



**Foundation Investigation and Design Report
Highway 11/17(New), Four Laning from 4.06 km
West of Highway 587 Westerly 14 km
Foundation Zone 1
Station 27+380 to 27+680**

GWP 6120-03-00

Geocres No.: 52A-136

**Prepared for
Ministry of Transportation, Northwestern Region**

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June 16, 2009

Ref. No. 08-0171

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Part A - FOUNDATION INVESTIGATION REPORT

1 Introduction

TBT Engineering (TBTE) has been retained by Engineering Northwest Limited (ENL) to provide foundation investigations and design services for embankments of the new Highway 11/17 Four Laning from MacKenzie Easterly (1.6 km west of Mackenzie Station Road to 0.3 km west of Eldorado Beach Road). As part of this assignment, a foundation investigation was required within four foundation zones:

- Foundation Zone 1
 - Immediately west of MacKenzie Station Road – 300 m Section
- Foundation Zone 2
 - Immediately west of MacKenzie Heights Road – 500 m Section
- Foundation Zone 3
 - 3 km east of MacKenzie Station Road – 600 m Section
- Foundation Zone 4
 - Immediately west of New Connection Birch Beach Road - 2 km Section

This report solely discusses the findings within Foundation Zone 1. Findings of the investigations at Foundation Zones 2, 3 and 4 are presented under separate cover.

The foundation investigation was carried out to investigate subsurface conditions at Foundation Zone 1. This investigation consisted of a number of boreholes drilled in the vicinity of the proposed new alignment, laboratory testing and geotechnical analysis of the data. This report (Part A) describes the subsurface conditions encountered during the investigation.

The foundation section has assigned GEOCREs No. **52A-136** to this site.

2 Site Description

Foundation Zone 1 is located immediately west of MacKenzie Station Road and extends easterly for 300 m. Foundation Zone 1 is located between Station 27+380 and 27+680 and is generally level from east to west with a slight downward grade running from north to south. The proposed new alignment will cross swampy terrain and will be located to the north of the existing highway (up to approximately 650 m).

2.1 Surficial Geology

The proposed alignment (all Foundation Zones) traverses several different surficial deposits, such as sand and gravel lacustrine delta deposits, sandy beach deposits, and ground moraine/till deposits all over bedrock, as shown on the best available mapping (OGS NOEGTS Map 5046 – Black Bay). In general, the proposed alignment (all Foundation Zones), has two areas a western and eastern area. The western part is expected to contain thicker, more extensive units than the eastern part; however, the surficial geology of both areas is predominantly controlled by proximity to past elevated levels of glacial lakes and spillways in the Lake Superior basin. Adjacent till deposits are related to sub-glacial processes, and pre-date those formed in a lacustrine paleo-environment.

The area from the western extent of the proposed alignment to approximate station 30+200 (encompassing Foundation Zone 1) is mapped to contain peat, underlain by a sand and gravel lacustrine delta deposit, associated with a former spillway occupying the Mackenzie River valley.

2.2 Bedrock Geology

The majority of the bedrock along the Foundation Zone 1 alignment is mapped to be medium to coarse grained, variably porphyritic pink felsic intrusives of (locally known as 'Mackenzie granite') as indicated on OGS Map P2985 (MacGregor Bedrock – East half).

3 Investigation Procedures

A geotechnical site investigation was undertaken between February 13 and 19, 2009. Sixteen boreholes were carried out along the proposed alignment.

The investigation was carried out using a CME 750 drill rig. The CME 750 drill rig is equipped for geotechnical testing and sampling. Hollow stem auger methods were utilized.

Soil samples were obtained at the boreholes using a split spoon sampler as a part of the Standard Penetration Testing (SPT). The SPT involves driving a thick walled sampler into the soils under a standardized energy (63.5 kg, falling 760 mm). The number of blows required to drive the sampler 0.3 m is known as the SPT blow count (N). All boreholes were drilled to auger refusal (N values > 100).

Borehole locations were measured in the field and ground surface elevations surveyed by ENL and referenced to data provided by MTO and the following datum:

Horizontal Datum:	NAD83 MTM Zone 15
Vertical Datum:	Canadian Geodetic Vertical Datum 1928
Benchmark:	GBM 93U168 Elevation 227.917

A summary of the borehole location data is provided on the enclosed Borehole Location Plan and Strata Drawings, Appendix C.

The borehole characteristics are summarized in Table 1.

Table 1: Drill Summary

Location	Surface Elevation (metres)	Refusal (Elevation/Depth) (metres)	Base of Peat (Elevation/Depth) (metres)
BH 1-01	234.7	226.2 / 8.5	234.6 / 0.1
BH 1-02	235.0	228.7 / 6.3	234.8 / 0.2
BH 1-03	235.7	229.2 / 6.5	235.5 / 0.2
BH 1-04	233.3	227.0 / 6.3	232.3 / 1.0
BH 1-05	233.9	231.6 / 2.3	233.1 / 0.8
BH 1-06	233.5	231.1 / 2.4	232.9 / 0.6
BH 1-07	233.0	231.9 / 1.1	232.2 / 0.8
BH 1-08	234.1	231.3 / 2.8	233.5 / 0.6
BH 1-09	232.5	231.3 / 1.2	231.9 / 0.6
BH 1-10	234.2	226.8 / 7.4	232.4 / 1.8
BH 1-11	233.5	229.2 / 4.3	231.8 / 1.7
BH 1-12	234.7	227.7 / 7.0	234.4 / 0.3
BH 1-13	233.7	227.3 / 6.4	233.0 / 0.7
BH 1-14	232.9	227.0 / 5.9	232.6 / 0.3
BH 1-15	235.0	229.2 / 5.8	234.2 / 0.8
BH 1-16	232.9	229.0 / 3.9	232.7 / 0.2

The boreholes were backfilled at the completion of the investigations using a bentonite backfill mixture to ensure the environmental integrity of the site and in compliance with Ontario Regulation 903.

Soil samples were transported to TBT Engineering's laboratory in Thunder Bay for testing. Routine testing included moisture content, Atterberg limits and grain size analysis. The results of this testing are shown on the Borehole Logs (Appendix A) and on the laboratory data reports (Appendix B).

4 Sub-Surface Conditions

Details of the subsurface conditions are provided on the borehole logs (Appendix A) and on the Soil Strata Drawings (Appendix C).

Within the Foundation Zone 1 (between Stations 27+380 and 27+680), the generalized subsurface stratigraphy consists of up to 1.8 m of peat/organics overlying a mixture of sands and silts, and followed by till to the extents of the boreholes.

4.1 Topsoil/Peat

Along the proposed alignment, topsoil/peat (swamp material) was encountered at all borehole locations. This material extended to depths ranging from 0.1 to 1.8 m (elevation 235.5 to 231.8 m) with an average depth of 0.7 m. In general, the peat deposit is deepest at near station 27+600 with depths of 1.7 to 1.8 m and thins out towards the east and west. Natural moisture contents varied between 85 and 872 % (dry weight basis).

4.2 Sands and Silts

Beneath the topsoil/peat a variable deposit of sands and silts was encountered, at all the boreholes with the exception of Borehole 1-09. The sands and silts extend to depths ranging from 0.9 to 6.1 m (elevation 233.4 to 227 m). This deposit consists of zones sand and silt existing in varying proportions. Grain size analysis shows great variation in the sampled material with material varying from 0-19% gravel, 25–96% sand, and 4 - 68% silt sized particles. This stratum is in a very loose to compact condition with SPT (N) values of 1 to 22 blows/0.3 m.

At Borehole 1-01, a clay lens was identified at 4.2m (elevation 230.5 m).

A discontinuous organic layer is present between this stratum at Borehole 1-05 at elevation 232.5 and the till with an approximate thickness of 0.1 m.

Two consolidated drained direct shear tests were carried out, one on a silty sand and the other on a sand and silt. The results of these tests have been illustrated graphically in Appendix B. The test results indicate a lower bound effective angle of internal friction (ϕ') of 32° with a effective cohesion intercept (C') of 0 kPa.

4.3 Till

Till was encountered beneath the sands and silts at Boreholes 1-01 to 1-06, 1-08, 1-10 to 1-13, 1-15, 1-16 and beneath the topsoil/peat at Boreholes 1-07 and 1-09. The till extends to the termination of the boreholes. Based on grain size analyses this stratum can consist of 0-21% gravel, 18-70% sand, and 27-81% silt and clay sized particles with occasional cobbles and boulders. This stratum is in compact to very dense condition with SPT (N) values of 10 to greater than 100 blows/0.3 m.

4.4 Refusal

Auger refusal was met at elevations ranging from 226.2 to 232.2 m (depths from 8.5 to 0.8m) at all borehole locations. Auger refusal may be on bedrock, or on cobbles and/or boulders. In addition to auger refusal SPT (N) values greater than 100 were encountered at the auger refusal depths. Coring of the refusal material was not part of the scope of work.

4.5 Ground Water

The ground water level during the field investigations was generally within 0.5 m of the peat surface, with the exception of Boreholes 1-01 to 1-03. At Boreholes 1-01 to 1-03 the ground water was recorded at depths varying from 1.1 to 2.7 m. Ground water levels measured within the boreholes at the time of this investigation generally varied between elevations of 232.5 and 234.9 m

Ground water levels may vary from season to season and from the effects of heavy precipitation events.

5 Miscellaneous

Laboratory testing was carried out at the TBT Engineering laboratory in Thunder Bay. The field operations were supervised by Herman Finke. Laboratory testing was supervised by T. Fummerton C.E.T. This report was prepared by S. Seller, P.Eng. and G. Maki, P.Eng., and reviewed by W. Hurley, P.Eng.

Part B - FOUNDATION DESIGN RECOMMENDATIONS

6 Introduction

The proposed Highway 11/17 new alignment will create four areas where high fill embankments will be constructed. As part of this assignment, a foundation design was required within four foundation zones:

- Foundation Zone 1
 - Approximate 7 m high embankment fill.
- Foundation Zone 2
 - Approximate 9 m high embankment fill.
- Foundation Zone 3
 - Approximate 12 m high embankment fill.
- Foundation Zone 4
 - Approximate 7 m high embankment fill.

The locations of these Foundation Zones is discussed in Part A. This design report solely discusses the findings within Foundation Zone 1. Findings of the investigations and design at Foundation Zones 2, 3 and 4 are presented under separate cover.

Foundation Zone 1 is located from station 27+380 to 27+680. This design alignment has a centre line grade which varies from elevations 240.0 to 242.0 m within Foundation Zone 1. The new centre line grade will be up to 7 m higher than the existing ground elevation. The east bound lanes (2) and west bound lanes (2) will be supported on overlapping embankments separated by a 30 m median.

The foundation investigation as described in Part A, was carried out to investigate subsurface conditions at Foundation Zone 1. This investigation consisted of a number of boreholes along the proposed alignment as well as routine and complex laboratory testing. The soils at this location consist of surficial peat (swamp material) to a maximum depth of 1.8 m underlain by sands and silts.

Given the limited presence of peat (average 0.7 m thick) and the non-cohesive granular foundation materials settlement performance and foundation related construction issues are expected to be minimal.

The purpose of this section of the report (Part B) is to document the options investigated, review the geotechnical analyses undertaken, and to provide specific foundation recommendations for the recommended option. These are based on the conditions encountered at the test locations, TBTE's interpretation of the subsurface conditions at the site and the highway design criteria.

7 Review of Foundation Options

A review of various foundation options was completed for this project. These ranged from peat excavation, construction over peat, the installation and use of wick drains, the use of lightweight fill, geosynthetic reinforcement, and Retained Soil Systems. Due to the limited thickness of peat and the competency of the existing foundation soils, peat excavation was considered to be the most feasible option with the best overall performance. The following table presents the foundation options reviewed

Table 2: Foundation Option Review

Option	Advantages	Disadvantages	Variables	Comments
Construction Over Peat	Quick construction.	Excessive and highly differential primary and secondary settlements.	Geogrid reinforcement will not be highly effective due to the condition of the foundation soils.	Not recommended due to relatively poor performance.
	No peat excavation and disposal required.		Lightweight fill would improve settlement performance at a relatively high expense.	
	-		Wick drains are not considered to be effective in removing secondary compression settlements.	
Construction With Peat Removal	Significantly improved settlement performance.	Excavation, and disposal of limited peat deposits	Geogrid reinforcement is not required.	Superior performance for a relatively low cost of peat excavation.
	Quick construction.		Lightweight fill is not required.	
	-		Wick drains are not required.	

8 Geotechnical Analyses

8.1 Geotechnical Model

Stability analyses were carried out on a composite section considered to be a conservative representation of the project. The composite section was modeled to incorporate the thickest peat, and sands and silts strata, along with the thinnest till layer and the highest embankment elevation from original ground, up to 8.5 m.

The embankment section was modeled to include a granular pavement structure (base and sub-base) and a Select Subgrade Material (SSM) or rock fill as embankment fill. The final embankment may consist of SSM, Granular B, or Rock Fill. Using the SSM as the embankment fill was the most conservative approach for the analysis.

The analyses were carried out to assess the stability for numerous embankment slopes. The design embankment slopes for this project are 4(horizontal) to 1 (vertical), where the property limits allow. Where property limits do not allow embankment slopes of 4(H):1(V) steeper slopes can be utilized in conjunction with guardrails. Stability analyses were carried out using Slope/W software and limit equilibrium analyses using the Morgenstern-Price method. Traffic loading was modeled with a distributed load of 20 kPa.

The soil parameters used for the analyses are shown in Table 3.

Table 3: Stability Analyses Soil Properties

Soil	Effective Shear Strength Properties		Undrained Shear Strength C_u (kPa)	Unit Weight γ (kN/m ³)
	Effective Angle of Internal Friction, ϕ' (degrees)	Effective Cohesion Intercept, C' (kPa)		
Pavement Structure	35	0	N/A	21
SSM	32	0	N/A	21
Sands and Silts	32	0	N/A	20
Till	32	0	N/A	20
Rock Fill	45	0	N/A	18

Settlement analysis was also carried out to determine the estimated magnitude and duration of primary settlements within the foundation soils. Settlement analysis was computed using Boussineq stress distribution and estimated soil properties as presented below:

Table 4: Settlement Analysis Soil Properties

Foundation Soil	Effective Young's Modulus, E' (MPa)
Sands and Silts	5
Till	50

8.2 Results of Geotechnical Analyses

Analysis of the composite section was conducted under the assumption that all topsoil/peat will be removed prior to placement of embankment material. The following table presents the calculated factors of safety against shear failure for various embankment slope configurations, and a maximum embankment height of 8.5 m.

Table 5: Slope Stability Analyses Results

Embankment Slope Grade (H:V)	Computed Factor of Safety
4:1	2.2
3:1	1.8
2:1	1.3
1.25:1 Rock Fill	1.3

Results of the slope stability analysis are provided in Appendix E.

Embankments may be constructed with side slopes of 2(H) : 1(V) or flatter as required by design, topography and/or property limits. Embankments below the pavement structure may be constructed from Granular B. SSM may be used above the water line. Side slopes of 1.25(H) :1(V) can be utilized for embankments constructed entirely of rock fill below the pavement structure.

Settlement estimates of the new construction were also computed. The estimated foundation soil settlement has been estimated to vary between >10 and 185 mm (maximum). The variance in the estimated maximum settlement is due to the potential

variation in thickness of the embankment and the thickness of foundation soils. The consolidation of the foundation soils will commence during fill placement and are expected to be effectively complete prior to final grading.

An allowance of 75 mm of additional fill should be considered to compensate for the embankment settlements occurring during construction. This allowance should be considered over the full width of the embankment from end to end within Foundation Zone 1.

“Punching” of the embankment fill into the subgrade during placement is expected to be minimal.

If rock embankments are utilized, they should be expected to undergo time dependent compressions within the rock fill itself. Settlements between 0.3 and 1 % of the height of the rock fill should be anticipated. Approximately half of these settlements are anticipated during the first year after placement. The remaining settlements will occur over a period of years

9 Construction Recommendations

The topsoil/peat (swamp) shall be excavated in entirety for the length of Foundation Zone 1. The excavation of the swamp is to be carried out in accordance with OPSS 209 using the Excavation Method (A), and OPSD 203.010 M. The embankment fill material below the pavement structure can consist of Granular “B” Type 2 or 3, rock fill or select subgrade material as provided under OPSS SP-110-S13 and OPSS SP -206-S03 for Rock Fill.

OPSS 209 (March 1998) and the modified OPSD are presented in Appendix D.

10 Construction Issues

Excavation of the peat along the proposed alignment may result in excess water within the excavation. Where excessive quantities of water exists “pumping” conditions of foundation soils and embankment materials placed within the water may occur.

Compaction efforts of the initial lifts may be hindered by these “pumping” conditions. The “pumping” conditions can be alleviated by ceasing compaction until porewater pressure in the material has dissipated, and/or lift thickness can be adjusted. Disposal of wet peat also should be considered.

11 Limitations

Conclusions and recommendations presented in this report are based on the information determined at the test hole locations. Subsurface and groundwater conditions between and beyond these locations may differ from those encountered. Conditions may become apparent during construction that were not detected and could not be anticipated at the time of the site investigation.

The comments given in this report on potential construction problems and possible methods of construction are intended only for the guidance of the designer.

