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GEOCRES No. _____

DIST. 54 REGION _____

W.P. No. 774-93-00(B)

CONT. No. _____

W. O. No. _____

STR. SITE No. 44-370

HWY. No. 11

LOCATION Hwy 522 Underpass

No. of PAGES - ~

OVERSIZE DRAWINGS TO BE INCLUDED WITH THIS REPORT. _____

REMARKS: _____

Trow

Foundation Investigation and Design Report For Approach Embankment Along Highway 522 Underpass (Site 44-370) at Trout Creek By-Pass (King's Highway 11) District 54, Sudbury, Ontario GWP No. 774-93-00 W.P. 770-93-01

Prepared for:

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SO7524G/C
July, 1999

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Appendix A

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Preface

Work Project GWP 774-93-00 is one of a series of projects for the four lane expansion of Highway 11. The project involves the four lane design of Highway 11, from 4.0 km south of Highway 522, northerly for 7.9 km. It will result in the construction of a westerly by-pass of the existing Highway 11 and the Town of Trout Creek.

This work project is located in the Townships of Laurier and Himsworth South, within the geographic District of Parry Sound. The project requires geotechnical input for the following major components:

- New pavement design for the entire length of the four lane by-pass, including associated service roads.
- New structure, Trout Creek South Interchange (underpass), Site 44-372.
- New structure, Trout Creek, Northbound Lanes, Site 44-371.
- New structure, Trout Creek, Southbound Lanes, Site 44-371.
- New structure, Highway 522 (underpass), Site 44-370.
- New structure, Trout Creek North Interchange (underpass), Site 44-369.

The following report deals with the new approach embankments for the flyover at Highway 522, Site 44-370. Separate reports will be submitted for the additional components.

PART 1 FOUNDATION INVESTIGATION

1.1 Introduction

This submission presents the results of a geotechnical foundation investigation by Trow Consulting Engineers Ltd. (Trow) for the new approach embankments for the flyover at Highway 522 and the proposed King's Highway 11, (Trout Creek By-Pass), at Site 44-370. It is Trow's understanding that a two span structure will be constructed, with the central pier located in the median of the proposed King's Highway 11. This report contains factual information (obtained from the field investigation) pertaining to the design parameters required for the approach embankments along Highway 522.

1.2 Site Description and Geological Setting

1.2.1 Site Description

The site is located in the Township of South Himsworth at the proposed bridge structure for Highway 522 and the proposed King's Highway 11, Trout Creek By-Pass, at Site 44-370.

The proposed new, two-span bridge will be constructed to carry Highway 522 traffic over the four lanes of King's Highway 11. An 8 m grade increase of Highway 522 at the bridge abutments is anticipated, in accordance with the proposed grading plan.

The terrain at the proposed bridge structure is relatively flat, although the grade of the existing Highway 522 rises gently towards both the west and east sides. The grade of Highway 522, at the bridge site is at elevation 315 m and the existing road then rises gradually some 5 m, over a distance of approximately 240 m on the east side (up to Station 10+240), and 3 m, over approximately 200 m on the west side (up to Station 9 + 800).

The grade of Highway 522 will be raised to elevation 323 m at the bridge to accommodate the proposed four lanes of the by-pass. This arrangement will require approach embankments along Highway 522, approximately 240 m long (from the east side) and 200 m long (from the west side).

No bedrock outcrops are visible in the immediate vicinity of the proposed bridge; however, a rock cut is visible approximately 200 m along Highway 522 on the west side. There are mature trees, with heavy underbrush on either side of Highway 522, i.e. along the alignment of the proposed King's Highway 11.

1.2.2 Geological Setting

According to OGS Maps 2544 and 2556, as well as Ontario Geological Survey Map P. 3160 (Quaternary geology, South River area), the site is located in what is known as the Central Gneiss Belt, i.e. mainly felsic igneous rocks of the Mesoproterozoic Group.

The overburden is expected to be relatively shallow, comprising, for the most part, of detaic sands and gravels with some prodeltaic deposits, mainly silts. A thin layer of basal, stoney, glacial till can be expected immediately over the bedrock.

1.3 Investigative Procedures

1.3.1 General

Part 1 of this report describes the investigative procedures adopted for the geotechnical assessment of the new approach embankments along Highway 522 at the proposed Trout Creek By-Pass, King's Highway 11. Properties of the overburden soils were obtained by in-situ and laboratory testing and the procedures, employed during the investigation, are described below.

1.3.2 Field Investigation

The field work for the investigation related to the proposed Highway 522 approach embankments was carried out on May 25 and June 24, 1998, and consisted of eight(8) boreholes (BH's 6-CP to 13-CP) inclusive, and two(2) dynamic cone penetration tests (C-4CP and C-5CP). The dynamic cones and boreholes were advanced to refusal at depths ranging from 3.5 m to 7.8 m. Boreholes 6-CP and 8-CP to 11-CP, as well as cone C-4CP, were located along the 240 m length of the east side approach fills, and boreholes 7-CP, 12-CP and 13-CP, and cone C-5CP along the 200 m length of the west approach fills.

The borehole and dynamic cone penetration locations are shown on the attached site plan, Drawing 1, in Appendix A. These locations, as well as the surface elevations, were established by Trow's field technician and a survey crew from Marshall Macklin Monaghan, and are referenced to geodetic datum.

The boreholes, cones and probes were advanced through the overburden soils using a truck mounted CME-55 drill, equipped with solid and hollow stem augers, and supplied and operated by a soils drilling contractor, Master Soil Investigation Limited. Soil samples were obtained by using a 51 mm O.D. split-spoon sampler in conjunction with standard penetration tests (ASTM D1586) at approximately 0.75 m and 1.5 m intervals. The standard penetration (N) values, together with the blows from the dynamic cone penetration tests, were recorded and used to provide an assessment of the compactness of the overburden soils. The recovered soil samples were used for identification and laboratory testing.

Upon completion, boreholes were backfilled with auger cuttings from the same boreholes, and compacted at regular intervals by applying back pressure with the auger. Where boreholes were advanced within the pavement surface, cold mix asphalt was placed to adequately patch the damaged area.

Details of the soil and bedrock conditions encountered in the boreholes are included on the logs in the attached Appendix A. The additional two standard data sheets, included with the logs, provide further details on soil descriptions for classification purposes. For completeness, two of the previous boreholes (boreholes 1-CF and 3-CF), advanced for the bridge structure at the abutments, have also been included.

1.3.3 Laboratory

The laboratory testing program for select soil samples consisted of the following:

- Natural moisture content determinations
- Grain size distribution analyses
- Laboratory shear tests

The laboratory test results are summarized on the attached borehole logs in Appendix A. The grain size distribution for selected soil samples are presented in Appendix B.

1.4 Subsurface Conditions

The borehole locations are shown on the site plan, Drawing 1, in Appendix A. Also included in Appendix A are the borehole and dynamic cone penetration logs. Based on this information, the following different soil layers were encountered:

- fill
- silt
- sand/sand and gravel
- bedrock

A summary of the above soil strata encountered in the boreholes, and inferred from the dynamic cone penetration tests, is presented below.

1.4.1 Fill

The fill at the test locations is associated with the road construction materials for the existing Highway 522. Beneath the present asphalt (~50 mm thick) and the base and subbase granulars (~700 mm thick), an underlying layer of sand and/or sand and gravel fill was encountered, which extends to depths generally in the 2.0 m to 2.5 m range. The fill is mostly sand, although it contains random pieces of old asphalt, some gravel and/or cobble sizes, as well as minor organic staining and contamination.

The compactness of the fill, based on the standard penetration resistance, "N", value ranged from 4 to 36 blows/300 mm, indicating a loose to dense state.

Grain size analyses on samples of the material confirm that the deposit is mainly a fine sand with a silt fraction of between 20% to 30%. Moisture contents vary from less than 10% above the water table to about 20% below the groundwater table.

1.4.2 Silt

A deposit of silt was encountered in five boreholes (boreholes 3-CF, 8-CP, 9-CP, 10-CP, 12-CP and 13-CP). This silt stratum is absent in the vicinity of the east abutment and is more prominent beneath the west approach embankment (boreholes 12-CP and 13-CP). The silt contains some sand seams and odd layering, where it is slightly cohesive. The standard penetration resistance "N" values ranged from 4 to 14 blows/300 mm, indicating a loose to compact state of compaction. The thickness ranged from 1 m (borehole 3-CF) to 3 m (borehole 12-CP), and the moisture content from 25% to 35%.

1.4.3 Sand and Gravel

A basal zone of sand and gravel was encountered in all boreholes, with the exception of boreholes 8-CP and 9-CP. The deposit is reasonably well-graded with up to 31% silt sizes in places. At some locations, the stratum appears to be weakly cemented, indicating a "till-like" structure. The standard penetration resistance "N" values range from 9 to 25 blows/300 mm, indicating a loose to compact condition. The thickness ranges from about 1 m at borehole 1-CF to 4 m at borehole 3-CF. Moisture contents ranged from 5% to 20%.

1.4.4 Bedrock

Bedrock was confirmed by retrieving "NQ" size cores in the two boreholes at the abutments (BH's 1-CF and 3-CF) at depths of 3.72 m (~El. 311.2 m) and 8.14 m (~El. 307.2 m).

Detailed descriptions of the rock are presented in Table 1-1 in Appendix A. Generally, the bedrock can be described as a pinkish, light grey, biotite-Homblende gneiss. The rock is strong and unweathered for the most part. Rock core recovery was 100% for all runs and the Rock Quality Designation (RQD) values ranged from 75% to 100%.

In the remaining boreholes and cones, the refusal levels noted in the logs are assumed to represent the bedrock surface.

1.5 Groundwater Conditions

Information regarding the groundwater levels at the site was obtained by measuring the water levels in the open boreholes after completion of drilling. The groundwater table, at the time of the field work, was established at a depth of about 2 m to 2.5 m below grade, which is close to the grade of the surrounding, poorly drained, relatively flat terrain.

Seasonal variations in the water table should be expected with higher levels during wetter periods of the year (such as spring thaw and late fall) and lower levels during drier periods.

Part 2 Discussion and Recommendations

2.1 Introduction

This submission presents the results of a geotechnical foundation investigation by Trow Consulting Engineers Ltd. (Trow) for the new approach embankments for the flyover at Highway 522 and the proposed King's Highway 11, Trout Creek By-Pass, at Site 44-370. It is Trow's understanding that a two-span structure will be constructed, with the central pier located in the median of the proposed King's Highway 11. This report contains factual information (obtained from the field investigation) pertaining to the design parameters required for the approach embankments along Highway 522.

As outlined in Part 1 of this report, the grade at Highway 522 at the structure is at elevation 315 m and the existing road then rises gradually some 5 m, over a distance of approximately 240 m on the east side (up to station 10+240) and 3 m, over approximately 200 m on the west side (up to station 9+800). The grade of Highway 522 will be raised to elevation 323 m at the bridge to accommodate the proposed four lanes of the By-Pass.

This geometric arrangement will require approach fills, along Highway 522, up to a maximum of 8 m at the proposed bridge abutments, before tying into the existing grade of Highway 522 at a distance of 240 m on the east side and 200 m on the west side.

2.2 Design

2.2.1 Stability

Based on the results of the boreholes and dynamic cone penetration tests, no instability problems are anticipated. The underlying granular soils, i.e. sand, silts and sand and gravels, are adequate to safely support the proposed approach fill heights.

Surficial topsoil and compressible organics, under the plan limits of the embankments where the approach fills encroach off the existing road construction and over the adjacent soils, should be removed. Based on Trow's adjacent borings for the pavement design of Highway 11, it is likely that the surficial organics will be about 300 mm to 600 mm thick.

If rock fill is used to construct the approach embankments, the side slopes and forward slopes should be constructed at a maximum gradient of 1.25H:1V. If Granular "B" is used, the side slopes should be constructed at 2H:1V.

2.2.2 Settlements

Since the proposed approach embankments are underlain by granular soils, long-term consolidation settlements are not anticipated. There will likely be some initial settlement, due to the surcharge embankment loads; however, it is anticipated that they will be less than 50 mm and will occur, almost entirely, within the construction phase.

2.3 Construction Considerations

2.3.1 Excavations

Temporary subexcavation for surficial organics is not expected to exceed 1 m and hence should be straightforward. Side slopes will remain stable if cut back at an angle of 1H:1V.

2.3.2 Raising the Grade

Rock fill or other granular fills placed below the groundwater table may be end-dumped. Once the material is 0.3 m above the water table, placement and compaction of the fills should be carried out according to current OPS specifications and practices.

2.4 General

The information presented in this report is based on a limited investigation designed to provide information to support an overall assessment of the current geotechnical conditions for the proposed approach embankments along Highway 522 at King's Highway 11, Trout Creek By-Pass. The conclusions presented in this report reflect site conditions existing at the time of the investigation. It is noted that the soil boundaries indicated on the logs are inferred from discontinuous sampling and observations during drilling. These boundaries are intended to reflect transition zones for the purpose of geotechnical design and should not be interpreted as exact planes of geological change.

This report has been prepared by Mr. I.W. Gore, P.Eng., and Mr. E.A. Gonneau, P.Eng., and reviewed by Mr. S.E. Gonsalves, P.Eng. The field investigation was performed by Mr. I. Dumpis, C.E.T.

We trust this report is satisfactory for your purposes. Should you have any questions, please do not hesitate to contact this office.

Trow Consulting Engineers Ltd.

E.A. Gonneau, P.Eng.
Project Manager

I.W. Gore, M.Sc., P.Eng.
Principal

S.E. Gonsalves, M.Sc., P.Eng.
Vice President

Encl.

Dist: Ministry of Transportation (8)
Planning & Design
Mr. E. Gallant

Marshall Macklin Monaghan (1)
Mr. R.D. Kivi, P.Eng.

IWG:jot/8.1/Geo/reports7524gc2.wpd

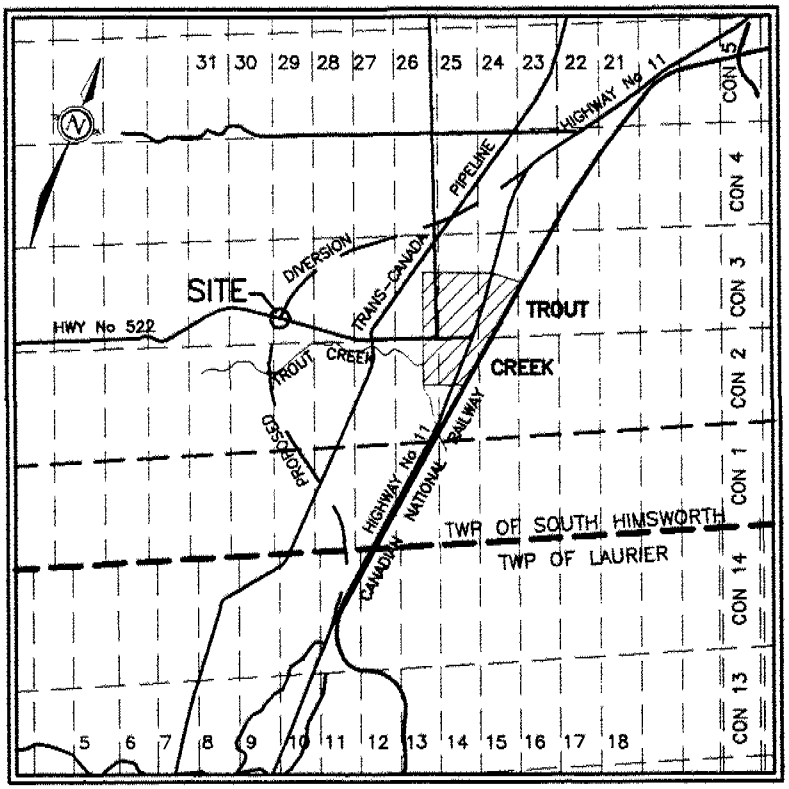
APPENDIX A

METRIC

DIMENSIONS ARE IN METRES
AND/OR MILLIMETRES
UNLESS OTHERWISE SHOWN

PLATE No	509-11/176-0
DRAWING No	05090011176
CONT No	
WP No	774-93-00

SHEET



KEY PLAN

1 km 0 1 km

TROW CONSULTING ENGINEERS LTD.
SUDBURY, ONTARIO

Trow PROJ. No. S07524GCP DWG. No. 1

MINISTRY OF TRANSPORTATION
ENGINEERING OFFICE
SURVEYS AND PLANS SECTION

KEY PLAN

PROPOSED CROSSING
AT
SEC HIGHWAY 522
AND
PROPOSED C/L MEDIAN HWY 11

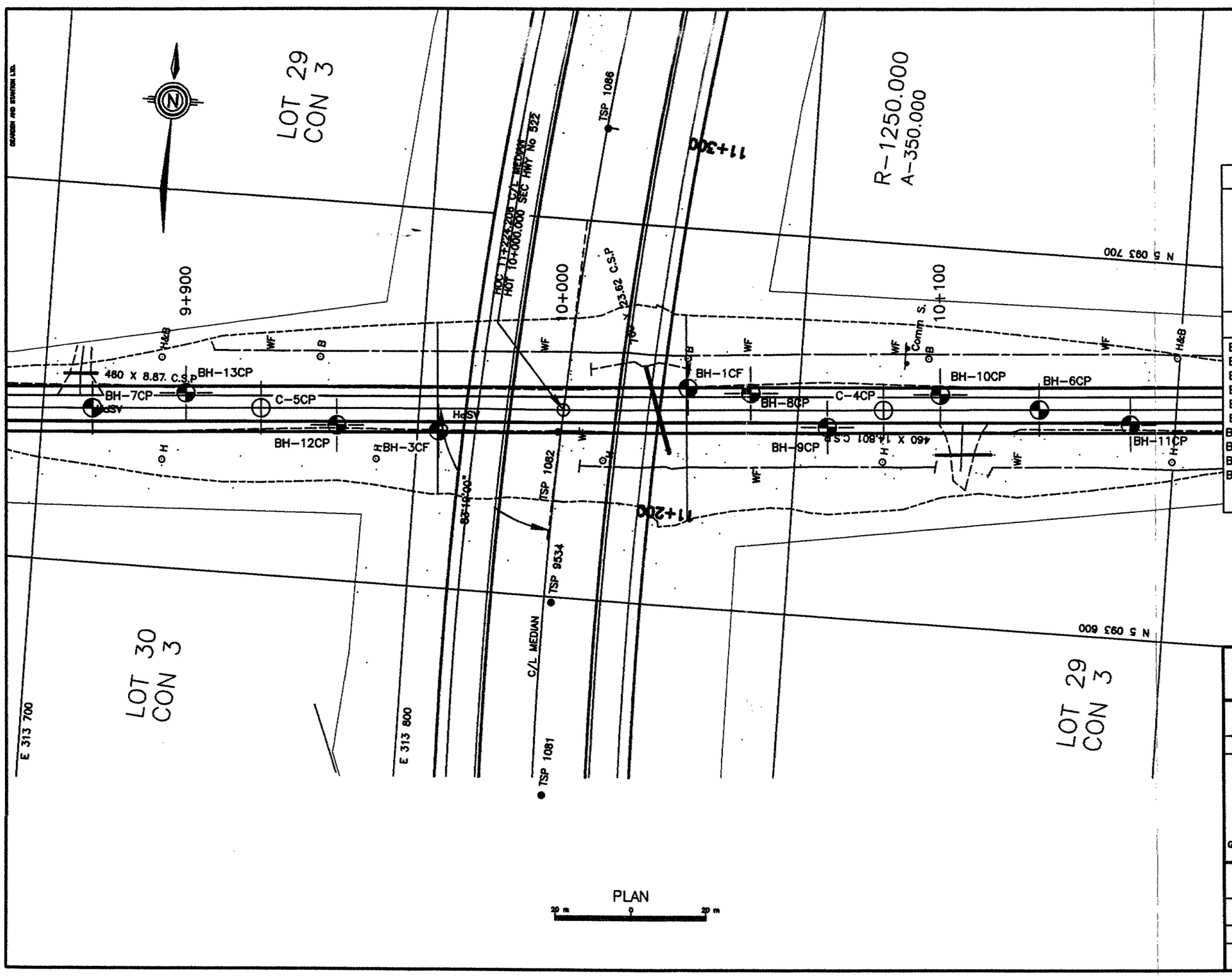
GEOG TWP SOUTH HIMSWORTH LOT 29 DIST OF PARRY SOUND CON 3

SCALE	DISTRICT	REGION
1:400	PARRY SOUND	NORTHERN
	ETR 509-11	

SURVEY DATE 97/10	PLAN DATE 97/10
SITE 44-370	PLAN E-509-11-12

PLATE No 509-11/176-0
DRAWING No 05090011176
CONT No
WP No 774-93-00

SHEET



LEGEND

- BOREHOLE
- AUGER PROBE
- DYNAMIC CONE PENETRATION TEST

No.	ELEV.	CO-ORDINATES NORTH	EAST
BH-1CF	314.90	5 093 657.8	313 870.8
BH-3CF	315.37	5 093 641.5	313 805.6
BH-6CP	316.81	5 093 658.9	313 963.6
BH-7CP	317.89	5 093 640.8	313 713.2
BH-8CP	315.05	5 093 657.7	313 887.4
BH-9CP	315.22	5 093 650.1	313 908.1
BH-10CP	315.95	5 093 660.9	313 937.3
BH-11CP	317.40	5 093 656.6	313 987.8
BH-12CP	316.15	5 093 641.0	313 778.4
BH-13CP	317.19	5 093 646.6	313 737.9
C-4CP	315.83	5 093 655.8	313 922.7
C-5CP	316.92	5 093 644.0	313 758.1

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

TROW CONSULTING ENGINEERS LTD.
SUDBURY, ONTARIO
Trow PROJ. No. S07524GCP DWG. No. 1A

MINISTRY OF TRANSPORTATION
ENGINEERING OFFICE
SURVEYS AND PLANS SECTION

BRIDGE SITE PLAN

PROPOSED CROSSING
AT
SEC HIGHWAY 522
AND
PROPOSED C/L MEDIAN HWY 11

GEOG TWP SOUTH HIMSWORTH LOT 29 — DIST OF PARRY SOUND CON 3

SCALE	DISTRICT	REGION
1:1000	PARRY SOUND	NORTHERN
	ETR 509-11	

SURVEY DATE 97/10 — PLAN DATE 97/10

SITE 44-370 — PLANE-509-11-12

RECORD OF BOREHOLE BH-1CF 1 OF 1

METRIC

W.P. 774-93-00 LOCATION 5 093 657.8 N, 313 870.8 E ORIGINATED BY I.D.

DIST 54 HWY 11 BOREHOLE TYPE Hollow Stem Augers / CME-55 COMPILED BY M.D.

DATUM Geodetic DATE May 12, 1998 CHECKED BY I.G.

ELEV. / DEPTH	DESCRIPTION	STRATA PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES BLOWS/0.3m	GROUND WATER CONDITIONS	ELEVATION SCALE (metres)	SPT TEST (N-Value) / CONE PENETRATION TEST (20 40 60 80)	SHEAR STRENGTH: Cu, KPa ● UNCONFINED QUICK TRIAXIAL × FIELD VANE LAB SHEAR (20 40 60 80)	PLASTIC LIMIT wp / NATURAL MOISTURE CONTENT w / LIQUID LIMIT wl — WATER CONTENT (%) (10 20 30 40)	UNIT WEIGHT kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION GR SA SI + CL
314.90	GROUND SURFACE											
0.00	**FILL,** mostly silty sand & gravel with a few cobble sizes, occasional pieces of asphalt, brown, moist. (compact)	F F F F	1	SS	28		314					
312.40							313	⊗		o		
2.50	**SAND & GRAVEL,** pockets of sand, some cobble sizes & possible boulders, brown, wet. (compact)		2	SS	13	▼	312	⊗		o		
311.18							311					
3.72	**BIOTITE HORNBLENDE GNEISS,** pinkish grey, excellent rock quality, unweathered.		3	NQ								Rec 100% RQD 98%
			4	NQ			310					Rec 100% RQD 100%
			5	NQ			309					Rec 100% RQD 100%
308.01												
6.89	END OF BOREHOLE											

Notes:
1) This borehole forms part of Highway 522 Underpass Foundation Investigation.
2) Borehole located at station 10+033.3, offset ~6.5 m left of centreline as referenced to Highway 522.

MT04 7524C 07/17/98

RECORD OF BOREHOLE BH-3CF 1 OF 1

METRIC

W.P. 774-93-00 LOCATION 5 093 641.5 N, 313 805.6 E ORIGINATED BY I.D.

DIST 54 HWY 11 BOREHOLE TYPE Hollow Stem Augers / CME-55 COMPILED BY M.D.

DATUM Geodetic DATE May 12, 1998 CHECKED BY I.G.

ELEV. / DEPTH	DESCRIPTION	STRATA PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES BLOWS/0.3m	GROUND WATER CONDITIONS	ELEVATION SCALE (metres)	SPT TEST (N-Value) / CONE PENETRATION TEST (20 40 60 80)	SHEAR STRENGTH: Cu, kPa (UNCONFINED QUICK TRIAXIAL ● FIELD VANE LAB SHEAR ×) (20 40 60 80)	PLASTIC LIMIT wp — NATURAL MOISTURE CONTENT w — LIQUID LIMIT wl; WATER CONTENT (%) (10 20 30 40)	UNIT WEIGHT kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION GR SA SI + CL
315.37	GROUND SURFACE						315					
0.00	**SAND & GRAVEL FILL,** occasional lumps of asphalt, brown, moist. (compact/dense)		1	SS	29	▽						
314.17							314					
1.20	**SAND,** brown, wet, traces of organics, (possible FILL). (compact)		2	SS	16							
312.37			3	SS	9		313					
3.00	**SILT,** grey, trace of clay, wet. (very loose)		4	SS	3		312					
311.37							311					
4.00	**SAND,** with gravel sizes, brown, moist then wet below ~6.0 m depth, occasional cobbles. (compact)		5	SS	18							7% 83% 10%
			6	SS	12		310					
			7	SS	19		309					
307.23							308					
8.14	**BIOTITE HORNBLENDE GNEISS,** pinkish grey, good to excellent rock quality, slightly weathered to unweathered.		8	NQ			307					Rec 97% RQD 76%
			9	NQ			306					Rec 100% RQD 76%
303.97			10	NQ			305					Rec 100% RQD 94%
11.40	END OF BOREHOLE						304					

Notes:
1) This borehole forms part of Highway 522 Underpass Foundation Investigation.
2) Borehole located at station 9+966.8, ~5.0 m right of centreline as referenced to Highway 522.

MT04 7524C 07/17/98

RECORD OF BOREHOLE C-4CP

1 OF 1

METRIC

W.P. 774-93-00 LOCATION 5 093 655.8 N, 313 922.7 E ORIGINATED BY I.D.

DIST 54 HWY 11 BOREHOLE TYPE Dynamic cone test / CME-55 COMPILED BY M.D.

DATUM Geodetic DATE May 25, 1998 CHECKED BY I.G.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE (metres)	SPT TEST (N-Value) / CONE PENETRATION TEST	PLASTIC LIMIT / NATURAL MOISTURE CONTENT / LIQUID LIMIT	UNIT WEIGHT	REMARKS & GRAIN SIZE DISTRIBUTION
ELEV. / DEPTH	DESCRIPTION	STRATA PLOT	NUMBER	TYPE	BLOWS/0.3m			SHEAR STRENGTH: Cu, KPa (UNCONFINED QUICK TRIAXIAL / FIELD VANE LAB SHEAR)	WATER CONTENT (%)		
315.83	GROUND SURFACE							20 40 60 80	wp — w — wl; 10 20 30 40	kN/m³	GR SA SI + CL
0.00	Dynamic cone test only.						315				
							314				
							313				
							312				
311.11											
4.72	END OF CONE TEST DUE TO BOUNCING REFUSAL ON BEDROCK OR BOULDER										

Notes:
1) This cone test forms part of Highway 522 Underpass Foundation Investigation.
2) Cone test located at station 10+085.0, on centreline as referenced to Highway 522.
3) Augered first 0.3 m through dense fill before driving cone test.

MTO4 7524C 07/17/98

RECORD OF BOREHOLE C-5CP

1 OF 1

METRIC

W.P. 774-93-00 LOCATION 5 093 644.0 N, 313 758.1 E ORIGINATED BY I.D.

DIST 54 HWY 11 BOREHOLE TYPE Dynamic cone test / CME-55 COMPILED BY M.D.

DATUM Geodetic DATE May 25, 1998 CHECKED BY I.G.

ELEV. / DEPTH	DESCRIPTION	STRATA PLOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: BLOWS/0.3m	GROUND WATER CONDITIONS	ELEVATION SCALE (metres)	SPT TEST (N-Value) / CONE PENETRATION TEST (20 40 60 80) / SHEAR STRENGTH: Cu, KPa (UNCONFINED QUICK TRIAXIAL ● FIELD VANE LAB SHEAR ×) (20 40 60 80)	PLASTIC LIMIT wp — NATURAL MOISTURE CONTENT w — LIQUID LIMIT wl / WATER CONTENT (%) (10 20 30 40)	UNIT WEIGHT kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION GR SA SI + CL
316.92	GROUND SURFACE										
0.00	Dynamic cone test only.						316 315 314 313 312 311 310				
309.15											
7.77	END OF CONE TEST DUE TO BOUNCING REFUSAL ON BEDROCK OR BOULDER										

Notes:
1) This cone test forms part of Highway 522 Underpass Foundation Investigation.
2) Cone test located at station 9+920.0, on centreline as referenced to Highway 522.
3) Augered first ~0.3 m through dense fill before driving cone test.

MTO4 7524C 07/17/98

RECORD OF BOREHOLE BH-6CP 1 OF 1

METRIC

W.P. 774-93-00 LOCATION 5 093 658.9 N, 313 963.6 E ORIGINATED BY I.D.

DIST 54 HWY 11 BOREHOLE TYPE Hollow Stem Augers / CME-55 COMPILED BY M.D.

DATUM Geodetic DATE May 25, 1998 CHECKED BY I.G.

ELEV. / DEPTH	DESCRIPTION	STRATA PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES BLOWS/0.3m	GROUND WATER CONDITIONS	ELEVATION SCALE (metres)	SPT TEST (N-Value) / CONE PENETRATION TEST (20 40 60 80)	SHEAR STRENGTH: Cu, KPa (UNCONFINED QUICK TRIAXIAL ○ / FIELD VANE LAB SHEAR ×) (20 40 60 80)	PLASTIC LIMIT wp / NATURAL MOISTURE CONTENT w / LIQUID LIMIT wl — WATER CONTENT (%) (10 20 30 40)	UNIT WEIGHT kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION GR SA SI + CL
316.81	GROUND SURFACE											
0.00	**ASPHALT,** ~40 mm over **SAND,** with gravel inclusions, brown to grey, some cobbles, moist to wet at base. (compact)		1	SS	24		316	⊗		○		
			2	SS	36		315	⊗		○		
314.21			3	SS	8	▼	314	⊗		○		
2.60	**PEAT,** numerous roots ~450 mm thick over **SILTY SAND,** with gravel, grey/brown, wet, (compact)		4	SS	9		313	⊗		○		
312.85												
3.96	END OF BOREHOLE DUE TO REFUSAL TO AUGER ON BEDROCK OR BOULDER											

Notes:
1) This borehole forms part of Highway 522 Underpass Foundation Investigation.
2) Borehole located at station 10+126.0, on centreline as referenced to Highway 522.
3) Borehole caved wet at ~4.0 m depth on completion.

MTO4 7524C 07/17/98

RECORD OF BOREHOLE BH-7CP 1 OF 1

METRIC

W.P. 774-93-00 LOCATION 5 093 640.8 N, 313 713.2 E ORIGINATED BY I.D.

DIST 54 HWY 11 BOREHOLE TYPE Standard Augers / CME-55 COMPILED BY M.D.

DATUM Geodetic DATE May 25, 1998 CHECKED BY I.G.

ELEV. DEPTH	DESCRIPTION	STRATA PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES BLOWS/0.3m	GROUND WATER CONDITIONS	ELEVATION SCALE (metres)	SPT TEST (N-Value) / CONE PENETRATION TEST (20 40 60 80) / SHEAR STRENGTH: Cu, KPa (UNCONFINED QUICK TRIAXIAL, FIELD VANE LAB SHEAR) (20 40 60 80)	PLASTIC LIMIT wp / NATURAL MOISTURE CONTENT w / LIQUID LIMIT wl / WATER CONTENT (%) (10 20 30 40)	UNIT WEIGHT kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION GR SA SI + CL
317.89	GROUND SURFACE										
0.00	**ASPHALT,** ~40 mm over **FILL,** roadbase.										
317.19											
0.70	**SAND FILL,** brown, moist to wet, some organic inclusions in parts. (loose/compact)		1	SS	11		317				
			2	SS	6		316				0% 67% 33%
315.59											
2.30	**SILTY SAND & GRAVEL,** brown, wet. (compact)		3	SS	17	▼	315				
			4	SS	24						
313.78							314				
4.11	END OF BOREHOLE DUE TO REFUSAL TO AUGER ON BEDROCK OR BOULDER										

Notes:
1) This borehole forms part of Highway 522 Underpass Foundation Investigation.
2) Borehole located at station 9+875.0, offset ~4.5 m right of centreline as referenced to Highway 522.
3) Borehole caved wet at ~5.1 m depth on completion.

