PRELIMINARY FOUNDATION INVESTIGATION AND DESIGN REPORT
for
HIGHWAY 4, KIPPEN RIVER BRIDGE #2
MTO WEST REGION 59 STRUCTURE REHABILITATIONS
CONTRACT 2
GWP 3125-03-01
TOWNSHIP OF TUCKERSMITH, HURON COUNTY, ONTARIO

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PML Ref.: 13KF006B
Index No.: 141FIR and 142FDR
GEOCRES No: 40P5-20
November 26, 2014

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Peto MacCallum Ltd.
CONSULTING ENGINEERS

PRELIMINARY FOUNDATION INVESTIGATION REPORT
For
Highway 4, Kippen River Bridge #2
MTO West Region 59 Structure Rehabilitations
Contract 2, GWP 3125-03-01
Township of Tuckersmith, Huron County, Ontario

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1. INTRODUCTION

This report summarizes the results of the foundation investigation carried out for the proposed rehabilitation of the Highway 4 Kippen River Bridge #2 over the Bannockburn River near the Town of Kippen, Ontario. The proposed rehabilitation is a part of the assignment for the rehabilitation of 59 structures in MTO West Region along Highways 4, 6, 401, 402 and 403. The study was carried out by Peto MacCallum Ltd. (PML) for MMM Group on behalf of the Ministry of Transportation of Ontario (MTO).

The purpose of this report was to summarize the subsurface stratigraphy encountered at the proposed structure site during the preliminary investigation.

2. SITE DESCRIPTION AND GEOLOGY

The existing structure was constructed in 1947 and is a single span rigid frame reinforced concrete bridge with a span length of about 10 m. The bridge is located on Highway 4 approximately 550 m south of Highway 12 in Huron County, Ontario.

Based on the book *"The Physiography of Southern Ontario"*, the project site is located within the physiographic region known as the Horseshoe Moraines. The Horshoe Moraines are mainly composed of irregular stony knobs and ridges comprised of tills (with some sand and gravel deposits) and pitted sand and gravel terraces and swampy valley floors. The typical bedrock types in this region are limestone, dolomite, shale and gypsum of the Dundee formation.

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3. SITE RECONNAISSANCE

As part of the current foundation engineering assessment study, site reconnaissance of the Kippen River Bridge #2 was carried out on May 10, 2014. A photographic record of the site visit is attached in Appendix A.

At the time of the site reconnaissance, the depth of the river was about 0.5 to 0.7 m. Concrete cracking and spalling were observed on the wingwalls adjacent to the abutment walls (Photographs 1 to 4). Surface cracks with wall surface deterioration and visible cracks were observed on the north and south abutment walls above the water level (Photographs 5 and 6). Concrete spalling at water level was observed on the south abutment wall (Photograph 6).

The embankments on either side of the bridge are steep. Erosion of adjacent earth slopes to the north and south abutments was observed. On the west slope adjacent to the north abutment, rock protection was placed to prevent further erosion of the slope surface (Photograph 7). In addition, scouring of the slope toe edges due to river water course were also observed near the abutment walls (Photographs 1 to 4). It is possible that the surface water running along the face of the slopes may have caused erosion of the slope surface. Observation below the water level could not been made and thus, potential river scouring effect below the water at the abutment walls by visual observations could not been made (Photographs 5 and 6). No visible signs of foundation settlement were observed.

No weep holes out of the abutment walls and no drainage pipes adjacent to the abutments were visible at the site. If any perforated pipes were installed behind the abutment walls, they were not visible to verify their conditions. Drainage condition at the bridge structure is considered poor.

4. INVESTIGATION PROCEDURES

The field work for this study was carried out on November 13, 2013. The investigation included two boreholes, with one borehole drilled at both the south and north abutment areas as shown on Drawing 1, appended.

The borehole locations were established in consultation with MMM. The borehole locations and elevations were surveyed in the field by MMM. All elevations in this report are expressed in metres.

The boreholes were advanced using continuous flight hollow stem augers advanced through the soil with a truck-mounted CME-55 drill rig, supplied and operated by a specialist drilling contractor, working under the full-time supervision of a PML field supervisor.

Soil samples were recovered from the boreholes at regular 0.75 or 1.5 m depth intervals using the standard penetration test method. Standard penetration tests were conducted to assess the strength characteristics of the substrata. Soils classifications were identified in accordance with the MTO soil classification manual procedures.

The groundwater conditions in the boreholes were assessed during drilling by visual examination of the soil, the sampler and drill rods as the samples were retrieved. The groundwater levels in the open boreholes during and following drilling were also obtained.

The boreholes were backfilled with a bentonite/grout mixture where required in accordance with the MTO guidelines and MOE Reg. 903 for borehole abandonment.

The recovered soil samples were returned to our laboratory in Toronto for detailed visual examination, laboratory testing and classification. The laboratory testing program included the following tests:

- Natural moisture content determinations (16)
- Grain size distribution analyses (6)
- Atterberg Limit Tests (3)

The results of the laboratory grain size distribution analysis and Atterberg Limit Tests are presented in Figures KR-GS-1 to KR-GS-5 and KR-PC-1 to KR-PC-2, respectively. All of the test results are summarized on the Record of Borehole sheets.

5. SUMMARIZED SUBSURFACE CONDITIONS

Reference is made to the appended Record of Borehole sheets for details of the subsurface conditions including soil classifications, inferred stratigraphy, standard penetration test data and groundwater observations. The results of laboratory grain size distributions and moisture content determinations are also shown on the Record of Borehole sheets.

The borehole locations and stratigraphic profile prepared from the borehole data are shown on Drawing 1. The boundaries between soil strata have been established at the borehole locations only. Between and beyond the boreholes, the boundaries are assumed and may vary.

The subsurface stratigraphy revealed in the boreholes drilled at the site generally comprised existing Highway 4 pavement structure over cohesive fill to 3.4 to 4.3 m (locally the fill was non-cohesive in the lower portions of borehole 1), over a gravelly sand deposit to about 10 m, which was underlain by a very dense silt till that extended to the 12.3 m borehole termination depth. Cobbles and boulders were encountered in both boreholes within the gravelly deposit.

A summary of the findings is given below.

5.1 Fill

A 3.4 and 4.3 m thick layer of embankment fill was encountered surficially in boreholes 1 and 2 respectively that extended to elevation 266.0 and 267.0. Surficially the fill comprised the Highway 4 pavement structure, which included 150 and 360 mm of asphaltic concrete in boreholes 2 and 1 respectively, locally over 180 mm of Portland cement concrete in borehole 1, underlain by 100 and 300 mm of granular fill composed of sand and gravel. Beneath the pavement structure, clayey silt fill which transitioned to a sandy silt fill and silty clay fill were

encountered in boreholes 1 and 2, respectively. The fill was soft to firm and loose to compact, (SPT-'N' values of 3 to 26) and moist (moisture contents of 19 to 37%). Organic and topsoil inclusions were noted within the fill in both boreholes.