Groundwater levels indicated are based on the information described within the report. The presence of all conditions that could affect the type and scope of dewatering procedures which may be considered cannot readily be determined from boreholes. These include local and seasonal fluctuations of the groundwater level, changes in soil conditions between test locations, thin and/or discontinuous layers of highly permeable soils, etc.

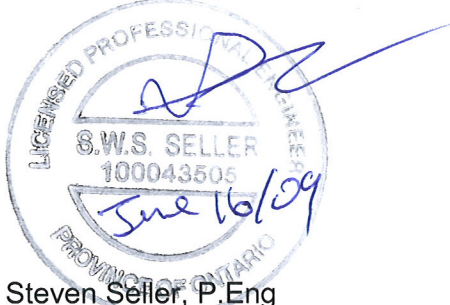
The information contained within this report in no way reflects any environmental aspect of the site or soil.

12 Closure

We trust the above addresses your project requirements at this time. Should you have any questions or comments, please do not hesitate the contact us at your convenience.

Yours truly,

For TBT ENGINEERING



Steven Seller, P.Eng
Project Engineer



Wayne Hurley, P. Eng
Vice-President, Engineering



Gordon Maki, P.Eng
Manager of Geotechnical Engineering

APPENDIX A

Borehole Logs

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

STRESS AND STRAIN

u_w	kPa	PORE WATER PRESSURE
r_u	l	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	l	COEFFICIENT OF FRICTION

MECHANICAL PROPERTIES OF SOIL

m_v	kPa^{-1}	COEFFICIENT OF VOLUME CHANGE
C_c	l	COMPRESSION INDEX
C_s	l	SWELLING INDEX
C_α	l	RATE OF SECONDARY CONSOLIDATION
C_v	m^2/s	COEFFICIENT OF CONSOLIDATION
H	m	DRAINAGE PATH
T_v	l	TIME FACTOR
U	%	DEGREE OF CONSOLIDATION
σ'_{v0}	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_f	l	SENSITIVITY = $\frac{C_u}{\tau_r}$

PHYSICAL PROPERTIES OF SOIL

ρ_s	kg/m^3	DENSITY OF SOLID PARTICLES	e	l, %	VOID RATIO	e_{\min}	l, %	VOID RATIO IN DENSEST STATE
γ_s	kN/m^3	UNIT WEIGHT OF SOLID PARTICLES	n	l, %	POROSITY	I_D	l	DENSITY INDEX = $\frac{e_{\max} - e}{e_{\max} - e_{\min}}$
ρ_w	kg/m^3	DENSITY OF WATER	w	l, %	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	l	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	l	LIQUIDITY INDEX = $\frac{w - w_p}{I_p}$	i	l	HYDRAULIC GRADIENT
γ_{sat}	kN/m^3	UNIT WEIGHT OF SATURATED SOIL	I_C	l	CONSISTENCY INDEX = $\frac{w_L - w}{I_p}$	k	m/s	HYDRAULIC CONDUCTIVITY
ρ'	kg/m^3	DENSITY OF SUBMERGED SOIL	e_{\max}	l, %	VOID RATIO IN LOOSEST STATE	j	kN/m^3	SEEPAGE FORCE
γ'	kN/m^3	UNIT WEIGHT OF SUBMERGED SOIL						

TBT Engineering Consulting Group			RECORD OF Borehole No 1-01			1 OF 1 METRIC		
W.P. 66 120-03-00			PROJECT Four Laning - From Hwy 587 Westerly			SITE NO. Foundation Zone 1 ORIGINATED BY AF		
DIST 61 HWY 11/17			LOCATION 27+393.9 o/s 16.9 Lt			TBTE JOB# 08-171 COMPILED BY TB		
DATE 2009 February 13			BOREHOLE TYPE Hollow Stem Auger			DATUM Geodetic CHECKED BY SS		
SOIL PROFILE			SAMPLES			DYNAMIC CONE PENETRATION RESISTANCE PLOT		
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	<div style="display: flex; justify-content: space-between;"> <div> <p>20 40 60 80 100</p> <p>SHEAR STRENGTH kPa</p> <p>○ UNCONFINED ✕ FIELD VANE</p> <p>■ SPT (N) ★ LAB VANE</p> <p>20 40 60 80 100</p> </div> <div> <p>20 40 60</p> <p>PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT</p> <p>W_p W W_L</p> <p>WATER CONTENT (%)</p> </div> </div>	
234.7	TOPSOIL SANDS & SILTS (of variable proportions) SAND - trace silt, brown, loose to very dense		1	AS			<div style="display: flex; justify-content: space-between;"> <div> <p>20 40 60 80 100</p> <p>SHEAR STRENGTH kPa</p> <p>○ UNCONFINED ✕ FIELD VANE</p> <p>■ SPT (N) ★ LAB VANE</p> <p>20 40 60 80 100</p> </div> <div> <p>20 40 60</p> <p>PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT</p> <p>W_p W W_L</p> <p>WATER CONTENT (%)</p> </div> </div>	
234.0			2	SS	8		234	
233.6			3	SS	9		233	
233.0			4	SS	5		232	
232.0			5	SS	6		231	
231.0			6	SS	8		230	
230.0	- clay lenses TILL - SAND - Silty, some gravel, occasional cobbles, grey, compact to very dense		7	SS	12		<div style="display: flex; justify-content: space-between;"> <div> <p>20 40 60 80 100</p> <p>SHEAR STRENGTH kPa</p> <p>○ UNCONFINED ✕ FIELD VANE</p> <p>■ SPT (N) ★ LAB VANE</p> <p>20 40 60 80 100</p> </div> <div> <p>20 40 60</p> <p>PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT</p> <p>W_p W W_L</p> <p>WATER CONTENT (%)</p> </div> </div>	
229.0			8	SS	41		228	
228.0			9	SS	20		227	
226.2	End of Borehole @ 8.5 m. Auger Refusal.		10	SS	100+		<div style="display: flex; justify-content: space-between;"> <div> <p>20 40 60 80 100</p> <p>SHEAR STRENGTH kPa</p> <p>○ UNCONFINED ✕ FIELD VANE</p> <p>■ SPT (N) ★ LAB VANE</p> <p>20 40 60 80 100</p> </div> <div> <p>20 40 60</p> <p>PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT</p> <p>W_p W W_L</p> <p>WATER CONTENT (%)</p> </div> </div>	

ON_MOT_BH-10 08-171 FOUNDATIONS ZONE 1.GPJ ON_MOT.GDT 09/6/15

TBT Engineering Consulting Group			RECORD OF Borehole No 1-02			1 OF 1 METRIC	
W.P. 66 120-03-00			PROJECT Four Laning - From Hwy 587 Westerly			SITE NO. Foundation Zone 1 ORIGINATED BY AF	
DIST 61 HWY 11/17			LOCATION 27+366.8 o/s 8.8 Lt			TBTE JOB# 08-171 COMPILED BY TB	
DATE 2009 February 13			BOREHOLE TYPE Hollow Stem Auger			DATUM Geodetic CHECKED BY SS	
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	ELEVATION SCALE	REMARKS & GRAIN SIZE DISTRIBUTION (%)
235.0	TOPSOIL						
234.9	SANDS & SILTS (of variable proportions)		1	AS			Water level @ 1.6 m on completion.
0.2	SAND - some silt, trace gravel, brown, loose to compact		2	SS	6		
			3	SS	11		1 83 (16)
			4	SS	6		
			5	SS	9		
	----- - occasional cobbles		6	SS	11		
			7	SS	8		0 96 (4)
	----- - trace silt		8	SS	100+		
229.3	TILL - SILT - Sandy, grey, very dense						
5.7							
228.7	End of Borehole @ 6.3 m. Auger Refusal.						
6.3							

DYNAMIC CONE PENETRATION RESISTANCE PLOT

SHEAR STRENGTH kPa

○ UNCONFINED ✕ FIELD VANE ● NATURAL MOISTURE CONTENT ▲ LIQUID LIMIT

■ SPT (N) ★ LAB VANE W_p W W_L

WATER CONTENT (%)

UNIT WEIGHT γ kN/m³

ON_MOT_BH-10 08-171 FOUNDATIONS ZONE 1.GPJ ON_MOT.GDT 09/6/15

TBT Engineering Consulting Group			RECORD OF Borehole No 1-03			1 OF 1 METRIC	
W.P. 66 120-03-00			PROJECT Four Laning - From Hwy 587 Westerly			SITE NO. Foundation Zone 1 ORIGINATED BY AF	
DIST 61 HWY 11/17			LOCATION 27+429.4 o/s 42.4 Lt			TBTE JOB# 08-171 COMPILED BY TB	
DATE 2009 February 12			BOREHOLE TYPE Hollow Stem Auger			DATUM Geodetic CHECKED BY SS	
SOIL PROFILE			SAMPLES			DYNAMIC CONE PENETRATION RESISTANCE PLOT	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE
235.7	TOPSOIL						
239.0	SANDS & SILTS (of variable proportions) SAND - Silty, brown, compact to very loose ----- - some silt ----- - sandy silt layer (150 mm) ----- - brown/grey ----- - layered, some gravel, occasional cobbles, grey, loose		1	AS			
0.2			2	SS	17		
			3	SS	17		
			4	SS	10		
			5	SS	8		
			6	SS	4		
			7	SS	5		
			8	SS	7		
229.4	TILL - SAND & SILT - occasional cobbles, very dense End of Borehole @ 6.5 m. Auger Refusal.		9	SS	100+		
6.3 229.2 6.5							

SHEAR STRENGTH kPa

○ UNCONFINED ✕ FIELD VANE

■ SPT (N) ★ LAB VANE

20 40 60 80 100

PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT

W_p W W_L

20 40 60

WATER CONTENT (%)

UNIT WEIGHT

γ

kN/m³

REMARKS & GRAIN SIZE DISTRIBUTION (%)

GR SA SI CL

Water level @ 2.7 m on completion.

0 90 (10)

0 58 (42)

ON_MOT_BH-10 08-171 FOUNDATIONS ZONE 1.GPJ ON_MOT.GDT 09/6/15

TBT Engineering Consulting Group			RECORD OF Borehole No 1-04			1 OF 1 METRIC	
W.P. 66 120-03-00			PROJECT Four Laning - From Hwy 587 Westerly			SITE NO. Foundation Zone 1 ORIGINATED BY HF	
DIST 61 HWY 11/17			LOCATION 27+394.9 o/s 6.7 Rt			TBTE JOB# 08-171 COMPILED BY TB	
DATE 2009 February 13			BOREHOLE TYPE Hollow Stem Auger			DATUM Geodetic CHECKED BY SS	
SOIL PROFILE			SAMPLES			DYNAMIC CONE PENETRATION RESISTANCE PLOT	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	<div style="display: flex; justify-content: space-between;"> <div> <p>20 40 60 80 100</p> <p>SHEAR STRENGTH kPa</p> <p>○ UNCONFINED ✕ FIELD VANE</p> <p>■ SPT (N) ★ LAB VANE</p> <p>20 40 60 80 100</p> </div> <div> <p>20 40 60</p> <p>WATER CONTENT (%)</p> <p>W_p W W_L</p> </div> </div>
233.3 0.0	PEAT - brown/black		1	AS			<div style="display: flex; justify-content: space-between;"> <div> <p>20 40 60 80 100</p> <p>SHEAR STRENGTH kPa</p> <p>○ UNCONFINED ✕ FIELD VANE</p> <p>■ SPT (N) ★ LAB VANE</p> <p>20 40 60 80 100</p> </div> <div> <p>20 40 60</p> <p>WATER CONTENT (%)</p> <p>W_p W W_L</p> </div> </div>
232.3 1.0	SANDS & SILTS (of variable proportions) SAND - Silty, brown, loose ----- - trace silt		2	SS	5		233
		3	SS	4	232		
		4	SS	8	231		
		5	SS	5	230		
		6	SS	4	229		
228.9 4.4	TILL - SAND - Silty, Gravelly, occasional cobbles, grey, compact to very dense	7	SS	17	228		
		8	SS	100+	227		
227.0 6.3	End of Borehole @ 6.3 m. Auger Refusal.						

ON_MOT_BH-10 08-171 FOUNDATIONS ZONE 1.GPJ ON_MOT.GDT 09/6/15

TBT Engineering Consulting Group			RECORD OF Borehole No 1-05			1 OF 1 METRIC				
W.P. 66 120-03-00			PROJECT Four Laning - From Hwy 587 Westerly			SITE NO. Foundation Zone 1 ORIGINATED BY AF				
DIST 61 HWY 11/17			LOCATION 27+481.6 o/s 20.2 Lt			TBTE JOB# 08-171 COMPILED BY TB				
DATE 2009 February 12			BOREHOLE TYPE Hollow Stem Auger			DATUM Geodetic CHECKED BY SS				
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 WATER CONTENT (%)	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE						
233.9 0.0	PEAT - brown/black		1	AS						Water level @ 0.2 m on completion.
233.1 0.8	SAND - some silt, some gravel, brown/grey, loose		2	SS	6					12 76 (12)
232.5 232.4 1.5	PEAT TILL - SAND - Silty, occasional cobbles, brown, compact to very dense		3	SS	14					
231.6 2.3	End of Borehole @ 2.3 m. Auger Refusal.		4	SS	100+					

x³, ★³: Numbers refer to Sensitivity ○ 3% STRAIN AT FAILURE
 NP Non Plastic

TBT Engineering Consulting Group			RECORD OF Borehole No 1-06			1 OF 1 METRIC				
W.P. 66 120-03-00			PROJECT Four Laning - From Hwy 587 Westerly			SITE NO. Foundation Zone 1 ORIGINATED BY HF				
DIST 61 HWY 11/17			LOCATION 27+474.3 o/s 3.5 Lt			TBTE JOB# 08-171 COMPILED BY TB				
DATE 2009 February 17			BOREHOLE TYPE Hollow Stem Auger			DATUM Geodetic CHECKED BY SS				
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 WATER CONTENT (%)	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE						
233.5 0.0	PEAT - some silt, brown		1	AS						Water level @ 0.5 m on completion.
232.9 0.6	SANDS & SILTS (of variable proportions) SAND & SILT - brown, loose		2	SS	7					0 37 (63) Non Plastic.
232.2 1.3	TILL - SAND - Silty, trace gravel, occasional cobbles, compact to very dense		3	SS	13					4 64 (32)
231.1 2.4	----- - SILT - Sandy, grey End of Borehole @ 2.4 m. Auger Refusal.		4	SS	100+					

TBT Engineering Consulting Group			RECORD OF Borehole No 1-07				1 OF 1		METRIC					
W.P. 66 120-03-00			PROJECT Four Laning - From Hwy 587 Westerly				SITE NO. Foundation Zone 1		ORIGINATED BY HF					
DIST 61 HWY 11/17			LOCATION 27+469.2 o/s 12.2 Rt				TBTE JOB# 08-171		COMPILED BY TB					
DATE 2009 February 17			BOREHOLE TYPE Hollow Stem Auger				DATUM Geodetic		CHECKED BY SS					
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						
233.0								20 40 60 80 100						
0.0	PEAT		1	AS										Water level @ 0.5 m on completion.
232.3														
0.8	TILL - SAND & SILT - some gravel, trace clay, occasional cobbles, grey, very dense		2	SS	100+									13 51 36 1
231.9	End of Borehole @ 1.1 m. Auger Refusal.													
1.1														

TBT Engineering Consulting Group			RECORD OF Borehole No 1-08			1 OF 1 METRIC				
W.P. 66 120-03-00			PROJECT Four Laning - From Hwy 587 Westerly			SITE NO. Foundation Zone 1 ORIGINATED BY AF				
DIST 61 HWY 11/17			LOCATION 27+532.9 o/s 49.3 Lt			TBTE JOB# 08-171 COMPILED BY TB				
DATE 2009 February 12			BOREHOLE TYPE Hollow Stem Auger			DATUM Geodetic CHECKED BY SS				
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 WATER CONTENT (%)	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE						
234.1	0.0	PEAT - brown/black								
233.5	0.6	SANDS & SILTS (of variable proportions) SAND & SILT - layered, brown, very loose to loose ----- - occasional cobbles, very loose to very dense	1	AS						
			2	SS	2					
			3	SS	11					
231.6	2.5	TILL - SILT - Sandy, occasional cobbles, brown, very dense	4	SS	3					
231.3	2.8	End of Borehole @ 2.8 m. Auger Refusal.	5	SS	100+					

x³, ★³: Numbers refer to Sensitivity ○ 3% STRAIN AT FAILURE
 NP Non Plastic

TBT Engineering Consulting Group			RECORD OF Borehole No 1-09			1 OF 1		METRIC							
W.P. 66 120-03-00			PROJECT Four Laning - From Hwy 587 Westerly			SITE NO. Foundation Zone 1		ORIGINATED BY AF							
DIST 61 HWY 11/17			LOCATION 27+531.7 o/s 41.3 Rt			TBTE JOB# 08-171		COMPILED BY TB							
DATE 2009 February 17			BOREHOLE TYPE Hollow Stem Auger			DATUM Geodetic		CHECKED BY SS							
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							
232.5								20 40 60 80 100							
0.0	PEAT		1	AS											
231.9															
0.6	TILL - SILT - some sand, trace gravel, occasional cobbles, grey, compact to very dense		2	SS	12										
231.3			3	SS	100+										
1.2	End of Borehole @ 1.2 m. Auger Refusal.														