MTO4 7524C 07/17/98

RECORD OF BOREHOLE BH-8CP 1 OF 1

METRIC

W.P. 774-93-00 LOCATION 5 093 657.7 N, 313 887.4 E ORIGINATED BY I.D.

DIST 54 HWY 11 BOREHOLE TYPE Standard Augers / CME-55 COMPILED BY M.D.

DATUM Geodetic DATE June 24, 1998 CHECKED BY I.G.

SOIL PROFILE			SAMPLES								
ELEV. / DEPTH	DESCRIPTION	STRATA PLOT	NUMBER	TYPE	BLOWS/0.3m	GROUND WATER CONDITIONS	ELEVATION SCALE (metres)	SPT TEST (N-Value) / CONE PENETRATION TEST; SHEAR STRENGTH: Cu, kPa (UNCONFINED QUICK TRIAXIAL, FIELD VANE LAB SHEAR); PLASTIC LIMIT, NATURAL MOISTURE CONTENT, LIQUID LIMIT; WATER CONTENT (%)	UNIT WEIGHT kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION GR SA SI + CL
315.05	GROUND SURFACE						315			
0.00 / 314.30	**SAND & GRAVEL FILL,** ~road shoulder, brown, moist. (compact)									
0.75 / 312.95	**FILL,** mostly sand & sand with silt & gravel, pieces of asphalt, brown, wet at base. (compact)		1	SS	12		314			0% 73% 27%
			2	SS	19	▼	313			
2.10 / 311.54	**SILT,** grey, trace of sand, some layering, wet, slightly cohesive in parts. (loose to compact) Some gravel sizes at base.		3	SS	6					0% 0% 100%
			4	SS	6		312	75 mm		
3.51	END OF BOREHOLE DUE TO REFUSAL TO AUGER ON BEDROCK OR BOULDER									

Notes:
1) This borehole forms part of Highway 522 Underpass Approach Investigation.
2) Borehole located at station 10+050.0, offset ~4.5 m left of centreline as referenced to Highway 522.
3) Borehole was dry & open to ~1.9 m depth on completion.

MTO4 7524C 07/17/98

RECORD OF BOREHOLE BH-9CP 1 OF 1

METRIC

W.P. 774-93-00 LOCATION 5 093 650.1 N, 313 908.1 E ORIGINATED BY I.D.

DIST 54 HWY 11 BOREHOLE TYPE Standard Augers / CME-55 COMPILED BY M.D.

DATUM Geodetic DATE June 23, 1998 CHECKED BY I.G.

ELEV. / DEPTH	DESCRIPTION	STRATA PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES BLOWS/0.3m	GROUND WATER CONDITIONS	ELEVATION SCALE (metres)	SPT TEST (N-Value) / CONE PENETRATION TEST (20 40 60 80)	SHEAR STRENGTH: Cu, KPa (UNCONFINED QUICK TRIAXIAL ● / FIELD VANE LAB SHEAR ×) (20 40 60 80)	PLASTIC LIMIT wp / NATURAL MOISTURE CONTENT w / LIQUID LIMIT wl — WATER CONTENT (%) (10 20 30 40)	UNIT WEIGHT kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION GR SA SI + CL
315.22	GROUND SURFACE						315					
0.00	**SAND & GRAVEL FILL,** road shoulder, brown, moist. (compact)	F										
314.47		F										
0.75	**SAND FILL,** trace of organics, brown, wet at base. (very loose)	F	1	SS	2		314	⊗				
		F										
313.22			2	SS	4	▼		⊗				
2.00	**SILT,** grey, trace of sand, slightly cohesive in parts, some layering, wet. (loose)						313					
			3	SS	11			⊗				
			4	SS	8		312	⊗				
311.20												
4.02	END OF BOREHOLE DUE TO REFUSAL TO AUGER ON BEDROCK OR BOULDER											

Notes:
1) This borehole forms part of Highway 522 Underpass Approach Investigation.
2) Borehole located at station 10+070.0, offset ~4.5 m right of centreline as referenced to Highway 522.
3) Water level was at ~2.5 m & hole was at ~2.6 m depth on completion.

MTO4 7524C 07/17/98

RECORD OF BOREHOLE BH-10CP 1 OF 1

METRIC

W.P. 774-93-00 LOCATION 5 093 660.9 N, 313 937.3 E ORIGINATED BY I.D.

DIST 54 HWY 11 BOREHOLE TYPE Standard Augers / CME-55 COMPILED BY M.D.

DATUM Geodetic DATE June 24, 1998 CHECKED BY I.G.

ELEV. / DEPTH	DESCRIPTION	STRATA PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES BLOWS/0.3m	GROUND WATER CONDITIONS	ELEVATION SCALE (metres)	SPT TEST (N-Value) / CONE PENETRATION TEST / SHEAR STRENGTH: Cu, KPa (UNCONFINED QUICK TRIAXIAL, FIELD VANE LAB SHEAR)	PLASTIC LIMIT / NATURAL MOISTURE CONTENT / LIQUID LIMIT / WATER CONTENT (%)	UNIT WEIGHT kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION GR SA SI + CL
315.95	GROUND SURFACE										
0.00	**SAND & GRAVEL FILL,** road shoulder, brown, moist. (compact)										
315.20											
0.75	**SAND FILL,** trace of organics, brown, moist. (loose)		1	SS	6		315	⊗	○		
314.15			2	SS	9	▼	314	⊗			
1.80	**SILT,** grey, trace of sand, some layering, wet. (loose to compact)		3	SS	11		313	⊗			
312.75											
3.20	**SILTY SAND & GRAVEL,** a few cobbles, brown, wet. (compact)		4	SS	20		312	⊗	○		
311.41											
4.54	END OF BOREHOLE DUE TO REFUSAL TO AUGER ON BEDROCK OR BOULDER										

Notes:
1) This borehole forms part of Highway 522 Underpass Foundation Investigation.
2) Borehole located at station 10+100.0, offset ~4.0 m left of centreline as referenced to Highway 522.
3) Borehole caved wet at ~3.3 m depth on completion.

MT04 7524C 07/17/98

RECORD OF BOREHOLE BH-11CP 1 OF 1

METRIC

W.P. 774-93-00 LOCATION 5 093 656.6 N, 313 987.8 E ORIGINATED BY I.D.

DIST 54 HWY 11 BOREHOLE TYPE Standard Augers / CME-55 COMPILED BY M.D.

DATUM Geodetic DATE June 24, 1998 CHECKED BY I.G.

ELEV. DEPTH	DESCRIPTION	STRATA PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES BLOWS/0.3m	GROUND WATER CONDITIONS	ELEVATION SCALE (metres)	SPT TEST (N-Value) / CONE PENETRATION TEST (20 40 60 80) / SHEAR STRENGTH: Cu, KPa (UNCONFINED QUICK TRIAXIAL ● FIELD VANE LAB SHEAR ×) (20 40 60 80)	PLASTIC LIMIT wp / NATURAL MOISTURE CONTENT w / LIQUID LIMIT wl — WATER CONTENT (%) (10 20 30 40)	UNIT WEIGHT kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION GR SA SI + CL
317.40	GROUND SURFACE										
0.00	**SAND & GRAVEL FILL,** road shoulder, brown, moist. (compact)						317				
316.65											
0.75	**SAND FILL,** trace of organics, pieces of asphalt, brown, moist to wet. (loose)		1	SS	9			⊗			
			2	SS	6	▼	316	⊗	○		8% 59% 33%
314.90							315				
2.50	**SILTY SAND & GRAVEL,** some cobbles with traces of organics, dark grey, wet. (compact)		3	SS	28			⊗			
			4	SS	14		314	⊗	○		
313.35											
4.05	END OF BOREHOLE DUE TO REFUSAL TO AUGER ON BEDROCK OR BOULDER										

Notes:
1) This borehole forms part of Highway 522 Underpass Foundation Investigation.
2) Borehole located at station 10+150.0, offset ~4.0 m right of centreline as referenced to Highway 522.
3) Borehole caved wet at ~3.9 m depth on completion.

MTO4 7524C 07/17/98

RECORD OF BOREHOLE BH-12CP 1 OF 1

METRIC

W.P. 774-93-00 LOCATION 5 093 641.0 N, 313 778.4 ORIGINATED BY I.D.

DIST 54 HWY 11 BOREHOLE TYPE Standard Augers / CME-55 COMPILED BY M.D.

DATUM Geodetic DATE June 23, 1998 CHECKED BY I.G.

ELEV. / DEPTH	DESCRIPTION	STRATA PLOT	NUMBER	TYPE	BLOWS/0.3m	GROUND WATER CONDITIONS	ELEVATION SCALE (metres)	SPT TEST (N-Value) / CONE PENETRATION TEST (20 40 60 80)	SHEAR STRENGTH: Cu, KPa ○ UNCONFINED QUICK TRIAXIAL ● ✕ FIELD VANE LAB SHEAR (20 40 60 80)	PLASTIC LIMIT wp / NATURAL MOISTURE CONTENT w / LIQUID LIMIT wl; WATER CONTENT (%) (10 20 30 40)	UNIT WEIGHT kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION GR SA (SI & CL)
316.15	GROUND SURFACE						316					
0.00 / 315.40	**SAND & GRAVEL FILL,** road shoulder, brown. (compact)	F										
0.75	**SAND FILL,** some layering, occasional organics, some silt, moist then wet at ~2.2 m depth. (loose to compact)	F	1	SS	7		315	⊗				
		F	2	SS	9	▼	314	⊗				
313.35		F	3	SS	34			⊗		○		0% 77% 23%
2.80	**SILT,** trace of sand & slightly cohesive in parts, some layering, grey/brown, wet. (loose to compact)		4	SS	8		313	⊗	✕	○		
			5	SS	4		312	⊗				
310.15							311					
6.00	**SILTY SAND & GRAVEL,** (till-like) brown, a few cobbles, wet. (dense)		6	SS	25		310	⊗		○		
308.38			7	SS	8		309	75 mm ⊗				
7.77	END OF BOREHOLE DUE TO REFUSAL TO AUGER ON BEDROCK OR BOULDER											

Notes:
1) This borehole forms part of Highway 522 Underpass Foundation Investigation.
2) Borehole located at station 9+940.0, offset ~4.5 m right of centreline as referenced to Highway 522.
3) Borehole caved wet at ~6.4 m depth on completion.
4) Lab shear test was a pocket penetrometer test.

MTO4 7524C 07/22/99

RECORD OF BOREHOLE BH-13CP 1 OF 1

METRIC

W.P. 774-93-00 LOCATION 5 093 646.6 N, 313 737.9 E ORIGINATED BY I.D.

DIST 54 HWY 11 BOREHOLE TYPE Standard Augers / CME-55 COMPILED BY M.D.

DATUM Geodetic DATE June 24, 1998 CHECKED BY I.G.

ELEV. / DEPTH	DESCRIPTION	STRATA PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES BLOWS/0.3m	GROUND WATER CONDITIONS	ELEVATION SCALE (metres)	SPT TEST (N-Value) / CONE PENETRATION TEST (20 40 60 80)	SHEAR STRENGTH: Cu, KPa (UNCONFINED QUICK TRIAXIAL ● / FIELD VANE LAB SHEAR ×) (20 40 60 80)	PLASTIC LIMIT wp / NATURAL MOISTURE CONTENT w / LIQUID LIMIT wl — WATER CONTENT (%) (10 20 30 40)	UNIT WEIGHT kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION GR SA SI + CL
317.19	GROUND SURFACE											
0.00 / 316.44	**SAND & GRAVEL FILL,** road shoulder, brown. (compact)						317					
0.75 / 314.99	**SAND FILL,** brown, moist. (loose)		1	SS	8		316	⊗				
			2	SS	3	▼	315	⊗		○		
2.20 / 312.39	**SILT,** trace of sand, some layering, brown to grey, moist to wet. (compact)		3	SS	15		314	⊗		○		
			4	SS	14		313	⊗		○		
4.80 / 309.63	**SILTY SAND & GRAVEL,** some cobble sizes, brown, with wet layers of sand. (loose to compact)		5	SS	23		312	⊗				
			6	SS	8		311	⊗				
7.56	END OF BOREHOLE DUE TO REFUSAL TO AUGER ON BEDROCK OR BOULDER						310					

Notes:
1) This borehole forms part of Highway 522 Underpass Foundation Investigation.
2) Borehole located at station 9+900.0, offset ~4.0 m left of centreline as referenced to Highway 522.
3) Borehole caved dry at ~1.6 m depth on completion.

MTO4 7524C 07/17/98

S07524G/C

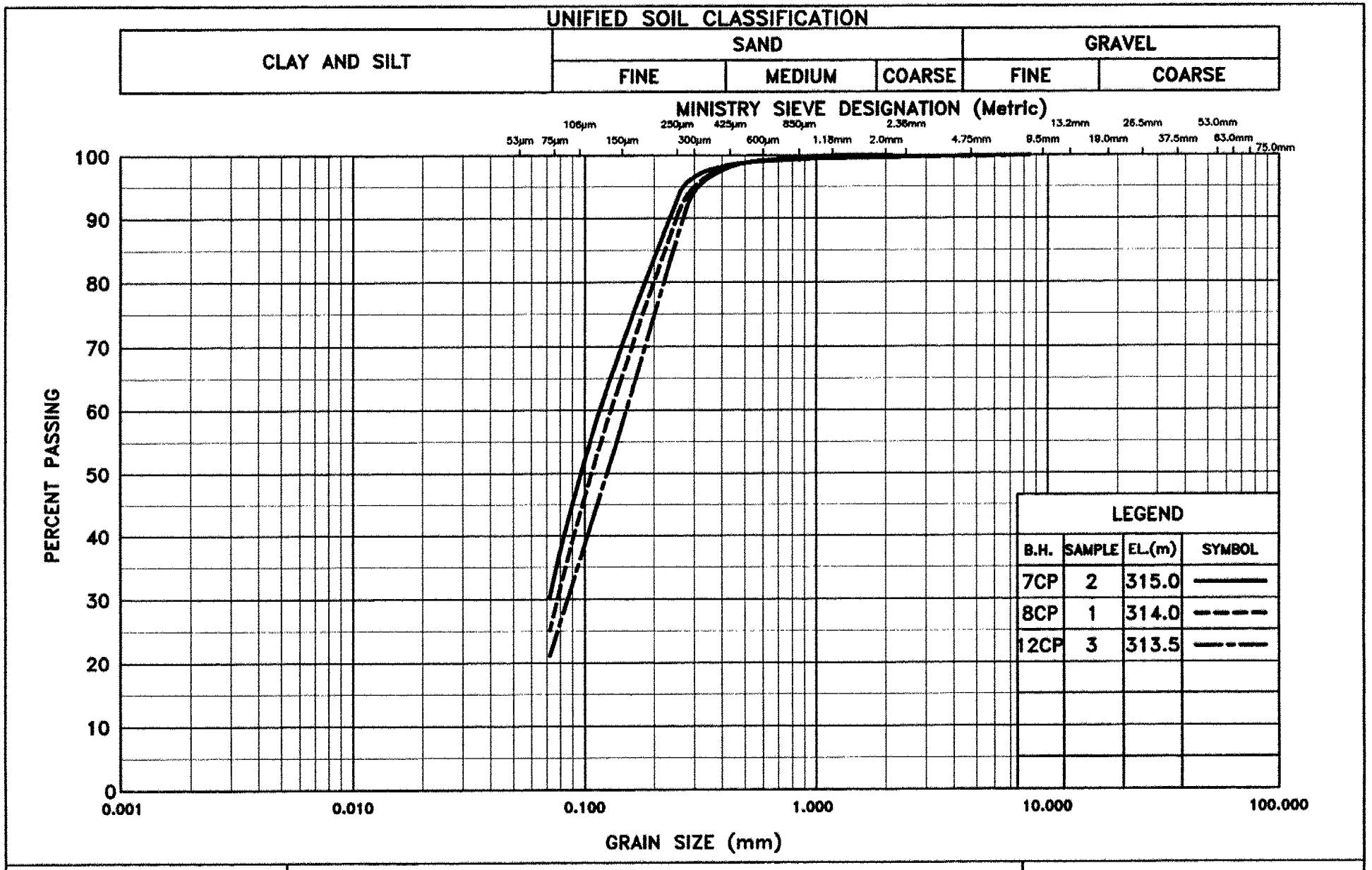
TABLE 1-1
ROCK CORE DESCRIPTION

BH#	Core Recovery				Core Description	
	Core #	Depth (m)	% CR*	% RQD**	Depth (m)	Description
HIGHWAY 522 BRIDGE FOUNDATION						
1-CF	1 2 3	3.72 to 4.72 4.72 to 5.88 5.88 to 6.89	100 100 100	98 100 100	3.72 to 6.89	**Biotite Horneblende Gneiss** - light grey to pinkish white, fine to medium grained, strong, unweathered, fractures very widely spaced, dipped at 80 to 90° from vertical, planar, smooth
3-CF	1 2 3	8.14 to 9.05 9.05 to 10.52 10.52 to 11.40	100 100 100	75 76 94	8.14 to 11.40	**Biotite Hornblende Gneiss (Garnetigerous)**, pinkish white to light grey, medium grained, strong unweathered, fractures moderately spaced, dipping at 0 to 10° and 80 to 90° from vertical, planar, smooth

*CR Core Recovery %
**RQD Rock Quality Designation %

Trow

APPENDIX B



Ministry of Transportation

METRIC

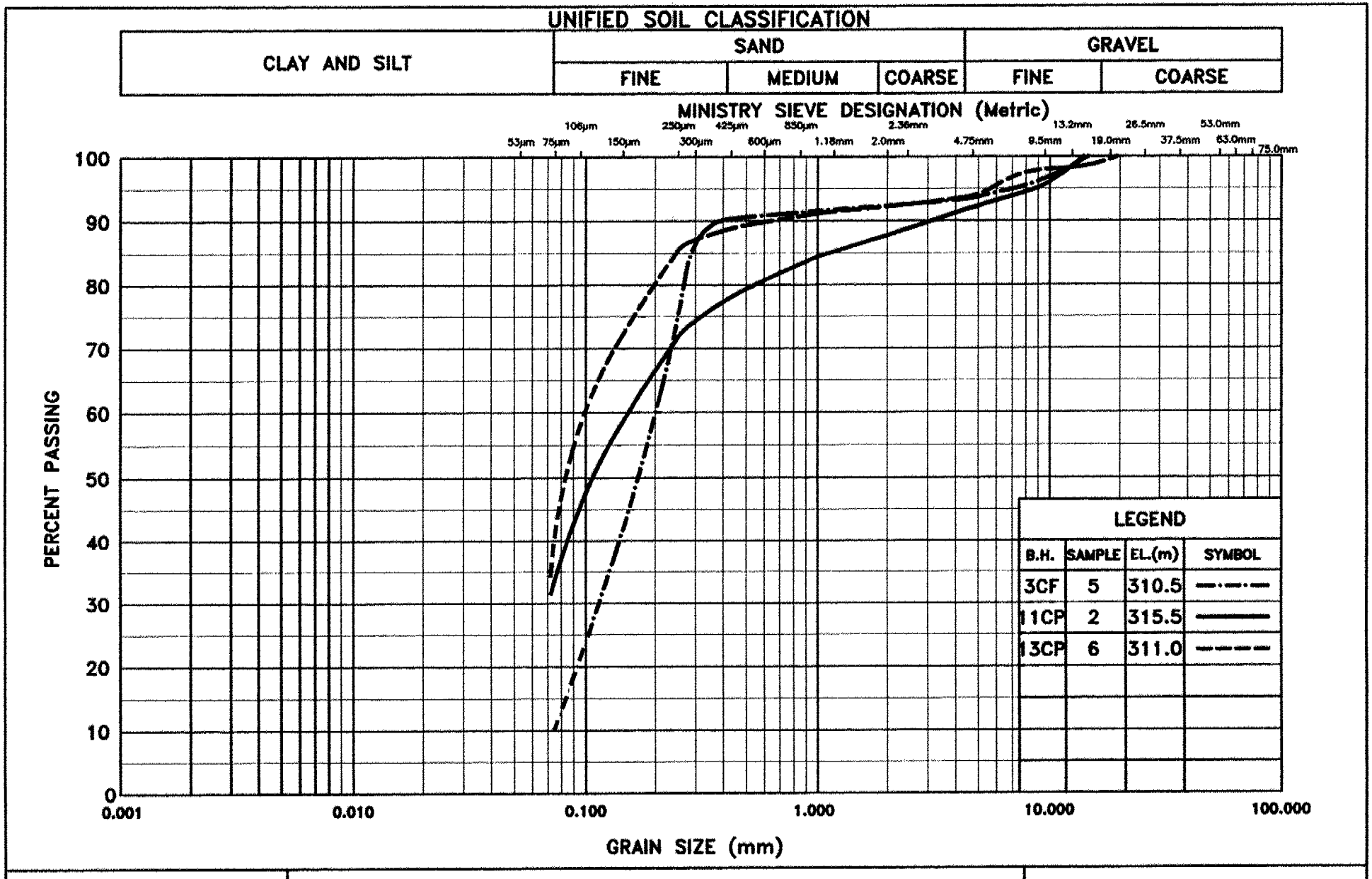
GRAIN SIZE DISTRIBUTION

ALL SAMPLES FINE SAND

FIGURE 1

W.P. 774-93-00

Trow PROJ. No. S07524GC



Ministry of Transportation

METRIC

GRAIN SIZE DISTRIBUTION

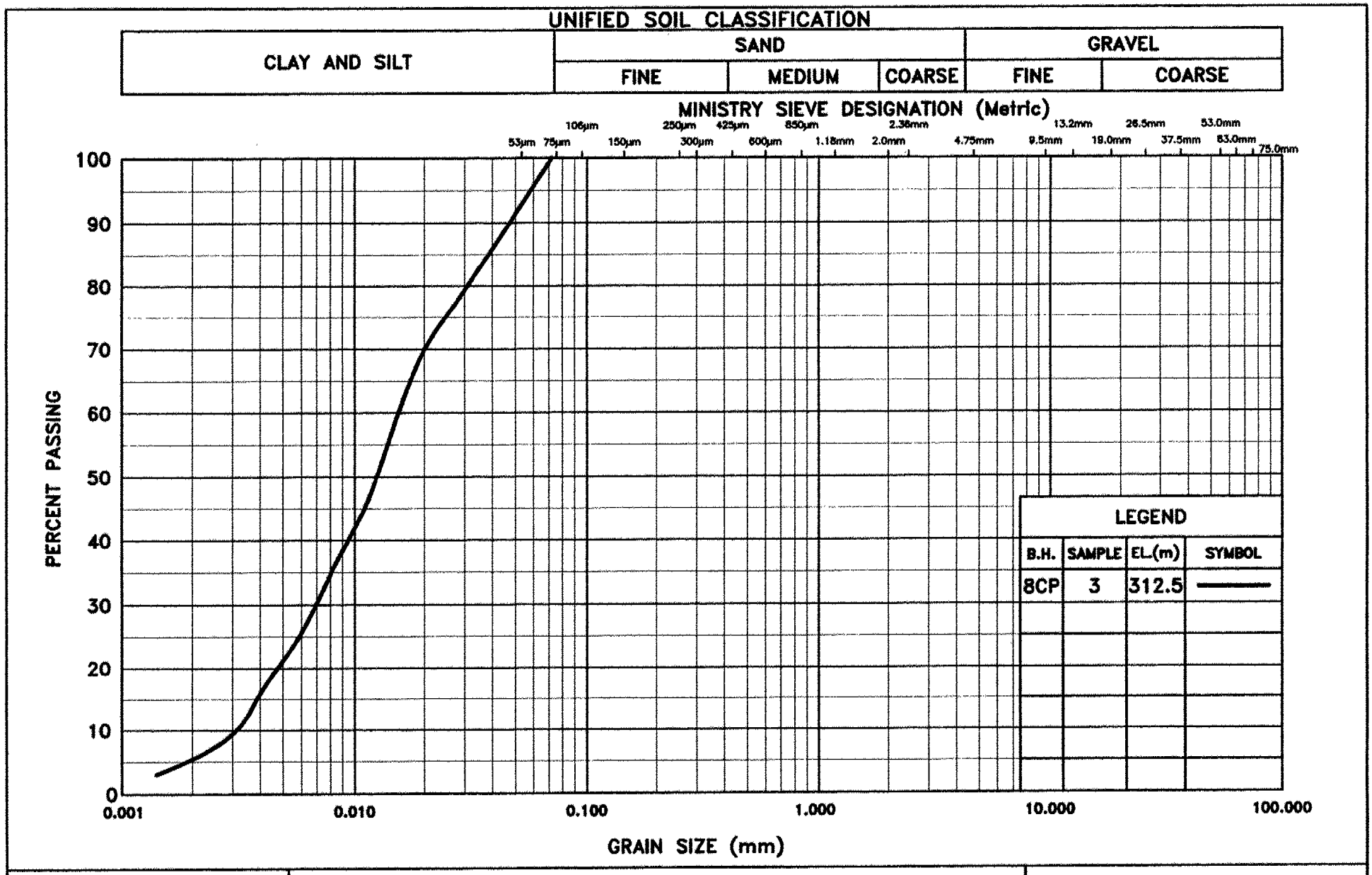
ALL SAMPLES SAND & GRAVEL

FIGURE 2

W.P. 774-93-00

Trow

PROJ. No. S07524GC



Ministry of Transportation

METRIC

GRAIN SIZE DISTRIBUTION

BH-8CP, SS-3 CLAY & SILT

FIGURE 3

W.P. 774-93-00

Trow

PROJ. No. S07524GC

DOCUMENT MICROFILMING IDENTIFICATION

G.I.-30 SEPT. 1976

GEOCRES No. _____

DIST. 54 REGION _____

W.P. No. 774-93-00(B)

CONT. No. _____

W. O. No. _____

STR. SITE No. 44-370

HWY. No. 11

LOCATION Hwy 522 Underpass

_____

No. of PAGES - 1

OVERSIZE DRAWINGS TO BE INCLUDED WITH THIS REPORT. _____

REMARKS: _____

Trow

Foundation Investigation and Design Report For Approach Embankment Along Highway 522 Underpass (Site 44-370) at Trout Creek By-Pass (King's Highway 11) District 54, Sudbury, Ontario GWP No. 774-93-00 W.P. 770-93-01

Prepared for:

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THORNHILL, Ontario
L3T 7N4

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Facsimile: (705) 674-8271

SO7524G/C
July, 1999

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Appendix A

Appendix B

Preface

Work Project GWP 774-93-00 is one of a series of projects for the four lane expansion of Highway 11. The project involves the four lane design of Highway 11, from 4.0 km south of Highway 522, northerly for 7.9 km. It will result in the construction of a westerly by-pass of the existing Highway 11 and the Town of Trout Creek.

This work project is located in the Townships of Laurier and Himsworth South, within the geographic District of Parry Sound. The project requires geotechnical input for the following major components:

- New pavement design for the entire length of the four lane by-pass, including associated service roads.
- New structure, Trout Creek South Interchange (underpass), Site 44-372.
- New structure, Trout Creek, Northbound Lanes, Site 44-371.
- New structure, Trout Creek, Southbound Lanes, Site 44-371.
- New structure, Highway 522 (underpass), Site 44-370.
- New structure, Trout Creek North Interchange (underpass), Site 44-369.

The following report deals with the new approach embankments for the flyover at Highway 522, Site 44-370. Separate reports will be submitted for the additional components.

PART 1 FOUNDATION INVESTIGATION

1.1 Introduction

This submission presents the results of a geotechnical foundation investigation by Trow Consulting Engineers Ltd. (Trow) for the new approach embankments for the flyover at Highway 522 and the proposed King's Highway 11, (Trout Creek By-Pass), at Site 44-370. It is Trow's understanding that a two span structure will be constructed, with the central pier located in the median of the proposed King's Highway 11. This report contains factual information (obtained from the field investigation) pertaining to the design parameters required for the approach embankments along Highway 522.

1.2 Site Description and Geological Setting

1.2.1 Site Description

The site is located in the Township of South Himsworth at the proposed bridge structure for Highway 522 and the proposed King's Highway 11, Trout Creek By-Pass, at Site 44-370.

The proposed new, two-span bridge will be constructed to carry Highway 522 traffic over the four lanes of King's Highway 11. An 8 m grade increase of Highway 522 at the bridge abutments is anticipated, in accordance with the proposed grading plan.

The terrain at the proposed bridge structure is relatively flat, although the grade of the existing Highway 522 rises gently towards both the west and east sides. The grade of Highway 522, at the bridge site is at elevation 315 m and the existing road then rises gradually some 5 m, over a distance of approximately 240 m on the east side (up to Station 10+240), and 3 m, over approximately 200 m on the west side (up to Station 9 + 800).

The grade of Highway 522 will be raised to elevation 323 m at the bridge to accommodate the proposed four lanes of the by-pass. This arrangement will require approach embankments along Highway 522, approximately 240 m long (from the east side) and 200 m long (from the west side).

No bedrock outcrops are visible in the immediate vicinity of the proposed bridge; however, a rock cut is visible approximately 200 m along Highway 522 on the west side. There are mature trees, with heavy underbrush on either side of Highway 522, i.e. along the alignment of the proposed King's Highway 11.

1.2.2 Geological Setting

According to OGS Maps 2544 and 2556, as well as Ontario Geological Survey Map P. 3160 (Quaternary geology, South River area), the site is located in what is known as the Central Gneiss Belt, i.e. mainly felsic igneous rocks of the Mesoproterozoic Group.

The overburden is expected to be relatively shallow, comprising, for the most part, of detaic sands and gravels with some prodeltaic deposits, mainly silts. A thin layer of basal, stoney, glacial till can be expected immediately over the bedrock.

1.3 Investigative Procedures

1.3.1 General

Part 1 of this report describes the investigative procedures adopted for the geotechnical assessment of the new approach embankments along Highway 522 at the proposed Trout Creek By-Pass, King's Highway 11. Properties of the overburden soils were obtained by in-situ and laboratory testing and the procedures, employed during the investigation, are described below.

1.3.2 Field Investigation

The field work for the investigation related to the proposed Highway 522 approach embankments was carried out on May 25 and June 24, 1998, and consisted of eight(8) boreholes (BH's 6-CP to 13-CP) inclusive, and two(2) dynamic cone penetration tests (C-4CP and C-5CP). The dynamic cones and boreholes were advanced to refusal at depths ranging from 3.5 m to 7.8 m. Boreholes 6-CP and 8-CP to 11-CP, as well as cone C-4CP, were located along the 240 m length of the east side approach fills, and boreholes 7-CP, 12-CP and 13-CP, and cone C-5CP along the 200 m length of the west approach fills.

The borehole and dynamic cone penetration locations are shown on the attached site plan, Drawing 1, in Appendix A. These locations, as well as the surface elevations, were established by Trow's field technician and a survey crew from Marshall Macklin Monaghan, and are referenced to geodetic datum.

The boreholes, cones and probes were advanced through the overburden soils using a truck mounted CME-55 drill, equipped with solid and hollow stem augers, and supplied and operated by a soils drilling contractor, Master Soil Investigation Limited. Soil samples were obtained by using a 51 mm O.D. split-spoon sampler in conjunction with standard penetration tests (ASTM D1586) at approximately 0.75 m and 1.5 m intervals. The standard penetration (N) values, together with the blows from the dynamic cone penetration tests, were recorded and used to provide an assessment of the compactness of the overburden soils. The recovered soil samples were used for identification and laboratory testing.

Upon completion, boreholes were backfilled with auger cuttings from the same boreholes, and compacted at regular intervals by applying back pressure with the auger. Where boreholes were advanced within the pavement surface, cold mix asphalt was placed to adequately patch the damaged area.

Details of the soil and bedrock conditions encountered in the boreholes are included on the logs in the attached Appendix A. The additional two standard data sheets, included with the logs, provide further details on soil descriptions for classification purposes. For completeness, two of the previous boreholes (boreholes 1-CF and 3-CF), advanced for the bridge structure at the abutments, have also been included.

1.3.3 Laboratory

The laboratory testing program for select soil samples consisted of the following:

- Natural moisture content determinations
- Grain size distribution analyses
- Laboratory shear tests

The laboratory test results are summarized on the attached borehole logs in Appendix A. The grain size distribution for selected soil samples are presented in Appendix B.

1.4 Subsurface Conditions

The borehole locations are shown on the site plan, Drawing 1, in Appendix A. Also included in Appendix A are the borehole and dynamic cone penetration logs. Based on this information, the following different soil layers were encountered:

- fill
- silt
- sand/sand and gravel
- bedrock

A summary of the above soil strata encountered in the boreholes, and inferred from the dynamic cone penetration tests, is presented below.

1.4.1 Fill

The fill at the test locations is associated with the road construction materials for the existing Highway 522. Beneath the present asphalt (~50 mm thick) and the base and subbase granulars (~700 mm thick), an underlying layer of sand and/or sand and gravel fill was encountered, which extends to depths generally in the 2.0 m to 2.5 m range. The fill is mostly sand, although it contains random pieces of old asphalt, some gravel and/or cobble sizes, as well as minor organic staining and contamination.

The compactness of the fill, based on the standard penetration resistance, "N", value ranged from 4 to 36 blows/300 mm, indicating a loose to dense state.