The results of three grain size distribution analyses and two Atterberg Limit Tests performed on samples of the fill are presented in Figures KR-GS-1 to KR-GS-3, and KR-PC-1 to KR-PC-2, respectively.

5.2 Sandy Silt

A 1.0 m thick sandy silt layer was contacted beneath the fill in borehole 1 at 4.3 m (elevation 266.0) that extended to 5.3 m (elevation 265.0). The sandy silt was compact (SPT 'N' value of 19) and moist (moisture content of 10%). The results of a grain size distribution analysis and Atterberg Limit Test completed on a sample this layer is presented on Figures KR-GS-4 and KR-PC-3, respectively.

5.3 Gravelly Sand

A 5.1 and 6.7 m thick gravelly sand deposit was contacted beneath sandy silt and fill at 5.3 and 3.4 m (elevation 265.0 and 267.0) in boreholes 1 and 2 respectively. The deposit extended to the silt till at 10.1 and 10.4 m (elevation 260.3 and 259.9) in boreholes 2 and 1, respectively. The deposit was compact to very dense (SPT-'N' values of 26 to 50 blows for 10 cm) and moist (moisture contents of 7 to 19%). Cobbles and boulders were noted within the deposit in both boreholes. The results of grain size distribution analyses completed on two samples of the deposit are shown on Figure KR-GS-5.

5.4 Silt Till

A 1.9 and 2.2 m thick silt till deposit was contacted underlying the gravelly sand to sand and gravel at 10.4 and 10.1 m (elevation 259.9 and 260.3) in boreholes 1 and 2, respectively. The silt till extended to the 12.3 m borehole termination depth in both boreholes, elevation 258.0 and 258.1. The material was very dense (SPT-'N' values of 65 blows for 15 cm to 100 blows for 10 cm) and moist (based on visual and tactile evidence).

5.5 Groundwater

In the process of augering, water strikes were observed at depths of 3.4 and 3.7 m (elevation 267.0 and 266.6) in boreholes 2 and 1 respectively. Upon completion of drilling groundwater was measured at 3.7 m in both boreholes. The groundwater levels at the site are subject to seasonal fluctuation and rainfall patterns.

The water level in the Bannockburn River was at the time of the investigation (November 13, 2013) was at elevation 267.8.

6. CLOSURE

Mr. F. Portela carried out the field investigation for this study under the supervision of Mr. A. DeSira, MEng, P.Eng., and Mr. C. M. P. Nascimento, P. Eng., Project Manager. London Soil Drilling supplied the drill rig for the subsurface exploration. The laboratory testing of the selected samples was carried out in the PML laboratory in Toronto.

This Foundation Investigation Report was prepared by Mr. A. DeSira, MEng, P.Eng., and reviewed by R. Ng, MBA, PhD, P.Eng. Mr. B. R. Gray, MEng, P. Eng., MTO Designated Principal Contact conducted an independent review of the report.

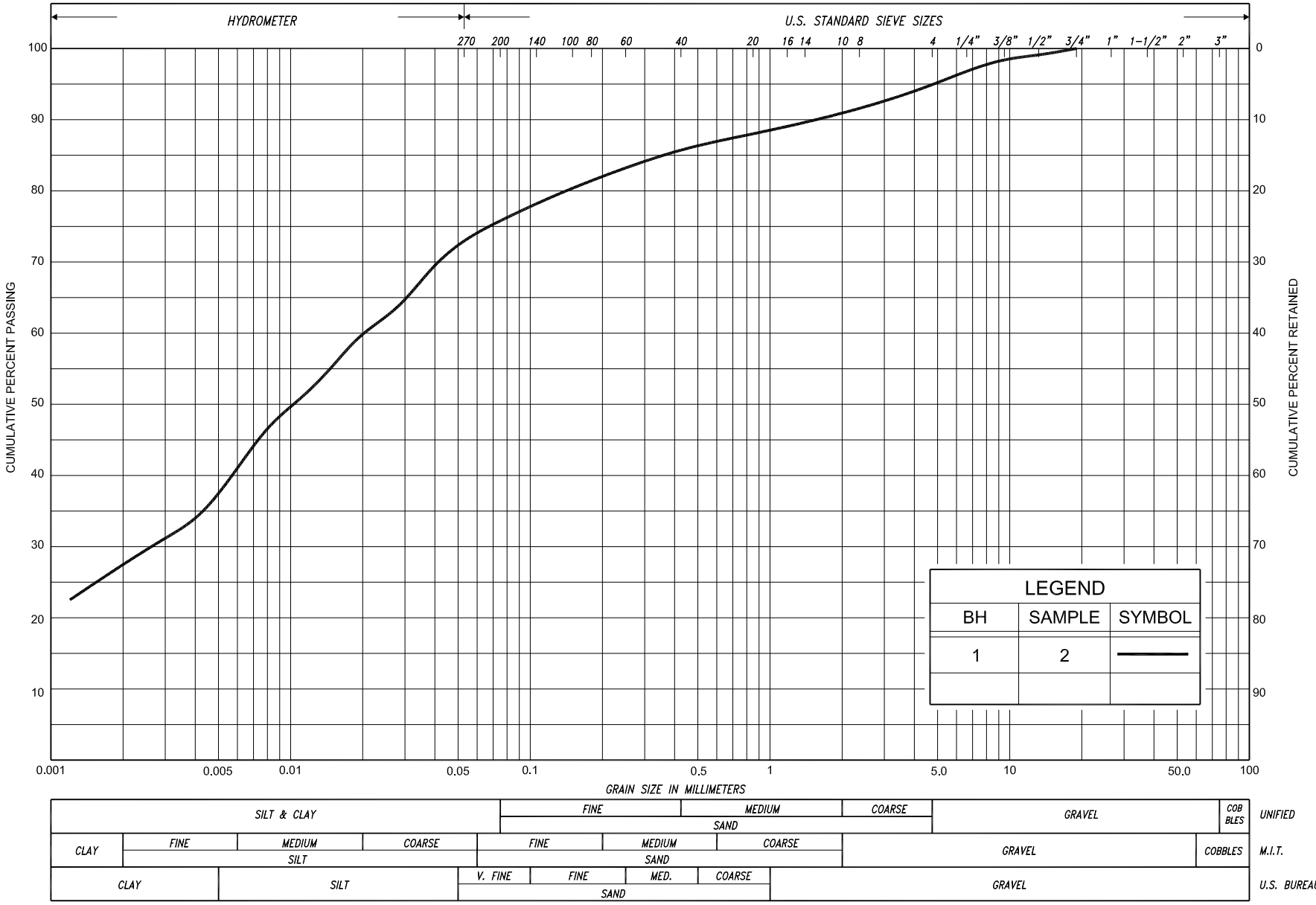
Yours very truly

Peto MacCallum Ltd.