TBT Engineering Consulting Group			RECORD OF Borehole No 1-10			1 OF 1 METRIC	
W.P. 66 120-03-00			PROJECT Four Laning - From Hwy 587 Westerly			SITE NO. Foundation Zone 1 ORIGINATED BY AF	
DIST 61 HWY 11/17			LOCATION 27+579.2 o/s 20.6 Lt			TBTE JOB# 08-171 COMPILED BY TB	
DATE 2009 February 12			BOREHOLE TYPE Hollow Stem Auger			DATUM Geodetic CHECKED BY SS	
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES		
234.2 0.0	PEAT - brown/black		1	AS			
			2	SS	1		
			3	SS	1		
232.4 1.8	SANDS & SILTS (of variable proportions) SAND - trace silt, trace gravel, brown, very loose to compact		4	SS	3		
			5	SS	16		
			6	SS	22		
			7	SS	1		
			8	SS	5		
			9	SS	100+		
227.2 7.0	TILL - SAND - Silty, trace gravel, occasional cobbles, brown, very dense						
226.8 7.4	End of Borehole @ 7.4 m. Auger Refusal.						

DYNAMIC CONE PENETRATION RESISTANCE PLOT		SHEAR STRENGTH kPa		WATER CONTENT (%)		UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
20	40	60	80	100	20		
		○ UNCONFINED ✕ FIELD VANE		W _p W W _L			Water level @ 0.5 m on completion. 3 87 (9) 3 71 (26) 0 79 (21)
		■ SPT (N) ★ LAB VANE					
234						457.3	
						515.6	
233						342.6	
232							
231							
230							
229							
228							
227							

ON_MOT_BH-10 08-171 FOUNDATIONS ZONE 1.GPJ ON MOT.GDT 09/6/15

TBT Engineering Consulting Group			RECORD OF Borehole No 1-11			1 OF 1 METRIC					
W.P. 66 120-03-00			PROJECT Four Laning - From Hwy 587 Westerly			SITE NO. Foundation Zone 1 ORIGINATED BY AF					
DIST 61 HWY 11/17			LOCATION 27+582.7 o/s 16.6 Rt			TBTE JOB# 08-171 COMPILED BY TB					
DATE 2009 February 18			BOREHOLE TYPE Hollow Stem Auger			DATUM Geodetic CHECKED BY SS					
SOIL PROFILE			SAMPLES		GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT SHEAR STRENGTH kPa ○ UNCONFINED ✕ FIELD VANE ■ SPT (N) ★ LAB VANE	PLASTIC LIMIT W _p NATURAL MOISTURE CONTENT W LIQUID LIMIT W _L WATER CONTENT (%)	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE							"N" VALUES
233.5 0.0	PEAT		1	AS						Water level @ 0.4 m on completion.	
			2	SS	1						
231.8 1.7	SANDS & SILTS (of variable proportions) SAND - some gravel, trace silt, brown, very loose to compact SILT - Sandy, some gravel, brown, loose to compact		3	SS	2					14 81 (5)	
			4	SS	11						
			5	SS	2						
229.7 3.8	TILL - SILT - Sandy, some gravel, brown, compact to very dense		6	SS	10					13 25 (62)	
229.2 4.3			7	SS	100+						
	End of Borehole @ 4.3 m. Auger Refusal.										

✕³, ★³: Numbers refer to Sensitivity ○ 3% STRAIN AT FAILURE
NP Non Plastic

TBT Engineering Consulting Group		RECORD OF Borehole No 1-12		1 OF 1 METRIC								
W.P. 66 120-03-00		PROJECT Four Laning - From Hwy 587 Westerly		SITE NO. Foundation Zone 1 ORIGINATED BY AF								
DIST 61 HWY 11/17		LOCATION 27+629.1 o/s 34.9 Lt		TBTE JOB# 08-171 COMPILED BY TB								
DATE 2009 February 18		BOREHOLE TYPE Hollow Stem Auger		DATUM Geodetic CHECKED BY SS								
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					
234.7	PEAT - brown											
0.0												
234.4	SANDS & SILTS (of variable proportions) SAND & SILT - brown, compact to very loose		1	AS								Water level @ 0.5 m on completion.
0.3			2	SS	13							0 45 (55)
			3	SS	3							
			4	SS	6							
			5	SS	1							0 59 (42)
			6	SS	3							
230.3	TILL - SAND & SILT - some gravel, occasional cobbles, grey, dense to very dense		7	SS	39							13 45 (42)
4.4												
			8	SS	100+							2 33 (66)
	- SILT - Sandy, trace gravel											
227.7	End of Borehole @ 7.0 m. Auger Refusal.		9	SS	100+							
7.0												

x³, ★³: Numbers refer to Sensitivity ○ 3% STRAIN AT FAILURE
 NP Non Plastic

ON_MOT_BH-10 08-171 FOUNDATIONS ZONE 1.GPJ ON MOT.GDT 09/6/15

TBT Engineering Consulting Group			RECORD OF Borehole No 1-13			1 OF 1 METRIC					
W.P. 66 120-03-00			PROJECT Four Laning - From Hwy 587 Westerly			SITE NO. Foundation Zone 1 ORIGINATED BY AF					
DIST 61 HWY 11/17			LOCATION 27+631.3 o/s 2.4 Rt			TBTE JOB# 08-171 COMPILED BY TB					
DATE 2009 February 18			BOREHOLE TYPE Hollow Stem Auger			DATUM Geodetic CHECKED BY SS					
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS					
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	ELEVATION SCALE	REMARKS & GRAIN SIZE DISTRIBUTION (%)				
233.7 0.0	PEAT - black		1	AS		<div style="display: flex; justify-content: space-between;"> <div> <p>DYNAMIC CONE PENETRATION RESISTANCE PLOT</p> <p>SHEAR STRENGTH kPa</p> <p>○ UNCONFINED ✕ FIELD VANE</p> <p>■ SPT (N) ★ LAB VANE</p> </div> <div> <p>20 40 60 80 100</p> <p>20 40 60 80 100</p> </div> </div>	<p>PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT</p> <p>W_p W W_L</p> <p>20 40 60</p> <p>WATER CONTENT (%)</p>	<p>UNIT WEIGHT</p> <p>γ</p> <p>kN/m³</p>	<p>GR SA SI CL</p>		
233.0 0.7	SANDS & SILTS (of variable proportions)		2	SS	4					233	4 86 (10)
	SAND - trace silt, trace gravel, brown, loose to compact		3	SS	12					232	6 75 (18)
	- some silt		4	SS	7					231	
	- Silty		5	SS	11					230	
	SILT - Sandy, grey, loose		6	SS	2					229	
	- brown		7	SS	3					228	Non Plastic.
227.9 5.8	TILL - SAND - Silty, trace gravel, grey, very dense		8	SS	100+						3 70 (27)
227.3 6.4	End of Borehole @ 6.4 m. Auger Refusal.										

TBT Engineering Consulting Group			RECORD OF Borehole No 1-14			1 OF 1 METRIC											
W.P. 66 120-03-00			PROJECT Four Laning - From Hwy 587 Westerly			SITE NO. Foundation Zone 1 ORIGINATED BY AF											
DIST 61 HWY 11/17			LOCATION 27+624.4 o/s 44.1 Rt			TBTE JOB# 08-171 COMPILED BY TB											
DATE 2009 February 19			BOREHOLE TYPE Hollow Stem Auger			DATUM Geodetic CHECKED BY SS											
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT SHEAR STRENGTH kPa <div style="display: flex; justify-content: space-between; font-size: 0.8em;"> 20 40 60 80 100 20 40 60 80 100 </div> <div style="display: flex; justify-content: space-between; font-size: 0.7em;"> ○ UNCONFINED ✕ FIELD VANE ■ SPT (N) ★ LAB VANE </div>	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												
232.9 0.0	PEAT																
232.6 0.3	SANDS & SILTS (of variable proportions) SAND - some silt, brown, loose to compact ----- - trace gravel ----- - Silty ----- SILT - Sandy, brown, loose		1	AS													Water level @ 0.3 m on completion.
			2	SS	4		232										
			3	SS	10		231										10 70 (20)
			4	SS	15		230										0 61 (40)
			5	SS	13		229										0 32 (68)
			6	SS	4		228										
			7	SS	4		227										
227.0 5.9	End of Borehole @ 5.9 m. Auger Refusal.		8	SS	100+												

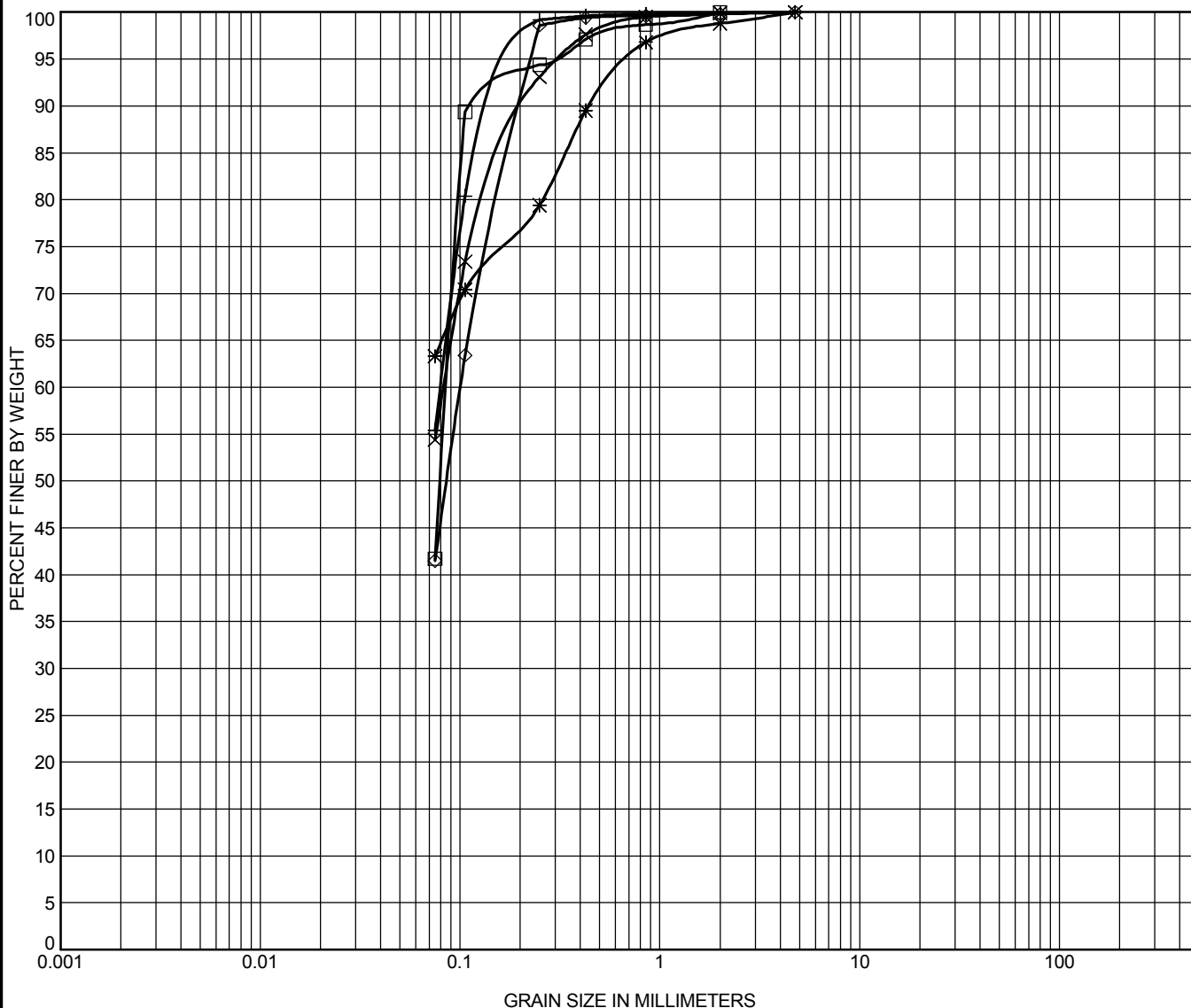
ON_MOT_BH-10 08-171 FOUNDATIONS ZONE 1.GPJ ON_MOT.GDT 09/6/15

TBT Engineering Consulting Group			RECORD OF Borehole No 1-15			1 OF 1 METRIC	
W.P. 66 120-03-00			PROJECT Four Laning - From Hwy 587 Westerly			SITE NO. Foundation Zone 1 ORIGINATED BY AF	
DIST 61 HWY 11/17			LOCATION 27+675.9 o/s 19.4 Lt			TBTE JOB# 08-171 COMPILED BY TB	
DATE 2009 February 19			BOREHOLE TYPE Hollow Stem Auger			DATUM Geodetic CHECKED BY SS	
SOIL PROFILE			SAMPLES			DYNAMIC CONE PENETRATION RESISTANCE PLOT	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	<div style="display: flex; justify-content: space-between;"> <div> <p>20 40 60 80 100</p> <p>SHEAR STRENGTH kPa</p> <p>○ UNCONFINED ✕ FIELD VANE</p> <p>■ SPT (N) ★ LAB VANE</p> <p>20 40 60 80 100</p> </div> <div> <p>20 40 60</p> <p>WATER CONTENT (%)</p> <p>W_p W W_L</p> </div> </div>
235.0	PEAT - brown/black		1	AS			
234.2	SANDS & SILTS (of variable proportions) SAND - some silt, trace gravel, brown, loose TILL - SAND & SILT - layered, trace gravel, occasional cobbles, brown/grey, compact to very dense	2	SS	9			
233.6		3	SS	16			
233.6		4	SS	25			
233.6		5	SS	100+			
233.6		6	SS	100+			
233.6	7	SS	100+				
233.6	8	SS	100+				
229.2	End of Borehole @ 5.8 m. Auger Refusal.						

TBT Engineering Consulting Group			RECORD OF Borehole No 1-16			1 OF 1 METRIC				
W.P. 66 120-03-00			PROJECT Four Laning - From Hwy 587 Westerly			SITE NO. Foundation Zone 1 ORIGINATED BY HF				
DIST 61 HWY 11/17			LOCATION 27+681.3 o/s 20.3 Rt			TBTE JOB# 08-171 COMPILED BY TB				
DATE 2009 February 19			BOREHOLE TYPE Hollow Stem Auger			DATUM Geodetic CHECKED BY SS				
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 WATER CONTENT (%)	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE						
232.9	TOPSOIL									
232.7										
0.2	SANDS & SILTS (of variable proportions) SAND - some gravel, some silt, brown, loose - trace gravel SILT - grey, compact		1	AS						
			2	SS	3					19 70 (11)
			3	SS	13					
230.8										
2.1	TILL - SAND & SILT - some gravel, occasional cobbles, grey, compact to very dense		4	SS	21					
			5	SS	16					11 37 (53)
			6	SS	100+					
229.0	End of Borehole @ 3.9 m. Auger Refusal.									
3.9										

APPENDIX B

Laboratory Test Data



SILT OR CLAY	SAND			GRAVEL		COBBLES
	fine	medium	coarse	fine	coarse	

Remarks:
SAND & SILT

Test Hole	Depth	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
□ 1-03	6.10	2	0.086			0.0	58.3	41.7	
* 1-06	0.75	4.75				0.0	36.7	63.3	
× 1-08	1.50	4.75	0.083			0.0	45.6	54.4	
+ 1-12	0.75	4.75	0.08			0.0	44.6	55.4	
◇ 1-12	3.00	4.75	0.1			0.0	58.5	41.5	