Grain size analyses on samples of the material confirm that the deposit is mainly a fine sand with a silt fraction of between 20% to 30%. Moisture contents vary from less than 10% above the water table to about 20% below the groundwater table.

1.4.2 Silt

A deposit of silt was encountered in five boreholes (boreholes 3-CF, 8-CP, 9-CP, 10-CP, 12-CP and 13-CP). This silt stratum is absent in the vicinity of the east abutment and is more prominent beneath the west approach embankment (boreholes 12-CP and 13-CP). The silt contains some sand seams and odd layering, where it is slightly cohesive. The standard penetration resistance "N" values ranged from 4 to 14 blows/300 mm, indicating a loose to compact state of compaction. The thickness ranged from 1 m (borehole 3-CF) to 3 m (borehole 12-CP), and the moisture content from 25% to 35%.

1.4.3 Sand and Gravel

A basal zone of sand and gravel was encountered in all boreholes, with the exception of boreholes 8-CP and 9-CP. The deposit is reasonably well-graded with up to 31% silt sizes in places. At some locations, the stratum appears to be weakly cemented, indicating a "till-like" structure. The standard penetration resistance "N" values range from 9 to 25 blows/300 mm, indicating a loose to compact condition. The thickness ranges from about 1 m at borehole 1-CF to 4 m at borehole 3-CF. Moisture contents ranged from 5% to 20%.

1.4.4 Bedrock

Bedrock was confirmed by retrieving "NQ" size cores in the two boreholes at the abutments (BH's 1-CF and 3-CF) at depths of 3.72 m (~El. 311.2 m) and 8.14 m (~El. 307.2 m).

Detailed descriptions of the rock are presented in Table 1-1 in Appendix A. Generally, the bedrock can be described as a pinkish, light grey, biotite-Homblende gneiss. The rock is strong and unweathered for the most part. Rock core recovery was 100% for all runs and the Rock Quality Designation (RQD) values ranged from 75% to 100%.

In the remaining boreholes and cones, the refusal levels noted in the logs are assumed to represent the bedrock surface.

1.5 Groundwater Conditions

Information regarding the groundwater levels at the site was obtained by measuring the water levels in the open boreholes after completion of drilling. The groundwater table, at the time of the field work, was established at a depth of about 2 m to 2.5 m below grade, which is close to the grade of the surrounding, poorly drained, relatively flat terrain.

Seasonal variations in the water table should be expected with higher levels during wetter periods of the year (such as spring thaw and late fall) and lower levels during drier periods.

Part 2 Discussion and Recommendations

2.1 Introduction

This submission presents the results of a geotechnical foundation investigation by Trow Consulting Engineers Ltd. (Trow) for the new approach embankments for the flyover at Highway 522 and the proposed King's Highway 11, Trout Creek By-Pass, at Site 44-370. It is Trow's understanding that a two-span structure will be constructed, with the central pier located in the median of the proposed King's Highway 11. This report contains factual information (obtained from the field investigation) pertaining to the design parameters required for the approach embankments along Highway 522.

As outlined in Part 1 of this report, the grade at Highway 522 at the structure is at elevation 315 m and the existing road then rises gradually some 5 m, over a distance of approximately 240 m on the east side (up to station 10+240) and 3 m, over approximately 200 m on the west side (up to station 9+800). The grade of Highway 522 will be raised to elevation 323 m at the bridge to accommodate the proposed four lanes of the By-Pass.

This geometric arrangement will require approach fills, along Highway 522, up to a maximum of 8 m at the proposed bridge abutments, before tying into the existing grade of Highway 522 at a distance of 240 m on the east side and 200 m on the west side.

2.2 Design

2.2.1 Stability

Based on the results of the boreholes and dynamic cone penetration tests, no instability problems are anticipated. The underlying granular soils, i.e. sand, silts and sand and gravels, are adequate to safely support the proposed approach fill heights.

Surficial topsoil and compressible organics, under the plan limits of the embankments where the approach fills encroach off the existing road construction and over the adjacent soils, should be removed. Based on Trow's adjacent borings for the pavement design of Highway 11, it is likely that the surficial organics will be about 300 mm to 600 mm thick.

If rock fill is used to construct the approach embankments, the side slopes and forward slopes should be constructed at a maximum gradient of 1.25H:1V. If Granular "B" is used, the side slopes should be constructed at 2H:1V.

2.2.2 Settlements

Since the proposed approach embankments are underlain by granular soils, long-term consolidation settlements are not anticipated. There will likely be some initial settlement, due to the surcharge embankment loads; however, it is anticipated that they will be less than 50 mm and will occur, almost entirely, within the construction phase.

2.3 Construction Considerations

2.3.1 Excavations

Temporary subexcavation for surficial organics is not expected to exceed 1 m and hence should be straightforward. Side slopes will remain stable if cut back at an angle of 1H:1V.

2.3.2 Raising the Grade

Rock fill or other granular fills placed below the groundwater table may be end-dumped. Once the material is 0.3 m above the water table, placement and compaction of the fills should be carried out according to current OPS specifications and practices.

2.4 General

The information presented in this report is based on a limited investigation designed to provide information to support an overall assessment of the current geotechnical conditions for the proposed approach embankments along Highway 522 at King's Highway 11, Trout Creek By-Pass. The conclusions presented in this report reflect site conditions existing at the time of the investigation. It is noted that the soil boundaries indicated on the logs are inferred from discontinuous sampling and observations during drilling. These boundaries are intended to reflect transition zones for the purpose of geotechnical design and should not be interpreted as exact planes of geological change.

This report has been prepared by Mr. I.W. Gore, P.Eng., and Mr. E.A. Gonneau, P.Eng., and reviewed by Mr. S.E. Gonsalves, P.Eng. The field investigation was performed by Mr. I. Dumpis, C.E.T.

We trust this report is satisfactory for your purposes. Should you have any questions, please do not hesitate to contact this office.

Trow Consulting Engineers Ltd.

E.A. Gonneau, P.Eng.
Project Manager

I.W. Gore, M.Sc., P.Eng.
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Encl.
Dist: Ministry of Transportation (8)
Planning & Design
Mr. E. Gallant

Marshall Macklin Monaghan (1)
Mr. R.D. Kivi, P.Eng.

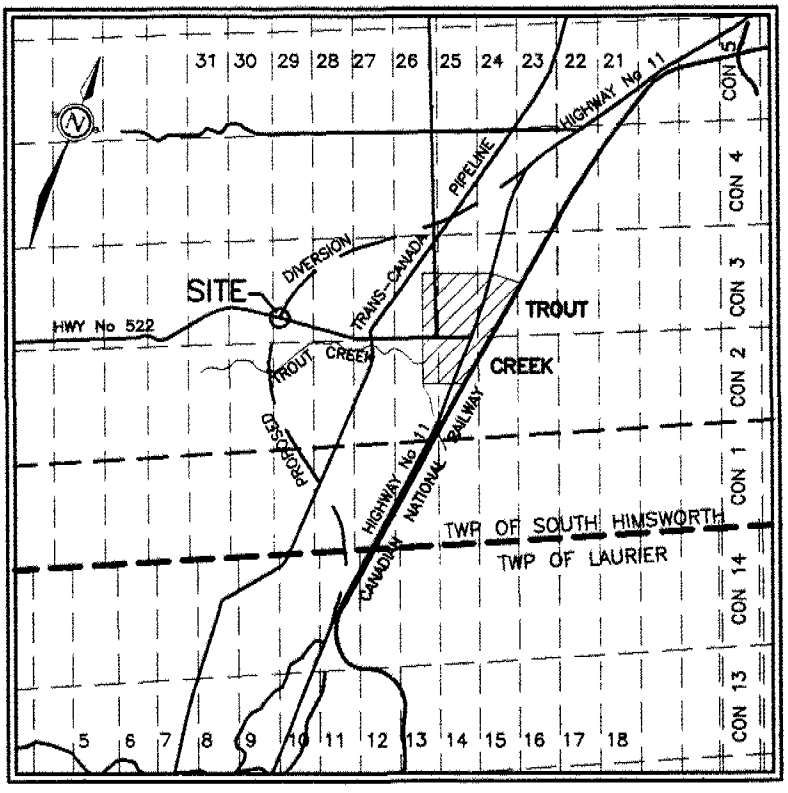
IWG:jot/8.1/Geo/reports7524gc2.wpd

APPENDIX A

METRIC

DIMENSIONS ARE IN METRES
AND/OR MILLIMETRES
UNLESS OTHERWISE SHOWN

PLATE No	509-11/176-0
DRAWING No	05090011176
CONT No	
WP No	774-93-00
SHEET	



KEY PLAN

1 km 0 1 km

TROW CONSULTING ENGINEERS LTD.
SUDBURY, ONTARIO

Trow PROJ. No. S07524GCP DWG. No. 1

MINISTRY OF TRANSPORTATION
ENGINEERING OFFICE
SURVEYS AND PLANS SECTION

KEY PLAN

PROPOSED CROSSING
AT
SEC HIGHWAY 522
AND
PROPOSED C/L MEDIAN HWY 11

GEOG TWP SOUTH HIMSWORTH LOT 29 DIST OF PARRY SOUND CON 3

SCALE	DISTRICT	REGION
1:400	PARRY SOUND	NORTHERN
	ETR 509-11	

SURVEY DATE	97/10	PLAN DATE	97/10
SITE 44-370	PLAN E-509-11-12		

PLATE No 509-11/176-0
DRAWING No 05090011176
CONT No
WP No 774-93-00

SHEET

LOT 29
CON 3

R-1250.000
A-350.000

N 5 093 700

9+900

10+000

10+100

11+300

11+200

TSP 1086

TSP 1082

TSP 9534

TSP 1081

C/L MEDIAN

E 313 700

E 313 800

N 5 093 600

LOT 30
CON 3

LOT 29
CON 3

460 X 8.87 C.S.P

460 X 14.801 C.S.P

BH-13CP
BH-7CP
BH-12CP
BH-3CF
BH-1CF
BH-8CP
BH-9CP
BH-10CP
BH-6CP
BH-11CP
C-5CP
C-4CP

H&SV
H&B
WF
B
H
Comm S.

PLAN
20 m 0 20 m

LEGEND

- BOREHOLE
- AUGER PROBE
- DYNAMIC CONE PENETRATION TEST

No.	ELEV.	CO-ORDINATES NORTH	EAST
BH-1CF	314.90	5 093 657.8	313 870.8
BH-3CF	315.37	5 093 641.5	313 805.6
BH-6CP	316.81	5 093 658.9	313 963.6
BH-7CP	317.89	5 093 640.8	313 713.2
BH-8CP	315.05	5 093 657.7	313 887.4
BH-9CP	315.22	5 093 650.1	313 908.1
BH-10CP	315.95	5 093 660.9	313 937.3
BH-11CP	317.40	5 093 656.6	313 987.8
BH-12CP	316.15	5 093 641.0	313 778.4
BH-13CP	317.19	5 093 646.6	313 737.9
C-4CP	315.83	5 093 655.8	313 922.7
C-5CP	316.92	5 093 644.0	313 758.1

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

TROW CONSULTING ENGINEERS LTD.
SUDBURY, ONTARIO
Trow
PROJ. No. S07524GCP DWG. No. 1A

MINISTRY OF TRANSPORTATION
ENGINEERING OFFICE
SURVEYS AND PLANS SECTION

BRIDGE SITE PLAN

PROPOSED CROSSING
AT
SEC HIGHWAY 522
AND
PROPOSED C/L MEDIAN HWY 11

GEOG TWP SOUTH HIMSWORTH LOT 29
DIST OF PARRY SOUND CON 3

SCALE	DISTRICT	REGION
1:1000	PARRY SOUND	NORTHERN
	ETR 509-11	

SURVEY DATE 97/10 PLAN DATE 97/10

SITE 44-370 PLANE-509-11-12

RECORD OF BOREHOLE BH-1CF 1 OF 1

METRIC

W.P. 774-93-00 LOCATION 5 093 657.8 N, 313 870.8 E ORIGINATED BY I.D.

DIST 54 HWY 11 BOREHOLE TYPE Hollow Stem Augers / CME-55 COMPILED BY M.D.

DATUM Geodetic DATE May 12, 1998 CHECKED BY I.G.

ELEV. / DEPTH	DESCRIPTION	STRATA PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES BLOWS/0.3m	GROUND WATER CONDITIONS	ELEVATION SCALE (metres)	SPT TEST (N-Value) / CONE PENETRATION TEST / SHEAR STRENGTH: Cu, KPa (UNCONFINED QUICK TRIAXIAL, FIELD VANE LAB SHEAR)	PLASTIC LIMIT wp / NATURAL MOISTURE CONTENT w / LIQUID LIMIT wl / WATER CONTENT (%)	UNIT WEIGHT kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION GR SA SI + CL
314.90	GROUND SURFACE							20 40 60 80	10 20 30 40		
0.00	**FILL,** mostly silty sand & gravel with a few cobble sizes, occasional pieces of asphalt, brown, moist. (compact)	F	1	SS	28		314	⊗	O		
312.40		F					313				
2.50	**SAND & GRAVEL,** pockets of sand, some cobble sizes & possible boulders, brown, wet. (compact)		2	SS	13	▼	312	⊗	O		
311.18							311				
3.72	**BIOTITE HORNBLENDE GNEISS,** pinkish grey, excellent rock quality, unweathered.		3	NQ			310				Rec 100% RQD 98%
			4	NQ			309				Rec 100% RQD 100%
			5	NQ							Rec 100% RQD 100%
308.01											
6.89	END OF BOREHOLE										

Notes:
1) This borehole forms part of Highway 522 Underpass Foundation Investigation.
2) Borehole located at station 10+033.3, offset ~6.5 m left of centreline as referenced to Highway 522.

MTO4 7524C 07/17/98

RECORD OF BOREHOLE BH-3CF 1 OF 1

METRIC

W.P. 774-93-00 LOCATION 5 093 641.5 N, 313 805.6 E ORIGINATED BY I.D.

DIST 54 HWY 11 BOREHOLE TYPE Hollow Stem Augers / CME-55 COMPILED BY M.D.

DATUM Geodetic DATE May 12, 1998 CHECKED BY I.G.

ELEV. / DEPTH	DESCRIPTION	STRATA PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES BLOWS/0.3m	GROUND WATER CONDITIONS	ELEVATION SCALE (metres)	SPT TEST (N-Value) / CONE PENETRATION TEST (20 40 60 80) / SHEAR STRENGTH: Cu, KPa (UNCONFINED QUICK TRIAXIAL ○ ● / FIELD VANE LAB SHEAR ×) (20 40 60 80)	PLASTIC LIMIT wp / NATURAL MOISTURE CONTENT w / LIQUID LIMIT wl — WATER CONTENT (%) (10 20 30 40)	UNIT WEIGHT kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION GR SA SI + CL
315.37	GROUND SURFACE						315				
0.00	**SAND & GRAVEL FILL,** occasional lumps of asphalt, brown, moist. (compact/dense)	F F	1	SS	29						
314.17							314				
1.20	**SAND,** brown, wet, traces of organics, (possible FILL). (compact)		2	SS	16	▽					
			3	SS	9		313				
312.37											
3.00	**SILT,** grey, trace of clay, wet. (very loose)		4	SS	3		312				
311.37							311				
4.00	**SAND,** with gravel sizes, brown, moist then wet below ~6.0 m depth, occasional cobbles. (compact)		5	SS	18						7% 83% 10%
			6	SS	12		310				
							309				
307.23			7	SS	19		308				
8.14	**BIOTITE HORNBLENDE GNEISS,** pinkish grey, good to excellent rock quality, slightly weathered to unweathered.		8	NQ			307				Rec 97% RQD 76%
			9	NQ			306				Rec 100% RQD 76%
							305				
			10	NQ							Rec 100% RQD 94%
303.97							304				
11.40	END OF BOREHOLE										

Notes:
1) This borehole forms part of Highway 522 Underpass Foundation Investigation.
2) Borehole located at station 9+966.8, ~5.0 m right of centreline as referenced to Highway 522.

MTO4 7524C 07/17/98

RECORD OF BOREHOLE C-4CP

1 OF 1

METRIC

W.P. 774-93-00 LOCATION 5 093 655.8 N, 313 922.7 E ORIGINATED BY I.D.

DIST 54 HWY 11 BOREHOLE TYPE Dynamic cone test / CME-55 COMPILED BY M.D.

DATUM Geodetic DATE May 25, 1998 CHECKED BY I.G.

ELEV. / DEPTH	DESCRIPTION	STRATA PLOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: BLOWS/0.3m	GROUND WATER CONDITIONS	ELEVATION SCALE (metres)	SPT TEST (N-Value) / CONE PENETRATION TEST; SHEAR STRENGTH: Cu, KPa (UNCONFINED QUICK TRIAXIAL, FIELD VANE LAB SHEAR)	PLASTIC LIMIT wp — NATURAL MOISTURE CONTENT w — LIQUID LIMIT wl; WATER CONTENT (%)	UNIT WEIGHT kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION GR SA SI + CL
315.83	GROUND SURFACE							20 40 60 80	10 20 30 40		
0.00	Dynamic cone test only.						315				
							314				
							313				
							312				
311.11											
4.72	END OF CONE TEST DUE TO BOUNCING REFUSAL ON BEDROCK OR BOULDER										

Notes:
1) This cone test forms part of Highway 522 Underpass Foundation Investigation.
2) Cone test located at station 10+085.0, on centreline as referenced to Highway 522.
3) Augered first 0.3 m through dense fill before driving cone test.

MTO4 7524C 07/17/98

RECORD OF BOREHOLE C-5CP

1 OF 1

METRIC

W.P. 774-93-00 LOCATION 5 093 644.0 N, 313 758.1 E ORIGINATED BY I.D.

DIST 54 HWY 11 BOREHOLE TYPE Dynamic cone test / CME-55 COMPILED BY M.D.

DATUM Geodetic DATE May 25, 1998 CHECKED BY I.G.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE (metres)	SPT TEST (N-Value) ⊗ / CONE PENETRATION TEST —— 20 40 60 80 / SHEAR STRENGTH: Cu, KPa ● UNCONFINED QUICK TRIAXIAL × FIELD VANE LAB SHEAR 20 40 60 80	PLASTIC LIMIT wp — NATURAL MOISTURE CONTENT w — LIQUID LIMIT wl / WATER CONTENT (%) 10 20 30 40	UNIT WEIGHT kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION GR SA SI + CL
ELEV. / DEPTH	DESCRIPTION	STRATA PLOT	NUMBER	TYPE	BLOWS/0.3m						
316.92 0.00	GROUND SURFACE Dynamic cone test only.						316 315 314 313 312 311 310				
309.15 7.77	END OF CONE TEST DUE TO BOUNCING REFUSAL ON BEDROCK OR BOULDER										

Notes:
1) This cone test forms part of Highway 522 Underpass Foundation Investigation.
2) Cone test located at station 9+920.0, on centreline as referenced to Highway 522.
3) Augered first ~0.3 m through dense fill before driving cone test.

MT04 7524C 07/17/98

RECORD OF BOREHOLE BH-6CP 1 OF 1

METRIC

W.P. 774-93-00 LOCATION 5 093 658.9 N, 313 963.6 E ORIGINATED BY I.D.

DIST 54 HWY 11 BOREHOLE TYPE Hollow Stem Augers / CME-55 COMPILED BY M.D.

DATUM Geodetic DATE May 25, 1998 CHECKED BY I.G.

ELEV. DEPTH	DESCRIPTION	STRATA PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES BLOWS/0.3m	GROUND WATER CONDITIONS	ELEVATION SCALE (metres)	SPT TEST (N-Value) / CONE PENETRATION TEST (20 40 60 80)	SHEAR STRENGTH: Cu, KPa (UNCONFINED QUICK TRIAXIAL ● / FIELD VANE LAB SHEAR ×) (20 40 60 80)	PLASTIC LIMIT wp — NATURAL MOISTURE CONTENT w — LIQUID LIMIT wl; WATER CONTENT (%) (10 20 30 40)	UNIT WEIGHT kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION GR SA SI + CL
316.81	GROUND SURFACE											
0.00	**ASPHALT,** ~40 mm over **SAND,** with gravel inclusions, brown to grey, some cobbles, moist to wet at base. (compact)		1	SS	24		316	⊗		○		
			2	SS	36		315	⊗		○		
314.21			3	SS	8	▼	314	⊗		○		
2.60	**PEAT,** numerous roots ~450 mm thick over **SILTY SAND,** with gravel, grey/brown, wet. (compact)		4	SS	9		313	⊗		○		
312.85												
3.96	END OF BOREHOLE DUE TO REFUSAL TO AUGER ON BEDROCK OR BOULDER											

Notes:
1) This borehole forms part of Highway 522 Underpass Foundation Investigation.
2) Borehole located at station 10+126.0, on centreline as referenced to Highway 522.
3) Borehole caved wet at ~4.0 m depth on completion.

MTO4 7524C 07/17/98

RECORD OF BOREHOLE BH-7CP 1 OF 1

METRIC

W.P. 774-93-00 LOCATION 5 093 640.8 N, 313 713.2 E ORIGINATED BY I.D.

DIST 54 HWY 11 BOREHOLE TYPE Standard Augers / CME-55 COMPILED BY M.D.

DATUM Geodetic DATE May 25, 1998 CHECKED BY I.G.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE (metres)	SPT TEST (N-Value) / CONE PENETRATION TEST; SHEAR STRENGTH: Cu, kPa (UNCONFINED QUICK TRIAXIAL, FIELD VANE LAB SHEAR)	PLASTIC LIMIT / NATURAL MOISTURE CONTENT / LIQUID LIMIT; WATER CONTENT (%)	UNIT WEIGHT	REMARKS & GRAIN SIZE DISTRIBUTION
ELEV. DEPTH	DESCRIPTION	STRATA PLOT	NUMBER	TYPE	BLOWS/0.3m			20 40 60 80	wp — w — wl; 10 20 30 40	kN/m³	GR SA SI + CL
317.89	GROUND SURFACE										
0.00	**ASPHALT**, ~40 mm over **FILL**, roadbase.										
317.19											
0.70	**SAND FILL**, brown, moist to wet, some organic inclusions in parts. (loose/compact)		1	SS	11		317				
			2	SS	6		316				0% 67% 33%
315.59											
2.30	**SILTY SAND & GRAVEL**, brown, wet. (compact)		3	SS	17	▼	315				
			4	SS	24						
313.78							314				
4.11	END OF BOREHOLE DUE TO REFUSAL TO AUGER ON BEDROCK OR BOULDER										

Notes:
1) This borehole forms part of Highway 522 Underpass Foundation Investigation.
2) Borehole located at station 9+875.0, offset ~4.5 m right of centreline as referenced to Highway 522.
3) Borehole caved wet at ~5.1 m depth on completion.

MTO4 7524C 07/17/98

RECORD OF BOREHOLE BH-8CP 1 OF 1

METRIC

W.P. 774-93-00 LOCATION 5 093 657.7 N, 313 887.4 E ORIGINATED BY I.D.

DIST 54 HWY 11 BOREHOLE TYPE Standard Augers / CME-55 COMPILED BY M.D.

DATUM Geodetic DATE June 24, 1998 CHECKED BY I.G.

SOIL PROFILE			SAMPLES										
ELEV. / DEPTH	DESCRIPTION	STRATA PLOT	NUMBER	TYPE	BLOWS/0.3m	GROUND WATER CONDITIONS	ELEVATION SCALE (metres)	SPT TEST (N-Value) ⊗ / CONE PENETRATION TEST (20 40 60 80)	SHEAR STRENGTH: Cu, kPa ○ UNCONFINED ● QUICK TRIAXIAL ✕ FIELD VANE ▮ LAB SHEAR (20 40 60 80)	PLASTIC LIMIT wp / NATURAL MOISTURE CONTENT w / LIQUID LIMIT wl; WATER CONTENT (%) (10 20 30 40)	UNIT WEIGHT kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION GR SA SI + CL
315.05	GROUND SURFACE						315					
0.00 / 314.30	**SAND & GRAVEL FILL,** ~road shoulder, brown, moist. (compact)	F										
0.75	**FILL,** mostly sand & sand with silt & gravel, pieces of asphalt, brown, wet at base. (compact)	F	1	SS	12		314	⊗		○		0% 73% 27%
312.95		F	2	SS	19	▼	313	⊗				
2.10	**SILT,** grey, trace of sand, some layering, wet, slightly cohesive in parts. (loose to compact)		3	SS	6			⊗		○		0% 0% 100%
311.54	Some gravel sizes at base.		4	SS	6		312	⊗				
3.51	END OF BOREHOLE DUE TO REFUSAL TO AUGER ON BEDROCK OR BOULDER											

Notes:
1) This borehole forms part of Highway 522 Underpass Approach Investigation.
2) Borehole located at station 10+050.0, offset ~4.5 m left of centreline as referenced to Highway 522.
3) Borehole was dry & open to ~1.9 m depth on completion.

MT04 7524C 07/17/98

RECORD OF BOREHOLE BH-9CP 1 OF 1

METRIC

W.P. 774-93-00 LOCATION 5 093 650.1 N, 313 908.1 E ORIGINATED BY I.D.

DIST 54 HWY 11 BOREHOLE TYPE Standard Augers / CME-55 COMPILED BY M.D.

DATUM Geodetic DATE June 23, 1998 CHECKED BY I.G.

ELEV. / DEPTH	DESCRIPTION	STRATA PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES BLOWS/0.3m	GROUND WATER CONDITIONS	ELEVATION SCALE (metres)	SPT TEST (N-Value) / CONE PENETRATION TEST (20 40 60 80) / SHEAR STRENGTH: Cu, KPa (UNCONFINED QUICK TRIAXIAL ● FIELD VANE LAB SHEAR ×) (20 40 60 80)	PLASTIC LIMIT wp — NATURAL MOISTURE CONTENT w — LIQUID LIMIT wl / WATER CONTENT (%) (10 20 30 40)	UNIT WEIGHT kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION GR SA SI + CL
315.22	GROUND SURFACE										
0.00	**SAND & GRAVEL FILL,** road shoulder, brown, moist. (compact)	F					315				
314.47		F									
0.75	**SAND FILL,** trace of organics, brown, wet at base. (very loose)	F	1	SS	2		314	⊗			
		F									
313.22			2	SS	4	▼		⊗			
2.00	**SILT,** grey, trace of sand, slightly cohesive in parts, some layering, wet. (loose)						313				
			3	SS	11			⊗			
			4	SS	8		312	⊗			
311.20											
4.02	END OF BOREHOLE DUE TO REFUSAL TO AUGER ON BEDROCK OR BOULDER										

Notes:
1) This borehole forms part of Highway 522 Underpass Approach Investigation.
2) Borehole located at station 10+070.0, offset ~4.5 m right of centreline as referenced to Highway 522.
3) Water level was at ~2.5 m & hole was at ~2.6 m depth on completion.

MTO4 7524C 07/11/98

RECORD OF BOREHOLE BH-10CP 1 OF 1

METRIC

W.P. 774-93-00 LOCATION 5 093 660.9 N, 313 937.3 E ORIGINATED BY I.D.

DIST 54 HWY 11 BOREHOLE TYPE Standard Augers / CME-55 COMPILED BY M.D.

DATUM Geodetic DATE June 24, 1998 CHECKED BY I.G.

ELEV. / DEPTH	DESCRIPTION	STRATA PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES BLOWS/0.3m	GROUND WATER CONDITIONS	ELEVATION SCALE (metres)	SPT TEST (N-Value) / CONE PENETRATION TEST / SHEAR STRENGTH: Cu, KPa (UNCONFINED QUICK TRIAXIAL, FIELD VANE LAB SHEAR)	PLASTIC LIMIT / NATURAL MOISTURE CONTENT / LIQUID LIMIT / WATER CONTENT (%)	UNIT WEIGHT kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION GR SA SI + CL
315.95	GROUND SURFACE							SPT/CPT 20 40 60 80; SHEAR STRENGTH 20 40 60 80	10 20 30 40		
0.00	**SAND & GRAVEL FILL,** road shoulder, brown, moist. (compact)	F									
315.20		F									
0.75	**SAND FILL,** trace of organics, brown, moist. (loose)	F	1	SS	6		315	⊗	○		
		F									
314.15			2	SS	9	▼	314	⊗			
1.80	**SILT,** grey, trace of sand, some layering, wet. (loose to compact)										
			3	SS	11		313	⊗	○		
312.75											
3.20	**SILTY SAND & GRAVEL,** a few cobbles, brown, wet. (compact)		4	SS	20		312	⊗	○		
311.41											
4.54	END OF BOREHOLE DUE TO REFUSAL TO AUGER ON BEDROCK OR BOULDER										

Notes:
1) This borehole forms part of Highway 522 Underpass Foundation Investigation.
2) Borehole located at station 10+100.0, offset ~4.0 m left of centreline as referenced to Highway 522.
3) Borehole caved wet at ~3.3 m depth on completion.

MTO4 7524C 07/17/98

RECORD OF BOREHOLE BH-11CP 1 OF 1

METRIC

W.P. 774-93-00 LOCATION 5 093 656.6 N, 313 987.8 E ORIGINATED BY I.D.

DIST 54 HWY 11 BOREHOLE TYPE Standard Augers / CME-55 COMPILED BY M.D.

DATUM Geodetic DATE June 24, 1998 CHECKED BY I.G.

ELEV. / DEPTH	DESCRIPTION	STRATA PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES BLOWS/0.3m	GROUND WATER CONDITIONS	ELEVATION SCALE (metres)	SPT TEST (N-Value) / CONE PENETRATION TEST (20 40 60 80) / SHEAR STRENGTH: Cu, KPa (UNCONFINED QUICK TRIAXIAL ⊗, FIELD VANE LAB SHEAR ×) (20 40 60 80)	PLASTIC LIMIT wp / NATURAL MOISTURE CONTENT w / LIQUID LIMIT wl — WATER CONTENT (%) (10 20 30 40)	UNIT WEIGHT kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION GR SA SI + CL
317.40	GROUND SURFACE										
0.00 / 316.65	**SAND & GRAVEL FILL,** road shoulder, brown, moist. (compact)	F					317				
0.75	**SAND FILL,** trace of organics, pieces of asphalt, brown, moist to wet. (loose)	F	1	SS	9			⊗			
314.90		F	2	SS	6	▼	316	⊗	○		8% 59% 33%
2.50	**SILTY SAND & GRAVEL,** some cobbles with traces of organics, dark grey, wet. (compact)	a, b, c, d	3	SS	28		315	⊗			
313.35		a, b, c, d	4	SS	14		314	⊗	○		
4.05	END OF BOREHOLE DUE TO REFUSAL TO AUGER ON BEDROCK OR BOULDER										

Notes:
1) This borehole forms part of Highway 522 Underpass Foundation Investigation.
2) Borehole located at station 10+150.0, offset ~4.0 m right of centreline as referenced to Highway 522.
3) Borehole caved wet at ~3.9 m depth on completion.

MTO4 7524C 07/17/98

RECORD OF BOREHOLE BH-12CP 1 OF 1

METRIC

W.P. 774-93-00 LOCATION 5 093 641.0 N, 313 778.4 ORIGINATED BY I.D.

DIST 54 HWY 11 BOREHOLE TYPE Standard Augers / CME-55 COMPILED BY M.D.

DATUM Geodetic DATE June 23, 1998 CHECKED BY I.G.

ELEV. / DEPTH	DESCRIPTION	STRATA PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES BLOWS/0.3m	GROUND WATER CONDITIONS	ELEVATION SCALE (metres)	SPT TEST (N-Value) / CONE PENETRATION TEST (20 40 60 80)	SHEAR STRENGTH: Cu, KPa (UNCONFINED QUICK TRIAXIAL ⊗, FIELD VANE LAB SHEAR ×) (20 40 60 80)	PLASTIC LIMIT wp / NATURAL MOISTURE CONTENT w / LIQUID LIMIT wl — WATER CONTENT (%) (10 20 30 40)	UNIT WEIGHT kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION GR SA (SI & CL)
316.15	GROUND SURFACE						316					
0.00 / 315.40	**SAND & GRAVEL FILL,** road shoulder, brown. (compact)	F										
0.75	**SAND FILL,** some layering, occasional organics, some silt, moist then wet at ~2.2 m depth. (loose to compact)	F	1	SS	7		315	⊗				
		F	2	SS	9	▼	314	⊗				
313.35		F	3	SS	34			⊗		○		0% 77% 23%
2.80	**SILT,** trace of sand & slightly cohesive in parts, some layering, grey/brown, wet. (loose to compact)		4	SS	8		313	⊗	×		○	
			5	SS	4		312					
310.15							311	⊗				
6.00	**SILTY SAND & GRAVEL,** (till-like) brown, a few cobbles, wet. (dense)		6	SS	25		310		⊗	○		
308.38			7	SS	8		309	75 mm ⊗				
7.77	END OF BOREHOLE DUE TO REFUSAL TO AUGER ON BEDROCK OR BOULDER											

Notes:
1) This borehole forms part of Highway 522 Underpass Foundation Investigation.
2) Borehole located at station 9+940.0, offset ~4.5 m right of centreline as referenced to Highway 522.
3) Borehole caved wet at ~6.4 m depth on completion.
4) Lab shear test was a pocket penetrometer test.

MTO4 7524C 07/22/99

RECORD OF BOREHOLE BH-13CP 1 OF 1

METRIC

W.P. 774-93-00 LOCATION 5 093 646.6 N, 313 737.9 E ORIGINATED BY I.D.