Robert Ng, MBA, PhD, P.Eng.
Senior Project Engineer

Brian R. Gray, MEng, P.Eng.
MTO Designated Principal Contact

AD/CN/BRG:ad-mi

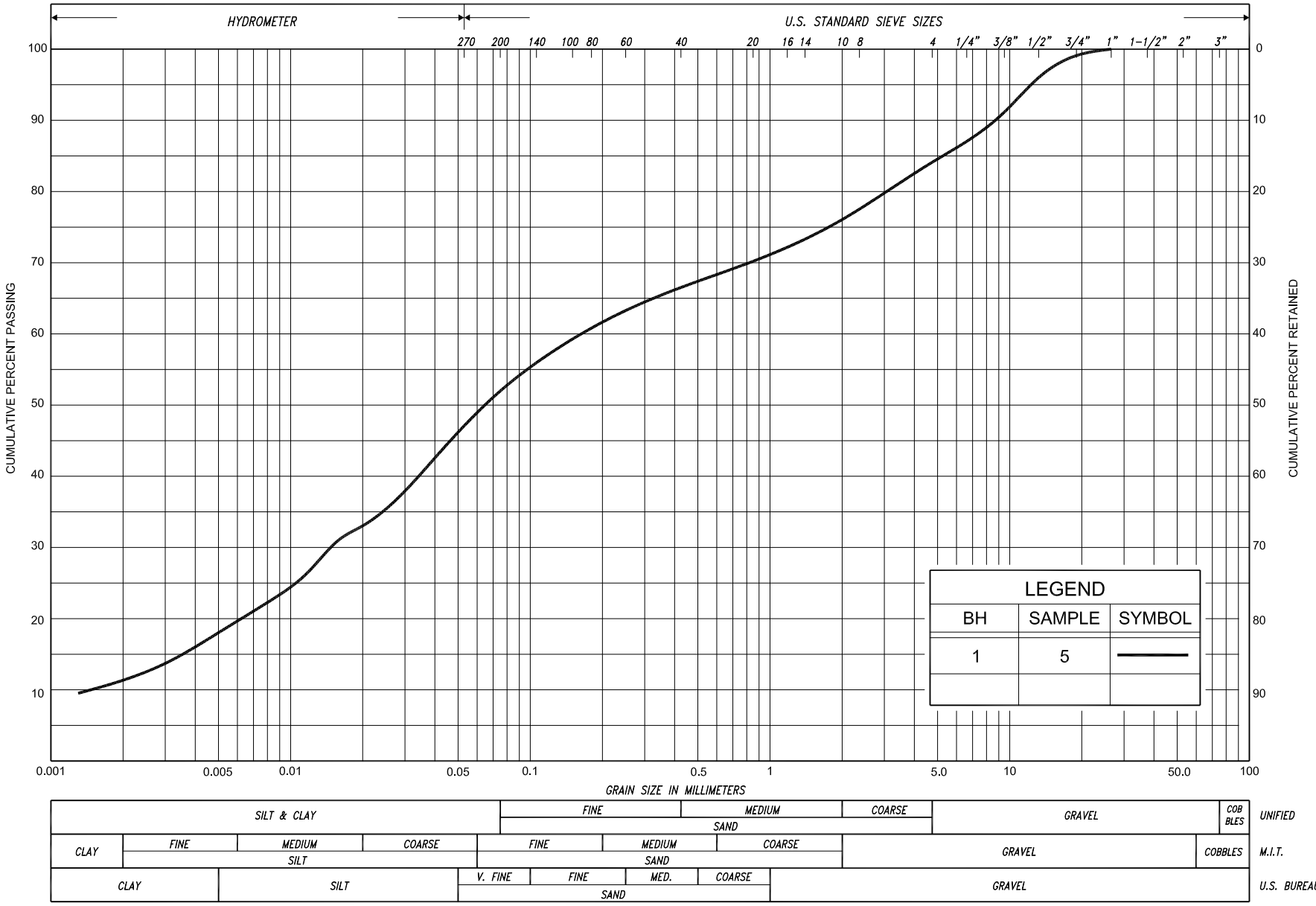


Ontario

GRAIN SIZE DISTRIBUTION

CLAYEY SILT, some sand, trace gravel (CL)
(FILL)

FIG No.	KR-GS-1
HWY:	4
W.P. No.	3125-03-01

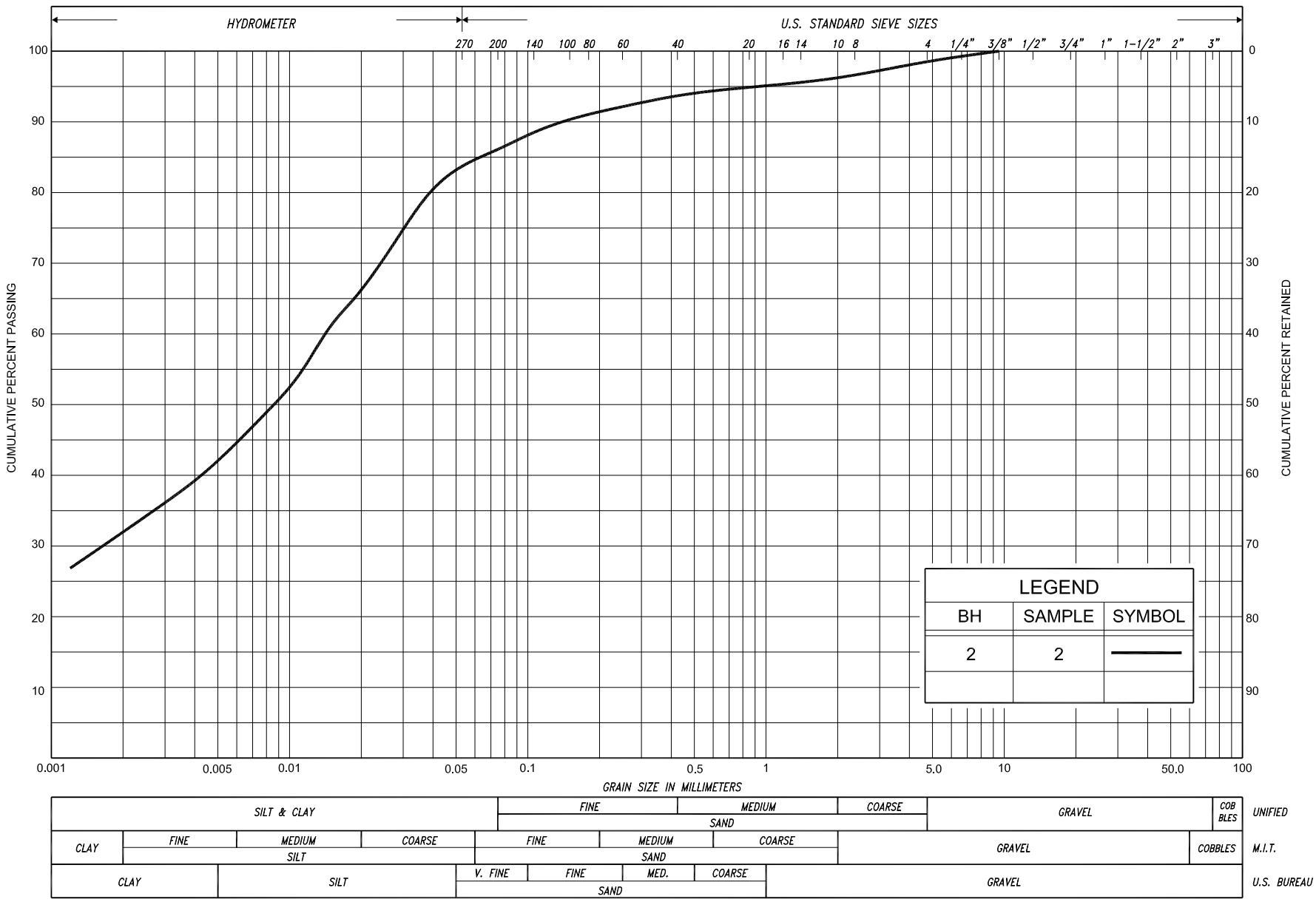


Ontario

GRAIN SIZE DISTRIBUTION

SANDY SILT, some clay, some gravel
(FILL)