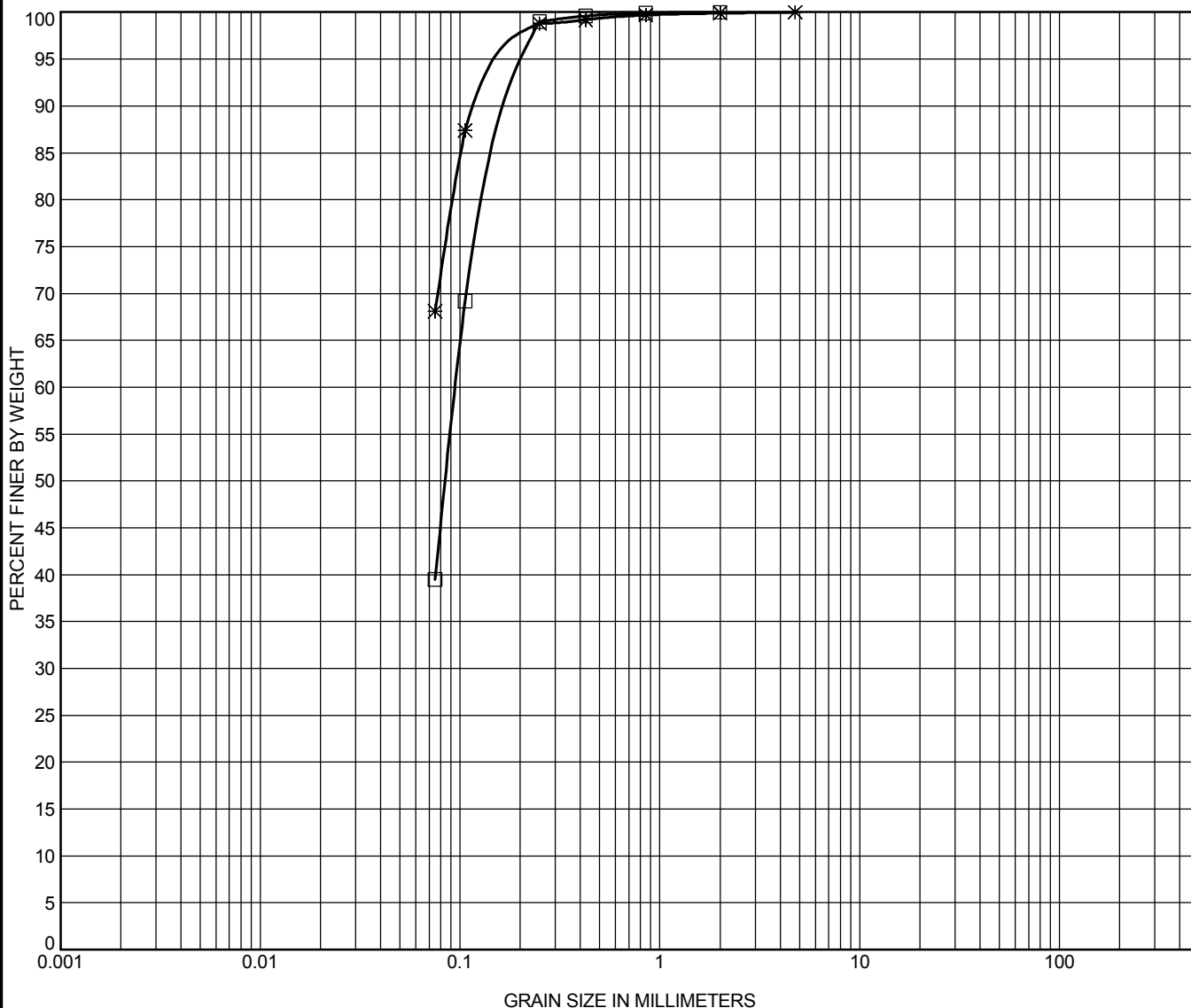
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Thunder Bay, Ontario P7C 3V4
PH: 807-624-5160
FX: 807-264-5161
Email: tbte@tbte.ca
Web: www.tbte.ca

GRAIN SIZE DISTRIBUTION

Project: Four Laning - From Hwy 587 Westerly

W P: 66 120-03-00

DIST: 61 HWY: 11/17



SILT OR CLAY	SAND			GRAVEL		COBBLES
	fine	medium	coarse	fine	coarse	

Remarks:
SAND & SILT

Test Hole	Depth	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
□ 1-14	3.00	2	0.095			0.0	60.5	39.5	
* 1-14	4.60	4.75				0.0	31.9	68.1	



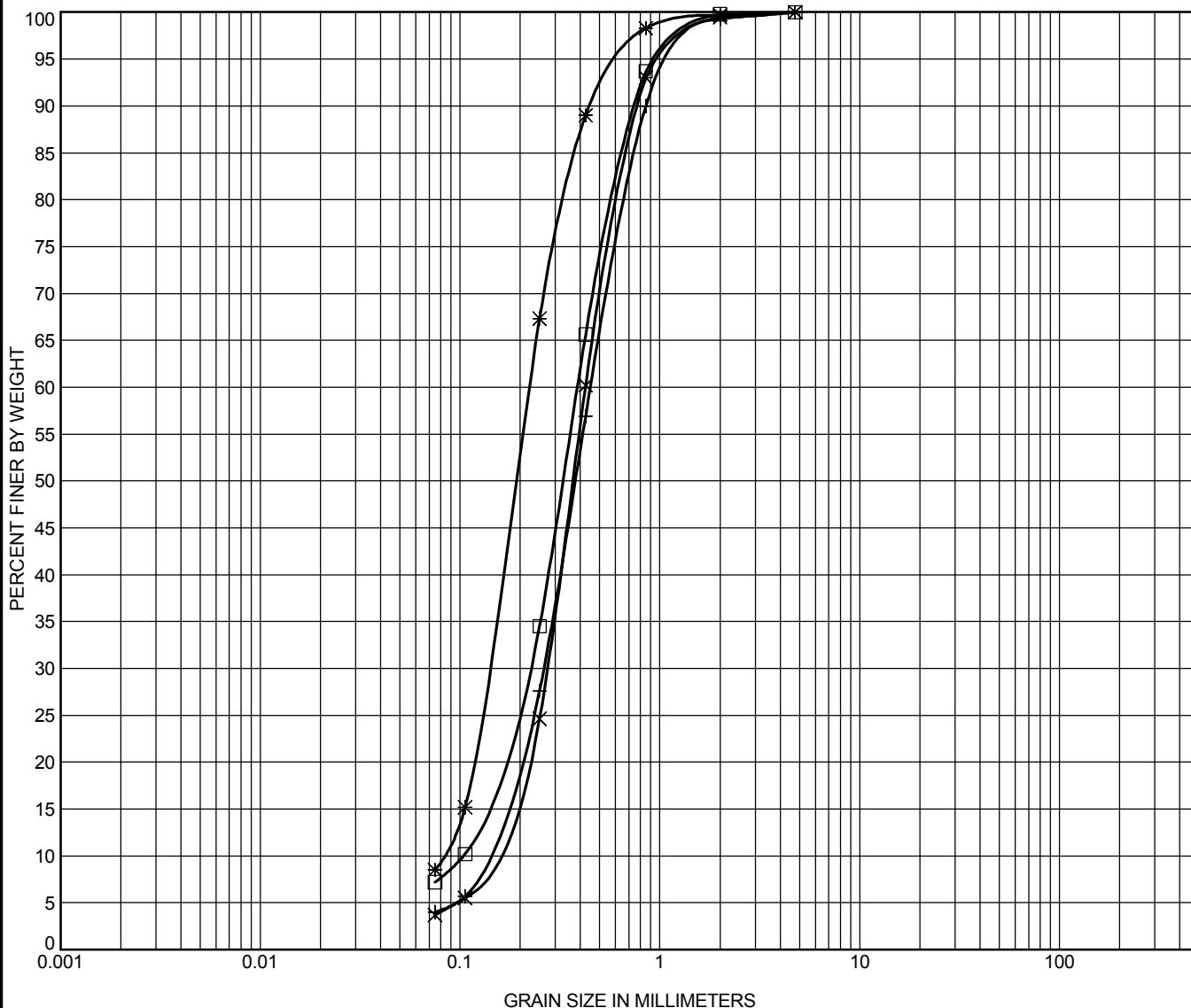
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GRAIN SIZE DISTRIBUTION

Project: Four Laning - From Hwy 587 Westerly

W P: 66 120-03-00

DIST: 61 HWY: 11/17



SILT OR CLAY	SAND			GRAVEL		COBBLES
	fine	medium	coarse	fine	coarse	

Remarks:
SAND - trace silt

Test Hole	Depth	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
□ 1-01	0.75	4.75	0.386	0.213	0.104	0.0	92.8	7.2	
* 1-01	3.00	4.75	0.222	0.135	0.081	0.0	91.5	8.5	
× 1-02	4.60	4.75	0.424	0.271	0.13	0.0	96.3	3.7	
+ 1-04	2.30	4.75	0.454	0.261	0.125	0.0	96.0	4.0	



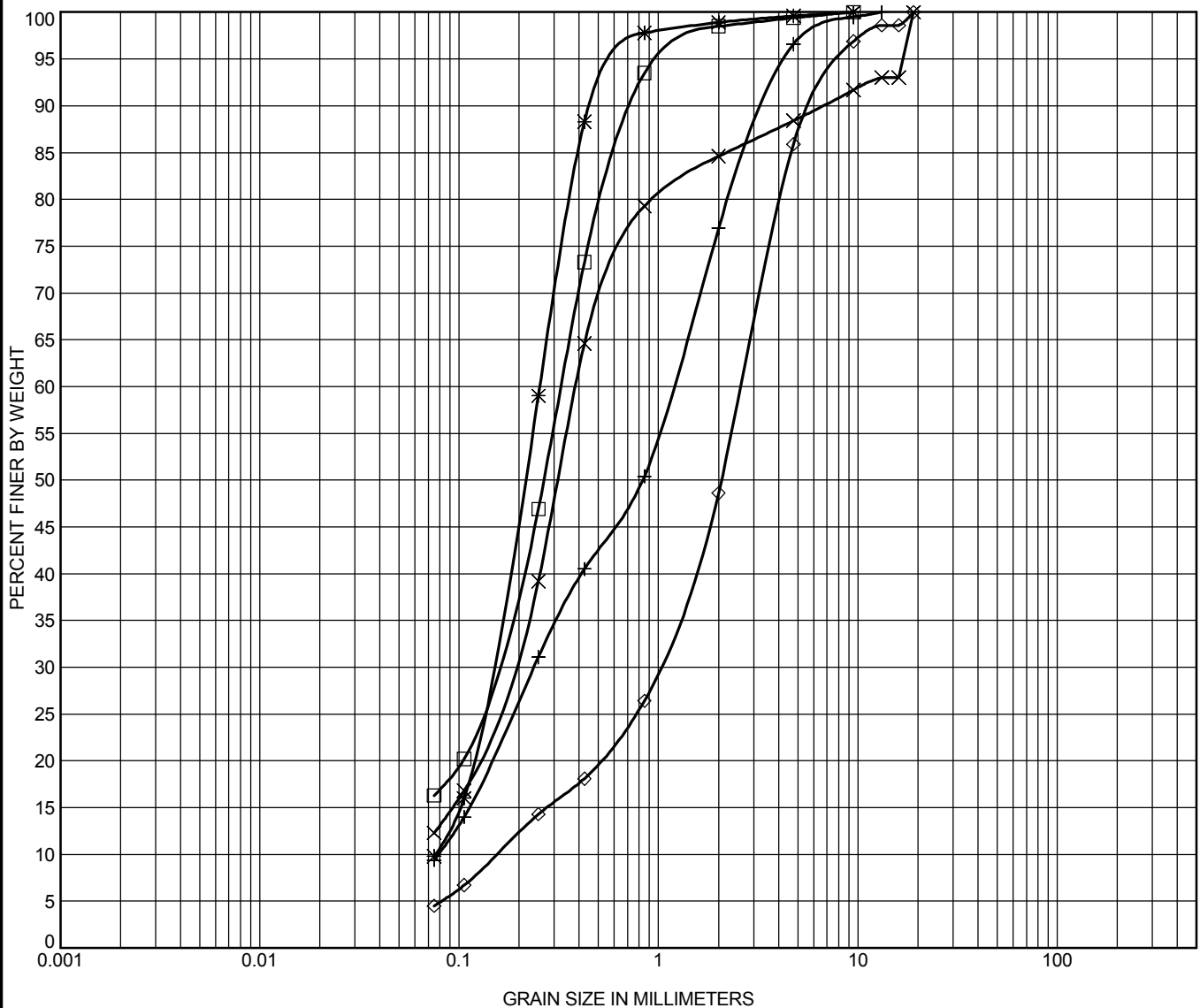
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GRAIN SIZE DISTRIBUTION

Project: Four Laning - From Hwy 587 Westerly

W P: 66 120-03-00

DIST: 61 HWY: 11/17



SILT OR CLAY	SAND			GRAVEL		COBBLES
	fine	medium	coarse	fine	coarse	

Remarks:
SAND - some silt, trace to some gravel

Test Hole	Depth	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
□ 1-02	1.50	9.5	0.325	0.145		0.6	83.1	16.3	
* 1-03	1.50	9.5	0.255	0.14	0.076	0.4	89.8	9.8	
× 1-05	0.75	19	0.386	0.176		11.6	76.1	12.3	
+ 1-10	2.30	13.2	1.159	0.237	0.078	3.4	87.2	9.4	
◇ 1-11	2.30	19	2.605	0.977	0.154	14.1	81.4	4.5	



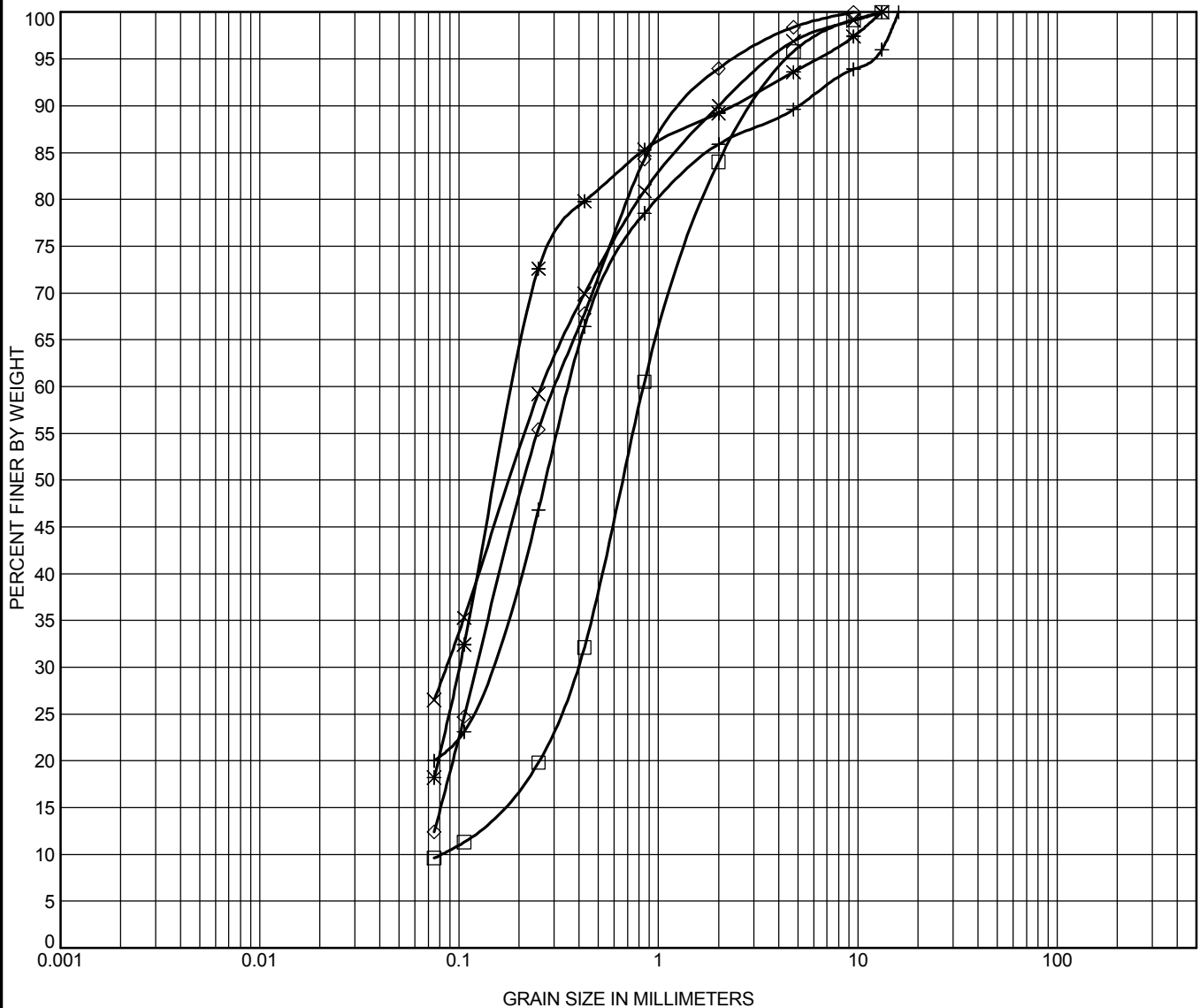
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GRAIN SIZE DISTRIBUTION

Project: Four Laning - From Hwy 587 Westerly

W P: 66 120-03-00

DIST: 61 HWY: 11/17



SILT OR CLAY	SAND			GRAVEL		COBBLES
	fine	medium	coarse	fine	coarse	

Remarks:
SAND - some silt, trace to some gravel

Test Hole	Depth	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
□ 1-13	0.75	13.2	0.84	0.388	0.081	4.2	86.2	9.6	
* 1-13	2.30	13.2	0.191	0.1		6.4	75.4	18.2	
× 1-13	6.10	13.2	0.26	0.086		3.1	70.4	26.5	
+ 1-14	1.50	16	0.357	0.136		10.4	69.6	20.0	
◇ 1-15	0.75	9.5	0.304	0.123		1.6	86.0	12.4	



