END OF BOREHOLE  Borehole dry upon completion													

# RECORD OF BOREHOLE No 135-40-2

1 OF 1

METRIC

W.P. 331-89-00 LOCATION WC 135-40; Sta. 31+688, O-S 4m Rt. ORIGINATED BY IK  
 DIST 4 HWY QEW BOREHOLE TYPE Solid Stem, Cone Test COMPILED BY IK  
 DATUM SEE TEXT DATE 94.08.10 & 94.08.10 CHECKED BY TO

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT w <sub>p</sub>	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w <sub>L</sub>	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa	WATER CONTENT (%)					
83.5	Ground Surface							20 40 60 80 100	20 40 60 80 100					
0.0	Mixture of Sand, Silt and Clay, trace gravel. (Fill) Stiff		1	AS			83							
82.0			2	SS	12		82							4 37 42 17
1.5	Het. mixture of Silt and Clay, some sand, trace gravel  (Glacial Till)  Very Stiff to Hard  Brown  Brown Grey		3	SS	21		81							
			4	SS	30		80							
			5	SS	26		79							
			6	SS	29		78							
			7	SS	34		77							
			8	SS	37		76							
75.3			9	SS	49									
8.2	END OF BOREHOLE  Borehole dry upon completion													

x<sup>3</sup>, x<sup>3</sup>; Numbers refer to Sensitivity 20 15 10 (% STRAIN AT FAILURE

# RECORD OF BOREHOLE No 135-40-3

1 OF 1

METRIC

W.P. 331-89-00 LOCATION WC 135-40; Sta. 31+688, O-S 28m Rt. ORIGINATED BY IK  
DIST 4 HWY QEW BOREHOLE TYPE Solid Stem COMPILED BY IK  
DATUM SEE TEXT DATE 94.08.11 & 94.08.11 CHECKED BY TO

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 <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)  GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20	40	60	80	100					
82.0	Ground Surface		1	SS	18												
0.0	Het. mixture of Silt and Clay, some sand, trace gravel  (Glacial Till)  Very Stiff to Hard		2	SS	29												
			3	SS	19												
			4	SS	20												
			5	SS	21												
			6	SS	24												
			7	SS	34												
			8	SS	30												
75.3																	
6.7	END OF BOREHOLE																



# RECORD OF BOREHOLE No 135-41-1

1 OF 1

METRIC

W.P. 331-89-00 LOCATION WC 135-41; Sta. 32+102, O-S 30m Lt. ORIGINATED BY IK  
DIST 4 HWY QEW BOREHOLE TYPE Solid Stem COMPILED BY IK  
DATUM SEE TEXT DATE 94.08.23 & 94.08.23 CHECKED BY TO

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT $\gamma$ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa						
79.9	Ground Surface							20 40 60 80 100						
0.0	Topsoil		1	SS	2									
79.3														
0.6	Het. mixture of Silt and Clay, some sand, trace gravel  (Glacial Till)  Very Stiff to Hard  Brown Grey		2	SS	21		79							
			3	SS	32		78							
			4	SS	27		77							
			5	SS	22		76							
			6	SS	24		75							
							74							
73.2			7	SS	19									
6.7	END OF BOREHOLE  Borehole dry upon completion													

$\times^3, \times^3$ ; Numbers refer to Sensitivity 20 15 10 (%) STRAIN AT FAILURE

# RECORD OF BOREHOLE No 135-41-2

1 OF 1

METRIC

W.P. 331-89-00 LOCATION WC 135-41; Sta. 32+102, O-S 3m Rt. ORIGINATED BY IK  
 DIST 4 HWY QEW BOREHOLE TYPE Solid Stem, Cone Test COMPILED BY IK  
 DATUM SEE TEXT DATE 94.08.10 & 94.08.10 CHECKED BY TO

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W <sub>P</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			"N" VALUES	SHEAR STRENGTH kPa					
82.1	Ground Surface												
82.0	75mm ASPHALT												
0.1	Mixture of Sand, Silt and Gravel. (Fill)		1	AS									
81.2	Het. mixture of Silt and Clay, some sand, trace gravel  (Glacial Till)  Very Stiff to Hard		2	SS	6								
0.9			3	SS	29								
			4	SS	25								
			5	SS	25								
			6	SS	18								
			7	SS	24								
			8	SS	33								
			9	SS	25								
74.5	END OF BOREHOLE												
7.6	Borehole dry upon completion												

# RECORD OF BOREHOLE No 135-41-3

1 OF 1

METRIC

W.P. 331-89-00 LOCATION WC 135-41; Sta. 32+102, O-S 36m Rt. ORIGINATED BY IK  
DIST 4 HWY QEW BOREHOLE TYPE Solid Stem COMPILED BY IK  
DATUM SEE TEXT DATE 94.08.11 & 94.08.11 CHECKED BY TO

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20	40	60	80	100					
80.5	Ground Surface																
80.4	50mm Topsoil		1	SS	8												
0.1	Het. mixture of Silt and Clay, some sand, trace gravel  (Glacial Till)  Very Stiff to Hard   Brown Grey		2	SS	27												
			3	SS	33												
			4	SS	24												
			5	SS	27												
			6	SS	32												
75.0																	
5.6	Shale Bedrock Poor to Fair		7	SS	50	100mm											
73.8																	
6.7	END OF BOREHOLE  Borehole dry upon completion																

x<sup>3</sup> . x<sup>3</sup>: Numbers refer to  
Sensitivity

20  
15 10 5  
(%) STRAIN AT FAILURE

# RECORD OF BOREHOLE No 136-01-1

1 OF 1

METRIC

W.P. 331-89-00 LOCATION WC 136-01; Sta. 10+419, O-S 23m Lt. ORIGINATED BY IK  
 DIST 4 HWY QEW BOREHOLE TYPE Solid Stem COMPILED BY IK  
 DATUM SEE TEXT DATE 94.08.23 & 94.08.23 CHECKED BY TO

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				UNIT WEIGHT $\gamma$ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa					
								20 40 60 80 100		PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			
80.2	Ground Surface												
79.9	Topsoil		1	SS	13								
0.3	Het. mixture of Silt and Clay, some sand, trace gravel  (Glacial Till)  Very Stiff to Hard		2	SS	26							20.7	
			3	SS	35								
			4	SS	63								
			5	SS	68	283mm							
			6	SS	26								
			7	SS	29								
73.5													
6.7	END OF BOREHOLE												
	Borehole dry upon completion												

# RECORD OF BOREHOLE No 136-01-2

1 OF 1

METRIC

W.P. 331-89-00 LOCATION WC 136-01; Sta. 10+419, O-S 4m Rt. ORIGINATED BY IK  
DIST 4 HWY QEW BOREHOLE TYPE Solid Stem, Cone Test COMPILED BY IK  
DATUM SEE TEXT DATE 94.08.11 & 94.08.11 CHECKED BY TO

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	*N* VALUES			SHEAR STRENGTH kPa ○ UNCONFINED    × FIELD VANE ● QUICK TRIAXIAL    × LAB VANE							
82.0	Ground Surface							20 40 60 80 100							
0.0								20 40 60 80 100							
81.7	Mixture of Sand, Silt and Gravel (Fill)		1	SS	8										
0.3															
	Mixture of Silt and Sand, trace clay (Fill), loose		2	SS	9										
80.3															
1.7	Het. mixture of Silt and Clay, some sand, trace gravel		3	SS	33										
	(Glacial Till)		4	SS	45										
	Very Stiff to Hard		5	SS	59										
			6	SS	69										
			7	SS	35										
			8	SS	49										
			9	SS	36										
73.8															
8.2	END OF BOREHOLE														
	Borehole dry upon completion														

Numbers refer to  
Sensitivity

20  
15  
10  
(%) STRAIN AT FAILURE



# RECORD OF BOREHOLE No 136-02-1

1 OF 1

METRIC

W.P. 331-89-00 LOCATION WC 136-02; Sta. 10+622, O-S 23m Lt. ORIGINATED BY IK  
 DIST 4 HWY QEW BOREHOLE TYPE Solid Stem COMPILED BY IK  
 DATUM SEE TEXT DATE 94.08.23 & 94.08.23 CHECKED BY TO

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W <sub>P</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	*N* VALUES			20 40 60 80 100	20 40 60 80 100					
81.3	Ground Surface													
81.0	Topsoil		1	SS	14		81							
0.3	Het. mixture of Silt and Clay, some sand, trace gravel  (Glacial Till)  Very Stiff to Hard  Brown Grey		2	SS	27		80							
			3	SS	24		79							
			4	SS	38		78							
			5	SS	36		77							
			6	SS	26		76							
74.6			7	SS	22		75							
6.7	END OF BOREHOLE  Borehole dry upon completion													

# RECORD OF BOREHOLE No 136-02-2

1 OF 1

METRIC

W.P. 331-89-00 LOCATION WC 136-02; Sta. 10+622, O-S 3m Rt. ORIGINATED BY IK  
DIST 4 HWY QEW BOREHOLE TYPE Solid Stem, Cone Test COMPILED BY IK  
DATUM SEE TEXT DATE 94.08.11 & 94.08.11 CHECKED BY TO

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		NATURAL MOISTURE CONTENT			UNIT WEIGHT $\gamma$ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20 40 60 80 100	20 40 60 80 100	PLASTIC LIMIT WP	W	LIQUID LIMIT WL		
82.2	Ground Surface													
0.0	Mixture of Sand, Silt and Gravel (Fill), compact		1	SS	7									
81.6														
0.6	Het. mixture of Silt and Clay, some sand, trace gravel  (Glacial Till)  Very Stiff to Hard		2	SS	6									
			3	SS	32									
			4	SS	34									
			5	SS	31									
			6	SS	43									
			7	SS	42									
			8	SS	30									
			9	SS	30									
74.5														
7.6	END OF BOREHOLE  Borehole dry upon completion													



### METRIC

$\times^3, \times^3$ : Numbers refer to Sensitivity

# RECORD OF BOREHOLE No 136-03-1

1 OF 1

METRIC

W.P. 331-89-00 LOCATION WC 136-03; Sta. 10+825, O-S 22m Lt. ORIGINATED BY IK  
 DIST 4 HWY QEW BOREHOLE TYPE Solid Stem COMPILED BY IK  
 DATUM SEE TEXT DATE 94.08.23 & 94.08.23 CHECKED BY TO

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT  γ  kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)  GR SA SI C
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa						
								20 40 60 80 100						
								○ UNCONFINED      × FIELD VANE ● QUICK TRIAXIAL    × LAB VANE						
							WATER CONTENT (%)							
							PLASTIC LIMIT      NATURAL MOISTURE CONTENT      LIQUID LIMIT w <sub>p</sub> w                      w <sub>L</sub>							
							20 40 60 80 100      10 20 30							
81.8	Ground Surface													
81.5	Topsoil		1	SS	2									
0.3	Het. mixture of Silt and Clay, some sand, trace gravel  (Glacial Till)  Very Stiff to Hard     Brown Grey		2	SS	13		81							
			3	SS	34		80						22.2	
			4	SS	26		79							
			5	SS	25		78							
			6	SS	28		77							
			7	SS	30		76							
76.1														
6.7	END OF BOREHOLE  Borehole dry upon completion													

# RECORD OF BOREHOLE No 136-03-2

1 OF 1

METRIC

W.P. 331-89-00 LOCATION WC 136-03; Sta. 10+825, O-S 3m Rt. ORIGINATED BY IK  
 DIST 4 HWY QEW BOREHOLE TYPE Solid Stem, Cone Test COMPILED BY IK  
 DATUM SEE TEXT DATE 94.08.11 & 94.08.11 CHECKED BY TO

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa	WATER CONTENT (%)					
82.3	Ground Surface													
0.0	Mixture of Sand, Silt and Gravel. (Fill), compact		1	AS										
81.5														
0.8	Het. mixture of Silt and Clay, some sand, trace gravel  (Glacial Till)  Very Stiff to Hard		2	SS	15									
			3	SS	36									
			4	SS	45									
			5	SS	55									
			6	SS	36									
			7	SS	30									
			8	SS	28									
			9	SS	33									
74.1														
8.2	END OF BOREHOLE  Borehole dry upon completion													

# RECORD OF BOREHOLE No 136-03-3

1 OF 1

METRIC

W.P. 331-89-00 LOCATION WC 136-03; Sta. 10+825, O-S 22m Rt. ORIGINATED BY IK  
DIST 4 HWY QEW BOREHOLE TYPE Solid Stem COMPILED BY IK  
DATUM SEE TEXT DATE 94.08.11 & 94.08.11 CHECKED BY TO

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa	WATER CONTENT (%)					
81.6	Ground Surface													
81.6 0.1	Topsoil		1	SS	14									
	Het. mixture of Silt and Clay, some sand, trace gravel		2	SS	36								21.0	0 15 55 30
	(Glacial Till)		3	SS	45									
	Very Stiff to Hard		4	SS	50									
			5	SS	31									
	Brown Grey		6	SS	29									
			7	SS	27									
74.9	END OF BOREHOLE													
8.7	Borehole dry upon completion													

# RECORD OF BOREHOLE No 136-04-1

1 OF 1

METRIC

W.P. 331-89-00 LOCATION WC 136-04; Sta. 11+101, O-S 23m Lt. ORIGINATED BY IK  
DIST 4 HWY QEW BOREHOLE TYPE Solid Stem COMPILED BY IK  
DATUM SEE TEXT DATE 94.08.23 & 94.08.23 CHECKED BY TO

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT $\gamma$ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	*N* VALUES			SHEAR STRENGTH kPa						
								WATER CONTENT (%)						
81.6	Ground Surface						20 40 60 80 100	PLASTIC LIMIT NATURAL MOISTURE CONTENT 1 LIQUID LIMIT						
81.3	Topsoil		1	SS	5		20 40 60 80 100	W <sub>p</sub> W W <sub>L</sub>						
0.3	Het. mixture of Silt and Clay, some sand, trace gravel		2	SS	26		81							
	(Glacial Till)		3	SS	49		80							
	Very Stiff to Hard		4	SS	41		79							
	Brown Grey		5	SS	28		78							
			6	SS	43		77							
							76							
74.9			7	SS	20		75						22.8	
6.7	END OF BOREHOLE													
	Borehole dry upon completion													

# RECORD OF BOREHOLE No 136-04-2

1 OF 1

METRIC

W.P. 331-89-00 LOCATION WC 136-04; Sta. 11+101, O-S 3m Rt. ORIGINATED BY IK  
DIST 4 HWY QEW BOREHOLE TYPE Solid Stem, Cone Test COMPILED BY IK  
DATUM SEE TEXT DATE 94.08.11 & 94.08.11 CHECKED BY TO

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT	PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES								
82.7	Ground Surface												
82.8	75mm ASPHALT												
0.1	Brown Sand and Gravel (Fill)		1	SS	7								
82.2	Het. mixture of Silt and Clay, some sand, trace gravel		2	SS	7								
0.5	(Glacial Till)		3	SS	22								
	Very Stiff to Hard		4	SS	32								
	Brown Grey		5	SS	28								
			6	SS	50								
			7	SS	48								
			8	SS	34								
75.1			9	SS	36								
7.8	END OF BOREHOLE												

# RECORD OF BOREHOLE No 136-04-3

1 OF 1

METRIC

W.P. 331-89-00 LOCATION WC 136-04; Sta. 11+101, O-S 23m Rt. ORIGINATED BY IK  
DIST 4 HWY QEW BOREHOLE TYPE Solid Stem COMPILED BY IK  
DATUM SFE TEXT DATE 94.08.12 & 94.08.12 CHECKED BY TO

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	*N* VALUES			SHEAR STRENGTH kPa	WATER CONTENT (%)					
81.5	Ground Surface													
81.2	Topsoil		1	SS	34									
0.3	Het. mixture of Silt and Clay, some sand, trace gravel  (Glacial Till)  Very Stiff to Hard  - medium to coarse gravel  Brown Grey		2	SS	26									
			3	SS	38									
			4	SS	74	225mm								
			5	SS	44									
			6	SS	42									
75.0			7	SS	80	275mm								
6.5	END OF BOREHOLE  Borehole dry upon completion													

×<sup>3</sup>, ×<sup>3</sup>: Numbers refer to  
Sensitivity

20  
15  
10

(%) STRAIN AT FAILURE

# RECORD OF BOREHOLE No 136-05-1

1 OF 1

METRIC

W.P. 331-89-00 LOCATION WC 136-05; Sta. 11+262, O-S 22m Lt. ORIGINATED BY IK  
 DIST 4 HWY QEW BOREHOLE TYPE Solid Stem COMPILED BY IK  
 DATUM SEE TEXT DATE 94.08.23 & 94.08.23 CHECKED BY TO

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT γ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa						
								20 40 60 80 100						
								○ UNCONFINED    × FIELD VANE ● QUICK TRIAXIAL    × LAB VANE						
							WATER CONTENT (%)							
							PLASTIC LIMIT    NATURAL MOISTURE CONTENT    LIQUID LIMIT w <sub>p</sub> w                      w <sub>L</sub>							
							20 40 60 80 100                      10 20 30							
81.7	Ground Surface													
81.7	Topsoil		1	SS	11									
0.3	Het. mixture of Silt and Clay, some sand, trace gravel		2	SS	47		81							
	(Glacial Till)		3	SS	50		80							
	Very Stiff to Hard		4	SS	47		79							
			5	SS	39		78							
			6	SS	24		77							
							76							
			7	SS	33		75							
75.0														
6.7	END OF BOREHOLE													
	Borehole dry upon completion													

x<sup>3</sup>, x<sup>3</sup>: Numbers refer to  
Sensitivity 20 15 10 5 0 (%) STRAIN AT FAILURE



# RECORD OF BOREHOLE No 136-05-2

1 OF 1

METRIC

W.P. 331-89-00 LOCATION WC 136-05; Sta. 11+262, O-S 3m Rt. ORIGINATED BY IK  
 DIST 4 HWY QEW BOREHOLE TYPE Solid Stem, Cone Test COMPILED BY IK  
 DATUM SEE TEXT DATE 94.08.11 & 94.08.12 CHECKED BY TO

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa	WATER CONTENT (%)					
82.9	Ground Surface													
82.9	Brown Sand (Fill)		1	SS	23									
0.3	Brown Silt (Fill), some sand, trace clay and gravel		2	SS	14									
	Compact													
81.1	Het. mixture of Silt and Clay, some sand, trace gravel		3	SS	34									
1.8	(Glacial Till)		4	SS	32									
	Very Stiff to Hard		5	SS	28									
			6	SS	52									
			7	SS	37									
			8	SS	28									
			9	SS	42									
74.7	END OF BOREHOLE													
8.2	Borehole dry upon completion													

# RECORD OF BOREHOLE No 136-05-3

1 OF 1

METRIC

W.P. 331-89-00 LOCATION WC 136-05; Sta. 11+262, O-S 22m Rt. ORIGINATED BY JK  
DIST 4 HWY QEW BOREHOLE TYPE Solid Stem COMPILED BY JK  
DATUM SEE TEXT DATE 94.08.12 & 94.08.12 CHECKED BY TO

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			UNIT WEIGHT $\gamma$ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)		
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa						
82.2	Ground Surface							20	40	60	80	100		
82.1	75mm Topsoil		1	SS	12		82							0 15 59 26
0.1	Het. mixture of Silt and Clay, some sand, trace gravel		2	SS	25		81							
	(Glacial Till)		3	SS	34		80							
	Very Stiff to Hard		4	SS	50		79							
	- seams of silty sand		5	SS	46		78							
	Brown Grey		6	SS	32		77							
			7	SS	32		76							
75.5	END OF BOREHOLE													
6.7														

# RECORD OF BOREHOLE No 136-06-1

1 OF 1

METRIC

W.P. 331-89-00 LOCATION WC 136-06; Sta. 11+446, O-S 23m Lt. ORIGINATED BY IK  
DIST 4 HWY QEW BOREHOLE TYPE Solid Stem COMPILED BY IK  
DATUM SEE TEXT DATE 94.08.23 & 94.08.23 CHECKED BY TO

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT $\gamma$ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL			
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa ○ UNCONFINED      × FIELD VANE ● QUICK TRIAXIAL    × LAB VANE							WATER CONTENT (%) w <sub>p</sub> w      w <sub>L</sub>		
81.8	Ground Surface							20	40	60	80	100					
80.8	Topsoil																
0.3	Het. mixture of Silt and Clay, some sand, trace gravel  (Glacial Till)  Very Stiff to Hard		1	SS	6		81								○		
			2	SS	35		80										
			3	SS	34												
			4	SS	54		79								○		
			5	SS	47												
			6	SS	32		78								○		
							77										
							76										
75.1			7	SS	31										○		
6.7	END OF BOREHOLE  Borehole dry upon completion																