FIG No.	KR-GS-2
HWY:	4
W.P. No.	3125-03-01

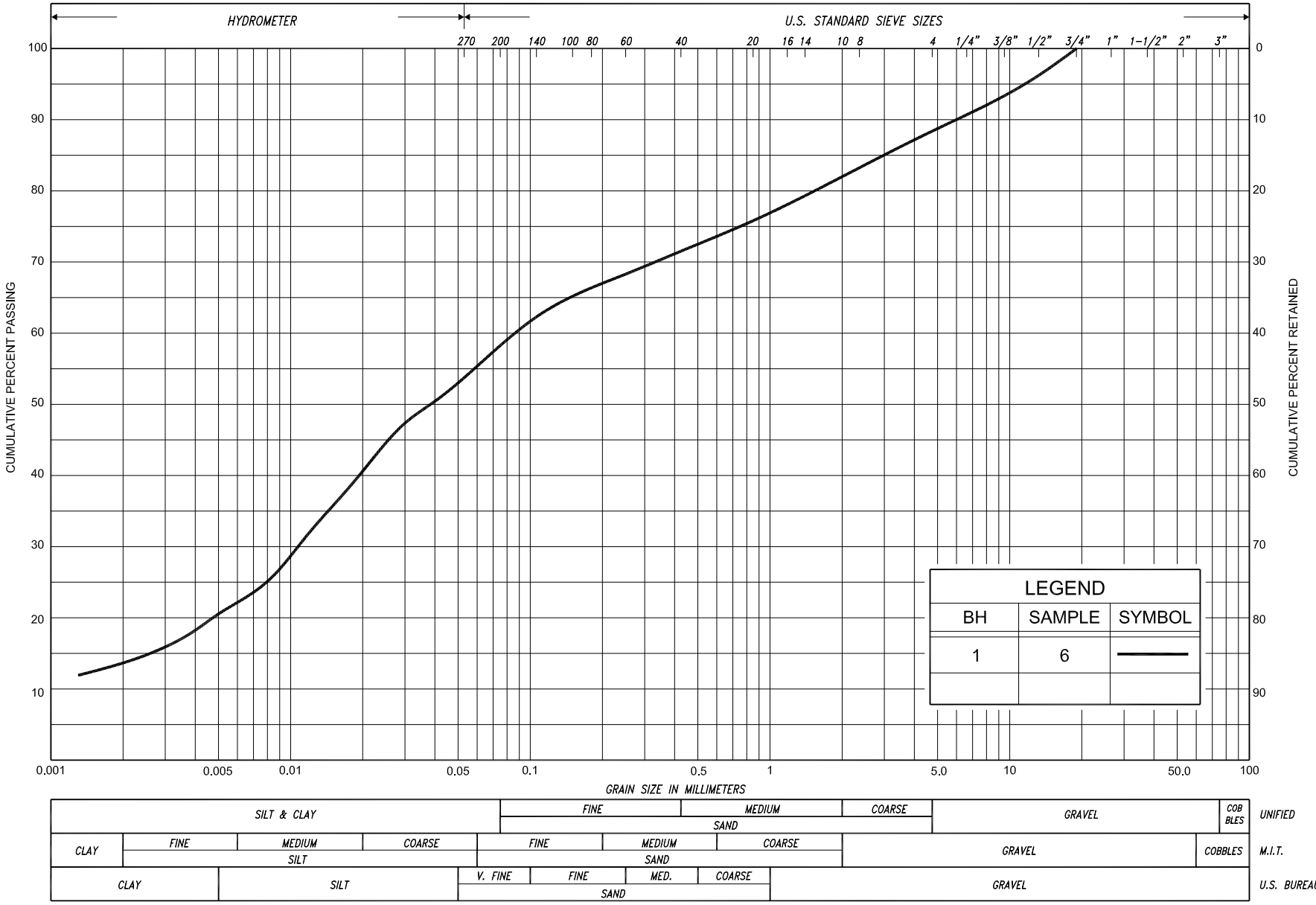


Ontario

GRAIN SIZE DISTRIBUTION

SILTY CLAY, some sand, trace gravel (CI)
(FILL)

