



**PRELIMINARY FOUNDATION INVESTIGATION AND DESIGN REPORT
for
PROPOSED HIGHWAY 11/17 FOUR-LANING
HIGH FILLS AND DEEP CUTS
FROM 0.4 KM WEST OF HODDER AVENUE/COPENHAGEN ROAD
EASTERLY FOR 5.1 KM
AGREEMENT NUMBER 6005-E-0002
GWP NO. 334-94-00
THUNDER BAY, ONTARIO**

PETO MacCALLUM LTD.
165 CARTWRIGHT AVENUE
TORONTO, ONTARIO
M6A 1V5
Phone: (416) 785-5110
Fax: (416) 785-5120
Email: Toronto@petomaccallum.com

Distribution:

- 3 cc: Stantec Consulting Ltd. for distribution to MTO,
Project Manager + one digital copy (PDF format)
- 1 cc: Stantec Consulting Ltd. for distribution to MTO,
Pavements and Foundations Section + one digital
copy (PDF format) + Drawings (AutoCAD format),
and 1 cc Part A only + one digital copy (PDF format)
- 2 cc: Stantec Consulting Ltd. + one digital copy
- 1 cc: PML Toronto

PML Ref.: 05TF040B
Index No.: 058FIDR
Geocres No.: 52A-131
June 18, 2007



TABLE OF CONTENTS

PART A - PRELIMINARY FOUNDATION INVESTIGATION

1. INTRODUCTION	1
2. SITE DESCRIPTION	2
3. INVESTIGATION PROCEDURES	3
4. SUMMARIZED SUBSURFACE CONDITIONS	4
4.1 General	4
4.2 Sta. 26+300 to 27+300 (Right)	
Boreholes 101 to 103, 105, 107, 109, 111, 113, 115, 117 and 119.....	4
4.2.1 Fill.....	4
4.2.2 Topsoil/Peat	5
4.2.3 Silty Sand	5
4.2.4 Sand to Silt Till	5
4.2.5 Bedrock	5
4.2.6 Groundwater	6
4.3 Sta. 26+300 to 27+300 (Left)	
Boreholes 104, 106, 106A, 108, 110, 112, 114, 116, 118, 120 and 121	6
4.3.1 Fill.....	6
4.3.2 Topsoil/Peat	6
4.3.3 Silty Sand/Sandy Silt/Silt.....	6
4.3.4 Sand/Silty Sand Till.....	7
4.3.5 Bedrock	7
4.3.6 Groundwater	8
5. MISCELLANEOUS	8

PART B - PRELIMINARY FOUNDATION DESIGN

6. ENGINEERING RECOMMENDATIONS.....	9
6.1 High Fill Section	9
6.2 Deep Cuts	11
6.3 Road Protection Considerations.....	12



7. SCOPE OF ADDITIONAL FOUNDATION INVESTIGATION	12
8. CLOSURE	13

Table 1 - List of Specifications Referenced in Report

Figures GS-1 and GS-2 - Results of Grain Size Distribution Analyses

Explanation of Terms Used in Report

Record of Borehole Sheets 101 to 121

Drawing B1 - Borehole Locations

Drawings B2 and B3 - Cross Sections

Appendix A - Copy of Record of Boreholes, Location Plans and Soil Strata

From:

- Foundation Investigation Report for Highway 11/17 Interchange at Terry Fox Lookout, W.P. 141/142-901-01, Site No. 48C-312 (Geocres Reference No. 52A-106) dated November 1991 prepared by McClymont and Rak Engineers Inc.
- Technical Memorandum for Embankment Widening for the W-N Ramp at Terry Fox Interchange, W.P. 621-89-00 (Geocres Reference No. 52A-114) dated September 17, 1992 prepared by MTO.

Appendix B - Site Photographs

PART A
PRELIMINARY FOUNDATION INVESTIGATION REPORT
for
Proposed Highway 11/17 Four-Laning
High Fills and Deep Cuts
From 0.4 Km West of Hodder Avenue/Copenhagen Road
Easterly for 5.1 km
Agreement Number 6005-E-0002
GWP No. 334-94-00
Thunder Bay, Ontario

1. INTRODUCTION

The construction of high fills and deep cuts is included in the four-laning improvement project for the Highway 11/17 from 0.4 km west of the Hodder Avenue/Copenhagen Road intersection for 5.1 km easterly in the City of Thunder Bay, Ontario. This preliminary report was prepared for Stantec Consulting Ltd. (Stantec) on behalf of the Ministry of Transportation of Ontario (MTO).

The four-laning of the highway will involve the construction of an embankment platform widening from Sta. 26+300 to 27+300. A deep rock cut is also planned to the north of the existing highway approximately between Sta. 26+600 and 26+750, where an ANSI site is located.

MTO previously carried out two investigations along the same section of the highway embankment. MTO provided a Foundation Investigation report for the previously planned Terry Fox Interchange W.P. 141/142-90-01 (Geocres reference No. 52A-106) dated November 1991 and a Technical Memorandum for the Embankment Widening for the W-N Ramp at the Terry Fox Interchange, WP 621-89-00 (Geocres 52A-114) dated September 17, 1992. Included in Appendix A is a copy of the previous relevant records of boreholes and location plans for reference.

Part A of this preliminary report summarizes the results of the current foundation investigation carried out at the high fill/deep rock cut sites.



2. SITE DESCRIPTION

The existing Highway 11/17 through the investigated section is presently a two-lane highway. The eastbound lane was locally constructed on a rock fill embankment up to 20 m high, while the westbound lane was built over shallower fill embankments and through local rock cuts, as inferred from a site inspection and from the previous records of borehole data.

A prominent rock outcrop extending about 13 m high above the Highway 11/17 pavement exists between about Sta. 26+660 and 26+740 north of the left shoulder of the current alignment. The outcrop has been designated as an Area of Natural and Scientific Interest (ANSI) site.

The area of the highway adjacent to the Terry Fox Scenic Lookout site (Sta. 26+250 to 26+450) was filled and widened in the past for the original Terry Fox Scenic Lookout site. It is also noted that a section of the toe of the existing embankment in front of the ANSI site (Sta. 26+600 to 26+750) was used as a disposal area for excess blasted rock from the construction of the current monument site.

The land along the investigated highway section is undeveloped except the Terry Fox Scenic Lookout site north of the highway. A paved entrance road leading to the site intersects the investigated section of highway at about Sta. 26+510. Elsewhere, the terrain has a typically hilly characteristic with relatively flat ground near the monument on a west to east direction. Currently, the ground slopes down steeply to the south. The terrain is typically covered with tall bushes and trees, in particular to the south of the toe of slope.

The investigated section of the highway straddles variable geological areas comprising glaciofluvial deposits of sands and silts, local ground moraines with glacial silt tills and bedrock outcrops. Swamp areas were detected at the east end of the investigated section.

The depth of foundation frost penetration for the area is 2.2 m, according to OPSD 3090.100.



3. INVESTIGATION PROCEDURES

The field work for this investigation was carried out between December 13 and 16, 2005. A total of 30 boreholes were drilled at the site. From this total, 21 boreholes numbered 101 to 120 and 106A were drilled at or near the originally proposed locations and borehole 121 was added 100 m east of borehole 120 to investigate a potential swamp location. The records of boreholes 101 to 121 and 106A are enclosed. In addition, 8 unsampled boreholes were added to the field program within 1.5 m of the original borehole locations to investigate the refusal depths and confirm the presence of probable bedrock. The field notes for these boreholes were added to the records of the respective boreholes. The locations of the boreholes 101 to 121 are shown on the attached Borehole Location Drawing B1.

The boreholes were advanced using continuous flight hollow stem augers through the soil cover with a track-mounted CME-75 drill rig, supplied and operated by a specialist drilling contractor, working under the full-time supervision of a member of our engineering staff. The boreholes extended to depths ranging from 0.5 to 8.1 m.

The borehole layout was established in accordance with the requirements noted in the Request for Proposal. PML selected the location of the boreholes that are shown on the Borehole Location Plan, Drawing 1. The ground surface elevations at the borehole locations were referred to geodetic datum by J. D. Barnes Surveyors Limited. All elevations in this report are expressed in meters.

Soils were identified in accordance with the MTO Soil Classification Manual procedures. The groundwater conditions in the boreholes were assessed during drilling by visual examination of the soil, the sampler and drill rods as the samples were retrieved and, where encountered, by measuring the groundwater level in the open boreholes. All of the boreholes were backfilled with a bentonite/cement mixture in accordance with the MTO and MOE (Reg. 903) guidelines for borehole abandonment.

The recovered soil samples were returned to our laboratory for detailed visual examination and classification. The laboratory testing program consisted of 34 natural moisture content determinations and grain size distribution analyses of 14 selected soil samples. The laboratory grain



size determinations are reported on Figures GS-1 and GS-2. All of the test results are summarized on the Record of Borehole sheets.

4. SUMMARIZED SUBSURFACE CONDITIONS

4.1 General

Reference is made to the appended Record of Borehole sheets for details of the subsurface conditions including soil classifications, inferred soil stratigraphy, natural moisture content determinations and results of grain size analyses. The results were cross-referenced with the previous borehole data enclosed in Appendix A.

A brief summary of the stratigraphy at the right (south) and left (north) of the highway is provided below for discussion purposes in this report.

4.2 Sta. 26+300 to 27+300 (Right)

Boreholes 101 to 103, 105, 107, 109, 111, 113, 115, 117 and 119

4.2.1 Fill

Although fill was not encountered in the current boreholes drilled along the south toe of slope of the highway, visual inspections indicated the presence of thick fill units. Namely, the widening of the right shoulder for original Terry Fox Scenic Lookout required filling, which possibly spilled over the edge of the previous embankment. This approximately 200 m long fill area is at the existing level of the Highway 11/17 from about Sta. 26+250 to 26+450.

Another area of fill occurred at the right toe of slope between about Sta. 26+610 and 26+730 (120 m long) where large boulders and blasted rock was stockpiled. We understand that this rock was excess blasted rock from previous highway construction operations.



4.2.2 Topsoil/Peat

Topsoil and peat deposits were found at the surface of all boreholes drilled right of the highway. The thickness of these organic deposits ranges from 300 mm to 2.5 m. The thickness is less than 0.9 m to the west of Sta. 26+900. Boreholes 102 and 103 were terminated on shale bedrock at 0.3 and 0.6 m depths, elevations 232.6 and 231.2, respectively.

4.2.3 Silty Sand

Cohesionless silty sand, sandy silt and silt some sand with variable amounts of gravel, cobbles and boulders were found below the organic deposits. These units were terminated on probable bedrock between Sta. 26+300 and 27+000 at depths ranging from 1.1 to 3.2 m. Boreholes 117 and 119 terminated in the silt some sand unit at depths ranging from 6.6 to 8.1 m.

The cohesionless units exhibited variable relative density from very loose to very dense. Typically these soils are in compact to very dense conditions with penetration resistances N-values ranging from 16 to over 50 blows per 300 mm penetration of the sampler. Particle size distribution charts of the materials are included in the envelope shown on the enclosed Figure GS-1.

4.2.4 Sand to Silt Till

Localized cohesionless compact to very dense sand to silty sand till containing cobbles and boulders was encountered below the peat in boreholes 113 and 115 drilled at Sta. 27+000 and 27+100, respectively. Borehole 113 terminated on bedrock at 3.8 m depth and borehole 115 terminated in the glacial till at 6.9 m depth. N-values ranged from 8 to over 50 blows. Particle size distribution charts of the till are included in the envelope shown on Figure GS-2.

4.2.5 Bedrock

Bedrock was contacted/inferred at depths ranging from 0.3 to 3.8 m, elevations 228.2 to 233.0 from Sta. 26+300 to 27+000. The bedrock/probable bedrock consisted of weathered shale (Tuff) that was penetrated up to 1.4 m by augering with difficulty.



These results correlate well with the previous record of boreholes in Appendix A (boreholes 92-1 to 92-3 and boreholes 5 and 6 show bedrock/probable bedrock at about elevations 228.1 to 232.0).

4.2.6 Groundwater

Groundwater was present in seven of the eleven boreholes drilled on the right side of the highway (boreholes 105, 107, 109, 113, 115, 117 and 119) at depths ranging from 0.3 to 2.6 m, elevations 230.7 to 237.5. The water level is expected to vary seasonally.

4.3 Sta. 26+300 to 27+300 (Left)

Boreholes 104, 106, 106A, 108, 110, 112, 114, 116, 118, 120 and 121

4.3.1 Fill

Fill units comprising mixed silty sand, sandy silt, topsoil, rock fragments, cobbles and boulders were encountered at the surface in boreholes 104, 106 and 106A drilled between Sta. 26+500 and Sta. 26+600. The thickness of the fill varied from 600 mm to 1.6 m in the boreholes. The fill extended to the 0.6 m termination depth of borehole 106A, where the borehole found the top of the bedrock which resulted from excavation of the rock outcrop previously present to the west of the ANSI site.

4.3.2 Topsoil/Peat

Topsoil units were typically encountered at the surface of the boreholes drilled between Sta. 26+700 and 27+300. The topsoil layers are 200 to 500 mm thick. The topsoil encountered in borehole 108 (Sta. 26+700) which was advanced from the top of the existing rock outcrop was mixed with cobbles and boulders. Borehole 121, drilled at Sta. 27+400 (100 m east of the high fill section to be investigated) encountered a 1.8 m thick layer of peat extending to elevation 236.9.

4.3.3 Silty Sand/Sandy Silt/Silt

Units of cohesionless silty sand, sandy silt and silt some sand were encountered in the boreholes drilled at and east of Sta. 26+800. These soils extended to 1.4 to 6.6 m in boreholes 110 to 121.



Boreholes 118 and 121 were terminated in these soils at their common termination depth of 6.6 m. The soils were in a compact to dense condition based on N-values ranging from 15 to over 50 blows. The particle size distribution charts of representative samples were included in the particle size envelope shown on Figure GS-1.

4.3.4 Sand/Silty Sand Till

Discontinuous 0.9 to 2.2 m thick deposits of compact to very dense sand to silty sand till containing cobbles and boulders were found in boreholes 104 and 106 and also in boreholes 114 and 116 and extended to 2.7 to 4.4 m mantling the bedrock. The N-values ranged from 17 to over 50 blows. Grain size distribution charts were included in the envelope shown on Figure GS-2.

The soil stratigraphy encountered in the current subsurface exploration are generally consistent with the findings of previous boreholes drilled by others near the location of the section of embankment investigated.

4.3.5 Bedrock

Bedrock was contacted/inferred in all boreholes drilled along the north side of the highway except boreholes 118 and 121 at depths ranging from 0.5 to 4.4 m, elevations 233.2 to 256.3 from Sta. 26+300 to 27+000. The bedrock surface is deeper than 6.6 m, elevations 234.8 and 232.1 in boreholes 118 and 121, respectively. The boreholes did not penetrate the bedrock, which was inferred by refusal to augering.

The results of the previous investigations carried out from the top of the existing highway platform between Stations 26+600 and 26+650 (boreholes 1 to 4 attached in Appendix A) also revealed bedrock at similar levels of 1.0 to 2.3 m depths, elevations 243.1 to 244.1. These boreholes penetrated into the bedrock 2.4 to 6.9 m. The measured RQD values indicated that the bedrock has generally a fair to excellent quality.

A prominent bedrock outcrop comprising an exposed near vertical rock face and is designated an ANSI site is present between approximate Stations 26+600 and 26+740 (140 m long exposed



face), to the east of the entrance to the Terry Fox Scenic Lookout site. Borehole 108 put down at the top of the site encountered 0.5 m of topsoil cover on the bedrock surface that was at about elevation 256.3 in the borehole. The estimated difference in elevation from the bedrock surface to the road surface was about 10.0 m.

The bedrock/probable bedrock penetrated in this investigation other than the ANSI site consisted of black weathered shale that the previous investigations classified as a Tuff. According to the previous investigations, the upper zone Tuff bedrock mantles an Iron Chert Formation.

4.3.6 Groundwater

Groundwater was present at about 2.1 m, elevation 244.1 in borehole 106 drilled east of the Terry Fox Scenic Lookout entrance road. Boreholes 114, 116, 118, 120 and 121 drilled on the left side of the highway east of the ANSI site encountered groundwater during and upon completion of drilling at depths ranging from 1.2 to 4.3 m, elevations 236.0 to 237.8. The water level will vary seasonally and with rainfall patterns.

5. MISCELLANEOUS

Mr. F. Portela carried out the subsurface investigation under the supervision and direction of Mr. C.M. P. Nascimento, P. Eng., Senior Project Engineer. DST Inc. supplied the drilling equipment.

Mr. C. M. P. Nascimento, P.Eng prepared and Mr. B. R. Gray, MEng, P.Eng. , MTO Designated Contact reviewed this Preliminary Foundation Investigation Report (Part A).

PART B
PRELIMINARY FOUNDATION DESIGN REPORT

for
Proposed Highway 11/17 Four-Laning
High Fills and Deep Cuts
From 0.4 Km West of Hodder Avenue/Copenhagen Road
Easterly for 5.1 Km
Agreement Number 6005-E-0002
GWP No. 334-94-00
Thunder Bay, Ontario

6. ENGINEERING RECOMMENDATIONS

This section of the report provides preliminary foundation engineering recommendations regarding design and comments for construction of the proposed high fill and deep cut along the Highway 11/17 embankment widening as part of the Highway 11/17 Preliminary Design. The recommendations are preliminary and based on the results of the limited subsurface investigation described in the Part A of this report.

The following sections of this report discuss the key issues (embankment stability, preliminary design and groundwater control) for the proposed preferred alignment of the highway four-laning.

Table 1 contains a list of the standard specifications referenced in this report. All elevations in this report are in metres.

6.1 High Fill Section

The Highway 11/17 four-laning comprising the high fill section will be located south of the highway between about Sta. 26+300 to 27+300 on Highway 11/17. According to the preliminary cross-section drawing provided by Stantec in February 2007, the proposed widening will require fill heights of 10 to 15 m between the proposed platform grades and the existing ground at the toe of slopes. The geometry of the additional fill is illustrated on six selected cross-sections provided by Stantec at Sta. 26+300, 26+500, 26+600, 26+700, 27+000 and 27+300 reproduced on Drawings B2 and B3. The new embankment platform grades will match the approximate existing pavement grades, as shown on the reference drawing.



The findings of the investigation indicate that the construction of the widening alternative to the north of the existing highway is feasible. The existing fill found between Sta. 26+500 and 26+600 should be removed and replaced with adequately installed rock or earth fill to construct the road platform. Topsoil and peat typically up to 500 mm thick and locally 1.8 m thick (borehole 121) encountered along the remaining section investigated should also be removed prior to constructing the road platform to minimize post-construction settlements and as part of the geotechnical treatment for the construction of the proposed embankments.