# RECORD OF BOREHOLE No 136-06-2

1 OF 1

METRIC

W.P. 331-89-00 LOCATION WC 136-06; Sta. 11+446, O-S 3.0m Rt. ORIGINATED BY IK  
DIST 4 HWY QEW BOREHOLE TYPE Solid Stem, Cone Test COMPILED BY IK  
DATUM SEE TEXT DATE 94.08.11 & 94.08.11 CHECKED BY TO

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W <sub>P</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa	WATER CONTENT (%)					
82.9	Ground Surface													
0.0	Mixture of Sand, Silt and Gravel (Fill), compact		1	SS	11									
82.3														
0.6	Het. mixture of Silt and Clay, some sand, trace gravel (Glacial Till)		2	SS	10									
	Very Stiff to Hard		3	SS	20									
			4	SS	28									
			5	SS	27									
			6	SS	40									
			7	SS	46									
			8	SS	38									
			9	SS	31									
75.3														
7.6	END OF BOREHOLE													
	Borehole dry upon completion													

# RECORD OF BOREHOLE No 136-06-3

1 OF 1

METRIC

W.P. 331-89-00 LOCATION WC 136-06: Sta. 11+446, O-S 23m Rt. ORIGINATED BY IK  
DIST 4 HWY QEW BOREHOLE TYPE Solid Stem COMPILED BY IK  
DATUM SEE TEXT DATE 94.08.12 & 94.08.12 CHECKED BY TO

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT		UNIT WEIGHT $\gamma$ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa		WATER CONTENT (%)			
82.1	Ground Surface							20 40 60 80 100		W <sub>p</sub> W W <sub>L</sub>			
82.0	Topsoil		1	SS	2			20 40 60 80 100					
0.1	Het. mixture of Silt and Clay, some sand, trace gravel		2	SS	25								
	(Glacial Till)		3	SS	31								
	Very Stiff to Hard		4	SS	70	290mm							
			5	SS	35								
			6	SS	50	125mm							
	Brown Grey		7	SS	28								
75.4													
6.7	END OF BOREHOLE												

# RECORD OF BOREHOLE No 136-07-1

1 OF 1

METRIC

W.P. 331-89-00 LOCATION WC 136-07; Sta. 11+656, O-S 22m Lt. ORIGINATED BY IK  
DIST 4 HWY QEW BOREHOLE TYPE Solid Stem COMPILED BY IK  
DATUM SEE TEXT DATE 94.08.17 & 94.08.17 CHECKED BY TO

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa							
82.5	Ground Surface							20 40 60 80 100							
82.4	50mm Topsoil		1	SS	3		82								
0.1	Het. mixture of Silt and Clay, some sand, trace gravel		2	SS	20		81								0 16 58 26
	(Glacial Till)		3	SS	23		80								
	Very Stiff to Hard		4	SS	50	100mm	79								
			5	SS	38		78								
	Brown Grey		6	SS	40		77								
			7	SS	31		76								
75.8	END OF BOREHOLE														
6.7	Borehole dry upon completion														

x<sup>3</sup>, x<sup>3</sup>: Numbers refer to Sensitivity 20 15 10 (%) STRAIN AT FAILURE

# RECORD OF BOREHOLE No 136-07-2

1 OF 1

METRIC

W.P. 331-89-00 LOCATION WC 136-07, Sta. 11+656, O-S 3m Rt. ORIGINATED BY IK  
 DIST 4 HWY QEW BOREHOLE TYPE Solid Stem, Cone Test COMPILED BY IK  
 DATUM SEE TEXT DATE 94.08.12 & 94.08.12 CHECKED BY TO

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			UNIT WEIGHT $\gamma$ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa				
83.1	Ground Surface							20 40 60 80 100				
0.0	Mixture of Sand, Silt and Gravel (Fill), compact		1	SS	10			○ UNCONFINED      × FIELD VANE				
82.4								● QUICK TRIAXIAL      × LAB VANE				
0.7	Brown Silt (Fill), sandy and clayey, trace gravel, compact		2	SS	12			WATER CONTENT (%)				
81.5								wp      w      wl				
1.6	Het. mixture of silt and clay, some sand, trace gravel		3	SS	27							
	(Glacial till)		4	SS	34							
	Very stiff to hard		5	SS	63							
	Brown Grey		6	SS	55							
			7	SS	48							
			8	SS	46							
			9	SS	68							
74.9												
8.2	END OF BOREHOLE											
	Borehole dry upon completion											

x<sup>3</sup>. x<sup>3</sup>: Numbers refer to  
Sensitivity

20  
15  
10

(%) STRAIN AT FAILURE

# RECORD OF BOREHOLE No 136-07-3

1 OF 1

METRIC

W.P. 331-89-00 LOCATION WC 136-07; Sta. 11+656, O-S 23m Rt. ORIGINATED BY IK  
DIST 4 HWY QEW BOREHOLE TYPE Solid Stem COMPILED BY IK  
DATUM SEE TEXT DATE 94.08.12 & 94.08.12 CHECKED BY TO

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W <sub>P</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa						
82.4	Ground Surface													
82.8	Topsoil		1	SS	6									
0.1	Het. mixture of Silt and Clay, some sand, trace gravel  (Glacial Till)  Very Stiff to Hard  Brown Grey		2	SS	21								23.0	
			3	SS	52									
			4	SS	31									5 24 56 15
			5	SS	31									
			6	SS	38									
			7	SS	28									
75.7														
6.7	END OF BOREHOLE  Borehole dry upon completion													



# RECORD OF BOREHOLE No 136-08-1

1 OF 1

METRIC

W.P. 331-89-00 LOCATION WC 136-08; Sta. 11+853, O-S 23m Lt. ORIGINATED BY IK  
 DIST HWY QEW BOREHOLE TYPE Solid Stem COMPILED BY IK  
 DATUM SEE TEXT DATE 94.08.17 & 94.08.17 CHECKED BY TO

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			UNIT WEIGHT $\gamma$ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa				
								20	40	60		
82.9	Ground Surface											
0.0	Topsoil		1	SS	3							
82.3												
0.6	Het. mixture of Silt and Clay, some sand, trace gravel  (Glacial Till)  Very Stiff to Hard		2	SS	26							
			3	SS	35							
			4	SS	42							
			5	SS	57							
			6	SS	71							
			7	SS	46							
76.2												
6.7	END OF BOREHOLE  Borehole dry upon completion											

$\times^3 \cdot \times^3$ : Numbers refer to  
Sensitivity

20  
15  
10

(%) STRAIN AT FAILURE

# RECORD OF BOREHOLE No 136-08-2

1 OF 1

METRIC

W.P. 331-89-00 LOCATION WC 136-08; Sta. 11+853, O-S 3m Rt. ORIGINATED BY IK  
DIST HWY QEW BOREHOLE TYPE Solid Stem, Cone Test COMPILED BY IK  
DATUM SEE TEXT DATE 94.08.12 & 94.08.12 CHECKED BY TO

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT $\gamma$ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa	WATER CONTENT (%)					
83.4	Ground Surface													
0.0	Mixture of Sand, Silt and Gravel (Fill), loose		1	SS	8		83							
82.5														
0.9	Het. mixture of Silt and Clay, some sand, trace gravel  (Glacial Till)  Very Stiff to Hard		2	SS	5		82							
			3	SS	34									
			4	SS	48									
			5	SS	60									
			6	SS	36									
			7	SS	44									
			8	SS	30									
			9	SS	65									
75.8														
7.6	END OF BOREHOLE  Borehole dry upon completion													

# RECORD OF BOREHOLE No 136-08-3

1 OF 1

METRIC

W.P. 331-89-00 LOCATION WC 136-08; Sta. 11+853, O-S 23m Rt. ORIGINATED BY IK  
 DIST HWY QFW BOREHOLE TYPE Solid Stem COMPILED BY IK  
 DATUM SEE TEXT DATE 94.08.12 & 94.08.12 CHECKED BY TO

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT γ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20	40	60	80	100		
82.5	Ground Surface													
82.2	Topsoil		1	SS	26									
0.3	Het. mixture of Silt and Clay, some sand, trace gravel  (Glacial Till)  Very Stiff to Hard		2	SS	44									
			3	SS	67	125mm								
			4	SS	72									
			5	SS	47									
			6	SS	50	125mm								
77.0														
5.5	Shale, Bedrock													
76.3	Poor to Fair		7	SS	50	75mm								
6.2	END OF BOREHOLE													
	Borehole dry upon completion													

×<sup>3</sup>, ×<sup>3</sup>: Numbers refer to Sensitivity 20 15 10 (% STRAIN AT FAILURE

# RECORD OF BOREHOLE No 136-09-1

1 OF 1

METRIC

W.P. 331-89-00 LOCATION WC 136-09; Sta. 12+059, O-S 34m Lt. ORIGINATED BY IK  
DIST 4 HWY QEW BOREHOLE TYPE Solid Stem COMPILED BY IK  
DATUM SEE TEXT DATE 94.08.17 & 94.08.17 CHECKED BY TO

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			UNIT WEIGHT γ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	*N* VALUES			SHEAR STRENGTH kPa				
82.8	Ground Surface							20 40 60 80 100				
82.8	Topsoil		1	SS	8			20 40 60 80 100				
0.2	Het. mixture of Silt and Clay, some sand, trace gravel		2	SS	54		82					
	(Glacial Till)		3	SS	36		81					
	Very Stiff to Hard		4	SS	66		80					
	Brown		5	SS	44		79					
			6	SS	51		78					
77.6							78					
5.3	Shale Bedrock Poor to Fair		7	SS	50	75mm	77					
76.6												
6.2	END OF BOREHOLE											
	Borehole dry upon completion											

\*<sup>3</sup> . \*<sup>3</sup> : Numbers refer to  
Sensitivity

20  
15  
10

(%) STRAIN AT FAILURE

# RECORD OF BOREHOLE No 136-09-2

1 OF 1

METRIC

W.P. 331-89-00 LOCATION WC 136-09; Sta. 12+059, O-S 3m Rt. ORIGINATED BY IK  
DIST HWY QEW BOREHOLE TYPE Solid Stem, Cone Test COMPILED BY IK  
DATUM SEE TEXT DATE 94.08.12 & 94.08.12 CHECKED BY TO

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT	PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	*N* VALUES								
83.7	Ground Surface												
0.0	Mixture of Sand, Silt and Gravel (Fill), compact.		1	SS	14								
82.8													
0.9	Het. mixture of Silt and Clay, some sand, trace gravel  (Glacial Till)  Very Stiff to Hard  Brown		2	SS	13								0 11 56 33
			3	SS	29								
			4	SS	35								
			5	SS	95								
			6	SS	70								
78.6			7	SS	91								
5.2	Shale  Bedrock  Poor to Fair		8	SS	100	75mm							
			9	SS	100	63mm							
76.4													
7.3	END OF BOREHOLE  Borehole dry upon completion												

# RECORD OF BOREHOLE No 136-09-3

1 OF 1

METRIC

W.P. 331-89-00 LOCATION WC 136-09; Sta. 12+059, O-S 24m Rt. ORIGINATED BY IK  
 DIST HWY QEW BOREHOLE TYPE Solid Stem COMPILED BY IK  
 DATUM SEE TEXT DATE 94.08.15 & 94.08.15 CHECKED BY TO

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT      NATURAL MOISTURE CONTENT      LIQUID LIMIT			UNIT WEIGHT $\gamma$ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa		WATER CONTENT (%)				
83.3	Ground Surface							20 40 60 80 100		W <sub>p</sub> W      W <sub>L</sub>				
0.0	Topsoil		1	SS	5		83							
82.6														
0.8	Het. mixture of Silt and Clay, some sand, trace gravel		2	SS	27		82							
	(Glacial Till)		3	SS	50									
	Very Stiff to Hard						81							
	Brown		4	SS	74									
80.3			5	SS	50	125mm	80							
3.1	Shale													
	Bedrock		6	SS	50	100mm	79							
	Poor to Fair						78							
							77							
76.6			7	SS	50	25mm								
6.7	END OF BOREHOLE													
	Borehole dry upon completion													

# RECORD OF BOREHOLE No 136-10-1

1 OF 1

METRIC

W.P. 331.89.00 LOCATION WC 136-10; Sta. 12+347, D-S 24m Lt. ORIGINATED BY IK  
 DIST 4 HWY QEW BOREHOLE TYPE Solid Stem, N-Casing, Rock Coring COMPILED BY IK  
 DATUM SEE TEXT DATE 94.08.18 & 94.08.18 CHECKED BY TO

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT  γ  kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)  GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	*N* VALUES			SHEAR STRENGTH kPa						
83.5	Ground Surface							20	40	60	80	100		
83.5	Topsoil		1	SS	4		83							
0.1	Het. mixture of silt and clay, some sand, trace gravel (Glacial Till), Very Stiff to Hard, brown		2	SS	80		82							
82.1	Shale		3	SS	50	150mm	81							
1.5	Bedrock		4	SS	50	150mm	80							
	Poor to Fair		5	NQ RC	REC 97%		79							RQD = 65%
			6	NQ RC	REC 100%		78							RQD = 73%
77.4	END OF BOREHOLE													
6.1														

# RECORD OF BOREHOLE No 136-10-2

1 OF 1

METRIC

W.P. 331-89-00 LOCATION WC 136-10; Sta. 12+347, O-S 3m Rt. ORIGINATED BY IK  
DIST 4 HWY QEW BOREHOLE TYPE Solid Stem, Cone Test COMPILED BY IK  
DATUM SEE TEXT DATE 94.08.16 & 94.08.16 CHECKED BY TO

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			UNIT WEIGHT $\gamma$ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa					
84.4	Ground Surface							20 40 60 80 100	PLASTIC LIMIT w <sub>p</sub>	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w <sub>L</sub>		
0.0	Mixture of Sand, Silt and Gravel (Fill) Compact		1	SS	9			20 40 60 80 100	○ UNCONFINED	✕ FIELD VANE			
83.4			2	SS	20				● QUICK TRIAXIAL	✕ LAB VANE			
1.1	Shale		3	SS	100	250mm			WATER CONTENT (%)				
	Bedrock		4	SS	60	125mm							
	Poor to Fair		5	SS	50	75mm							
			6	SS	60	50mm							
			7	SS	60	63mm							
			8	SS	65	25mm							
76.8			9	SS	70	25mm							
7.7	END OF BOREHOLE												
	Borehole dry upon completion												



# RECORD OF BOREHOLE No 136-10-3

1 OF 1

METRIC

W.P. 331-89-00 LOCATION WC 136-10; Sta. 12+347, O-S 30m Rt. ORIGINATED BY IK  
 DIST 4 HWY QEW BOREHOLE TYPE Solid Stem COMPILED BY IK  
 DATUM SEE TEXT DATE 94.08.15 & 94.08.15 CHECKED BY TO

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			UNIT WEIGHT $\gamma$ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa				
83.0	Ground Surface						83	20 40 60 80 100				
0.0	Het. mixture of Silt and Clay, some sand, trace gravel		1	SS	9			○ UNCONFINED    × FIELD VANE ● QUICK TRIAXIAL    × LAB VANE				
82.6	(Glacial Till), very stiff to hard, brown		2	SS	50	50mm	82	20 40 60 80 100			10 20 30	0 23 73 5
0.5	Shale		3	SS	50	100mm	81					
	Bedrock		4	SS	50	125mm	80					
	Poor to Fair		5	SS	50	25mm	79					
			6	SS	50	25mm	78					
			7	SS	50	25mm	77					
76.3												
6.7	END OF BOREHOLE											
	Borehole dry upon completion											

# RECORD OF BOREHOLE No 136-11-1

1 OF 1

METRIC

W.P. 331-89-00 LOCATION WC 136-11; Sta. 12+675, O-S 25m Lt. ORIGINATED BY IK  
DIST 4 HWY QEW BOREHOLE TYPE Solid Stem, N-Casing, Rock Coring COMPILED BY IK  
DATUM SEE TEXT DATE 94.08.17 & 94.08.18 CHECKED BY TO

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT w <sub>p</sub>	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w <sub>L</sub>	UNIT WEIGHT γ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL							
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			"N" VALUES	SHEAR STRENGTH kPa						WATER CONTENT (%)						
						20	40	60	80	100	20	40	60	80	100	10	20	30		
83.3	Ground Surface																			
83.3 0.2	Topsoil		1	SS	5															
	Het. mixture of Silt and Clay, some sand, trace gravel (Glacial Till), very stiff to hard, brown		2	SS	22															
81.8	Shale		3	SS	50	100mm														
1.5	Bedrock		4	SS	50	50mm														
	Fair to Good																			
			5	NQ RC	REC 97%															ROD = 88%
			6	NQ RC	REC 100%															ROD = 70%
77.1																				
6.2	END OF BOREHOLE																			

# RECORD OF BOREHOLE No 136-11-2

1 OF 1

METRIC

W.P. 331-89-00 LOCATION WC 136-11; Sta. 12+675, O.S. 3m Rt. ORIGINATED BY IK  
 DIST HWY QEW BOREHOLE TYPE Solid Stem, Cone Test COMPILED BY IK  
 DATUM SEE TEXT DATE 94.08.16 & 94.08.16 CHECKED BY TO

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT		UNIT WEIGHT $\gamma$ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa		WATER CONTENT (%)			
84.8	Ground Surface							20 40 60 80 100		10 20 30			
0.0	Mixture of Sand, Silt and Gravel (Fill), trace clay, compact		1	SS	10			○ UNCONFINED      × FIELD VANE		w <sub>p</sub> w      w <sub>L</sub>			
			2	SS	10			● QUICK TRIAXIAL      × LAB VANE					
82.8			3	SS	15								
2.0	Shale		4	SS	60	125mm							
	Bedrock		5	SS	60	50mm							
	Poor to Fair		6	SS	60	63mm							
			7	SS	60	63mm							
			8	SS	60	50mm							
77.1			9	SS	60	50mm							
7.7	END OF BOREHOLE												
	Borehole dry upon completion												

# RECORD OF BOREHOLE No 136-11-3

1 OF 1

METRIC

W.P. 331-89-00 LOCATION WC 136-11; Sta. 12+675, O-S 32m Rt. ORIGINATED BY IK  
DIST 4 HWY QEW BOREHOLE TYPE Solid Stem COMPILED BY IK  
DATUM SEE TEXT DATE 94.08.15 & 94.08.15 CHECKED BY TO

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			UNIT WEIGHT $\gamma$ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa				
84.5	Ground Surface							20 40 60 80 100				
84.8	Topsoil		1	SS	7							
0.2	Het. mixture of Silt and Clay, some sand, trace gravel (Glacial Till), very stiff to hard		2	SS	50	25mm						
83.0			3	SS	50	75mm						
1.5	Shale											
	Bedrock		4	SS	50	25mm						
	Poor to Fair		5	SS	50	25mm						
			6	SS	50	25mm						
			7	SS	50	100mm						
77.8												
6.7	END OF BOREHOLE											

# RECORD OF BOREHOLE No 136-12-1

1 OF 1

METRIC

W.P. 331-89-00 LOCATION WC 136-12; Sta. 12+885, O-S 36m Lt. ORIGINATED BY IK  
 DIST HWY QEW BOREHOLE TYPE Solid Stem COMPILED BY IK  
 DATUM SEE TEXT DATE 94.08.17 & 94.08.17 CHECKED BY TO

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	*N* VALUES			SHEAR STRENGTH kPa						
83.0	Ground Surface							20 40 60 80 100						
82.8	Topsoil		1	SS	37			○ UNCONFINED    × FIELD VANE						
0.2	Shale		2	SS	50	100mm		● QUICK TRIAXIAL    × LAB VANE						
	Bedrock		3	SS	50	100mm								
	Poor to Fair		4	SS	50	100mm								
			5	SS	50	40mm								
			6	SS	50	40mm								
76.8			7	SS	50	25m								
6.2	END OF BOREHOLE													
	Borehole dry upon completion													

# RECORD OF BOREHOLE No 136-12-2

1 OF 1

METRIC

W.P. 331-89-00 LOCATION WC 136-12; Sta. 12+885, O-S 3m Rt. ORIGINATED BY IK  
DIST 4 HWY QEW BOREHOLE TYPE Solid Stem, Cone Test COMPILED BY IK  
DATUM SEE TEXT DATE 94.08.17 & 94.08.17 CHECKED BY TO

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT w <sub>p</sub>	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w <sub>L</sub>	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)					
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20	40						60	80	100	20	40
84.5	Ground Surface																		
0.0	Mixture of Sand, Silt and Gravel (Fill), compact		1	SS	20														
83.7																			
0.8	Clayey Silt (Fill), trace sand, very stiff, brown		2	SS	25														
82.9																			
1.7	Shale		3	SS	35														
	Bedrock		4	SS	70	100mm													
	Poor to Fair		5	SS	60	25mm													
			6	SS	70	125mm													
			7	SS	60	100mm													
			8	SS	60	50mm													
76.8			9	SS	60	50mm													
7.7	END OF BOREHOLE																		