FIG No.	KR-GS-3
HWY:	4
W.P. No.	3125-03-01

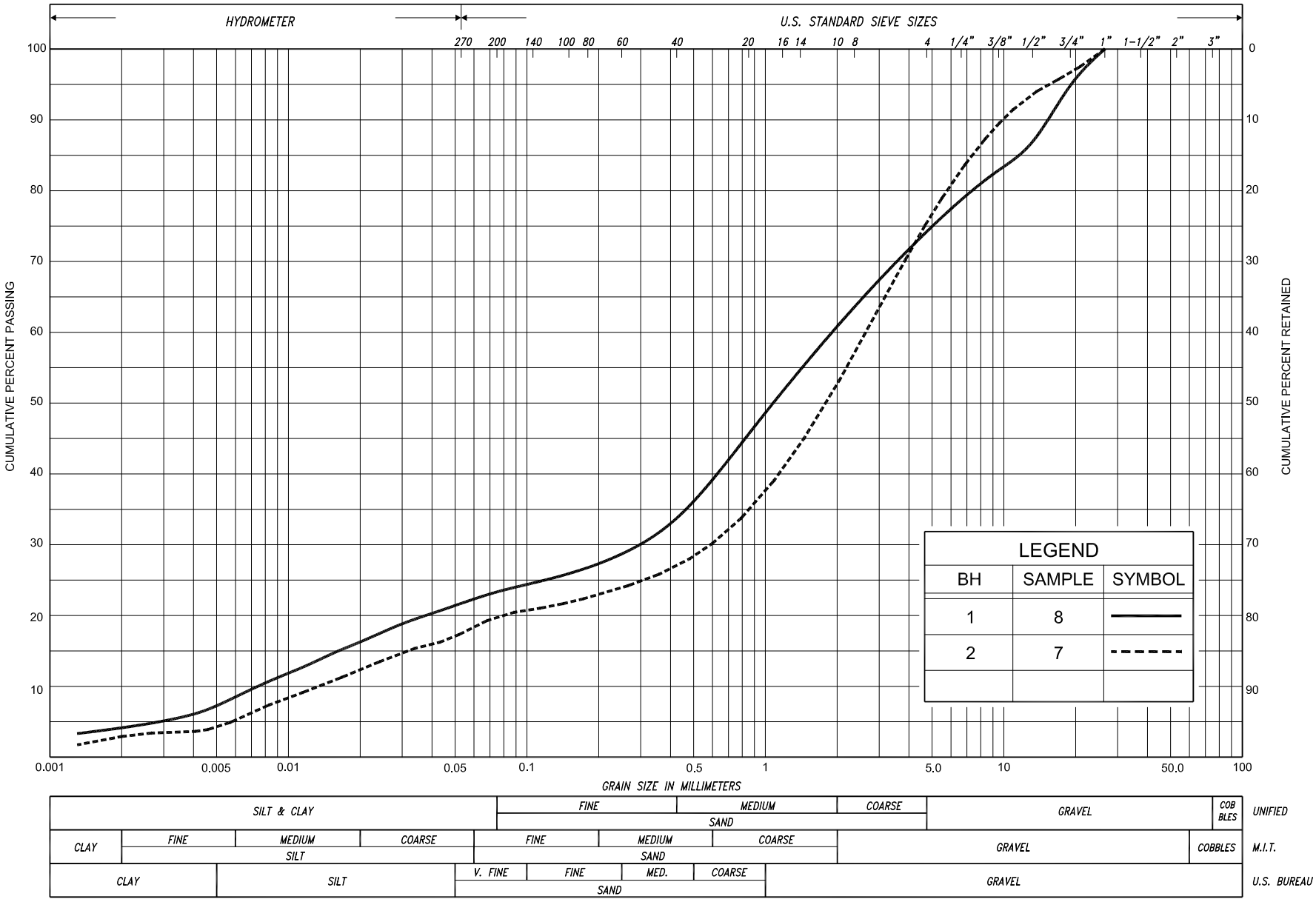


Ontario

GRAIN SIZE DISTRIBUTION

SANDY SILT, some clay, some gravel (ML)