DIST 54 HWY 11 BOREHOLE TYPE Standard Augers / CME-55 COMPILED BY M.D.

DATUM Geodetic DATE June 24, 1998 CHECKED BY I.G.

ELEV. / DEPTH	DESCRIPTION	STRATA PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES BLOWS/0.3m	GROUND WATER CONDITIONS
317.19	GROUND SURFACE					
0.00	**SAND & GRAVEL FILL,** road shoulder, brown. (compact)					
316.44						
0.75	**SAND FILL,** brown, moist. (loose)		1	SS	8	
			2	SS	3	▼
314.99						
2.20	**SILT,** trace of sand, some layering, brown to grey, moist to wet. (compact)		3	SS	15	
			4	SS	14	
312.39						
4.80	**SILTY SAND & GRAVEL,** some cobble sizes, brown, with wet layers of sand. (loose to compact)		5	SS	23	
			6	SS	8	
309.63						
7.56	END OF BOREHOLE DUE TO REFUSAL TO AUGER ON BEDROCK OR BOULDER					

Notes:
1) This borehole forms part of Highway 522 Underpass Foundation Investigation.
2) Borehole located at station 9+900.0, offset ~4.0 m left of centreline as referenced to Highway 522.
3) Borehole caved dry at ~1.6 m depth on completion.

ELEVATION SCALE (metres): 317, 316, 315, 314, 313, 312, 311, 310

SPT TEST (N-Value) ⊗
CONE PENETRATION TEST
20 40 60 80

SHEAR STRENGTH: Cu, KPa
○ UNCONFINED QUICK TRIAXIAL ● FIELD VANE × LAB SHEAR
20 40 60 80

PLASTIC LIMIT — NATURAL MOISTURE CONTENT — LIQUID LIMIT
wp ⊢ ○ w ⊣ wl
WATER CONTENT (%)
10 20 30 40

UNIT WEIGHT kN/m³

REMARKS & GRAIN SIZE DISTRIBUTION
GR SA SI + CL

MTO4 7524C 07/17/98

S07524G/C

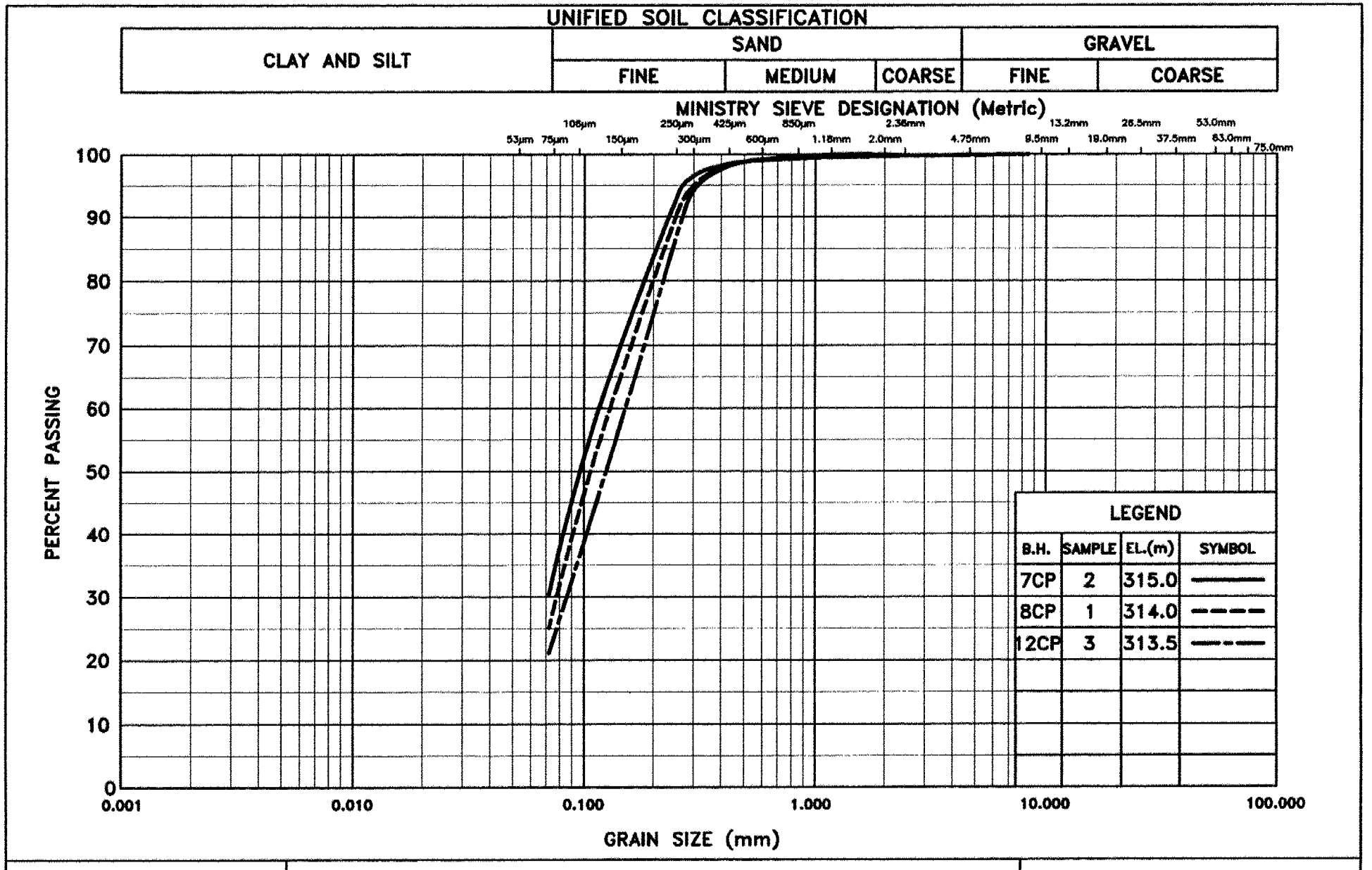
TABLE 1-1
ROCK CORE DESCRIPTION

BH#	Core Recovery				Core Description	
	Core #	Depth (m)	% CR*	% RQD**	Depth (m)	Description
HIGHWAY 522 BRIDGE FOUNDATION						
1-CF	1 2 3	3.72 to 4.72 4.72 to 5.88 5.88 to 6.89	100 100 100	98 100 100	3.72 to 6.89	**Biotite Horneblende Gneiss** - light grey to pinkish white, fine to medium grained, strong, unweathered, fractures very widely spaced, dipped at 80 to 90° from vertical, planar, smooth
3-CF	1 2 3	8.14 to 9.05 9.05 to 10.52 10.52 to 11.40	100 100 100	75 76 94	8.14 to 11.40	**Biotite Hornblende Gneiss (Garnetigerous)**, pinkish white to light grey, medium grained, strong unweathered, fractures moderately spaced, dipping at 0 to 10° and 80 to 90° from vertical, planar, smooth

*CR Core Recovery %
**RQD Rock Quality Designation %

Trow

APPENDIX B



Ministry of Transportation

METRIC

GRAIN SIZE DISTRIBUTION

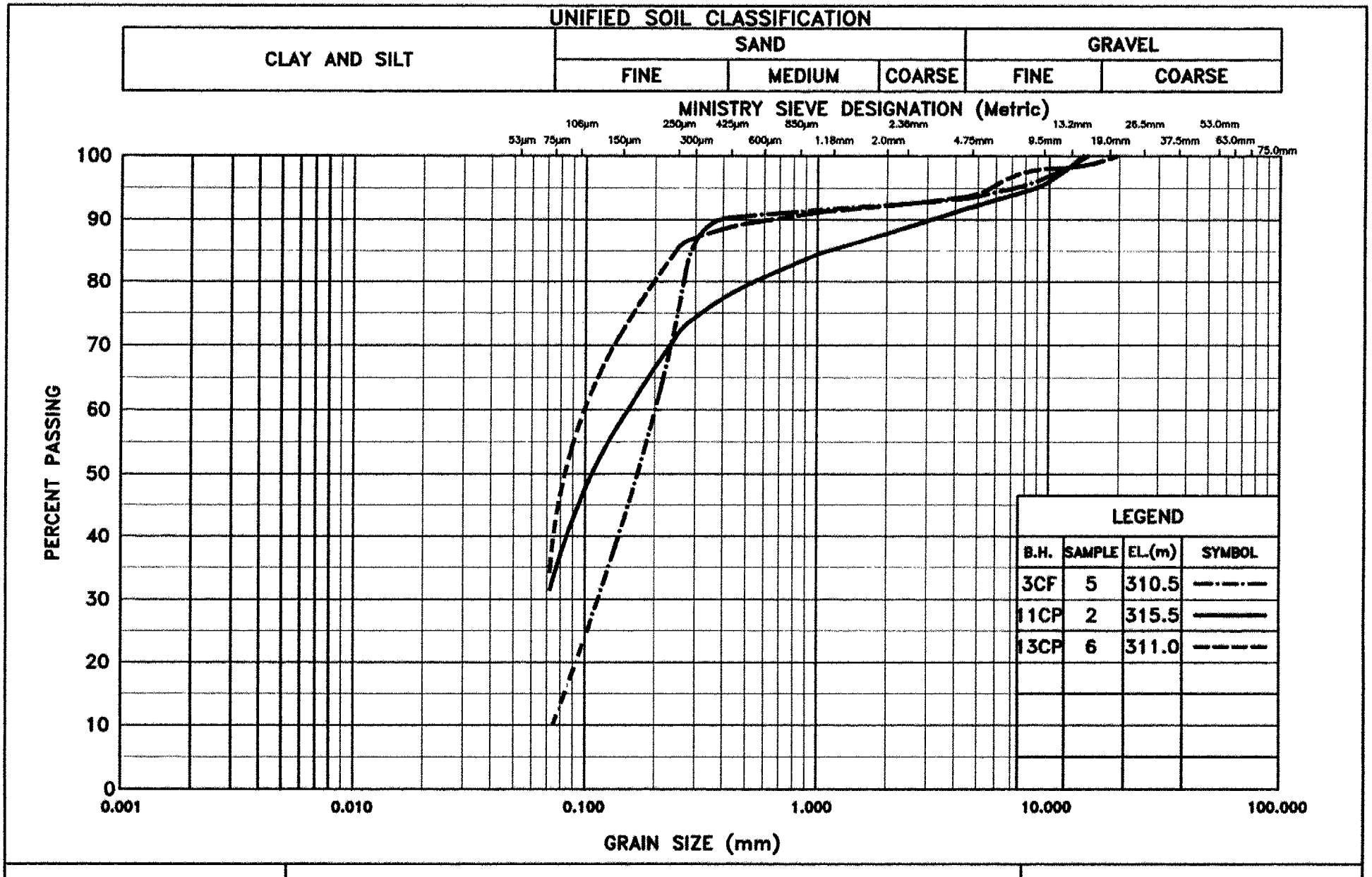
ALL SAMPLES FINE SAND

FIGURE 1

W.P. 774-93-00

Trow

PROJ. No. S07524GC



Ministry of Transportation

METRIC

GRAIN SIZE DISTRIBUTION

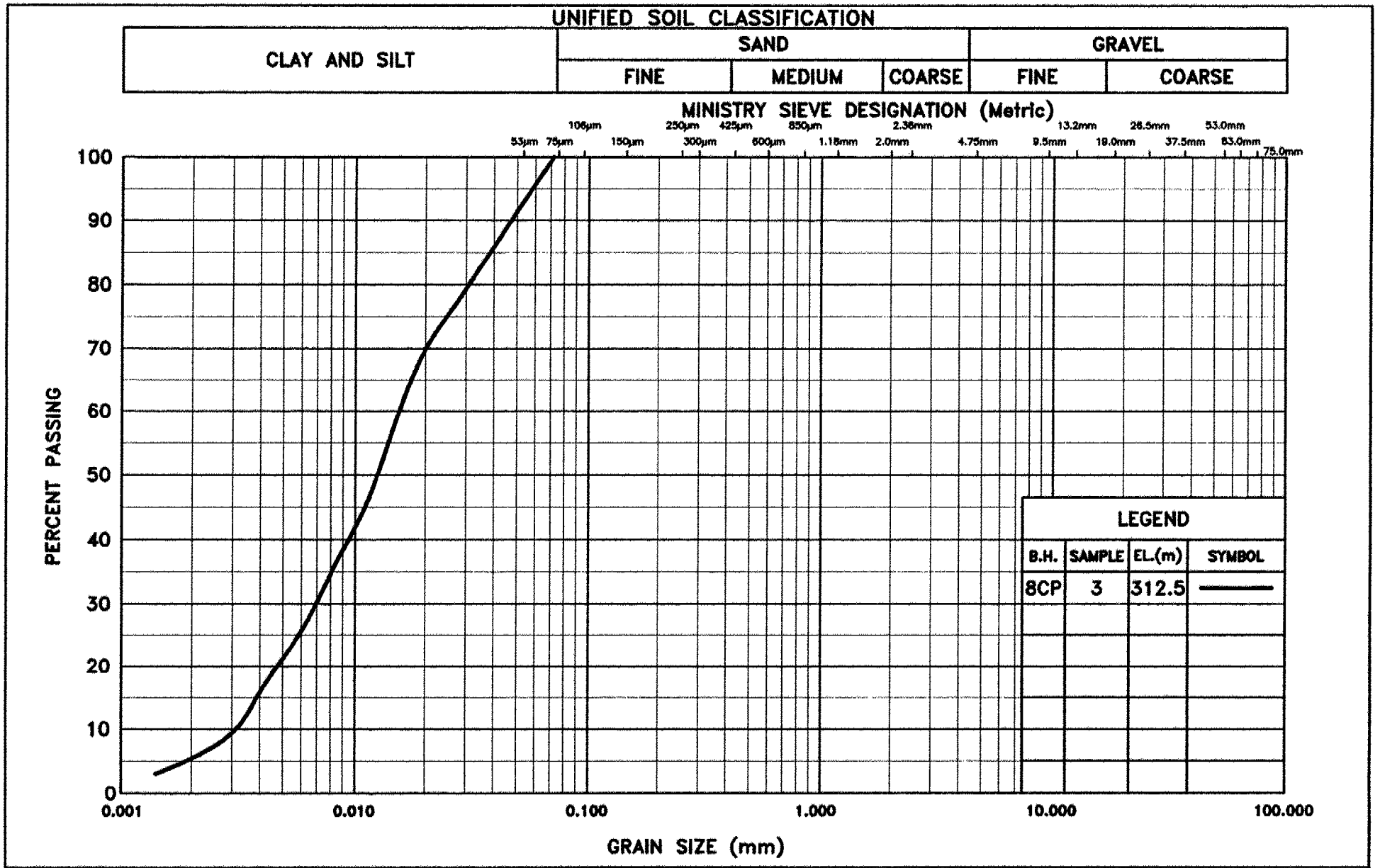
ALL SAMPLES SAND & GRAVEL

FIGURE 2

W.P. 774-93-00

Trow

PROJ. No. S07524GC



Ministry of Transportation

METRIC

GRAIN SIZE DISTRIBUTION

BH-8CP, SS-3 CLAY & SILT

FIGURE 3

W.P. 774-93-00

Trow

PROJ. No. S07524GC

DOCUMENT MICROFILMING IDENTIFICATION

G.I.-30 SEPT. 1976

GEOCRES No. 31E-177

DIST. 54 REGION

W.P. No. 774-93-00(B)

CONT. No.

W. O. No.

STR. SITE No. 44-370

HWY. No. 11

LOCATION Hwy 522 Underpass

No of PAGES - —

OVERSIZE DRAWINGS TO BE INCLUDED WITH THIS REPORT.

REMARKS:

Trow

GEOCRES # 31E-171

Foundation Investigation and Design Report For Approach Embankment Along Highway 522 Underpass (Site 44-370) at Trout Creek By-Pass (King's Highway 11) District 54, Sudbury, Ontario GWP No. 774-93-00 W.P. 770-93-01

Prepared for:

Marshall Macklin Monoghan
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THORNHILL, Ontario
L3T 7N4

Trow Consulting Engineers Ltd.

1074 Webbwood Drive
Sudbury, Ontario P3C 3B7
Telephone: (705) 674-9681
Facsimile: (705) 674-8271

SO7524G/C
July, 1999

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Appendix A

Appendix B

Preface

Work Project GWP 774-93-00 is one of a series of projects for the four lane expansion of Highway 11. The project involves the four lane design of Highway 11, from 4.0 km south of Highway 522, northerly for 7.9 km. It will result in the construction of a westerly by-pass of the existing Highway 11 and the Town of Trout Creek.

This work project is located in the Townships of Laurier and Himsworth South, within the geographic District of Parry Sound. The project requires geotechnical input for the following major components:

- New pavement design for the entire length of the four lane by-pass, including associated service roads.
- New structure, Trout Creek South Interchange (underpass), Site 44-372.
- New structure, Trout Creek, Northbound Lanes, Site 44-371.
- New structure, Trout Creek, Southbound Lanes, Site 44-371.
- New structure, Highway 522 (underpass), Site 44-370.
- New structure, Trout Creek North Interchange (underpass), Site 44-369.

The following report deals with the new approach embankments for the flyover at Highway 522, Site 44-370. Separate reports will be submitted for the additional components.

PART 1 FOUNDATION INVESTIGATION

1.1 Introduction

This submission presents the results of a geotechnical foundation investigation by Trow Consulting Engineers Ltd. (Trow) for the new approach embankments for the flyover at Highway 522 and the proposed King's Highway 11, (Trout Creek By-Pass), at Site 44-370. It is Trow's understanding that a two span structure will be constructed, with the central pier located in the median of the proposed King's Highway 11. This report contains factual information (obtained from the field investigation) pertaining to the design parameters required for the approach embankments along Highway 522.

1.2 Site Description and Geological Setting

1.2.1 Site Description

The site is located in the Township of South Himsworth at the proposed bridge structure for Highway 522 and the proposed King's Highway 11, Trout Creek By-Pass, at Site 44-370.

The proposed new, two-span bridge will be constructed to carry Highway 522 traffic over the four lanes of King's Highway 11. An 8 m grade increase of Highway 522 at the bridge abutments is anticipated, in accordance with the proposed grading plan.

The terrain at the proposed bridge structure is relatively flat, although the grade of the existing Highway 522 rises gently towards both the west and east sides. The grade of Highway 522, at the bridge site is at elevation 315 m and the existing road then rises gradually some 5 m, over a distance of approximately 240 m on the east side (up to Station 10+240), and 3 m, over approximately 200 m on the west side (up to Station 9 + 800).

The grade of Highway 522 will be raised to elevation 323 m at the bridge to accommodate the proposed four lanes of the by-pass. This arrangement will require approach embankments along Highway 522, approximately 240 m long (from the east side) and 200 m long (from the west side).

No bedrock outcrops are visible in the immediate vicinity of the proposed bridge; however, a rock cut is visible approximately 200 m along Highway 522 on the west side. There are mature trees, with heavy underbrush on either side of Highway 522, i.e. along the alignment of the proposed King's Highway 11.

1.2.2 Geological Setting

According to OGS Maps 2544 and 2556, as well as Ontario Geological Survey Map P. 3160 (Quaternary geology, South River area), the site is located in what is known as the Central Gneiss Belt, i.e. mainly felsic igneous rocks of the Mesoproterozoic Group.

The overburden is expected to be relatively shallow, comprising, for the most part, of detaic sands and gravels with some prodeltaic deposits, mainly silts. A thin layer of basal, stoney, glacial till can be expected immediately over the bedrock.

1.3 Investigative Procedures

1.3.1 General

Part 1 of this report describes the investigative procedures adopted for the geotechnical assessment of the new approach embankments along Highway 522 at the proposed Trout Creek By-Pass, King's Highway 11. Properties of the overburden soils were obtained by in-situ and laboratory testing and the procedures, employed during the investigation, are described below.

1.3.2 Field Investigation

The field work for the investigation related to the proposed Highway 522 approach embankments was carried out on May 25 and June 24, 1998, and consisted of eight(8) boreholes (BH's 6-CP to 13-CP) inclusive, and two(2) dynamic cone penetration tests (C-4CP and C-5CP). The dynamic cones and boreholes were advanced to refusal at depths ranging from 3.5 m to 7.8 m. Boreholes 6-CP and 8-CP to 11-CP, as well as cone C-4CP, were located along the 240 m length of the east side approach fills, and boreholes 7-CP, 12-CP and 13-CP, and cone C-5CP along the 200 m length of the west approach fills.

The borehole and dynamic cone penetration locations are shown on the attached site plan, Drawing 1, in Appendix A. These locations, as well as the surface elevations, were established by Trow's field technician and a survey crew from Marshall Macklin Monaghan, and are referenced to geodetic datum.

The boreholes, cones and probes were advanced through the overburden soils using a truck mounted CME-55 drill, equipped with solid and hollow stem augers, and supplied and operated by a soils drilling contractor, Master Soil Investigation Limited. Soil samples were obtained by using a 51 mm O.D. split-spoon sampler in conjunction with standard penetration tests (ASTM D1586) at approximately 0.75 m and 1.5 m intervals. The standard penetration (N) values, together with the blows from the dynamic cone penetration tests, were recorded and used to provide an assessment of the compactness of the overburden soils. The recovered soil samples were used for identification and laboratory testing.

Upon completion, boreholes were backfilled with auger cuttings from the same boreholes, and compacted at regular intervals by applying back pressure with the auger. Where boreholes were advanced within the pavement surface, cold mix asphalt was placed to adequately patch the damaged area.

Details of the soil and bedrock conditions encountered in the boreholes are included on the logs in the attached Appendix A. The additional two standard data sheets, included with the logs, provide further details on soil descriptions for classification purposes. For completeness, two of the previous boreholes (boreholes 1-CF and 3-CF), advanced for the bridge structure at the abutments, have also been included.

1.3.3 Laboratory

The laboratory testing program for select soil samples consisted of the following:

- Natural moisture content determinations
- Grain size distribution analyses
- Laboratory shear tests

The laboratory test results are summarized on the attached borehole logs in Appendix A. The grain size distribution for selected soil samples are presented in Appendix B.

1.4 Subsurface Conditions

The borehole locations are shown on the site plan, Drawing 1, in Appendix A. Also included in Appendix A are the borehole and dynamic cone penetration logs. Based on this information, the following different soil layers were encountered:

- fill
- silt
- sand/sand and gravel
- bedrock

A summary of the above soil strata encountered in the boreholes, and inferred from the dynamic cone penetration tests, is presented below.

1.4.1 Fill

The fill at the test locations is associated with the road construction materials for the existing Highway 522. Beneath the present asphalt (~50 mm thick) and the base and subbase granulars (~700 mm thick), an underlying layer of sand and/or sand and gravel fill was encountered, which extends to depths generally in the 2.0 m to 2.5 m range. The fill is mostly sand, although it contains random pieces of old asphalt, some gravel and/or cobble sizes, as well as minor organic staining and contamination.

The compactness of the fill, based on the standard penetration resistance, "N", value ranged from 4 to 36 blows/300 mm, indicating a loose to dense state.

Grain size analyses on samples of the material confirm that the deposit is mainly a fine sand with a silt fraction of between 20% to 30%. Moisture contents vary from less than 10% above the water table to about 20% below the groundwater table.

1.4.2 Silt

A deposit of silt was encountered in five boreholes (boreholes 3-CF, 8-CP, 9-CP, 10-CP, 12-CP and 13-CP). This silt stratum is absent in the vicinity of the east abutment and is more prominent beneath the west approach embankment (boreholes 12-CP and 13-CP). The silt contains some sand seams and odd layering, where it is slightly cohesive. The standard penetration resistance "N" values ranged from 4 to 14 blows/300 mm, indicating a loose to compact state of compaction. The thickness ranged from 1 m (borehole 3-CF) to 3 m (borehole 12-CP), and the moisture content from 25% to 35%.

1.4.3 Sand and Gravel

A basal zone of sand and gravel was encountered in all boreholes, with the exception of boreholes 8-CP and 9-CP. The deposit is reasonably well-graded with up to 31% silt sizes in places. At some locations, the stratum appears to be weakly cemented, indicating a "till-like" structure. The standard penetration resistance "N" values range from 9 to 25 blows/300 mm, indicating a loose to compact condition. The thickness ranges from about 1 m at borehole 1-CF to 4 m at borehole 3-CF. Moisture contents ranged from 5% to 20%.

1.4.4 Bedrock

Bedrock was confirmed by retrieving "NQ" size cores in the two boreholes at the abutments (BH's 1-CF and 3-CF) at depths of 3.72 m (~El. 311.2 m) and 8.14 m (~El. 307.2 m).

Detailed descriptions of the rock are presented in Table 1-1 in Appendix A. Generally, the bedrock can be described as a pinkish, light grey, biotite-Homblende gneiss. The rock is strong and unweathered for the most part. Rock core recovery was 100% for all runs and the Rock Quality Designation (RQD) values ranged from 75% to 100%.

In the remaining boreholes and cones, the refusal levels noted in the logs are assumed to represent the bedrock surface.

1.5 Groundwater Conditions

Information regarding the groundwater levels at the site was obtained by measuring the water levels in the open boreholes after completion of drilling. The groundwater table, at the time of the field work, was established at a depth of about 2 m to 2.5 m below grade, which is close to the grade of the surrounding, poorly drained, relatively flat terrain.

Seasonal variations in the water table should be expected with higher levels during wetter periods of the year (such as spring thaw and late fall) and lower levels during drier periods.

Part 2 Discussion and Recommendations

2.1 Introduction

This submission presents the results of a geotechnical foundation investigation by Trow Consulting Engineers Ltd. (Trow) for the new approach embankments for the flyover at Highway 522 and the proposed King's Highway 11, Trout Creek By-Pass, at Site 44-370. It is Trow's understanding that a two-span structure will be constructed, with the central pier located in the median of the proposed King's Highway 11. This report contains factual information (obtained from the field investigation) pertaining to the design parameters required for the approach embankments along Highway 522.

As outlined in Part 1 of this report, the grade at Highway 522 at the structure is at elevation 315 m and the existing road then rises gradually some 5 m, over a distance of approximately 240 m on the east side (up to station 10+240) and 3 m, over approximately 200 m on the west side (up to station 9+800). The grade of Highway 522 will be raised to elevation 323 m at the bridge to accommodate the proposed four lanes of the By-Pass.

This geometric arrangement will require approach fills, along Highway 522, up to a maximum of 8 m at the proposed bridge abutments, before tying into the existing grade of Highway 522 at a distance of 240 m on the east side and 200 m on the west side.

2.2 Design

2.2.1 Stability

Based on the results of the boreholes and dynamic cone penetration tests, no instability problems are anticipated. The underlying granular soils, i.e. sand, silts and sand and gravels, are adequate to safely support the proposed approach fill heights.

Surficial topsoil and compressible organics, under the plan limits of the embankments where the approach fills encroach off the existing road construction and over the adjacent soils, should be removed. Based on Trow's adjacent borings for the pavement design of Highway 11, it is likely that the surficial organics will be about 300 mm to 600 mm thick.

If rock fill is used to construct the approach embankments, the side slopes and forward slopes should be constructed at a maximum gradient of 1.25H:1V. If Granular "B" is used, the side slopes should be constructed at 2H:1V.

2.2.2 Settlements

Since the proposed approach embankments are underlain by granular soils, long-term consolidation settlements are not anticipated. There will likely be some initial settlement, due to the surcharge embankment loads; however, it is anticipated that they will be less than 50 mm and will occur, almost entirely, within the construction phase.

2.3 Construction Considerations

2.3.1 Excavations

Temporary subexcavation for surficial organics is not expected to exceed 1 m and hence should be straightforward. Side slopes will remain stable if cut back at an angle of 1H:1V.

2.3.2 Raising the Grade

Rock fill or other granular fills placed below the groundwater table may be end-dumped. Once the material is 0.3 m above the water table, placement and compaction of the fills should be carried out according to current OPS specifications and practices.

2.4 General

The information presented in this report is based on a limited investigation designed to provide information to support an overall assessment of the current geotechnical conditions for the proposed approach embankments along Highway 522 at King's Highway 11, Trout Creek By-Pass. The conclusions presented in this report reflect site conditions existing at the time of the investigation. It is noted that the soil boundaries indicated on the logs are inferred from discontinuous sampling and observations during drilling. These boundaries are intended to reflect transition zones for the purpose of geotechnical design and should not be interpreted as exact planes of geological change.

This report has been prepared by Mr. I.W. Gore, P.Eng., and Mr. E.A. Gonneau, P.Eng., and reviewed by Mr. S.E. Gonsalves, P.Eng. The field investigation was performed by Mr. I. Dumpis, C.E.T.

We trust this report is satisfactory for your purposes. Should you have any questions, please do not hesitate to contact this office.

Trow Consulting Engineers Ltd.

E.A. GONNEAU

E.A. Gonneau, P.Eng.
Project Manager

I. W. GORE

I.W. Gore, M.Sc., P.Eng.
Principal

S.E.M. GONSALVES

S.E. Gonsalves, M.Sc., P.Eng.
Vice President

Encl.

Dist: Ministry of Transportation (8)
Planning & Design
Mr. E. Gallant

Marshall Macklin Monaghan (1)
Mr. R.D. Kivi, P.Eng.

IWG:jot/8.1/Geo/reports7524gc2.wpd

APPENDIX A

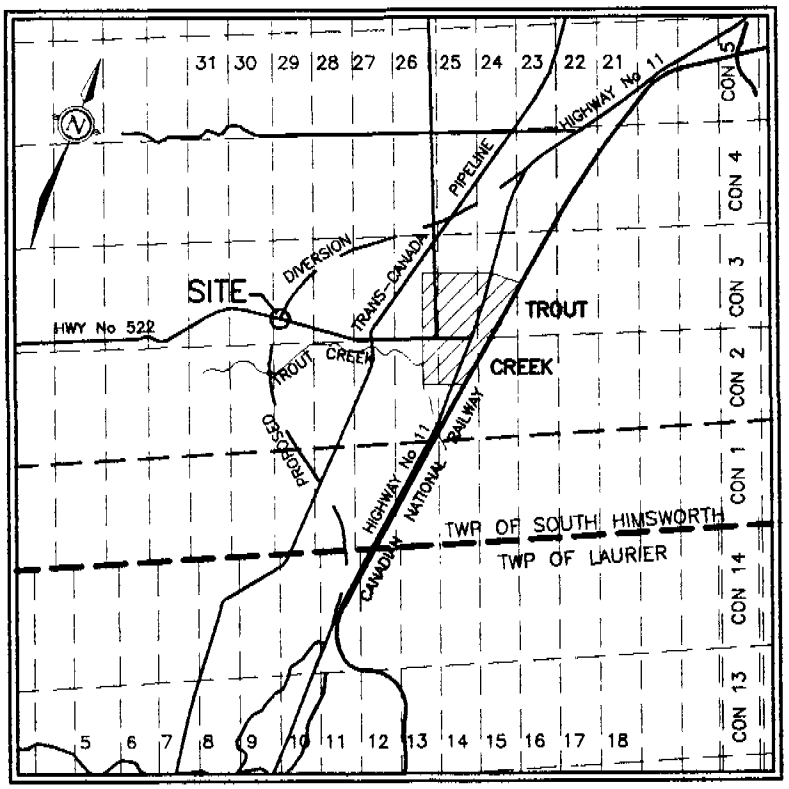
METRIC

DIMENSIONS ARE IN METRES AND/OR MILLIMETRES UNLESS OTHERWISE SHOWN

PLATE No	509-11/176-0
DRAWING No	05090011176
CONT No	
WP No	774-93-00

SHEET

Revised



KEY PLAN

1 km 0 1 km

TROW CONSULTING ENGINEERS LTD.
SUDBURY, ONTARIO

Trow PROJ. No. S07524GCP DWG. No. 1

MINISTRY OF TRANSPORTATION
ENGINEERING OFFICE
SURVEYS AND PLANS SECTION

KEY PLAN

PROPOSED CROSSING
AT
SEC HIGHWAY 522
AND
PROPOSED C/L MEDIAN HWY 11

GEOG TWP SOUTH HIMSWORTH LOT 29 — DIST OF PARRY SOUND CON 3

SCALE	DISTRICT	REGION
1:400	PARRY SOUND	NORTHERN
	ETR 509-11	

SURVEY DATE	97/10	PLAN DATE	97/10
SITE 44-370	PLAN E-509-11-12		

PLATE No 509-11/176-0
DRAWING No 05090011176
CONT No
WP No 774-93-00

SHEET

Notes

LOT 29
CON 3

R-1250.000
A-350.000

LOT 30
CON 3

LOT 29
CON 3

N 5 093 700

N 5 093 600

E 313 700

E 313 800

9+900

10+000

10+100

11+300

11+200

HOC 11+263.208 C/L MEDIAN
HOT 10+666.000 SEC HWY No 522

TSP 1086

TSP 1082

TSP 9534

TSP 1081

C/L MEDIAN

123.62 C.S.P

460 X 8.87 C.S.P

460 X 14.801 C.S.P

Comm S.