Widening the embankment to the south of the existing highway is also considered feasible. The condition of the rock fill placed over the south embankment for the original Terry Fox Scenic Lookout site (Sta. 26+250 to 26+450) and the bouldery waste rockfill placed at the right toe of slope from about Sta. 26+610 to 26+730 (in front of the ANSI site) should be verified during detail design. It is anticipated that construction of the widened platform over these areas will require at least partial removal of the rockfill from previous shoulder widening at the original location of the Terry Fox Scenic Lookout site and construction of new fill. The up to 800 mm thick peat encountered at the right toe of slope along the alignment should be removed.

In general, the slope geometry should be designed according to the standard MTO slope configuration for rockfill embankments (1.25 H to 1V) and 2 m wide benches provided at 10 m intervals of height (OPSD 202.010). The new rock fill should be placed in accordance with OPSD 200.020, 201.020, 202.020, SP 206S03 and SP 105S10. The benching procedures (OPSD 208.010) should be used where applicable. Removal of organic soils is recommended to minimize construction settlements and avoid creating preferred slip planes under the fill. The procedure outlined in OPSD 203.030 is recommended for widenings and/or grade changes.

It is anticipated that construction of the embankment widening as recommended will not cause instability since the existing non-organic soil cover comprises entirely of cohesionless soils in typically compact to very dense condition.

The earth fill slopes, if employed, should be protected against surface erosion by sodding (OPSS 571) and suitable vegetation.



There will be settlements of the embankment fills that are constructed with rockfill or earth fill materials. The embankments will be up to about 15 m high. The magnitude of the settlement of these fills depends on the workmanship employed by the contractor. If placed in accordance with the requirements of SP 206S03 and OPSS 501 (Method A), estimated maximum fill settlements should be less than 80 to 100 mm. About 50% of the estimated total settlements should be complete within 1 to 2 months after placement of the fill with the remainder occurring in the long term due to consolidation of the rockfill. Preloading should be employed to reduce long-term settlements in particular in areas where existing rockfill found at previous shoulder widenings and at the toe of slope mentioned previously is not completely removed and recompacted.

The native very dense silty sand and silt to sand till are classified as Type 2 soil according to Occupational Health and Safety Act (OHSA) (Ontario Regulation 213/91) criteria. The fills and compact silt sand are classified as Type 3 soils. The excavations should be carried out in accordance with the soils in the slopes having the highest soil Type number. The need to excavate flatter side slopes if excessively soft/wet materials or concentrated seepage zones are encountered locally should be considered.

6.2 Deep Cuts

The approximately 10.5 m deep excavation for construction of the deep cuts on the north side of the highway at Sta. 26+600 to 26+740 will extend through the exposed rock outcrop. The cut slopes are expected to be stable at nearly vertical slopes, as inferred from the existing exposed rock face. The rock face should be inspected by a rock specialist during Detail Design to evaluate rock fall probability and protection measures.

The rock is classified as Type 1 soil according to the OHSA criteria.



6.3 Road Protection Considerations

Should construction and traffic staging require traffic adjacent to the excavations it is anticipated that a suitable roadway protection scheme following SP 105S19 will be required to support the walls of the excavation and adjacent traffic lanes during construction.

Several protection scheme alternatives such as sheet piling, sheeting supported by rakers or bracing, cantilever or anchored soldier piles and lagging may be considered. It is noted however that soldier pile and lagging schemes are not considered adequate where the excavation will be carried out through embankment sand and gravel fills or native materials in particular under the groundwater table. For preliminary design purposes the road protection schemes should be designed for performance level 1b to prevent movement of the existing embankment. The contractor is responsible for the selection, preparation and performance of a detailed design for the road protection scheme.

7. SCOPE OF ADDITIONAL FOUNDATION INVESTIGATION

Based on the results of the site review and proposed alignment and required high fills and deep rock cuts, the recommended additional scope of fieldwork is as follows:

- Additional boreholes should be carried out from the top of existing fill in the original Terry Fox Scenic Lookout site to evaluate the need to rework or replace the existing fill.
- The condition of the existing bouldery fill at the waste stockpile at the south toe of slope between Sta. 26+610 and 26+730 should be investigated with test pits.



8. CLOSURE

This Preliminary Foundation Design Report (Part B) was prepared by Mr. C. M. P. Nascimento, P.Eng., Senior Project Engineer and reviewed by Mr. B. R. Gray, MEng, P.Eng., MTO Designated Contact.

Yours very truly,

Peto MacCallum Ltd.

A handwritten signature in black ink, reading "C. M. P. Nascimento", is written over the circular professional engineer stamp.



C. M. P. Nascimento, P.Eng.,
Senior Foundation Engineer

A handwritten signature in blue ink, reading "Brian R. Gray", is written over the circular professional engineer stamp.



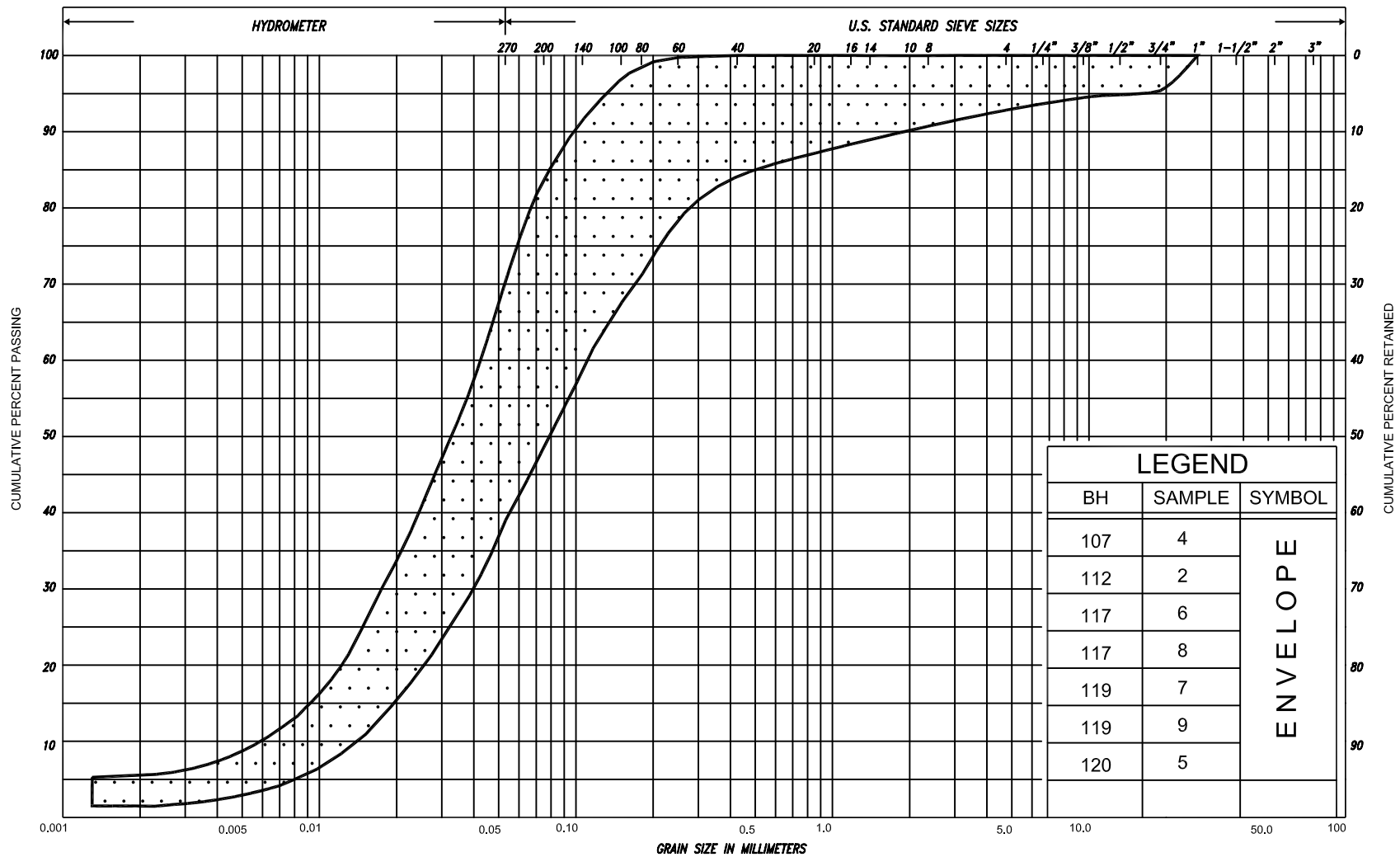
Brian R. Gray, MEng, P.Eng.
MTO Designated Contact

CN/BRG:cn-mi

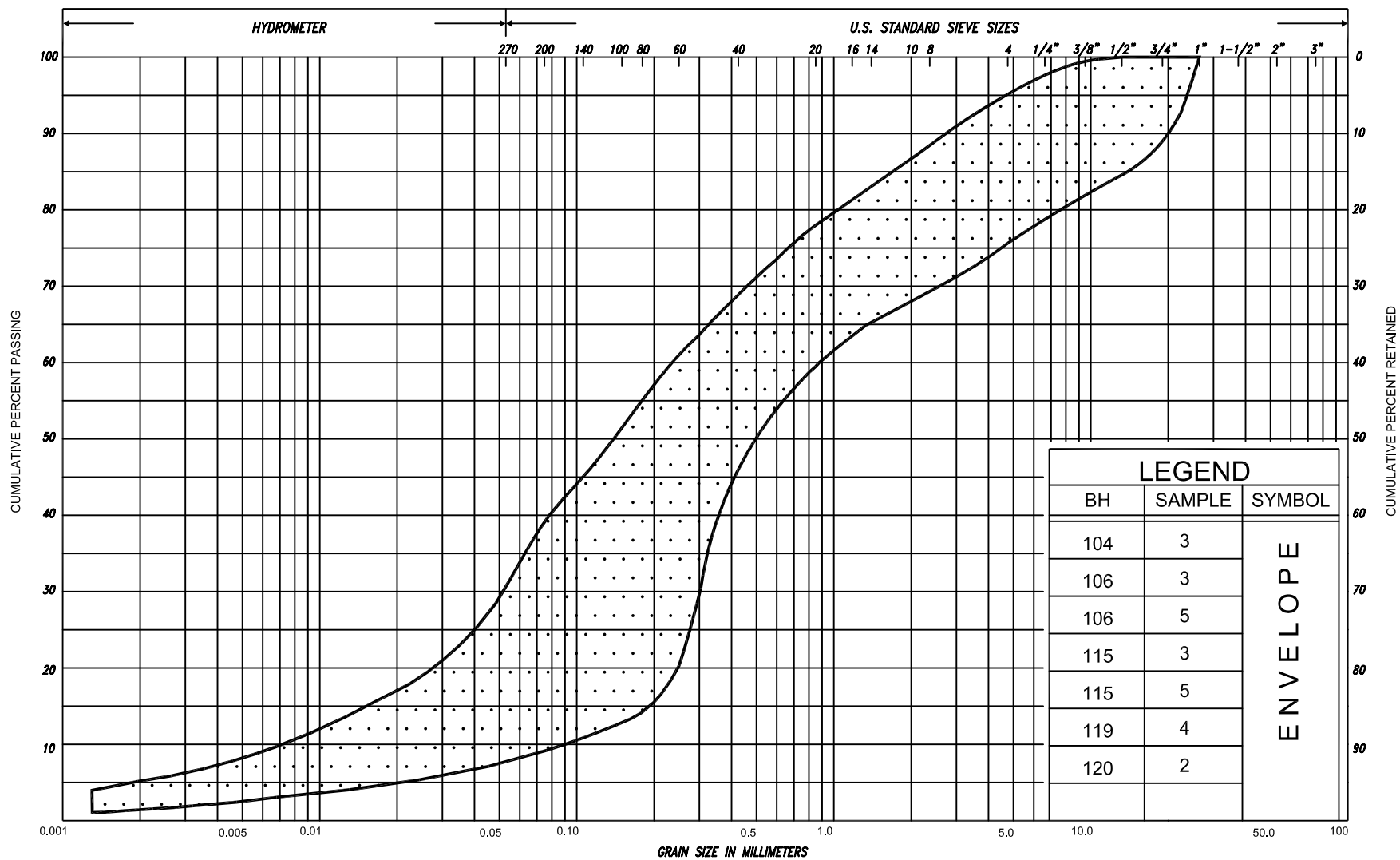


TABLE 1
LIST OF STANDARD SPECIFICATIONS REFERENCED IN REPORT

DOCUMENT	TITLE	DATE
OPSS 501	Construction Specification for Compacting	November 2005
OPSS 571	Construction Specification for Sodding	November 2001
SP 105S10	Construction Specification for Compaction	November 2004
SP 105S19	Construction Specification for Protection Systems	November 2006
SP 206S03	Construction Specification for Grading	November 2006
OPSD 200.020	Earth/Shale Grading – Divided Rural	November 2005
OPSD 201.020	Rock Grading-Divided Rural	November 2005
OPSD 202.010	Slope Flattening Using Excess Material on Earth or Rock Embankment	November 2005
OPSD 202.020	Drainage Gap for Slope Flattening on Rock or Granular Embankment	November 2005
OPSD 203.030	Embankment Over Swamps – Existing Slopes Maintained	November 2005
OPSD 208.010	Benching of Earth Slopes	November 2003
OPSD 3090.100	Foundation Frost Depth for Northern Ontario	November 2005



SILT & CLAY				FINE		MEDIUM		COARSE		GRAVEL				COB BLES	UNIFIED		
				SAND													
CLAY	FINE		MEDIUM	COARSE	FINE		MEDIUM		COARSE		GRAVEL				COBBLES	M.I.T.	
CLAY		SILT			SAND							GRAVEL					U.S. BUREAU
					V. FINE	FINE	MED.	COARSE									



SILT & CLAY				FINE		MEDIUM		COARSE		GRAVEL			COB BLES	UNIFIED			
				SAND													
CLAY	FINE		MEDIUM		COARSE		FINE		MEDIUM		COARSE		GRAVEL		COBBLES	M.I.T.	
	SILT																
CLAY		SILT			V. FINE		FINE		MED.		COARSE		GRAVEL			U.S. BUREAU	
					SAND												

EXPLANATION OF TERMS USED IN REPORT

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

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

SOILS ARE DESCRIBED BY THEIR COMPOSITION AND CONSISTENCY OR DENSENESS.

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

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

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

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

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

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

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

R Q D (%)	0 - 25	25 - 50	50 - 75	75 - 90	90 - 100
	VERY POOR	POOR	FAIR	GOOD	EXCELLENT

JOINTING AND BEDDING:

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

ABBREVIATIONS AND SYMBOLS

FIELD SAMPLING

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

STRESS AND STRAIN

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

MECHANICAL PROPERTIES OF SOIL

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

PHYSICAL PROPERTIES OF SOIL




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

RECORD OF BOREHOLE No 101


1 of 1



METRIC

G.W.P. 334-94-00 LOCATION Co-ords: 5 371 930 N; 366 225 E ORIGINATED BY F.P.
 DIST Thunder Bay HWY 11/17 BOREHOLE TYPE Continuous Flight Hollow Stem Augers COMPILED BY F.P.
 DATUM Geodetic DATE December 14, 2005 CHECKED BY _____

SOIL PROFILE			SAMPLES			GROUND WATER * CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT w _p	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa									
								○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE									
234.1	Ground Surface						20	40	60	80	100						
0.0	Peat, fine fibrous Black		1	AS	-											Top 25cm frozen	
233.2																	
0.9																	
233.0	Silty sand, organic inclusions		2	SS	45												
1.1	Dense Brown Wet Black Shale bedrock, weathered		3	SS	50/10cm												
232.3	End of borehole																
1.8	Refusal on bedrock																

RECORD OF BOREHOLE No 102										1 of 1		METRIC					
G.W.P. 334-94-00			LOCATION			Co-ords: 5 371 965 N; 366 326 E Sta. 26+400, o/s 70m Rt.			ORIGINATED BY F.P.								
DIST Thunder Bay HWY 11/17			BOREHOLE TYPE			Continuous Flight Hollow Stem Augers			COMPILED BY F.P.								
DATUM Geodetic			DATE			December 14, 2005			CHECKED BY								
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS *	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC NATURAL LIQUID LIMIT MOISTURE LIMIT CONTENT			UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20	40	60	80	100	W _p	w	W _L		
232.9	Ground Surface																
0.0	Topsoil		1	AS	-												Top 20cm frozen
0.3	Black Shale bedrock, weathered		2	SS	80/18cm												
231.2			3	SS	65/18cm												
1.7	End of borehole Refusal on probable bedrock Borehole redrilled 1.5m north and obtained refusal at 0.3m depth. * Borehole dry on completion of drilling																

RECORD OF BOREHOLE No 103 1 of 1 METRIC																
G.W.P. 334-94-00		LOCATION		Co-ords: 5 371 998 N; 366 426 E Sta. 26+500, o/s 70m Rt.				ORIGINATED BY F.P.								
DIST Thunder Bay HWY 11/17		BOREHOLE TYPE		Continuous Flight Hollow Stem Augers				COMPILED BY F.P.								
DATUM Geodetic		DATE		December 14, 2005				CHECKED BY								
SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS *	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC NATURAL LIQUID LIMIT MOISTURE LIMIT CONTENT			UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			"N" VALUES	SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE					WATER CONTENT (%) w _p w w _L			
231.8	Ground Surface															
0.0	Peat, fine fibrous		1	AS	-	231										Top 30cm frozen
231.2	Dark brown															
0.6	Black Shale bedrock weathered		2	SS	73											
230.1			3	SS	50/5cm											
1.7	End of borehole Refusal on bedrock															
* Borehole dry on completion of drilling																

RECORD OF BOREHOLE No 104 1 of 1 METRIC																
G.W.P. 334-94-00		LOCATION		Co-ords: 5 372 090 N; 366 388 E Sta. 26+497, o/s 30m Lt.				ORIGINATED BY F.P.								
DIST Thunder Bay HWY 11/17		BOREHOLE TYPE		Continuous Flight Hollow Stem Augers				COMPILED BY F.P.								
DATUM Geodetic		DATE		December 16, 2005				CHECKED BY								
SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS *	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT w	LIQUID LIMIT W _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			"N" VALUES	SHEAR STRENGTH kPa								
249.1	Ground Surface															
0.0	Mixed sandy silt and silty sand, gravel, cobbles, topsoil		1	AS	-											
	Compact Dark brown Wet (FILL)		2	SS	10											
247.5	Silty sand, trace clay, some gravel, cobbles, boulders		3	SS	17											
1.6	Compact to dense Brown Wet (TILL)		4	SS	30/0cm											
246.4	End of borehole															
2.7	Refusal on probable bedrock															
	Sampler bouncing on boulder at 2.2m depth															
	* Borehole dry on completion of drilling															

METRIC

____ CHECKED BY ____

(%) STRAIN AT FAILURE

METRIC

____ CHECKED BY ____

20
15 — 5 (%) STRAIN AT FAILURE
10

RECORD OF BOREHOLE No 106A 1 of 1 METRIC																		
G.W.P. <u>334-94-00</u>		LOCATION <u>Co-ords: 5 372 129 N; 366 480 E</u>		ORIGINATED BY <u>F.P.</u>														
DIST <u>Thunder Bay HWY 11/17</u>		BOREHOLE TYPE <u>Continuous Flight Hollow Stem Augers</u>		COMPILED BY <u>F.P.</u>														
DATUM <u>Geodetic</u>		DATE <u>December 16, 2005</u>		CHECKED BY _____														
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS *	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT NATURAL MOISTURE CONTENT			LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa					W _p W W _L					
247.0	Ground Surface																	
0.0	Mixture of rock fragments, cobbles, boulders, topsoil	X																
246.4	End of borehole	X																
0.6	Refusal on probable bedrock																	
<div style="margin-bottom: 10px;"> Notes: Borehole moved to two locations about 1.5m apart, and refusal at 0.6m depth was obtained. </div> <div> Boreholes drilled in area of previously removed bedrock outcrop. </div>																		

RECORD OF BOREHOLE No 107

1 of 1

METRIC

G.W.P. 334-94-00

LOCATION

Co-ords: 5 372 098 N; 366 611 E
Sta. 26+700, o/s 58.5m Rt.

