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G.I.-30 SEPT. 1976

GEOCRES No. 31G-196

DIST. 9 REGION           

W.P. No. 24-78-07

CONT. No.           

W. O. No.           

STR. SITE No.           

HWY. No. 43

LOCATION Hwy 43 CURRAN DRAIN  
RELOCATION STA 26+879  
No (EASTS OF CHESTERVILLE)

=====

OVERSIZE DRAWINGS TO BE INCLUDED WITH THIS REPORT.           

REMARKS:



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## FOUNDATION DESIGN SECTION

# foundation investigation and design report

ENGINEERING MATERIALS OFFICE  
FOUNDATION DESIGN SECTION

WP 24-78-07 DIST 9  
HWY 43 STR SITE N/A

Curran Drain Culvert Replacement

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FOUNDATION INVESTIGATION REPORT  
For  
Curran Drain Culvert Replacement  
Hwy. 43  
W.P. 24-78-07, Site N/A  
District 9, Ottawa

INTRODUCTION

This report summarizes the results of a foundation investigation implemented at the aforementioned site. It is proposed to replace the existing reinforced concrete box culvert that has experienced structural distress with another structure at an alignment skew and west of the existing. This report provides recommendations pertaining to the structure foundations and related earthworks.

The fieldwork for the investigation was carried out on 88 08 10 and consisted of two sampled boreholes. The boreholes ranged in depth from 7.8 m to 8.0 m below the existing ground surface and were advanced using hollow stem continuous flight augers. Subsoil samples were retrieved at selected intervals, identified in the field and transported to the laboratory for further visual examination and applicable testing.

SITE DESCRIPTION AND GEOLOGY

The site is located immediately west and adjacent to the existing Hwy. 43 - Curran Drain culvert crossing in the Township of Winchester, County of Dundas. The town of Chesterville is located approximately 4 km west of the site.

The terrain surrounding the site is generally flat and used primarily as farmland. A drainage basin, approximately 6 square kilometres in area is located immediately south of the site.

Physiographically, the area lies in the region known as the Winchester clay plain and consists, as the name implies, of grey, massive, plastic clays. Although the clay plains are dominant, an underlying glacial till is also present and in many places protrudes the clay plain. Bedrock composed of dark grey bedded limestone of the Palaeozoic Era underlies the till deposit at depths

ranging from 20 to 40 metres. The overburden was deposited by a succession of advances and retreats of the Wisconsin ice sheet in the Pleistocene Period.

#### SUBSURFACE CONDITIONS

Subsoil conditions are generally uniform across the site. Underlying the road base and subbase that consists of brown, compact sand and gravel (fill), the native surficial deposit consists of a clay material. This stratum extends for a thickness of 3.8 m to 4.0 m and is in turn underlain by a heterogeneous mixture of clayey silt, sand and gravel (glacial till). The extent of this deposit was not proven in the scope of the investigation.

The boundaries between the various soil types, in situ and laboratory test results as well as stabilized ground water levels, are shown on the attached Record of Borehole Sheets in the Appendix. A plan of the site illustrating the locations of the boreholes and a subsoil stratigraphical section are also provided on Dwg. 247807-A.

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

#### Sand & Gravel (Fill)

The highway roadway base and subbase material consists of a sand and gravel fill material. The fill material which is brown and in a compact state of condition, has a thickness of approximately 0.6 m to 0.8 m and extends from a ground surface elevation of 70.6 m.

#### Clay

Underlying the roadway base exists the native surficial deposit which consists of a grey clay soil of thickness ranging from 3.8 m to 4.0 m. Atterberg Limits were obtained to evaluate the behaviour of this cohesive deposit and the results are plotted in Figure No. 1. The results reveal that this layer is highly plastic and hence compressible. The natural moisture contents are also high and in the order of 40 percent, hence contributing to the highly plastic nature of

the soil. Grain size distribution curves are also plotted for this stratum on Figure No. 2 and are illustrative of high clay contents (40-50 percent range) inherent of highly plastic soils.

The consistency of the soil as determined by 'N' values obtained from the standard penetration test (ASTM D1586) varies from firm to stiff.

#### Heterogeneous mixture of Clayey Silt, Sand and Gravel (Glacial Till)

Underlying the highly plastic surficial clay layer is an unstratified deposit consisting of a heterogeneous mixture of clayey silt, sand and gravel. The deposit is of glacial origin and the behaviour of the fine grained portion of the till matrix was evaluated by performing Atterberg Limit tests and visual examination. The results reveal that the soil generally exhibits a cohesive and low plasticity behaviour. The Atterberg Limit test results are plotted on Figure No. 3. Moisture contents are generally below 10 percent. Grain size distribution curves illustrating the composition of the till deposit are illustrated in Figure 4.

#### GROUNDWATER CONDITIONS

Observation of the groundwater level was carried out by measuring the water level in the open boreholes. Measurements revealed stabilized levels at an elevation ranging from 67.0 m to 67.3 m which is present in the surficial clay layer approximately 0.5 m above the underlying glacial till deposit or equivalent to approximately 3.0 m below the ground surface.

## DISCUSSION AND RECOMMENDATIONS

It is proposed to replace the existing concrete box culvert at the crossing of the Curran Drain and Hwy. 43 with a new structure adjacent and at an alignment skew to the existing structure. The replacement proposal was initiated in response to the identification that the existing culvert had experienced structural distress. Evidence of this distressed state of condition is reflected in pavement settlements and cracking that have developed.

Two alternatives have been proposed for the replacement at the revised alignment:

- 1) A new reinforced concrete box culvert of equivalent size.
- 2) A 3150 x 2007 structural plate horizontal elliptical culvert.

Recommendations for both alternatives are provided in this report. It is understood that the profile grade will be unchanged and hence the embankment height will remain at approximately 1.5 m. Excavation cuts to the depth of the founding elevation of the replacement culvert will be advanced along the same alignment both upstream and downstream of the culvert.

### Alternative 1 - Concrete Box Culvert

#### Foundations

The proposed concrete culvert structure may be founded on spread footings at or below Elev. 68.1 m. The concrete floor should be supported on a 0.5 m thick Granular 'A' pad that extends a minimum of 1 m beyond the plan limits of the culvert and sloped at 1H:1V at the boundary of the excavation. This pad should be placed in the dry and compacted according to the current MTO standards.

For purposes of the O.H.B.D.C., the following design values are recommended for the spread footings designed and constructed in compliance with the aforementioned conditions.

Table 1 - Foundation Recommendations

Footing Elev. (m)	Factored Bearing Capacity at U.L.S. (kPa)	Bearing Capacity at S.L.S. Type II (kPa)
<68.1	115	75

Sliding resistance between the concrete and the foundation soil should be calculated in accordance with Section 6.7.3.3.2 of the O.H.B.D.C. An unfactored adhesion value of 75 kPa can be applied in this computation.

The underside of all footings should be provided with a minimum 1.8 metres of earth cover for frost protection. In addition, to protect the footings against scour, a properly designed rip-rap meeting the hydrological requirements at the site, should be placed at the culvert channel outlet.

#### Settlements

In view of the compressible nature of the surficial native clay stratum, consolidation settlements can be expected as a result of the applied loadings. Based on consolidation test data of similar material in the area, total settlements of approximately 100 mm can be anticipated. Consequently, it is recommended that the culvert be designed with a camber of 150 mm between the mid span and the outlet as illustrated in Figure 5.

#### Backfill to Structure

To prevent hydrostatic pressure build-up, backfill to the culvert walls should consist of Granular 'A' or Granular 'B' with parameters as tabulated in Table 2 below.

Table 2 - Granular Backfill Parameters

	Granular 'A'	Granular 'B'
Angle of Internal Friction ( $\phi$ )	35°	30°
Unit Weight (kN/m <sup>3</sup> ), $\gamma$	22.8	21.2



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

The backfill should be constructed in 300 mm lifts on alternating sides of the culvert so that the maximum differential in backfill heights at no time exceed 300 mm. O.P.S.D. 803 series illustrate the applicable backfill standards and specifications.

#### Stability of Approaches and Cut Slopes

Stability computations using Bishop's Total Stress Analysis revealed that no stability problems are anticipated for the Hwy. 43 approach embankments which are in the order of 2.5 m above the culvert foundations. The granular backfill specified in the previous section and transverse slopes of 2H:1V were used in the analysis.