# RECORD OF BOREHOLE No 136-12-3

1 OF 1

METRIC

W.P. 331-89-00 LOCATION WC 136-12; Sta. 12+885, O-S 26m Rt. ORIGINATED BY IK  
 DIST HWY OFW BOREHOLE TYPE Solid Stem COMPILED BY IK  
 DATUM SEE TEXT DATE 94.08.15 & 94.08.15 CHECKED BY TO

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT w <sub>p</sub>	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w <sub>L</sub>	UNIT WEIGHT γ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			"N" VALUES	SHEAR STRENGTH kPa						
83.7	Ground Surface													
0.0	Het. mixture of Silt and Clay, some sand, trace gravel (Glacial Till) Very Stiff to Hard		1	SS	12		83							0 17 65 18
82.2			2	SS	76									
1.5	Shale		3	SS	50	75mm	82							
	Bedrock													
	Poor to Fair		4	SS	50	10mm	81							
			5	SS	50	10mm	80							
			6	SS	50	10mm	79							
							78							
77.5						100mm								
6.3	END OF BOREHOLE													
	Borehole dry upon completion													

$\times^3, \times^3$ : Numbers refer to  
Sensitivity

20  
15  
10

(%) STRAIN AT FAILURE

# RECORD OF BOREHOLE No 136-13-1

1 OF 1

METRIC

W.P. 331-89-00 LOCATION WC 136-13; Sta. 13+085, O-S 32m Lt. ORIGINATED BY IK  
DIST 4 HWY QEW BOREHOLE TYPE Solid Stem COMPILED BY IK  
DATUM SEE TEXT DATE 94.08.17 & 94.08.17 CHECKED BY TO

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			UNIT WEIGHT  kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa				
								20	40	60		
82.5	Ground Surface											
82.2	Topsoil		1	SS	6							
0.3	Het. mixture of Silt and Clay, some sand, trace gravel  (Glacial Till)  Very Stiff to Hard  Brown		2	SS	20							
			3	SS	13							
			4	SS	15							
			5	SS	32							
			6	SS	33							
78.3	Shale											
4.3	Bedrock											
76.3	Poor to Fair											
6.2	END OF BOREHOLE											
	Borehole dry upon completion											

x<sup>3</sup>, x<sup>3</sup>: Numbers refer to Sensitivity 20 15 10 (%) STRAIN AT FAILURE



# RECORD OF BOREHOLE No 136-13-2

1 OF 1

METRIC

W.P. 331-89-00 LOCATION WC 136-13; Sta. 13+085, O-S 3m Lt. ORIGINATED BY IK  
DIST HWY QFW BOREHOLE TYPE Solid Stem, Cone Test COMPILED BY IK  
DATUM SEE TEXT DATE 94.08.12 & 94.08.12 CHECKED BY TO

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT w <sub>p</sub>	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w <sub>L</sub>	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa							WATER CONTENT (%)
								○ UNCONFINED	× FIELD VANE						
83.7	Ground Surface							20 40 60 80 100	20 40 60 80 100	10 20 30	kN/m <sup>3</sup>	GR SA SI CL			
0.0	Silty Sand (Fill), some gravel, compact Brown		1	SS	9										
82.6															
1.1	Het. mixture of Silt and Clay, some sand, trace gravel  (Glacial Till)  Very Stiff to Hard		2	SS	13										
			3	SS	17										
			4	SS	20										
			5	SS	25										
			6	SS	39										
79.0			7	SS	70	38mm									
4.7	Shale  Bedrock  Poor to Fair		8	SS	100	75mm									
			9	SS	100	75mm									
76.2															
7.6	END OF BOREHOLE  Borehole dry upon completion														

x<sup>3</sup> x<sup>3</sup>: Numbers refer to Sensitivity 20 15 10 5 10 (%) STRAIN AT FAILURE

# RECORD OF BOREHOLE No 136-13-3

1 OF 1

METRIC

W.P. 331-89-00 LOCATION WC 136-13; Sta. 13+085, O-S 47m Rt. ORIGINATED BY IK  
DIST HWY QEW BOREHOLE TYPE Solid Stem COMPILED BY IK  
DATUM SEE TEXT DATE 94.08.15 & 94.08.15 CHECKED BY TO

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W <sub>P</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20	40	60	80	100					
82.8	Ground Surface		1	SS	4												
0.0	Het. mixture of Silt and Clay, some sand, trace gravel  (Glacial Till)  Very Stiff to Hard   Brown Grey		2	SS	4												
			3	SS	18												
			4	SS	50												
79.6			5	SS	50	50mm											
3.3	Shale  Bedrock  Poor to Fair		6	SS	50	135mm											
			7	SS	50	75mm											
76.2																	
6.7	END OF BOREHOLE																

## METRIC

DATUM SEE TEXT DATE 94.08.16 & 94.08.16 CHECKED BY TO

$\times^3, \times^3$ : Numbers refer to Sensitivity

# RECORD OF BOREHOLE No 136-14-2

1 OF 1

METRIC

W.P. 331-89-00 LOCATION WC 136-14; Sta. 13+278, O-S 3m Lt. ORIGINATED BY IK  
DIST HWY QEW BOREHOLE TYPE Solid Stem, Cone Test COMPILED BY IK  
DATUM SEE TEXT DATE 84.08.13 & 94.08.13 CHECKED BY TO

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT $\gamma$ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa	WATER CONTENT (%)					
83.7	Ground Surface													
83.6	100mm Asphalt													
0.1	Mixture of Sand, Silt and Gravel (Fill), loose, brown		1	SS	9									
82.6														
1.1	Het. mixture of Silt and Clay, some sand, trace gravel		2	SS	8									
	(Glacial Till)		3	SS	19									
	Very Stiff to Hard		4	SS	29									
	Brown		5	SS	18									
			6	SS	8									
			7	SS	7									
			8	SS	130									
			9	SS	37									
76.1														
7.6	END OF BOREHOLE													
	Borehole dry upon completion													

# RECORD OF BOREHOLE No 136-14-3

1 OF 1

METRIC

W.P. 331-89-00 LOCATION WC 136-14; Sta. 13+278, O-S 34m Rt. ORIGINATED BY IK  
DIST 4 HWY QEW BOREHOLE TYPE Solid Stem COMPILED BY IK  
DATUM SEE TEXT DATE 94.08.15 & 94.08.15 CHECKED BY TO

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT $\gamma$ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	*N* VALUES			20	40	60	80	100		
83.0	Ground Surface						83							
82.9	Topsoil		1	SS	10		82							
0.3	Het. mixture of Silt and Clay, some sand, trace gravel  (Glacial Till)  Very Stiff to Hard  Brown Grey		2	SS	27		81							
			3	SS	31		80							
			4	SS	25		79							
			5	SS	15		78							
			6	SS	12		77							
76.3			7	SS	45									
6.7	END OF BOREHOLE  Borehole dry upon completion													

$\times^3, \times^3$ : Numbers refer to Sensitivity 20 15 10 (%) STRAIN AT FAILURE

# RECORD OF BOREHOLE No 136-15-1

1 OF 1

METRIC

W.P. 331-89-00 LOCATION WC 136-15; Sta. 13+499, O-S 23m Lt. ORIGINATED BY IK  
DIST HWY QEW BOREHOLE TYPE Solid Stem COMPILED BY IK  
DATUM SEE TEXT DATE 94.08.16 & 94.08.16 CHECKED BY TO

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT w <sub>p</sub>	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w <sub>L</sub>	UNIT WEIGHT γ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20	40	60					
82.6	Ground Surface														
82.6 0.1	Topsoil		1	SS	9										
	Het. mixture of Silt and Clay, some sand, trace gravel		2	SS	32										
	(Glacial Till)		3	SS	28										
	Very Stiff to Hard		4	SS	17										
	Brown Grey		5	SS	11										
			6	SS	11										
			7	SS	41										
75.9	END OF BOREHOLE														
6.7	Borehole dry upon completion														

# RECORD OF BOREHOLE No 136-15-2

1 OF 1

METRIC

W.P. 331-89-00 LOCATION WC 136-15; Sta. 13+489, O-S 3m Lt. ORIGINATED BY IK  
 DIST 4 HWY QEW BOREHOLE TYPE Solid Stem, Cone Test COMPILED BY IK  
 DATUM SEE TEXT DATE 94.08.12 & 94.08.12 CHECKED BY TO

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT WP	NATURAL MOISTURE CONTENT W	LIQUID LIMIT WL	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)					
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	*N* VALUES			20	40						60	80	100	20	40
83.6	Ground Surface																		
83.6	50mm Asphalt																		
0.1	Mixture of Sand and Gravel (Fill), trace silt, compact		1	SS	13														
83.2	Het. mixture of Silt and Clay, some sand, trace gravel		2	SS	6														
0.5	(Glacial Till)		3	SS	21														
	Very Stiff to Hard		4	SS	31														
	Brown Grey		5	SS	22														
			6	SS	16														
			7	SS	9														
			8	SS	27														
			9	SS	29														
76.0	END OF BOREHOLE																		
7.6	Borehole dry upon completion																		

# RECORD OF BOREHOLE No 136-15-3

1 OF 1

METRIC

W.P. 331-89-00 LOCATION WC 136-15; Sta. 13+499, O-S 21m Rt. ORIGINATED BY IK  
 DIST HWY QEW BOREHOLE TYPE Solid Stem COMPILED BY IK  
 DATUM SEE TEXT DATE 94.08.15 & 94.08.15 CHECKED BY TO

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			UNIT WEIGHT $\gamma$ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL		
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa						
								20 40 60 80 100						
								○ UNCONFINED    ✕ FIELD VANE ● QUICK TRIAXIAL    ✕ LAB VANE						
							WATER CONTENT (%)							
							20 40 60 80 100			10 20 30				
							PLASTIC LIMIT    NATURAL MOISTURE CONTENT    LIQUID LIMIT							
							w <sub>p</sub> w    w <sub>L</sub>							
82.5	Ground Surface													
82.0	Topsoil		1	SS	7		82							
0.1	Het. mixture of Silt and Clay, some sand, trace gravel		2	SS	35		81							
	(Glacial Till)		3	SS	28		80							
	Very Stiff to Hard		4	SS	24		79							
			5	SS	14		78							
	Brown Grey		6	SS	23		77							
			7	SS	46		76							
75.8														
6.7	END OF BOREHOLE													
	Borehole dry upon completion													



# RECORD OF BOREHOLE No 136-16-1

1 OF 1

METRIC

W.P. 331-89-00 LOCATION WC 136-16; Sta. 13+817, O-S 27m Lt. ORIGINATED BY IK  
 DIST HWY QEW BOREHOLE TYPE Solid Stem COMPILED BY IK  
 DATUM SEE TEXT DATE 94.08.16 & 94.08.16 CHECKED BY TO

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				UNIT WEIGHT $\gamma$ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa ○ UNCONFINED      × FIELD VANE ● QUICK TRIAXIAL    × LAB VANE					
83.4	Ground Surface												
83.4 0.2	Topsoil		1	SS	7		83						
	Mixture of Sand, Silt and Gravel (Fill), loose		2	SS	6		82						
82.0													
1.4	Het. mixture of Silt and Clay, some sand, trace gravel (Glacial Till) Very Stiff to Hard Grey		3	SS	28		81						
			4	SS	37		80						
			5	SS	58		79						
79.2			6	SS	55		78						
4.2	Shale												
	Bedrock												
	Poor to Fair												
77.2			7	SS	50	150mm							
6.3	END OF BOREHOLE												

# RECORD OF BOREHOLE No 136-16-2

1 OF 1

METRIC

W.P. 331-89-00 LOCATION WC 136-16; Sta. 13+817, O-S 3m Lt. ORIGINATED BY IK  
DIST HWY QEW BOREHOLE TYPE Solid Stem, Cone Test COMPILED BY IK  
DATUM SEE TEXT DATE 94.08.12 & 94.08.12 CHECKED BY TO

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT NATURAL MOISTURE CONTENT		UNIT WEIGHT  γ  kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa		WATER CONTENT (%)			
84.7	Ground Surface							20 40 60 80 100		10 20 30			
0.0	Mixture of Sand, Silt and Gravel  (Fill)  Loose to Compact		1	SS	19			○ UNCONFINED    × FIELD VANE		● QUICK TRIAXIAL    × LAB VANE			
			2	SS	10								
			3	SS	6								
82.2			4	SS	15								
2.6	Het. mixture of Silt and Clay, some sand, trace gravel  (Glacial Till)  Very Stiff to Hard  Grey		5	SS	60	125mm							
			6	SS	60	125mm							
			7	SS	60	125mm							
78.7			8	SS	60	10mm							
6.1	Shale  Bedrock  Poor to Fair		9	SS	60	25mm							
76.5													
8.2	END OF BOREHOLE												

×<sup>3</sup>, ×<sup>3</sup>: Numbers refer to  
Sensitivity 20 15 10 (%) STRAIN AT FAILURE

# RECORD OF BOREHOLE No 136-16-3

1 OF 1

METRIC

W.P. 331-89-00 LOCATION WC 136-16; Sta. 13+817, O-S 29m Rt. ORIGINATED BY IK  
 DIST HWY QEW BOREHOLE TYPE Solid Stem COMPILED BY IK  
 DATUM SEE TEXT DATE 94.08.16 & 94.08.16 CHECKED BY TO

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa								
83.2	Ground Surface							20	40	60	80	100				
83.9	Topsoil		1	SS	8	250mm	83									
0.1	Silty Sand (Fill), some gravel Loose Brown		2	SS	7		82									
81.7			3	SS	22		81									
1.5	Het. mixture of Silt and Clay, some sand, trace gravel (Glacial Till) Very Stiff to Hard Brown		4	SS	60		80									
79.9			5	SS	100	10mm	79									
3.3	Shale		6	SS	100		78									
	Bedrock															
	Poor to Fair															
77.1			7	SS	60	80mm										
6.2	END OF BOREHOLE															

x<sup>3</sup>. x<sup>3</sup>: Numbers refer to  
Sensitivity

20  
15  
10  
(%) STRAIN AT FAILURE

# RECORD OF BOREHOLE No 138-06-1

1 OF 1

METRIC

W.P. 333-89-00 LOCATION WC 138-06; Sta. 12+489, O-S 42m Lt. ORIGINATED BY IK  
DIST 4 HWY QEW BOREHOLE TYPE Solid Stem COMPILED BY IK  
DATUM SEE TEXT DATE 94.08.25 & 94.08.25 CHECKED BY TO

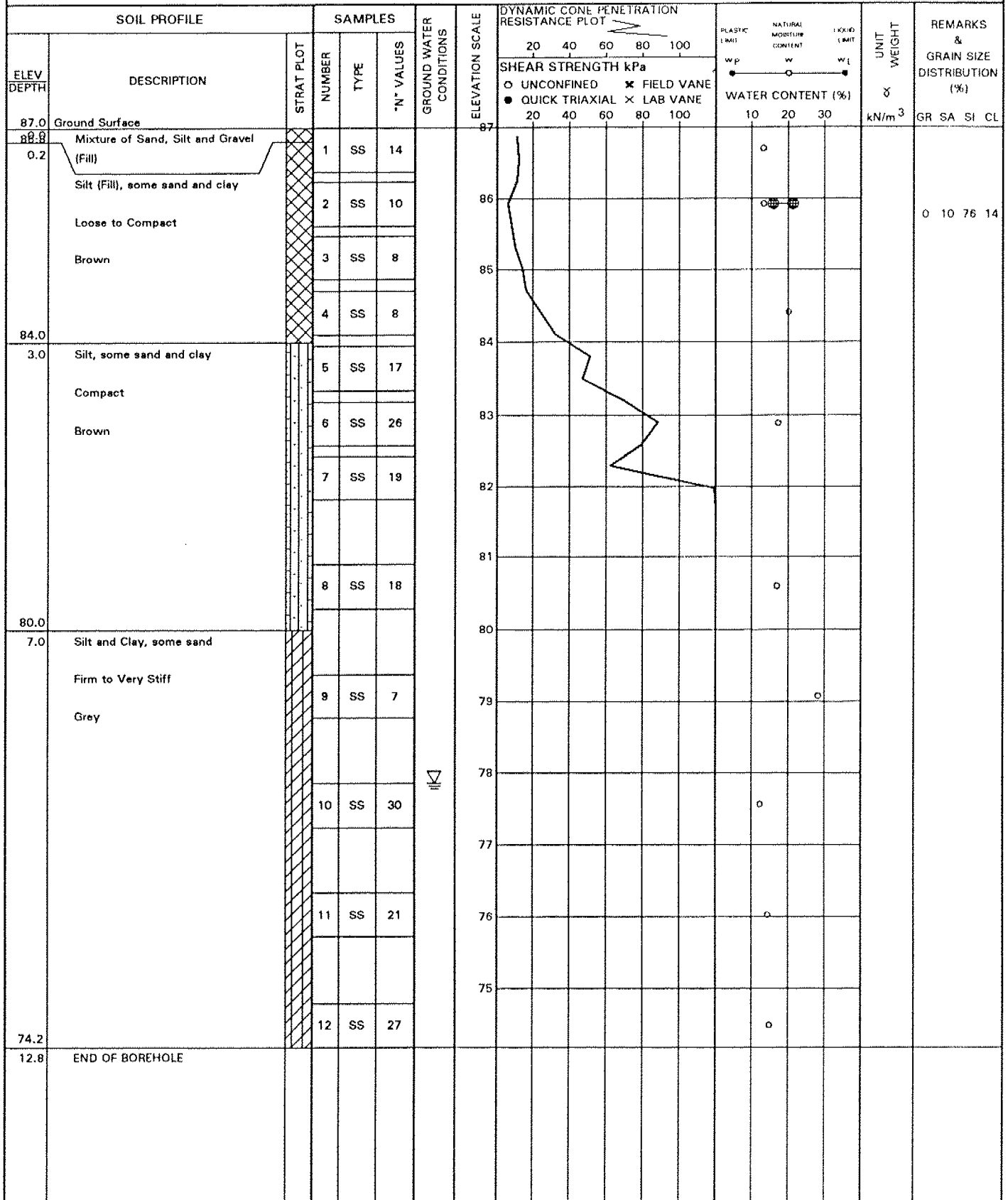
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			UNIT WEIGHT γ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)		
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa						
								20 40 60 80 100						
								○ UNCONFINED    × FIELD VANE ● QUICK TRIAXIAL    × LAB VANE						
							WATER CONTENT (%)							
							PLASTIC LIMIT    NATURAL MOISTURE CONTENT    LIQUID LIMIT							
							WP    W    WL							
85.7	Ground Surface													
85.6	Topsoil		1	SS	28									
0.1	Silt (Fill), some sand and clay, trace gravel		2	SS	26									
	Compact		3	SS	30									
	Brown		4	SS	20									
82.7														
3.0	Silt, some sand and clay		5	SS	23									
	Compact		6	SS	18									
	Brown		7	SS	17									
79.6														
6.1	Silt and Clay, some sand		8	SS	11									
	Stiff to Very Stiff													
			9	SS	18									
			10	SS	20									
			11	SS	25									

# RECORD OF BOREHOLE No 138-06-2

1 OF 1

METRIC

W.P. 333-89-00 LOCATION WC 138-06; Sta. 12+489, O-S 3m Rt. ORIGINATED BY JK  
DIST 4 HWY QEW BOREHOLE TYPE Solid Stem, Cone Test COMPILED BY JK  
DATUM SEE TEXT DATE 94.08.17 & 94.08.17 CHECKED BY TO



# RECORD OF BOREHOLE No 138-06-3

1 OF 1

METRIC

W.P. 333-89-00 LOCATION WC 138-06; Sta. 12+489, O-S 38m Rt. ORIGINATED BY IK  
DIST 4 HWY QEW BOREHOLE TYPE Solid Stem COMPILED BY IK  
DATUM SEE TEXT DATE 94.08.24 & 94.08.24 CHECKED BY TO

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			UNIT WEIGHT $\gamma$ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)  GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa				
								20 40 60 80 100				
								20 40 60 80 100				
			UNCONFINED      FIELD VANE QUICK TRIAXIAL      LAB VANE			WATER CONTENT (%) w <sub>p</sub> w      w <sub>L</sub>						
82.6	Ground Surface											
82.3	Topsoil		1	SS	5							
0.3	Silt, some sand and clay  Loose to Compact  Brown		2	SS	11							
			3	SS	4							
			4	SS	11							
			5	SS	8							
78.2	Silt and Clay, some sand		6	SS	7							
3.4	Stiff  Brown Grey		7	SS	11							
			8	SS	24							
74.4	Very Stiff											
8.2	END OF BOREHOLE											