FIG No.	KR-GS-4
HWY:	4
W.P. No.	3125-03-01

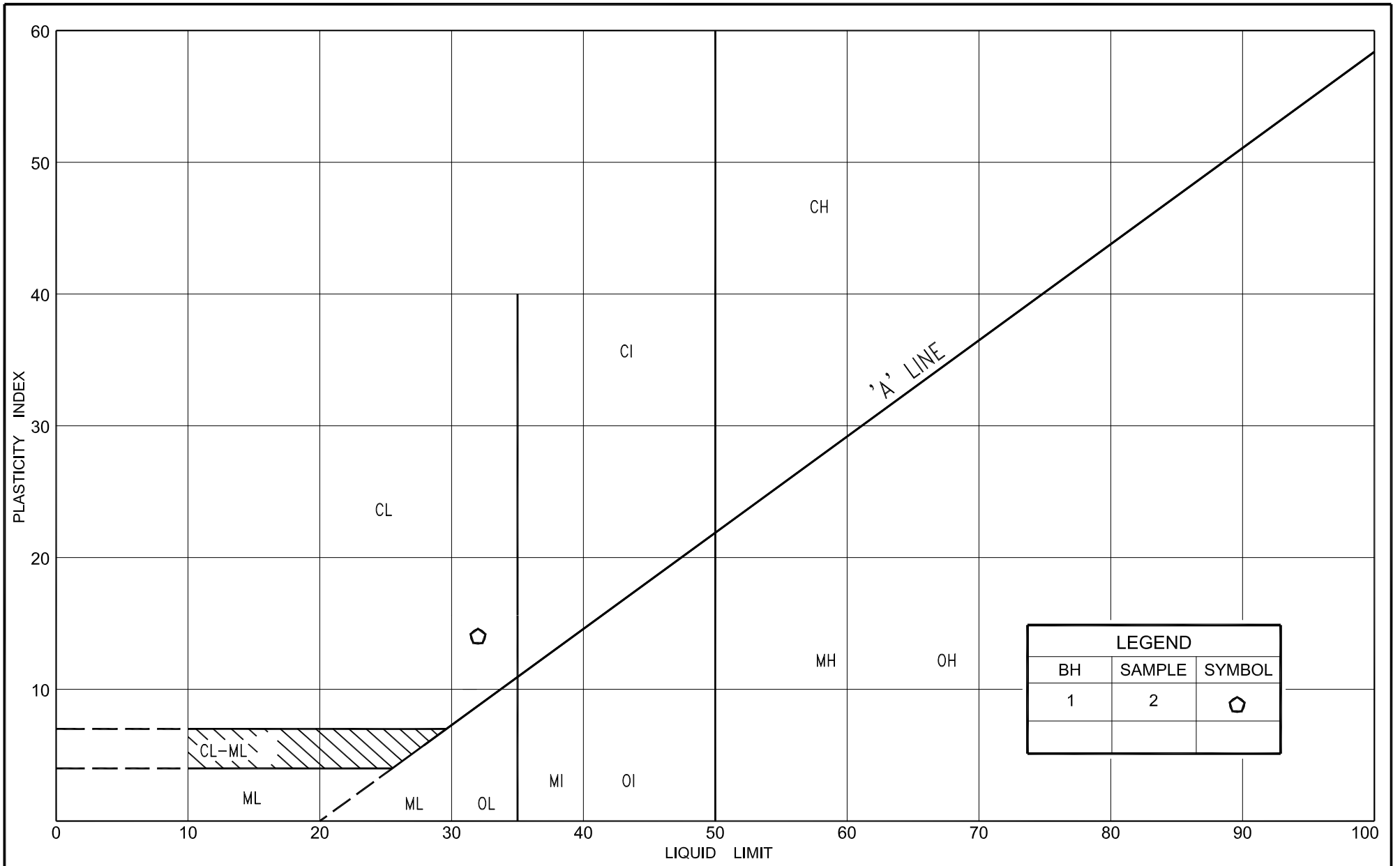


Ontario

GRAIN SIZE DISTRIBUTION

GRAVELLY SAND, some silt, trace clay

FIG No.	KR-GS-5
HWY:	4
W.P. No.	3125-03-01

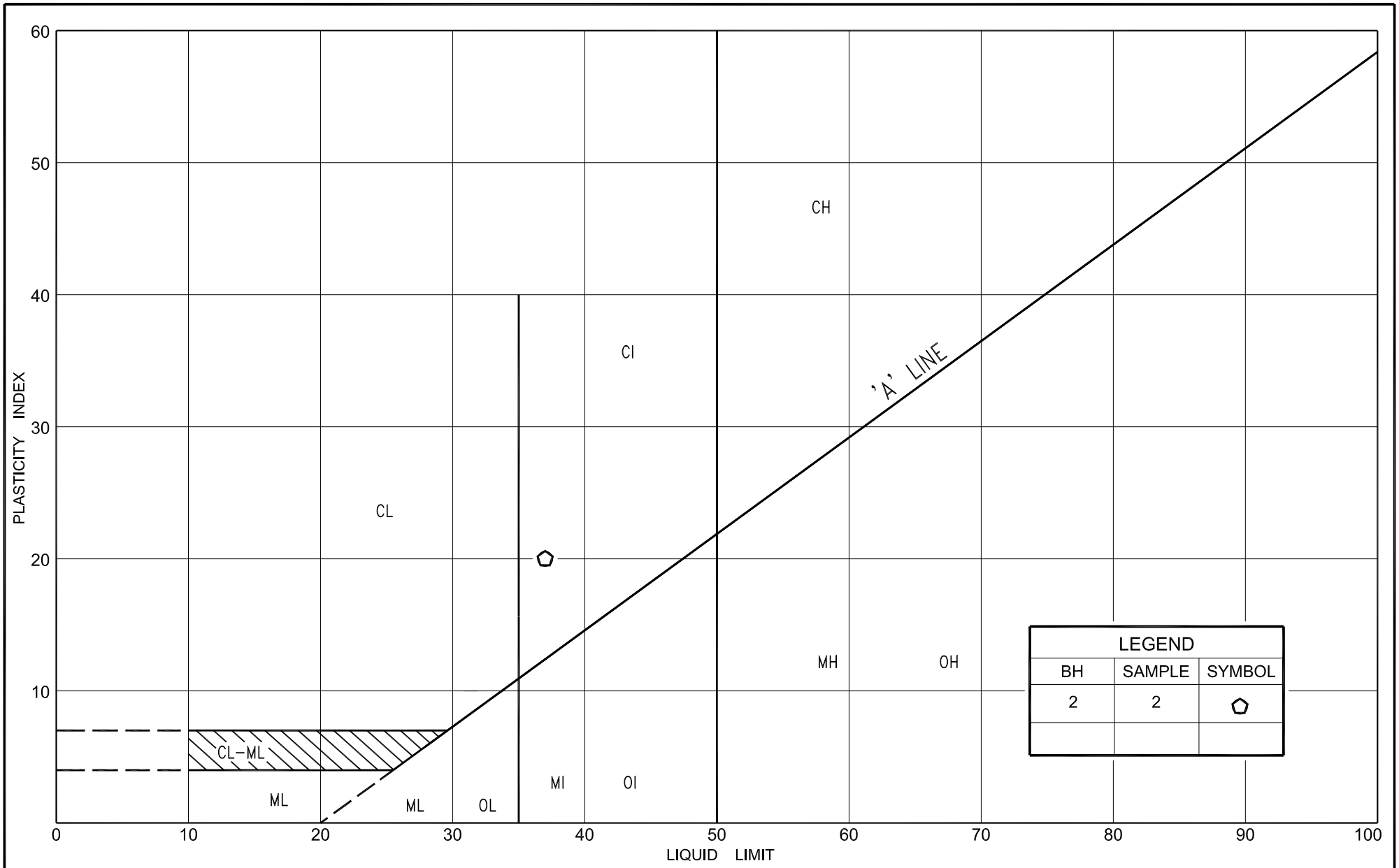


Ontario

PLASTICITY CHART

CLAYEY SILT, some sand, trace gravel (CL)
(FILL)

FIG No.	KR-PC-1
HWY:	4
W.P. No.	3125-03-01

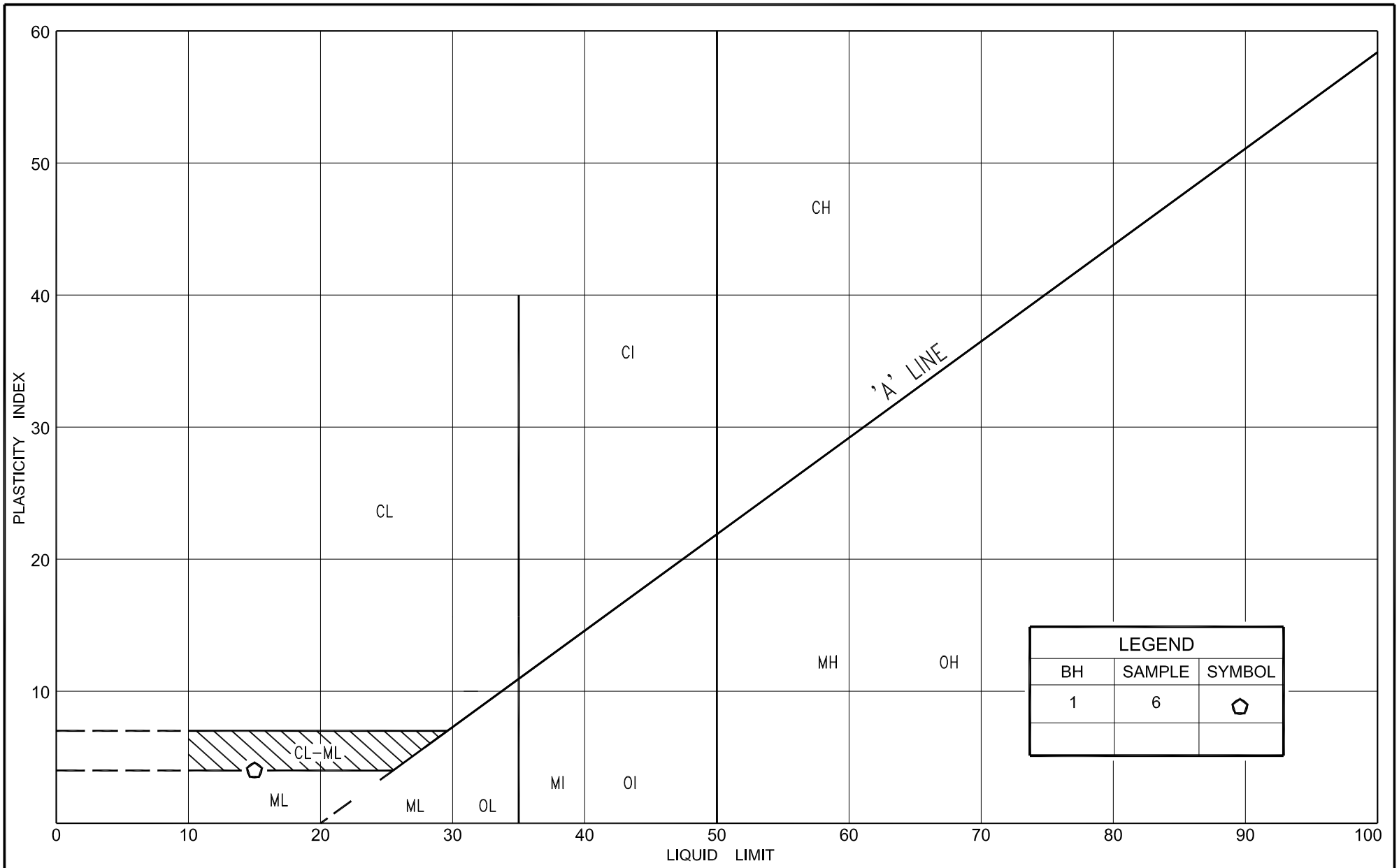


Ontario

PLASTICITY CHART

SILTY CLAY, some sand, trace gravel (CI)
(FILL)

FIG No.	KR-PC-2
HWY:	4
W.P. No.	3125-03-01



Ontario

PLASTICITY CHART

SANDY SILT, some clay, some gravel (ML)

FIG No.	KR-PC-3
HWY:	4
W.P. No.	3125-03-01

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.