In addition, an Effective Stress Analysis was implemented to evaluate the stability of the cut at the culvert outlet/inlet. Again no stability problems are anticipated for the permanent slopes excavated at 2H:1V. It is recommended that the cut slopes be protected against surface erosion and scour that can result. Rip-rap complying to hydrological requirements can be used up to the H.W.L.

#### Alternative 2 - Structural Pipe Culvert

##### Foundations

The foundation for the structural pipe culvert can be founded at the elevation recommended for the concrete box culvert (at or below Elev. 68.1 m) and constructed in accordance with the bedding requirements as specified in the O.P.S.D. 802 series. The major items of consideration are summarized below.

- 1) The bedding should consist of a granular 'A' pad with a minimum thickness of 300 mm. The excavation for the bedding should extend to a width of a minimum 1.5 metres on either side of the culvert.
- 2) For the width of the area under the bottom radius of the pipe arch the bed should be levelled and left uncompacted for a depth of 300 mm below the invert level.
- 3) The area adjacent to the haunches of the pipe and under the portion of the sloping invert should be compacted by means of hand tamping.
- 4) The culvert pipe bed is to be carefully shaped to receive the lowest segment of pipe formed by the bottom radius.
- 5) The minimum depth of cover shall be the span of the pipe culvert divided by 6 or 300 mm, whichever is greater.

#### Settlements

The pipe culvert shall be designed with a camber of 150 mm as illustrated in Figure 5. This is to account for the anticipated settlements as mentioned earlier in the concrete box culvert alternative.

#### Backfill to Structure

Backfill for the plate pipe culvert shall be designed and constructed according to O.P.S.D. 803 series. The following items of consideration are hereby reinforced.

- 1) The frost penetration depth at the site is 1.8 m and the frost taper should be designed accordingly.
- 2) The backfill material should be machine compacted on both sides of the pipe simultaneously in equal lifts.

3) To prevent piping around the culvert, a 1 metre thick blanket of approved impermeable material (refer to O.P.S.S. 1205) should be placed at the culvert inlet as a sealer behind a 600 mm layer of rip-rap. This blanket should extend to the high water level. Around the culvert outlet, a 1 metre thick blanket of granular 'A' material should be placed as a filter behind a 600 mm layer of rip-rap.

4) The passive resistance of the granular backfill and any other applicable earth pressure can be calculated using the properties tabulated in Table 2.

#### Stability of Approaches and Cut Slopes

The comments pertaining to the concrete box culvert are equally applicable for the pipe culvert alternative.

#### CONSTRUCTION CONSIDERATIONS - GENERAL

The following comments address general construction considerations that are applicable at the site regardless of the alternative selected.

##### 1. Dewatering

Excavations for footings carried out below the water level prevailing at the time of construction may require dewatering. Due to the relatively impervious nature of the clay subsoil, conventional sump pumping techniques will suffice to adequately dewater the excavation.

To prevent the inflow of water from the drain to the footing excavation, a temporary diversion of the drain will be required. This can be achieved by constructing an impervious earth dam upstream.

##### 2. Stage Construction

Stage construction can be facilitated by two methods.

a) Temporary Slopes

Any scheme applying temporary slopes can be constructed at a slope 1.5H:1V for cuts and/or fills less than 3 metres.

b) Temporary Shoring

A cantilever soldier pile lagging system can be installed. For design purposes, earth pressures are to be computed in accordance with Section 6.6.1.2 of the O.H.B.D.C. using the following parameters.

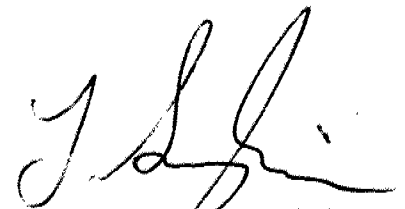
Table 3 - Shoring Design Parameters

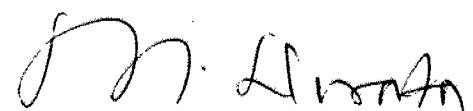
<u>Material</u>	<u><math>\gamma</math> (kN/m<sup>3</sup>)</u>	<u><math>\phi</math></u>	<u><math>C_u</math> (kPa)</u>
Granular 'A'	(See Table 1)		N/A
Granular 'B'	(See Table 1)		N/A
Clay	17	N/A	35
(Glacial Till)	22	N/A	150

MISCELLANEOUS

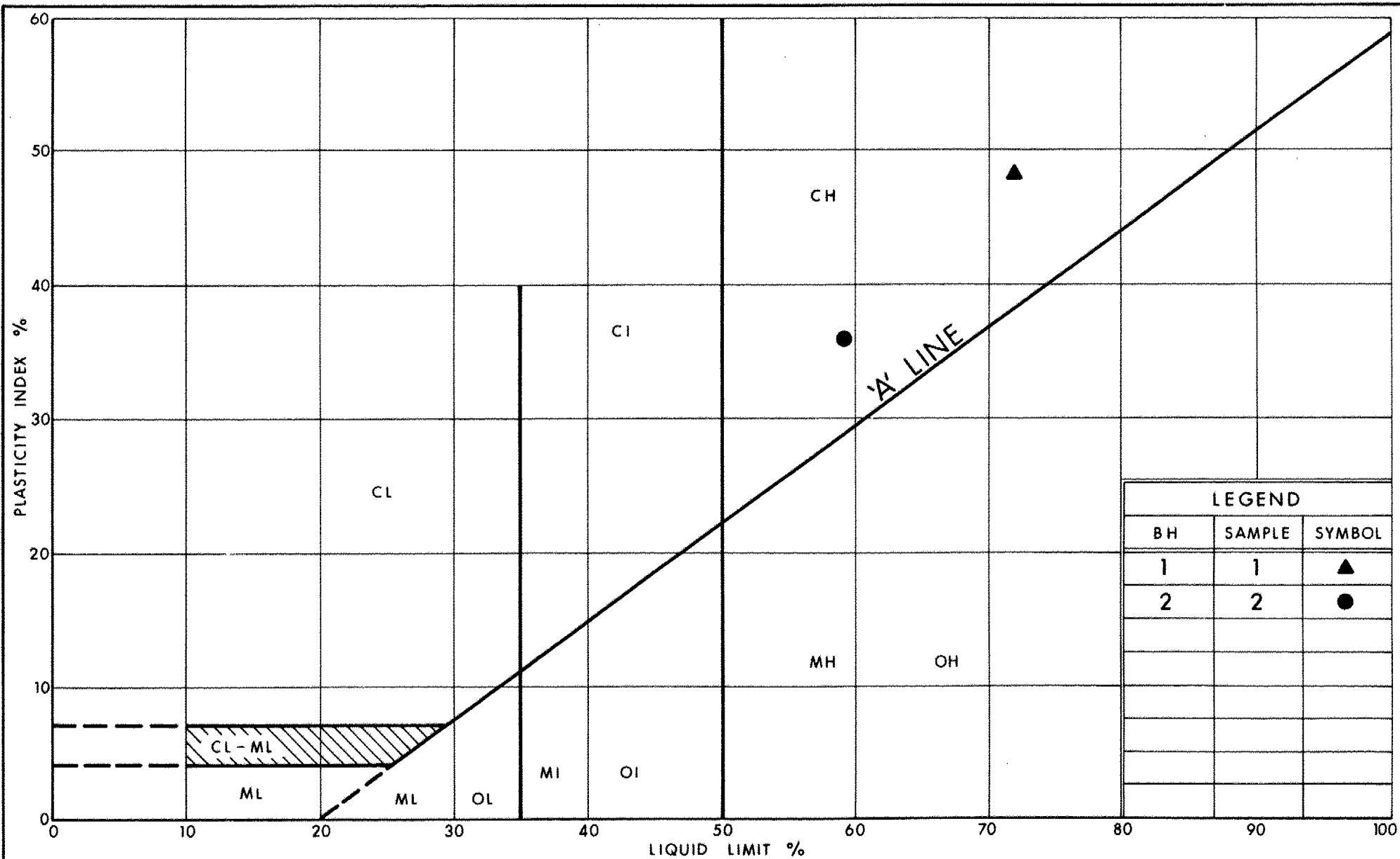
The fieldwork for this investigation was carried out under the supervision of M. Schnarr, Student Engineer, utilizing equipment owned and operated by Marathon Drilling Co. This report was written by T. Sangiuliano and reviewed by Mr. D. Dundas, Senior Foundation Engineer.