$\times^3, \times^3$ : Numbers refer to Sensitivity 20 15 10 (% STRAIN AT FAILURE

# RECORD OF BOREHOLE No 138-07-1

1 OF 1

METRIC

W.P. 333-89-00 LOCATION WC 138-07; Sta. 13 + 248, O-S 25m Lt. ORIGINATED BY IK  
DIST 4 HWY QEW BOREHOLE TYPE Solid Stem COMPILED BY IK  
DATUM SEE TEXT DATE 94.08.24 & 94.08.24 CHECKED BY TO

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					NATURAL MOISTURE CONTENT			UNIT WEIGHT γ <sub>s</sub> kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20	40	60	80	100	W <sub>p</sub>	W	W <sub>L</sub>		
85.8	Ground Surface																
85.5	Topsoil		1	SS	11												
0.3	Sandy Silt, trace clay																
	Loose to Compact		2	SS	16												
	Brown		3	SS	10												
			4	SS	3												
			5	SS	10												
82.0																	
3.8	Silt and Clay, sandy		6	SS	3												
	Very Stiff																
	Grey																
			7	SS	16												
			8	SS	11												
			9	SS	23												
76.1																	
9.8	END OF BOREHOLE																

# RECORD OF BOREHOLE No 138-07-2

1 OF 1

METRIC

W.P. 333-89-00 LOCATION WC 138-07; Sta. 13+248, O-S 3m Rt. ORIGINATED BY IK  
DIST 4 HWY QEW BOREHOLE TYPE Solid Stem, Cone Test COMPILED BY IK  
DATUM SEE TEXT DATE 94.08.18 & 94.08.18 CHECKED BY TO

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			UNIT WEIGHT  γ  kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)  GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa ○ UNCONFINED      ✕ FIELD VANE ● QUICK TRIAXIAL    ✕ LAB VANE				
86.2	Ground Surface											
85.9	Mixture of Sand Silt and Gravel (Fill)		1	SS	16		86					
0.3	Compact		2	SS	15		85					
	Silt (Fill), some sand, trace clay and gravel		3	SS	14		84					
	Loose to Compact		4	SS	7		83					
	Brown		5	SS	8		82					
82.8	Silt and Clay, some sand		6	SS	3		81					
3.4	Soft		7	SS	3		80					
	Brown Grey						79					
	Very Stiff		8	SS	27		78					
			9	SS	20		77					
			10	SS	16							
76.5												
9.8	END OF BOREHOLE											



# RECORD OF BOREHOLE No 138-07-3

1 OF 1

METRIC

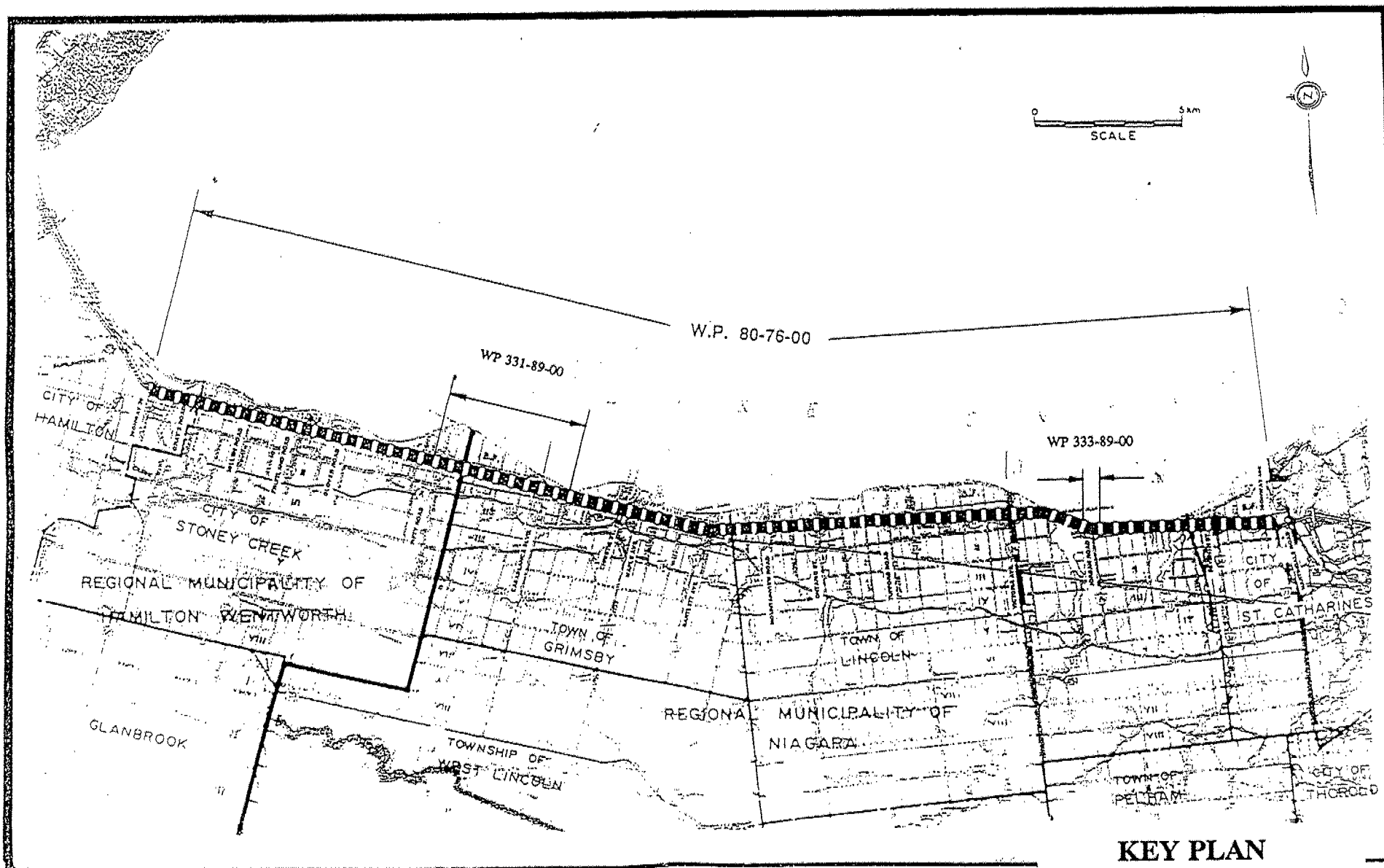
W.P. 333-89-00 LOCATION WC 138-07; Sta. 13+248, O-S 24m Rt. ORIGINATED BY JK  
DIST 4 HWY QEW BOREHOLE TYPE Solid Stem COMPILED BY JK  
DATUM SEE TEXT DATE 94.08.24 & 94.08.24 CHECKED BY TO

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL			
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa								WATER CONTENT (%)		
								○ UNCONFINED	× FIELD VANE	● QUICK TRIAXIAL							× LAB VANE	
86.4	Ground Surface						20	40	60	80	100							
86.1	Topsoil		1	SS	9													
0.3	Silt (Fill), some sand, trace clay		2	SS	17													
	Compact		3	SS	11													
	Brown																	
84.0																		
2.4	Silt, some sand and clay, compact, brown		4	SS	9													
			5	SS	11													
82.7																		
3.7	Silt and Clay, some sand, some organics to 5m.		6	SS	5													
	Firm to Stiff																	
	Grey																	
			7	SS	12													
			8	SS	7													
			9	SS	16													
76.7																		
9.8	END OF BOREHOLE																	

x<sup>3</sup>, x<sup>3</sup>: Numbers refer to  
Sensitivity

20  
15  
10  
(%) STRAIN AT FAILURE

## APPENDIX 2



**KEY PLAN  
FIGURE 1**

**TABLE 1**  
**CULVERT DETAILS**

<b>Culvert No.</b>	<b>Approx. Sta.</b>	<b>Approx. Elev. Culvert Invert (m)</b>	<b>Approx. Elev. Top of Culvert (m)</b>
WC135-40	31+688	82.0	82.6
WC135-41	32+102	78.2	80.9
WC136-01	10+419	80.8	81.8
WC136-02	10+622	81.0	81.6
WC136-03	10+825	81.0	81.7
WC136-04	11+101	81.4	82.0
WC136-05	11+262	81.4	82.3
WC136-06	11+446	82.0	82.8
WC136-07	11+656	81.8	82.4
WC136-08	11+853	81.6	82.3
WC136-09	12+059	82.4	83.3
WC136-10	12+347	82.6	83.5
WC136-11	12+675	83.3	83.9
WC136-12	12+885	82.9	83.5
WC136-13	13+085	82.3	83.0
WC136-14	13+278	82.6	83.2
WC136-15	13+499	81.3	82.3
WC136-16	13+817	82.6	83.8
WC138-06	12+489	82.8	83.8
WC138-07	13+248	83.4	84.8

**TABLE 2****REPORT OF SOIL CHEMISTRY ANALYSIS**

Parameter	LOQ	Units	135-40-2 SS 2	136-01-2 SS 1	136-03-2 SS 1	136-04-3 SS 1	138-06-2 SS 6	136-07-2 SS 2	136-09-2 SS 2	136-13-2 SS 2	Replicate	136-14-3 SS 1	136-16-2 SS 3
Chloride	0.5	mg/kg	620	762	534	1780	314	467	290	906	913	66.2	224
Sulphate	0.5	mg/kg	103	108	746	676	93.8	96.6	102	102	106	216	112
pH	0.01	units	8.03	8.66	7.63	7.52	8.42	8.18	8.40	8.45	8.48	7.75	8.99
Moisture Content	0.01	%	12.1	13.9	6.27	30.6	13.7	9.25	7.81	8.75	10.3	14.9	4.64

Notes:

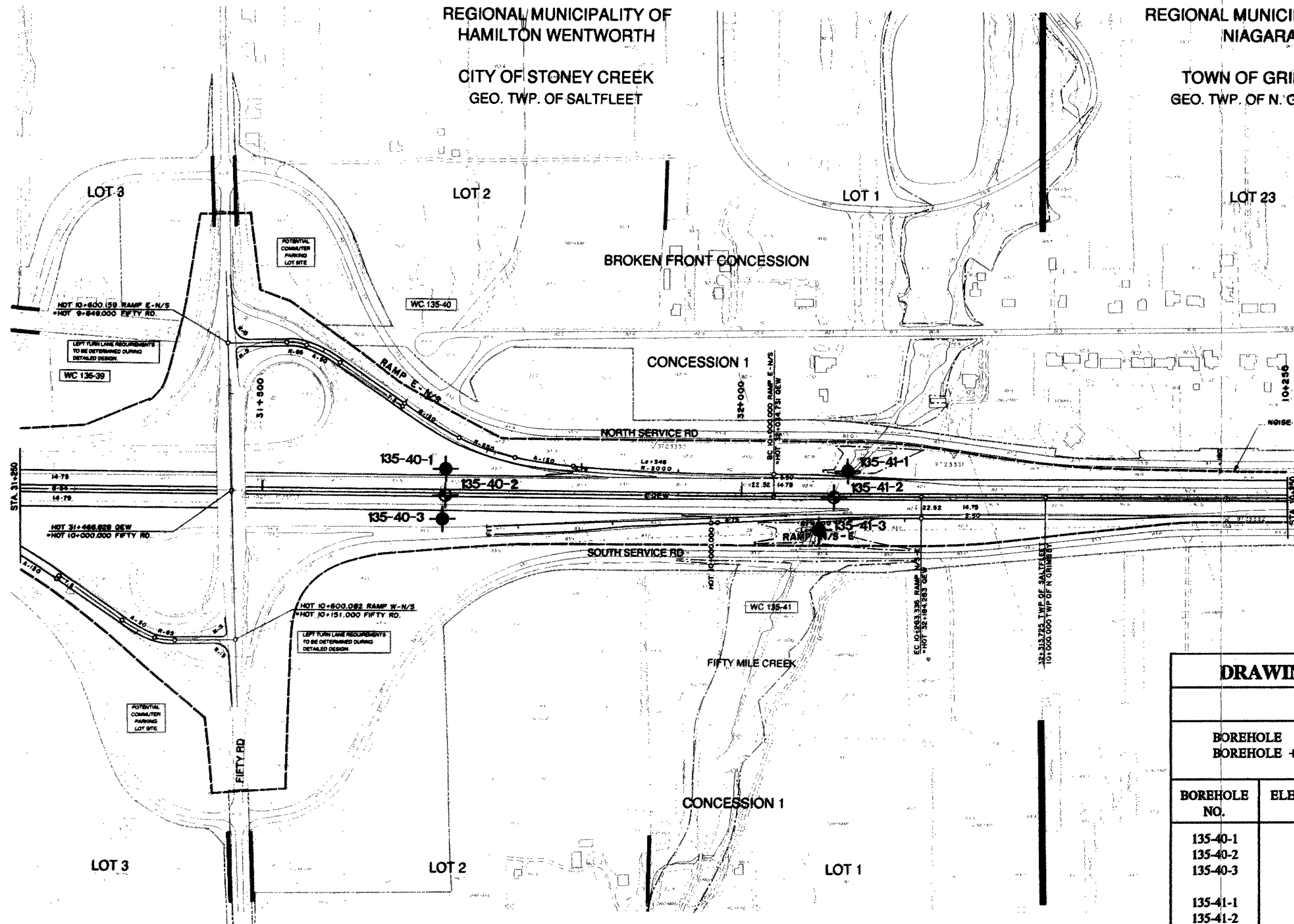
LOQ = Limit of Quantitation = lowest level of the parameter that can be quantified with confidence.

PDR Plates

1:4000

REGIONAL MUNICIPALITY OF  
HAMILTON WENTWORTH  
CITY OF STONEY CREEK  
GEO. TWP. OF SALT FLEET

REGIONAL MUNICIPALITY OF  
NIAGARA  
TOWN OF GRIMSBY  
GEO. TWP. OF N. GRIMSBY



### DRAWING NO. 3318900-A

#### LEGEND

BOREHOLE  
BOREHOLE + CONE

BOREHOLE NO.	ELEVATION (m)	STATION	OFFSET
135-40-1	81.8	31+688	25m Lt.
135-40-2	83.5	31+688	4m Rt.
135-40-3	82.0	31+688	28m Rt.
135-41-1	79.9	32+102	30m Lt.
135-41-2	82.1	32+102	3m Rt.
135-41-3	80.5	32+102	36m Rt.

PLATE  
C4-8

ULTIMATE PHASE  
STA. 31+250 TO STA. 10+250

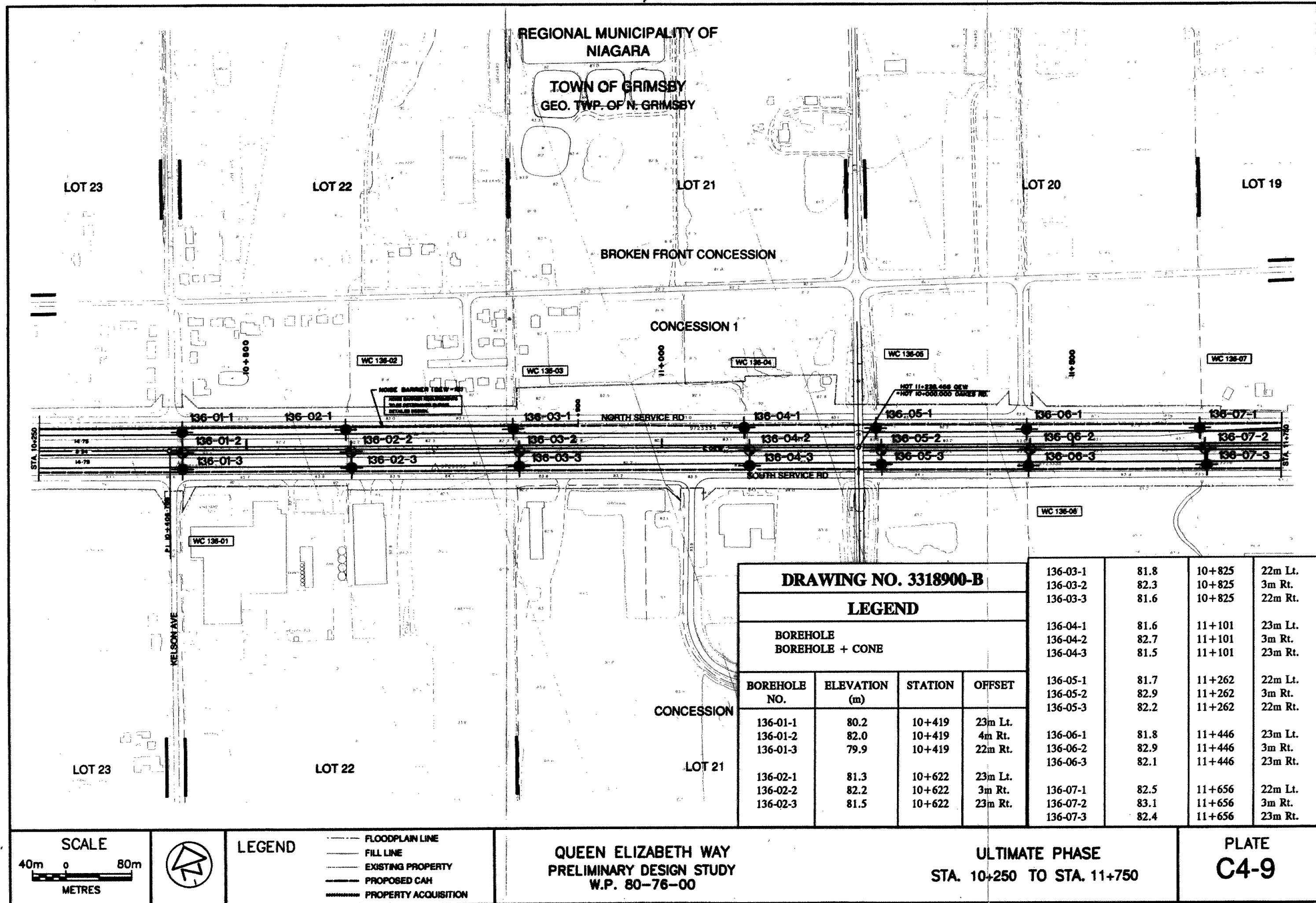
QUEEN ELIZABETH WAY  
PRELIMINARY DESIGN STUDY  
W.P. 80-76-00

#### LEGEND

- FLOODPLAIN LINE
- FILL LINE
- EXISTING PROPERTY
- PROPOSED CAH
- PROPERTY ACQUISITION



SCALE  
40m 0 80m  
METRES





REGIONAL MUNICIPALITY OF  
NIAGARA

TOWN OF GRIMSBY  
GEO. TWP. OF N. GRIMSBY

LAKE ONTARIO

LOT 19

LOT 18

LOT 17

LOT 16

BROKEN FRONT CONCESSION

CONCESSION 1

NOT 10+526.578 RAMP E-N/S  
NOT 9+881.000 CASABLANCA BLVD.

LEFT TURN LANE REQUIREMENTS  
TO BE DETERMINED DURING  
DETAILED DESIGN

WC 136-10

WC 136-11

WC 136-12

RAMP E-N/S

NOT 12+714.887 O.E.W.  
NOT 10+000.000 CASABLANCA BLVD.

136-13-1

136-13-2

136-13-3

RAMP N/S-E

WC 136-13

LEFT TURN LANE REQUIREMENTS  
TO BE DETERMINED DURING  
DETAILED DESIGN

NOT 10+627.355 RAMP W-N/S  
NOT 10+138.000 CASABLANCA BLVD.

CONCESSION 1

LOT 17

LOT 16

CANADIAN NATIONAL RAILWAYS

DRAWING NO. 3318900-C

LEGEND

BOREHOLE  
BOREHOLE + CONE

BOREHOLE NO.	ELEVATION (m)	STATION	OFFSET
136-08-1	82.9	11+853	23m Lt.
136-08-2	83.4	11+853	3m Rt.
136-08-3	82.5	11+853	23m Rt.
136-09-1	82.8	12+059	34m Lt.
136-09-2	83.7	12+059	3m Rt.
136-09-3	83.3	12+059	24m Rt.

136-10-1	83.5	12+347	24m Lt.
136-10-2	84.4	12+347	3m Rt.
136-10-3	83.0	12+347	30m Rt.
136-11-1	83.3	12+675	25m Lt.
136-11-2	84.8	12+675	3m Rt.
136-11-3	84.5	12+675	32m Rt.
136-12-1	83.0	12+885	36m Lt.
136-12-2	84.5	12+885	3m Rt.
136-12-3	83.7	12+885	26m Rt.
136-13-1	82.5	13+085	32m Lt.
136-13-2	83.7	13+085	3m Lt.
136-13-3	82.8	13+085	47m Rt.