H&B

WF

B

H

HdSV

BH-13CP
BH-7CP
C-5CP
BH-12CP
BH-3CF
BH-1CF
BH-8CP
C-4CP
BH-9CP
BH-10CP
BH-6CP
BH-11CP

PLAN

20 m 0 20 m

LEGEND

- BOREHOLE
- AUGER PROBE
- DYNAMIC CONE PENETRATION TEST

No.	ELEV.	CO-ORDINATES NORTH	EAST
BH-1CF	314.90	5 093 657.8	313 870.8
BH-3CF	315.37	5 093 641.5	313 805.6
BH-6CP	316.81	5 093 658.9	313 963.6
BH-7CP	317.89	5 093 640.8	313 713.2
BH-8CP	315.05	5 093 657.7	313 887.4
BH-9CP	315.22	5 093 650.1	313 908.1
BH-10CP	315.95	5 093 660.9	313 937.3
BH-11CP	317.40	5 093 656.6	313 987.8
BH-12CP	316.15	5 093 641.0	313 778.4
BH-13CP	317.19	5 093 646.6	313 737.9
C-4CP	315.83	5 093 655.8	313 922.7
C-5CP	316.92	5 093 644.0	313 758.1

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

TROW CONSULTING ENGINEERS LTD.
SUDBURY, ONTARIO
Trow PROJ. No. S07524GCP DWG. No. 1A

MINISTRY OF TRANSPORTATION
ENGINEERING OFFICE
SURVEYS AND PLANS SECTION

BRIDGE SITE PLAN

PROPOSED CROSSING
AT
SEC HIGHWAY 522
AND
PROPOSED C/L MEDIAN HWY 11

GEOG TWP SOUTH HIMSWORTH LOT 29 — DIST OF PARRY SOUND CON 3

SCALE	DISTRICT	REGION
1:1000	PARRY SOUND	NORTHERN
	ETR 509-11	

SURVEY DATE 97/10 PLAN DATE 97/10

SITE 44-370 PLANE-509-11-12

RECORD OF BOREHOLE BH-1CF 1 OF 1

METRIC

W.P. 774-93-00 LOCATION 5 093 657.8 N, 313 870.8 E ORIGINATED BY I.D.

DIST 54 HWY 11 BOREHOLE TYPE Hollow Stem Augers / CME-55 COMPILED BY M.D.

DATUM Geodetic DATE May 12, 1998 CHECKED BY I.G.

ELEV. / DEPTH	DESCRIPTION	STRATA PLOT	NUMBER	TYPE	BLOWS/0.3m	GROUND WATER CONDITIONS	ELEVATION SCALE (metres)	SPT TEST (N-Value) / CONE PENETRATION TEST; SHEAR STRENGTH: Cu, KPa (UNCONFINED QUICK TRIAXIAL, FIELD VANE LAB SHEAR)	PLASTIC LIMIT wp / NATURAL MOISTURE CONTENT w / LIQUID LIMIT wl; WATER CONTENT (%)	UNIT WEIGHT kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION GR SA SI + CL
314.90	GROUND SURFACE							20 40 60 80	10 20 30 40		
0.00	**FILL,** mostly silty sand & gravel with a few cobble sizes, occasional pieces of asphalt, brown, moist. (compact)	F F F	1	SS	28		314 313	⊗	O		
312.40							312				
2.50	**SAND & GRAVEL,** pockets of sand, some cobble sizes & possible boulders, brown, wet. (compact)		2	SS	13	▼		⊗	O		
311.18							311				
3.72	**BIOTITE HORNBLENDE GNEISS,** pinkish grey, excellent rock quality, unweathered.		3	NQ							Rec 100% RQD 98%
			4	NQ			310				Rec 100% RQD 100%
							309				
308.01			5	NQ							Rec 100% RQD 100%
6.89	END OF BOREHOLE										

Notes:
1) This borehole forms part of Highway 522 Underpass Foundation Investigation.
2) Borehole located at station 10+033.3, offset 6.5 m left of centreline as referenced to Highway 522.

MTO4 7524C 07/17/98

RECORD OF BOREHOLE BH-3CF 1 OF 1

METRIC

W.P. 774-93-00 LOCATION 5 093 641.5 N, 313 805.6 E ORIGINATED BY I.D.

DIST 54 HWY 11 BOREHOLE TYPE Hollow Stem Augers / CME-55 COMPILED BY M.D.

DATUM Geodetic DATE May 12, 1998 CHECKED BY I.G.

ELEV. / DEPTH	DESCRIPTION	STRATA PLOT	NUMBER	TYPE	BLOWS/0.3m	GROUND WATER CONDITIONS	ELEVATION SCALE (metres)	SPT TEST (N-Value) / CONE PENETRATION TEST (20 40 60 80) / SHEAR STRENGTH: Cu, KPa (UNCONFINED QUICK TRIAXIAL ● / FIELD VANE LAB SHEAR ×) (20 40 60 80)	PLASTIC LIMIT wp / NATURAL MOISTURE CONTENT w / LIQUID LIMIT wl — WATER CONTENT (%) (10 20 30 40)	UNIT WEIGHT kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION GR SA SI + CL
315.37	GROUND SURFACE						315				
0.00	**SAND & GRAVEL FILL,** occasional lumps of asphalt, brown, moist. (compact/dense)		1	SS	29			⊗	○		
314.17							314				
1.20	**SAND,** brown, wet, traces of organics, (possible FILL). (compact)		2	SS	16	▽		⊗	○		
			3	SS	9		313	⊗	○		
312.37											
3.00	**SILT,** grey, trace of clay, wet. (very loose)		4	SS	3		312	⊗	○		
311.37							311				
4.00	**SAND,** with gravel sizes, brown, moist then wet below ~6.0 m depth, occasional cobbles. (compact)		5	SS	18			⊗	○		7% 83% 10%
			6	SS	12		309	⊗	○		
307.23			7	SS	19		308	⊗	○		
8.14	**BIOTITE HORNBLENDE GNEISS,** pinkish grey, good to excellent rock quality, slightly weathered to unweathered.		8	NQ			307				Rec 97% RQD 76%
			9	NQ			306				Rec 100% RQD 76%
							305				
303.97			10	NQ			304				Rec 100% RQD 94%
11.40	END OF BOREHOLE										

Notes:
1) This borehole forms part of Highway 522 Underpass Foundation Investigation.
2) Borehole located at station 9+966.8, ~5.0 m right of centreline as referenced to Highway 522.

MT04 7524C 07/17/98

RECORD OF BOREHOLE C-4CP

METRIC

W.P. 774-93-00 LOCATION 5 093 655.8 N, 313 922.7 E ORIGINATED BY I.D.

DIST 54 HWY 11 BOREHOLE TYPE Dynamic cone test / CME-55 COMPILED BY M.D.

DATUM Geodetic DATE May 25, 1998 CHECKED BY I.G.

ELEV. / DEPTH	SOIL PROFILE: DESCRIPTION	STRATA PLOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: BLOWS/0.3m	GROUND WATER CONDITIONS	ELEVATION SCALE (metres)	SPT TEST (N-Value) / CONE PENETRATION TEST; SHEAR STRENGTH: Cu, KPa (UNCONFINED QUICK TRIAXIAL ● / FIELD VANE LAB SHEAR ×)	WATER CONTENT (%) (PLASTIC LIMIT wp, NATURAL MOISTURE CONTENT w, LIQUID LIMIT wl)	UNIT WEIGHT kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION GR SA SI + CL
315.83	GROUND SURFACE							20 40 60 80	10 20 30 40		
0.00	Dynamic cone test only.						315				
							314				
							313				
							312				
311.11											
4.72	END OF CONE TEST DUE TO BOUNCING REFUSAL ON BEDROCK OR BOULDER										

Notes:
1) This cone test forms part of Highway 522 Underpass Foundation Investigation.
2) Cone test located at station 10+085.0, on centreline as referenced to Highway 522.
3) Augered first ~0.3 m through dense fill before driving cone test.

MTO4 7524C 07/17/98

RECORD OF BOREHOLE C-5CP 1 OF 1

METRIC

W.P. 774-93-00 LOCATION 5 093 644.0 N, 313 758.1 E ORIGINATED BY I.D.

DIST 54 HWY 11 BOREHOLE TYPE Dynamic cone test / CME-55 COMPILED BY M.D.

DATUM Geodetic DATE May 25, 1998 CHECKED BY I.G.

ELEV. / DEPTH	DESCRIPTION	STRATA PLOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: BLOWS/0.3m	GROUND WATER CONDITIONS	ELEVATION SCALE (metres)	SPT TEST (N-Value) / CONE PENETRATION TEST; SHEAR STRENGTH: Cu, KPa (UNCONFINED QUICK TRIAXIAL, FIELD VANE LAB SHEAR)	PLASTIC LIMIT / NATURAL MOISTURE CONTENT / LIQUID LIMIT; WATER CONTENT (%)	UNIT WEIGHT kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION GR SA SI + CL
316.92	GROUND SURFACE							SPT TEST (N-Value) CONE PENETRATION TEST 20 40 60 80; SHEAR STRENGTH: Cu, KPa ● UNCONFINED QUICK TRIAXIAL ▮ FIELD VANE × LAB SHEAR 20 40 60 80	PLASTIC LIMIT wp — NATURAL MOISTURE CONTENT w — LIQUID LIMIT wl; WATER CONTENT (%) 10 20 30 40		
0.00	Dynamic cone test only.						316 315 314 313 312 311 310				
309.15											
7.77	END OF CONE TEST DUE TO BOUNCING REFUSAL ON BEDROCK OR BOULDER Notes: 1) This cone test forms part of Highway 522 Underpass Foundation Investigation. 2) Cone test located at station 9+920.0, on centreline as referenced to Highway 522. 3) Augered first ~0.3 m through dense fill before driving cone test.										

MTO4 7524C 07/17/98

RECORD OF BOREHOLE BH-6CP 1 OF 1

METRIC

W.P. 774-93-00 LOCATION 5 093 658.9 N, 313 963.6 E ORIGINATED BY I.D.

DIST 54 HWY 11 BOREHOLE TYPE Hollow Stem Augers / CME-55 COMPILED BY M.D.

DATUM Geodetic DATE May 25, 1998 CHECKED BY I.G.

ELEV. / DEPTH	DESCRIPTION	STRATA PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES BLOWS/0.3m	GROUND WATER CONDITIONS	ELEVATION SCALE (metres)	SPT TEST (N-Value) / CONE PENETRATION TEST (20 40 60 80)	SHEAR STRENGTH: Cu, KPa — UNCONFINED QUICK TRIAXIAL ● / FIELD VANE LAB SHEAR × (20 40 60 80)	PLASTIC LIMIT wp — NATURAL MOISTURE CONTENT w — LIQUID LIMIT wl; WATER CONTENT (%) (10 20 30 40)	UNIT WEIGHT kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION GR SA SI + CL
316.81	GROUND SURFACE											
0.00	**ASPHALT**, ~40 mm over **SAND**, with gravel inclusions, brown to grey, some cobbles, moist to wet at base. (compact)		1	SS	24		316	⊗	○			
			2	SS	36		315	⊗	○			
314.21			3	SS	8	▼	314	⊗	○			
2.60	**PEAT**, numerous roots ~450 mm thick over **SILTY SAND**, with gravel, grey/brown, wet. (compact)		4	SS	9		313	⊗	○			
312.85												
3.96	END OF BOREHOLE DUE TO REFUSAL TO AUGER ON BEDROCK OR BOULDER											

Notes:
1) This borehole forms part of Highway 522 Underpass Foundation Investigation.
2) Borehole located at station 10+126.0, on centreline as referenced to Highway 522.
3) Borehole caved wet at ~4.0 m depth on completion.

MTO4 7524C 07/17/98

RECORD OF BOREHOLE BH-7CP 1 OF 1

METRIC

W.P. 774-93-00 LOCATION 5 093 640.8 N, 313 713.2 E ORIGINATED BY I.D.

DIST 54 HWY 11 BOREHOLE TYPE Standard Augers / CME-55 COMPILED BY M.D.

DATUM Geodetic DATE May 25, 1998 CHECKED BY I.G.

ELEV. / DEPTH	DESCRIPTION	STRATA PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES BLOWS/0.3m	GROUND WATER CONDITIONS	ELEVATION SCALE (metres)	SPT TEST (N-Value) / CONE PENETRATION TEST (20 40 60 80)	PLASTIC LIMIT / NATURAL MOISTURE CONTENT / LIQUID LIMIT (wp, w, wl)	UNIT WEIGHT kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION GR SA SI + CL
317.89	GROUND SURFACE							SHEAR STRENGTH: Cu, KPa ○ UNCONFINED ● QUICK TRIAXIAL × FIELD VANE ▮ LAB SHEAR (20 40 60 80)	WATER CONTENT (%) (10 20 30 40)		
0.00	**ASPHALT,** ~40 mm over **FILL,** roadbase.										
317.19											
0.70	**SAND FILL,** brown, moist to wet, some organic inclusions in parts. (loose/compact)		1	SS	11		317	⊗	○		
			2	SS	6		316	⊗	○		0% 67% 33%
315.59											
2.30	**SILTY SAND & GRAVEL,** brown, wet. (compact)		3	SS	17	▼	315	⊗	○		
			4	SS	24			⊗	○		
313.78							314				
4.11	END OF BOREHOLE DUE TO REFUSAL TO AUGER ON BEDROCK OR BOULDER										

Notes:
1) This borehole forms part of Highway 522 Underpass Foundation Investigation.
2) Borehole located at station 9+875.0, offset ~4.5 m right of centreline as referenced to Highway 522.
3) Borehole caved wet at ~5.1 m depth on completion.

MTO4 7524C 07/17/98

RECORD OF BOREHOLE BH-8CP 1 OF 1

METRIC

W.P. 774-93-00 LOCATION 5 093 657.7 N, 313 887.4 E ORIGINATED BY I.D.

DIST 54 HWY 11 BOREHOLE TYPE Standard Augers / CME-55 COMPILED BY M.D.

DATUM Geodetic DATE June 24, 1998 CHECKED BY I.G.

ELEV. / DEPTH	DESCRIPTION	STRATA PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES BLOWS/0.3m	GROUND WATER CONDITIONS	ELEVATION SCALE (metres)	SPT TEST (N-Value) / CONE PENETRATION TEST / SHEAR STRENGTH: Cu, KPa (UNCONFINED QUICK TRIAXIAL, FIELD VANE LAB SHEAR)	WATER CONTENT (%) (PLASTIC LIMIT wp, NATURAL MOISTURE CONTENT w, LIQUID LIMIT wl)	UNIT WEIGHT kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION GR SA SI + CL
315.05	GROUND SURFACE						315	20 40 60 80	10 20 30 40		
0.00 314.30	**SAND & GRAVEL FILL,** ~road shoulder, brown, moist. (compact)										
0.75 312.95	**FILL,** mostly sand & sand with silt & gravel, pieces of asphalt, brown, wet at base. (compact)		1	SS	12		314	⊗	○		0% 73% 27%
			2	SS	19	▼	313	⊗			
2.10 311.54	**SILT,** grey, trace of sand, some layering, wet, slightly cohesive in parts. (loose to compact) Some gravel sizes at base.		3	SS	6			⊗	○		0% 0% 100%
			4	SS	6		312.75 mm	⊗			
3.51	END OF BOREHOLE DUE TO REFUSAL TO AUGER ON BEDROCK OR BOULDER										

Notes:
1) This borehole forms part of Highway 522 Underpass Approach Investigation.
2) Borehole located at station 10+050.0, offset ~4.5 m left of centreline as referenced to Highway 522.
3) Borehole was dry & open to ~1.9 m depth on completion.

MTO4 7524C 07/17/98

RECORD OF BOREHOLE BH-9CP 1 OF 1

METRIC

W.P. 774-93-00 LOCATION 5 093 650.1 N, 313 908.1 E ORIGINATED BY I.D.

DIST 54 HWY 11 BOREHOLE TYPE Standard Augers / CME-55 COMPILED BY M.D.

DATUM Geodetic DATE June 23, 1998 CHECKED BY I.G.

ELEV. / DEPTH	DESCRIPTION	STRATA PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES BLOWS/0.3m	GROUND WATER CONDITIONS	ELEVATION SCALE (metres)	SPT TEST (N-Value) / CONE PENETRATION TEST (20 40 60 80)	SHEAR STRENGTH: Cu, KPa (UNCONFINED QUICK TRIAXIAL ● / FIELD VANE LAB SHEAR ×) (20 40 60 80)	PLASTIC LIMIT wp / NATURAL MOISTURE CONTENT w / LIQUID LIMIT wl — WATER CONTENT (%) (10 20 30 40)	UNIT WEIGHT kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION GR SA SI + CL
315.22	GROUND SURFACE						315					
0.00 / 314.47	**SAND & GRAVEL FILL,** road shoulder, brown, moist. (compact)	F										
0.75 / 313.22	**SAND FILL,** trace of organics, brown, wet at base. (very loose)	F	1	SS	2		314	⊗				
			2	SS	4	▼		⊗				
2.00 / 311.20	**SILT,** grey, trace of sand, slightly cohesive in parts, some layering, wet. (loose)		3	SS	11		313	⊗				
			4	SS	8		312	⊗				
4.02	END OF BOREHOLE DUE TO REFUSAL TO AUGER ON BEDROCK OR BOULDER											

Notes:
1) This borehole forms part of Highway 522 Underpass Approach Investigation.
2) Borehole located at station 10+070.0, offset ~4.5 m right of centreline as referenced to Highway 522.
3) Water level was at ~2.5 m & hole was at ~2.6 m depth on completion.

MTO4 7524C 07/17/98

RECORD OF BOREHOLE BH-10CP 1 OF 1

METRIC

W.P. 774-93-00 LOCATION 5 093 660.9 N, 313 937.3 E ORIGINATED BY I.D.

DIST 54 HWY 11 BOREHOLE TYPE Standard Augers / CME-55 COMPILED BY M.D.

DATUM Geodetic DATE June 24, 1998 CHECKED BY I.G.

ELEV. / DEPTH	DESCRIPTION	STRATA PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES BLOWS/0.3m	GROUND WATER CONDITIONS	ELEVATION SCALE (metres)	SPT TEST (N-Value) / CONE PENETRATION TEST; SHEAR STRENGTH: Cu, KPa (UNCONFINED QUICK TRIAXIAL, FIELD VANE LAB SHEAR)	WATER CONTENT (%) (PLASTIC LIMIT wp, NATURAL MOISTURE CONTENT w, LIQUID LIMIT wl)	UNIT WEIGHT kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION GR SA SI + CL
315.95	GROUND SURFACE										
0.00 / 315.20	**SAND & GRAVEL FILL,** road shoulder, brown, moist. (compact)	F									
0.75 / 314.15	**SAND FILL,** trace of organics, brown, moist. (loose)	F	1	SS	6		315				
			2	SS	9	▼	314				
1.80 / 312.75	**SILT,** grey, trace of sand, some layering, wet. (loose to compact)		3	SS	11		313				
3.20 / 311.41	**SILTY SAND & GRAVEL,** a few cobbles, brown, wet. (compact)		4	SS	20		312				
4.54	END OF BOREHOLE DUE TO REFUSAL TO AUGER ON BEDROCK OR BOULDER										

Notes:
1) This borehole forms part of Highway 522 Underpass Foundation Investigation.
2) Borehole located at station 10+100.0, offset ~4.0 m left of centreline as referenced to Highway 522.
3) Borehole caved wet at ~3.3 m depth on completion.

MT04 7524C 07/17/98

RECORD OF BOREHOLE BH-11CP 1 OF 1

METRIC

W.P. 774-93-00 LOCATION 5 093 656.6 N, 313 987.8 E ORIGINATED BY I.D.

DIST 54 HWY 11 BOREHOLE TYPE Standard Augers / CME-55 COMPILED BY M.D.

DATUM Geodetic DATE June 24, 1998 CHECKED BY I.G.

ELEV. / DEPTH	DESCRIPTION	STRATA PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES BLOWS/0.3m	GROUND WATER CONDITIONS	ELEVATION SCALE (metres)	SPT TEST (N-Value) / CONE PENETRATION TEST; SHEAR STRENGTH: Cu, KPa (UNCONFINED QUICK TRIAXIAL, FIELD VANE LAB SHEAR)	PLASTIC LIMIT wp / NATURAL MOISTURE CONTENT w / LIQUID LIMIT wl; WATER CONTENT (%)	UNIT WEIGHT kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION GR SA SI + CL
317.40	GROUND SURFACE							20 40 60 80	10 20 30 40		
0.00	**SAND & GRAVEL FILL,** road shoulder, brown, moist. (compact)	F					317				
316.65		F									
0.75	**SAND FILL,** trace of organics, pieces of asphalt, brown, moist to wet. (loose)	F	1	SS	9			⊗			
		F					316				
			2	SS	6	▼		⊗	○		8% 59% 33%
314.90							315				
2.50	**SILTY SAND & GRAVEL,** some cobbles with traces of organics, dark grey, wet. (compact)	a b c d	3	SS	28			⊗			
		a b c d	4	SS	14		314	⊗	○		
313.35											
4.05	END OF BOREHOLE DUE TO REFUSAL TO AUGER ON BEDROCK OR BOULDER										

Notes:
1) This borehole forms part of Highway 522 Underpass Foundation Investigation.
2) Borehole located at station 10+150.0, offset ~4.0 m right of centreline as referenced to Highway 522.
3) Borehole caved wet at ~3.9 m depth on completion.

MTO4 7524C 07/17/98

RECORD OF BOREHOLE BH-12CP 1 OF 1

METRIC

W.P. 774-93-00 LOCATION 5 093 641.0 N, 313 778.4 ORIGINATED BY I.D.

DIST 54 HWY 11 BOREHOLE TYPE Standard Augers / CME-55 COMPILED BY M.D.

DATUM Geodetic DATE June 23, 1998 CHECKED BY I.G.

ELEV. / DEPTH	DESCRIPTION	STRATA PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES BLOWS/0.3m	GROUND WATER CONDITIONS	ELEVATION SCALE (metres)	SPT TEST (N-Value) / CONE PENETRATION TEST (20 40 60 80)	SHEAR STRENGTH: Cu, KPa ● UNCONFINED QUICK TRIAXIAL ○ FIELD VANE × LAB SHEAR (20 40 60 80)	PLASTIC LIMIT wp — NATURAL MOISTURE CONTENT w — LIQUID LIMIT wl; WATER CONTENT (%) (10 20 30 40)	UNIT WEIGHT kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION GR SA (SI & CL)
316.15	GROUND SURFACE						316					
0.00 / 315.40	**SAND & GRAVEL FILL,** road shoulder, brown, (compact)	F										
0.75	**SAND FILL,** some layering, occasional organics, some silt, moist then wet at ~2.2 m depth. (loose to compact)	F	1	SS	7		315	⊗				
		F	2	SS	9	▼	314	⊗				
313.35		F	3	SS	34			⊗		○		0% 77% 23%
2.80	**SILT,** trace of sand & slightly cohesive in parts, some layering, grey/brown, wet. (loose to compact)		4	SS	8		313	⊗	×	○		
			5	SS	4		312	⊗				
310.15							311					
6.00	**SILTY SAND & GRAVEL,** (till-like) brown, a few cobbles, wet. (dense)		6	SS	25		310		⊗	○		
308.38			7	SS	8		309	75 mm ⊗				
7.77	END OF BOREHOLE DUE TO REFUSAL TO AUGER ON BEDROCK OR BOULDER											

Notes:
1) This borehole forms part of Highway 522 Underpass Foundation Investigation.
2) Borehole located at station 9+940.0, offset ~4.5 m right of centreline as referenced to Highway 522.
3) Borehole caved wet at ~6.4 m depth on completion.
4) Lab shear test was a pocket penetrometer test.

MTO4 7524C 07/22/99

RECORD OF BOREHOLE BH-13CP 1 OF 1

METRIC

W.P. 774-93-00 LOCATION 5 093 646.6 N, 313 737.9 E ORIGINATED BY I.D.

DIST 54 HWY 11 BOREHOLE TYPE Standard Augers / CME-55 COMPILED BY M.D.

DATUM Geodetic DATE June 24, 1998 CHECKED BY I.G.

ELEV. / DEPTH	DESCRIPTION	STRATA PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES BLOWS/0.3m	GROUND WATER CONDITIONS	ELEVATION SCALE (metres)	SPT TEST (N-Value) / CONE PENETRATION TEST / SHEAR STRENGTH: Cu, KPa (UNCONFINED QUICK TRIAXIAL, FIELD VANE LAB SHEAR)	PLASTIC LIMIT wp / NATURAL MOISTURE CONTENT w / LIQUID LIMIT wl / WATER CONTENT (%)	UNIT WEIGHT kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION GR SA SI + CL
317.19	GROUND SURFACE										
0.00 / 316.44	**SAND & GRAVEL FILL,** road shoulder, brown. (compact)	F					317				
0.75 / 314.99	**SAND FILL,** brown, moist. (loose)	F	1	SS	8		316	⊗			
			2	SS	3	▼	315	⊗	○		
2.20 / 312.39	**SILT,** trace of sand, some layering, brown to grey, moist to wet. (compact)		3	SS	15			⊗	○		
			4	SS	14		314	⊗	○		
4.80 / 309.63	**SILTY SAND & GRAVEL,** some cobble sizes, brown, with wet layers of sand. (loose to compact)		5	SS	23		313				
							312	⊗			
			6	SS	8		311	⊗			
							310				
7.56	END OF BOREHOLE DUE TO REFUSAL TO AUGER ON BEDROCK OR BOULDER										

Notes:
1) This borehole forms part of Highway 522 Underpass Foundation Investigation.
2) Borehole located at station 9+900.0, offset ~4.0 m left of centreline as referenced to Highway 522.
3) Borehole caved dry at ~1.6 m depth on completion.

MTO4 7524C 07/17/98

S07524G/C

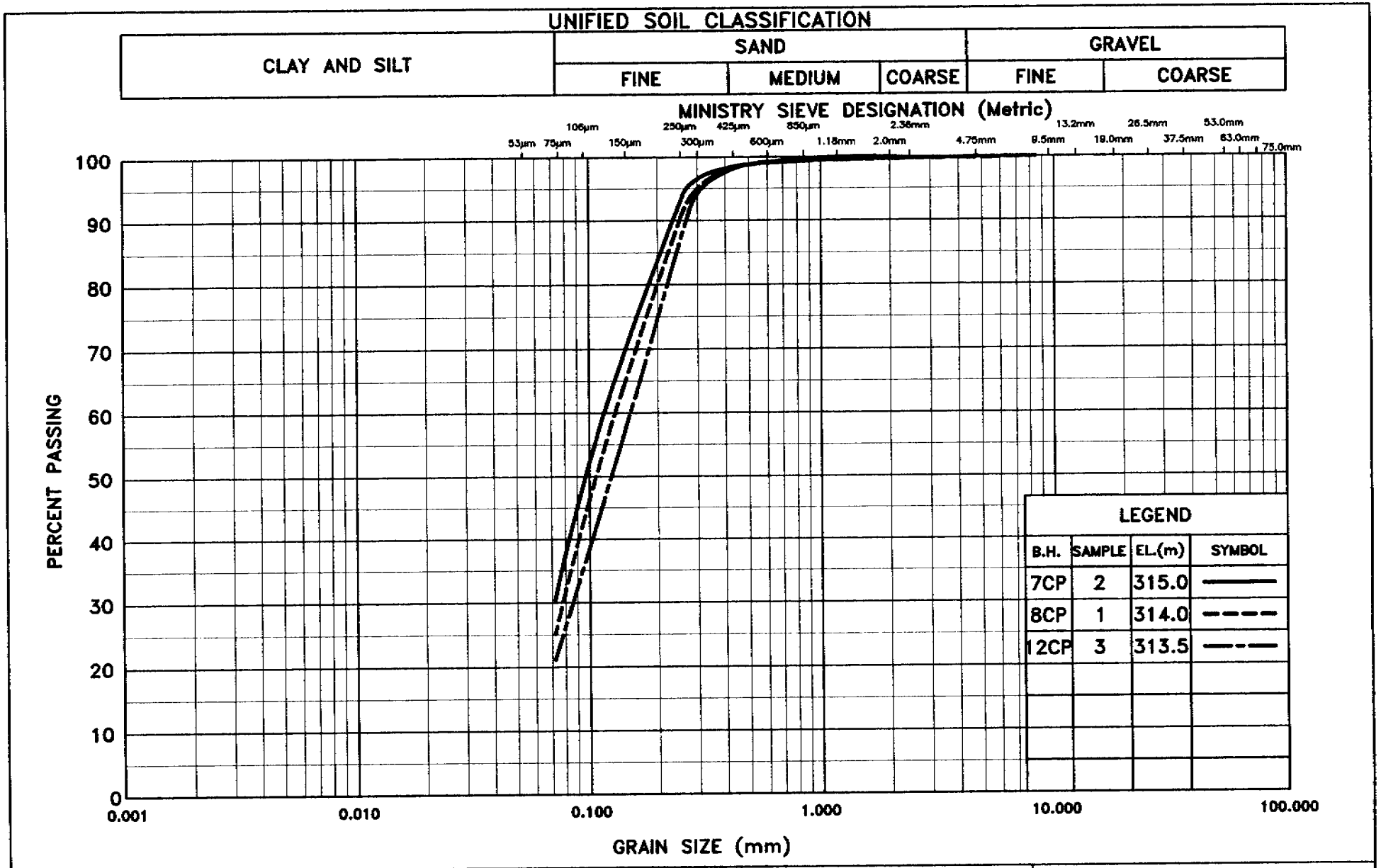
TABLE 1-1
ROCK CORE DESCRIPTION

BH#	Core Recovery				Core Description	
	Core #	Depth (m)	% CR*	% RQD**	Depth (m)	Description
HIGHWAY 522 BRIDGE FOUNDATION						
1-CF	1 2 3	3.72 to 4.72 4.72 to 5.88 5.88 to 6.89	100 100 100	98 100 100	3.72 to 6.89	**Biotite Horneblende Gneiss** - light grey to pinkish white, fine to medium grained, strong, unweathered, fractures very widely spaced, dipped at 80 to 90° from vertical, planar, smooth
3-CF	1 2 3	8.14 to 9.05 9.05 to 10.52 10.52 to 11.40	100 100 100	75 76 94	8.14 to 11.40	**Biotite Hornblende Gneiss (Garnetigerous)**, pinkish white to light grey, medium grained, strong unweathered, fractures moderately spaced, dipping at 0 to 10° and 80 to 90° from vertical, planar, smooth