  
T. Sangiuliano, P.Eng.  
Foundation Engineer

  
M.S. Devata, P.Eng.  
Chief Foundation Engineer

## **APPENDIX**



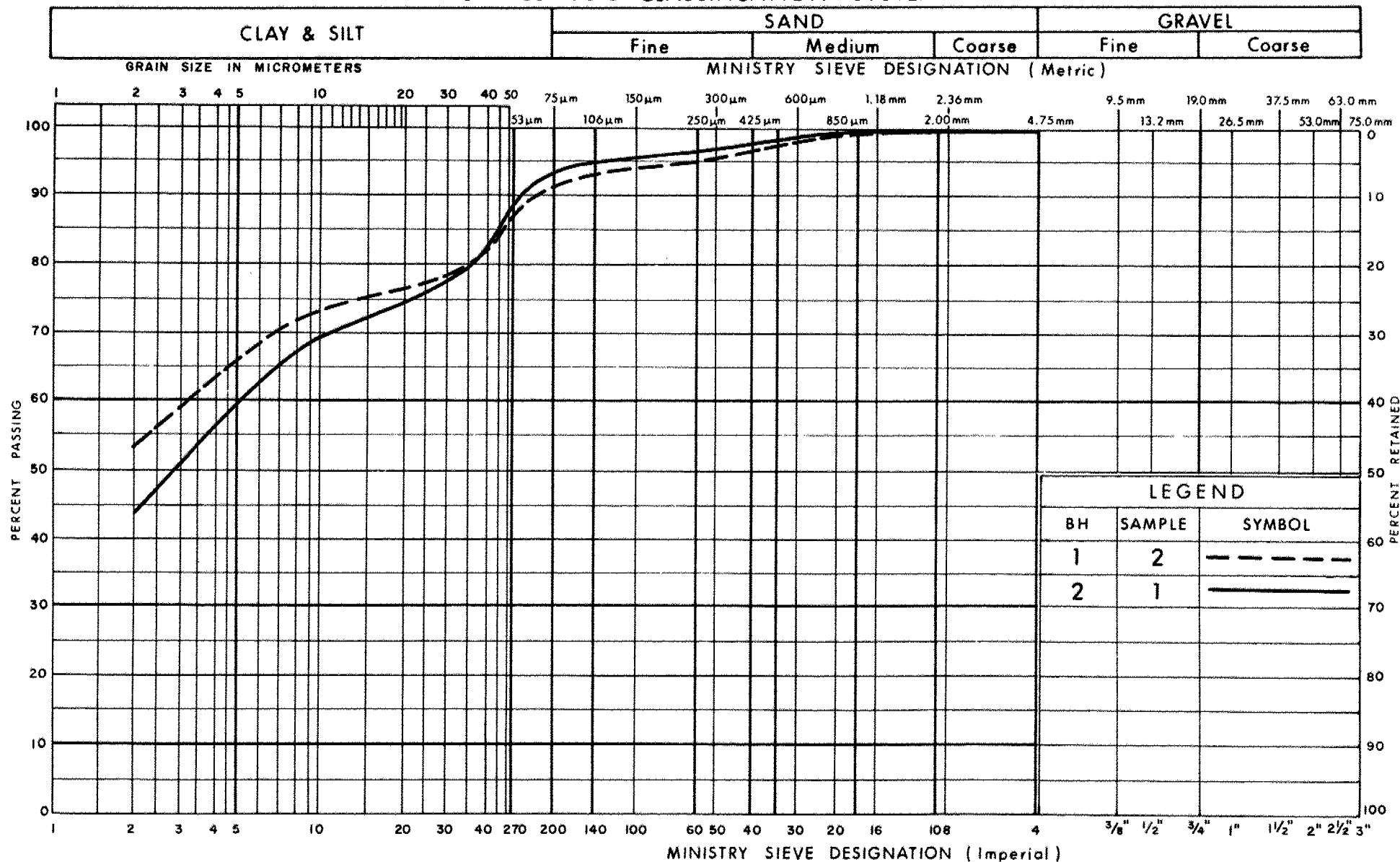
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# PLASTICITY CHART CLAY

FIG No 1

W P 24-78-07

## UNIFIED SOIL CLASSIFICATION SYSTEM

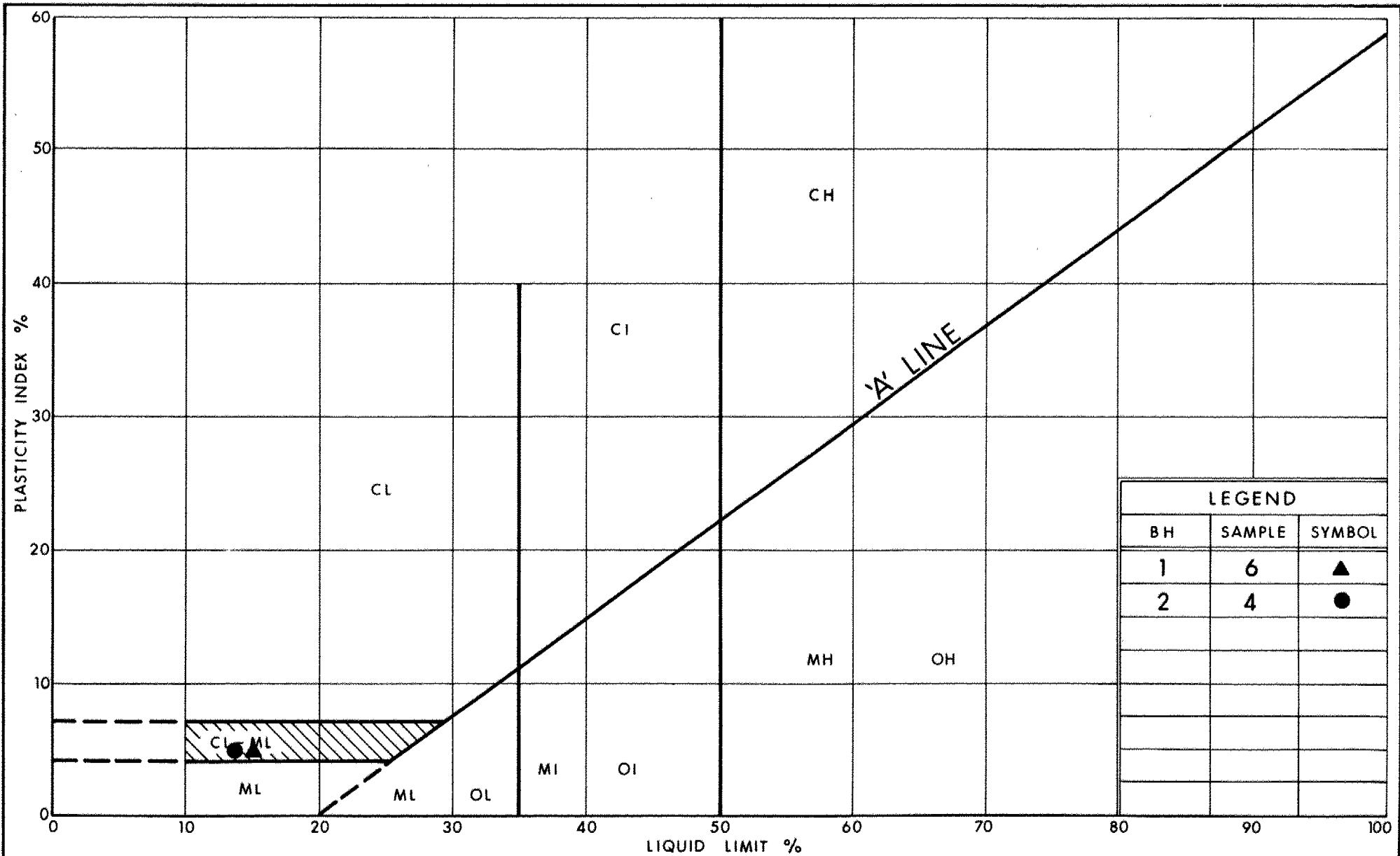


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## GRAIN SIZE DISTRIBUTION CLAY