ORIGINATED BY F.P.

DIST Thunder Bay HWY 11/17

BOREHOLE TYPE

Continuous Flight Hollow Stem Augers









COMPILED BY F.P.



DATUM Geodetic

DATE

December 14, 2005

CHECKED BY

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC NATURAL LIQUID LIMIT MOISTURE CONTENT LIMIT			UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa					W _p W W _L					WATER CONTENT (%)
231.4	Ground Surface							20	40	60	80	100						
0.0	Peat, fine fibrous Black		1	AS	-	 *	231											
230.6						 *												
0.8	Sand and silt, trace clay, trace gravel, cobbles		2	SS	76		230											
	Dense Brown Moist to very dense to wet		3	SS	48													
			4	SS	46		229											
																		
228.2			5	SS	60/15cm													
3.2	End of borehole Refusal on probable bedrock																	
	 <																	

RECORD OF BOREHOLE No 108 1 of 1 METRIC																	
G.W.P. 334-94-00			LOCATION			Co-ords: 5 372 175 N; 366 567 E Sta. 26+700, o/s 30m Lt.					ORIGINATED BY F.P.						
DIST Thunder Bay HWY 11/17			BOREHOLE TYPE			Test pit and Manual Sampling					COMPILED BY F.P.						
DATUM Geodetic			DATE			December 16, 2005					CHECKED BY						
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS *	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE					W _p W W _L WATER CONTENT (%)				
256.8	Ground Surface																
0.0	Topsoil, cobbles and boulders															Top 20cm	
256.3	Dark brown Moist															frozen	
0.5	End of borehole																
	Refusal on probable bedrock																
	* Borehole dry on completion of drilling																
	Notes: Borehole moved 1.5m West, refusal at 0.6m Borehole moved 1.5m East, refusal at 0.6m Boreholes drilled on top of bedrock outcrop.																

RECORD OF BOREHOLE No 109

1 of 1

METRIC

G.W.P. 334-94-00 LOCATION Co-ords: 5 372 156 N; 366 692 E ORIGINATED BY F.P.
 DIST Thunder Bay HWY 11/17 BOREHOLE TYPE Continuous Flight Hollow Stem Augers COMPILED BY F.P.
 DATUM Geodetic DATE December 14, 2005 CHECKED BY _____

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT w _p	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)			
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa										WATER CONTENT (%)		
								○ UNCONFINED		+ FIELD VANE		● QUICK TRIAXIAL						x LAB VANE		
232.4	Ground Surface							20	40	60	80	100					GR SA SI CL			
0.0	Peat, fine fibrous		1	AS	-	▼* ▼*	232										Top 30cm frozen			
0.3	Black Sand and silt, trace clay, trace gravel, cobbles and boulders																			
	Dense Brown Wet to very dense		2	SS	50/15cm		231													
230.6																				
1.8	Probable Shale bedrock, weathered						230													
229.8																				
2.6	End of borehole																			
	Refusal on probable bedrock																			
	 * 2005 12 14																			
	▽ Water level observed during drilling																			
	▼ Water level measured after drilling																			
	Note: Refusal encountered at original borehole location at 0.3m depth, borehole moved 1.5m westerly.																			

RECORD OF BOREHOLE No 110

1 of 1

METRIC

G.W.P. 334-94-00 LOCATION Co-ords: 5 372 223 N; 366 654 E ORIGINATED BY F.P.
 DIST Thunder Bay HWY 11/17 BOREHOLE TYPE Continuous Flight Hollow Stem Augers COMPILED BY F.P.
 DATUM Geodetic DATE December 14, 2005 CHECKED BY

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS *	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC NATURAL LIQUID LIMIT MOISTURE LIMIT CONTENT			UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES		SHEAR STRENGTH kPa					W _p	W	W _L		
237.7	Ground Surface						20	40	60	80	100					
0.0	Sand and silt, with gravel, trace clay, cobbles organics inclusions		1	AS	-											Top 25cm frozen
	Dense Brown Wet		2	SS	49	237										
236.3																
1.4	End of borehole Refusal on probable bedrock															
	* Borehole dry on completion of drilling															
	Note: Borehole moved 3m south due to slope of ground															

RECORD OF BOREHOLE No 111										1 of 1		METRIC					
G.W.P. 334-94-00			LOCATION			Co-ords: 5 372 213 N; 366 776 E Sta. 26+900, o/s 43m Rt.			ORIGINATED BY F.P.								
DIST Thunder Bay HWY 11/17			BOREHOLE TYPE			Continuous Flight Hollow Stem Augers			COMPILED BY F.P.								
DATUM Geodetic			DATE			December 14, 2005			CHECKED BY								
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS *	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT w	LIQUID LIMIT W _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE									
234.0	Ground Surface																
0.0	Peat, fine fibrous		1	AS	-												Top 25cm frozen
0.3	Black Sand and silt, trace clay, trace gravel, cobbles and boulders		2	AS	-												
	Dense Brown Moist to very dense		3	SS	50/15cm												
231.5			4	SS	30/5cm												
2.5	End of borehole Refusal on probable bedrock * Borehole dry on completion of drilling Note: Borehole moved 1.5m north, auger refusal at 2.3m																

RECORD OF BOREHOLE No 112

1 of 1

METRIC

G.W.P. 334-94-00 LOCATION Co-ords: 5 372 276 N; 366 739 E ORIGINATED BY F.P.
 DIST Thunder Bay HWY 11/17 BOREHOLE TYPE Continuous Flight Hollow Stem Augers COMPILED BY F.P.
 DATUM Geodetic DATE December 15, 2005 CHECKED BY _____

SOIL PROFILE			SAMPLES			GROUND WATER * CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT						PLASTIC LIMIT w _p	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa										
								○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE										
239.0	Ground Surface							20	40	60	80	100						
0.0	Topsoil																	
0.3	Sand and silt, trace clay, trace gravel, cobbles and boulders Very dense Brown Moist		1	AS	-		238										Top 20cm frozen	
			2	SS	55			237										
						3	SS	50/15cm										
236.3																		
2.7	End of borehole Refusal on probable bedrock 																	

RECORD OF BOREHOLE No 113															1 of 1		METRIC	
G.W.P. 334-94-00			LOCATION			Co-ords: 5 372 272 N; 366 857 E Sta. 27+000, o/s 33m Rt.					ORIGINATED BY F.P.							
DIST Thunder Bay HWY 11/17			BOREHOLE TYPE			Continuous Flight Hollow Stem Augers					COMPILED BY F.P.							
DATUM Geodetic			DATE			December 13, 2005					CHECKED BY							
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE					W _p W W _L WATER CONTENT (%)					
234.6	Ground Surface																	
0.0	Peat, fine fibrous, cobbles and boulders Dark brown		1	AS	-											Top 30cm frozen		
233.4																		
1.2	Silt and sand, trace to with gravel, trace clay, cobbles Compact Grey Wet to dense (TILL)		2	SS	19													
			3	SS	38													
			4	SS	20/0cm													
230.8	End of borehole Refusal on probable bedrock Sampler bouncing on boulder at 3.0m depth.																	
3.8																		
	* 2005 12 13 ▽ Water level observed during drilling ▼ Water level measured after drilling																	

METRIC

CHECKED BY

20
15 — 5 (%) STRAIN AT FAILURE
10

RECORD OF BOREHOLE No 115

1 of 1

METRIC

G.W.P. 334-94-00 LOCATION Co-ords: 5 372 324 N; 366 942 E Sta. 27+100, o/s 32m Rt. ORIGINATED BY F.P.
DIST Thunder Bay HWY 11/17 BOREHOLE TYPE Continuous Flight Hollow Stem Augers COMPILED BY F.P.
DATUM Geodetic DATE December 13, 2005 CHECKED BY

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT w	LIQUID LIMIT W _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20	40	60	80	100					
236.6	Ground Surface																
0.0	Peat, amorphous		1	AS	-		236										Top 25cm frozen
235.6	Dark brown		2	SS	7											150	
1.0	Silty sand, trace to some gravel, trace clay, cobbles and boulders		3	SS	8		235										7 61 30 2
	Compact Brown Wet to grey (TILL)		4	SS	29		234										
			5	SS	47		233										15 46 37 2
	Dense Grey Moist to very dense		6	SS	20/8cm												
			7	SS	20/5cm		232										
							231										
			8	SS	50/8cm												
229.7	End of borehole		9	SS	50/8cm		230										
6.9	Sampler bouncing on cobbles from 3.8m depth.																
	* 2005 12 13																
	▽ Water level observed during drilling																
	▼ Water level measured after drilling																

RECORD OF BOREHOLE No 116

1 of 1

METRIC

G.W.P. 334-94-00

LOCATION

Co-ords: 5 372 377 N; 366 911 E
Sta. 27+100, o/s 30m Lt.

ORIGINATED BY F.P.

DIST Thunder Bay HWY 11/17

BOREHOLE TYPE

Continuous Flight Hollow Stem Augers

COMPILED BY F.P.

DATUM Geodetic

DATE

December 15, 2005

CHECKED BY

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT						PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%)		
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa						WATER CONTENT (%)						
240.7	Ground Surface							20	40	60	80	100								
0.0	Topsoil																			
0.3	Sand and silt to Silt with sand, trace clay, trace gravel, cobbles Compact Brown Moist		1	AS	-		240													Top 32cm frozen
			2	SS	17															
			3	SS	26		239							○						
238.6																				
2.1	Sand to silty sand with gravel Compact Brown Moist to very dense to wet (TILL)		4	SS	50/15cm		238							○						
			5	SS	27		237							○						
			6	SS	31/15cm															
236.4																				
4.3	End of borehole Refusal on probable bedrock <																			

* 2005 12 15












Water level measured
after drilling

RECORD OF BOREHOLE No 117

1 of 1

METRIC

G.W.P. 334-94-00 LOCATION Co-ords: 5 372 376 N; 367 028 E ORIGINATED BY F.P.
 DIST Thunder Bay HWY 11/17 BOREHOLE TYPE Continuous Flight Hollow Stem Augers COMPILED BY F.P.
 DATUM Geodetic DATE December 13, 2005 CHECKED BY _____

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%)				
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa					w _p	w	w _L						
240.1	Ground Surface							20	40	60	80	100									
0.0	Topsoil		1	AS	-		240												Top 25cm frozen		
239.6	Sand to silty sand, cobbles and boulders Dense Brown Moist to to very dense to wet						239												0 23 75 2		
0.5				2	SS	32															
				3	SS	81/27cm															
							238												0 26 72 2		
				4	SS	55															
237.1	Silt, some sand trace clay Dense Brown Wet						237												0 26 72 2		
3.0																					
				5	SS	34															
	Compact Grey						236												0 23 75 2		
				6	SS	30															
							235												0 26 72 2		
				7	SS	16															
233.5	Dense		8	SS	41		234												0 26 72 2		
6.6	End of borehole																				
	Note: Borehole refusal obtained at 1.7m at original location on probable boulder. Borehole moved 1.5m southerly and continued from new location. * 2005 12 13  Water level observed during drilling  Water level measured after drilling																				

METRIC

Sta. 27+200, o/s 30m Lt.

ORIGINATED BY F.P.

COMPILED BY F.P.

____ CHECKED BY ____

(%) STRAIN AT FAILURE

RECORD OF BOREHOLE No 119 1 of 1 METRIC																	
G.W.P. 334-94-00			LOCATION			Co-ords: 5 372 426 N; 367 114 E Sta. 27+300, o/s 31m Rt.					ORIGINATED BY F.P.						
DIST Thunder Bay HWY 11/17			BOREHOLE TYPE			Continuous Flight Hollow Stem Augers					COMPILED BY F.P.						
DATUM Geodetic			DATE			December 13, 2005					CHECKED BY						
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB VANE					W _p w W _L WATER CONTENT (%)				
238.5	Ground Surface																
0.0	Peat, fine fibrous Black		1	AS	-	K*	238										
			2	SS	1		237										
			3	SS	1										325		
236.0							236										
2.5	Sand, some silt trace gravel, trace clay		4	SS	5	↓*											
235.4	Compact Grey Wet																
3.1	Silt, some sand, trace clay		5	SS	18		235										
	Compact Grey Wet						234										
	Dense to very dense		6	SS	49												
							233										
			7	SS	54												
							232										
			8	SS	34												
							231										
230.4			9	SS	66												
8.1	End of borehole																
* 2005 12 13 Water level observed during drilling Water level measured after drilling																	

METRIC

____ CHECKED BY _____

20
15 — 5 (%) STRAIN AT FAILURE
10

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



SHEET

DISTRICT OF THUNDER BAY

CITY OF THUNDER BAY

TWP OF MACGREGOR

11 & 17

CURRENT RIVER

HODDER AVE.

BOULEVARD





LAKE

SITE

CPR

CNR

LAKE SUPERIOR

LEGEND	
	Borehole
	Dynamic Cone Penetration Test (Cone)
	Borehole & Cone
N	Blows/0.3m (Std. Pen Test, 475 J / blow)
CONE	Blows/0.3m (60° Cone, 475 J / blow)
	W L at time of investigation December 2005

BH No	ELEVATION	CO—ORDINATES	
		NORTHINGS	EASTINGS
101	234.1	5 371 930	366 225
102	232.9	5 371 965	366 326
103	231.8	5 371 998	366 426
104	249.1	5 372 090	366 388
105	232.4	5 372 050	366 518
106	246.2	5 372 108	366 436
106A	247.0	5 372 129	366 480
107	231.4	5 372 098	366 611
108	256.8	5 372 175	366 567
109	232.4	5 372 156	366 692
110	237.7	5 372 223	366 654
111	234.0	5 372 213	366 776
112	239.0	5 372 276	366 739
113	234.6	5 372 272	366 857

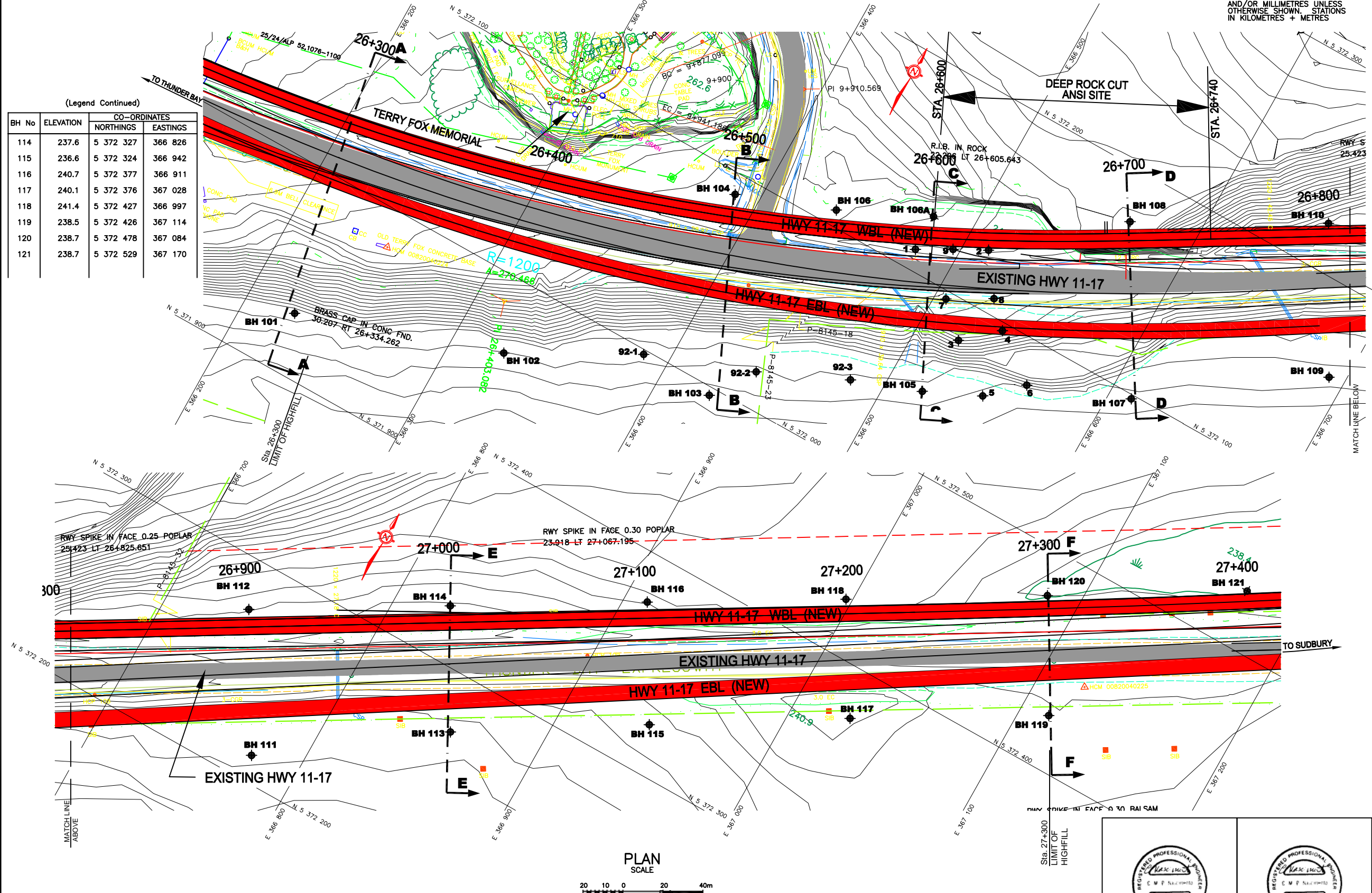
(Legend Continues)

REVISIONS		
DATE	BY	DESCRIPTION

Geocres No. 52A-131

HWY No 11/17				DIST THUNDER BAY	
SUBM'D	FP	CHECKED CN	DATE JUNE 18, 2007	SITE	—
DRAWN	NA	CHECKED CN	APPROVED BRG	DWG	B1

BH No	ELEVATION	CO-ORDINATES	
		NORTHINGS	EASTINGS
114	237.6	5 372 327	366 826
115	236.6	5 372 324	366 942
116	240.7	5 372 377	366 911
117	240.1	5 372 376	367 028
118	241.4	5 372 427	366 997
119	238.5	5 372 426	367 114
120	238.7	5 372 478	367 084
121	238.7	5 372 529	367 170



NOTES:

1. FOR SECTIONS A-A TO C-C REFER DRAWING F2 AND FOR D-D, E-E AND F-F DRAWING F3.
2. THIS DRAWING IS FOR SUBSURFACE INFORMATION ONLY. SURFACE DETAILS AND FEATURES ARE FOR CONCEPTUAL ILLUSTRATIONS.