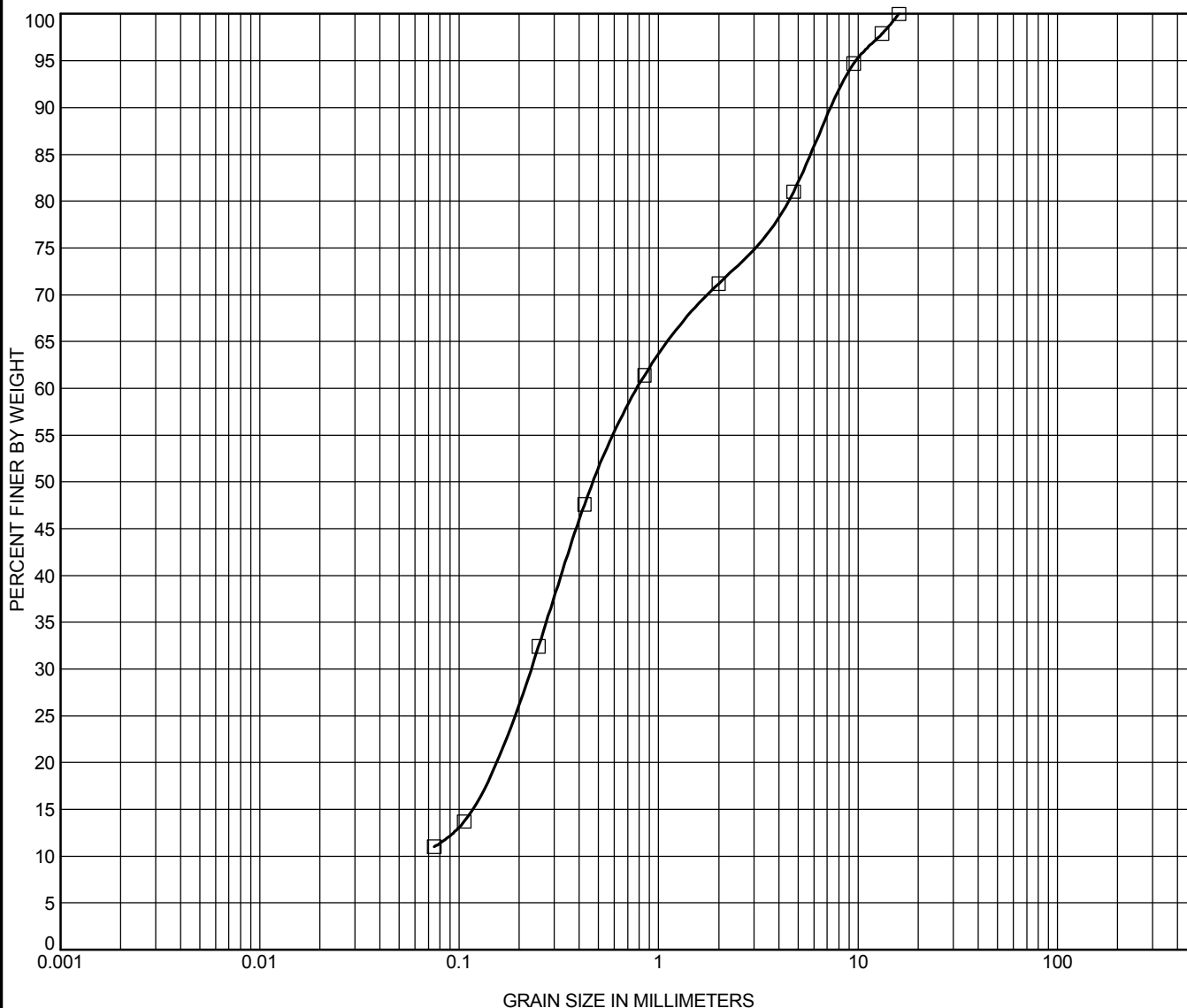
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GRAIN SIZE DISTRIBUTION

Project: Four Laning - From Hwy 587 Westerly

W P: 66 120-03-00

DIST: 61 HWY: 11/17



SILT OR CLAY	SAND			GRAVEL		COBBLES
	fine	medium	coarse	fine	coarse	

Remarks:

SAND - some silt, trace to some gravel

Test Hole	Depth	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
1-16	0.75	16	0.792	0.224		19.0	70.0	11.0	



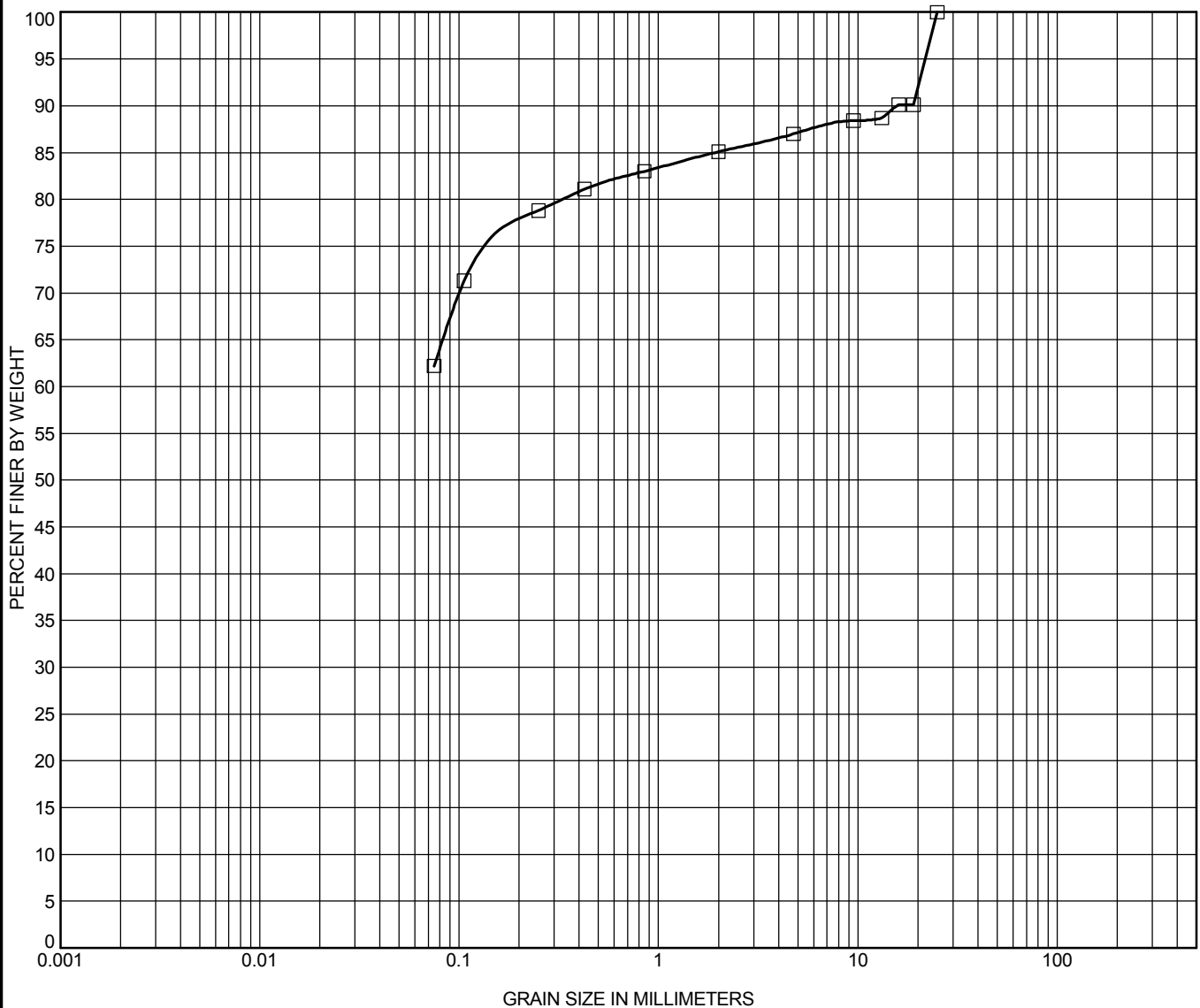
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GRAIN SIZE DISTRIBUTION

Project: Four Laning - From Hwy 587 Westerly

W P: 66 120-03-00

DIST: 61 HWY: 11/17



SILT OR CLAY	SAND			GRAVEL		COBBLES
	fine	medium	coarse	fine	coarse	

Remarks:
SILT - Sandy, some gravel

Test Hole	Depth	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
1-11	3.80	25				13.0	24.8	62.2	



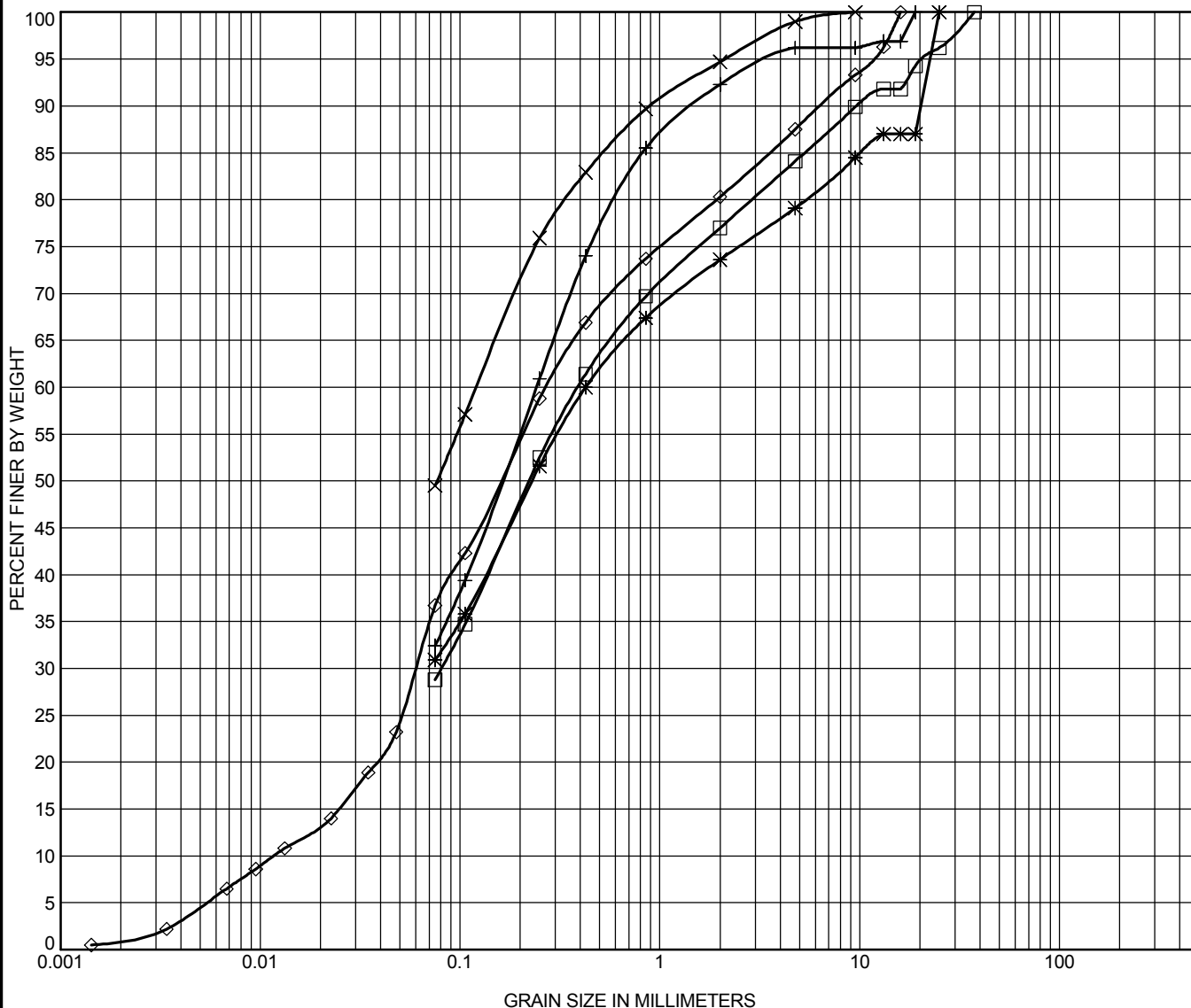
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GRAIN SIZE DISTRIBUTION

Project: Four Laning - From Hwy 587 Westerly

W P: 66 120-03-00

DIST: 61 HWY: 11/17



SILT OR CLAY	SAND			GRAVEL		COBBLES
	fine	medium	coarse	fine	coarse	

Remarks:
SAND & SILT to Silty - trace to some gravel

Test Hole	Depth	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
□ 1-01	6.10	37.5	0.391	0.08		15.9	55.3	28.8	
* 1-04	4.60	25	0.425			20.9	48.2	30.9	
× 1-04	6.10	9.5	0.121			1.0	49.5	49.5	
+ 1-06	1.50	19	0.241			3.8	63.8	32.4	
◇ 1-07	0.75	16	0.27	0.06	0.012	12.5	50.8	36.7	



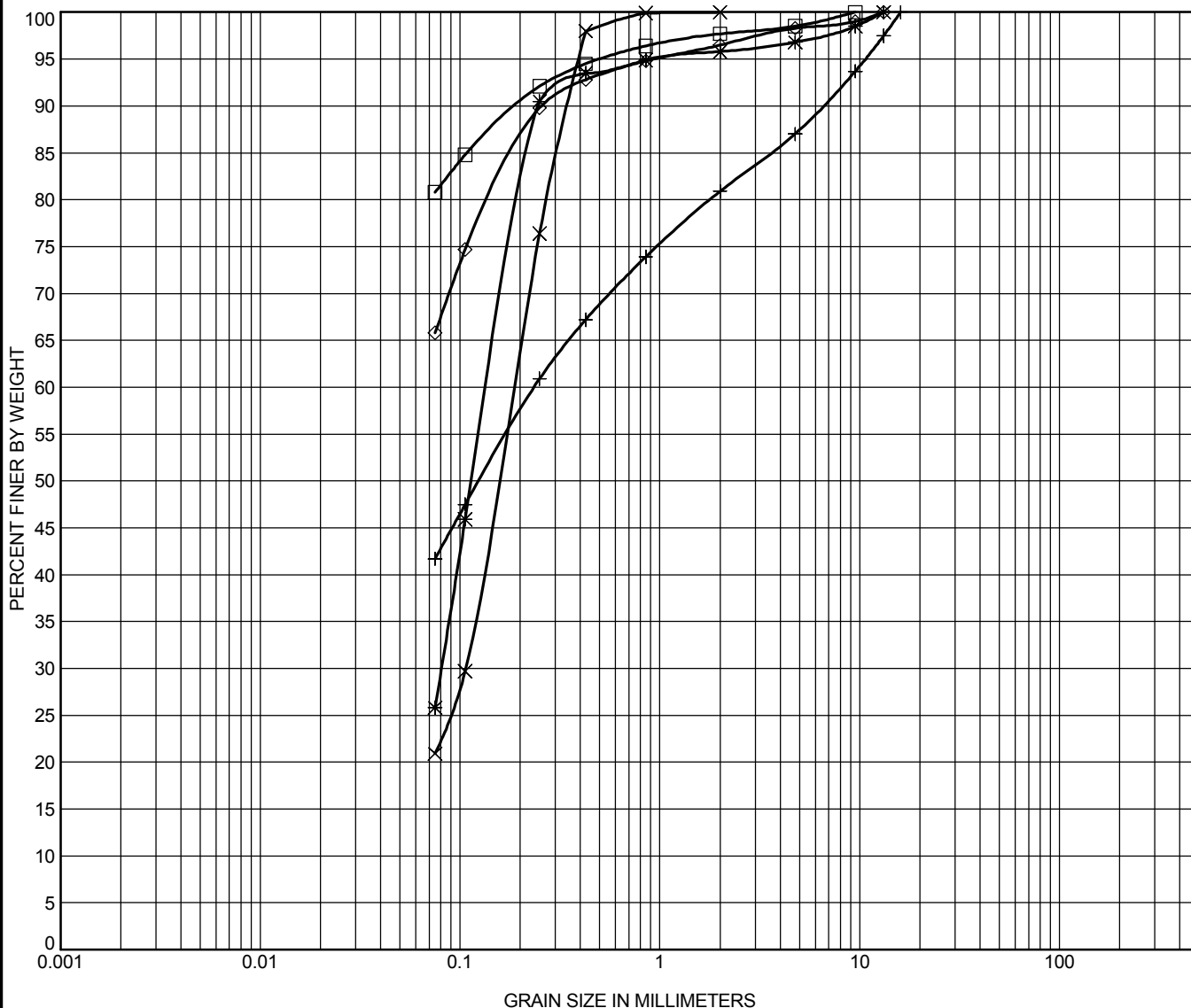
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GRAIN SIZE DISTRIBUTION

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W P: 66 120-03-00

DIST: 61 HWY: 11/17



SILT OR CLAY	SAND			GRAVEL		COBBLES
	fine	medium	coarse	fine	coarse	

Remarks:
SAND & SILT to Silty - trace to some gravel

Test Hole	Depth	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
□ 1-09	0.75	9.5				1.5	17.7	80.8	
* 1-10	3.80	13.2	0.139	0.081		3.2	71.0	25.8	
× 1-10	6.10	2	0.185	0.107		0.0	79.1	20.9	
+ 1-12	4.60	16	0.236			13.0	45.3	41.7	
◇ 1-12	6.10	13.2				1.7	32.5	65.8	