FIG No 2

WP 24-78-07



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Ontario

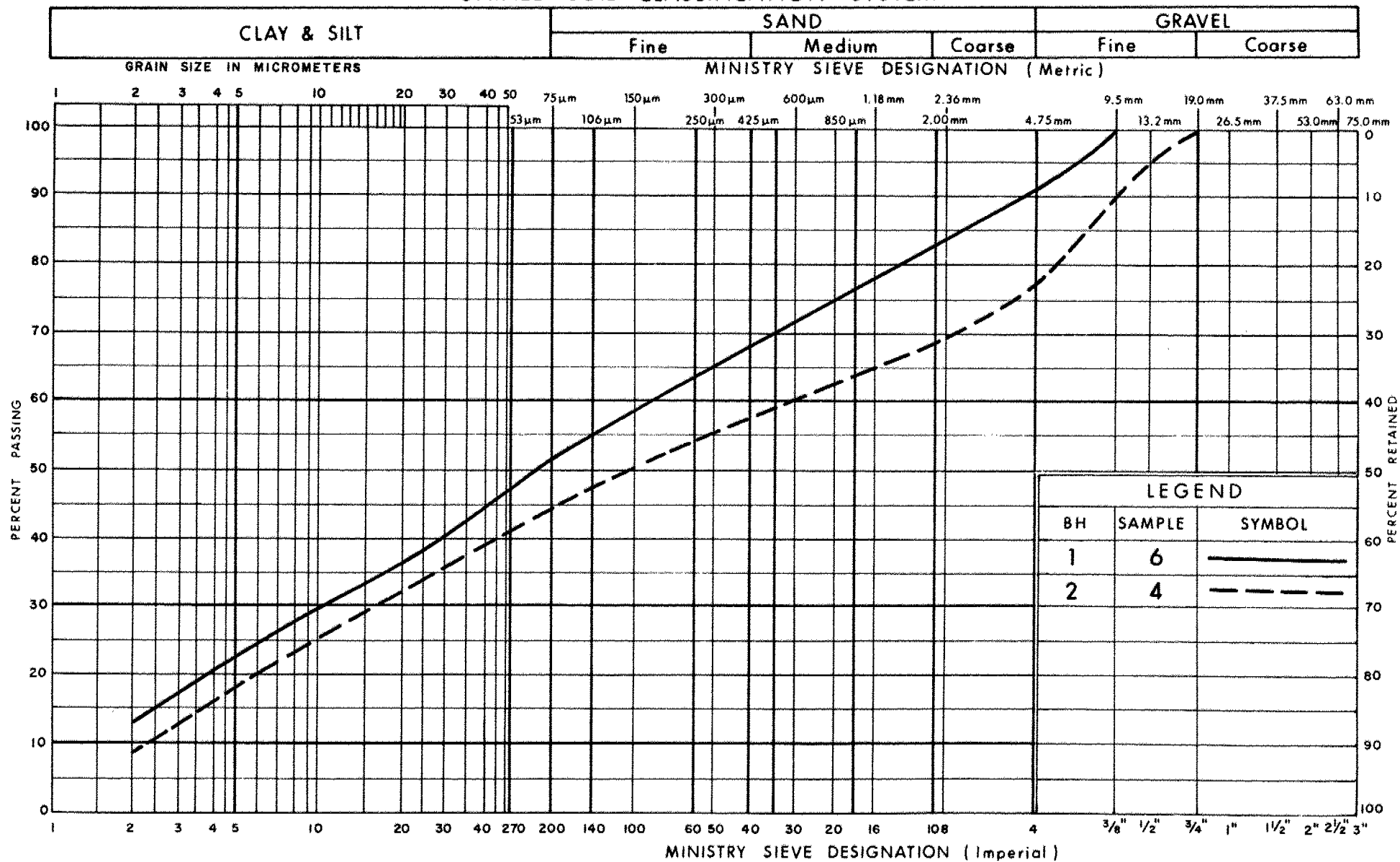
PLASTICITY CHART  
HET MIXTURE OF  
CLAYEY SILT, SAND & GRAVEL (Glacial Till)

FIG No 3

W P 24-78-07



## UNIFIED SOIL CLASSIFICATION SYSTEM



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

FIG No 4

W P 24-78-07

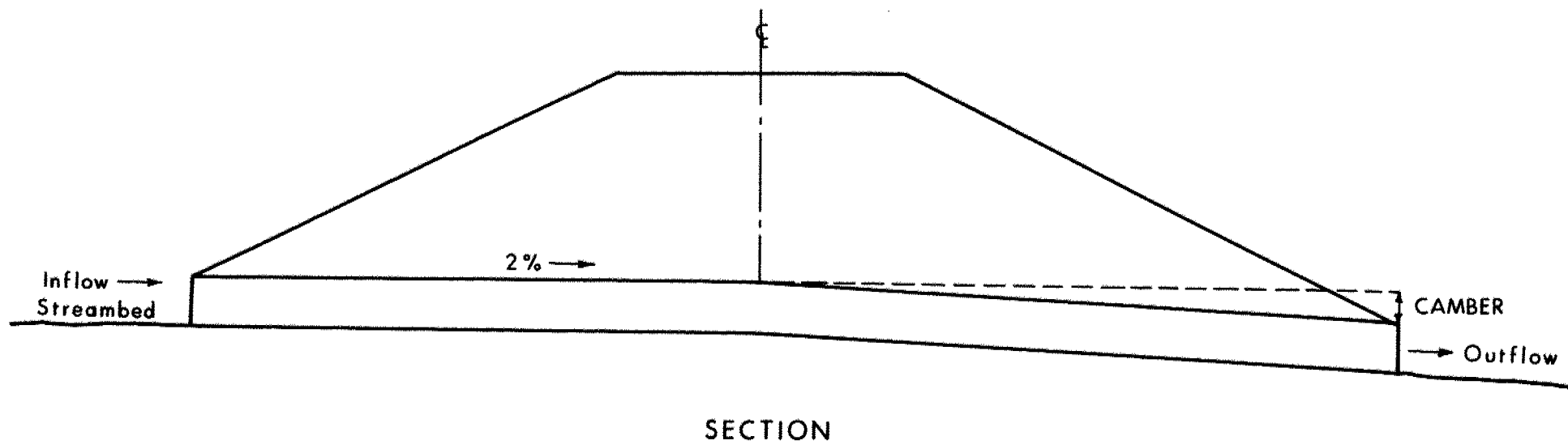


Fig 5 - CAMBER LAYOUT

## EXPLANATION OF TERMS USED IN REPORT

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

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

SOILS ARE DESCRIBED BY THEIR COMPOSITION AND CONSISTENCY OR DENSENESS

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

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

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

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

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

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

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

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

**JOINTING AND BEDDING:**

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

## ABBREVIATIONS AND SYMBOLS

### FIELD SAMPLING

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

### MECHANICAL PROPERTIES OF SOIL

$m_v$	$\text{kPa}^{-1}$	COEFFICIENT OF VOLUME CHANGE
$C_c$	1	COMPRESSION INDEX
$C_s$	1	SWELLING INDEX
$C_\alpha$	1	RATE OF SECONDARY CONSOLIDATION
$c_v$	$\text{m}^2/\text{s}$	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

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

# RECORD OF BOREHOLE No 1

METRIC

W P 24-78-07 LOCATION Sta. 10+005.0; o/s 0.8 m Lt  $\nabla$  Curran Drain Relocation ORIGINATED BY MS  
 DIST 9 HWY 43 BOREHOLE TYPE H-S Auger COMPILED BY MS  
 DATUM Geodetic DATE 88 08 10 CHECKED BY TS

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 $\gamma$	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100				
70.6	Ground Surface															
0.0	Sand and Gravel (Fill)															
69.8	Brown, Compact															
0.8	Clay		1	SS	12		70									
	Grey,		2	SS	12											
	Firm to Stiff		3	SS	7		68								17.7	0 7 39 54
			4	SS	7										16.0	
66.0																
4.6	Heterogeneous Mixture of Clayey Silt, Sand and Gravel (Glacial Till)		5	SS	6		66									
	Grey,		6	SS	120/8cm											
	Firm to Hard						64								21.7	9 39 39 13
62.6			7	SS	120/5cm											
8.0	End of Borehole															