Stantec drawings:
574_base.dwg; contour.dwg; Terry_Fox_Alt_EF.dwg dated November 22, 2006

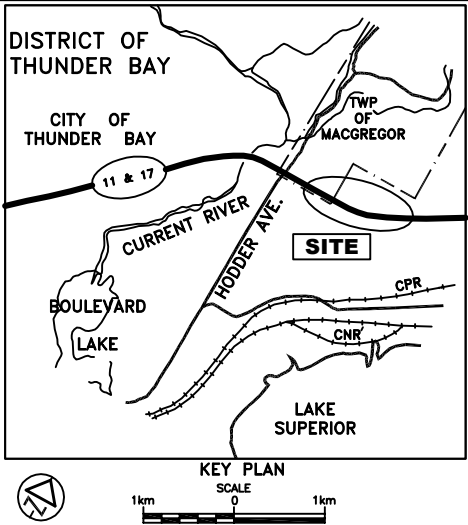


METRIC
DIMENSIONS ARE IN METRES
AND/OR MILLIMETRES UNLESS
OTHERWISE SHOWN. STATIONS
IN KILOMETRES + METRES

CONT No
GWP No 334-94-00

HIGHWAY 11/17
FOUR LANE
HIGHFILL/DEEPCUT
CROSS SECTIONS

SHEET

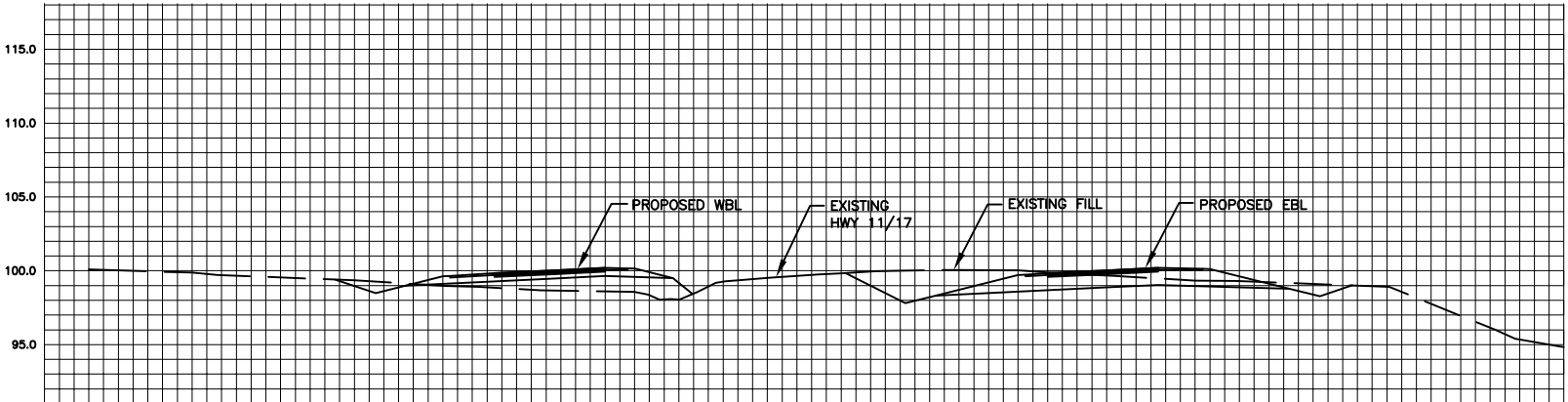


LEGEND			
	Borehole		
	Dynamic Cone Penetration Test (Cone)		
	Borehole & Cone		
N	Blows/0.3m (Std. Pen Test, 475 J / blow)		
CONE	Blows/0.3m (60° Cone, 475 J / blow)		
	W L at time of investigation December 2005		

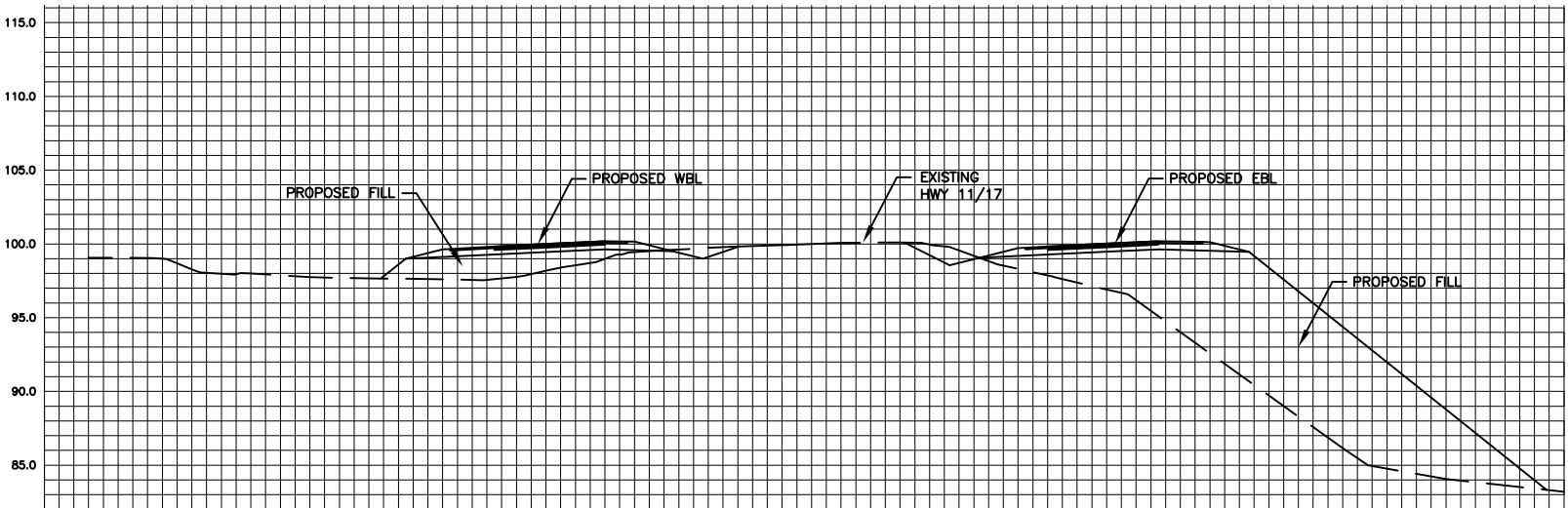
BH No	ELEVATION	STATION	
		NORTHINGS	EASTINGS
	REFER	DRAWING	F1 FOR DETAILS

REVISIONS		
DATE	BY	DESCRIPTION

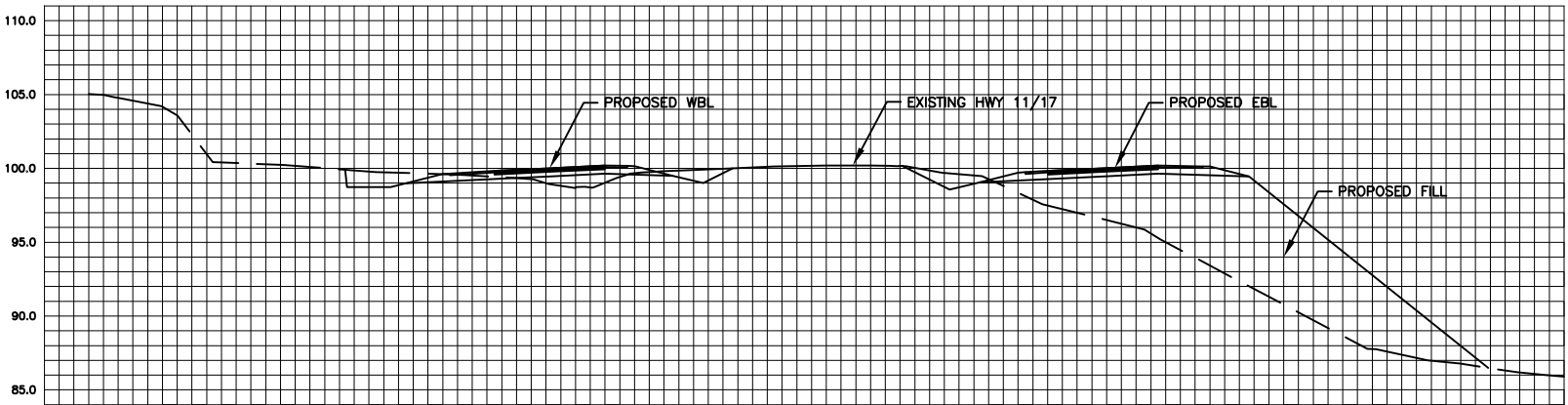
Geocres No. 52A-131					
HWY No	11/17	DATE		JUNE 18, 2007	DIST THUNDER BAY
SUBM'D	MR	CHECKED	CN	SITE	-
DRAWN	NA	CHECKED	CN	APPROVED	BRG
				EDWG	B2



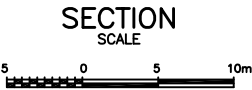
SECTION A-A STA. 26+300



SECTION B-B STA. 26+500



SECTION C-C STA. 26+600



- NOTES:
- FOR LOCATION OF SECTIONS REFER DRAWING B1.
 - CROSS-SECTIONS ARE REPRODUCED FOR FILL HEIGHT AND LOCATION PURPOSES ONLY. ELEVATION 100.0 WAS ASSUMED AT APPROXIMATE LEVEL OF EXISTING HIGHWAY 11/17.
 - THIS DRAWING IS FOR SUBSURFACE INFORMATION ONLY. SURFACE DETAILS AND FEATURES ARE FOR CONCEPTUAL ILLUSTRATION.

Ref: Stantec Consulting drawing
Terry_Fox_Hwy_11_17_cross_sections received on March 16, 2007

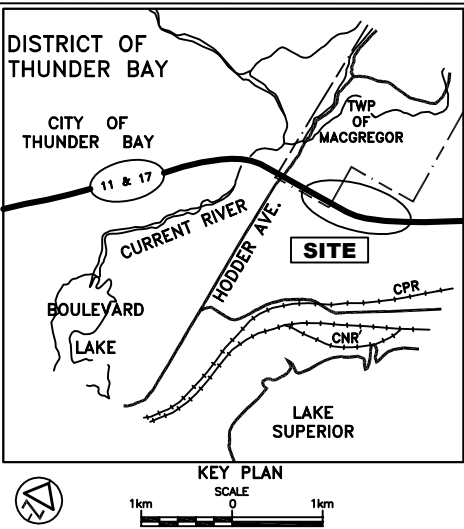


METRIC
DIMENSIONS ARE IN METRES
AND/OR MILLIMETRES UNLESS
OTHERWISE SHOWN. STATIONS
IN KILOMETRES + METRES

CONT No
GWP No 334-94-00

HIGHWAY 11/17
FOUR LANE
HIGHFILL/DEEPCUT
CROSS SECTIONS

SHEET



LEGEND

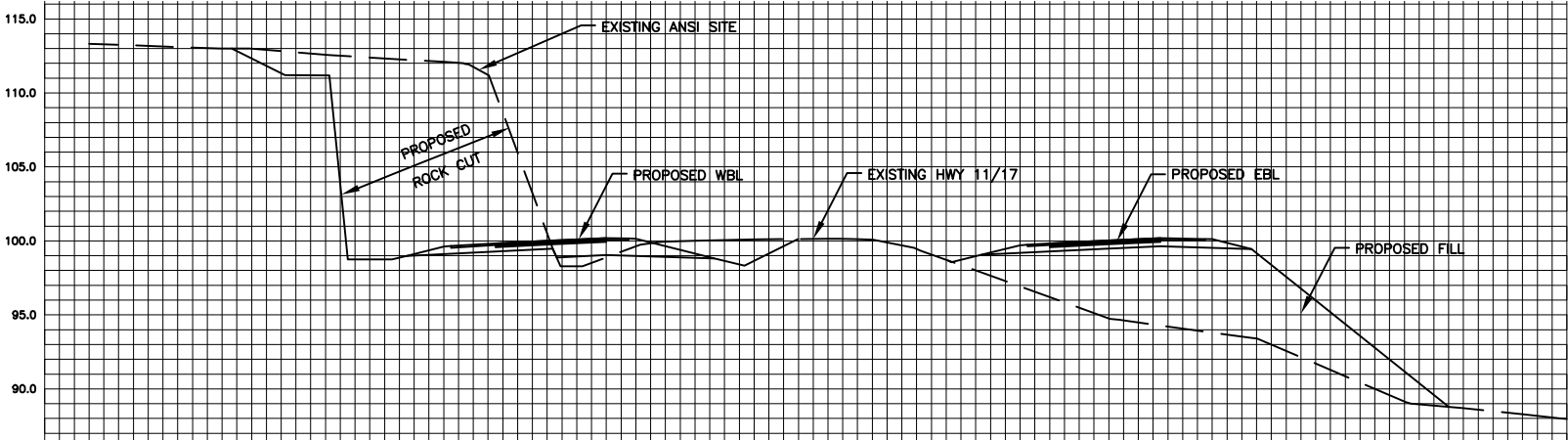
- Borehole
- Dynamic Cone Penetration Test (Cone)
- Borehole & Cone
- N Blows/0.3m (Std. Pen Test, 475 J / blow)
- CONE Blows/0.3m (60° Cone, 475 J / blow)
- W L at time of investigation December 2005

BH No	ELEVATION	STATION	
		NORTHINGS	EASTINGS
	REFER	DRAWING	F1 FOR DETAILS

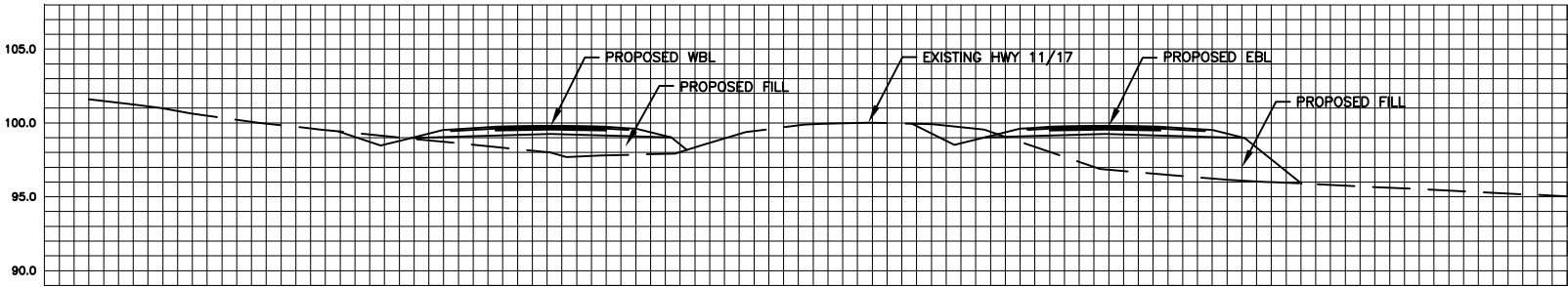
REVISIONS	DATE	BY	DESCRIPTION

Geocres No. 52A-131

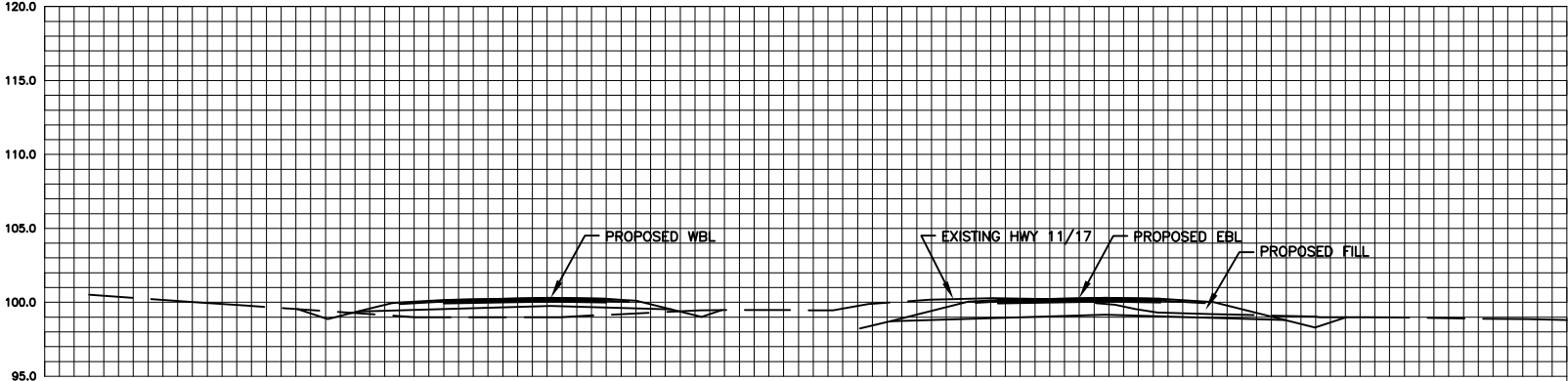
HWY No	11/17	DIST	THUNDER BAY
SUBM'D	MR	CHECKED	CN
DATE	JUNE 18, 2007	SITE	-
DRAWN	NA	CHECKED	CN
APPROVED	BRG	DWG	B3



SECTION D-D STA. 26+700



SECTION E-E STA. 27+000



SECTION F-F STA. 27+300



- NOTES:
- FOR LOCATION OF SECTIONS REFER DRAWING B1.
 - CROSS-SECTIONS ARE REPRODUCED FOR FILL HEIGHT AND LOCATION PURPOSES ONLY. ELEVATION 100.0 WAS ASSUMED AT APPROXIMATE LEVEL OF EXISTING HIGHWAY 11/17.
 - THIS DRAWING IS FOR SUBSURFACE INFORMATION ONLY. SURFACE DETAILS AND FEATURES ARE FOR CONCEPTUAL ILLUSTRATION.