PLATE  
C4-10

ULTIMATE PHASE  
STA. 11+750 TO STA. 13+250

QUEEN ELIZABETH WAY  
PRELIMINARY DESIGN STUDY  
W.P. 80-76-00

LEGEND

- FLOODPLAIN LINE
- FILL LINE
- EXISTING PROPERTY
- PROPOSED CAH
- PROPERTY ACQUISITION



SCALE  
40m 0 80m  
METRES

REGIONAL MUNICIPALITY OF  
NIAGARA  
TOWN OF GRIMSBY  
GEO. TWP. OF N. GRIMSBY

LAKE ONTARIO

LOT 15

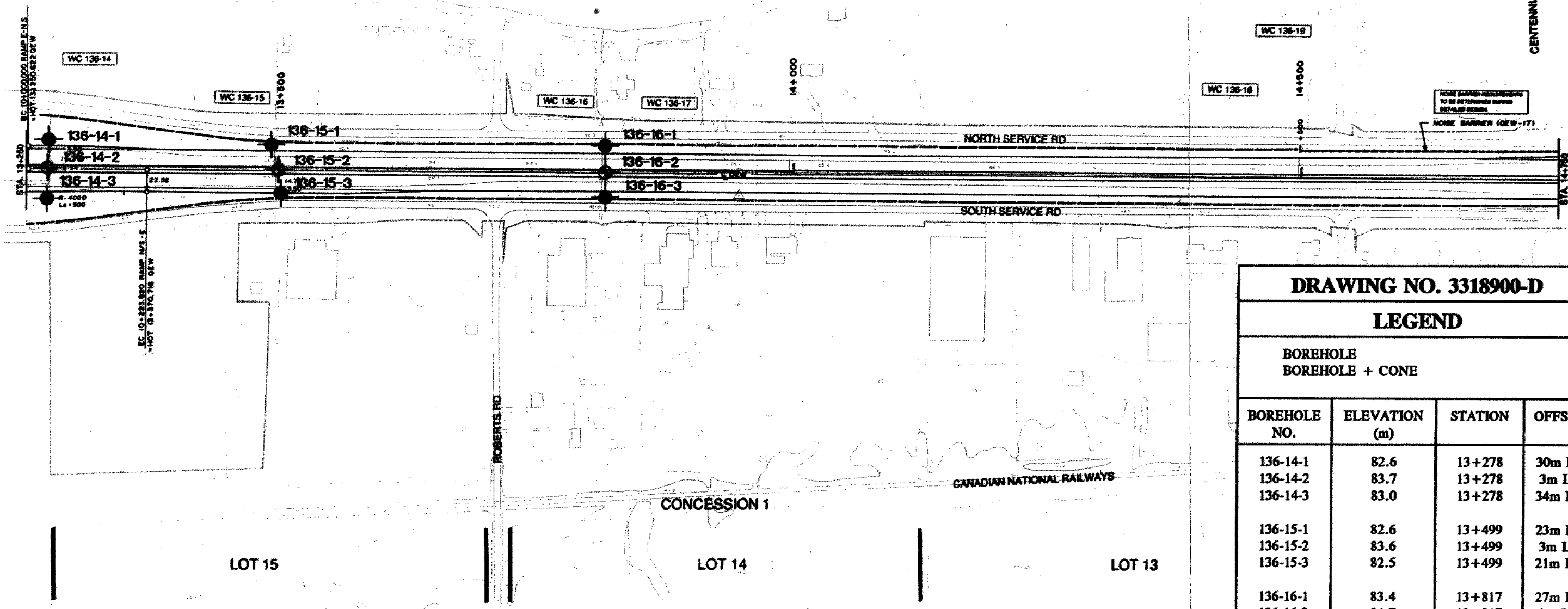
LOT 14

LOT 13

LOT 12

CONCESSION 1

CENTENNIAL DR

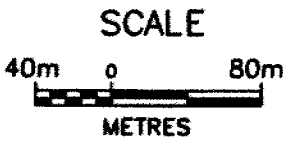


DRAWING NO. 3318900-D

LEGEND

BOREHOLE  
BOREHOLE + CONE

BOREHOLE NO.	ELEVATION (m)	STATION	OFFSET
136-14-1	82.6	13+278	30m Lt.
136-14-2	83.7	13+278	3m Lt.
136-14-3	83.0	13+278	34m Rt.
136-15-1	82.6	13+499	23m Lt.
136-15-2	83.6	13+499	3m Lt.
136-15-3	82.5	13+499	21m Rt.
136-16-1	83.4	13+817	27m Lt.
136-16-2	84.7	13+817	3m Lt.
136-16-3	83.2	13+817	29m Rt.



LEGEND

- FLOODPLAIN LINE
- FILL LINE
- EXISTING PROPERTY
- PROPOSED CAH
- PROPERTY ACQUISITION

QUEEN ELIZABETH WAY  
PRELIMINARY DESIGN STUDY  
W.P. 80-76-00

ULTIMATE PHASE  
STA. 13+250 TO STA. 14+750

PLATE  
C4-11

REGIONAL MUNICIPALITY OF  
NIAGARA  
TOWN OF LINCOLN  
GEO. TWP. OF LOUTH

LOT 19

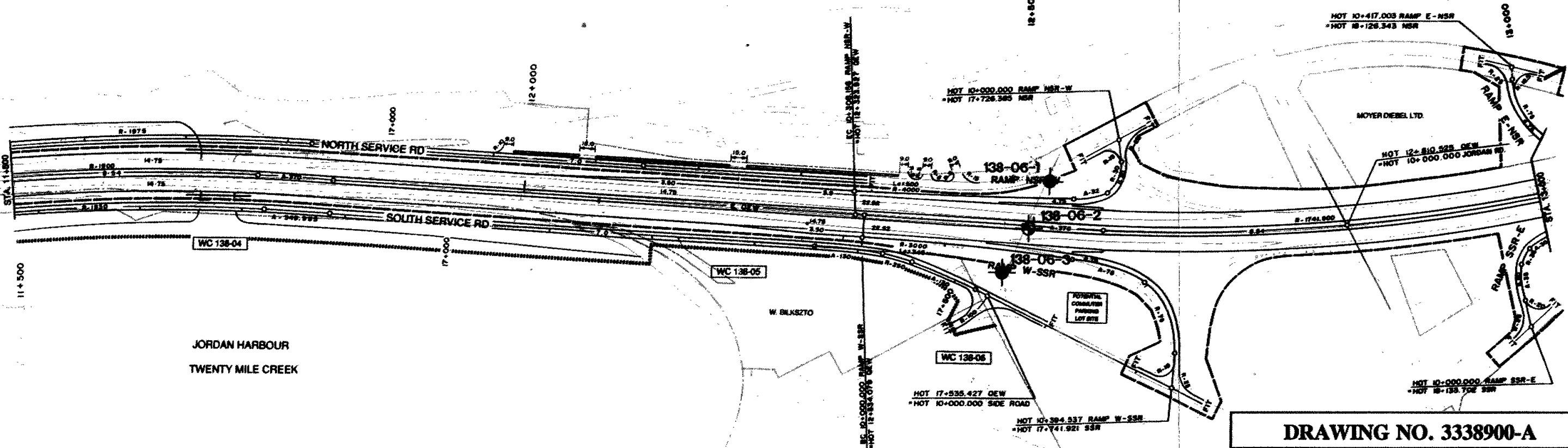
LOT 18

LOT 17

LOT 16

BROKEN FRONT CONCESSION

LAKE ONTARIO

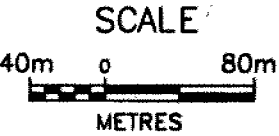


DRAWING NO. 3338900-A

LEGEND

BOREHOLE  
BOREHOLE + CONE

BOREHOLE NO.	ELEVATION (m)	STATION	OFFSET
138-06-1	85.7	12+489	42m Lt.
138-06-2	87.0	12+489	3m Rt.
138-06-3	82.6	12+489	38m Rt.



LEGEND

- FLOODPLAIN LINE
- FILL LINE
- EXISTING PROPERTY
- PROPOSED CAH
- PROPERTY ACQUISITION

QUEEN ELIZABETH WAY  
PRELIMINARY DESIGN STUDY  
W.P. 80-76-00

ULTIMATE PHASE  
STA. 11+500 TO STA. 13+000

PLATE  
C4-23

REGIONAL MUNICIPALITY OF  
NIAGARA

TOWN OF LINCOLN  
GEO. TWP. OF LOUTH

LOT 16

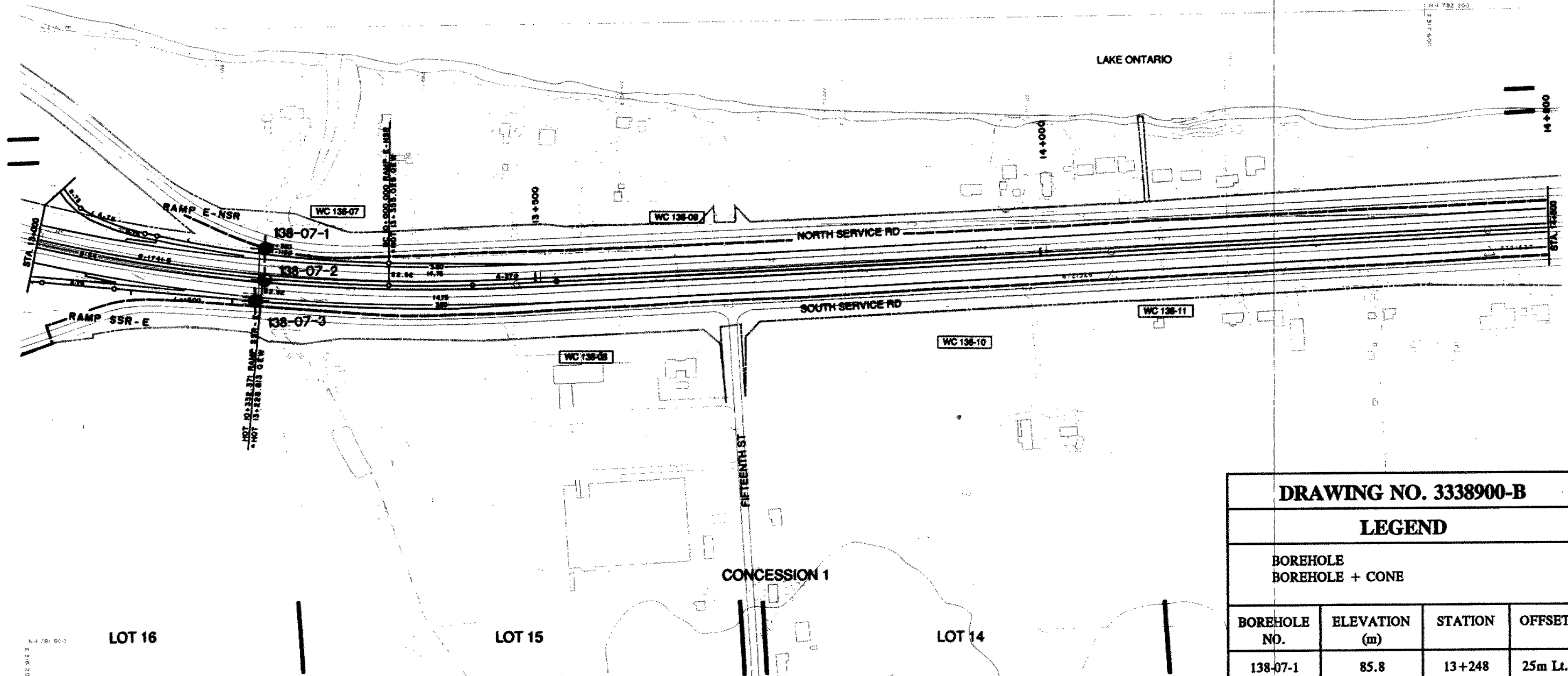
LOT 15

LOT 14

LOT 13

BROKEN FRONT CONCESSION

LAKE ONTARIO



DRAWING NO. 3338900-B

LEGEND

BOREHOLE  
BOREHOLE + CONE

BOREHOLE NO.	ELEVATION (m)	STATION	OFFSET
138-07-1	85.8	13+248	25m Lt.
136-07-2	86.2	13+248	3m Rt.
136-07-3	86.4	13+248	24m Rt.

PLATE  
C4-24

ULTIMATE PHASE  
STA. 13+000 TO STA. 14+500

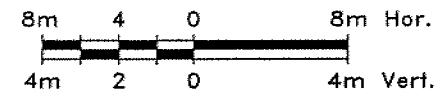
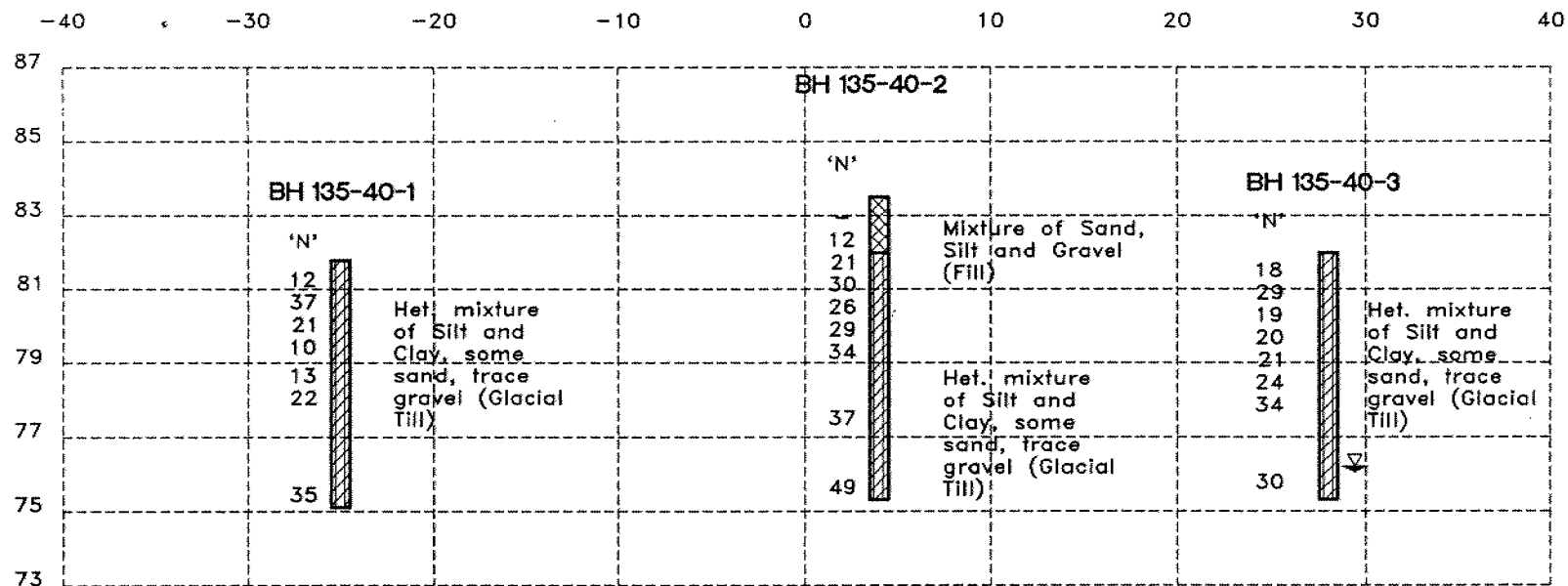
QUEEN ELIZABETH WAY  
PRELIMINARY DESIGN STUDY  
W.P. 80-76-00

LEGEND

- FLOODPLAIN LINE
- FILL LINE
- EXISTING PROPERTY
- PROPOSED CAN
- PROPERTY ACQUISITION



SCALE  
40m 0 80m  
METRES



WC 135-40 - C PROFILE STATION 31+688

Job No.:  
WP 331-89-00

Dwg. No.:  
3318900-E

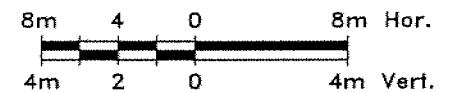
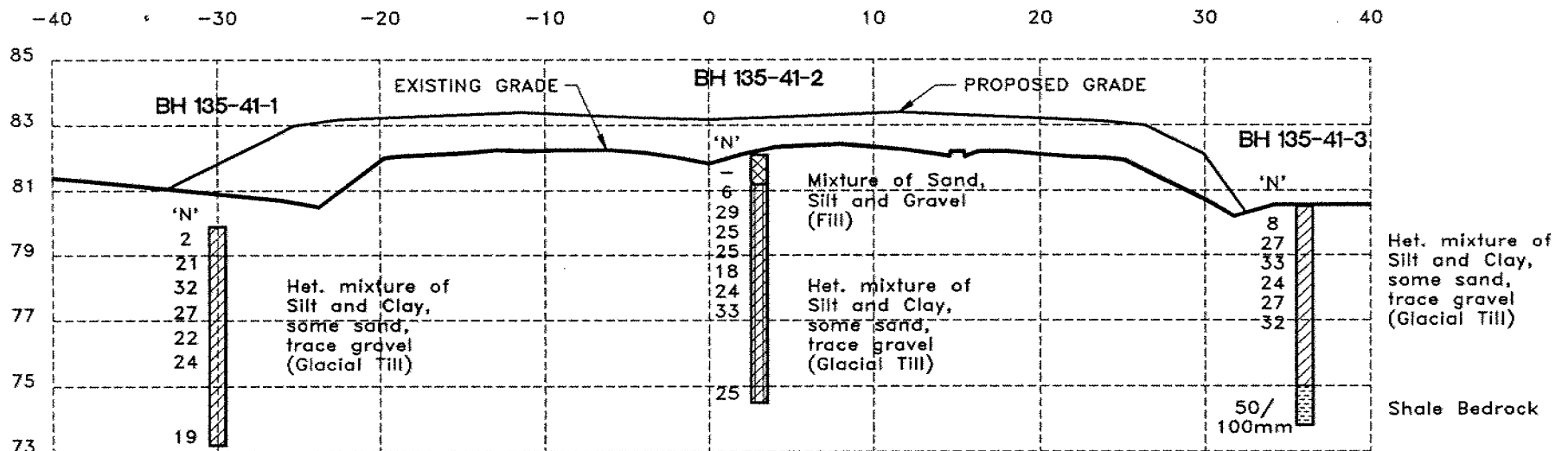
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94/09/06

Dwn. by:  
TA

Appd.:  
TO



Jacques  
Whitford



WC 135-41 - C PROFILE STATION 32+102

Job No.:  
WP 331-89-00

Dwg. No.:  
3318900-F

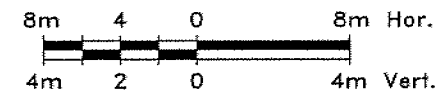
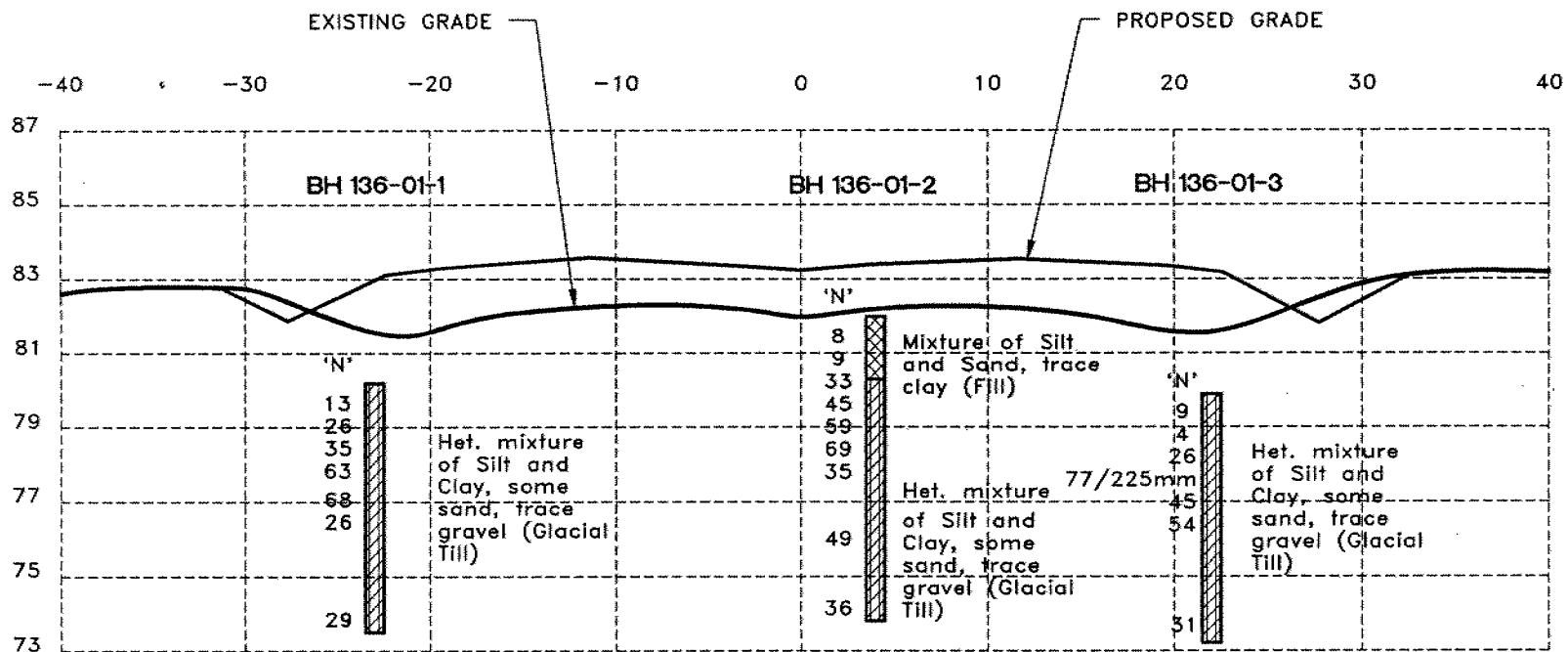
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Jacques  
Whitford