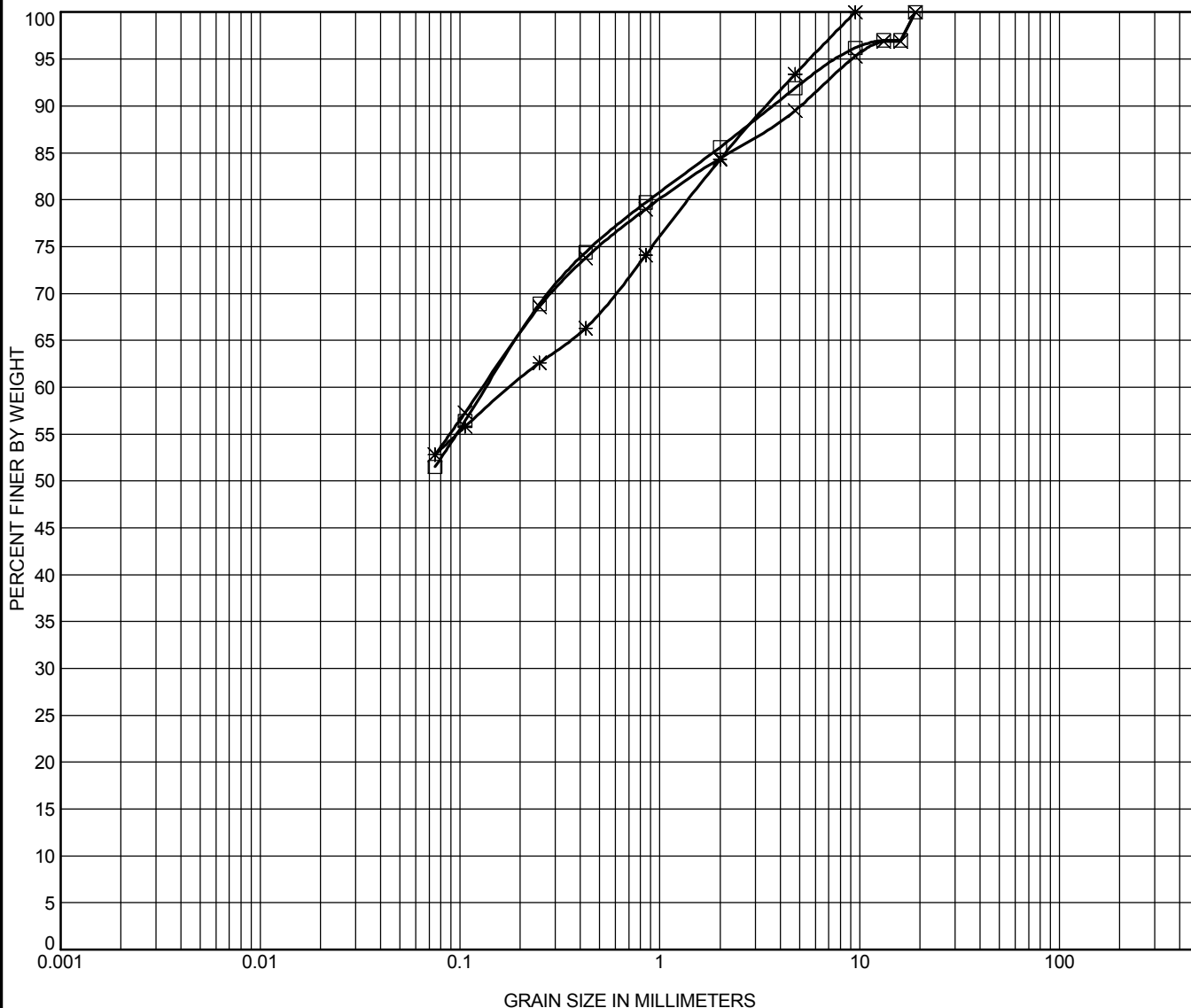
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GRAIN SIZE DISTRIBUTION

Project: Four Laning - From Hwy 587 Westerly

W P: 66 120-03-00

DIST: 61 HWY: 11/17



SILT OR CLAY	SAND			GRAVEL		COBBLES
	fine	medium	coarse	fine	coarse	

Remarks:
SAND & SILT to Silty - trace to some gravel

Test Hole	Depth	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
□ 1-15	2.30	19	0.136			8.1	40.4	51.5	
* 1-15	3.80	9.5	0.18			6.6	40.6	52.8	
× 1-16	3.00	19	0.13			10.5	36.7	52.8	



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GRAIN SIZE DISTRIBUTION

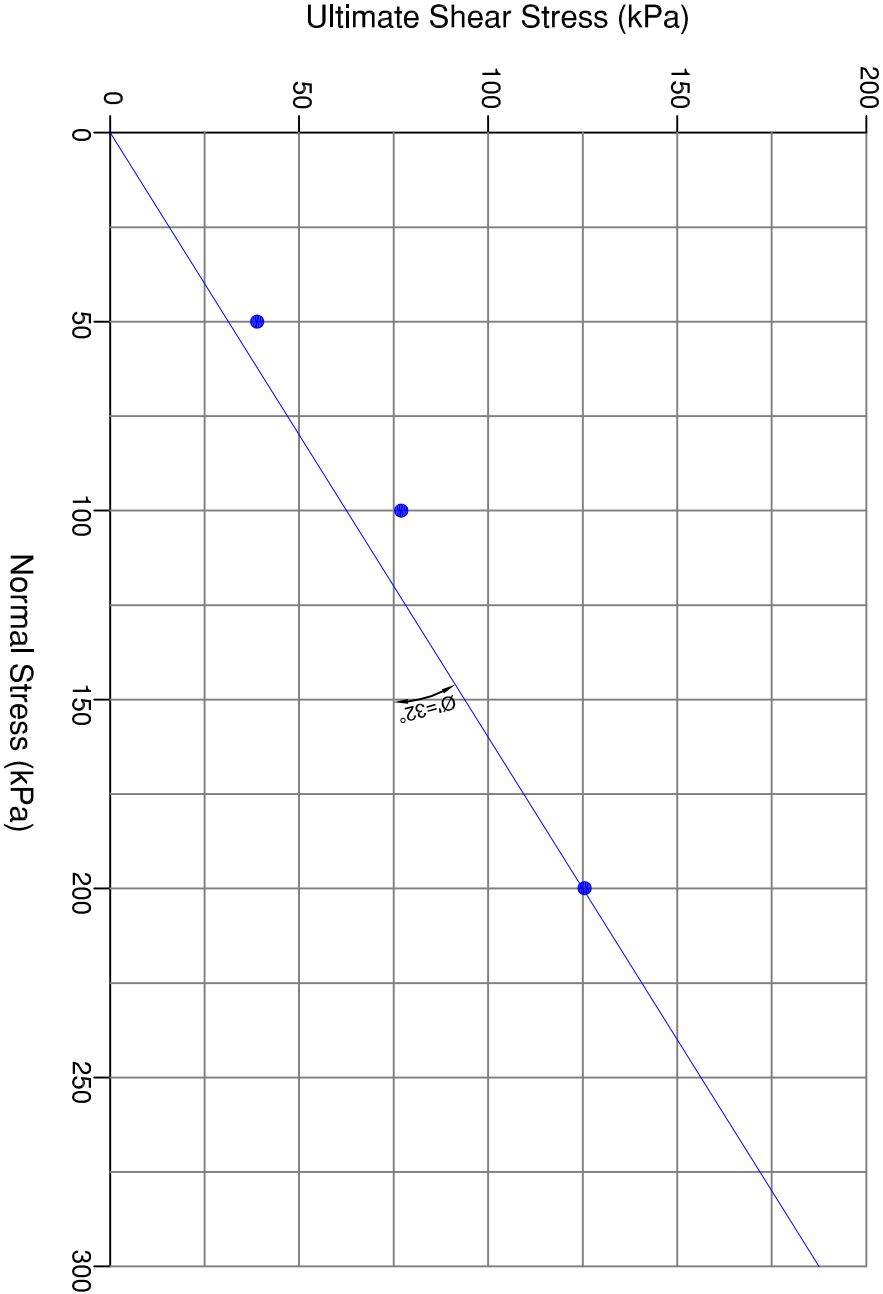
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DIST: 61 HWY: 11/17

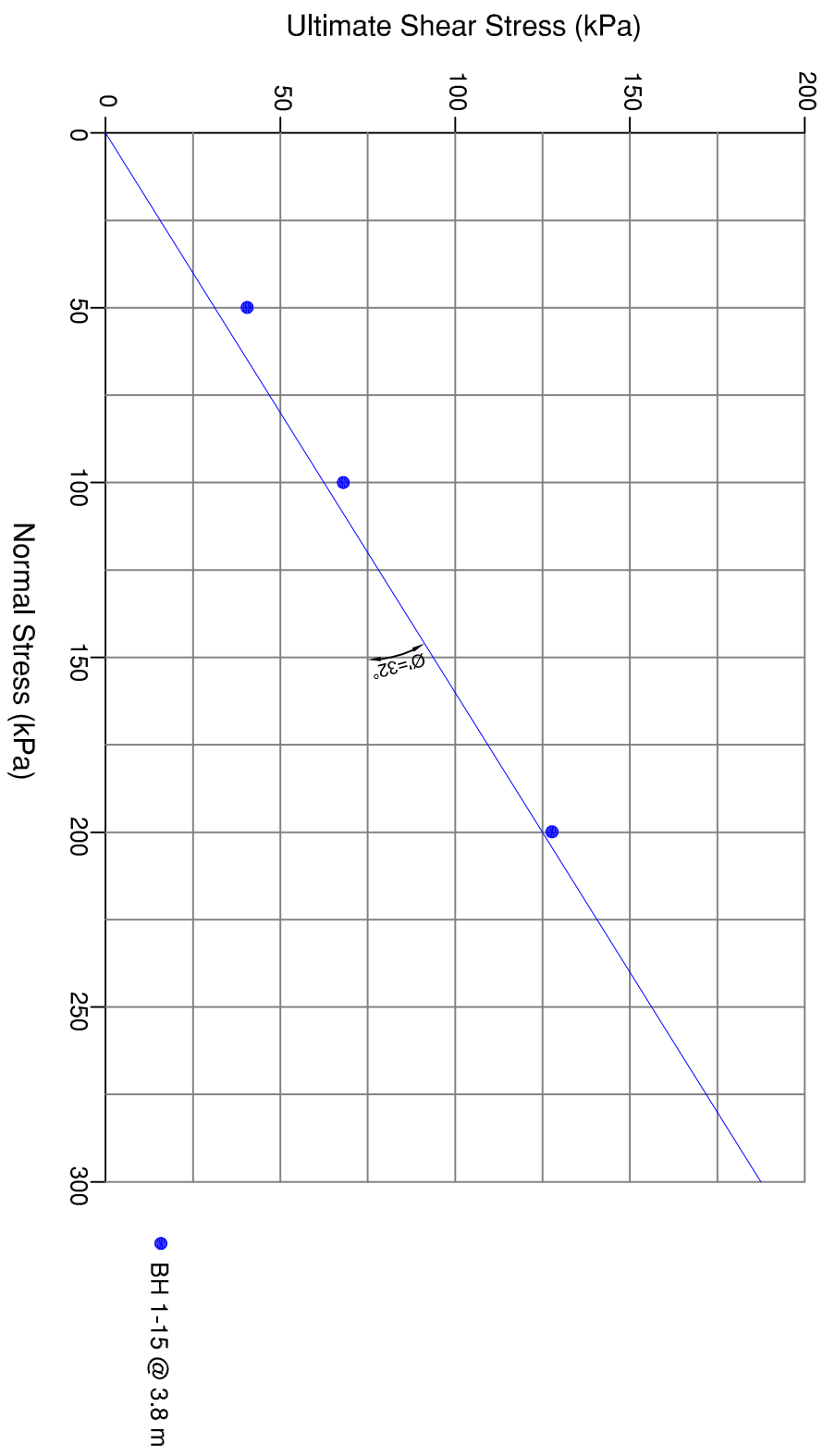
CONSOLIDATED/DRAINED
DIRECT SHEAR TESTING - Silty Sand

CONT No	xxxxxx
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GEOCRES No	52A-136
11/17 4 LAINING	
FOUNDATION ZONE	1
TOWNSHIP OF MCGREGOR	

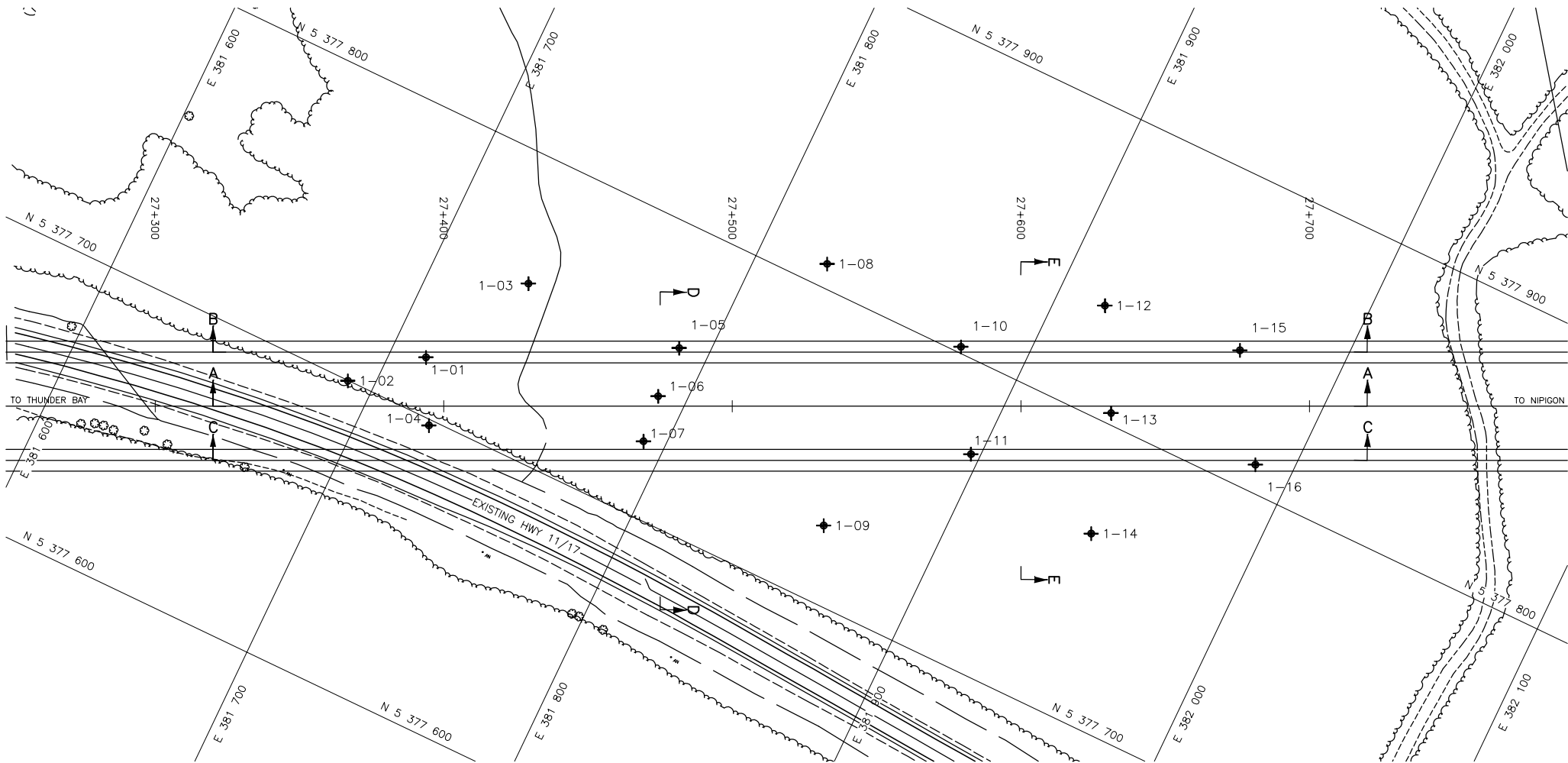


● BH 1-10 @ 3.8 m

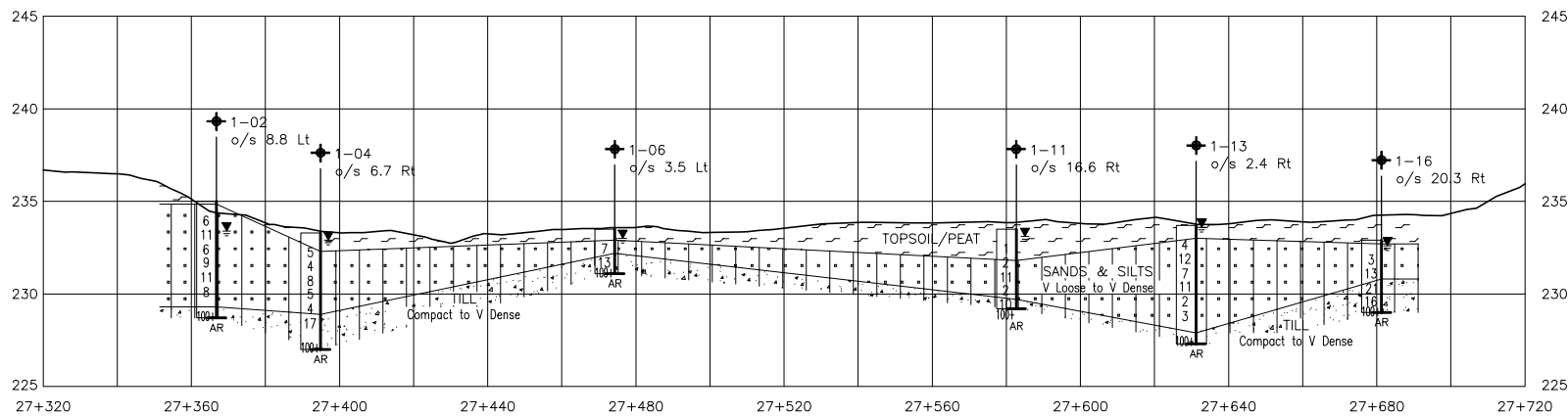
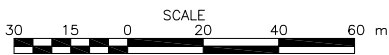
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<div> <div>GWP No</div> <div>6120-03-00</div> </div>		<div> <div>GEOCRES No</div> <div>52A-136</div> </div>
<div> <div>11/17 4 LANING</div> <div>FOUNDATION ZONE 1</div> <div>TOWNSHIP OF MccGREGOR</div> </div>		