Ref; Stantec Consulting drawing
Terry_Fox_Hwy_11_17_cross_sections received on March 16, 2007



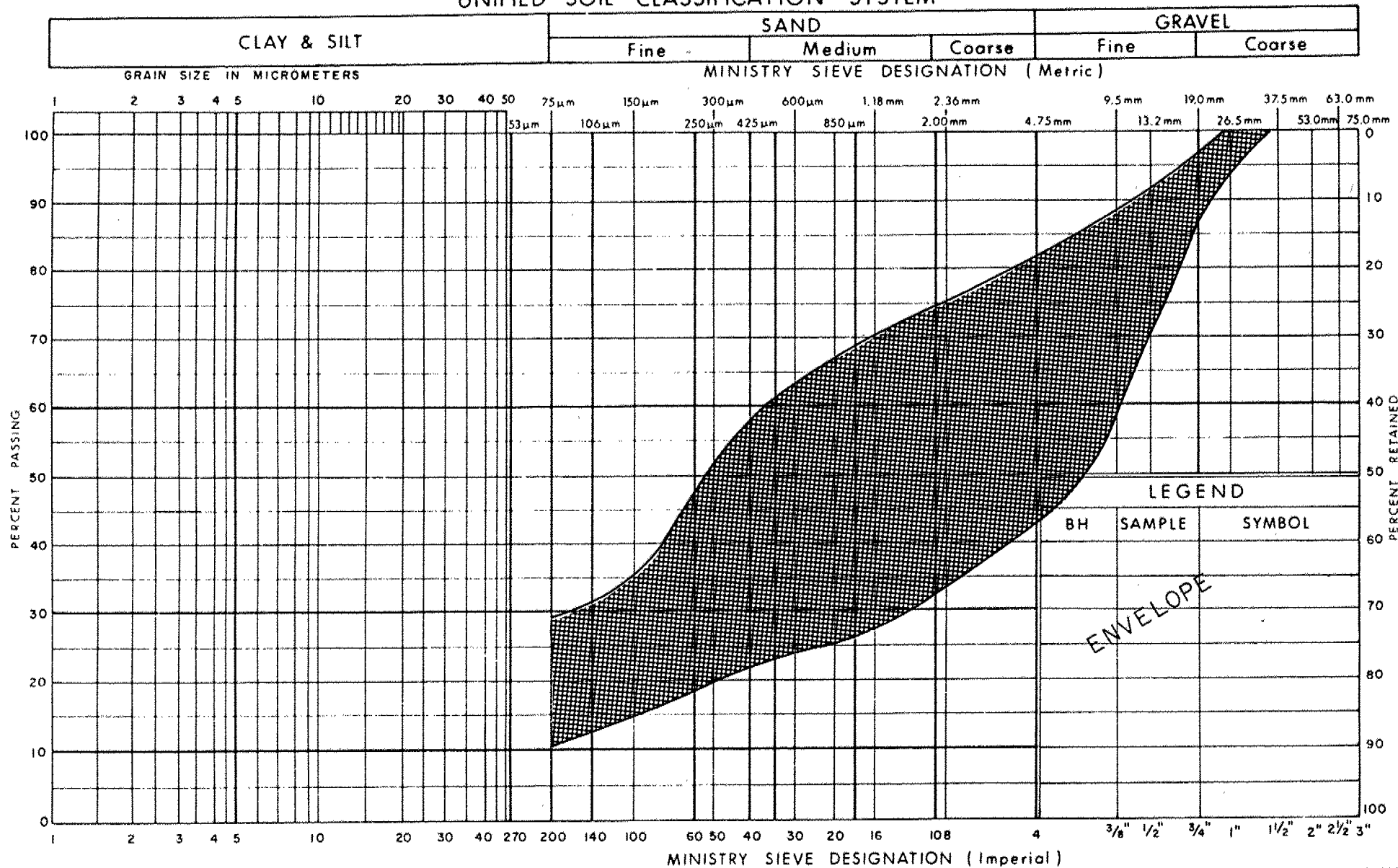
APPENDIX A

Copy of Record of Boreholes, Location Plans and Soil Strata From:

- Foundation Investigation Report for Highway 11/17 Interchange at Terry Fox Lookout, W.P. 141/142-901-01, Site No. 48C-312 (Geocres Reference No. 52A-106) dated November 1991 prepared by McClymont and Rak Engineers Inc.
- Technical Memorandum for Embankment Widening for the W-N Ramp at Terry Fox Interchange, W.P. 621-89-00 (Geocres Reference No. 52A-114) dated September 17, 1992 prepared by MTO.

Foundation Investigation Report for Highway 11/17 Interchange at Terry Fox Lookout, W.P. 141/142-901-01, Site No. 48C-312 (Geocres Reference No. 52A-106) dated November 1991 prepared by McClymont and Rak Engineers Inc.

UNIFIED SOIL CLASSIFICATION SYSTEM



Ontario

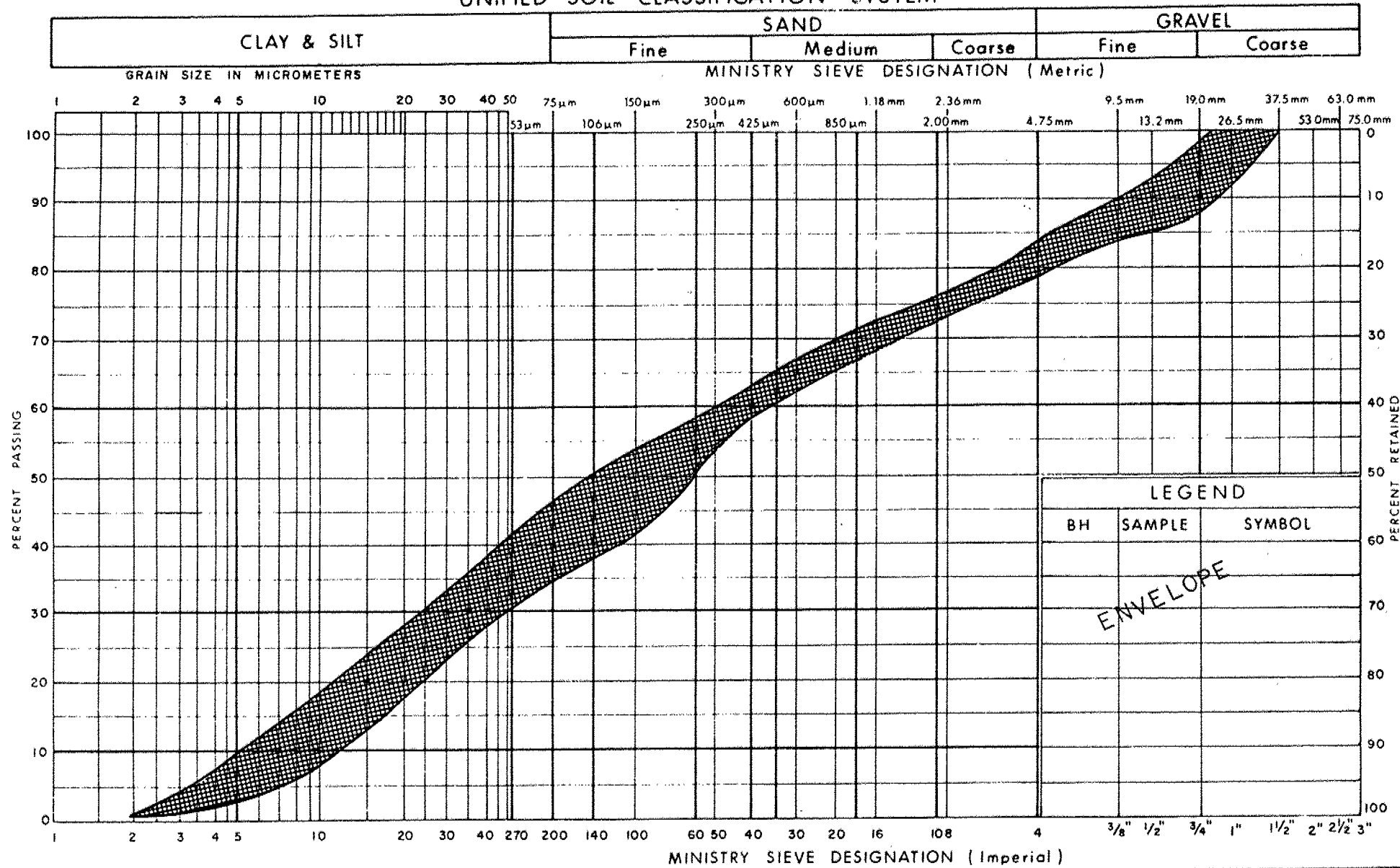
Ministry of
Transportation

GRAIN SIZE DISTRIBUTION
Mixture of gravel, sand, silt and rock fragments
(FILL)

FIG No 1

W P 141/142-90-01

UNIFIED SOIL CLASSIFICATION SYSTEM



Ontario

Ministry of
Transportation

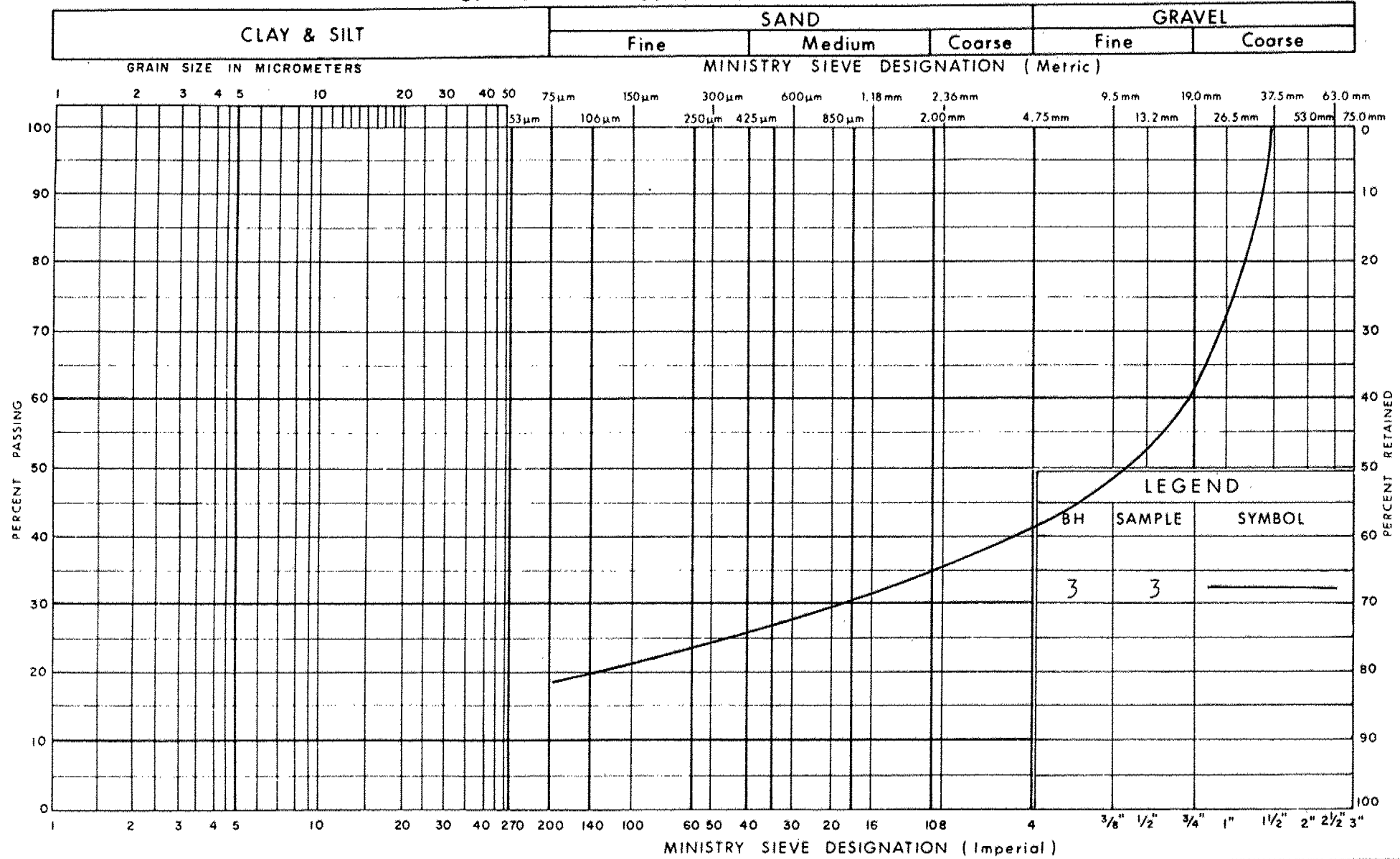
GRAIN SIZE DISTRIBUTION

Sand and Silt, some gravel
(FILL)

FIG No 2

W P 141/142-90-01

UNIFIED SOIL CLASSIFICATION SYSTEM



Ministry of
Transportation

Ontario

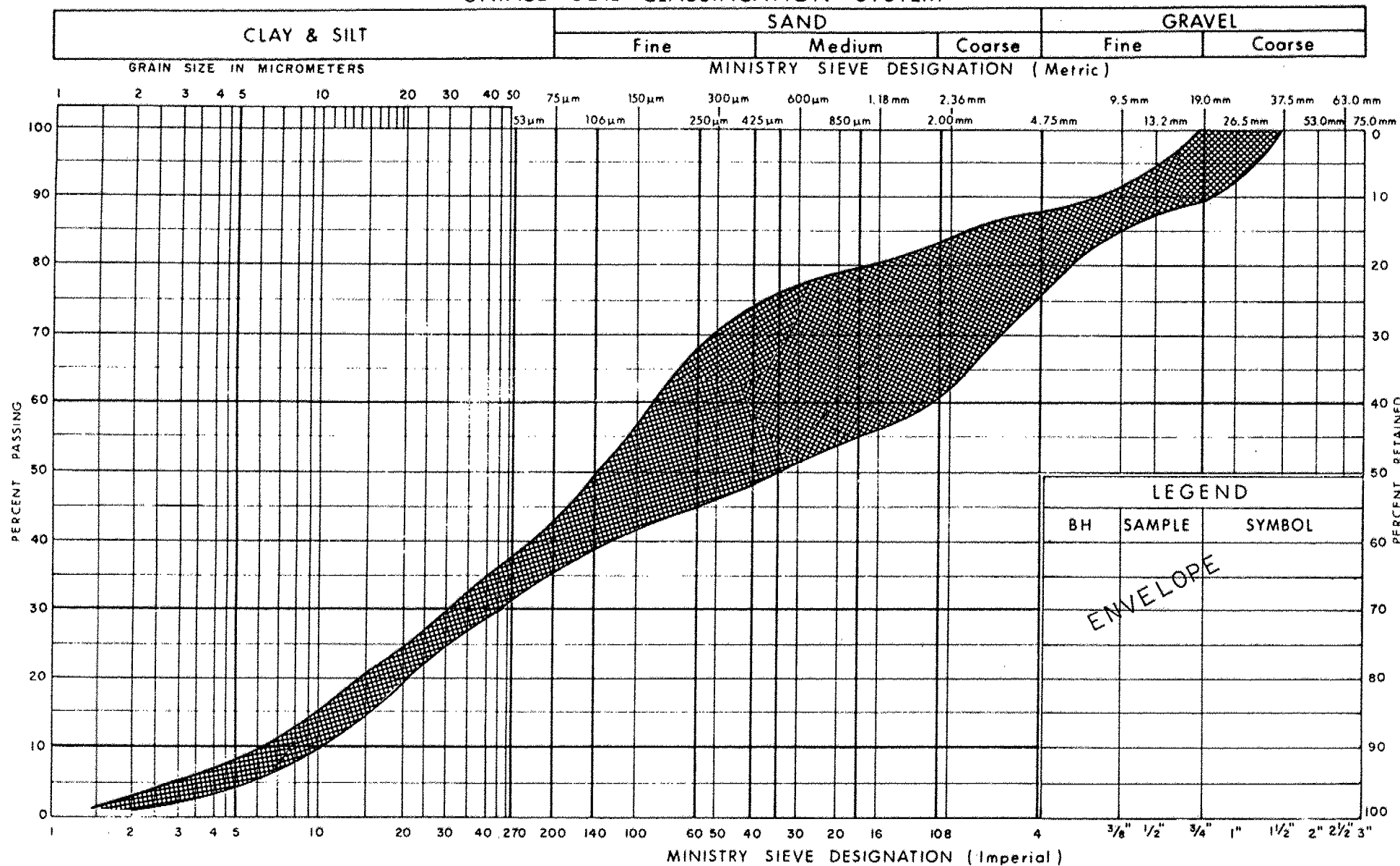
GRAIN SIZE DISTRIBUTION

Sandy Gravel, some silt

FIG No 3

W P 141/142-90-01

UNIFIED SOIL CLASSIFICATION SYSTEM



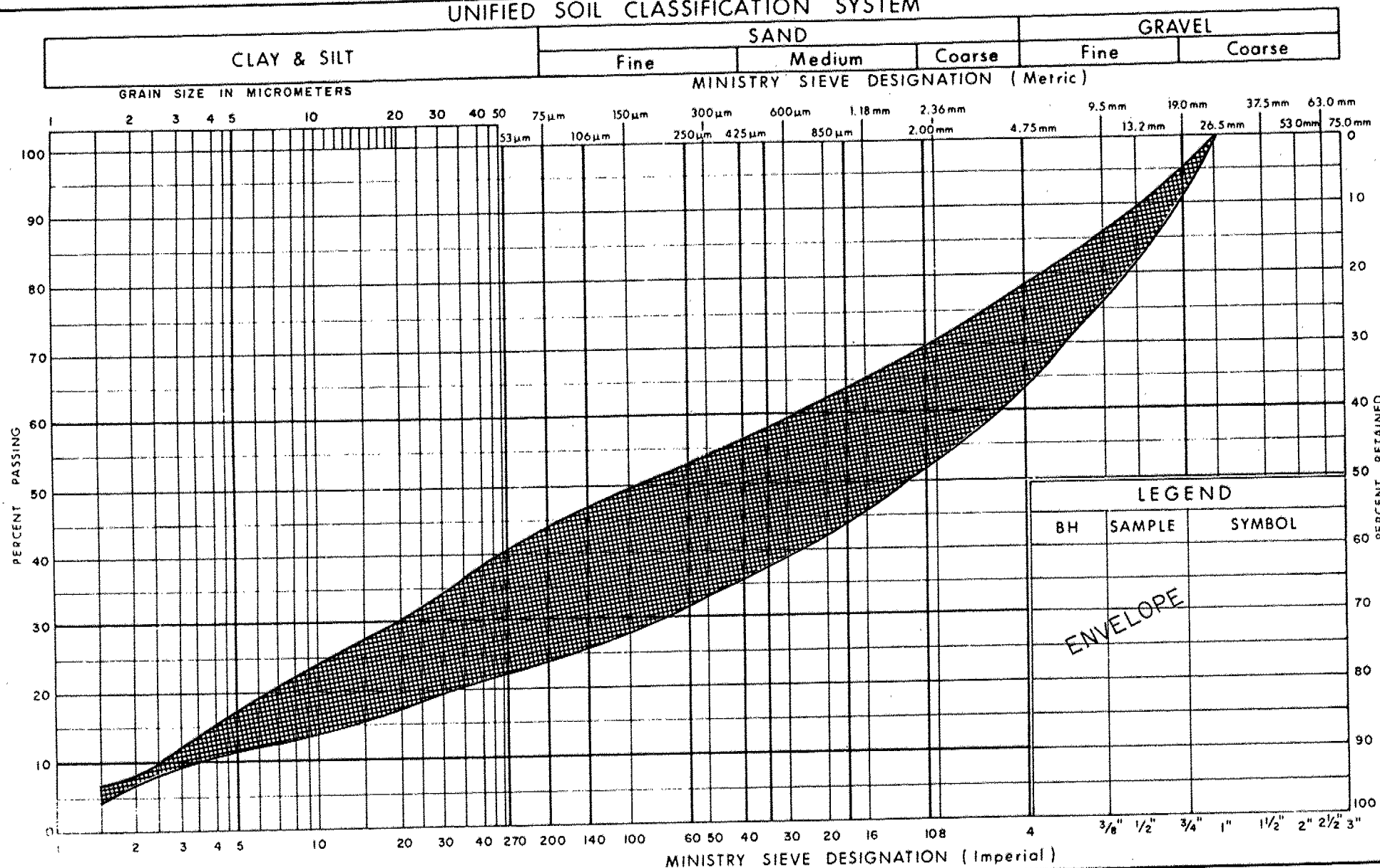
Ministry of
Transportation

GRAIN SIZE DISTRIBUTION
Sand and silt, some gravel, trace of clay

FIG No 4

W P 141/142-90-01

UNIFIED SOIL CLASSIFICATION SYSTEM



Ministry of
Transportation

GRAIN SIZE DISTRIBUTION
Mixture of rock fragments, gravel, sand, silt and
trace of clay

FIG No 5

W P 141/142-90-01

EXPLANATION OF TERMS USED IN REPORT

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

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

SOILS ARE DESCRIBED BY THEIR COMPOSITION AND CONSISTENCY OR DENSENESS.