COMPOSITION: SECONDARY SOIL COMPONENTS ARE DESCRIBED ON THE BASIS OF PERCENTAGE BY MASS OF THE WHOLE SAMPLE AS FOLLOWS:

PERCENT BY MASS	0 – 10	10 – 20	20 – 30	30 – 40	> 40
	TRACE	*SOME*	*WITH*	*ADJECTIVE (SILTY)*	*AND (AND SILT)*

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 (R Q D), 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
F V	FIELD VANE		

STRESS AND STRAIN

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

MECHANICAL PROPERTIES OF SOIL

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

PHYSICAL PROPERTIES OF SOIL

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

Ontario

Peto MacCallum Ltd. CONSULTING ENGINEERS

Foundation Design

RECORD OF BOREHOLE No. 1 1 of 1 METRIC

W.P. 3125-03-01 **LOCATION** Coords: 4 814 521.5 N; 385 305.7 E **ORIGINATED BY** F.P.

DIST London **HWY** 4 **BOREHOLE TYPE** Continuous Flight Hollow Stem Augers **COMPILED BY** A.D.

DATUM Geodetic **DATE** November 13, 2013 **CHECKED BY** B.R.G.

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
270.3	Ground Surface										
0.0	360 mm asphalt over 180 mm concrete over 100 mm sand and gravel						270				
269.7											
0.6	(PAVEMENT FILL)										
	Clayey silt some sand, trace gravel organic inclusions Soft to firm Brown Moist		1	SS	3		269		○		
			2	SS	5				⊢○⊣		5 19 49 27
	Sandy silt some clay, some gravel Loose to compact Brown Moist (FILL)		3	SS	9		268				
			4	SS	26	▽* ▼*	267				
266.0			5	SS	19				○		16 32 40 12
4.3	Sandy silt some clay, some gravel Compact Brown Moist		6	SS	19		266		⊣○		12 30 45 13
265.0											
5.3	Gravelly sand some silt, trace clay cobbles and boulders Compact to very dense Grey Moist		7	SS	39		265		○		
			8	SS	28		264		○		26 51 19 4
			9	SS	62		263		○		
			10	SS	50/15cm		262				
259.9							261				
10.4	Silt, some sand some clay, trace gravel Very dense Grey Moist (TILL)		11	SS	50/8cm		260				
							259				
258.0			12	SS	100/10cm		258				
12.3	End of borehole										

* 2013 11 13

▽ Water level observed during drilling

▼ Water level measured after drilling

ON MTO_VER3 NEW LOGO WP 13KF006B.GPJ ON_MOT.GDT 8/8/2014 9:22:58 AM

+7, ×5 : Numbers refer to Sensitivity

20 / 15 ○ 5 / 10 (%) STRAIN AT FAILURE

Ontario

Peto MacCallum Ltd. CONSULTING ENGINEERS

Foundation Design

RECORD OF BOREHOLE No. 2 1 of 1 METRIC

W.P. 3125-03-01 **LOCATION** Coords: 4 814 488.4 N; 385 316.7 E **ORIGINATED BY** F.P.

DIST London **HWY** 4 **BOREHOLE TYPE** Continuous Flight Hollow Stem Augers **COMPILED BY** A.D.

DATUM Geodetic **DATE** November 13, 2013 **CHECKED BY** B.R.G.

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
270.4	Ground Surface										
0.0 / 269.9	150 mm asphalt over 300 mm sand and gravel						270				
0.5	(PAVEMENT FILL)										
	Silty clay some sand, trace gravel topsoil inclusions		1	SS	5				○		
	Soft to frim Dark brown Moist (FILL)		2	SS	4		269		○—●		2 12 53 33
			3	SS	4		268		○		
267.0			4	SS	11	▽*	267		○		
3.4	Gravelly sand some silt, trace clay					▼*					
	Compact to Grey Moist very dense		5	SS	26		266				
			6	SS	33				○		
	wet sand layers		7	SS	40		265		○		25 55 17 3
	cobbles and boulders		8	SS	43		264		○		
			9	SS	43		263		○		
			10	SS	50/10cm		262				
260.3							261				
10.1	Silt, some sand some clay, trace gravel										
	Very dense Grey Moist (TILL)		11	SS	65/15cm		260				
258.1			12	SS	100/13cm		259				
12.3	End of borehole										