APPENDIX C
Borehole Locations and Soil Strata Drawings



PLAN



SECTION A - A



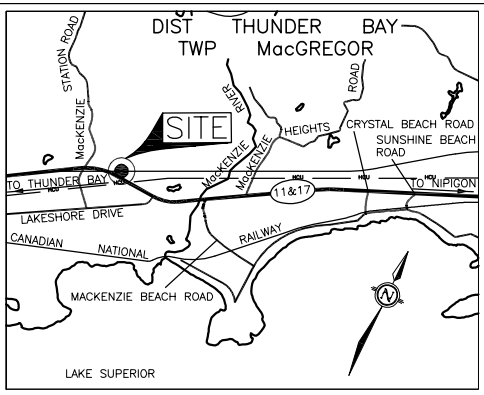
METRIC
DIMENSIONS ARE IN METRES
AND/OR MILLIMETRES
UNLESS OTHERWISE SHOWN

CONT No xxxxxx
GWP No 6120-03-00
GEOCRES No 52A-136



4 LANEING EAST MCKENZIE EAST
TOWNSHIP OF MacGREGOR
BOREHOLE LOCATIONS AND SOIL STRATA

SHEET



KEY PLAN
1.0 km 0 1.0 km
SCALE 1:100,000

NOTE

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

LEGEND

- Borehole
- 'N' Std Pen Test (Blows/0.3m)
- WL at time of investigation

SOIL STRATA SYMBOLS			
	PEAT or TOPSOIL		SAND & SILT
	SAND		GLACIAL TILLS Non Cohesive

No	ELEVATION	CO-ORDINATES	
		NORTH	EAST
1-01	234.7	15 5 377 719	381 712
1-02	235.0	15 5 377 700	381 691
1-03	235.7	15 5 377 757	381 733
1-04	233.3	15 5 377 698	381 723
1-05	233.9	15 5 377 760	381 790
1-06	233.5	15 5 377 741	381 790
1-07	233.0	15 5 377 725	381 793
1-08	234.1	15 5 377 808	381 823
1-09	232.5	15 5 377 726	381 861
1-10	234.2	15 5 377 802	381 878
1-11	233.5	15 5 377 770	381 897
1-12	234.7	15 5 377 836	381 917
1-13	233.7	15 5 377 804	381 935
1-14	232.9	15 5 377 763	381 946
1-15	235.0	15 5 377 843	381 965
1-16	232.9	15 5 377 809	381 987

REVISIONS					
	2009/MO/DY	TB	FOR REVIEW		
	DATE	BY	REVISION		
4 LANING MCKENZIE EAST			DIST		THUNDER BAY
SUBM'D	..	CHECKED	DATE XXXXX	SITE	ZONE 1
DRAWN	TB	CHECKED	WH	DWG	1
			APPROVED		

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

CONT No xxxxxx
GWP No 6120-03-00
GEOCRES No 52A-136

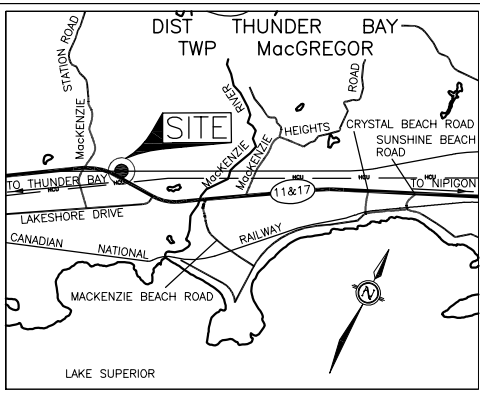


4 LANEING EAST McKENZIE EAST
TOWNSHIP OF MacGREGOR
BOREHOLE LOCATIONS AND SOIL STRATA

SHEET



TBT ENGINEERING

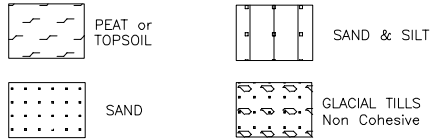


KEY PLAN
1.0 km 0 1.0 km
SCALE 1:100,000

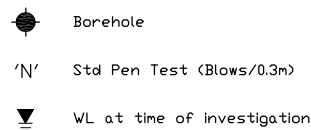
NOTE

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

SOIL STRATA SYMBOLS



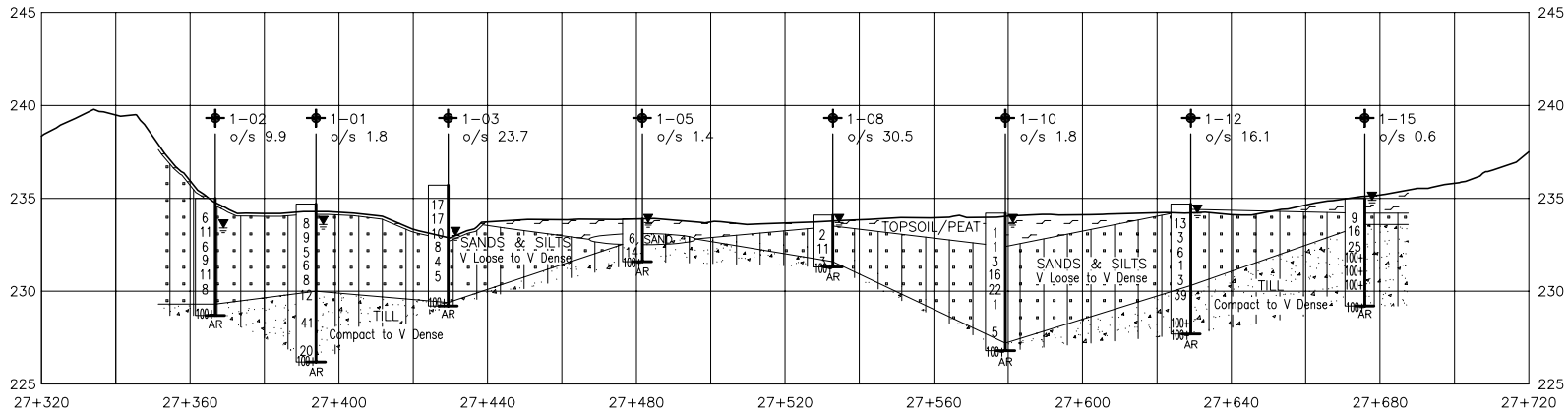
LEGEND



No	ELEVATION	CO-ORDINATES	
		NORTH	EAST
1-01	234.7	15 5 377 719	381 712
1-02	235.0	15 5 377 700	381 691
1-03	235.7	15 5 377 757	381 733
1-04	233.3	15 5 377 698	381 723
1-05	233.9	15 5 377 760	381 790
1-06	233.5	15 5 377 741	381 790
1-07	233.0	15 5 377 725	381 793
1-08	234.1	15 5 377 808	381 823
1-09	232.5	15 5 377 726	381 861
1-10	234.2	15 5 377 802	381 878
1-11	233.5	15 5 377 770	381 897
1-12	234.7	15 5 377 836	381 917
1-13	233.7	15 5 377 804	381 935
1-14	232.9	15 5 377 763	381 946
1-15	235.0	15 5 377 843	381 965
1-16	232.9	15 5 377 809	381 987

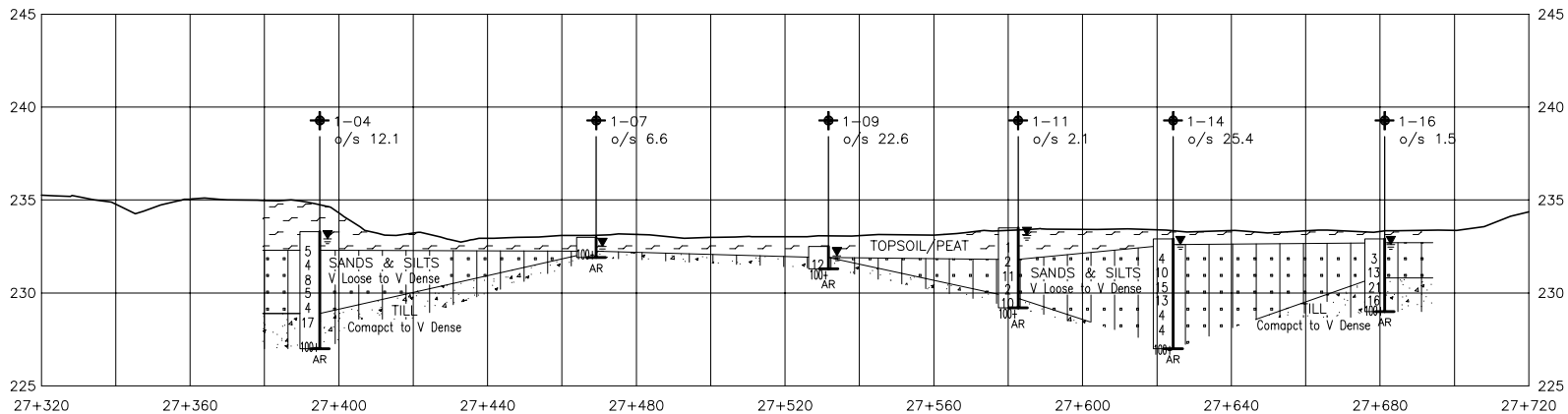
REVISIONS

2009/MO/DY	TB	FOR REVIEW	
DATE	BY	REVISION	
4 LANEING McKENZIE EAST		DIST	THUNDER BAY
SUBM'D ..	CHECKED	DATE XXXXX	SITE
DRAWN TB	CHECKED WH	APPROVED	ZONE 1
		DWG	1



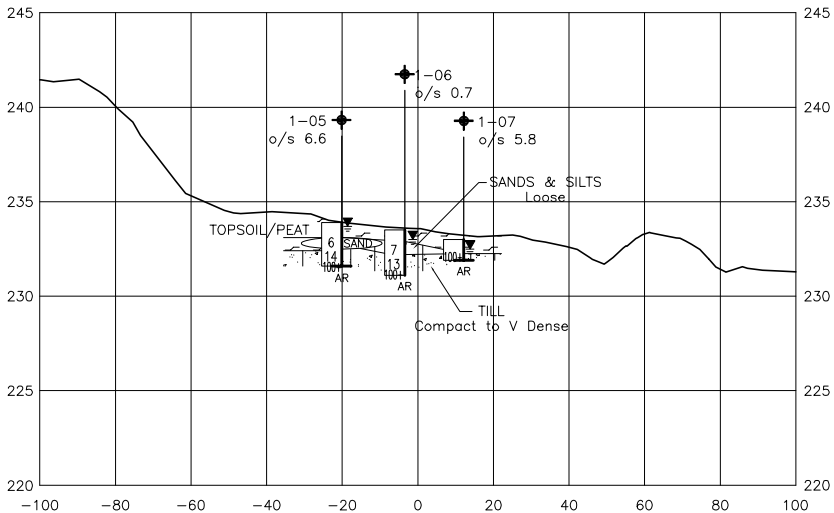
SECTION B-B

SCALE
HOR 30 15 0 20 40 60 m
VERT 6 3 0 4 8 12 m



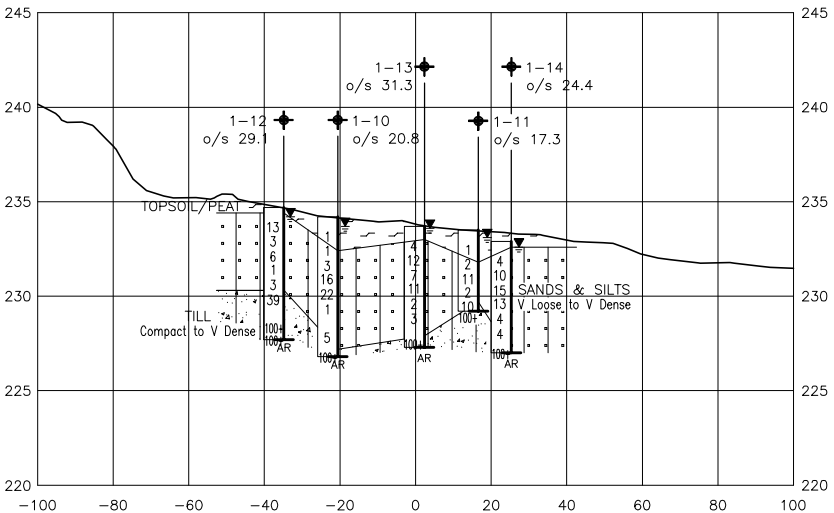
SECTION C-C

SCALE
HOR 30 15 0 20 40 60 m
VERT 6 3 0 4 8 12 m



SECTION D-D

SCALE
HOR 30 15 0 20 40 60 m
VERT 6 3 0 4 8 12 m

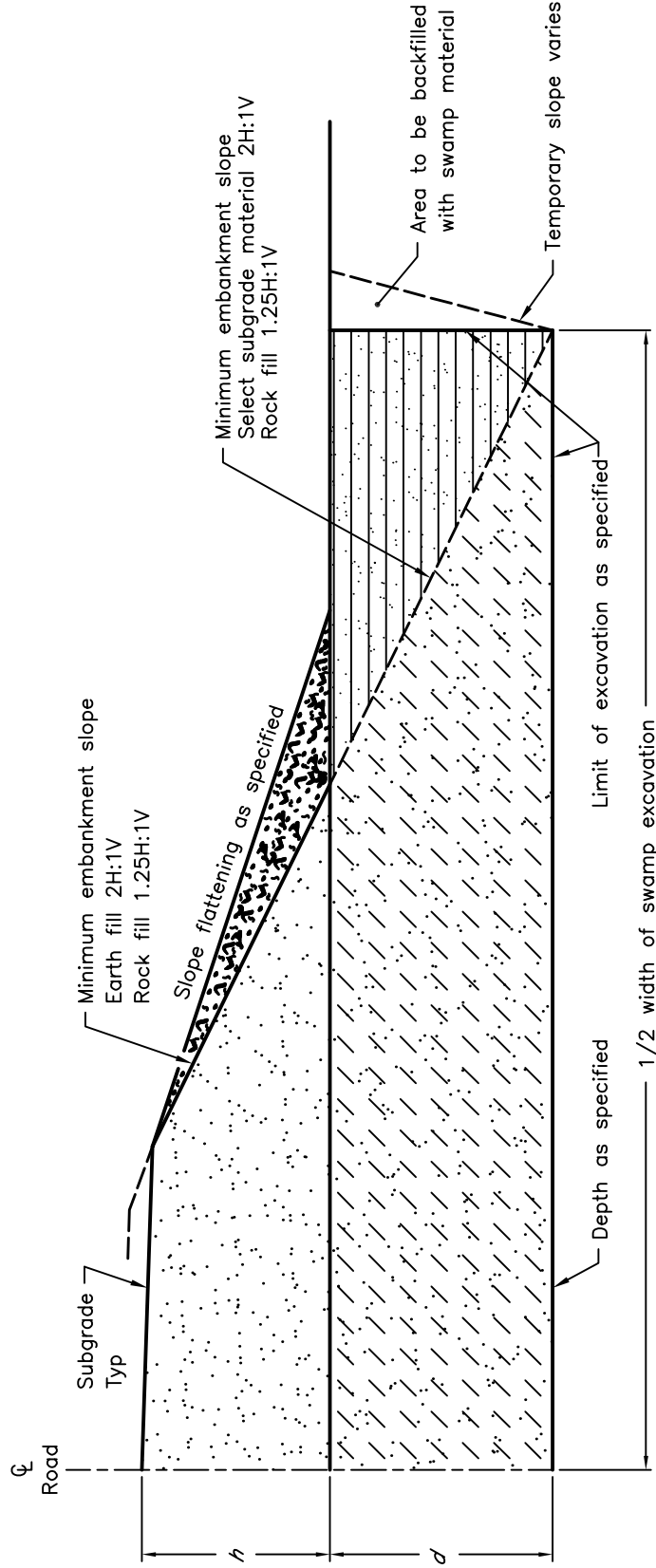


SECTION E-E

SCALE
HOR 30 15 0 20 40 60 m
VERT 6 3 0 4 8 12 m

APPENDIX D

OPSD 203.010 M and OPSS 209



NOTES:

- A For this OPSD, h must be $\leq 8.0\text{m}$ and d must be $\leq 6.0\text{m}$.
- B Height of fill is the vertical difference between top of subgrade and top of swamp elevation measured at new road centreline.
- C Excavate swamp material full width.
- D All dimensions are in millimetres unless otherwise shown.