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

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

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

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

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

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

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

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

JOINTING AND BEDDING:

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

ABBREVIATIONS AND SYMBOLS

FIELD SAMPLING

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

MECHANICAL PROPERTIES OF SOIL

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

STRESS AND STRAIN

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

PHYSICAL PROPERTIES OF SOIL

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

RECORD OF BOREHOLE No 1

METRIC

W P 141/142-90-01 LOCATION Station 26 + 614.1m (WBL), 2.6m Lt of prop. WBL 0 ORIGINATED BY SM
 DIST 19 HWY 11 & 17 BOREHOLE TYPE Solid stem auger, bicone, BQ rock core COMPILED BY SM
 DATUM Geodetic DATE 91 09 9-10 CHECKED BY SB

OFFICE REPORT ON SOIL EXPLORATION

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT Σ					UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100		
246.4	Ground surface													
0.0	Asphalt: 80 mm Crushed stone: 100 mm		1	SS	39	Seal	246							26 63 (11)
	Mixture of gravel, sand, silt, rock fragments, cobbles and boulders, brown to grey, dense		2	SS	49		245							19 54 (27)
244.1	(FILL)						244							RQD 32%
2.3	Tuff Bedrock black-grey, unweathered, very close to close spacing, poor to good quality		3	RC BQ	REC 94%	Seal	243							RQD 75%
			4	RC BQ	REC 100%		242							RQD 92%
242.1			5	RC BQ	REC 100%		241							RQD 52%
4.3	Chert Iron Formation Bedrock black-grey to olive grey, fine to medium grained, medium strong, very close to moderately close spacing, fair to excellent quality		6	RC BQ	REC 100%		240							RQD 69%
			7	RC BQ	REC 100%		239							RQD 83%
			8	RC BQ	REC 100%		238							RQD 68%
237.2			9	RC BQ	REC 100%	Piezometer								
9.2	End of Borehole													
	NOTE: After 2 days, G.W.L. at 8.3m depth. (possible drilling water)													

RECORD OF BOREHOLE No 2

METRIC

W P 141/142-90-01 LOCATION Station 26 + 636.2m (WBL), 2.9m Lt of prop. WBL 6 ORIGINATED BY SM
 DIST 19 HWY 11 & 17 BOREHOLE TYPE Solid stem auger, bicone, BQ rock core COMPILED BY SM
 DATUM Geodetic DATE 91 09 10-11 CHECKED BY SB

OFFICE REPORT ON SOIL EXPLORATION

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT NATURAL MOISTURE CONTENT			UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES		20	40	60	80	100	W _p	W	W _L		
245.8	Ground surface															
0.0	Asphalt: 80 mm Crushed stone: 100 mm Mixture of gravel, sand, silt, rock fragments, cobbles and boulders, brown to grey, very dense (FILL)		1	SS	53	Dry						0				
244.0	Tuff Bedrock black-grey, unweathered, very close to close spacing, good quality		2	SS	58/15	cm						0				58 29 (13)
1.8	Chert Iron Formation Bedrock black-grey to olive grey, medium strong, fair quality		3	RC BQ	REC 100%											RQD 78%
242.6			4	RC BQ	REC 100%											RQD 66%
241.4	End of Borehole															
4.4																

RECORD OF BOREHOLE No 3

METRIC

W P 141/142-90-01 LOCATION Station 26 + 615.9m (EBL), 2.1m Lt of prop. EBL E ORIGINATED BY SM
 DIST 19 HWY 11 & 17 BOREHOLE TYPE Solid stem auger, bicone, BQ rock core COMPILED BY SM
 DATUM Geodetic DATE 91 09 11-12 CHECKED BY SB

OFFICE REPORT ON SOIL EXPLORATION

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100					
245.2	Ground surface																GR SA SI CL
0.0	Sand and Silt some gravel, trace of clay, organic specs, brown, compact		1	SS	13	Dry	245							0			14 52 33 1
			2	SS	10		244							0			15 39 45 1
243.7	(FILL)																
1.5	Sandy Gravel some silt, oxidized, compact		3	SS	27		243							0			59 22 (19)
243.1																	
2.1	Chert Iron Formation Bedrock black-grey to olive grey, fine to medium grained, medium strong, very close to moderately close spacing, good quality		4	RC BQ	REC 100%		242										RQD 82%
			5	RC BQ	REC 100%		241										RQD 79%
240.7																	
4.5	End of Borehole																

RECORD OF BOREHOLE No 4

METRIC

W P 141/142-90-01 LOCATION Station 26 + 637.3m (EBL), 2.3m Lt of prop. EBL 6
 DIST 19 HWY 11 & 17 BOREHOLE TYPE Solid stem auger, bicone, BQ rock core
 DATUM Geodetic DATE 91 09 12-14

ORIGINATED BY SM
 COMPILED BY SM
 CHECKED BY SB

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100					
244.7	Ground surface																
0.0	Sand and Silt some gravel, trace of clay, organic specs, brown, compact (FILL)		1	SS	16	Dry	244							0			20 38 (42)
243.7																	
1.0	Chert Iron Formation Bedrock black-grey to olive grey, fine to medium grained, medium strong, very close to moderately close spacing, fair to excellent quality		2	RC BQ	REC 93%		243										RQD 53%
			3	RC BQ	REC 100%		242										RQD 62%
			4	RC BQ	REC 100%		241										RQD 86%
			5	RC BQ	REC 92%		240										RQD 81%
			6	RC BQ	REC 100%		239										RQD 92%
238.0																	
6.7	End of Borehole																

OFFICE REPORT ON SOIL EXPLORATION

RECORD OF BOREHOLE No 5

METRIC

W P 141/142-90-01 LOCATION Station 26 + 632.9m (EBL), 32.2m Rt of prop. EBL E ORIGINATED BY SM
DIST 19 HWY 11 & 17 BOREHOLE TYPE Solid stem auger COMPILED BY SM
DATUM Geodetic DATE 91 09 13 CHECKED BY SB

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC NATURAL LIQUID LIMIT MOISTURE CONTENT LIMIT			UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20 40 60 80 100	W _p	W	W _L	WATER CONTENT (%)			
231.6	Ground surface										10 20 30		GR SA SI CL		
0.0	Organic Loam very loose		1	SS	4		231						(w = 117%)		
230.9							230								25 39 33 3
0.7	Sand and Silt some gravel, trace of clay, stratified, compact to dense		2	SS	17							0			17 44 (39)
			3	SS	37							0			36 40 (24)
229.3			4	SS	50/10cm							0			29 43 20 8
2.3	Mixture of rock fragments, gravel, sand, silt, trace of clay, very dense						229								
228.1	Probable Bedrock		5	SS	50/9cm	Piezometer					0	(non-plastic)			
3.5	Auger refusal at 3.5m														

OFFICE REPORT ON SOIL EXPLORATION

+3, x5: Numbers refer to
Sensitivity

20
15 5 (%) STRAIN AT FAILURE
10

RECORD OF BOREHOLE No 6

METRIC

W P 141/142-90-01 LOCATION Station 26 + 651.6m (EBL), 27.4m Rt of prop. EBL C ORIGINATED BY SM
 DIST 19 HWY 11 & 17 BOREHOLE TYPE Solid stem auger COMPILED BY SM
 DATUM Geodetic DATE 91 09 13 CHECKED BY SB

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			20	40	60	80	100					
232.1	Ground surface															
0.0	Organic loam very loose		1	SS	3											
231.2																
0.9	Sand and silt some gravel, trace of clay, stratified, compact to dense		2	SS	27											
			3	SS	45											
229.7																
2.4	Mixture of rock fragments, gravel, sand, silt, trace of clay, very dense		4	SS	98											
			5	SS	100											
228.1	Probable Bedrock															
4.0	Auger refusal at 4.0m															

OFFICE REPORT ON SOIL EXPLORATION

METRIC

W P 141/142-90-01 LOCATION Station 26 + 622.1m (WBL), 11.3m Rt of prop. WBL & ORIGINATED BY SM
DIST 19 HWY 11 & 17 BOREHOLE TYPE Solid stem auger COMPILED BY SM
DATUM Geodetic DATE 91 09 13 CHECKED BY SB

[illegible]

OFFICE REPORT ON SOIL EXPLORATION

+3, x5: Numbers refer to Sensitivity

20
15 ϕ 5 (%) STRAIN AT FAILURE
10

RECORD OF BOREHOLE No 8

METRIC

W P 141/142-90-01 LOCATION Station 26 + 643.2m (WBL), 11.3m Rt of prop. WBL E ORIGINATED BY SM
 DIST 19 HWY 11 & 17 BOREHOLE TYPE Solid stem auger COMPILED BY SM
 DATUM Geodetic DATE 91 09 13 CHECKED BY SB

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT Y	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100	W _p	W	W _L		
246.0	Ground surface																
0.0	Asphalt: 40 mm Mixture of gravel, sand, silt, rock fragments, cobbles and boulders, brown, dense (FILL)					Dry											
244.6																	
1.4	Auger refusal at 1.4m																

OFFICE REPORT ON SOIL EXPLORATION

RECORD OF BOREHOLE No 9

METRIC

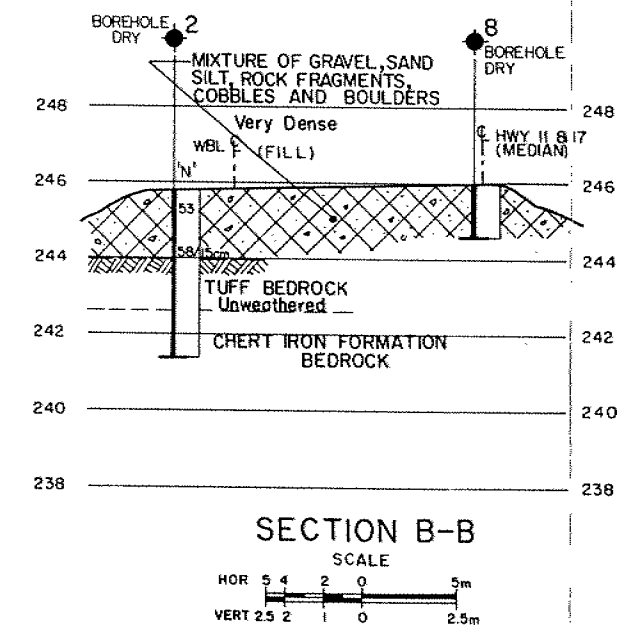
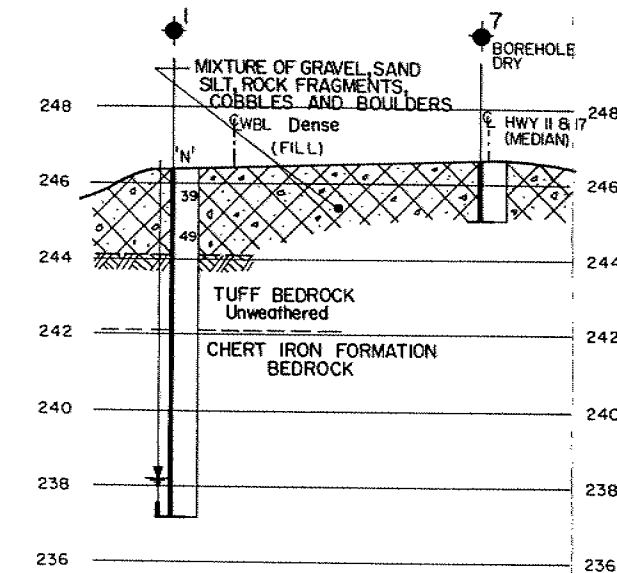
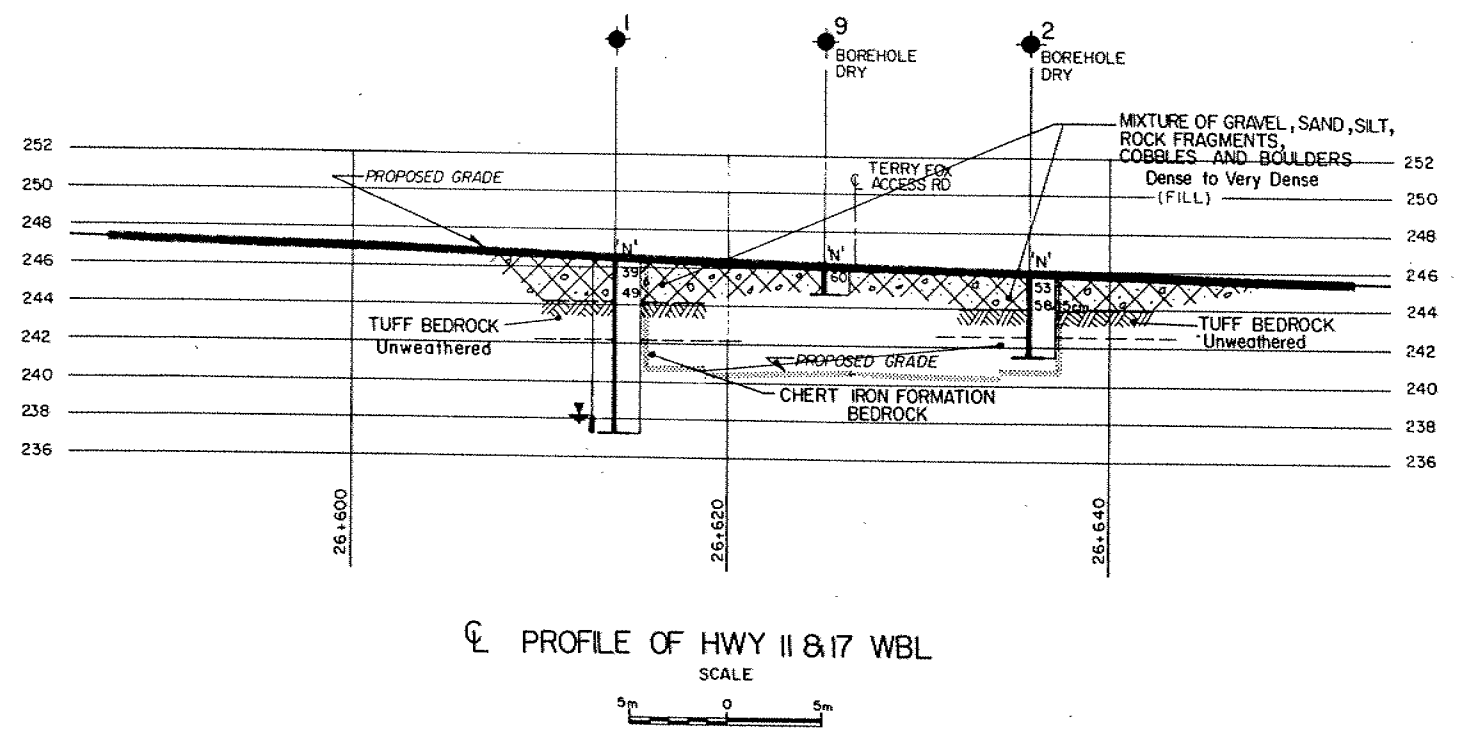
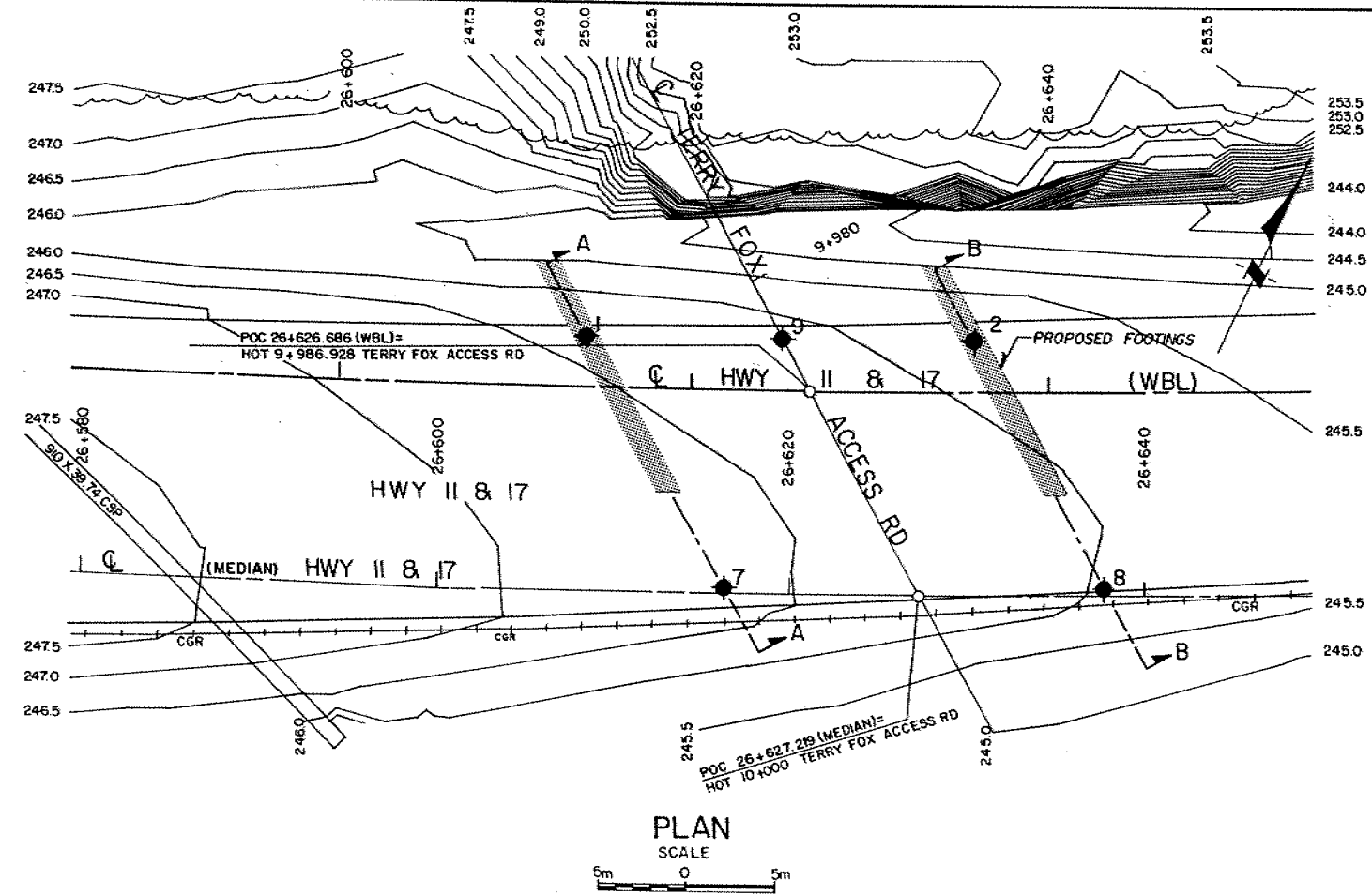
W P 141/142-90-01 LOCATION Station 26 + 625.0m (WBL), 2.9m Lt of prop. WBL E
 DIST 19 HWY 11 & 17 BOREHOLE TYPE Solid stem auger
 DATUM Geodetic DATE 91 09 11
 ORIGINATED BY SM
 COMPILED BY SM
 CHECKED BY SB