WC 136-01 -  $\zeta$  PROFILE STATION 10+419

Job No.:  
WP 331-89-00

Dwg. No.:  
3318900-G

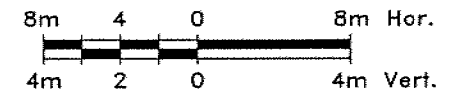
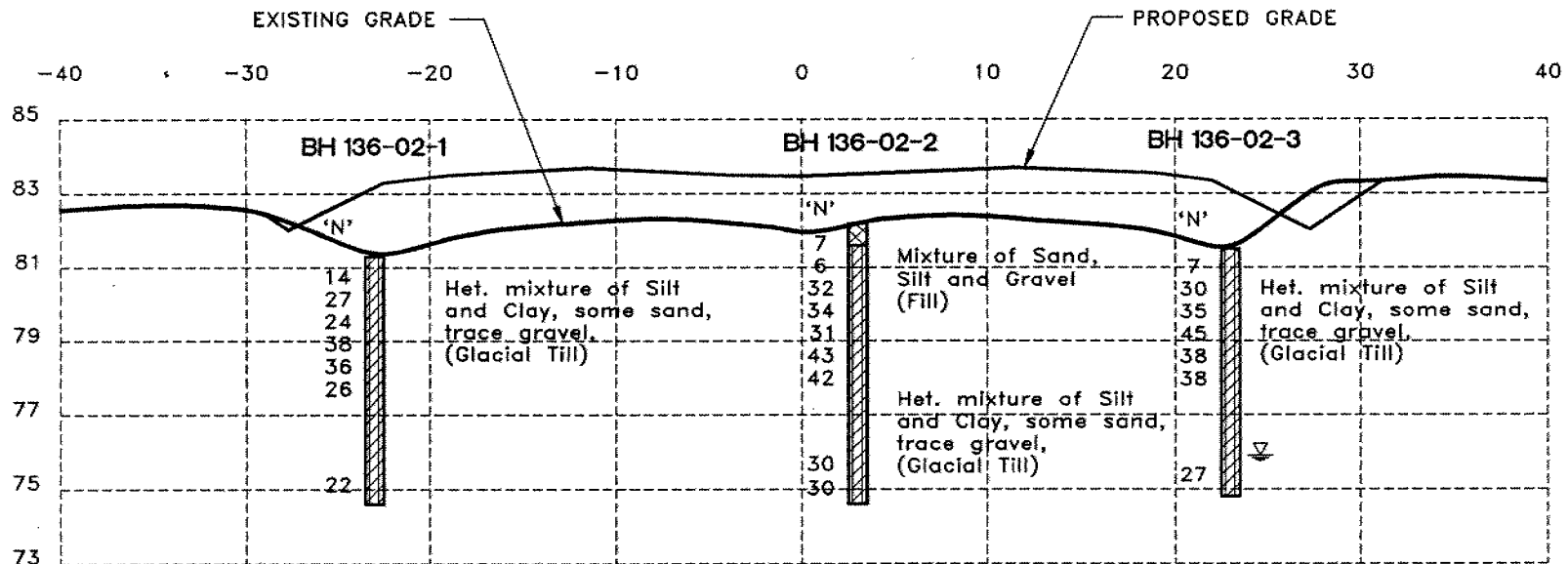
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Jacques  
Whitford



WC 136-02 - C PROFILE STATION 10+622

Job No.:  
WP 331-89-00

Dwg. No.:  
3318900-H

Date:  
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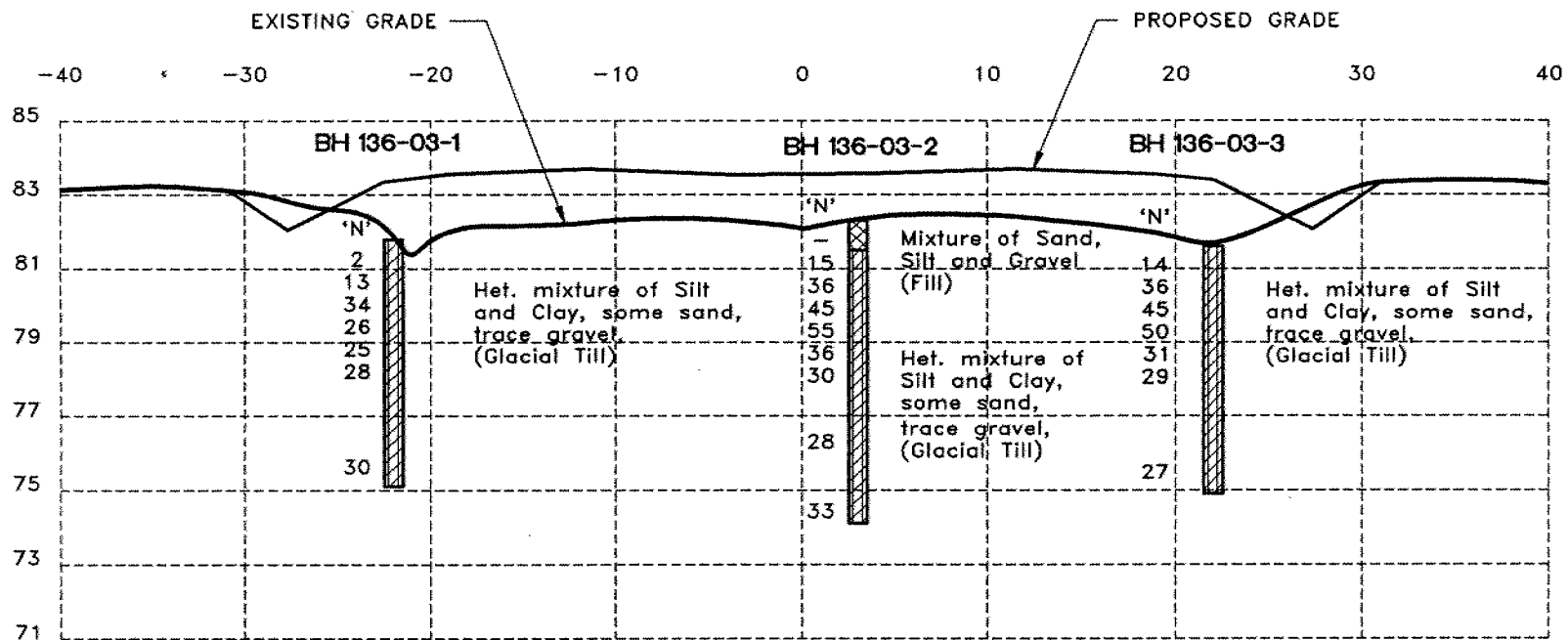
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TO



Jacques  
Whitford





WC 136-03 - C PROFILE STATION 10+825

Job No.:  
WP 331-89-00

Dwg. No.:  
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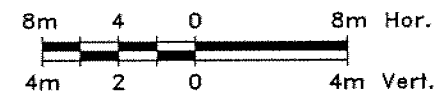
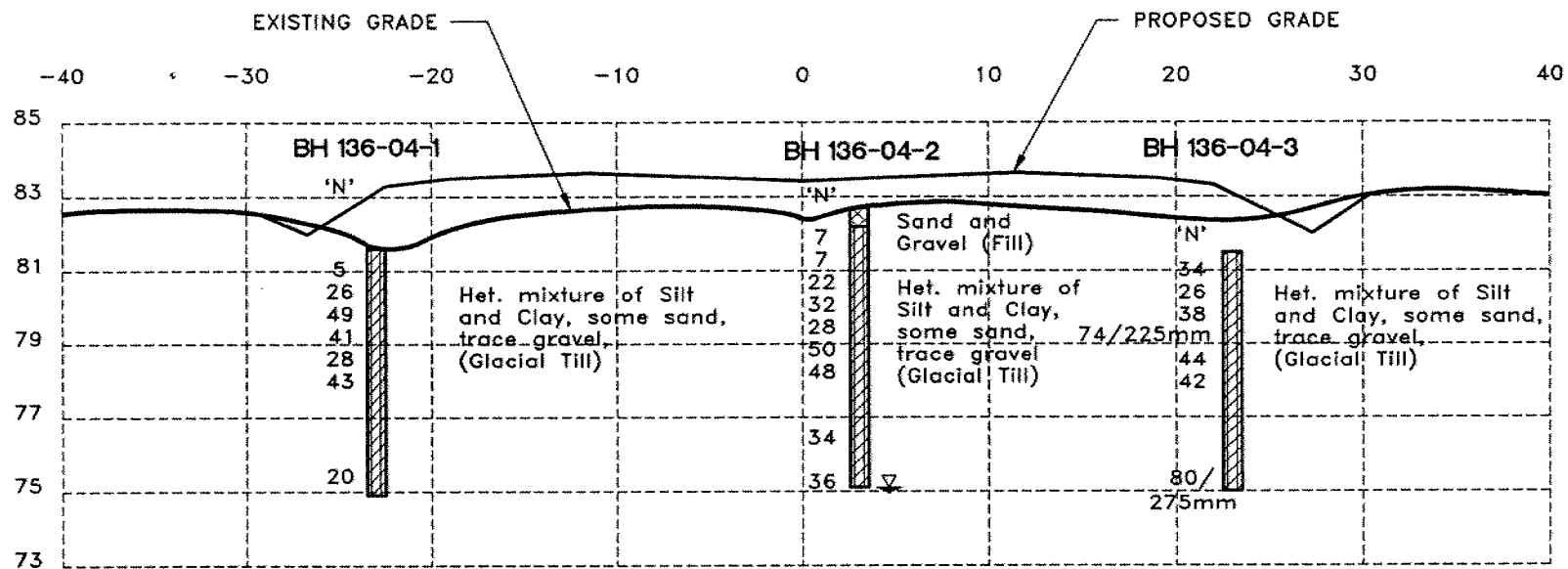
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TA

Appd.:  
TO



Jacques  
Whitford



WC 136-04 - C PROFILE STATION 11+101

Job No.:  
WP 331-89-00

Dwg. No.:  
3318900-J

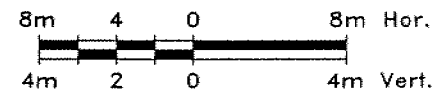
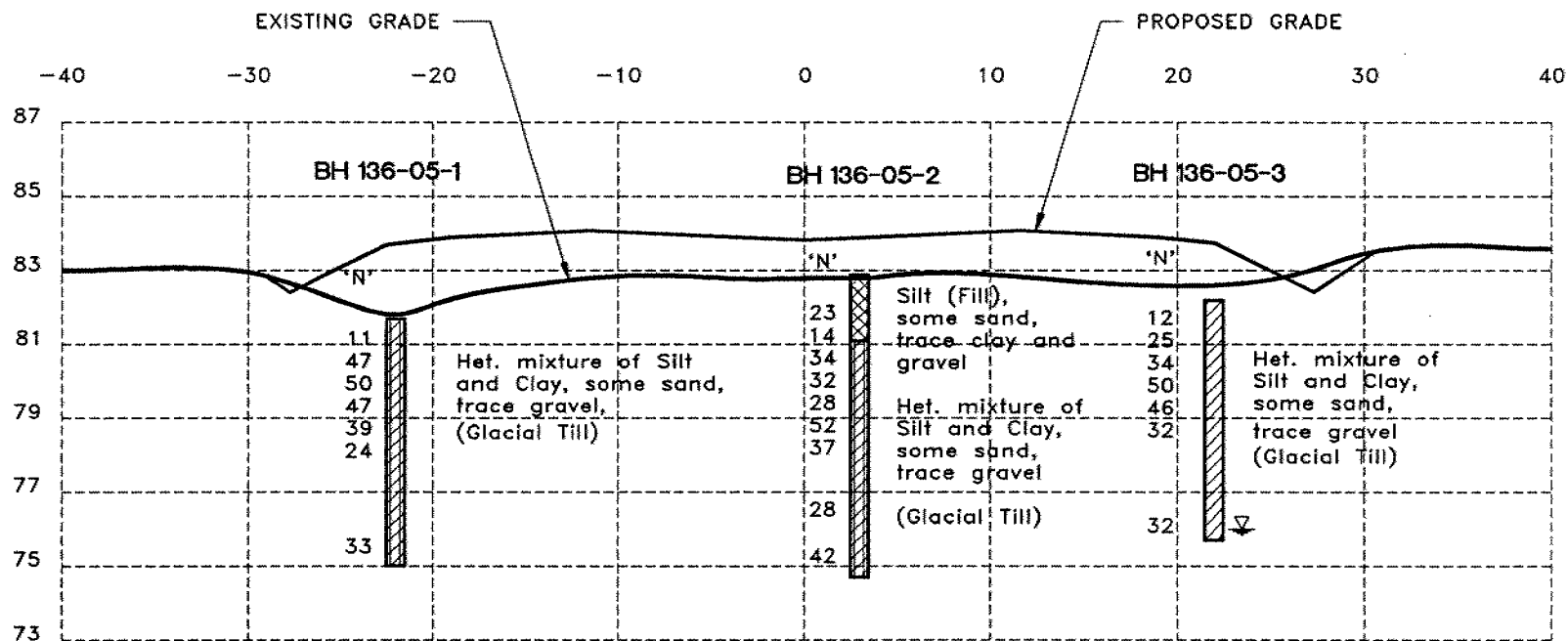
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94/09/06

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TA

Appd.:  
TO



Jacques  
Whitford



WC 136-05 - C PROFILE STATION 11+262

Job No.:  
WP 331-89-00

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3318900-K

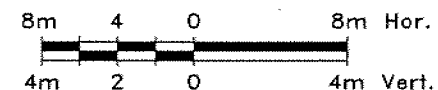
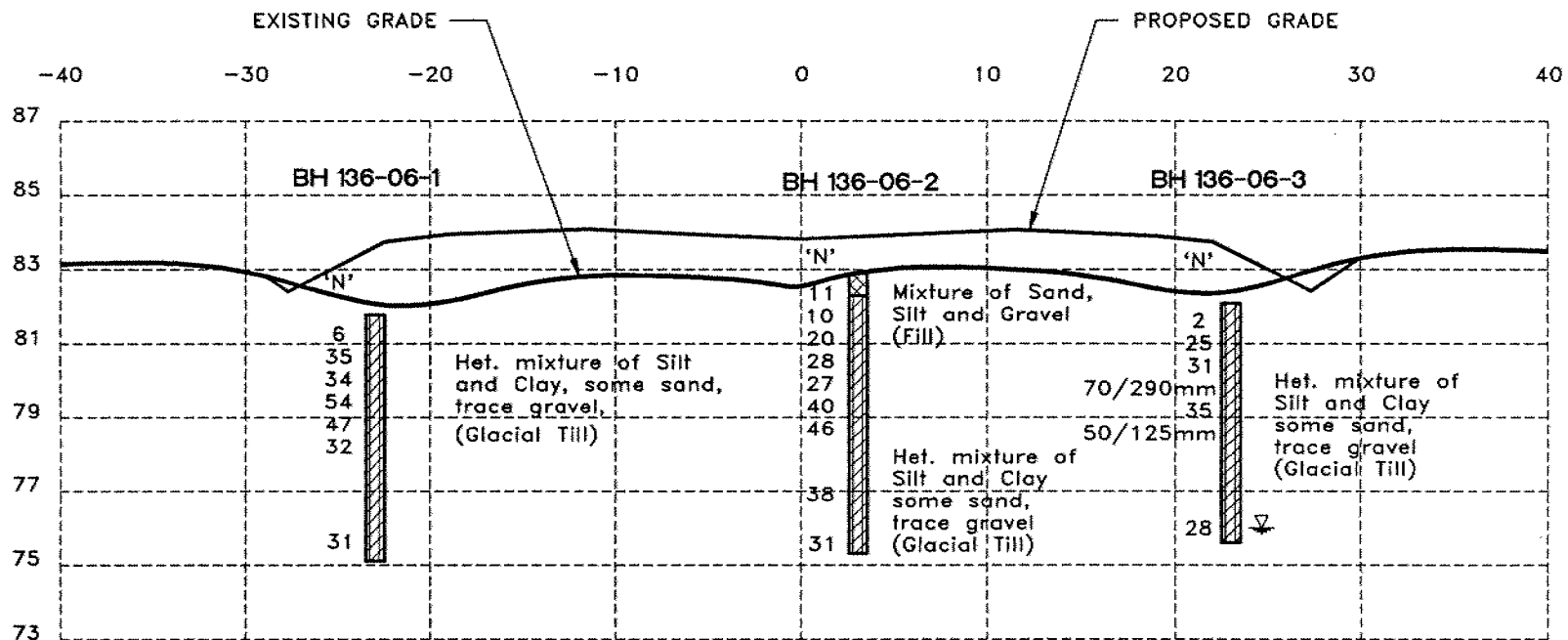
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TA

Appd.:  
TO



Jacques  
Whitford



WC 136-06 - C PROFILE STATION 11+446

Job No.:  
WP 331-89-00

Dwg. No.:  
3318900-L

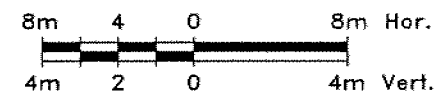
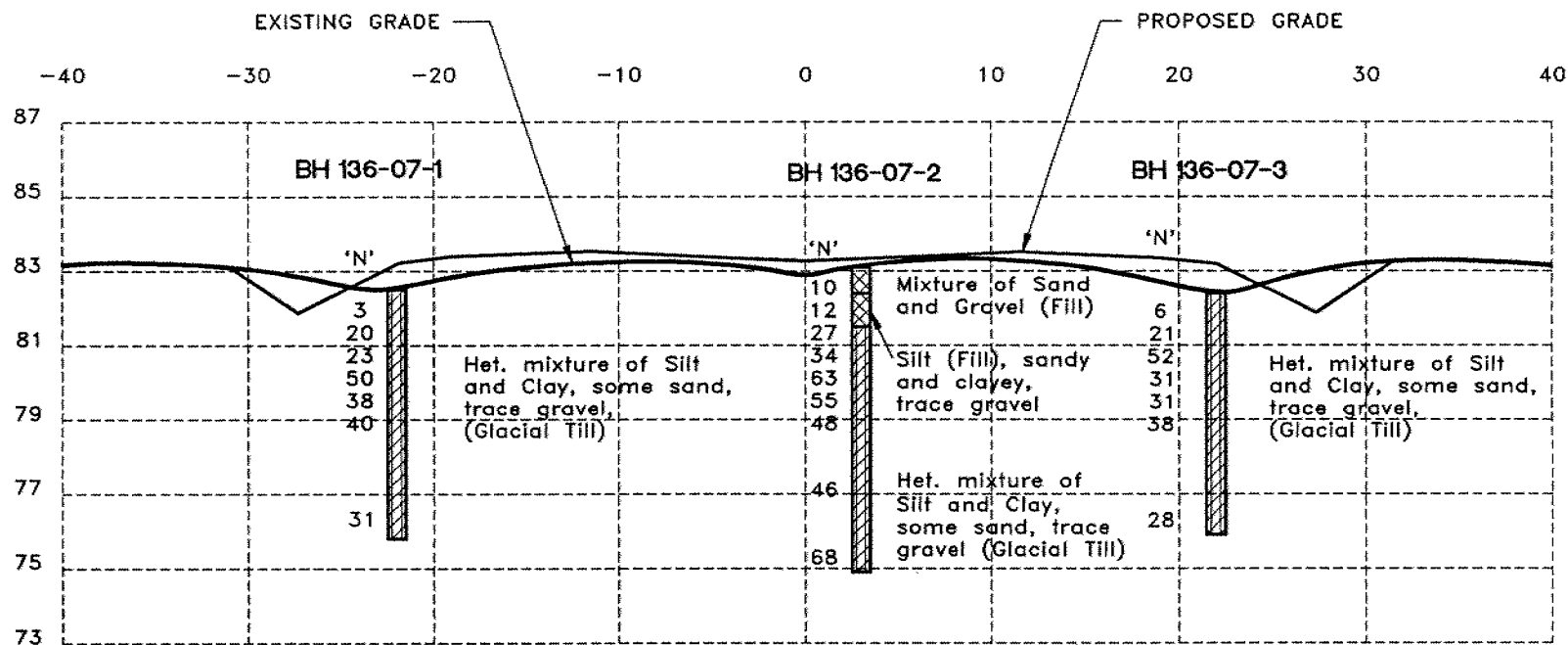
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94/09/06