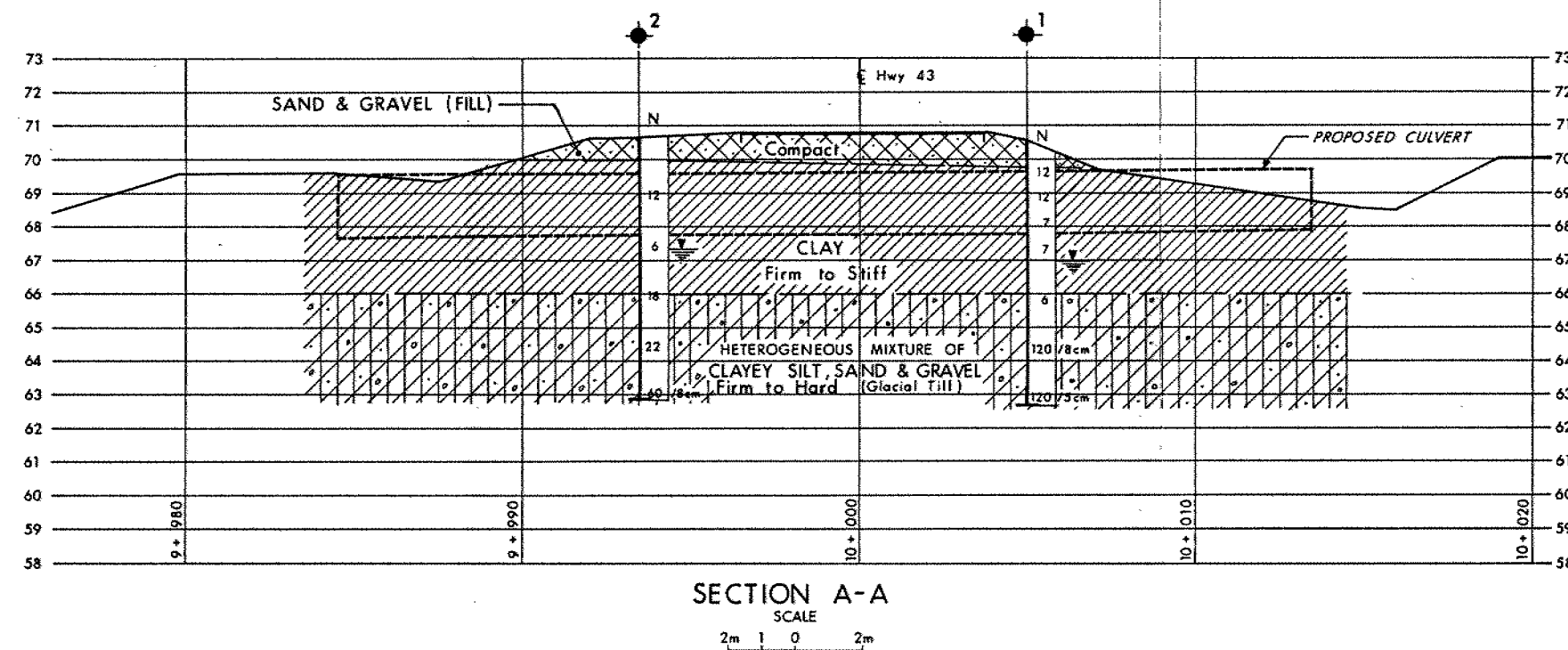
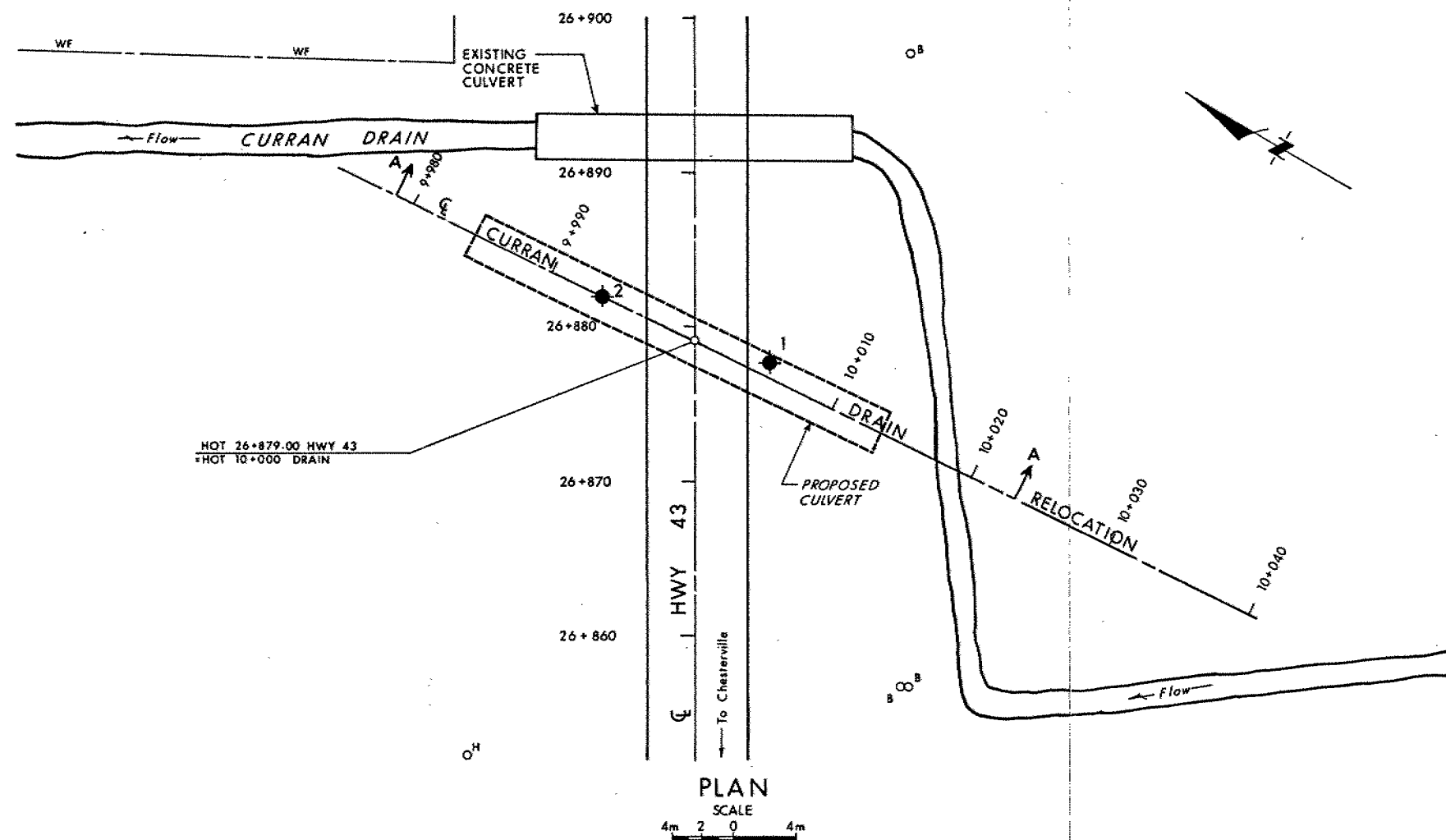
OFFICE REPORT ON SOIL EXPLORATION

# RECORD OF BOREHOLE No 2

METRIC

W P 24-78-07 LOCATION Sta. 9+993.5; E Curran Drain Relocation  
 DIST 9 HWY 43 BOREHOLE TYPE H-5 Auger  
 DATUM Geodetic DATE 88 08 10  
 ORIGINATED BY MS  
 COMPILED BY MS  
 CHECKED BY TS

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 Y	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES		20	40	60	80	100			
70.6	Ground Surface													
70.0	Sand and Gravel (Fill)													
0.6	Brown, Compact													
	Clay													
	Grey,		1	SS	12									0 6 52 42
	Firm to Stiff		2	SS	6								16.0	
66.0														
4.6	Heterogeneous Mixture of Clayey Silt, Sand and Gravel (Glacial Till) Grey, V. Stiff to Hard		3	SS	18									
			4	SS	22									
62.8			5	SS	60/	8cm							22.1	22 33 36 9
7.8	End of Borehole													



*METRIC*

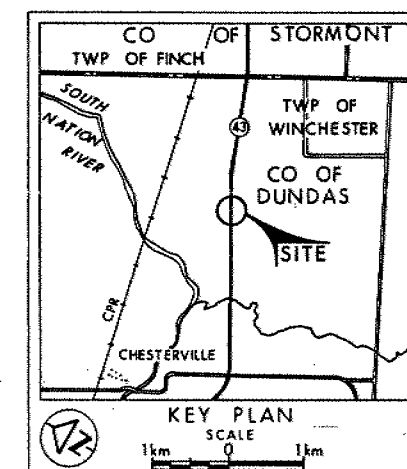
DIMENSIONS ARE IN METRES  
AND/OR MILLIMETRES UNLESS  
OTHERWISE SHOWN. STATIONS  
IN KILOMETRES + METRES.