* 2013 11 13

▽ Water level observed during drilling

▼ Water level measured after drilling

ON MTO_VER3 NEW LOGO WP 13KF006B.GPJ ON_MOT.GDT 8/8/2014 9:23:00 AM

+7, ×5 : Numbers refer to Sensitivity

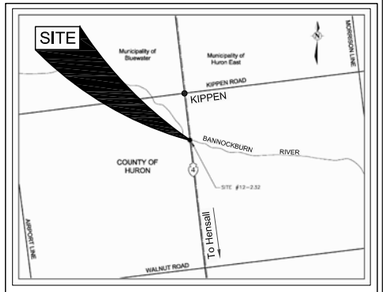
20 / 15 — 5 / 10 (%) STRAIN AT FAILURE

CONT No
WP No 3125-03-01

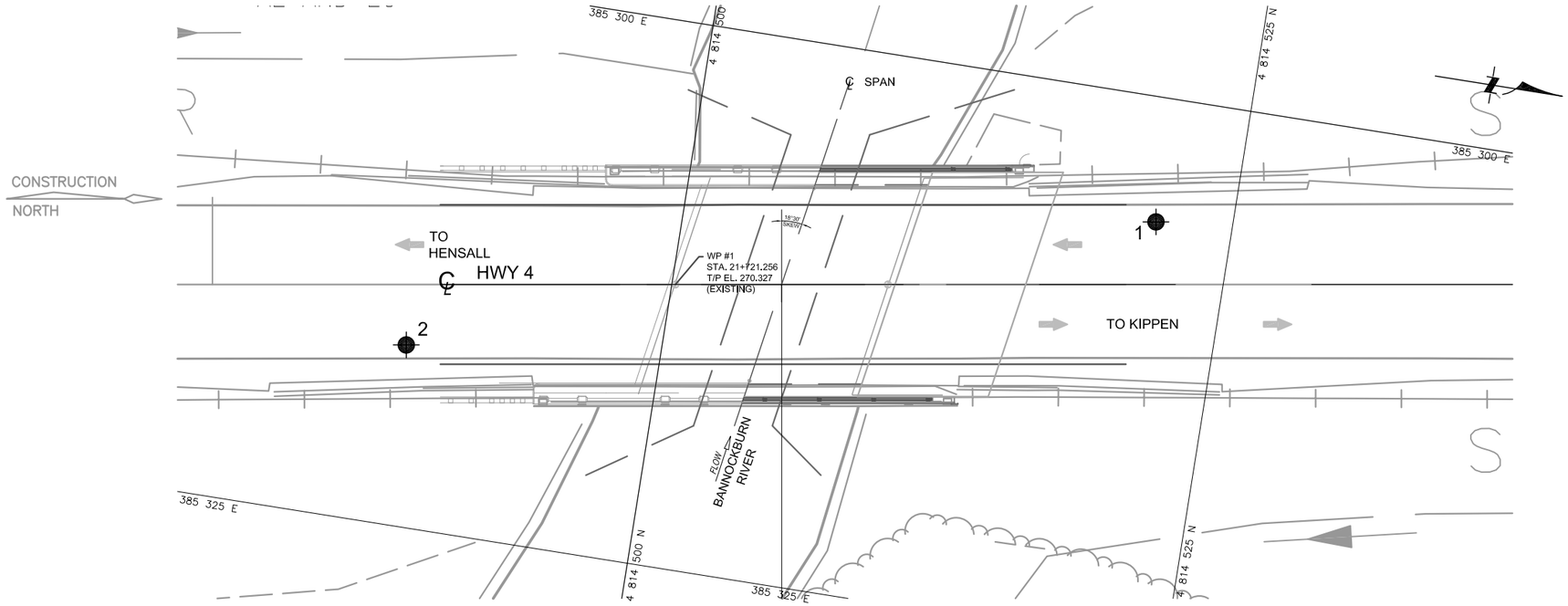
KIPPEN RIVER BRIDGE # 2
HIGHWAY 4
BOREHOLE LOCATIONS AND SOIL STRATA

SHEET

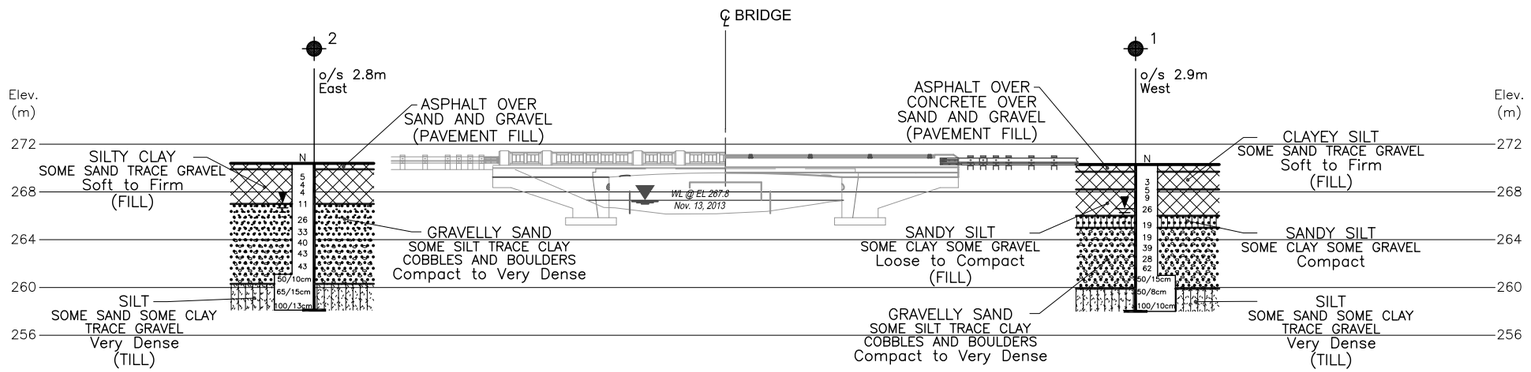
Peto MacCallum Ltd.
CONSULTING ENGINEERS



KEY PLAN
N.T.S.



PLAN
SCALE
2.5 0 2.5 5m



PROFILE ALONG ℄ HIGHWAY 4
SCALE
HORIZONTAL
1.25 0 1.25 2.5m
VERTICAL
2.5 0 2.5 5m

LEGEND

- Borehole
- Borehole and cone
- Cone penetration test
- N — Blows/0.3m (Std. Pen Test, 475 J/blow)
- CONE — Blows/0.3m (60° Cone, 475 J/blow)
- W L at time of investigation Nov. 2013
- Head ARTESIAN WATER Encountered
- PIEZOMETER

BH No	ELEVATION	COORDINATES NORTHINGS	EASTINGS
1	270.3	4 814 521.5	385 305.7
2	270.4	4 814 488.4	385 316.7

NOTES:

1. THIS DRAWING SHOULD BE READ IN CONJUNCTION WITH RECORD OF BOREHOLES AND REPORT
2. THIS DRAWING IS FOR SUBSURFACE INFORMATION ONLY. SURFACE DETAILS AND FEATURES ARE FOR CONCEPTUAL ILLUSTRATION.
3. DIMENSIONS ARE IN METRES AND/OR MILLIMETRES UNLESS OTHERWISE SHOWN. STATIONS ARE IN KILOMETRES AND METRES.

LICENSED PROFESSIONAL ENGINEER
R. M. CONG
NOV. 26, 2014
PROVINCE OF ONTARIO

REGISTERED PROFESSIONAL ENGINEER
B. R. GRAY
NOV. 26, 2014
PROVINCE OF ONTARIO

Ref No. MRC Drawing: S3813-001-001GA.dwg; dated April 2014

— NOTE —
The boundaries between soil strata have been established only at Borehole locations. Between Boreholes the boundaries are assumed from geological evidence.

REVISIONS	DATE	BY	DESCRIPTION

Geocres No. 40P5-20

HWY No	4			DIST	LONDON
SUBM'D	NA	CHECKED	AD	DATE	NOV. 26, 2014
DRAWN	NA	CHECKED	RN	APPROVED	BRG
SITE	12-232				
DWG	1				

APPENDIX A

Site Photographs

Photograph 1: Looking north at the adjacent east slope of the north abutment from the east slope of the south side of the bridge. Cracks were observed on the wingwall. Slight scouring of the slope toe edge was observed. (May 10, 2014)

Photograph 2: Looking at the east slope adjacent to the south abutment. Scouring of the slope toe edge and erosion of the slope surface were observed. (May 10, 2014)

Photograph 3: Looking at the west slope adjacent to the north abutment. Scouring of the slope toe edge was observed. Concrete deterioration on wingwall was also observed. (May 10, 2014)

Photograph 4: Looking at the east slope adjacent to the south abutment. Scouring of the slope toe edge was observed. Concrete deterioration on east wingwall of the south abutment was also observed. (May 10, 2014)

Photograph 5: Looking north from the west slope of the south side of the bridge. Minor surface cracks, wall surface deterioration and a visible crack on the north abutment wall were observed. Potential scouring effect could not been verified under the water at the abutment wall. (May 10, 2014)

Photograph 6: Looking south from the west slope of the north side of the bridge. Minor surface cracks, wall surface deterioration and a visible crack on the south abutment wall were observed. Concrete spallings off the wall at the water level was also observed. Potential scouring effect could not been verified under the water at the abutment wall. (May 10, 2014)

Photograph 7: Looking north at the west slope adjacent to the north abutment. Rock protection placed on the slope to prevent slope surface erosion. (May 10, 2014)