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TA

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TO



Jacques  
Whitford



WC 136-07 - C PROFILE STATION 11+656

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WP 331-89-00

Dwg. No.:  
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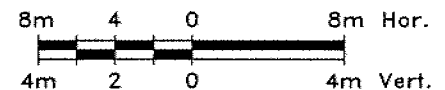
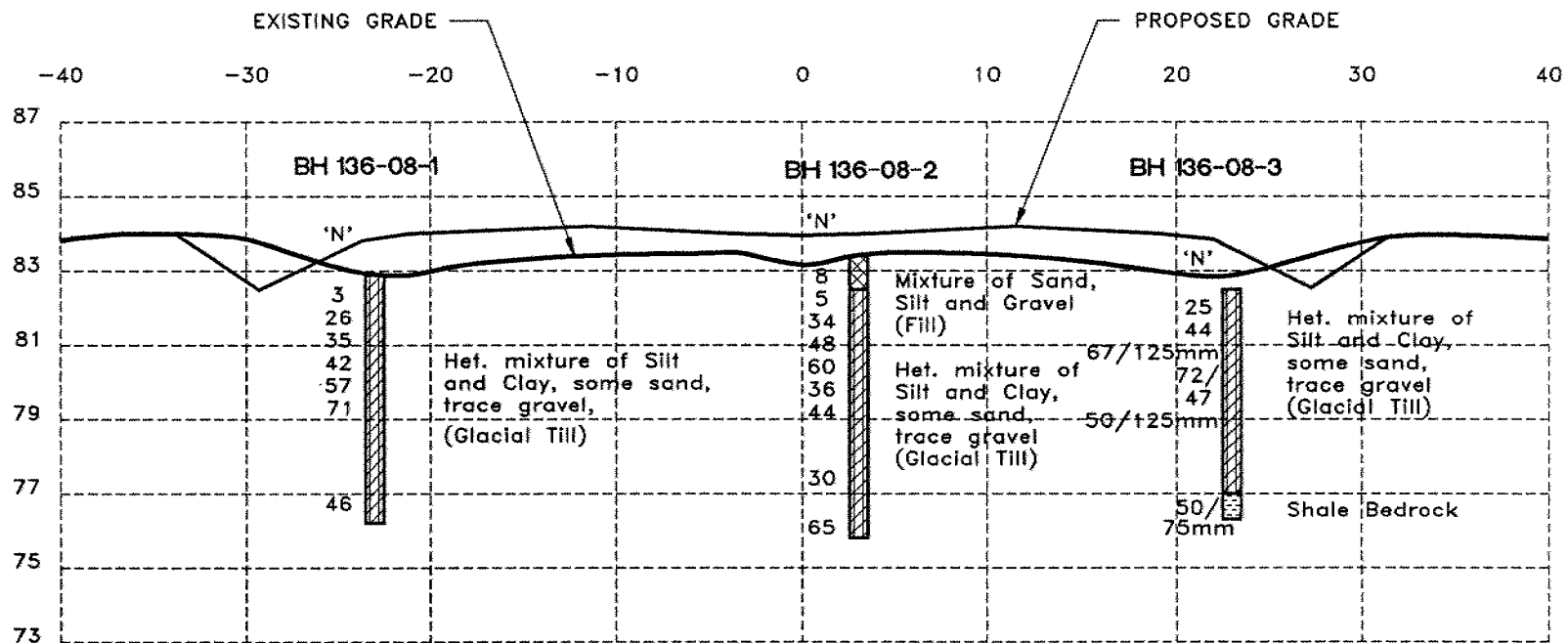
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Appd.:  
TO



Jacques  
Whitford



WC 136-08 - C PROFILE STATION 11+853

Job No.:  
WP 331-89-00

Dwg. No.:  
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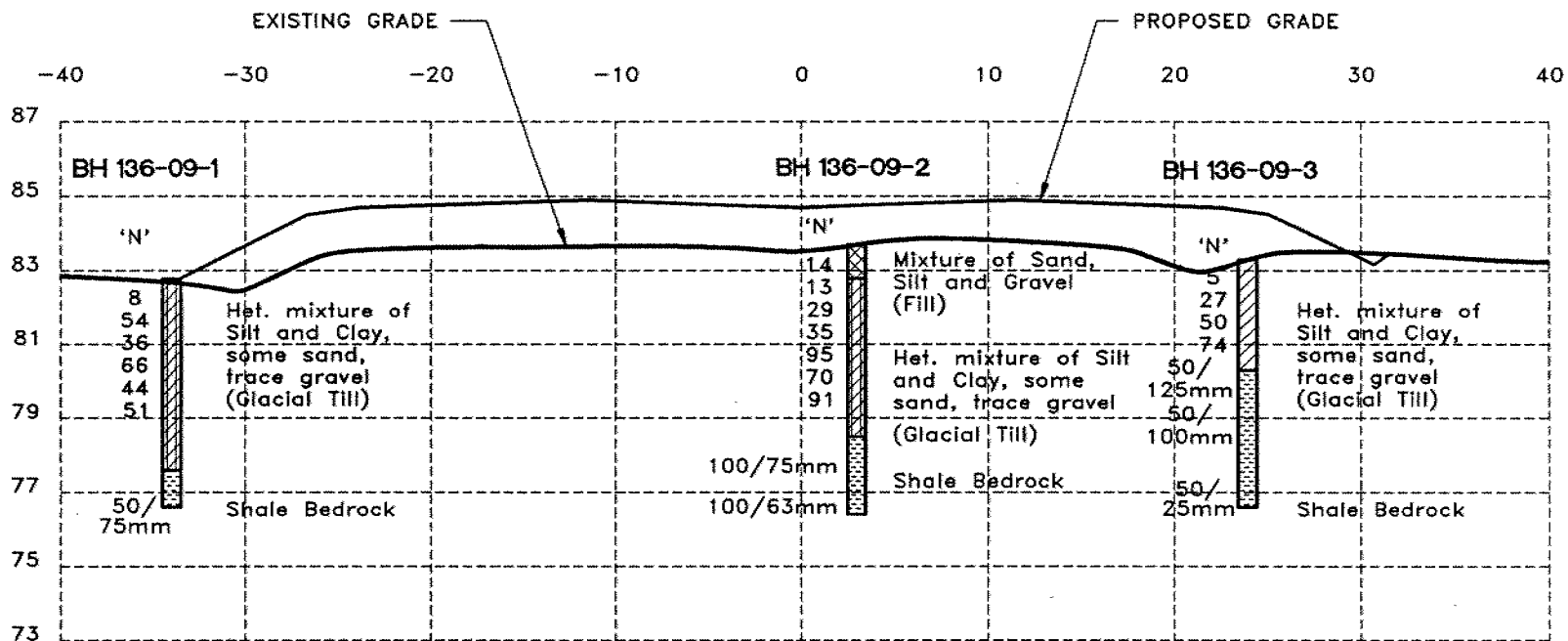
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TA

Appd.:  
TO



Jacques  
Whitford



WC 136-09 - C PROFILE STATION 12+059

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WP 331-89-00

Dwg. No.:  
3318900-O

Date:  
94/09/06

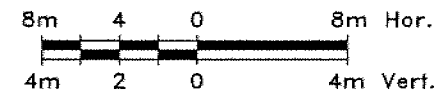
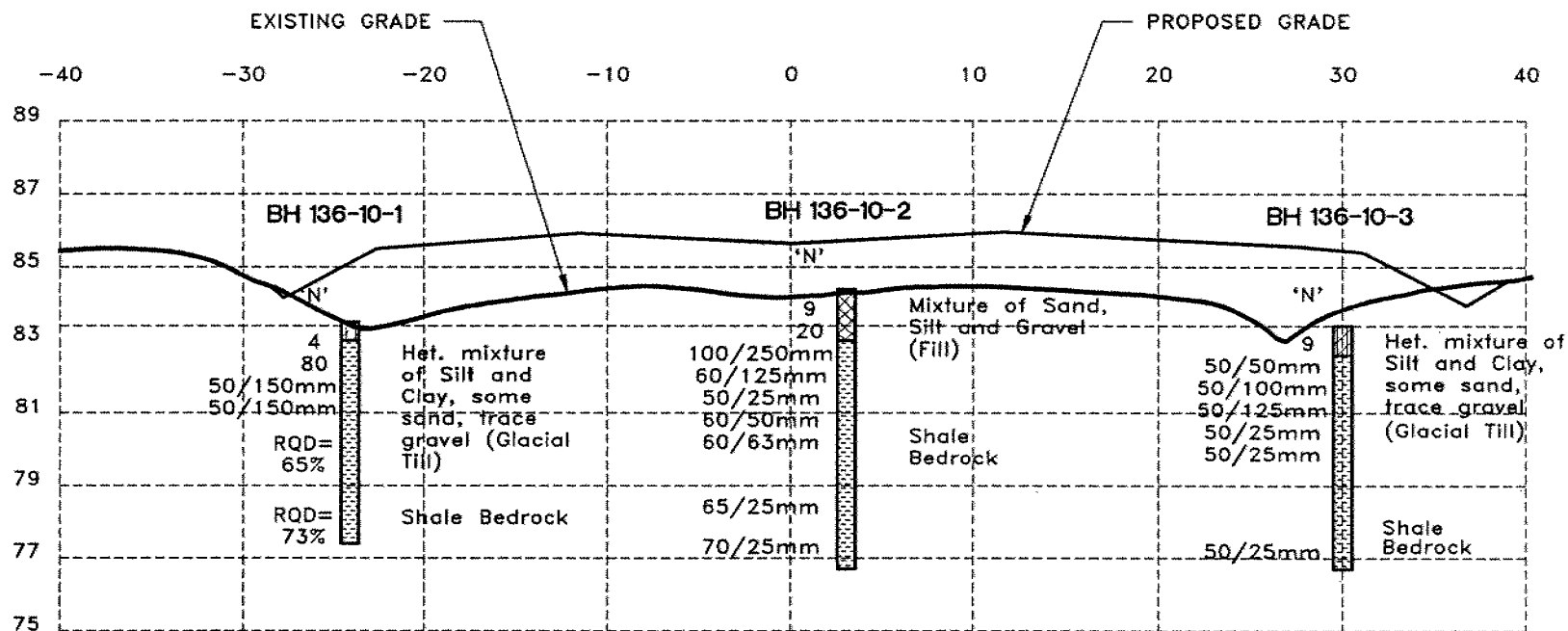
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TO



Jacques  
Whitford

33189000



WC 136-10 - C PROFILE STATION 12+347

Job No.:  
WP 331-89-00

Dwg. No.:  
3318900-P

Date:  
94/09/06

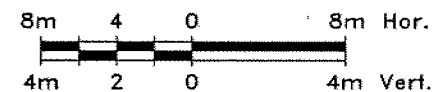
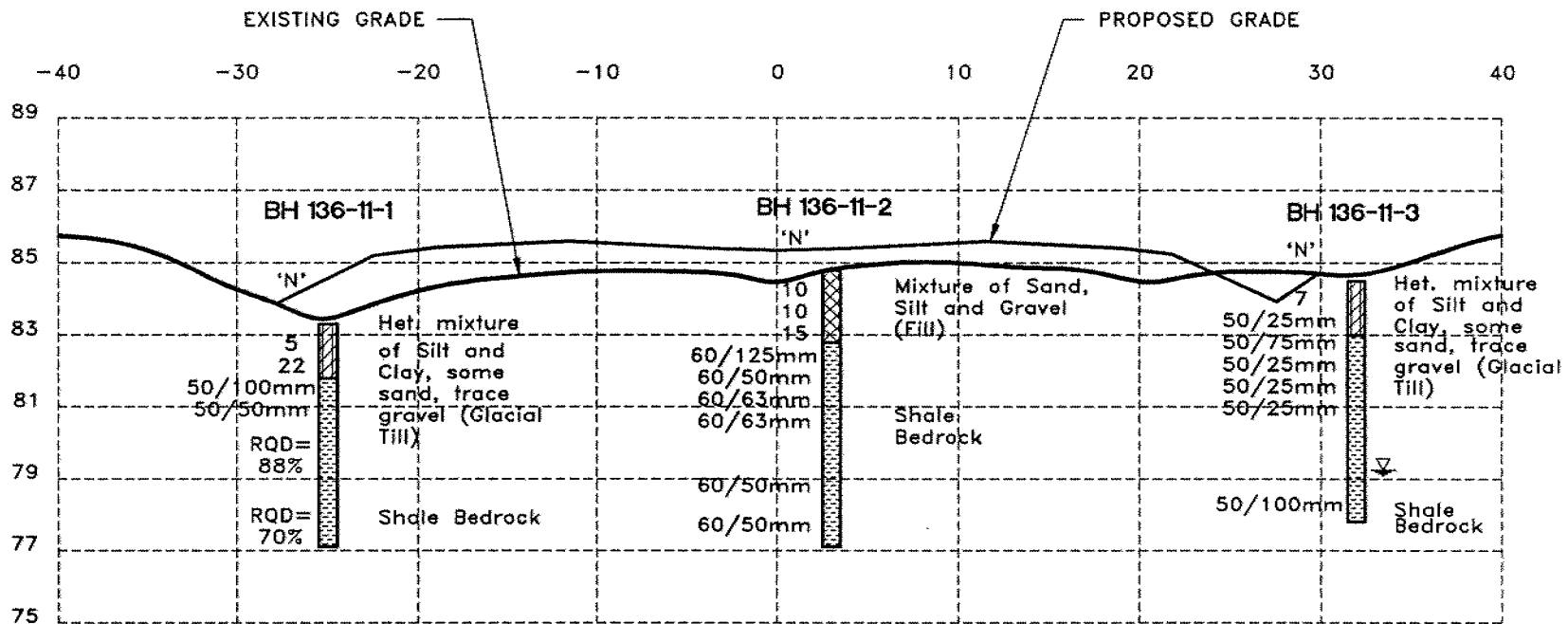
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Appd.:  
TO



Jacques  
Whitford





WC 136-11 - C PROFILE STATION 12+675

Job No.:  
WP 331-89-00

Dwg. No.:  
3318900-0

Date:  
94/09/06

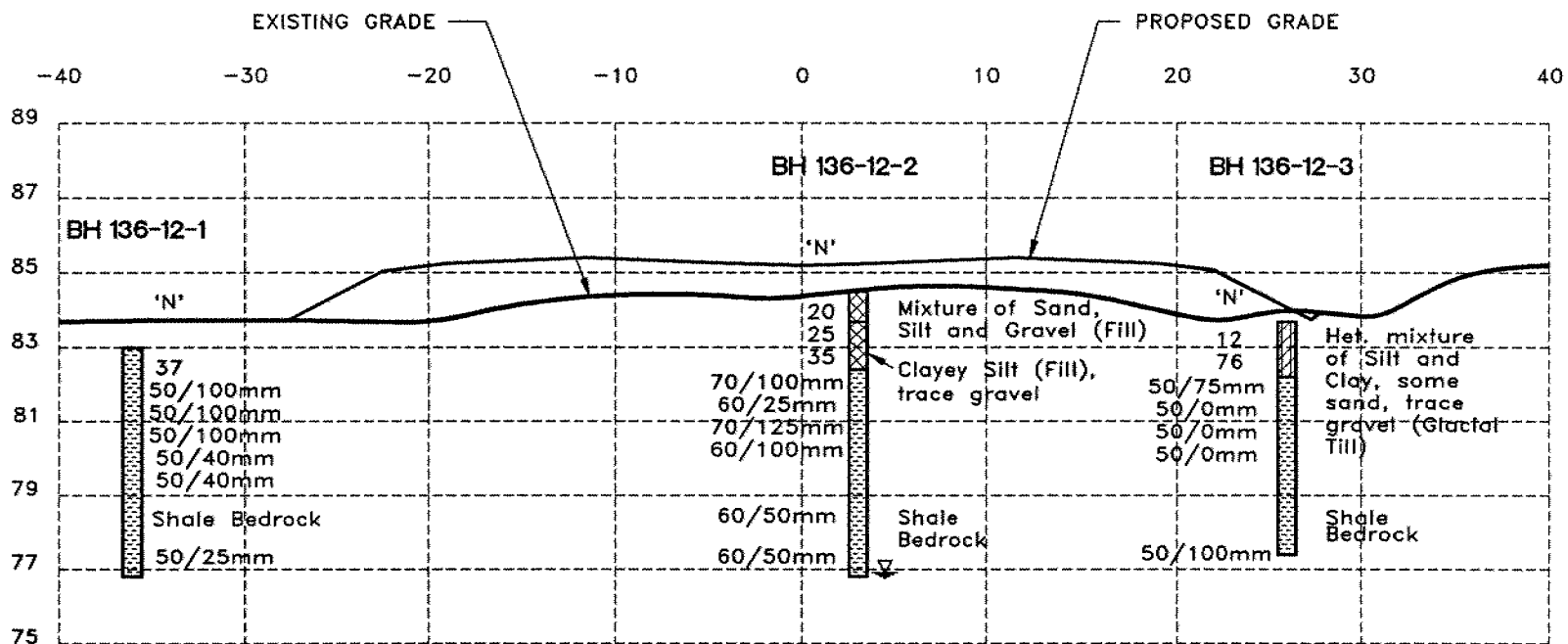
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Appd.:  
TO



Jacques  
Whitford

33189000



WC 136-12 - C PROFILE STATION 12+885

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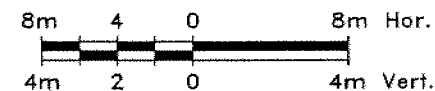
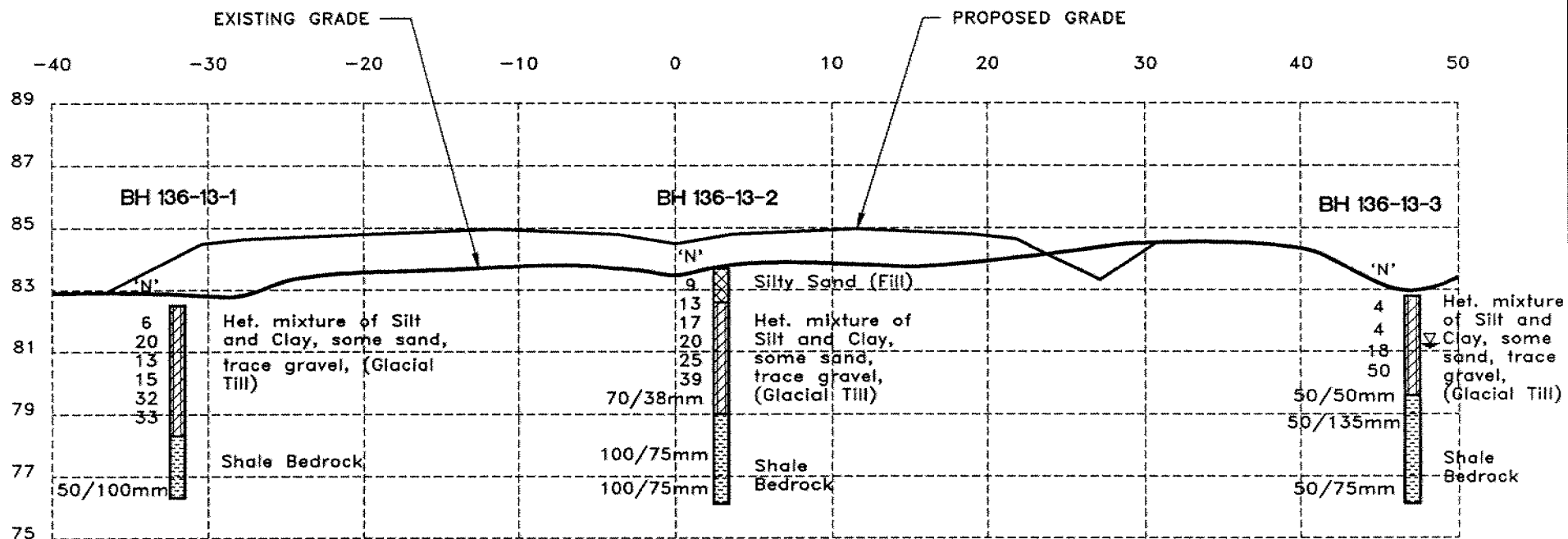
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Dwn. by:  
TA