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC NATURAL LIQUID LIMIT MOISTURE CONTENT LIMIT			UNIT WEIGHT Y	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			'N' VALUES	20	40	60	80	100	W _p	W		
246.2	Ground surface															
0.0	Asphalt: 80 mm Crushed stone: 100mm Mixt. of gravel, sand, silt, rock fragments, cobbles & boulders, brown to grey, very dense (FILL)		1	SS	60	Dry	246									
244.7	Auger refusal at 1.5m						245									
1.5																

OFFICE REPORT ON SOIL EXPLORATION

+³, x⁵: Numbers refer to
Sensitivity

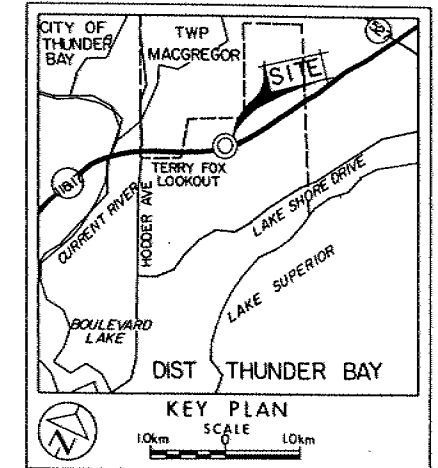
20
15 ϕ 5 (%) STRAIN AT FAILURE
10



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

CONT No WP No 141/142-90-01	SHEET
TERRY FOX ACCESS RD AND HWY II & 17 (WBL) BORE HOLE LOCATIONS & SOIL STRATA	

MCCLYMONT & RAK ENGINEERS, INC.



LEGEND			
●	Bore Hole		
⊕	Dynamic Cone Penetration Test (Cone)		
⊙	Bore Hole & Cone		
N	Blows/0.3m (Std Pen Test, 475 J/blow)		
CONE	Blows/0.3m (60° Cone, 475 J/blow)		
W	WL at time of investigation Sept 1991		
—	PIEZOMETER		

No	ELEVATION	STATION	OFFSET
1	246.4	26+614 (WBL)	2.6 LT
2	245.8	26+636.2 (WBL)	2.9 LT
7	246.6	26+622.1 (WBL)	11.3 RT
8	246.0	26+643.2 (WBL)	11.3 RT
9	246.2	26+625.0 (WBL)	2.9 LT

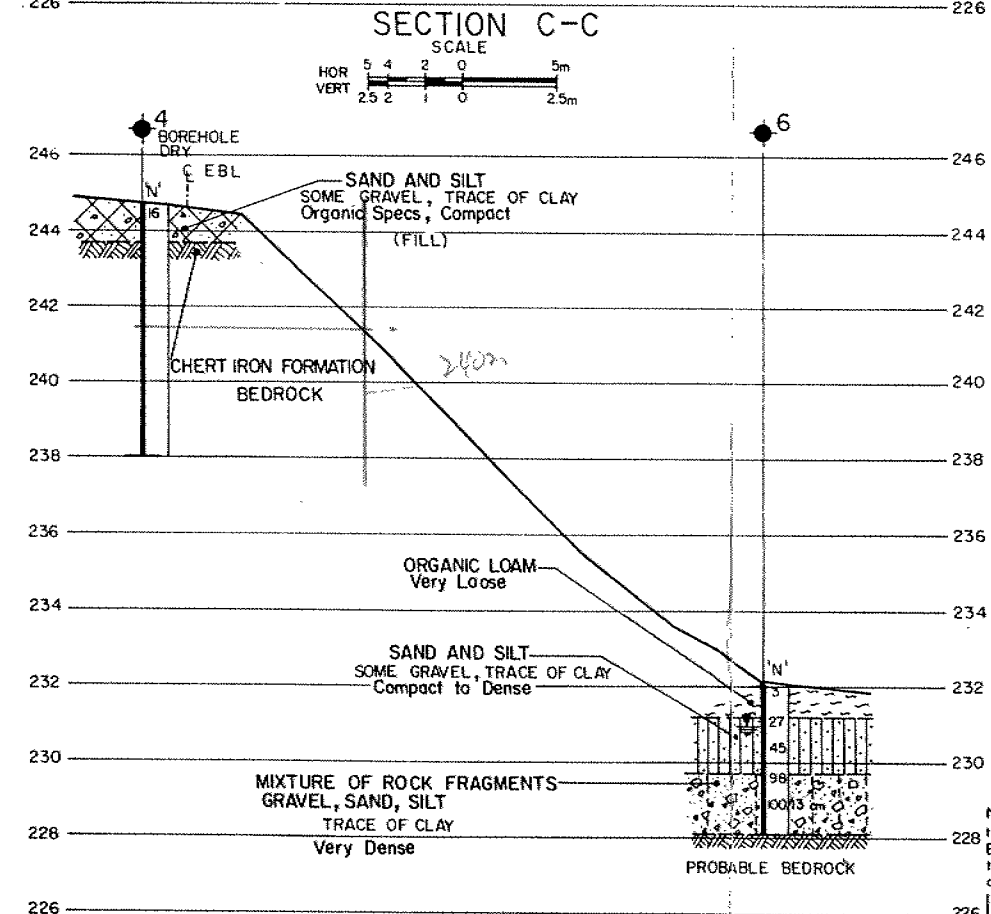
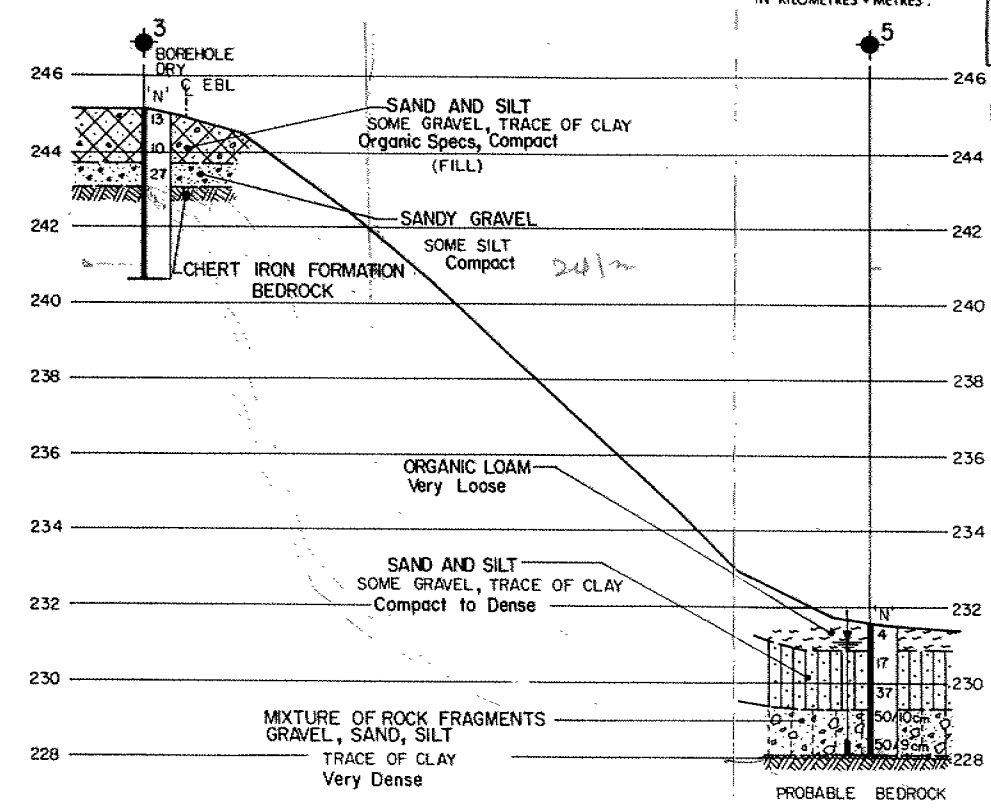
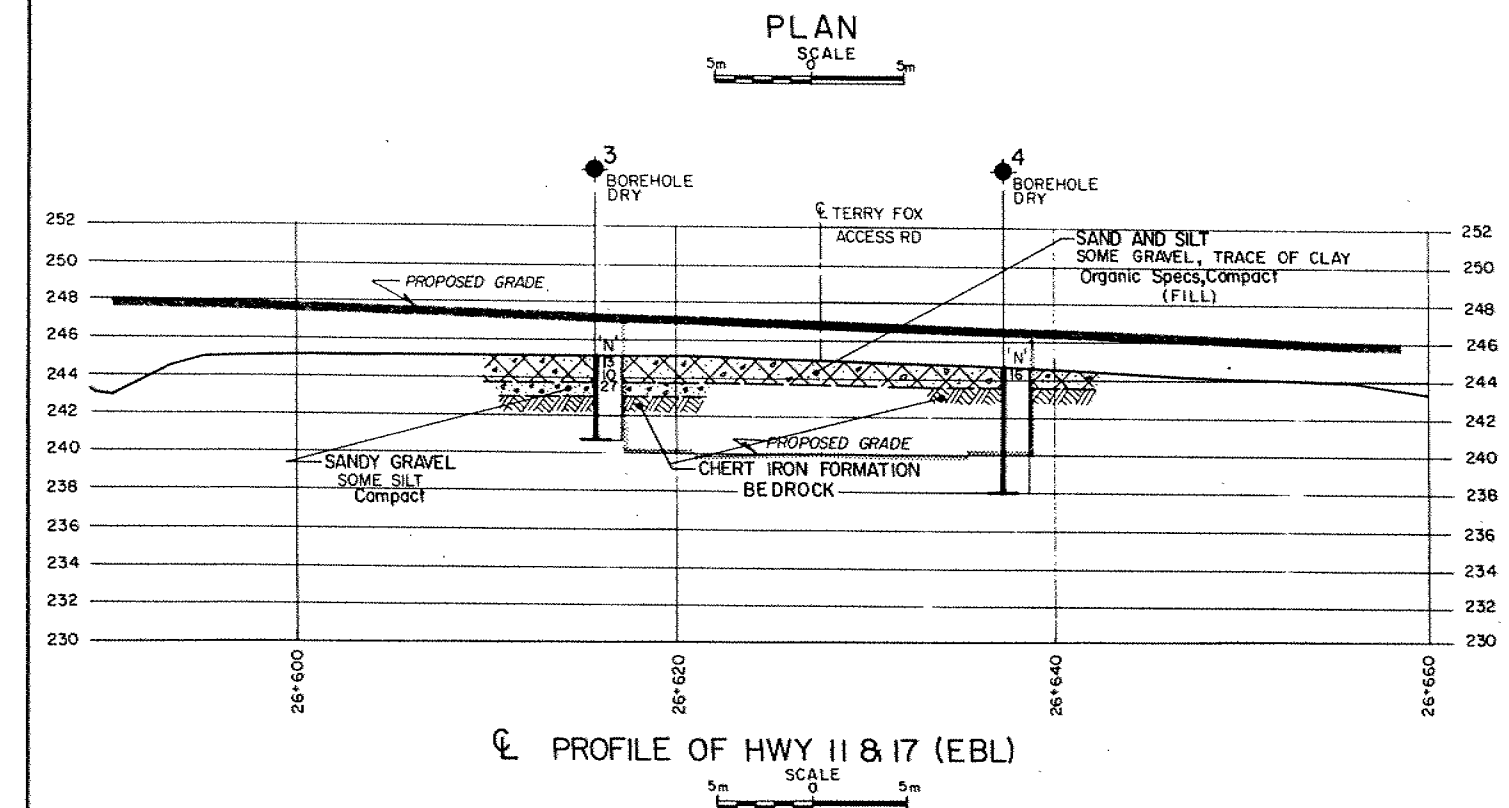
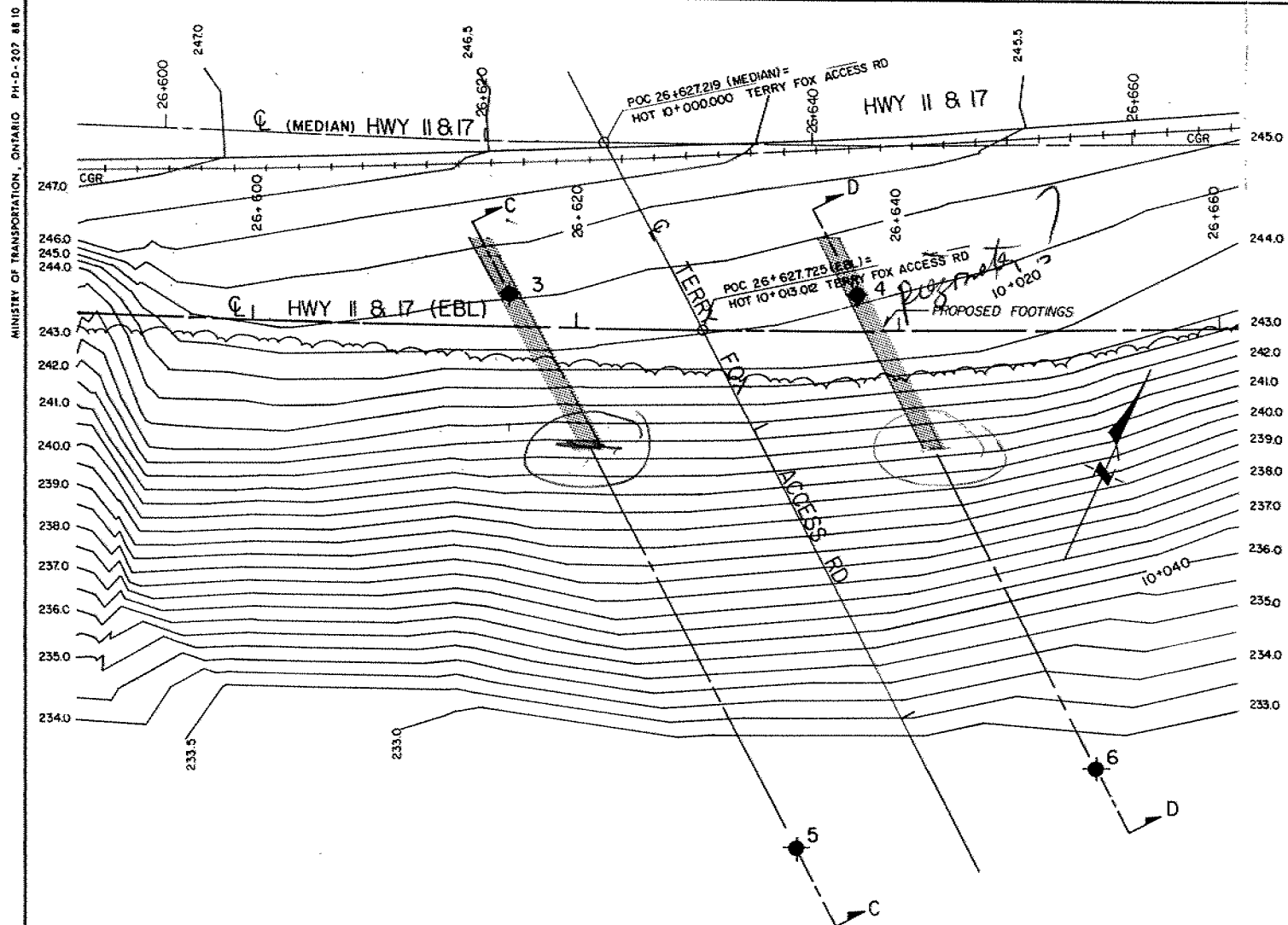
NOTE
The boundaries between soil strata have been established only at Bore Hole locations. Between Bore Holes the boundaries are assumed from geological evidence.