*CR Core Recovery %
**RQD Rock Quality Designation %

Trow

APPENDIX B



Ministry of Transportation

METRIC

GRAIN SIZE DISTRIBUTION

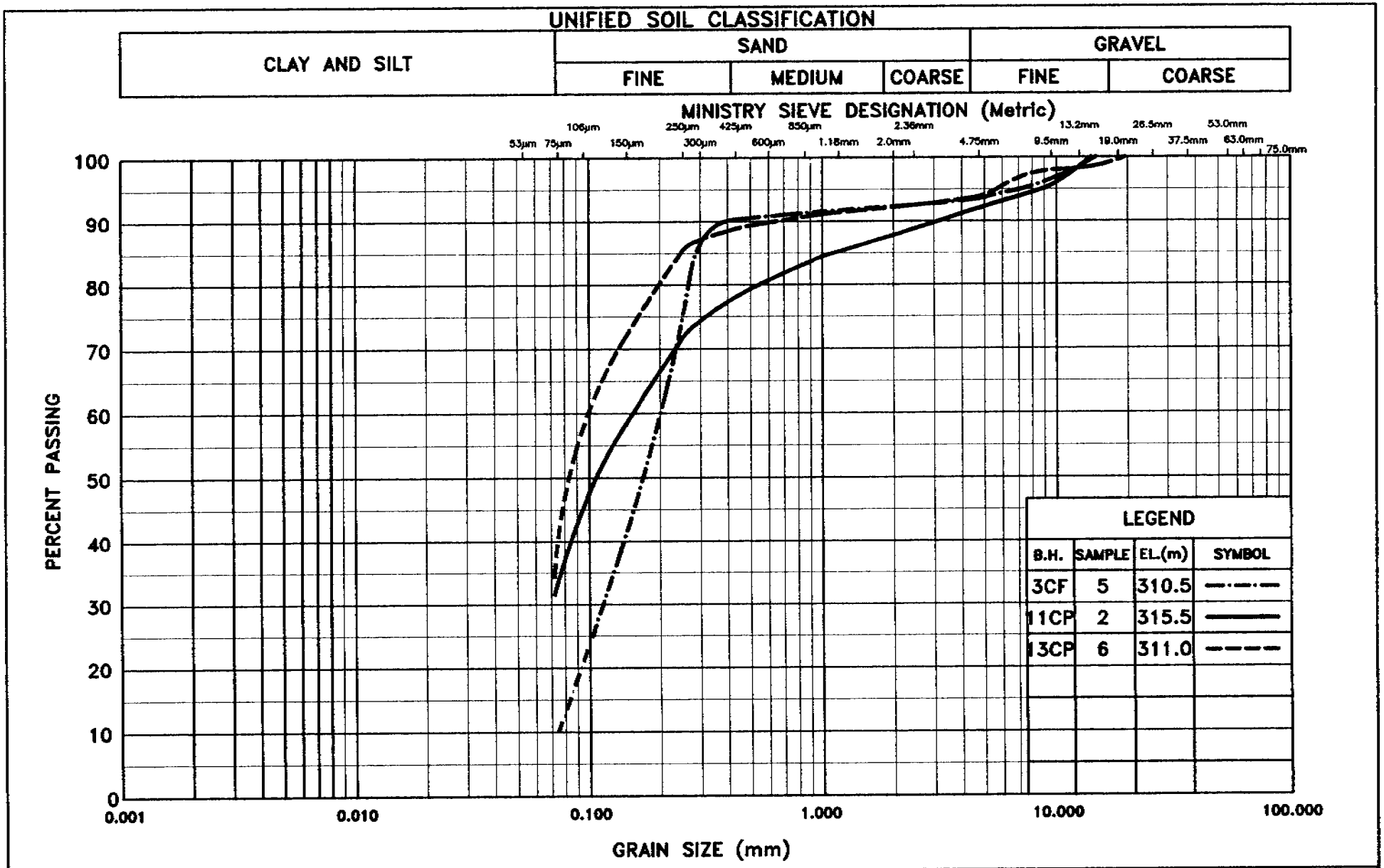
ALL SAMPLES FINE SAND

FIGURE 1

W.P. 774-93-00

Trow

PROJ. No. S07524GC



Ministry of Transportation

METRIC

GRAIN SIZE DISTRIBUTION

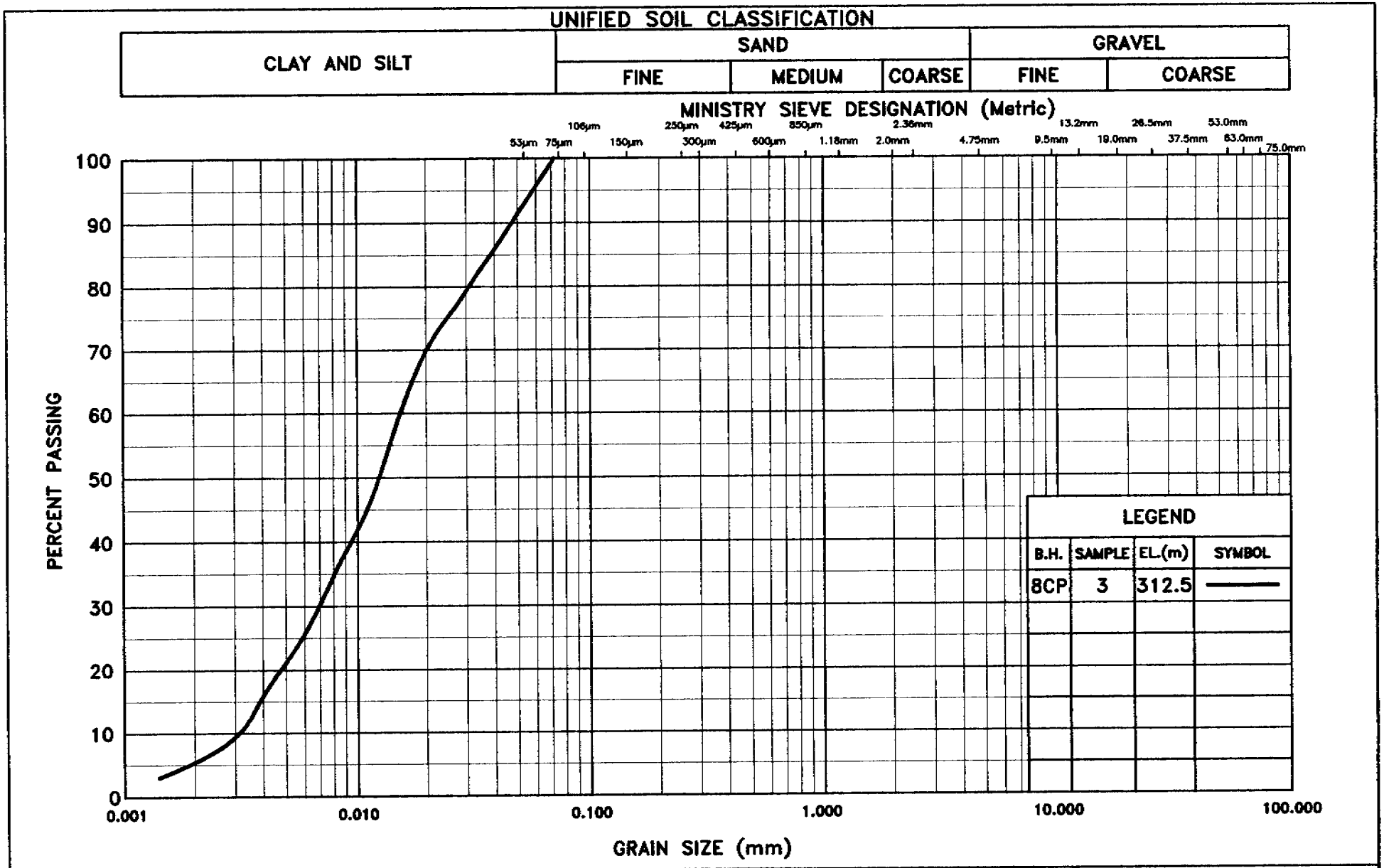
ALL SAMPLES SAND & GRAVEL

FIGURE 2

W.P. 774-93-00

Trow

PROJ. No. S07524GC



Ministry of Transportation

METRIC

GRAIN SIZE DISTRIBUTION

BH-8CP, SS-3 CLAY & SILT

FIGURE 3

W.P. 774-93-00

Trow

PROJ. No. S07524GC

Trow

GEOCRES #31E-177

Foundation Investigation and Design Report Bridge Structure, Highway 522 Underpass (Site 44-370) Trout Creek By-Pass (King's Highway 11) District 54, Sudbury GWP No. 774-93-00 W.P. No. 770-93-01

Prepared for:

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SO7524G/C
July, 1999

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Preface

Work Project GWP 774-93-00 is one of a series of projects for the four lane expansion of Highway 11. The project involves the four lane design of Highway 11, from 4.0 km south of Highway 522, northerly for 7.9 km. It will result in the construction of a westerly by-pass of the existing Highway 11 and the Town of Trout Creek.

This work project is located in the Townships of Laurier and Himsworth South, within the geographic District of Parry Sound. The project requires geotechnical input for the following major components:

- New pavement design for the entire length of the four lane by-pass, including associated service roads.
- New structure, Trout Creek South Interchange (underpass), Site 44-372.
- New structure, Trout Creek, Northbound Lanes, Site 44-371.
- New structure, Trout Creek, Southbound Lanes, Site 44-371.
- New structure, Highway 522 (underpass), Site 44-370.
- New structure, Trout Creek North Interchange (underpass), Site 44-369.

The following report deals with the new bridge structure at Highway 522, Site 44-370. Separate reports will be submitted for the additional components.

PART 1 FOUNDATION INVESTIGATION

1.1 Introduction

This submission presents the results of a geotechnical foundation investigation by Trow Consulting Engineers Ltd. (Trow) for the proposed crossing at Highway 522 and the proposed King's Highway 11 (Trout Creek By-Pass), at Site 44-370. It is Trow's understanding that a two span structure will be constructed, with the central pier located in the median of the proposed King's Highway 11. This report contains factual information (obtained from the field investigation) pertaining to the design parameters required for the bridge foundations and related earthworks.

1.2 Site Description and Geological Setting

1.2.1 Site Description

The site is located in the Township of South Himsworth at the proposed Highway 11 (Trout Creek By-Pass), and Highway 522 intersection, approximate Station 11+224 along the proposed Highway 11, which corresponds to Station 10+000, along Highway 522 at this location.

The proposed new, two-span bridge will be constructed to carry Highway 522 traffic over the four lanes of King's Highway 11. An approximately 8 m grade increase of Highway 522 at the bridge abutments is anticipated, in accordance with the proposed grading plan.

The terrain at the proposed bridge structure is relatively flat, although the grade of the existing Highway 522 rises gently towards both the west and east sides. The existing grade of Highway 522, at the bridge site, is at elevation 315 m and the road then rises gradually some 5 m, over a distance of approximately 240 m on the east side (up to Station 10+240), and 3 m, over approximately 200 m on the west side (up to Station 9 + 800).

The grade of Highway 522 will be raised to elevation 323 m at the bridge to accommodate the proposed four lanes of the by-pass. This arrangement will require approach embankments along Highway 522, approximately 240 m long (from the east side) and 200 m long (from the west side).

No bedrock outcrops are visible in the immediate vicinity of the proposed bridge; however, a rock cut is visible approximately 200 m along Highway 522 on the west side. There are mature trees, with heavy underbrush on either side of Highway 522, i.e. along the alignment of the proposed King's Highway 11.

1.2.2 Geological Setting

According to OGS Maps 2544 and 2556, as well as Ontario Geological Survey Map P. 3160 (Quaternary geology, South River area), the site is located in what is known as the Central Gneiss Belt, i.e. mainly felsic igneous rocks of the Mesoproterozoic Group.

The overburden is expected to be relatively shallow, comprising, for the most part, of detaic sands and gravels with some prodeltaic deposits, mainly silts. A thin layer of basal, stoney, glacial till can be expected immediately over the bedrock.

1.3 Investigative Procedures

1.3.1 General

Part 1 of this report describes the investigative procedures adopted for the geotechnical assessment of the Highway 522 flyover structure at Trout Creek By-Pass, King's Highway 11. Properties of the overburden soils were obtained by in-situ and laboratory testing and the procedures employed during the investigation, are described below.

1.3.2 Field Investigation

The field work for the investigation related to the proposed bridge structure was carried out between May 12 and May 13, 1998, and on May 25, 1998, and consisted of five(5) boreholes (BH's 1-CF to 5-CF), three(3) dynamic cone penetration tests (C-1CF to C-3CF) and four(4) additional auger probes (AP-1CF to AP-4CF). At least three (3) explorations were completed at each of the foundation elements. The probes, dynamic cones and boreholes were advanced to depths ranging from 3.7 m to 11.4 m.

The borehole, probe and dynamic cone penetration locations are shown on the attached site plan, Drawing 1, in Appendix A. These locations, as well as the surface elevations, were established by a survey crew from Marshall Macklin Monaghan, and are referenced to geodetic datum.

The boreholes, cones and probes were advanced through the overburden soils using a truck mounted CME-55 drill, equipped with solid and hollow stem augers, and operated by a soils drilling contractor, Marathon Drilling Limited. Soil samples were obtained by using a 51 mm O.D. split-spoon sampler in conjunction with standard penetration tests (ASTM D1586) at approximately 0.75 m and 1.5 m intervals. The standard penetration (N) values, together with the blows from the dynamic cone penetration tests, were recorded and used to provide an assessment of the compactness of the overburden soils. The recovered soil samples were used for identification and laboratory testing.

Upon completion, boreholes were backfilled with auger cuttings from the same boreholes, and compacted at regular intervals by applying back pressure with the auger. Where boreholes were advanced within the pavement surface, cold mix asphalt was placed to adequately patch the damaged area.

At three (3) of the borehole locations, i.e. at each of the three foundation elements, conventional rock coring techniques were used to advance the boreholes approximately 3 metres into the underlying bedrock. An "NQ" size core barrel and casing were used and core samples of the bedrock were retrieved for rock quality determination and classification.

Details of the soil and bedrock conditions encountered in the boreholes are included on the logs in the attached Appendix A. The additional two standard information sheets included with the logs, provide further details on soil descriptions for classification purposes.

1.3.3 Laboratory

The laboratory testing program for select soil samples consisted of the following:

- Natural moisture content determinations
- Grain size distribution analyses
- Laboratory shear tests

The laboratory test results are summarized on the attached borehole logs in Appendix A. The grain size distribution for selected soil samples are presented in Appendix B.

1.4 Subsurface Conditions

The borehole locations are shown on the site plan, Drawing 1, in Appendix A. Also included in Appendix A are the borehole, probe and dynamic cone penetration logs. Soil sections, longitudinal, as well as at each of the three foundation elements, are plotted on Drawings 1A, 1B and 1C. Based on this information, the following different soil layers were encountered:

- fill
- silt
- sand/sand and gravel
- bedrock

A summary of the above soil strata encountered in the boreholes, and inferred from the probes and dynamic cone penetration tests, is presented below.

1.4.1 Fill

The fill at the test locations is associated with the road construction materials for the existing Highway 522. Beneath the present asphalt (~50 mm thick) and the base and subbase granulars (~300 mm thick), an underlying layer of sand fill was generally encountered, which extends to depths of 1 m to 2 m below the road grade. The sand fill is generally fine, although it contains random pieces of old asphalt, some gravel and/or cobble sizes, as well as minor organic staining and contamination. At borehole 3-CF, a sand stratum extends somewhat deeper, to about 3 m depth. Since this deposit also contains minor organic inclusions, it is also believed to be fill or possibly alluvial in origin, having been deposited by previous meanderings of an adjacent small creek, which runs beneath the existing Highway 522 in this area.

The compactness of the fill, based on the standard penetration resistance, "N", values ranged from 4 to 35 blows/300 mm, indicating a loose to dense state.

Grain size analyses on samples of the material confirm that the deposit is mainly a fine sand with a silt fraction of between 7% to 20%. Moisture contents vary from less than 10% above the water table to about 20% below the groundwater table.

1.4.2 Silt

A deposit of silt was encountered in three boreholes (boreholes 2-CF, 3-CF and 5-CF). This silt stratum is absent beneath the east abutment (boreholes 1-CF and 4-CF). The silt contains some sand seams and odd layering where it is slightly cohesive. The standard penetration resistance "N" values ranged from 3 to 9 blows/300 mm, indicating a very loose to loose state of compaction. The thickness ranged from 1 m (borehole 3-CF) to 3 m (borehole 2-CF), and the moisture content from 25% to 35%.

1.4.3 Sand and Gravel

A basal zone of sand and gravel was encountered in all five boreholes, with the exception of borehole 2-CF. The deposit is reasonably well-graded with up to 31% silt sizes in places. At some locations, the deposit appears to be weakly cemented, exhibiting a "till-like" structure. At borehole 4-CF, the sand and gravel contains odd, small pieces of wood and cobble sizes. At this particular location, the sand and gravel deposit is likely fill, associated with backfill around the existing, adjacent, 780 mm diameter, CSP culvert.

The standard penetration resistance "N" values, with the exception of borehole 4, ranged from 12 to 41 blows/300 mm, indicating a compact to dense condition. The thickness ranges from about 1 m at borehole 1-CF to 4 m at borehole 3-CF. Moisture contents range from 5% to 20%, although at borehole 4-CF, higher moisture contents of 25% to 30% were measured.

1.4.4 Bedrock

Bedrock was confirmed by retrieving "NQ" size cores in the boreholes (BH's 1-CF, 2-CF and 3-CF), i.e. at one borehole beneath each of the three foundation elements. Based on the borehole, probe and dynamic cone penetration tests, the bedrock level was established at the following depths:

- East Abutment (BH's 1-CF and 4-CF, AP-3-CF, C-1CF)
  3.7 m (~El. 311 m) to 4.5 m (~El. 310.4 m)

- Centre Pier (BH 2-CF, AP-1-CF, AP-2-CF)
  5.0 m (~El. 310 m) to 5.3 m (~El. 309.1 m)
- West Abutment (BH's 3-CF and 5-CF, AP-4-CF, C-2CF)
  5.3 m (~El. 310 m) to 8.1 m (~El. 307.2 m)

Detailed descriptions of the rock are presented in Table 1-1 in Appendix A. Generally, the bedrock can be described as a pinkish, light grey, biotite-Homblende gneiss. The rock is strong and unweathered for the most part.

Rock core recovery was 100% for all runs and the Rock Quality Designation (RQD) values ranged from 66% to 100%.

1.5 Groundwater Conditions

Information regarding the groundwater levels at the site was obtained by measuring the water levels in the open boreholes after completion of drilling. The groundwater table, at the time of the field work, was established at a depth of about 2 m to 2.5 m below the grade of Highway 522, which is close to the grade of the surrounding, poorly drained, relatively flat terrain.

Seasonal variations in the water table should be expected with higher levels during wetter periods of the year (such as spring thaw and late fall) and lower levels during drier periods.

Part 2 Engineering Discussions and Recommendations

2.1 General

The following subsections address geotechnical considerations pertaining to the proposed two-span bridge for the Highway 522 underpass of the Trout Creek By-Pass (King's Highway 11). A two-span bridge is proposed to carry Highway 522 traffic over the four lanes of the new By-Pass. The central pier will be located in the By-Pass median, with the abutments located on the west and east sides of the south and north bound lanes of Highway 11.

2.2 Foundations

Based on the explorations, bedrock was encountered at depths of approximately 4 m at the east abutment (8 m from the proposed profile grade), 5 m at the central pier (7.5 m from the proposed profile grade), and 5 m to 8 m at the west abutment (7 m from the proposed profile grade). Foundation alternatives include piled foundations (integral abutments can be considered, although the rock is probably too shallow at the east abutment and pier), and/or spread foundations excavated to sound bedrock. At the west abutment, excavations of up to 8 m below grade will be required, i.e. where the deepest bedrock was encountered. Consequently, at the west abutment, it may be possible to establish the foundations at a higher level on the native, compact, granular soils.

Other options include installing a compacted granular mat over competent material (till and/or rock) to support the foundations, or possibly using caisson-type foundations. However, conventional augered caisson foundations are not normally practical in Northern Ontario because of potential, unknown, sharp irregularities in the bedrock surface, difficulties "seating" casing into the hard, strong, Precambrian rock, as well as the potential excavation difficulties with water seepages in the granular overburden and possible boulders near the rock contact.

Foundation options and design parameters are discussed in the following paragraphs.

2.2.1 Foundations on Bedrock

2.2.1.1 East Abutment

At the location of the east abutment (BH-1CF, 4-CF, cone 1-CF and AP3-CF), there is approximately 4 m of overburden soil overlying bedrock. As such, it would be feasible to excavate down to the rock and place the foundation directly on the bedrock surface. For the purpose of design, in accordance with the Ontario Highway Bridge Design Code, the following bearing capacities can be used for spread footings placed directly on the gneiss bedrock, subject to inspection by a qualified geotechnical engineer.

Table 2-1
Spread Footing Capacity on Bedrock

	Spread Footing
Factored Bearing Capacity at ULS	7,500 kPa

The above Factored Bearing Capacity at ULS applies to spread footings placed directly on bedrock with a good Rock Mass Quality (RQD>75). The bearing capacity at SLS will not govern for a spread footing founded on bedrock, since the loads required to produce unacceptable settlements of the structure will be much larger than the recommended values for the factored capacity at ULS.

For the east abutment area, the borehole, cone and probe data indicate that the construction of spread footings on bedrock would require excavation and removal of approximately 4 m of overburden soil, i.e. down to approximate El. 310 m. The footing area must be cleared of all loose materials prior to placement of concrete and inspected by a qualified geotechnical engineer to verify the Rock Mass Quality.

As per Section 6-8.4.2 of the Ontario Highway Bridge design code, a reduction factor would normally be applied to the Ultimate Bearing Resistance at ULS (7,500 kPa) to account for the effects of inclined loadings. Recent comments, however, received from the Pavement and Foundation Section of MTO indicate that "*Although the OHBDC Code talks about bearing resistance reduction due to inclined loadings for footing on bedrock. The OHBDC committee has decided that no such reduction will be required if the footing is constructed on bedrock*". As such, for spread footings on

bedrock, the structural engineer should consult with the Ministry to confirm that a reduction factor for inclined loadings need not be applied.

2.2.1.2 Centre Pier

The subsurface conditions for the centre pier location (BH-2CF, AP1-CF and AP2-CF) are similar to those discussed for the east abutment, although the overburden is slightly thicker, i.e. approximately 5 m. As a result, spread footings placed directly on bedrock using the bearing values given in table 2-2, below, are an option for the central pier foundations subject to inspection during construction by a qualified geotechnical engineer. The bedrock surface is expected at a depth of about 5 m below grade (~El. 310 m).

TABLE 2-2
Spread Footing Capacity on Bedrock

	Spread Footing
Factored Bearing Capacity at ULS	7,500 kPa

The above Factored Bearing Capacity at ULS applies to spread footings placed directly on bedrock with a good Rock Mass Quality (RQD>75). The bearing capacity at SLS will not govern for a spread footing founded on bedrock, since the loads required to produce unacceptable settlements of the structure will be much larger than the recommended values for the factored capacity at ULS.

2.2.1.3 West Abutment

The subsurface conditions for the west abutment location (Boreholes 5-CF, 3-CF, cone 2-CF and AP4-CF) are similar to those discussed for the centre pier and east abutment; however, on the south side (cone C-2CF and borehole 3-CF), the rock is locally deeper, i.e. at a depth of some 8 m below grade. Foundations placed directly on bedrock can be designed using the bearing values specified in Table 2-3, below, subject to inspection during construction by a qualified geotechnical engineer.

TABLE 2-3 Spread Footing Capacity on Bedrock	
	Spread Footing
Factored Bearing Capacity at ULS	7,500 kPa

The above Factored Bearing Capacity at ULS applies to spread footings placed directly on bedrock with a good Rock Mass Quality (RQD>75). The bearing capacity at SLS will not govern for a spread footing founded on bedrock, since the loads required to produce unacceptable settlements of the structure will be much larger than the recommended values for the factored capacity at ULS.

Given the depth to bedrock at this abutment, and the high water table, necessitating 6 m to 8 m excavations below the groundwater table, spread footings located on the bedrock may not be the most prudent foundation alternative at this site, as construction difficulties may arise. As such, the other foundation options discussed in this report may be more suitable for this abutment.

As a further alternative, given the depth to rock at this abutment, foundations placed at a higher elevation on the compact and dense, native, sand/sand and gravel strata should also be considered. The compact and dense sand/sand and gravel stratum was encountered at a depth of about 4 m (elevation 311 m) beneath the west abutment location. Since the level of the sand and gravel stratum is about 2.5 m below the water table, dewatering will be required if this option is selected. Foundations placed on the undisturbed, dewatered, sand/sand and gravel stratum could be designed using the bearing capacity values specified in Table 2-4, below.

TABLE 2-4 Spread Footing Capacity on Sand/Sand & Gravel	
	Spread Footing
Factored Bearing Capacity at ULS	300 kPa
Bearing Capacity at SLS	150 kPa

Although founding the abutment on the underlying native sand/sand and gravel strata will require shallower excavations than founding the abutment on bedrock, excavations, will still be required below the water table. This may require dewatering, which may include sheet piling to accomplish.

As such, considering the low allowable bearing resistance values and the potential need for dewatering, this option is not recommended.

2.2.1.4 Anticipated Bedrock Elevations

The following table summarizes the location and estimated bedrock elevations at the three foundation elements.

Table 2-5
Location and Estimated Elevation of Bedrock Foundation

Location	Boreholes & Probe Holes	Overburden Thickness (m)	Approximate Bedrock Elevation (m)
East Abutment	Borehole 1-CF	3.7	311.0
	Borehole 4-CF	4.4*	310.4
	Probe Hole AP-3CF	4.1*	311.0
	Cone C-1CF	3.7*	311.4
	Cone C-3CF	5.1*	310.0
Centre Pier	Borehole 2CF	5.2	309.9
	Probe Hole AP-1CF	5.0*	310.0
	Probe Hole AP-2CF	5.3*	310.0
West Abutment	Borehole 3CF	8.1	307.2
	Borehole 5CF	5.3*	310.0
	Cone C-2CF	8.2*	307.5
	Probe Hole AP-4CF	6.7*	309.1

Assumed bedrock level

The above elevations are for preliminary design purposes and were estimated based on the factual borehole, dynamic cone and auger probe holes drilled near the abutment and pier locations. Interpolation between boreholes and probe holes is approximate, and as such, actual footing elevations will depend on the conditions encountered at the time of construction. The bedrock surface in Northern Ontario is known to be erratic. The rock surface at the footing base must be cleaned of all loosened or highly fractured rock and be inspected by a qualified geotechnical engineer to verify the Rock Mass Quality prior to placement of concrete.

2.2.2 Footings on Compacted Granular Pad

It may be feasible to establish footings on a Granular A (or equivalent) compacted granular pad. The existing upper loose soils should be subexcavated down to bedrock at both the east and west abutments, as well as at the central pier. As an alternative, at the west abutment, it may only be necessary to excavate down to 4 m (El. 311 m), i.e. down to the compact and/or dense, native, granular soil horizon, provided that the groundwater is controlled to prevent disturbance. The granular pad, when placed over the rock (pier and east abutment) and/or over sand and gravel (west abutment), should extend horizontally a minimum of 1.0 m beyond the plan limits of the footing and have side slopes no steeper than 1 horizontal to 1 vertical. The granular material should be compacted to 100 percent Standard Proctor Maximum Dry Density.

The bearing capacities recommended for the abutment footings placed on this compacted granular pad design, based on the Ontario Highway Bridge Design Code, are as follows:

TABLE 2-6
Spread Footing Capacity on Compacted Granular Mat

	Spread Footing
Factored Bearing Capacity at ULS	400 kPa
Bearing Capacity at SLS	200 kPa

As an alternative to using a granular pad, it would also be feasible to "upfill" over the bedrock, or possibly over the native sand and gravel at the west abutment, and up to underside of the proposed foundations, with lean concrete (typically 15 Mpa mix).

Footings placed on a granular pad beneath the groundwater table will require additional construction considerations. It is very difficult to compact the granular material to an acceptable Standard Proctor Maximum Dry Density by excavation and replacement methods underwater. Since the groundwater table was measured to be above the bedrock level at the time of the investigation, it is probable that dewatering will be required to ensure the granular material can be placed and compacted at optimum moisture levels. Alternatively, the granular material could be replaced by a nominal 400 mm clear stone beneath the groundwater table.

2.2.3 Frost Protection

Frost cover is not required for footings placed directly on bedrock. Due to the open nature of bridges, for footings placed on a granular pad, or the native granular soil for the west abutment, a minimum frost cover of 2 m should be provided.

2.2.4 Sliding Resistance

The computation of the sliding resistance of the spread footings shall be carried out in accordance with O.H.B.D.C. An unfactored friction angle, ϕ of 32 degrees can be used for sliding along the bedrock and footing base and ϕ of 35 degrees for sliding along granular soils (native sand/sand and gravel or engineered granular pad).

If the factored resistance against sliding failure is inadequate based on friction, then the footings normally could be anchored into bedrock by means of keys, dowels or sockets. However, given the hardness of the bedrock encountered at the site sockets and keys will likely be impractical, and developing adequate resistance against sliding of spread footings founded on the sloping bedrock at the site will likely require dowels. An unfactored coefficient of passive earth pressure, K_p', equal to 3.7, can be used for design of a passive resistance key.

2.2.5 Piled Foundation

2.2.5.1 Capacity and Length

Piling could be considered for the foundation elements at this site. However, because of the proximity of bedrock at the east abutment and central pier (<5 m below grade), piles may only be feasible for support at the west abutment, i.e. where bedrock is deeper. End bearing piles are normally only feasible when the length/width ratio exceeds 10, i.e. a length of 3 m for a 300 mm pile section, since it is very difficult to achieve adequate lateral support for the piles, and the piles will tend to rotate if the applied loading is eccentric.

Piles driven to bedrock can be designed based on the following Limit States design values in accordance with the O.H.B.D.C.

Table 2-7 Design Pile Capacities (kN)		
	HP 310x79	**HP 310x110**
Factored Axial Resistance*	1430 kN	2000 kN
* *Note: Structural Office Policy Memo 98-01, April 15, 1998*		

Based on the attached borehole logs in Appendix A, the previous Table 2-5 shows a summary of the approximate bedrock elevation at the test locations at which piles would be expected to be founded. Drawings 1A, 1B and 1C in Appendix A show interpreted soil and rock subsurface profiles at the two abutments and pier.

It should be noted that the elevations given in Table 2-5 are approximate. Furthermore, although not experienced in the borings put down at this site, the bedrock elevation in this part of the country can be variable and may change rapidly over a very short distance.

2.2.5.2 Construction

All piles should be driven to bedrock. Since the boreholes indicate that the bedrock elevations are relatively uniform, the potential for irregular, steeply sloping bedrock at the foundation locations is considered to be low to moderate. The bedrock in this part of Northern Ontario, however, is known to be variable. As such, some minor problems may arise during pile seating. At some locations, the piles may have a tendency to skip over the bedrock surface resulting in alignment problems and deeper penetration. In the event that this problem occurs, somewhat longer piles may be required and, in some cases, piles may have to be added or replaced.

To minimize seating difficulties, rock injector points should be considered to facilitate proper seating. All piles must be fitted with reinforcing plates welded to the flanges as per OPSD 3301 to minimize pile damage. It is recommended that, during pile driving and upon initial contact with the bedrock, the pile driving energy should be reduced and subsequently increased incrementally until the piles have been sufficiently seated. OSLO, or similar rock points, installed and driven in accordance with OPSD 3304 and OPSS 903, respectively, may be considered. Once the locations and orientations of the piles have been determine (i.e. during the preliminary design stage), the use of such methods will be determined and recommendations will be provided by this office as required.

All lateral loads at the abutments should be supported using inclined piles.

2.2.5.3 Horizontal Subgrade Reaction Parameters

Should finite element modelling techniques be utilized, the Horizontal Subgrade Reaction Parameters can be calculated as follows:

$k = k_1 Z/B$

Where: k_1 = coefficient of horizontal subgrade reaction for a 300 mm (1 ft.) Wide pile at 300 mm (1 ft.). The values of k_1 are given below in tonnes/m^3

Z = depth
B = width of pile

	Dry	Submerged
Sand and Gravel Fill (compact)	700	450
Silt (loose)	225	110
Sand and Gravel (compact)	700	450
Sand and Gravel (loose)	350	175

These values are for design in the elastic range and are taken from published values.

2.2.6 Caisson Foundations

2.2.6.1 Bearing Capacity

Where bedrock is deeper at the west abutment, a caisson type foundation system to rock could be considered. Caisson foundations placed directly on bedrock could be designed using the bearing values specified in Table 2-8, below.

TABLE 2-8 Caisson Foundation Capacity on Bedrock	
	Spread Footing
Factored Bearing Capacity at ULS	5,000 kPa

The above Factored Bearing Capacity at ULS applies to caisson foundations placed directly on bedrock with a good Rock Mass Quality (RQD>75). The bearing capacity at SLS will not govern for a caisson founded on bedrock, since the loads required to produce unacceptable settlements of the structure will be much larger than the recommended values for the factored capacity at ULS.

2.2.6.2 Construction

As noted earlier in this report, caisson foundations, which are typically large diameter augered elements, which are cased to rock, are not normally feasible in Northern Ontario. The potential for sharp, unknown irregularities in the bedrock surface, difficulties "seating" and sealing casings at the hard strong bedrock contact, as well as the potential excavation difficulties with water seepages in the granular soils and possible boulders near the rock contact, render augered caissons difficult, if not impractical. As such, if caissons are considered at the west abutment, they will likely have to be installed using a backhoe type excavator with temporary braced shoring to support the open excavation sides and appropriate dewatering procedures..

2.3 Backfill

Backfill to abutments or retaining walls should consist of free-draining granular materials such as Granular "A" and Granular "B" or rock fill. Computation of earth pressures shall be in accordance with Section 6.7.4 of the Ontario Highway Bridge Design Code. Unfactored properties for backfill materials are provided in the following table.

Table 2-9 Material Types and Unfactored Properties					
Material	**Friction Angle, ϕ'**	**γ(kN/m^3)**	**K_a**	**K_p**	**K_o**
Granular A	35 degrees	22.5	0.27	3.7	0.43
Granular B	30 degrees	21.1	0.33	3.0	0.50
Rock Fill	35 degrees	18.0	0.27	3.7	0.43

Note: *K_a is the earth pressure coefficient corresponding to the active state.*
K_p is the earth pressure coefficient corresponding to the passive state.
K_o is the earth pressure coefficient at rest.

If rock fill is used as backfill behind abutments, the particle size should be limited to no greater than 300 mm and the backfill must be placed carefully in a manner that does not cause damage to the abutments or other structural components of the bridge.

As shown in figure 6.7.4.3 of the Ontario Highway Bridge Design Code, the lateral earth pressure, as a result of compaction shall be increased by 16 kPa.

2.4 Excavations

2.4.1 Overburden

Excavations through overburden soil will be required if spread foundations are used. The overburden granular soils are classified as Type 3 soils and the maximum depth of excavation anticipated at the site is approximately 8 metres at the west abutment. As such, excavations in accordance with the Occupational Health and Safety Regulations for Construction Projects for Type 3 soils will be adequate, provided the groundwater in the overburden soil is removed. If appropriate dewatering is not done, the soil would have to be classified as a Type 4 soil and any excavation greater than 1.2 m should then be sloped to 3 horizontal to 1 vertical, starting from the base of the excavation, or appropriate shoring provided.

2.4.2 Bedrock

Any removal of bedrock required for the foundations (spread footings and/or at the base of caissons) will require drilling and blasting procedures.

2.5 Approach Embankments

No stability or significant settlement problems are anticipated for the approach embankments established over the essentially granular soils. Topsoil and compressible organics (if present) must be removed from the plan limit of the approach embankments. Based on Trow's adjacent borings for the pavement design of Highway 11, it is likely that the surficial organics will be about 300 mm to 600 mm thick. If rock fill is used to construct the approach embankments, the side slopes and forward slopes should be constructed at a maximum gradient of 1.25H:1V. If Granular "A" or Granular "B" is used, the forward and side slopes should be constructed at 2H (minimum):1V.