CONT No  
WP No 24-78-07





**CURRAN DRAIN CULVERT**  
(HWY 43)  
BORE HOLE LOCATIONS & SOIL STRATA



SHEET



### LEGEND

- |   |                                       |
|---|---------------------------------------|
|  | Bore Hole                             |
|  | Dynamic Cone Penetration Test (Cone)  |
|  | Bore Hole & Cone                      |
| N   | Blows/0.3m (Std Pen Test, 475 J/blow) |
| CONE  | Blows/0.3m {60° Cone, 475 J/blow}     |
|  | WL at time of investigation 88.08     |

No	ELEVATION	STATION	OFFSET
1	70.6	10 + 005.0	0.8 m Lt
2	70.6	9 + 993.5	℄

NOTE

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

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

REV	DATE	BY	DESCRIPTION
Geocres No 31G-196			
HWY No 43			DIST 9
SUBMD TS	CHECKED	DATE 89 06 16	SITE
DRAWN DT	CHECKED	APPROVED	DWG 247807-A

memorandum

To: Mr. D.H. Dundas  
Senior Foundation Engineer  
Foundation Design Section  
Room 315, Central Building  
Downsview, Ontario

Date: September 28, 1988

From: Planning & Design Section  
Eastern Region, Kingston

Re: W.P. 24-78-01, Curran Dorain Culvert  
Replacement, Highway 43, District 9, Ottawa

Attached is the proposed culvert replacement for the Curran Municipal Drain. In order to determine staging and detour requirements, will you please provide our office with the steepest cut back slope the soil conditions will allow near center line, during the placing of the first half of the culvert.

This project is in the final design stage and is presently scheduled for design complete on 88-10-15.

I trust this is sufficient information for your recommendations.



D.R. Moon  
Project Manager

DRM:sc

20188 12121 FROM MTO 613-545-4786

PAGE.003

METRIC  
DIMENSIONS ARE IN METRES  
AND/OR MILLIMETRES  
UNLESS OTHERWISE SHOWN

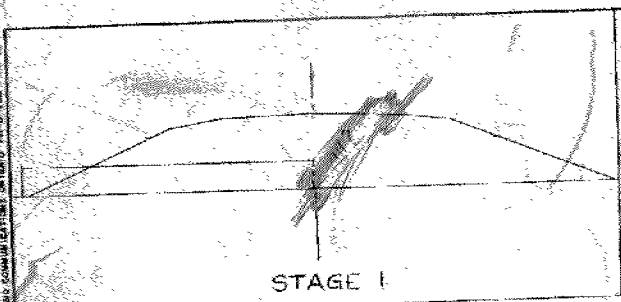
PLATE No  
CONT No  
WP No 24-78-01



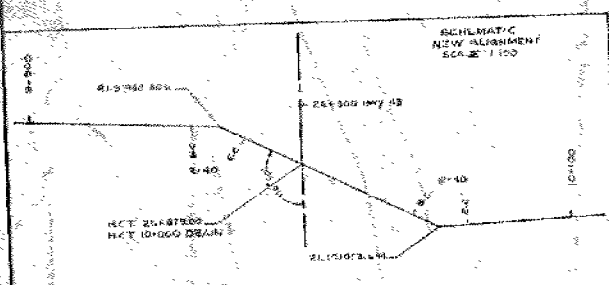
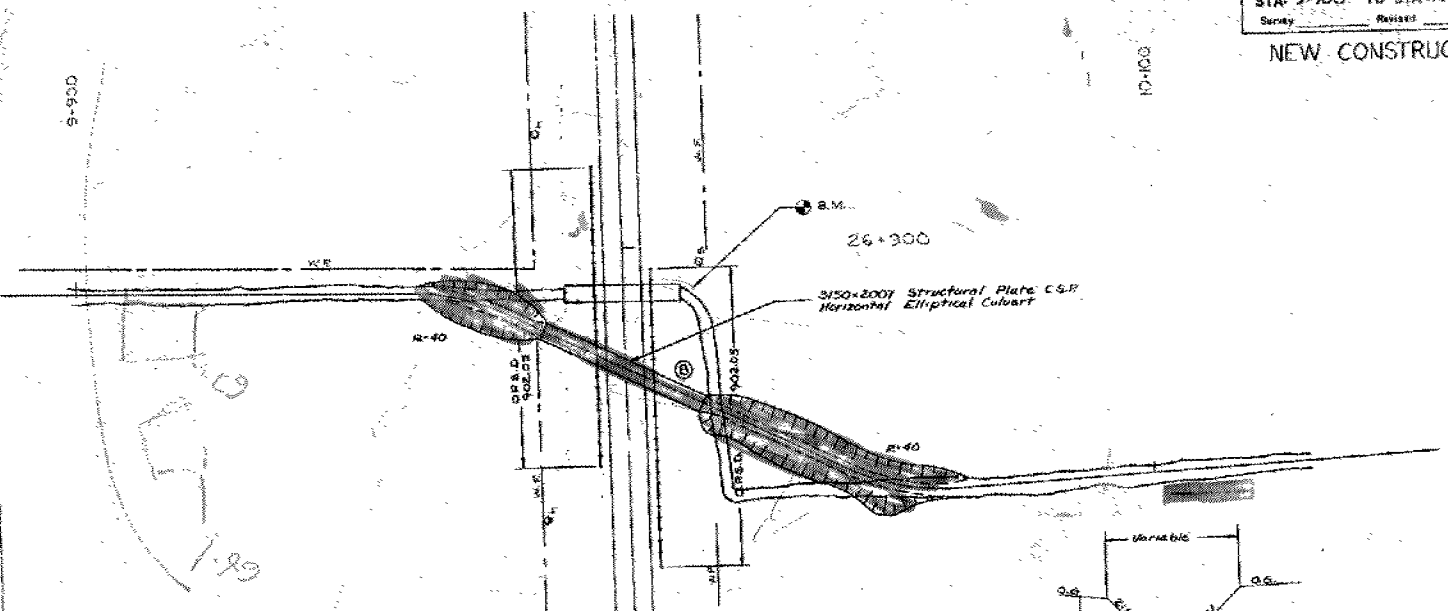
CURBAN DRAIN  
STA 9+900 TO STA 10+100  
Survey Revised