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

REV.	DATE	BY	DESCRIPTION

Geocres No 52A-106

HWY No II & 17	DIST 19
SUBM'D SB	CHECKED
DRAWN	CHECKED
DATE Oct 1991	SITE 48C-312
APPROVED	DWG 141/142-90-01-A

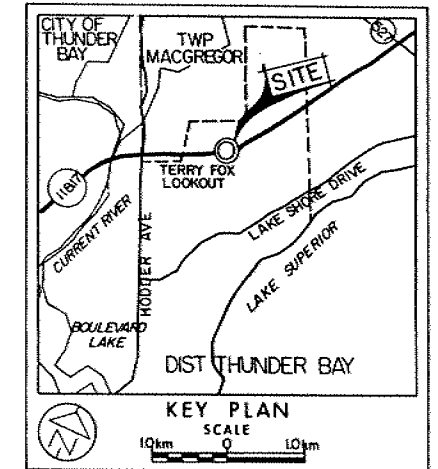


METRIC
DIMENSIONS ARE IN METRES
AND/OR MILLIMETRES UNLESS
OTHERWISE SHOWN. STATIONS
IN KILOMETRES + METRES.

CONT No
WP No 141/142-90-01
TERRY FOX ACCESS ROAD
AND
HWY 11 & 17 (EBL)
BORE HOLE LOCATIONS & SOIL STRATA



MCCLYMONT & RAK ENGINEERS, INC.



LEGEND

- Bore Hole
- ⊕ Dynamic Cone Penetration Test (Cone)
- ⊙ Bore Hole & Cone
- N Blows/0.3m (Std Pen Test, 475 J/blow)
- CONE Blows/0.3m (60° Cone, 475 J/blow)
- W.L. at time of investigation Sept 1991
- PIEZOMETER

No	ELEVATION	STATION	OFFSET
3	245.2	26+615.9 (EBL)	2.1 LT
4	244.7	26+637.3 (EBL)	2.3 LT
5	231.6	26+632.9 (EBL)	32.2 RT
6	232.1	26+651.6 (EBL)	27.4 RT

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

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

DATE	BY	DESCRIPTION

Geocres No 52 A-106

HWY No	11 & 17	DIST	19
SUBM'D SB	CHECKED	DATE Oct 1991	SITE 48C-312
DRAWN ER	CHECKED	APPROVED	DWG 141/142-90-01-B

Technical Memorandum for Embankment Widening for the W-N Ramp at
Terry Fox Interchange, W.P. 621-89-00 (Geocres Reference No. 52A-114)
dated September 17, 1992 prepared by MTO.

GEOCRES No. 52A-114DIST. 19 REGION W.P. No. 621-89-00/01CONT. No. W. O. No. STR. SITE No. HWY. No. 11 & 17LOCATION W-N Ramp at Terry Fox
InterchangeNo of PAGES -

OVERSIZE DRAWINGS TO BE INCLUDED WITH THIS REPORT. REMARKS:

ENGINEERING MATERIALS OFFICE
FOUNDATION DESIGN SECTION

WP 621-89-00

DIST 19

HWY 11 & 17

STR SITE

Embankment Widening for the W-N Ramp
at Terry Fox Interchange

DISTRIBUTION

R.J. Krisciunas
J.R. Morgenroth (3)
O.E. Ramakko
F.A. Adams (2)
K.G. Bassi
S.J. Dunham
E.A. Joseph
G. Norman (Cover Only)
F. Bacchus (Cover Only)
File

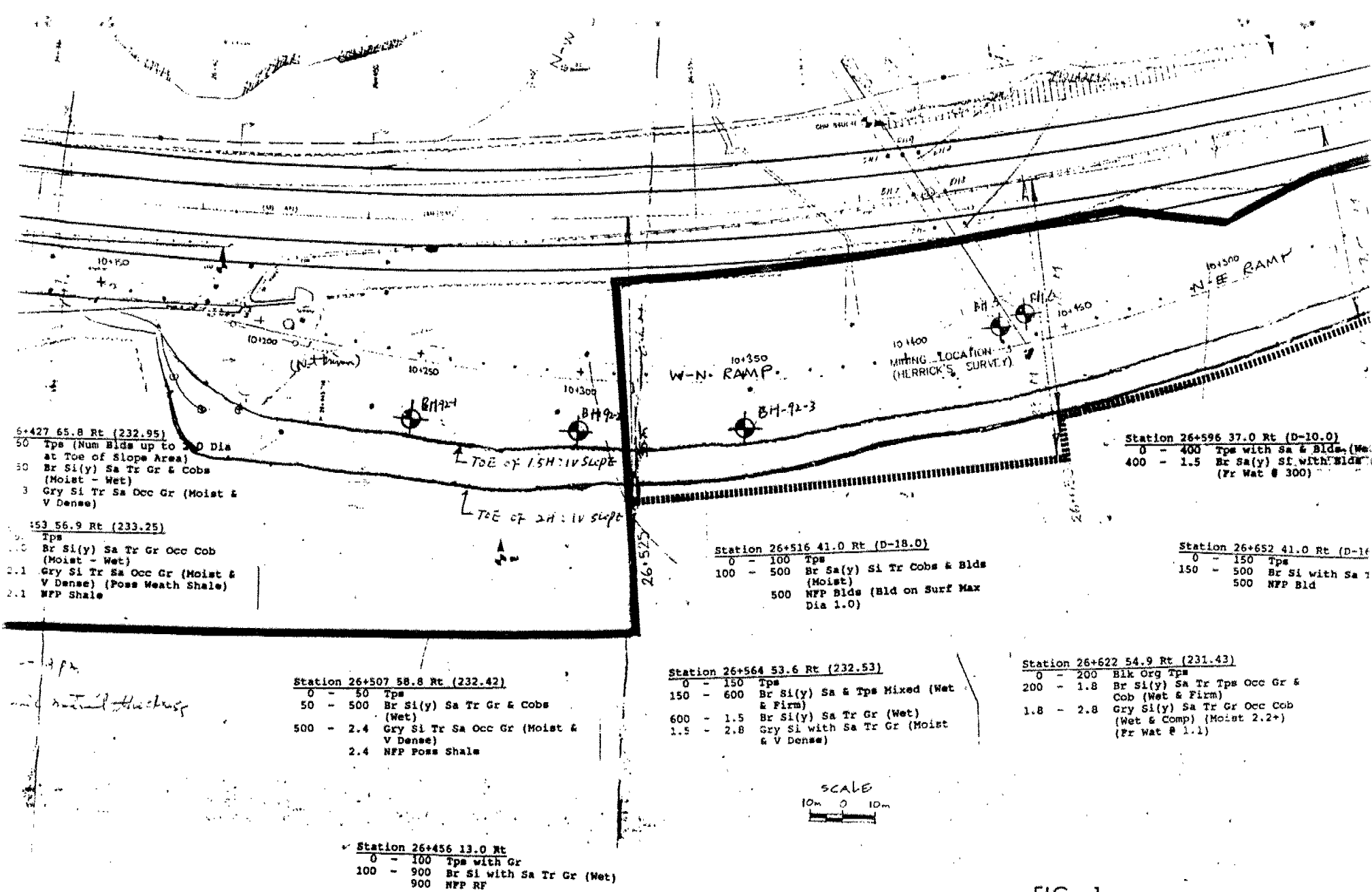


FIG -1
 BOREHOLE LOCATIONS
 WP 621-89-00

EXPLANATION OF TERMS USED IN REPORT

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

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

SOILS ARE DESCRIBED BY THEIR COMPOSITION AND CONSISTENCY OR DENSENESS.

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

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

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

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

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

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

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

R Q D (%)	0 - 25	25 - 50	50 - 75	75 - 90	90 - 100
	VERY POOR	POOR	FAIR	GOOD	EXCELLENT

JOINTING AND BEDDING:

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

ABBREVIATIONS AND SYMBOLS

FIELD SAMPLING

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

MECHANICAL PROPERTIES OF SOIL

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

STRESS AND STRAIN

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

PHYSICAL PROPERTIES OF SOIL

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

ROCK CORE DESCRIPTION **WP 621-89-00**

Page 1 of 1

CORE RECOVERY					CORE DESCRIPTION	
BH#	RC#	DEPTH (m)	% CR*	% RQD*	DEPTH (m)	DESCRIPTION
92-1	-					
92-2	-					
92-3	4	2.59-3.53	100	11	2.59-4.11	SHALE, black to medium grey; fine grained; weak; unweathered to slightly weathered; fractures close to extremely close spaced, flat to near vertical, planar to undulating, smooth.
	5	3.53-4.11	100	0		

*CR = CORE RECOVERY

*RQD = ROCK QUALITY DESIGNATION

(NOTE: Depths are approximated where core recovery is less than 100%)

Logged by: DAW, Soils and Aggregates Section


RECORD OF BOREHOLE No 92-1 1 OF 1 METRIC

W.P. 621-89-00 LOCATION Co-ords: N 5 371 765.6; E 366 394.0 ORIGINATED BY MI
 DIST 19 HWY 11/17 BOREHOLE TYPE HS Auger and BXL Rock Core COMPILED BY MI
 DATUM Geodetic DATE July 23, 1992 CHECKED BY TCK

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT 7 kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20 40 60 80 100	W _P W W _L	SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE					WATER CONTENT (%) 10 20 30		
232.8	Ground Surface																
0.0	Sandy Silt (Topsoil)																
232.0																	
0.8	Bedrock weathered shale of the Rove Formation		1	SS	100	/30cm	232										
			2	SS	100	/20cm	231										
			3	SS	50	/5cm	230										
			4	SS	100	/20cm	229										
			5	SS	100	/8cm	228										
			6	SS	80	/8cm	227										
226.6																	
6.2	End of Borehole																

RECORD OF BOREHOLE No 92-2 1 OF 1 METRIC

W.P. 621-89-00 LOCATION Co-ords: N 5 371 779.2; E 366 444.1 ORIGINATED BY MI
 DIST 19 HWY 11/17 BOREHOLE TYPE HS Auger and BXL Rock Core COMPILED BY MI
 DATUM Geodetic DATE July 23, 1992 CHECKED BY TCK

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _P	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100					
231.8	Ground Surface																
0.0	Sandy Silt (Topsoil)																
231.0																	
0.8	Bedrock weathered shale of the Rove Formation		1	SS	69	 23cm	231										
			2	SS	100		230										
			3	SS	50												
			4	SS	100		229										
228.3																	
3.5	End of Borehole																

RECORD OF BOREHOLE No 92-3

1 OF 1

METRIC

W.P. 621-89-00 LOCATION Co-ords: N 5 371 795.7; E 366 493.1 ORIGINATED BY MI
DIST 19 HWY 11/17 BOREHOLE TYPE HS Auger COMPILED BY MI
DATUM Geodectic DATE July 23, 1992 CHECKED BY TCK

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC NATURAL LIQUID LIMIT MOISTURE LIMIT CONTENT			UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100	W _p	W	W _L		
231.2	Ground Surface																
0.0	Sandy Silt (Topsoil)																
230.4																	
0.8	Bedrock Shale of the Rove Formation		1	SS	72												
			2	SS	102												
			3	SS	60												
			4	RC	REC 100%												
			5	RC	REC 100%												
227.1	End of Borehole																

RECORD OF BOREHOLE No 5

METRIC

W P 141/142-90-01 LOCATION Station 26 + 632.9m (EBL), 32.2m Rt of prop. EBL 6
 DIST 19 HWY 11 & 17 BOREHOLE TYPE Solid stem auger ORIGINATED BY SM
 DATUM Geodetic DATE 91 09 13 COMPILED BY SM
 CHECKED BY SB

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100					
231.6	Ground surface																
0.0	Organic Loam very loose		1	SS	4	Seal	231									117%	
230.9																	
0.7	Sand and Silt some gravel, trace of clay, stratified, compact to dense		2	SS	17		230						0				25 39 33 3
			3	SS	37								0				17 44 (39)
229.3																	
2.3	Mixture of rock fragments, gravel, sand, silt, trace of clay, very dense		4	SS	50/10cm		229						0				36 40 (24)
			5	SS	50/9cm								0				29 43 20 8
228.1	Probable Bedrock					Piezometer											
3.5	Auger refusal at 3.5m																

OFFICE REPORT ON SOIL EXPLORATION

RECORD OF BOREHOLE No 6

METRIC

W P 141/142-90-01 LOCATION Station 26 + 651.6m (EBL), 27.4m Rt of prop. EBL C
 DIST 19 HWY 11 & 17 BOREHOLE TYPE Solid stem auger ORIGINATED BY SM
 DATUM Geodetic DATE 91 09 13 COMPILED BY SM
 CHECKED BY SB

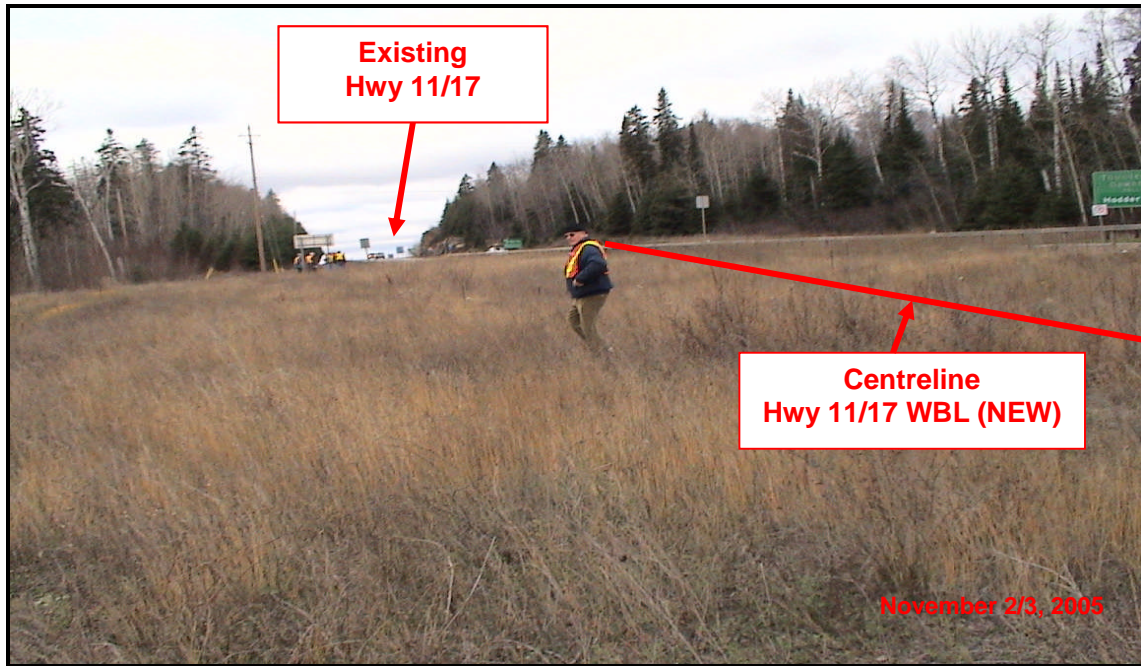
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100					
232.1	Ground surface																
0.0	Organic Loam very loose		1	SS	3		232										
231.2																	
0.9	Sand and Silt some gravel, trace of clay, stratified, compact to dense		2	SS	27		231										
			3	SS	45												
229.7							230										
2.4	Mixture of rock fragments, gravel, sand, silt, trace of clay, very dense		4	SS	98												
			5	SS	100	13cm	229										
228.1	Probable Bedrock																
4.0	Auger refusal at 4.0m																

OFFICE REPORT ON SOIL EXPLORATION



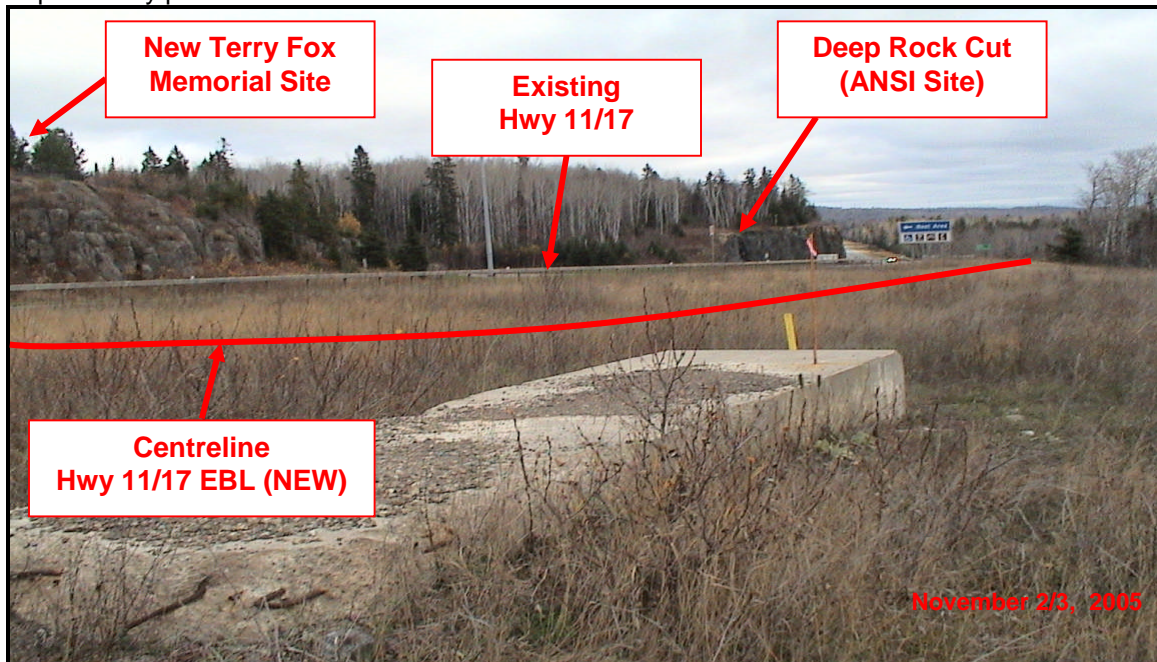
APPENDIX B

Site Photographs



Highway 11/17 STA. 26+300 O/S 30 m Right

Photograph 1: Looking west to Highway 11/17. Mr. B.R. Gray in the foreground standing on fill previously placed for access to the old monument.



Highway 11/17 STA. 26+330 O/S 30 m Right

Photograph 2: Looking east along top of fill placed at previous Terry Fox Memorial site.



Highway 11/17 STA. 26+550

Photograph 3: View looking east from north side of Highway 11/17, about 20 m from pavement, at about STA. 26+550. Note: West end of 11 m high ANSI exposure, at about STA. 26+650.



Highway 11/17 STA. 26+600 O/S 50 m South of Centreline

Photograph 4: View looking west at rubble rock fill at south toe of embankment opposite Terry Fox Lookout at about STA. 26+600. Note: Rockfill size to 2 m and extensive voiding observed.