The geotechnical conditions are such that integral abutment design could be considered, if feasible, from structural, practical and economical considerations. It should be noted, however, that the depth to bedrock at the east abutment and pier is less than approximately 5 m.

2.6 General

The information presented in this report is based on a limited investigation designed to provide information to support an overall assessment of the current geotechnical conditions at the site of the proposed Highway 522/King's Highway 11 Trout Creek By-Pass. The conclusions presented in this report reflect site conditions existing at the time of the investigation. It is noted that the soil boundaries indicated on the logs are inferred from discontinuous sampling and observations during drilling. These boundaries are intended to reflect transition zones for the purpose of geotechnical design and should not be interpreted as exact planes of geological change.

This report has been prepared by Mr. I.W. Gore, P.Eng., and Mr. E.A. Gonneau, P.Eng., and reviewed by Mr. S.E. Gonsalves, P.Eng. The field investigation was performed by Mr. I. Dumpis, C.E.T.

We trust this report is satisfactory for your purposes. Should you have any questions, please do not hesitate to contact this office.

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IWG/jot/wp8.1/Geo/reportss/7524c1.wpd

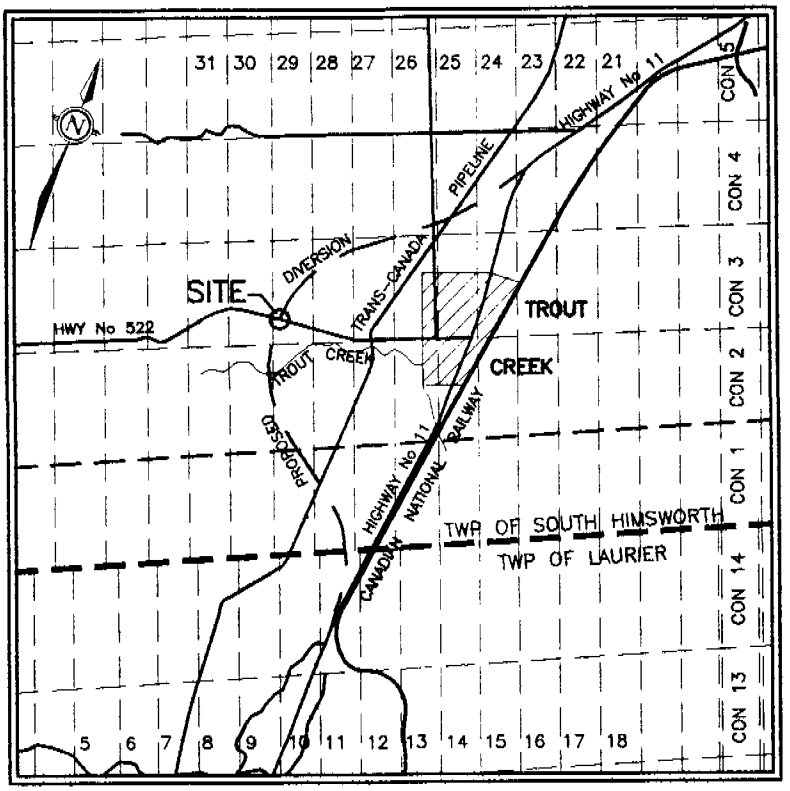
APPENDIX A

METRIC

DIMENSIONS ARE IN METRES
AND/OR MILLIMETRES
UNLESS OTHERWISE SHOWN

PLATE No	509-11/176-0
DRAWING No	05090011176
CONT No	
WP No	774-93-00

SHEET



KEY PLAN

1 km 0 1 km

TROW CONSULTING ENGINEERS LTD.
SUDBURY, ONTARIO

Trow PROJ. No. S07524GCF DWG. No. 1

MINISTRY OF TRANSPORTATION
ENGINEERING OFFICE
SURVEYS AND PLANS SECTION

KEY PLAN

PROPOSED CROSSING
AT
SEC HIGHWAY 522
AND
PROPOSED C/L MEDIAN HWY 11

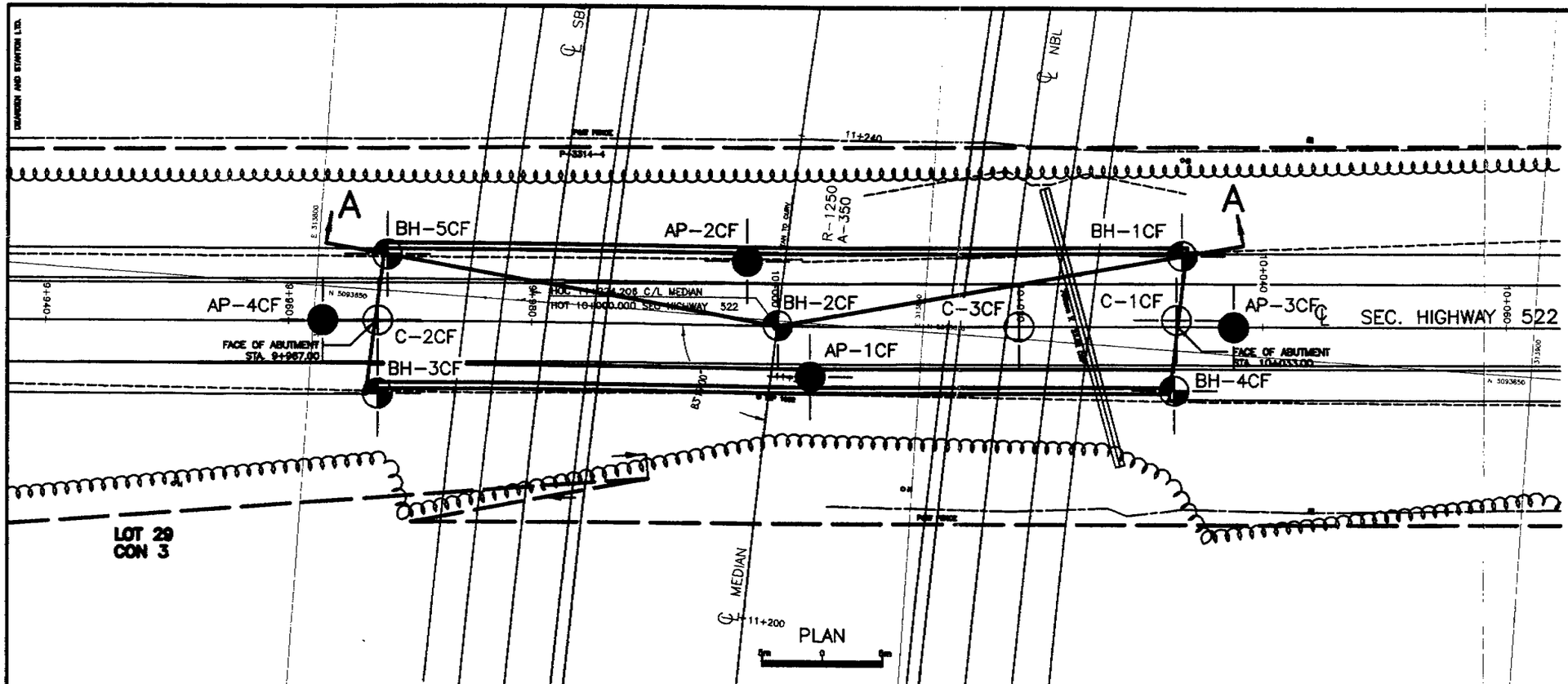
GEOG TWP SOUTH HIMSWORTH LOT 29 — DIST OF PARRY SOUND CON 3

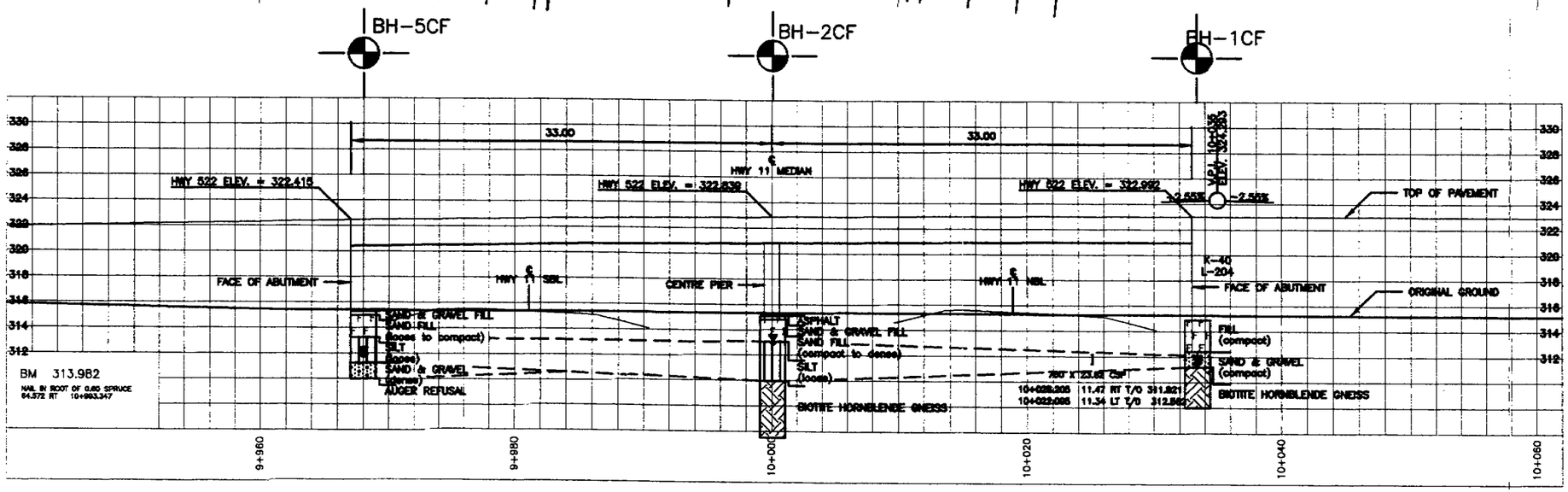
SCALE	DISTRICT	REGION
1:400	PARRY SOUND	NORTHERN
	ETR 509-11	
SURVEY DATE 97/10	PLAN DATE 97/10	
SITE 44-370	PLAN E-509-11-12	

PLATE No 509-11/176-0
DRAWING No 05090011176
CONT No
WP No 774-93-00

SHEET

Revised





SECTION A-A
ON PROFILE OF SEC HIGHWAY 522

LEGEND

- BOREHOLE
- AUGER PROBE
- DYNAMIC CONE PENETRATION TEST
- GROUND WATER LEVEL

No.	ELEV.	CO-ORDINATES NORTH	CO-ORDINATES EAST
BH-1CF	314.90	5 093 657.8	313 870.8
BH-2CF	315.13	5 093 649.6	313 838.0
BH-3CF	315.37	5 093 641.5	313 805.6
BH-4CF	314.98	5 093 646.7	313 870.9
BH-5CF	315.24	5 093 653.0	313 805.6
C-1CF	315.14	5 093 652.5	313 870.7
C-2CF	315.67	5 093 647.5	313 805.2
C-3CF	315.18	5 093 651.0	313 857.8
AP-1CF	315.93	5 093 645.6	313 841.0
AP-2CF	314.93	5 093 654.7	313 835.1
AP-3CF	315.16	5 093 652.3	313 875.4
AP-4CF	315.74	5 093 647.2	313 800.8

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

TROW CONSULTING ENGINEERS LTD.
SUDBURY, ONTARIO
Trow PROJ. No. S07524GCF DWG. No. 1A

MINISTRY OF TRANSPORTATION
ENGINEERING OFFICE
SURVEYS AND PLANS SECTION

SECTION A-A

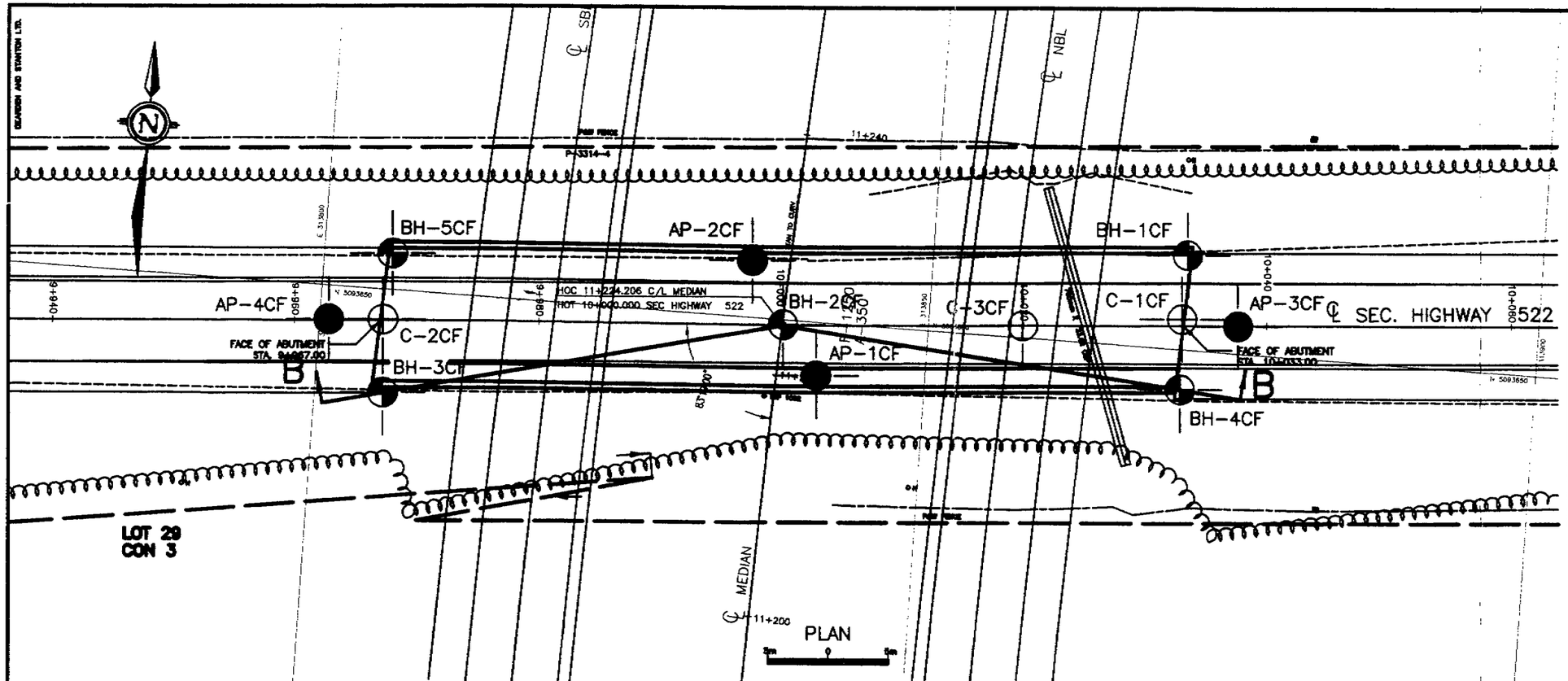
PROPOSED CROSSING
AT
SEC HIGHWAY 522
AND
PROPOSED C/L MEDIAN HWY 11

GEOG TWP SOUTH HIMSWORTH LOT 29
DIST OF PARRY SOUND CON 3

SCALE	DISTRICT	REGION
1:400	PARRY SOUND	NORTHERN
	ETR 509-11	

SURVEY DATE 97/10 PLAN DATE 97/10

SITE 44-370 PLAN E-509-11-12



SECTION B–B
ON PROFILE OF SEC HIGHWAY 522

PLATE No 509–11/176–0
DRAWING No 05090011176
CONT No
WP No 774–93–00

SHEET

Revised

LEGEND

- BOREHOLE
- AUGER PROBE
- DYNAMIC CONE PENETRATION TEST
- GROUND WATER LEVEL

No.	ELEV.	CO–ORDINATES NORTH	EAST
BH–1CF	314.90	5 093 657.8	313 870.8
BH–2CF	315.13	5 093 649.6	313 838.0
BH–3CF	315.37	5 093 641.5	313 805.6
BH–4CF	314.98	5 093 646.7	313 870.9
BH–5CF	315.24	5 093 653.0	313 805.6
C–1CF	315.14	5 093 652.5	313 870.7
C–2CF	315.67	5 093 647.5	313 805.2
C–3CF	315.18	5 093 651.0	313 857.8
AP–1CF	315.93	5 093 645.6	313 841.0
AP–2CF	314.93	5 093 654.7	313 835.1
AP–3CF	315.16	5 093 652.3	313 875.4
AP–4CF	315.74	5 093 647.2	313 800.8

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

TROW CONSULTING ENGINEERS LTD.
SUDBURY, ONTARIO
Trow PROJ. No. S07524GCF DWG. No. 1B

MINISTRY OF TRANSPORTATION
ENGINEERING OFFICE
SURVEYS AND PLANS SECTION

SECTION B–B

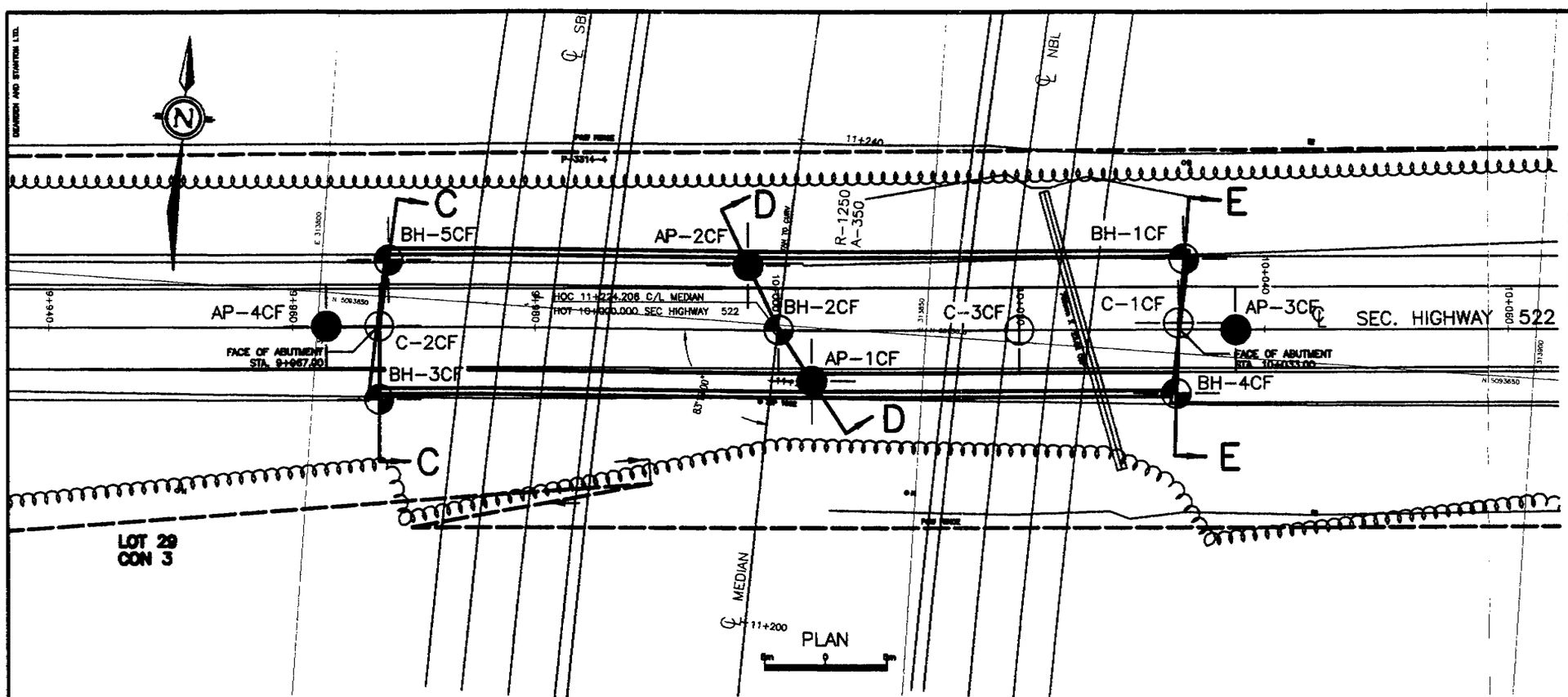
PROPOSED CROSSING
AT
SEC HIGHWAY 522
AND
PROPOSED C/L MEDIAN HWY 11

GEOG TWP SOUTH HIMSWORTH LOT 29 — DIST OF PARRY SOUND CON 3

SCALE	DISTRICT	REGION
1:400	PARRY SOUND	NORTHERN
	ETR 509–11	
SURVEY DATE 97/10	PLAN DATE 97/10	
SITE 44–370	PLANE–509–11–12	

DEARDEN AND STANTON LTD.

PLATE No 509-11/176-0
DRAWING No 05090011176
CONT No
WP No 774-93-00
SHEET
Revised



LEGEND

- BOREHOLE
- AUGER PROBE
- DYNAMIC CONE PENETRATION TEST
- GROUND WATER LEVEL

No.	ELEV.	CO-ORDINATES NORTH	EAST
BH-1CF	314.90	5 093 657.8	313 870.8
BH-2CF	315.13	5 093 649.6	313 838.0
BH-3CF	315.37	5 093 641.5	313 805.6
BH-4CF	314.98	5 093 646.7	313 870.9
BH-5CF	315.24	5 093 653.0	313 805.6
C-1CF	315.14	5 093 652.5	313 870.7
C-2CF	315.67	5 093 647.5	313 805.2
C-3CF	315.18	5 093 651.0	313 857.8
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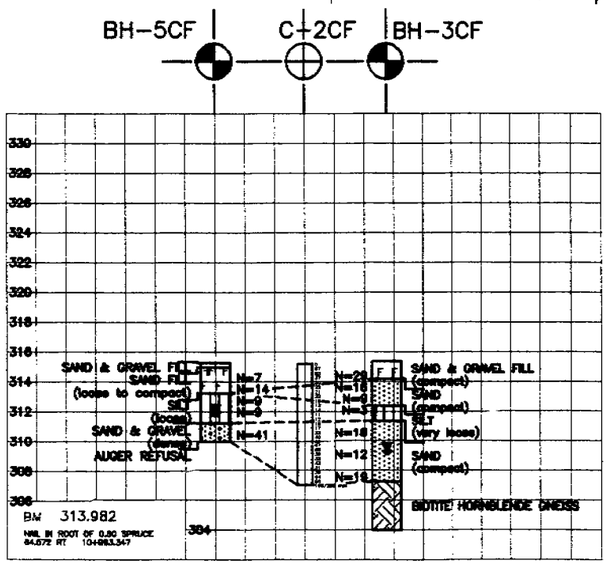
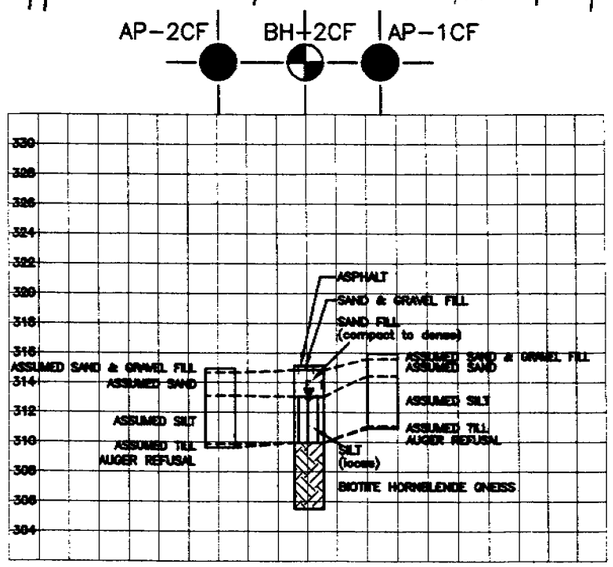
AP-2CF	314.93	5 093 654.7	313 835.1
AP-3CF	315.16	5 093 652.3	313 875.4
AP-4CF	315.74	5 093 647.2	313 800.8

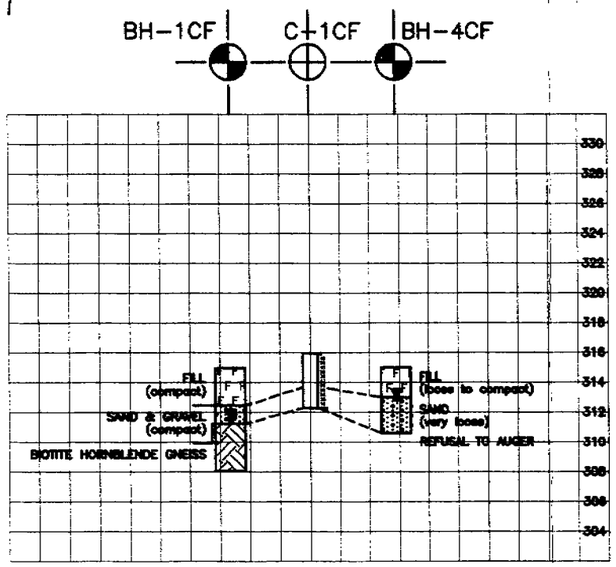


SECTION C-C



SECTION D-D

5m 0 5m



SECTION E-E

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

TROW CONSULTING ENGINEERS LTD.
SUDBURY, ONTARIO
Trow PROJ. No. S07524GCF DWG. No. 1C

MINISTRY OF TRANSPORTATION
ENGINEERING OFFICE
SURVEYS AND PLANS SECTION

SECTION C-C, D-D & E-E

PROPOSED CROSSING
AT
SEC HIGHWAY 522
AND
PROPOSED C/L MEDIAN HWY 11

GEOG TWP SOUTH HIMSWORTH LOT 29 | DIST OF PARRY SOUND CON 3

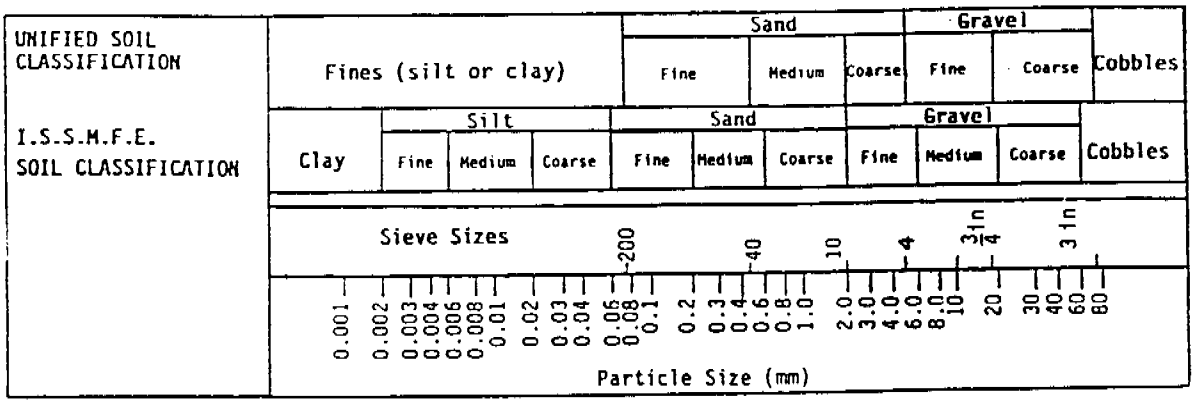
SCALE	DISTRICT	REGION
1:400	PARRY SOUND	NORTHERN
	ETR 509-11	

SURVEY DATE 97/10 | PLAN DATE 97/10

SITE 44-370 | PLAN E-509-11-12

NOTES ON SAMPLE DESCRIPTIONS

1. All descriptions included in this report follow the I.S.S.M.F.E. as suggested in the Canadian Foundation Manual. The laboratory grain-size analysis also follows this classification system. Others may designate the unified classification system as their source; a comparison of the two is shown for your information. Please note that, with the exception of those samples where the grain-size analysis has been carried out, all samples are classified visually and the accuracy of visual examination is not sufficient to differentiate between the classification systems or exact grain sizing.



2. **FILL:** Where fill is designated on the borehole log, it is defined as indicated by the sample recovered during the boring process. The reader is cautioned that fills are heterogeneous in nature and variable in density or degree of compaction. The borehole description may therefore not be applicable as a general description of the site fill material. All fills should be expected to contain obstructions such as large concrete pieces of subsurface basements, floors, tanks, etc.; none of these may have been encountered in the borehole. Since boreholes cannot accurately define the contents of fill, test pits are recommended to provide supplementary information. Despite the use of test pits, the heterogeneous nature of fill will leave some ambiguity as to the exact and correct composition of the fill. Most fills contain pockets, seams, or layers of organically contaminated soil. This organic material can result in the generation of methane gas and/or significant on-going and future settlements. Some fill material may be contaminated by toxic waste that renders it unacceptable for deposition in any but designated land fill sites. Unless specifically stated, the fill on this site has not been tested for contaminants that may be considered hazardous. This testing and a potential hazard study can be carried out if you so request. In most residential/commercial areas undergoing reconstruction, buried oil tanks are common but are not detectable using conventional geotechnical procedures.

3. **TILL:** The term till on the borehole logs indicate that the material originates from a geological process associated with glaciation. As a result of this geological process, the till must be considered heterogeneous in composition and, as such, may contain pockets and/or seams of material such as sand, gravel silt or clay. As till often contains cobbles (60 to 200 mm) or boulders (over 200 mm), contractors may encounter them during excavation, even if they are not indicated by the borings. It should be appreciated that normal sampling equipment cannot differentiate the size, or type of any obstruction. Because of the horizontal and vertical variability of till, the sample description may be applicable to a very limited areas; caution is therefore essential when dealing with sensitive excavations or dewatering programs in till material.

4. The following table gives a description of the soil based on particle sizes. With the exception of those samples where grain-size analyses have been performed, all samples are classified visually. The accuracy of visual examination is not sufficient to differentiate between this classification system or exact grain size.

Soil Classification		Terminology	Proportion
Clay	< 0.002 mm		
Silt	0.002 to 0.06 mm	"trace" (eg. trace sand)	1% - 10%
Sand	0.06 to 2 mm	"some" (eg. some sand)	10% - 20%
Gravel	2 to 60 mm	adjective (eg. sandy)	20% - 35%
Cobbles	60 to 200 mm	and (eg. and sand)	> 35%
Boulders	> 200 mm	noun (eg. boulders)	> 35% and main fraction

Classification system as suggested in the Canadian Foundation Engineering Manual, 3rd Edition, unless otherwise noted.

The compactness of cohesionless soils and the consistency of cohesive soils are defined by the following:

Cohesionless Soil		Cohesive Soil	
Compactness	Standard Penetration Resistance "N" Blows/0.3 m	Consistency	Undrained Shear Strength (kPa)
Very Loose	0 to 4	Very Soft	< 12
Loose	4 to 10	Soft	12 - 25
Compact	10 to 30	Firm	25 - 50
Dense	30 to 50	Stiff	50 - 100
Very Dense	Over 50	Very Stiff	100 - 200
		Hard	> 200

5. Rock Coring

Where rock drilling was carried out, the term RQD (Rock Quality Designation) is used. The RQD is an indirect measure of the number of fractures and soundness of the rock mass. It is obtained from the rock cores by summing the length of core recovered, counting only those pieces of sound core that are 100 mm or more in length. The RQD value is expressed as a percentage and is the ratio of the summed core lengths to the total length of core run. The classification based on the RQD value is given below.

RQD Classification	RQD
Very poor quality	< 25
Poor quality	25 - 50
Fair quality	50 - 75
Good quality	75 - 90
Excellent quality	90 - 100

Recovery Designation % Recovery = $\frac{\text{Length of Core Per Run}}{\text{Total Length of Run}} \times 100$

RECORD OF BOREHOLE BH-1CF 1 OF 1

METRIC

W.P. 774-93-00 LOCATION 5 093 657.8 N, 313 870.8 E ORIGINATED BY I.D.

DIST 54 HWY 11 BOREHOLE TYPE Hollow Stem Augers / CME-55 COMPILED BY M.D.

DATUM Geodetic DATE May 12, 1998 CHECKED BY I.G.

ELEV. / DEPTH	DESCRIPTION	STRATA PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES BLOWS/0.3m	GROUND WATER CONDITIONS	ELEVATION SCALE (metres)	SPT TEST (N-Value) / CONE PENETRATION TEST (20 40 60 80)	SHEAR STRENGTH: Cu, KPa (UNCONFINED QUICK TRIAXIAL ● / FIELD VANE LAB SHEAR ×) (20 40 60 80)	PLASTIC LIMIT wp / NATURAL MOISTURE CONTENT w / LIQUID LIMIT wl — WATER CONTENT (%) (10 20 30 40)	UNIT WEIGHT kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION GR SA SI + CL
314.90	GROUND SURFACE											
0.00	**FILL,** mostly silty sand & gravel with a few cobble sizes, occasional pieces of asphalt, brown, moist. (compact)	F										
		F	1	SS	28		314					
312.40		F					313	⊗		O		
2.50	**SAND & GRAVEL,** pockets of sand, some cobble sizes & possible boulders, brown, wet. (compact)		2	SS	13	▼	312	⊗		O		
311.18							311					
3.72	**BIOTITE HORNBLENDE GNEISS,** pinkish grey, excellent rock quality, unweathered.		3	NQ			310					Rec 100% RQD 98%
			4	NQ			309					Rec 100% RQD 100%
308.01			5	NQ								Rec 100% RQD 100%
6.89	END OF BOREHOLE											

Notes:
1) This borehole forms part of Highway 522 Underpass Foundation Investigation.
2) Borehole located at station 10+033.3, offset 6.5 m left of centreline as referenced to Highway 522.