SHEET

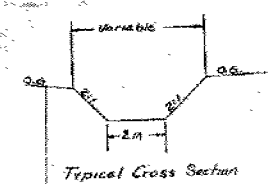
NEW CONSTRUCTION



STAGE I

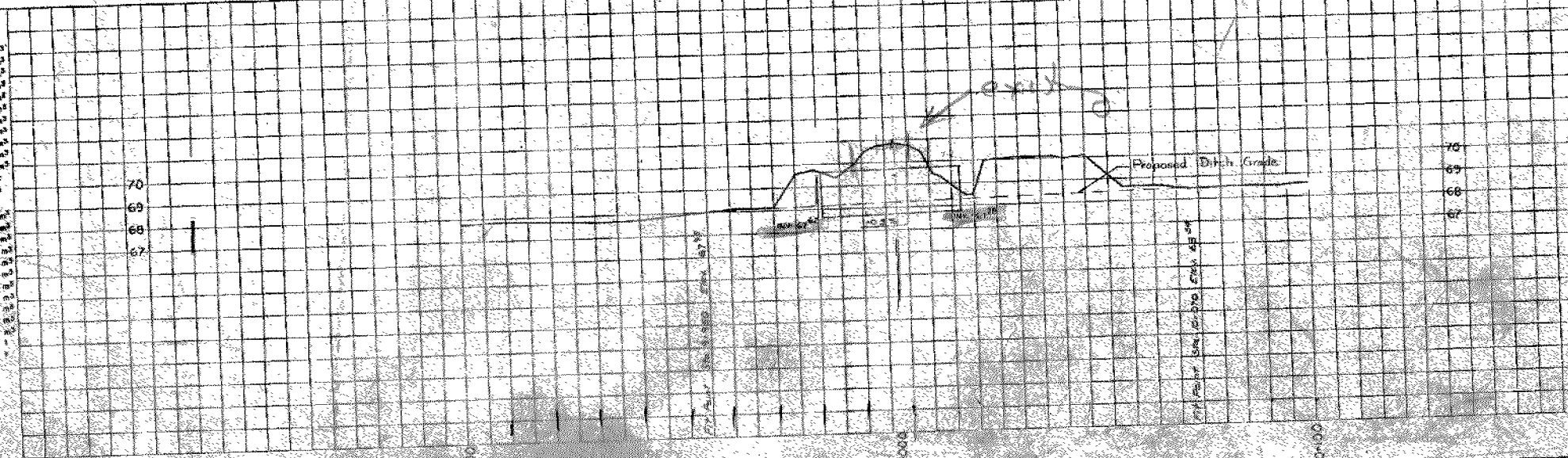


SCHEMATIC  
NEW ALIGNMENT  
SCALE 1:100



QUANTITIES

- EC
- ED
- EB
- NE
- MBE
- EF
- EC
- RD
- MR
- RF
- SR
- SSR
- EC
- ED
- EB
- NE
- MBE
- EF
- EC
- RD
- MR
- RF
- SR
- SSR



QUANTITIES

Station	Quantity
EC	237
ED	105
EB	
NE	
MBE	
EF	
EC	
RD	
MR	
RF	
SR	
SSR	
EC	
ED	
EB	
NE	
MBE	
EF	
EC	
RD	
MR	
RF	
SR	
SSR	

SCALES





# memorandum



To: T.C. Lane  
Head  
Structural Section  
Kingston

Date: 1988 09 08

Atten: H.S. Kleywegt

From: Foundation Design Section  
Room 315, Central Building

RE: Curran Drain Culvert Replacement  
W.P. 24-78-07, Site N/A  
Hwy. 43, District 9, Ottawa

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The fieldwork for the foundation investigation for the above-noted project has been completed.

As you have requested, this memo provides a summary of subsurface conditions, and recommendations for design and construction, which will permit this project to proceed. The complete foundation report will be forwarded to you at a later date. However, if additional information is required, please contact this office.

## **SITE DESCRIPTION**

The site is located just east of Chesterville at the crossing of Curran Drain and Highway 43.

The existing culvert is 3.4 x 1.2 m open concrete culvert at Sta. 26 + 893. This culvert is functionally impaired, probably due to undercutting of its footing by overexcavation of the drainage channel. The Hwy. 43 embankment is in the order of 1.5 m high and the only signs of distress are settlements over the culvert area due to structural distress of the culvert.

## **SUBSURFACE CONDITIONS**

The existing roadbed is composed of approximately 0.5 m of sand and gravel (extending from Elev. 70.6 to 70.1 m). This material overlies 4 m of firm to stiff silty clay (extending from Elev. 70.1 to 66.1 m) which in turn overlies firm to hard, but generally very stiff to hard clayey silt till of undetermined depth. The groundwater elevation is at the invert of the existing channel (68.9 m) approximately 1.7 m below the roadbed surface.

## **RECOMMENDATIONS**

It is proposed to construct a new concrete box culvert of equivalent size, with invert at Elev. 68.1+. The new alignment will be constructed on a skew at Sta. 26 + 879.

.....2

The box culvert can be founded below Elev. 68.1 on a 0.5 m thick Granular 'A' pad. The pad should extend a minimum of 1 m beyond the plan limits of the culvert, and extend at a 1H:1V slope to the base of the pad. It may be more practical to fill the entire excavation below the base of culvert with Granular 'A'.

For the purposes of the O.H.B.D.C. the following design values are recommended for a culvert founded on a 0.5 m thick pad of compacted Granular 'A'.

Factored Bearing Capacity at U.L.S. = 115 kPa

Bearing Capacity at S.L.S. Type II = 75 kPa

Backfill at the culvert should be constructed in accordance with appropriate O.P.S.D. standards (OPSD 803 series), with frost protection at 1.8 m. The backfill should be constructed in 300 mm lifts on alternating sides of the culvert so that the maximum differential in backfill heights at no time exceed 300 mm.

A 150 mm mid span camber is recommended. The upstream half of the culvert should be laid on almost a flat grade. The 150 mm elevation drop is between the mid span and outlet.

Excavations for footings carried out below the water level prevailing at the time of construction may require dewatering. Dewatering operations may involve the construction of an upstream dam of impervious material to divert the drain. Due to the relatively impervious nature of the clay subsoil, normal sump pumping will adequately dewater the excavation.

Temporary slopes less than 3 m high may be at 1.5H:1V. Permanent slopes should be at 2H:1V.

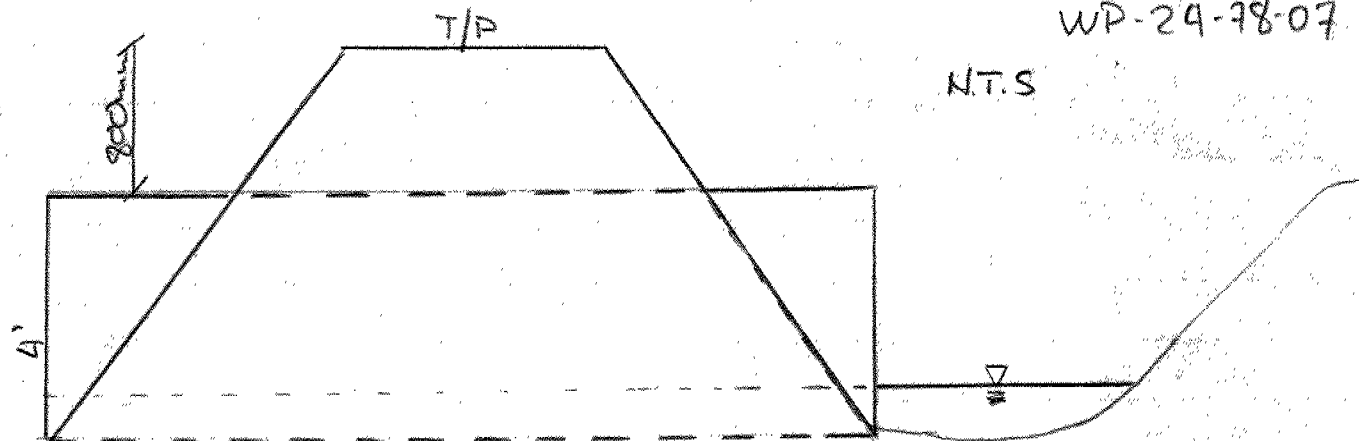
If construction of the culvert is to be staged, and shoring is required, please contact this office for parameters for earth pressure calculations.

*D. H. Dundas*

D.H. Dundas, P. Eng.  
Senior Foundation Engineer

DHD/mmj

WP-24-78-07



\* NO EXTRA FILL TO BE ADDED

\* NEW ALIGNMENT FOR REPLACEMENT CULVERT

(SINCE SOIL IS REMOVED TO INSTALL CULVERT, THE NET ROAD FILL WEIGHT WILL BE LESS THAN BEFORE.)

### GEOCRES

#### POSSIBLE SOIL TYPES.

##### GEODEX # 84

- i) • SILT CLAY TO CLAY (0'-17')
  - [TOPSOIL FOR 0'-3'] FISSURED
  - [SOFT FOR 3'-17']
- DENSE TILL WITH BOULDERS (17'-35')

\* ORGANIC LAYER @ 10 ft (3 1/2" THICK)

FOUND IN SOME BH.