Appd.:  
TO



Jacques  
Whitford



WC 136-13 - C PROFILE STATION 13+085

Job No.:  
WP 331-89-00

Dwg. No.:  
3318900-S

Date:  
94/09/06

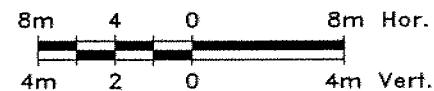
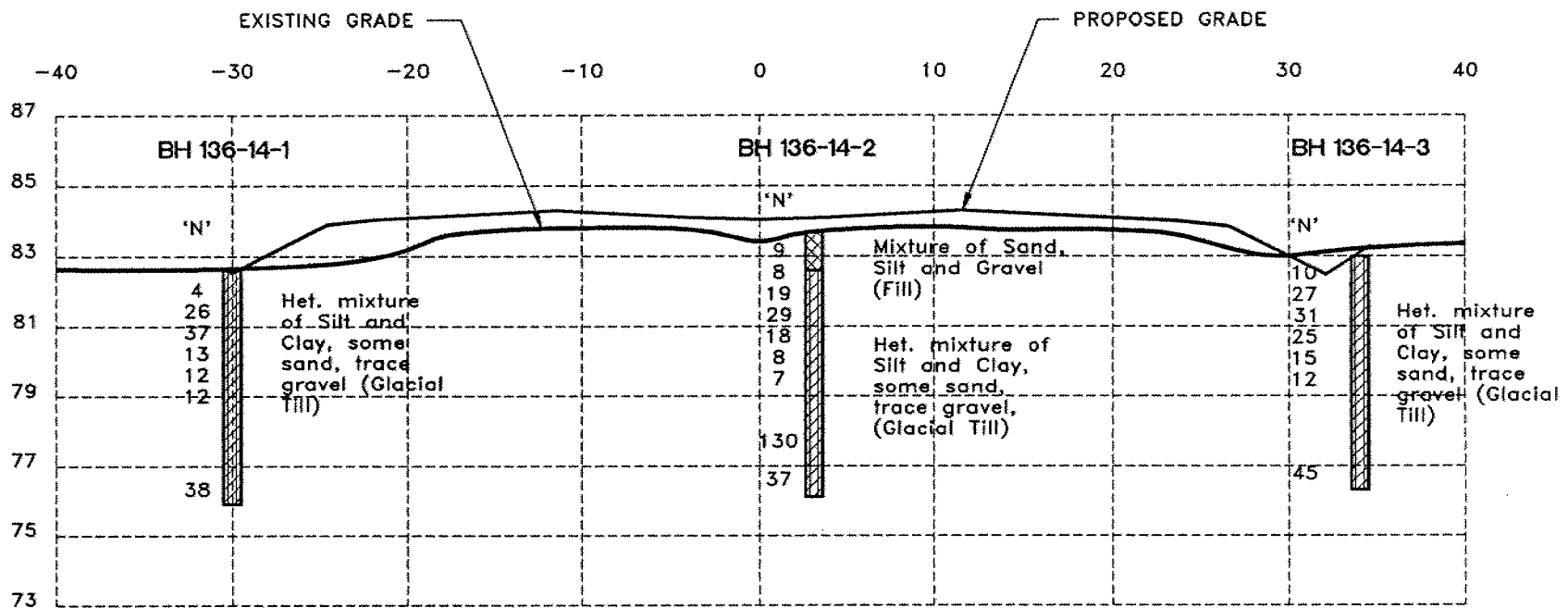
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Appd.:  
TO



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Whitford

3318900S



WC 136-14 - C PROFILE STATION 13+278

Job No.:  
WP 331-89-00

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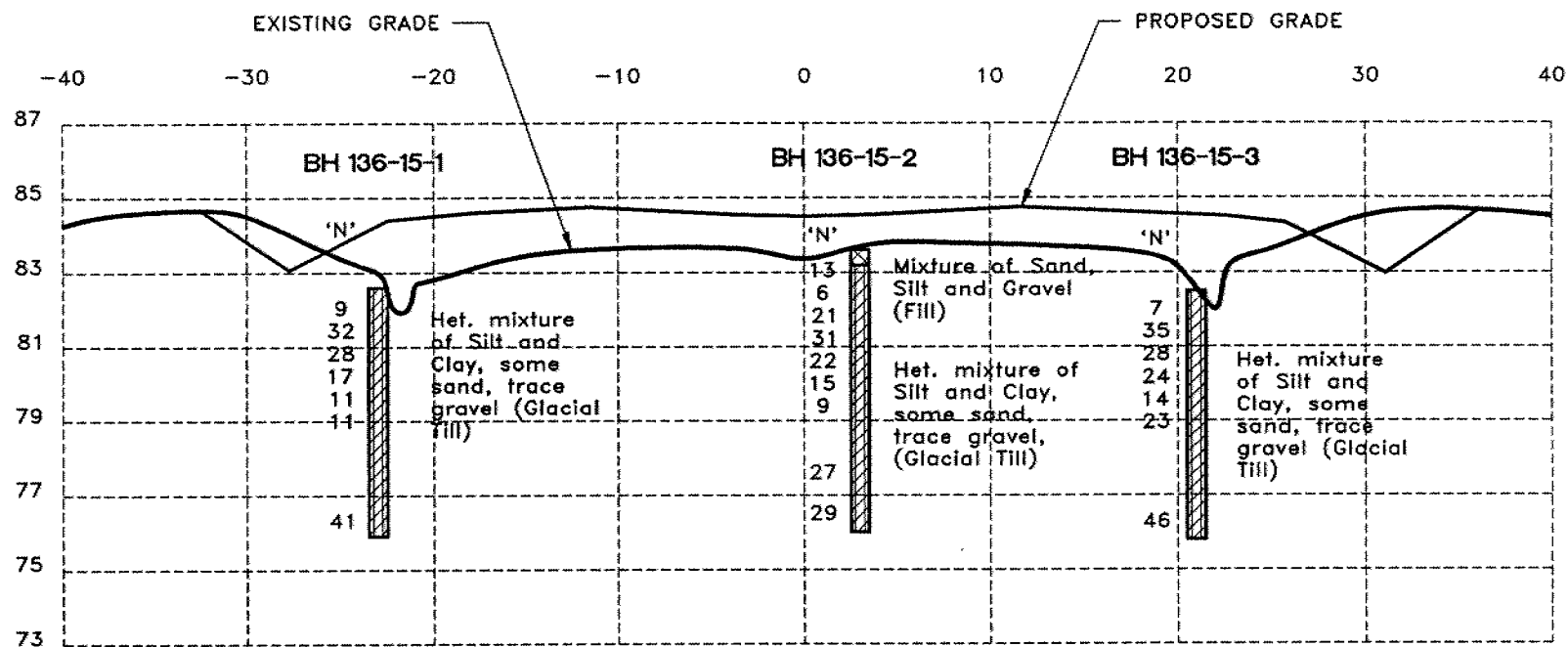
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Appd.:  
TO



Jacques  
Whitford



WC 136-15 -  $\zeta$  PROFILE STATION 13+499

Job No.:  
WP 331-89-00

Dwg. No.:  
3318900-U

Date:  
94/09/06

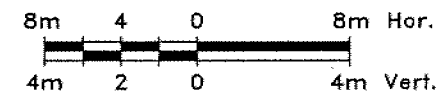
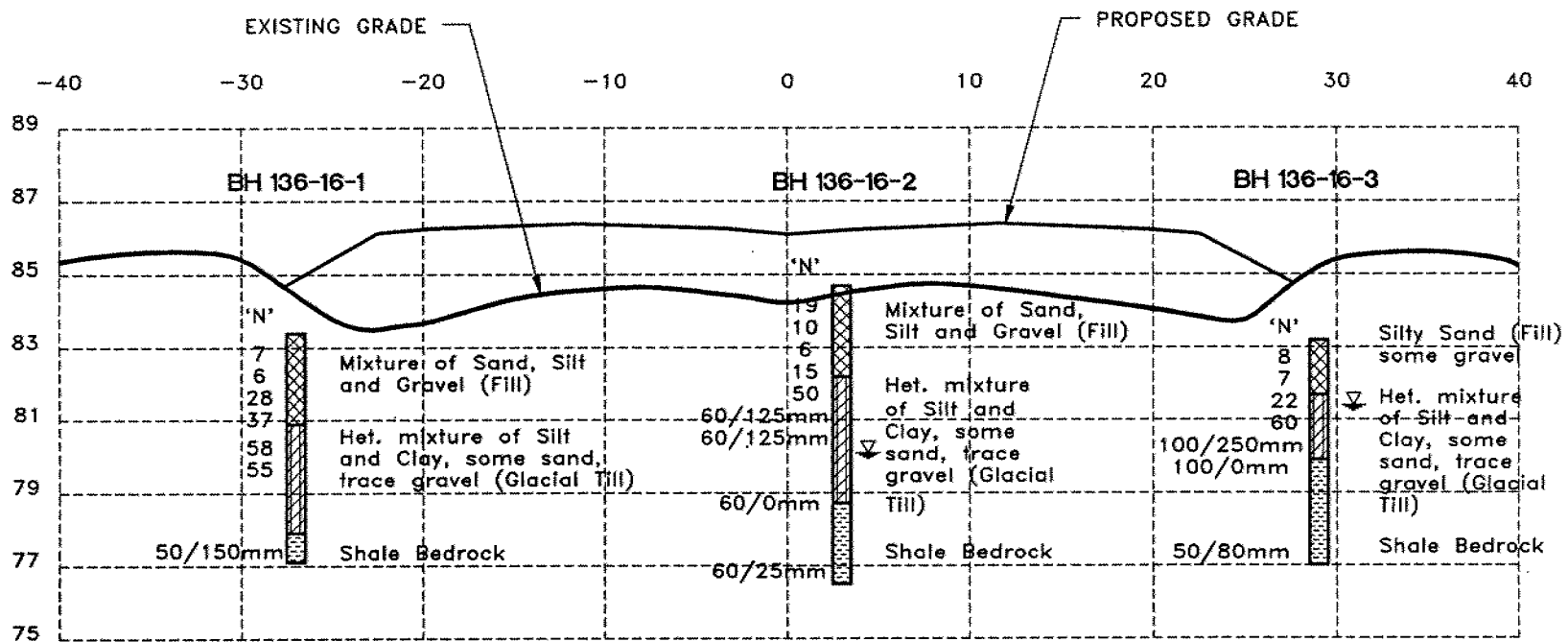
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Appd.:  
TO



Jacques  
Whitford

3318900-U



WC 136-16 - C PROFILE STATION 13+817

Job No.:  
WP 331-89-00

Dwg. No.:  
3318900-V

Date:  
94/09/06

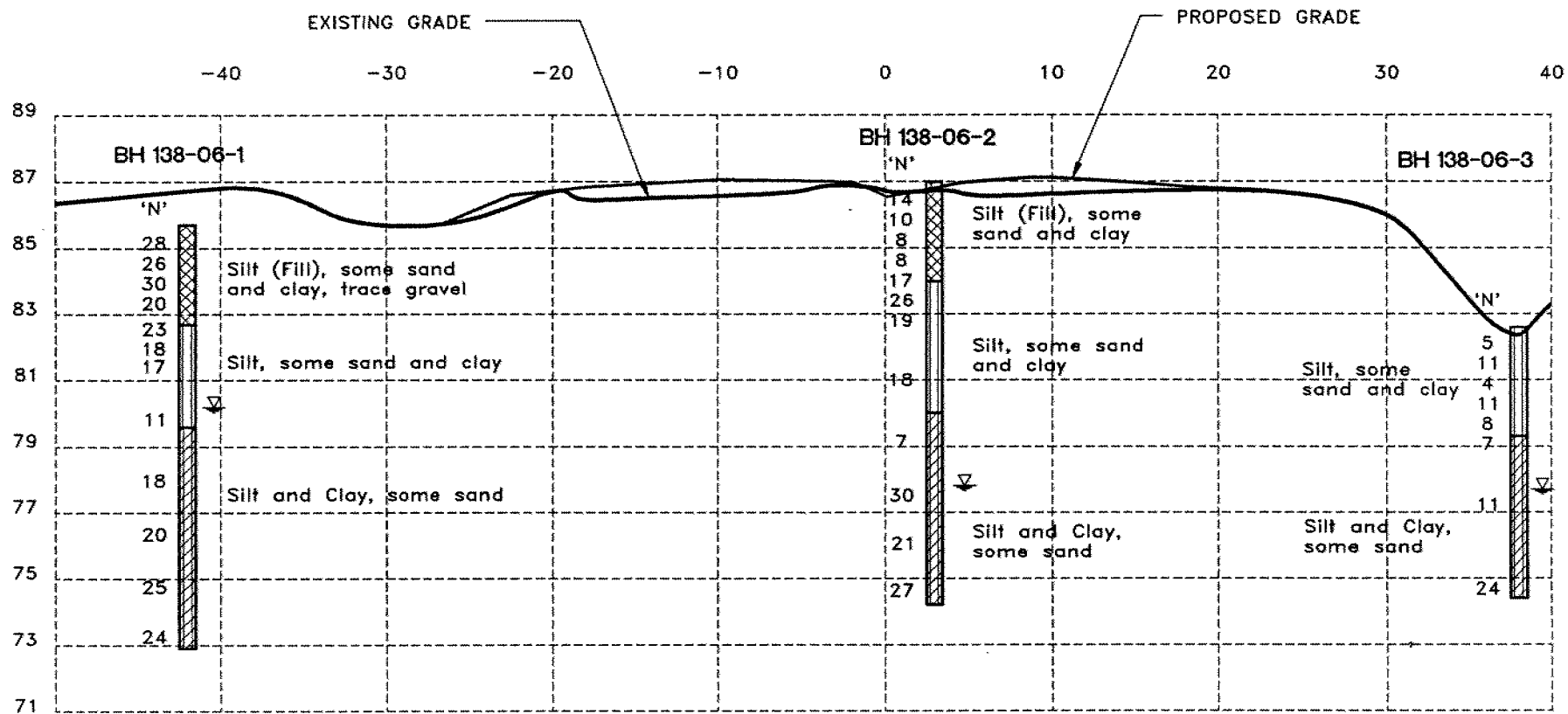
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TA

Appd.:  
TO



Jacques  
Whitford

3318900-V



WC 138-06 - C PROFILE STATION 12+489

Job No.:  
WP 333-89-00

Dwg. No.:  
3338900-C

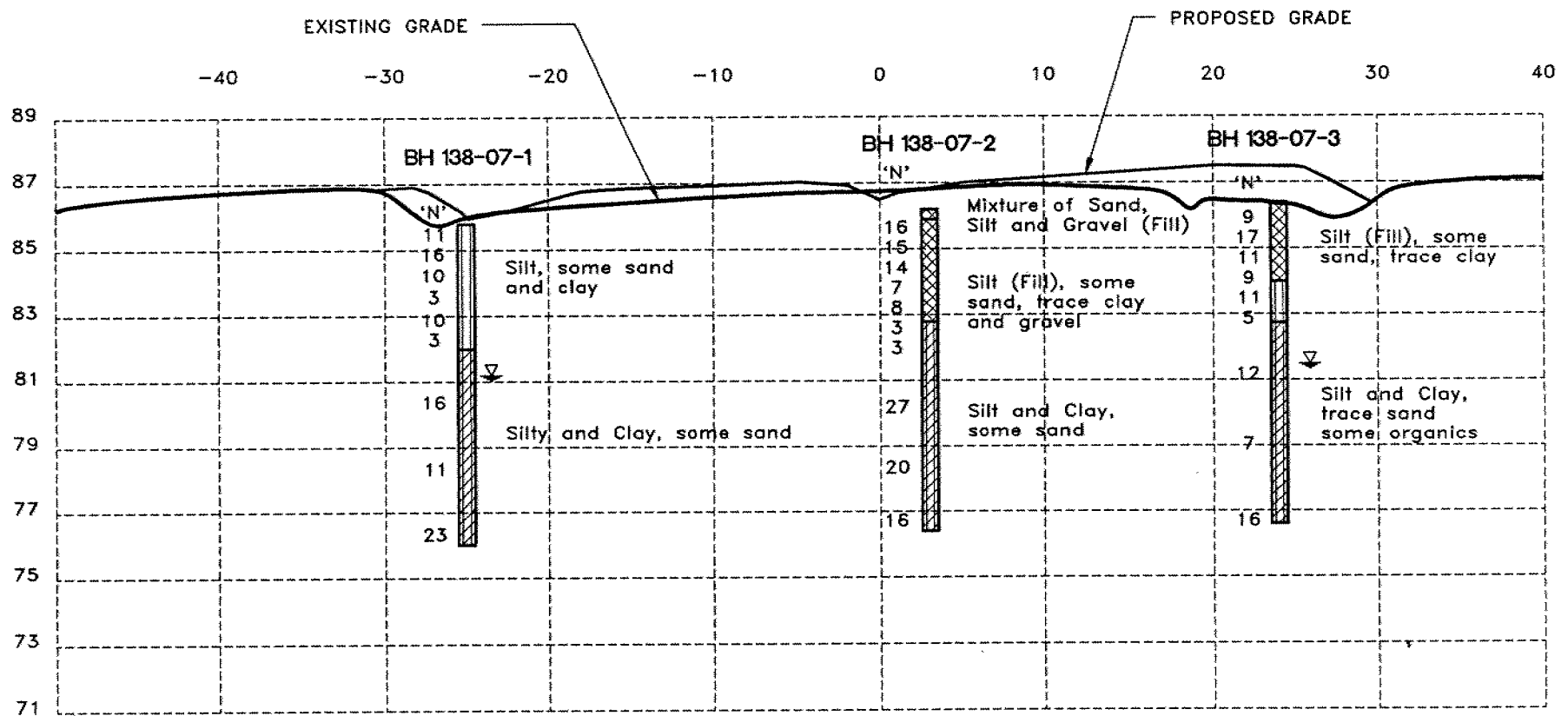
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94/09/06

Dwn. by:  
TA

Appd.:  
TO



Jacques  
Whitford



WC 138-07 -  $\phi$  PROFILE STATION 13+248

Job No.:  
WP 333-89-00

Dwg. No.:  
3338900-D

Date:  
94/09/06

Dwn. by:  
TA

Appd.:  
TO



Jacques  
Whitford



# MEMORANDUM



To: Distribution

Date: September 15, 1994

From: Pavements and Foundations Section  
Room 315, Central Bldg.

Tel: (416) 235-3731  
Fax: (416) 235-5240

Re: Foundation Investigation and Design Report

For

Culvert Replacement

W.P. 331-89-00  
Queen Elizabeth Way  
Fifty Road to Casablanca Boulevard  
Stoney Creek and Grimsby

and

W.P. 333-89-00  
Queen Elizabeth Way  
Jordan Road  
St. Catharines

The Pavements and Foundations Section retained Jacques Whitford Environment Ltd., consulting geotechnical engineers, to carry out a foundation investigation for the above-noted project. The Foundation Investigation and Design Report is forwarded under cover of this memo.

After preparing the consultant agreement, this office provided technical supervision including the establishment of terms of reference and review of the consultant's proposal and the consultant's progress at all stages of the project. The consultant's draft report was reviewed and comments were provided.

The Foundation Investigation (subsurface information) portion of the report was reviewed for format only, and its accuracy and completeness are the responsibility of the consultant. The Foundation Design (recommendation) portion of the report is supplemented by the following.

## 1) Pg 10 Section 5.3.1 Construction Method

For preparation of the bedding for pre-cast concrete box culverts, the native soil below the plan limits of the culvert should be subexcavated to a depth of 0.5m below culvert invert and backfilled with Granular A or HL8 stone to 0.5 above the higher of base of excavation or prevailing groundwater level. That portion of the excavation below prevailing groundwater level should not be dewatered and the backfill below groundwater level should not be compacted. Backfill above prevailing groundwater level should be compacted per OPSS. If necessary, backfill should be regraded to invert elevation after the compaction process.

## 2) Pg 10 Section 5.3.2 Native Soil Support

The unfactored coefficient of friction between concrete and shale bedrock should be 0.40.

3) Pg 11 Section 5.3.3 All Culvert Sites

Requirements for frost cover apply to open footings. It is assumed that the structural design of box culverts is capable of resisting frost pressures and that therefore frost cover is not a consideration for box culverts.

4) Pg 12 Section 5.4 Culvert Backfill

Backfill to culverts below the frost line may consist of suitable embankment material in accordance with OPSD - 803.02.



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