MTO4 7524C 07/17/98

RECORD OF BOREHOLE BH-2CF 1 OF 1

METRIC

W.P. 774-93-00 LOCATION 5 093 649.6 N, 313 838.0 E ORIGINATED BY I.D.

DIST 54 HWY 11 BOREHOLE TYPE Hollow Stem Augers / CME-55 COMPILED BY M.D.

DATUM Geodetic DATE May 13, 1998 CHECKED BY I.G.

ELEV. / DEPTH	DESCRIPTION	STRATA PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES BLOWS/0.3m	GROUND WATER CONDITIONS	ELEVATION SCALE (metres)	SPT TEST (N-Value) / CONE PENETRATION TEST / SHEAR STRENGTH: Cu, KPa (UNCONFINED QUICK TRIAXIAL, FIELD VANE LAB SHEAR)	WATER CONTENT (%) (PLASTIC LIMIT wp, NATURAL MOISTURE CONTENT w, LIQUID LIMIT wl)	UNIT WEIGHT kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION GR SA SI + CL
315.13	GROUND SURFACE						315				
315.13 / 0.00	**ASPHALT,** 50 mm thick over **SAND & GRAVEL FILL**	F									
314.83 / 0.30	**SAND FILL,** some gravel inclusions, traces of organics, brown, moist. (compact/dense)	F	1	SS	35		314				0% 80% 20%
			2	SS	25		313				
313.03 / 2.10	**SILT,** fine sand inclusions in parts with occasional fine clay layers, grey, wet. (loose)		3	SS	9	▼					
			4	SS	5		312				
	Some cobble sizes at base.		5	SS	5		311				
309.95 / 5.18	**BIOTITE HORNBLENDE GNEISS,** pinkish grey, fair to excellent rock quality, slightly weathered to unweathered.		6	NQ			310				Rec 99% RQD 68%
			7	NQ			309				Rec 100% RQD 75%
			8	NQ			308				Rec 100% RQD 93%
			9	NQ			307				Rec 100% RQD 82%
305.50 / 9.63	END OF BOREHOLE						306				

Notes:
1) This borehole forms part of Highway 522 Underpass Foundation Investigation.
2) Borehole located at station 10+000.0, on centreline as referenced to Highway 522.

MTO4 7524C 07/17/98

RECORD OF BOREHOLE BH-3CF 1 OF 1

METRIC

W.P. 774-93-00 LOCATION 5 093 641.5 N, 313 805.6 E ORIGINATED BY I.D.

DIST 54 HWY 11 BOREHOLE TYPE Hollow Stem Augers / CME-55 COMPILED BY M.D.

DATUM Geodetic DATE May 12, 1998 CHECKED BY I.G.

ELEV. / DEPTH	DESCRIPTION	STRATA PLOT	NUMBER	TYPE	BLOWS/0.3m	GROUND WATER CONDITIONS	ELEVATION SCALE (metres)	SPT TEST (N-Value) / CONE PENETRATION TEST (20 40 60 80) / SHEAR STRENGTH: Cu, KPa (UNCONFINED QUICK TRIAXIAL ○ ● / FIELD VANE LAB SHEAR ×) (20 40 60 80)	PLASTIC LIMIT wp / NATURAL MOISTURE CONTENT w / LIQUID LIMIT wl — WATER CONTENT (%) (10 20 30 40)	UNIT WEIGHT kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION GR SA (SI & CL)
315.37	GROUND SURFACE										
0.00	**SAND & GRAVEL FILL,** occasional lumps of asphalt, brown, moist. (compact)	F					315				
314.17		F	1	SS	29			⊗	○		
1.20	**SAND,** brown, wet, traces of organics, (possible FILL). (compact)		2	SS	16	▽	314	⊗	○		
312.37			3	SS	9		313	⊗	○		
3.00	**SILT,** grey, trace of clay, wet. (very loose)		4	SS	3		312	⊗	○		
311.37											
4.00	**SAND,** with gravel sizes, brown, wet occasional cobbles. (compact)		5	SS	18		311	⊗	○		7% 83% 10%
			6	SS	12		310				
307.23			7	SS	19		309	⊗	○		
8.14	**BIOTITE HORNBLENDE GNEISS,** pinkish grey, good to excellent rock quality, slightly weathered to unweathered.		8	NQ			308				Rec 97% RQD 76%
			9	NQ			307	⊗	○		Rec 100% RQD 76%
			10	NQ			306				Rec 100% RQD 94%
303.97							305				
11.40	END OF BOREHOLE						304				

Notes:
1) This borehole forms part of Highway 522 Underpass Foundation Investigation.
2) Borehole located at station 9+966.8, 5.0 m right of centreline as referenced to Highway 522.

MTO4 7524C 07/31/98

RECORD OF BOREHOLE BH-4CF 1 OF 1

METRIC

W.P. 774-93-00 LOCATION 5 093 646.7 N, 313 870.9 E ORIGINATED BY I.D.

DIST 54 HWY 11 BOREHOLE TYPE Hollow Stem Augers / CME-55 COMPILED BY M.D.

DATUM Geodetic DATE May 13, 1998 CHECKED BY I.G.

SOIL PROFILE			SAMPLES									
ELEV. / DEPTH	DESCRIPTION	STRATA PLOT	NUMBER	TYPE	BLOWS/0.3m	GROUND WATER CONDITIONS	ELEVATION SCALE (metres)	SPT TEST (N-Value) ⊗ / CONE PENETRATION TEST —— 20 40 60 80 / SHEAR STRENGTH: Cu, KPa ● UNCONFINED QUICK TRIAXIAL × FIELD VANE LAB SHEAR 20 40 60 80	PLASTIC LIMIT wp — NATURAL MOISTURE CONTENT w — LIQUID LIMIT wl / WATER CONTENT (%) 10 20 30 40	UNIT WEIGHT kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION GR SA SI + CL
314.98	GROUND SURFACE										
0.00	**FILL**, sand & gravel, occasional cobble sizes, some silt, brown, moist. (loose to compact)	F F F	1	SS	4		314	⊗ ○			
312.98			2	SS	15	▼	313	⊗ ○			
2.00	**SAND & GRAVEL**, organic inclusions with wood, some cobbles, dark grey, wet. (very loose)		3	SS	7			⊗ ○			15% 66% 19%
310.59			4	SS	1		312	⊗ ○			
4.39	END OF BOREHOLE DUE TO REFUSAL TO AUGER ON BEDROCK OR BOULDER						311				

Notes:
1) This borehole forms part of Highway 522 Underpass Foundation Investigation.
2) Borehole located at station 10+032.2, ~5.8 m right centreline as referenced to Highway 522.
3) Borehole caved wet at ~3.8 on completion.

MTO4 7524C 07/17/98

RECORD OF BOREHOLE BH-5CF 1 OF 1

METRIC

W.P. 774-93-00 LOCATION 5 093 653.0 N, 313 805.6 E ORIGINATED BY I.D.

DIST 54 HWY 11 BOREHOLE TYPE Hollow Stem Augers / CME-55 COMPILED BY M.D.

DATUM Geodetic DATE May 13, 1998 CHECKED BY I.G.

ELEV. / DEPTH	DESCRIPTION	STRATA PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES BLOWS/0.3m	GROUND WATER CONDITIONS	ELEVATION SCALE (metres)	SPT TEST (N-Value) / CONE PENETRATION TEST (20 40 60 80) / SHEAR STRENGTH: Cu, KPa (UNCONFINED QUICK TRIAXIAL ⊗, FIELD VANE LAB SHEAR ×) (20 40 60 80)	PLASTIC LIMIT wp / NATURAL MOISTURE CONTENT w / LIQUID LIMIT wl — WATER CONTENT (%) (10 20 30 40)	UNIT WEIGHT kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION GR SA SI + CL
315.24	GROUND SURFACE										
314.94 0.30	**SAND & GRAVEL FILL**						315				
	SAND FILL, traces of organics, brown, moist. (loose to compact)		1	SS	7			⊗	○		
313.24 2.00	**SILT,** occasional seams of firm clay, brown to grey. (loose)		2	SS	14		314	⊗	○		2% 91% 7%
			3	SS	9	▼	313	⊗	○		
311.24 4.00	**SAND & GRAVEL,** brown, moist. (dense)		4	SS	9		312	⊗	○		0% 22% 78%
			5	SS	41		311	⊗	○ ○		8% 61% 31%
309.97 5.27	END OF BOREHOLE DUE TO REFUSAL TO AUGER ON BEDROCK OR BOULDER						310				

Notes:
1) This borehole forms part of Highway 522 Underpass Foundation Investigation.
2) Borehole located at station 9+967.3, offset ~6.0 m left of centreline as referenced to Highway 522.
3) Borehole caved wet at ~4.8 m depth on completion.

MT04 7524C 07/17/98

RECORD OF BOREHOLE C-1CF

1 OF 1

METRIC

W.P. 774-93-00 LOCATION 5 093 652.5 N, 313 870.7 E ORIGINATED BY I.D.

DIST 54 HWY 11 BOREHOLE TYPE Dynamic cone test / CME-55 COMPILED BY M.D.

DATUM Geodetic DATE May 13, 1998 CHECKED BY I.G.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE (metres)	SPT TEST (N-Value) / CONE PENETRATION TEST	PLASTIC LIMIT / NATURAL MOISTURE CONTENT / LIQUID LIMIT	UNIT WEIGHT	REMARKS & GRAIN SIZE DISTRIBUTION
ELEV. / DEPTH	DESCRIPTION	STRATA PLOT	NUMBER	TYPE	BLOWS/0.3m			SHEAR STRENGTH: Cu, KPa (UNCONFINED QUICK TRIAXIAL ● / FIELD VANE LAB SHEAR ×)	WATER CONTENT (%)	kN/m³	GR SA SI + CL
315.14	GROUND SURFACE							20 40 60 80	wp — w — wl		
0.00	Dynamic cone test only.						315		10 20 30 40		
							314				
							313				
							312				
311.48											
3.66	END OF CONE TEST DUE TO BOUNCING REFUSAL ON BEDROCK OR BOULDER										

Notes:
1) This cone test forms part of Highway 522 Underpass Foundation Investigation.
2) Cone test located at station 10+033.0, on centreline as referenced to Highway 522.

MTO4 7524C 07/17/98

RECORD OF BOREHOLE C-2CF 1 OF 1

METRIC

W.P. 774-93-00 LOCATION 5 093 647.5 N, 313 805.2 E ORIGINATED BY I.D.

DIST 54 HWY 11 BOREHOLE TYPE Dynamic cone test / CME-55 COMPILED BY M.D.

DATUM Geodetic DATE May 13, 1998 CHECKED BY I.G.

ELEV. / DEPTH	SOIL PROFILE: DESCRIPTION	STRATA PLOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: BLOWS/0.3m	GROUND WATER CONDITIONS	ELEVATION SCALE (metres)	SPT TEST (N-Value) / CONE PENETRATION TEST; SHEAR STRENGTH: Cu, KPa (UNCONFINED QUICK TRIAXIAL, FIELD VANE LAB SHEAR)	PLASTIC LIMIT wp / NATURAL MOISTURE CONTENT w / LIQUID LIMIT wl; WATER CONTENT (%)	UNIT WEIGHT kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION GR SA SI + CL
315.67	GROUND SURFACE										
0.00	Dynamic cone test only.						315	20 40 60 80	10 20 30 40		
							314				
							313				
							312				
							311				
							310				
							309				
							308				
307.47											
8.20	END OF CONE TEST DUE TO BOUNCING REFUSAL ON BEDROCK OR BOULDER										

Notes:
1) This cone test forms part of Highway 522 Underpass Foundation Investigation.
2) Cone test located at station 9+967.0, on centreline as referenced to Highway 522.

MTO4 7524C 07/17/98

RECORD OF BOREHOLE C-3CF 1 OF 1

METRIC

W.P. 774-93-00 LOCATION 5 093 651.0 N, 313 857.8 E ORIGINATED BY I.D.

DIST 54 HWY 11 BOREHOLE TYPE Dynamic cone test / CME-55 COMPILED BY M.D.

DATUM Geodetic DATE May 25, 1998 CHECKED BY I.G.

ELEV. / DEPTH	DESCRIPTION	STRATA PLOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: BLOWS/0.3m	GROUND WATER CONDITIONS	ELEVATION SCALE (metres)	SPT TEST (N-Value) / CONE PENETRATION TEST; SHEAR STRENGTH: Cu, KPa (UNCONFINED QUICK TRIAXIAL, FIELD VANE LAB SHEAR)	WATER CONTENT (%) (PLASTIC LIMIT wp, NATURAL MOISTURE CONTENT w, LIQUID LIMIT wl)	UNIT WEIGHT kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION GR SA SI + CL
315.18	GROUND SURFACE										
0.00	Dynamic cone test only.						315				
							314				
							313				
							312				
							311				
310.07											
5.11	END OF CONE TEST DUE TO BOUNCING REFUSAL ON BEDROCK OR BOULDER										

Notes:
1) This cone test forms part of Highway 522 Underpass Foundation Investigation.
2) Borehole located at station 10+020.0, on centreline as referenced to Highway 522.
3) Augered first ~0.3 m through dense fill before driving cone test.

MTO4 7524C 07/17/98

RECORD OF BOREHOLE AP-1CF 1 OF 1

METRIC

W.P. 774-93-00 LOCATION 5 093 645.6 N, 313 841.0 E ORIGINATED BY I.D.

DIST 54 HWY 11 BOREHOLE TYPE Standard Augers / CME-55 COMPILED BY M.D.

DATUM Geodetic DATE May 13, 1998 CHECKED BY I.G.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE (metres)	SPT TEST (N-Value) / CONE PENETRATION TEST ⊗ — 20 40 60 80	PLASTIC LIMIT / NATURAL MOISTURE CONTENT / LIQUID LIMIT — wp W wl	UNIT WEIGHT	REMARKS & GRAIN SIZE DISTRIBUTION
ELEV. / DEPTH	DESCRIPTION	STRATA PLOT	NUMBER	TYPE	BLOWS/0.3m			SHEAR STRENGTH: Cu, KPa ● UNCONFINED QUICK TRIAXIAL × FIELD VANE LAB SHEAR — 20 40 60 80	WATER CONTENT (%) — 10 20 30 40	kN/m³	GR SA SI + CL
315.93 / 0.00	GROUND SURFACE										
315.56 / 0.37	ASSUMED SAND & GRAVEL FILL						315				
	ASSUMED SAND										
314.41 / 1.52							314				
	ASSUMED SILT						313				
							312				
311.05 / 4.88	~~ASSUMED TILL~~						311				
310.93 / 5.00	END OF PROBE DUE TO REFUSAL TO AUGER ON BEDROCK OR BOULDER										

Notes:
1) This auger probe forms part of Highway 522 Underpass Foundation Investigation.
2) Auger probe located at station 10+002.5, offset ~5.0 m left of centreline as referenced to Highway 522.

MTO4 7524C 07/17/98

RECORD OF BOREHOLE AP-2CF 1 OF 1

METRIC

W.P. 774-93-00 LOCATION 5 093 654.7 N, 313 835.1 E ORIGINATED BY I.D.

DIST 54 HWY 11 BOREHOLE TYPE Standard Augers / CME-55 COMPILED BY M.D.

DATUM Geodetic DATE May 13, 1998 CHECKED BY I.G.

ELEV. / DEPTH	DESCRIPTION	STRATA PLOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: BLOWS/0.3m	GROUND WATER CONDITIONS	ELEVATION SCALE (metres)	SPT TEST (N-Value) / CONE PENETRATION TEST (20 40 60 80) / SHEAR STRENGTH: Cu, KPa (UNCONFINED QUICK TRIAXIAL ● / FIELD VANE LAB SHEAR ×) (20 40 60 80)	PLASTIC LIMIT wp / NATURAL MOISTURE CONTENT w / LIQUID LIMIT wl / WATER CONTENT (%) (10 20 30 40)	UNIT WEIGHT kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION GR SA SI + CL
314.93	GROUND SURFACE										
314.63 / 0.30	ASSUMED FILL										
	ASSUMED SAND						314				
313.10 / 1.83							313				
	ASSUMED SILT						312				
							311				
309.84 / 5.09	ASSUMED TILL						310				
309.60 / 5.33	END OF PROBE DUE TO REFUSAL TO AUGER ON BEDROCK OR BOULDER										

Notes:
1) This auger probe forms part of Highway 522 Underpass Foundation Investigation.
2) Borehole located at station 9+997.5 offset 5.0 m left of centreline as referenced to Highway 522.

MTO4 7524C 07/17/98

RECORD OF BOREHOLE AP-3CF 1 OF 1

METRIC

W.P. 774-93-00 LOCATION 5 093 652.3 N, 313 875.4 E ORIGINATED BY I.D.

DIST 54 HWY 11 BOREHOLE TYPE Standard Augers / CME-55 COMPILED BY M.D.

DATUM Geodetic DATE May 13, 1998 CHECKED BY I.G.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE (metres)	SPT TEST (N-Value) / CONE PENETRATION TEST; SHEAR STRENGTH: Cu, KPa (UNCONFINED QUICK TRIAXIAL ●, FIELD VANE LAB SHEAR ×)	PLASTIC LIMIT wp / NATURAL MOISTURE CONTENT w / LIQUID LIMIT wl; WATER CONTENT (%)	UNIT WEIGHT	REMARKS & GRAIN SIZE DISTRIBUTION
ELEV. / DEPTH	DESCRIPTION	STRATA PLOT	NUMBER	TYPE	BLOWS/0.3m			20 40 60 80	10 20 30 40	kN/m³	GR SA SI + CL
315.16	GROUND SURFACE										
0.00	**ASPHALT,** 45 mm over						315				
	ASSUMED SAND										
							314				
313.64 1.52											
	ASSUMED SILT						313				
							312				
311.35 3.81											
311.08 4.08	ASSUMED SILTY SAND & GRAVEL										
	END OF PROBE DUE TO REFUSAL TO AUGER ON BEDROCK OR BOULDER										

Notes:
1) This auger probe forms part of Highway 522 Underpass Foundation Investigation.
2) Borehole located at station 10+037.0, on centreline as referenced to Highway 522.

MTO4 7524C 07/17/98

RECORD OF BOREHOLE AP-4CF 1 OF 1

METRIC

W.P. 774-93-00 LOCATION 5 093 647.2 N, 313 800.8 E ORIGINATED BY I.D.

DIST 54 HWY 11 BOREHOLE TYPE Standard Augers / CME-55 COMPILED BY M.D.

DATUM Geodetic DATE May 13, 1998 CHECKED BY I.G.

ELEV. / DEPTH	DESCRIPTION	STRATA PLOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: BLOWS/0.3m	GROUND WATER CONDITIONS	ELEVATION SCALE (metres)	SPT TEST (N-Value) / CONE PENETRATION TEST (20 40 60 80) / SHEAR STRENGTH: Cu, KPa (UNCONFINED QUICK TRIAXIAL ● / FIELD VANE LAB SHEAR ×) (20 40 60 80)	PLASTIC LIMIT wp / NATURAL MOISTURE CONTENT w / LIQUID LIMIT wl — WATER CONTENT (%) (10 20 30 40)	UNIT WEIGHT kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION GR SA SI + CL
315.74	GROUND SURFACE										
0.00	**ASPHALT,** 145 mm over						315				
	ASSUMED SAND						314				
							313				
							312				
311.17 / 4.57							311				
	ASSUMED SILT						310				
309.49 / 6.25											
309.03 / 6.71	ASSUMED COBBLES										
	END OF PROBE DUE TO REFUSAL TO AUGER ON BEDROCK OR BOULDER										

Notes:
1) This auger probe forms part of Highway 522 Underpass Foundation Investigation.
2) Borehole located at station 9+963.0, on centreline as referenced to Highway 522.

MTO4 7524C 07/17/98

S07524G/C

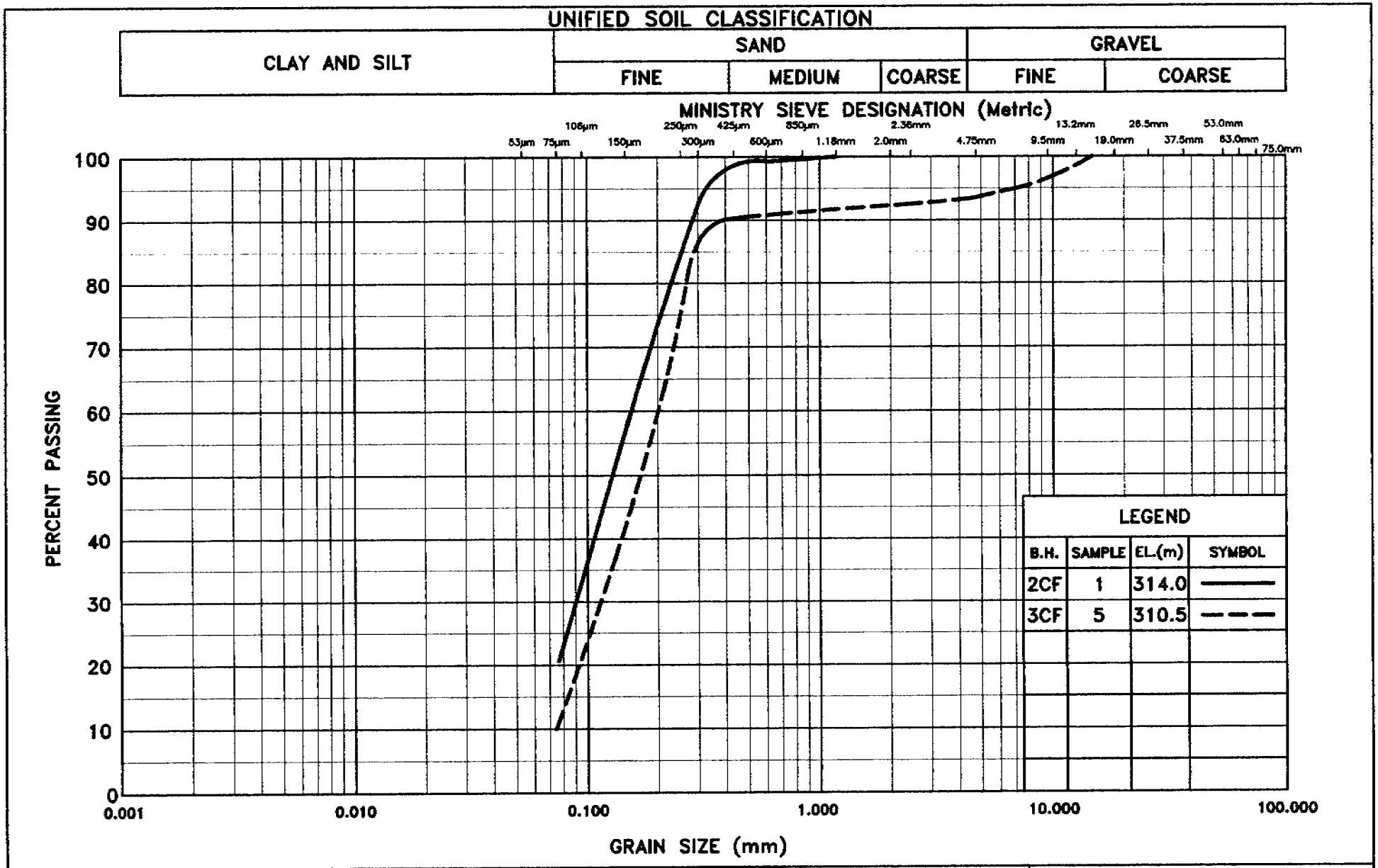
TABLE 1-1
ROCK CORE DESCRIPTION

BH#	Core Recovery				Core Description	
	Core #	Depth (m)	% CR*	% RQD**	Depth (m)	Description
HIGHWAY 522 BRIDGE FOUNDATION						
1-CF	3 4 5	3.72 to 4.72 4.72 to 5.88 5.88 to 6.89	100 100 100	98 100 100	3.72 to 6.89	**Bioitite Horneblende Gneiss** - light grey to pinkish white, fine to medium grained, strong, unweathered, fractures very widely spaced, dipped at 80 to 90° from vertical, planar, smooth
2-CF	6 7 8 9	5.18 to 5.94 5.94 to 6.71 6.71 to 7.47 7.47 to 9.63	100 100 100 100	66 75 93 82	5.18 to 9.63	**Biotite Hornblende Gneiss** - light grey to pinkish white, with pegmatitic quartz inclusions, medium to coarse grained, strong, unweathered, fractures moderate to very close spread, dipping at 45° from vertical planar, smooth
3-CF	8 9 10	8.14 to 9.05 9.05 to 10.52 10.52 to 11.40	100 100 100	75 76 94	8.14 to 11.40	**Biotite Hornblende Gneiss (Garnetigerous)**, pinkish white to light grey, medium grained, strong unweathered, fractures moderately spaced, dipping at 0 to 10° and 80 to 90° from vertical, planar, smooth

*CR Core Recovery %
**RQD Rock Quality Designation %

Trow

APPENDIX B



Ministry of Transportation

METRIC

GRAIN SIZE DISTRIBUTION

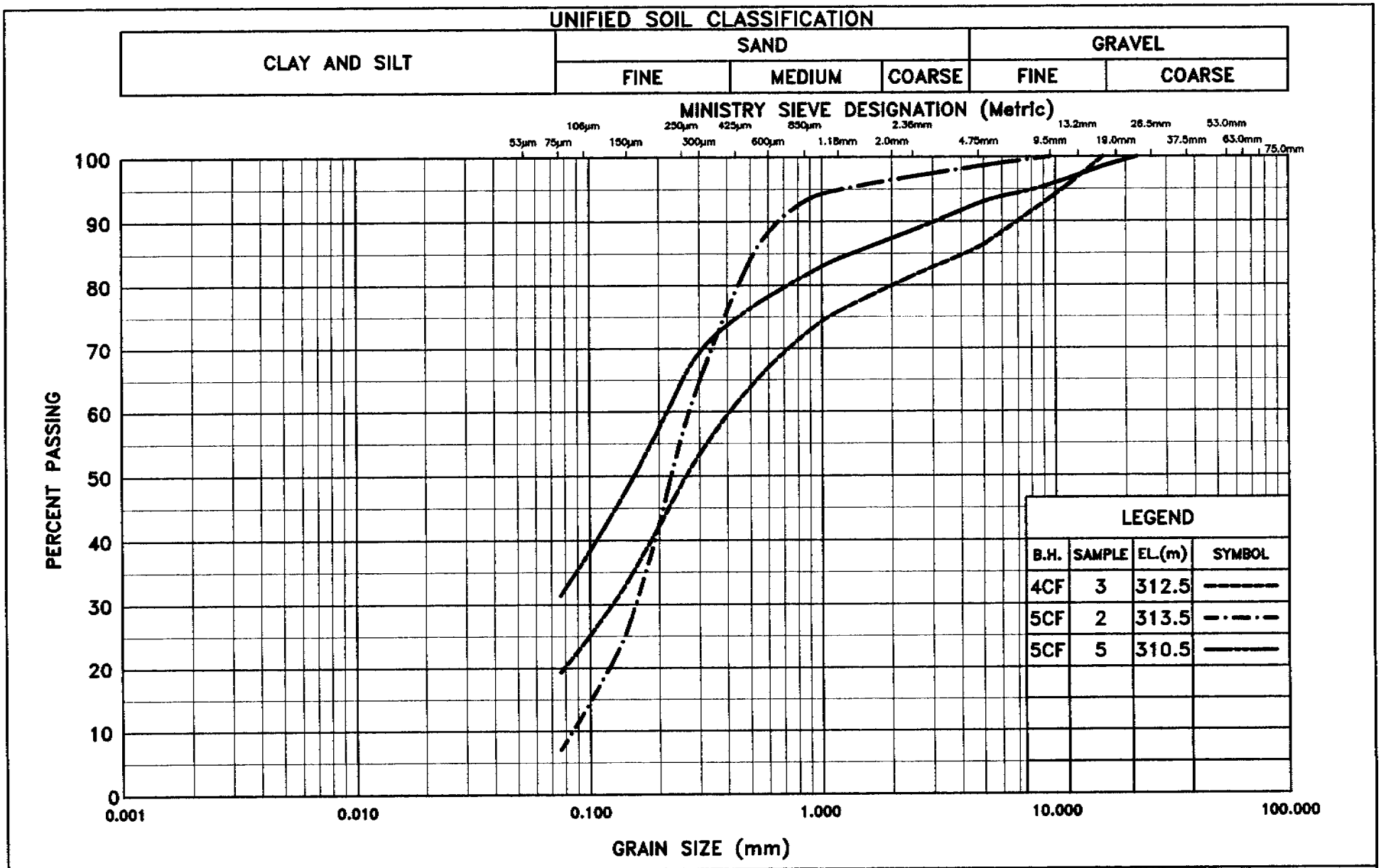
ALL SAMPLES FINE SAND

FIGURE 1

W.P. 774-93-00

Trow

PROJ. No. S07524GCF



Ministry of Transportation

METRIC

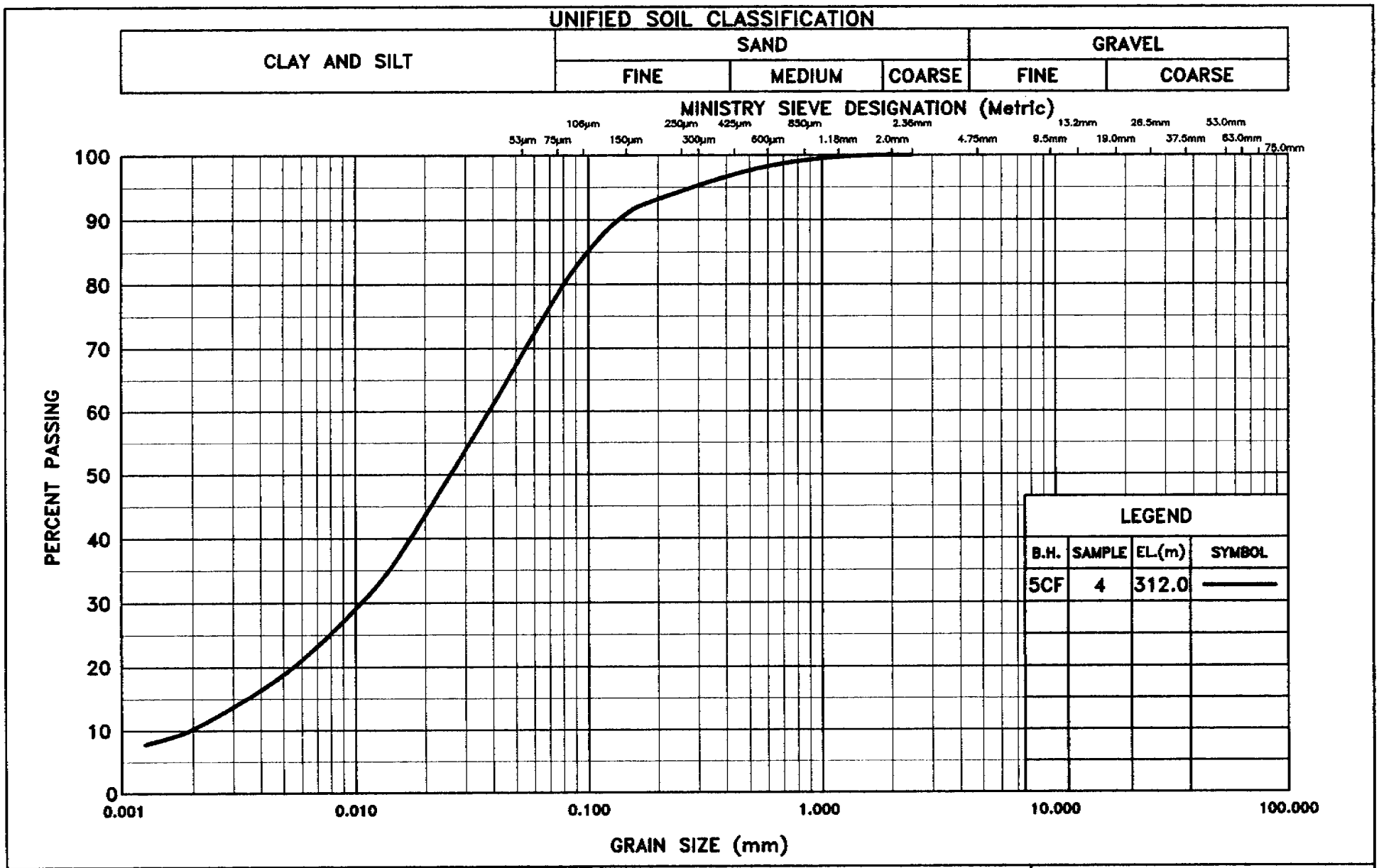
GRAIN SIZE DISTRIBUTION

ALL SAMPLES FINE/MEDIUM SAND, with gravel

FIGURE 2

W.P. 774-93-00

Trow PROJ. No. S07524GCF



Ministry of Transportation

METRIC

GRAIN SIZE DISTRIBUTION

BH-5, SAMPLE 4: SILT, some sand, trace of clay

FIGURE 3

W.P. 774-93-00

Trow

PROJ. No. S07524GCF