\* ARTESIAN CONDITIONS FOUND IN  
BH CLOSE TO SOUTH NATION RIVER.

##### GEODEX # 93

- ii) • CLAYEY SILT (0'-8') (STIFF)
- CI-SI TILL (8'-12') (SOFT) (REWORKED)
- [DENSE TILL (12'-35')  
WITH BOULDER]

WP-24-78-07

SLOPES

NO INFORMATION ON EXISTING ROAD SLOPES IS GIVEN BUT PICTURES INDICATE A 2H:1V TO 1H:1V SLOPE IN THE DITCH

NEW CULVERT

- (i) FLEXIBLE PIPE CULVERT BEARING ON A GRANULAR CUSHION.
- ii) RIGID CONCRETE BOX CULVERT: SETTLEMENT MUST BE CONSIDERED.

SETTLEMENT/CONSOLIDATION

GEODEX #84: 0.2-0.3 feet DUE TO 20 feet HIGH EMBANKMENT  
(COMPLETED IN 10-20 YEARS)

\* IN THIS CASE THERE WILL BE A NET DECREASE  
IN ROAD FILL  $\therefore$  SETTLEMENT IS NOT A PROBLEM.

ORIGINAL CULVERT

"FUNCTIONALLY IMPAIRED"

- \* WHAT IS THE PROBLEM!
- SETTLEMENT OF CULVERT
  - TOO SMALL SIZE
  - CONCRETE FAILURE

CONCLUSION.

• THE REPLACEMENT CULVERT DESIGN WILL NOT ADD ANY MORE WEIGHT TO THE UNDERLYING SOILS, HENCE SETTLEMENT / CONSOLIDATION WILL NOT BE A PROBLEM.

NOTE \* POSSIBLE THAT OLD CULVERT FAILED DUE TO SETTLEMENT / CONSOLIDATION OF ORGANIC LAYER.



# RECORD OF BOREHOLE ~~82~~

## METRIC

W P \_\_\_\_\_ LOCATION GEODEX #93 ORIGINATED BY \_\_\_\_\_  
DIST \_\_\_\_\_ HWY \_\_\_\_\_ BOREHOLE TYPE TYPICAL B.H. COMPILED BY JBF  
DATUM \_\_\_\_\_ DATE \_\_\_\_\_ CHECKED BY \_\_\_\_\_

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 (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE								
	TOPSOIL				8							
					11							
5	CLAYEY SILT (SOFT)				13							0,7,68,25
					13							
					12							
10	CLAYEY SILT REWORKED ZONES				7							
					6							
					8							
15	TILL				22							0,84,(16)
					16							
					47							
20	(DENSE)				35							
					54							
25	WITH BOULDERS				51							29,50,(21)
					93							
30					77							
					121							
35												



# RECORD OF BOREHOLE

## METRIC

W P \_\_\_\_\_ LOCATION GEODEX #84 ORIGINATED BY \_\_\_\_\_  
DIST \_\_\_\_\_ HWY \_\_\_\_\_ BOREHOLE TYPE TYPICAL BH COMPILED BY JBF  
DATUM \_\_\_\_\_ DATE \_\_\_\_\_ CHECKED BY \_\_\_\_\_

SOIL PROFILE			SAMPLES		GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 SHEAR STRENGTH ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB VANE 75 150 225 300 kPa	PLASTIC LIMIT W <sub>p</sub> NATURAL MOISTURE CONTENT W LIQUID LIMIT W <sub>L</sub> WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE						
FEET										
	TOPSOIL					5				
						6				
5	SILTY CLAY					2				
	TO					4				
	CLAY					4				
10	(FISSURED)					4				
						2				
15						2				
						2				
20	DENSE TILL					140				
	SOME					38				
25						24				
	BOULDERS					57				
						97				
30						115				
						160				
35										
40										

UNDISTURBED  
REMOULDED

FIELD VANE

WATER CONTENT

# memorandum



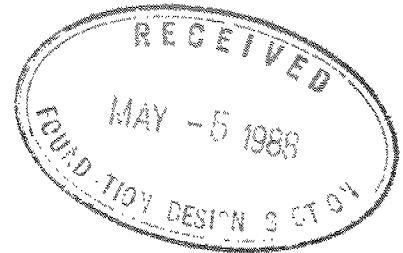
545-4715

To: M. S. Devata  
Chief Foundations Engineer  
Foundation Design Section  
Downsview, Ontario

Date: May 4, 1988

From: Structural Section  
Eastern Region  
Kingston, Ontario

Re: Foundation Investigation Request  
for New Culvert, Highway 43  
East of Chesterville, Sta. 26+879  
W.P. 24-78-07



A new culvert is to be installed at the above location to replace an existing 11'x4' culvert that is functionally impaired. This is to request your foundation design recommendations for the replacement culvert.

Accompanying this memorandum are the following:

- a) 1:50,000 site location map.
- b) Plan of new culvert.
- c) Two photographs of site.
- d) OB-MT-314 Form.

A completed hydrology study anticipates a Q25 of 5 m<sup>3</sup> /sec. for the culvert. The culvert is part of a municipal drain system in Williamsburgh Township. The existing culvert has approximately 800 mm cover to T/P.

I trust this is sufficient information to carry out the investigation.

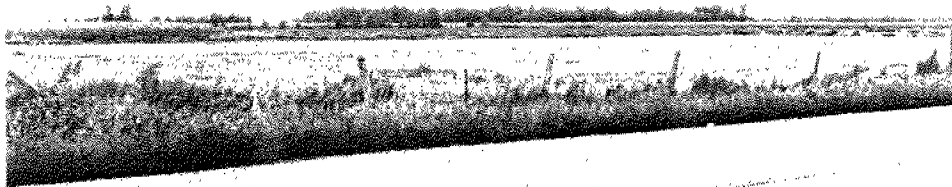
A handwritten signature in dark ink, appearing to read "H. Kleywegt".

H.S. Kleywegt  
for:  
E.C. Lane  
Head, Structural Section

ECL:HSK:bd

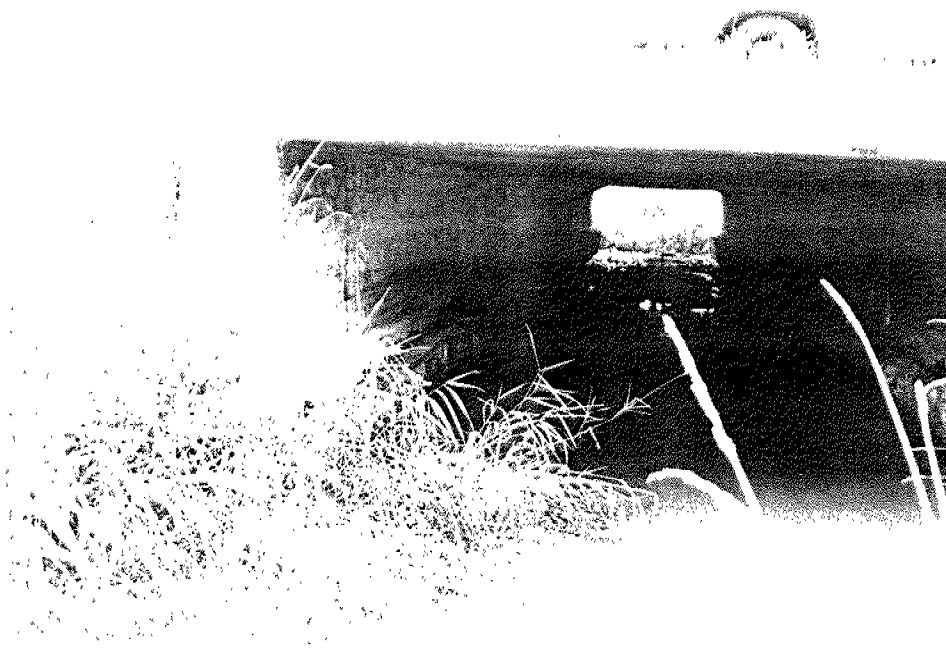
Encl.





HWY 43 AT 11'x4' CULVERT STN 26+893

DIPS IN PAVEMENT AT THE SHOULDER DEFINE  
THE CULVERT LOCATION.



HWY 43 - END VIEW OF 11'x4' CULVERT  
AT STN 26+893