LEGEND:

- Embankment materials as specified
- Excavated swamp material
- Excavate and backfill as specified
- Excavate and backfill with swamp material

- h – Height of fill
- d – Depth of sub-excitation

ONTARIO PROVINCIAL STANDARD DRAWING

Nov 2005 Rev 2

EMBANKMENTS OVER SWAMP

NEW CONSTRUCTION



OPSD – 203.010M

**CONSTRUCTION SPECIFICATION FOR
EMBANKMENTS OVER SWAMPS**

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209.04	Not Used	.02	Rental of Swamp Excavation Equipment
209.05	MATERIALS	.03	Select Subgrade Material
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.02	Earth or Rock Borrow	209.09.01.04	Geotextile
.03	Select Subgrade Material	209.09.02	Plan Quantity Measurement
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209.06	EQUIPMENT	209.10	BASIS OF PAYMENT
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.02	Clearing and Close Cut Clearing	.05	Management of Swamp Material Excavated by Equipment Rental
.03	Method 'A' - Excavation		
209.07.03.01	Embankment Construction and Backfill	209.01	SCOPE
209.07.04	Method 'B' - Floatation		This specification covers the requirements for the construction of embankments over swamps.
209.07.04.01	Swamp Waves	209.02	REFERENCES
.02	Embankment Construction		This specification refers to the following standards, specifications or publications:
.03	Geotextile		
209.07.05	Method 'C' - Displacement		
209.07.05.01	Embankment Construction		
209.07.06	Management of Excavated Material		

- OPSS 127 Schedule of Rental Rates for Construction Equipment Including Model and Specification Reference
- OPSS 180 Management and Disposal of Excess Material

Ontario Provincial Standard Specifications, Construction:

- OPSS 201 Clearing, Close Cut Clearing, Grubbing and Removal of Surface Boulders
- OPSS 206 Grading
- OPSS 212 Borrow

Ontario Provincial Standard Specifications, Material:

- OPSS 1010 Aggregates - Granular A, B, M and Select Subgrade Material
- OPSS 1860 Geotextiles

209.03 DEFINITIONS

For the purposes of this specification, the following definitions apply:

Floatation: means to build the embankment directly on the swamp, minimizing the displacement of the swamp material.

Displacement: means to build the embankment directly on the swamp, in such a manner as to displace as much of the underlying swamp material as possible.

Swamp Material: means the materials within the swamp excavation, floatation or displacement limits, except rock, masonry, natural wood and manufactured products.

209.05 MATERIALS

209.05.01 Embankment Materials

Embankment materials shall consist of earth, rock, or select subgrade material as specified.

209.05.01.01 Earth or Rock

Earth or rock shall be as defined in OPSS 206.

209.05.01.02 Earth or Rock Borrow

Earth or rock borrow shall be according to OPSS 212.

209.05.01.03 Select Subgrade Material

Select subgrade material shall be according to OPSS 1010.

209.05.02 Geotextiles

Geotextiles shall be according to OPSS 1860.

209.06 EQUIPMENT

209.06.01 Swamp Excavator

Where the item Rental of Swamp Excavation Equipment is used, the minimum size of a swamp excavator shall be a 40,000 kg crawler mounted dragline with a 1.3 m³ bucket.

209.06.02 Spreading, Levelling and Compaction Equipment

Where the floatation method is used, spreading, levelling and compaction equipment shall be restricted to a gross weight which is not detrimental to the integrity of the root mat.

209.07 CONSTRUCTION

209.07.01 General

The work of embankment construction shall be carried out using one or more of the following methods as specified:

- Method 'A' - Excavation
- Method 'B' - Floatation
- Method 'C' - Displacement

209.07.02 Clearing and Close Cut Clearing

Before beginning embankment construction, required clearing and close cut clearing shall be completed according to OPSS 201.

209.07.03 Method 'A' - Excavation

The work shall include the excavation of all materials from within the designated limits, except those defined as rock and the handling, placing, shaping, trimming, and hauling of excavated material.

Excavated material shall be placed clear of the sides of the embankment limits and any drainage facilities. The operations of excavation and backfilling shall be carried out simultaneously, except where excavation results in a relatively stable trench. In such cases, the excavation and backfilling may be carried out as separate operations with the prior written approval of the Contract Administrator.

209.07.03.01 Embankment Construction and Backfill

When conditions permit, backfill shall be placed according to OPSS 206. However, when wet conditions exist, backfill material may be placed up to 300 mm above original ground without compaction.

Embankment material placed subsequent to the backfill material shall be placed according to OPSS 206.

209.07.04 Method 'B' - Floatation

The work shall consist of the controlled placing of the embankment material, and the removal of surcharges as designated from above the subgrade and the hauling and incorporating of this material into the work according to OPSS 206.

209.07.04.01 Swamp Waves

Swamp waves shall not be excavated or otherwise disturbed.

209.07.04.02 Embankment Construction

The embankment shall be constructed according to OPSS 206 except that vibratory compaction equipment shall not be used within 1.0 m of the original surface of the swamp.

Each layer shall be built using an outside to inside sequence by keeping the outer one third portions of the layer at least 30 metres ahead of the centre portion.

209.07.04.03 Geotextile

Where geotextile is to be placed, the area designated for geotextile shall be close cut cleared and cleared of objects that might damage the geotextile. Close cut clearing shall be carried out in such a manner that the integrity of the root mat is not damaged.

Adjacent sections of the geotextile shall be overlapped a minimum of 500 mm or shall be sewn together according to OPSS 1860.

Should the geotextile be damaged, that section shall be repaired by placing a piece of geotextile large enough to cover the damaged section and meeting the overlap requirement above.

The placement operation shall be such that the geotextile is not exposed to daylight for more than 3 days.

If the geotextile is damaged due to the Contractor's operation during the embankment construction, the embankment material shall be removed from the geotextile, and the damaged area repaired at no additional cost to the Owner.

209.07.05 Method 'C' - Displacement

The work shall consist of the controlled placing of the embankment materials, the excavation of swamp waves and displaced material, the removal of surcharges and other material as designated from above the subgrade and related side slopes, and the

hauling and incorporating of this material into the work according to OPSS 206.

209.07.05.01 Embankment Construction

The embankment shall be built in such a manner as to displace as much of the material underlying the embankment as possible. An inside to outside construction sequence shall be used, keeping the inside one third portion 30 m ahead of the outside portions.

When a stable platform has been established, embankment materials placed 300 mm above original ground shall be placed according to OPSS 206.

209.07.06 Management of Excavated Material

Excavated swamp material shall be utilized as much as possible within the right of way, adjacent to the embankment and conforming to standard right of way offset. This shall be done by widening embankments, flattening side slopes, and constructing modified cross sections, as specified. Such materials shall be trimmed to provide smooth, slightly contours and to provide drainage.

The volume of excavated material that is possible to be used within the contract limits or designated areas is that specified in the contract documents. Excess excavated swamp material shall be managed according to OPSS 180.

To distinguish between wood and swamp material for the purposes of management of excess material, wood that has decomposed and breaks down readily upon handling shall be considered swamp material.

209.09 MEASUREMENT FOR PAYMENT

209.09.01 Actual Measurement

209.09.01.01 Excavation

Measurement for excavation will be made in cubic metres by the method of average end areas. The quantity for payment will be the lesser of the following:

- a. actual excavation, or
- b. excavation to the length, width, and depth as specified.

209.09.01.02 Rental of Swamp Excavation Equipment

Measurement for payment of rental equipment will be by the number of hours that the equipment is actually engaged in the work.

When the excavated material has been placed in a location which will not interfere with subsequent excavation, measurement will not be made for the double handling required in grading, levelling and trimming of such materials.

209.09.01.03 Select Subgrade Material

209.09.01.03.01 Tonne Measurement

Should the Contract require payment by the tonne, the method of determining the mass of materials for payment shall be according to OPSS 102.

209.09.01.03.02 Cubic Metre Measurement

Should the Contract require payment by the cubic metre, one of the two following methods will be employed, as specified.

1. End Area Method

Volume of materials will be measured in their original position and computed in cubic metres by the method of average end areas.

Original cross sections will be taken after the area has been cleared, grubbed and stripped of unsuitable material. These operations shall be completed a minimum of three working days in advance of excavation to allow for the required cross sectioning.

2. Truck Box Method

Materials will be measured in cubic metres, loose, by predetermined truck box capacities. The predetermined capacity of each truck will be that computed from its box dimensions.

Each truck shall be uniquely and readily identifiable.

209.09.01.04 Geotextile

Geotextile will be measured in square metres in place, with no allowance for overlaps.

209.09.02 Plan Quantity Measurement

209.09.02.01 Excavation Geotextile

When measurement is by Plan Quantity, such measurement will be based on the units shown in the clauses under Actual Measurement.

209.10 BASIS OF PAYMENT

209.10.01 Excavation

Payment for swamp excavation shall be at the contract price for the item Earth Excavation, Grading according to OPSS 206.

Payment shall not be made for the removal of materials that slide or slough inside the excavation limits.

209.10.02 Rental of Swamp Excavation Equipment - Item

Payment at the contract price for the above item shall be full compensation for furnishing and operating the minimum size equipment specified, including mats when necessary, for the excavation and for the management of the material adjacent to the excavation. Where the Contract Administrator approves the use of larger equipment, the contract price per hour will be adjusted by adding, to the contract price, the difference between the rate set out in OPSS 127 for the minimum size equipment specified, and the rate set out in OPSS 127 for the larger equipment to be employed.

209.10.03 Floatation and Displacement Method

Payment shall not be made for materials displaced by floatation or displacement.

209.10.04 Select Subgrade Material - Itemy Geotextile - Item

Payment at the contract price for the above items shall be full compensation for all labour, and material required to do the work.

209.10.05 Management of Swamp Material Excavated by Equipment Rental

The management of material which cannot be accommodated adjacent to the excavation shall be paid as Extra Work, and shall include:

- a. loading and hauling when the material has been piled on the right of way and could not have been loaded originally or
- b. hauling only when the material is loaded directly into trucks from the excavation, and
- c. unloading and grading the material to smooth and slightly contours.

Where drilling, blasting and mucking are required as a part of the work for this item, the following progress payments shall be made: 33 percent of the progress volume for drilling, and 33 percent of the progress volume for blasting.

206.10.06 Rock Face - Item

Payment at the Plan Quantity Contract price for the above item shall be full compensation for all Labour, Equipment and Material to do the work.

On completion of drilling and blasting, a progress payment of 50 percent of the above item shall be made.

On completion of mucking, a progress payment of 75 percent shall be made.

206.10.07 Rock Embankment - Item

Payment at the Contract price for the above item shall be full compensation for all Labour, Equipment and Material to do the work.

206.10.08 Rock Supply – Item

Payment at the contract price for the above item shall be full compensation for all Labour, Equipment and Material to do the work.

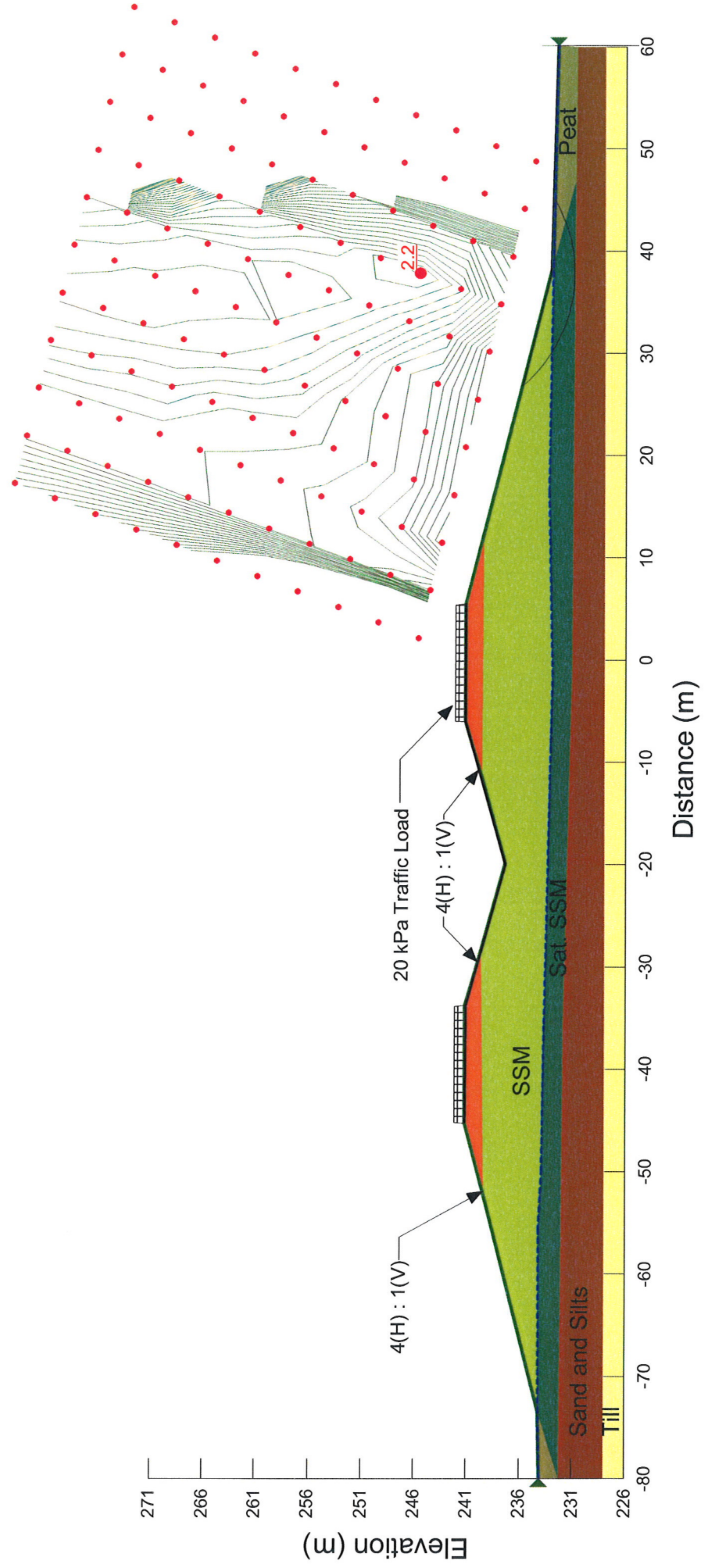
Progress payments shall be made as 33% of the progress volume for drilling, and 33% of the progress volume for blasting.

The unit price tendered for this item is excluded from the provisions of GC 8.01.02 01) for renegotiation of unit prices.

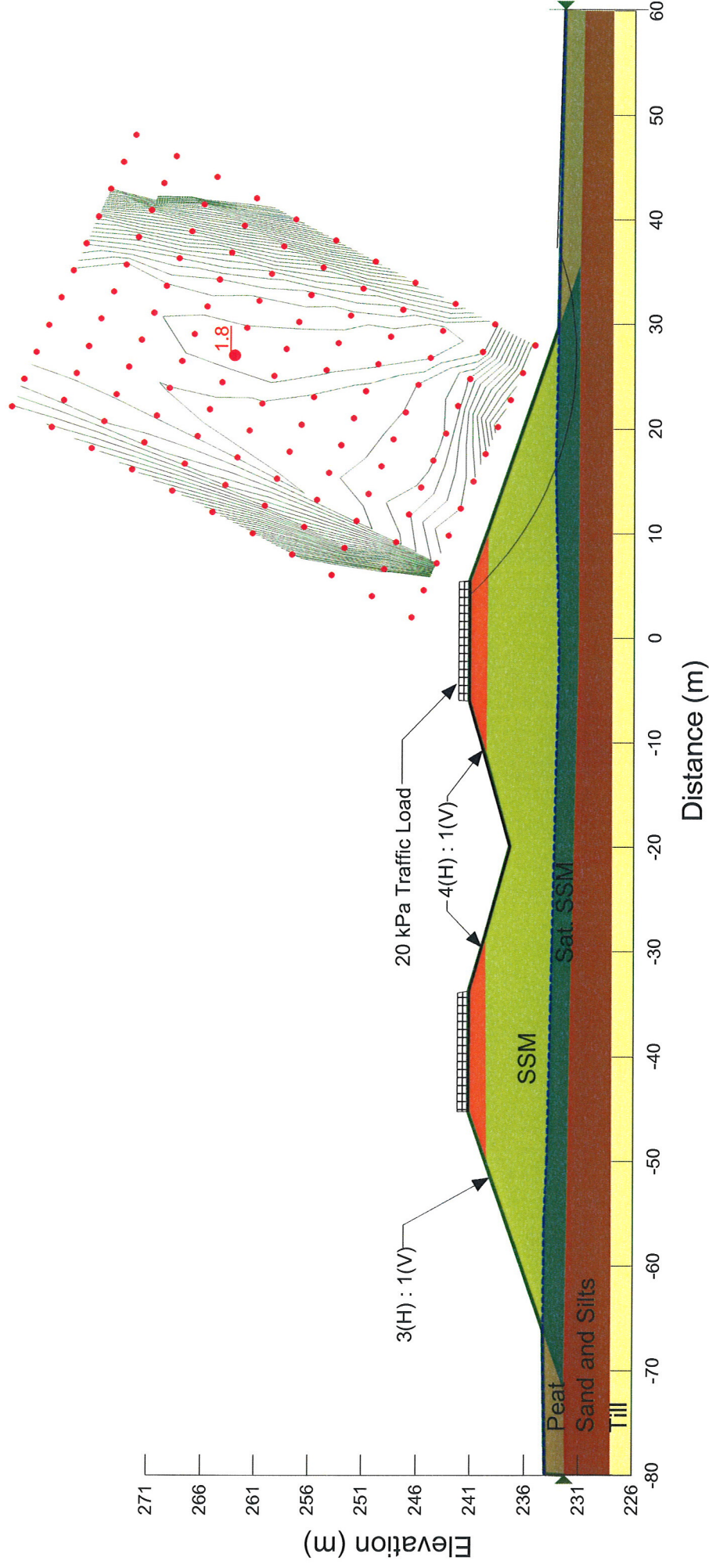
APPENDIX E

Slope Stability Plots

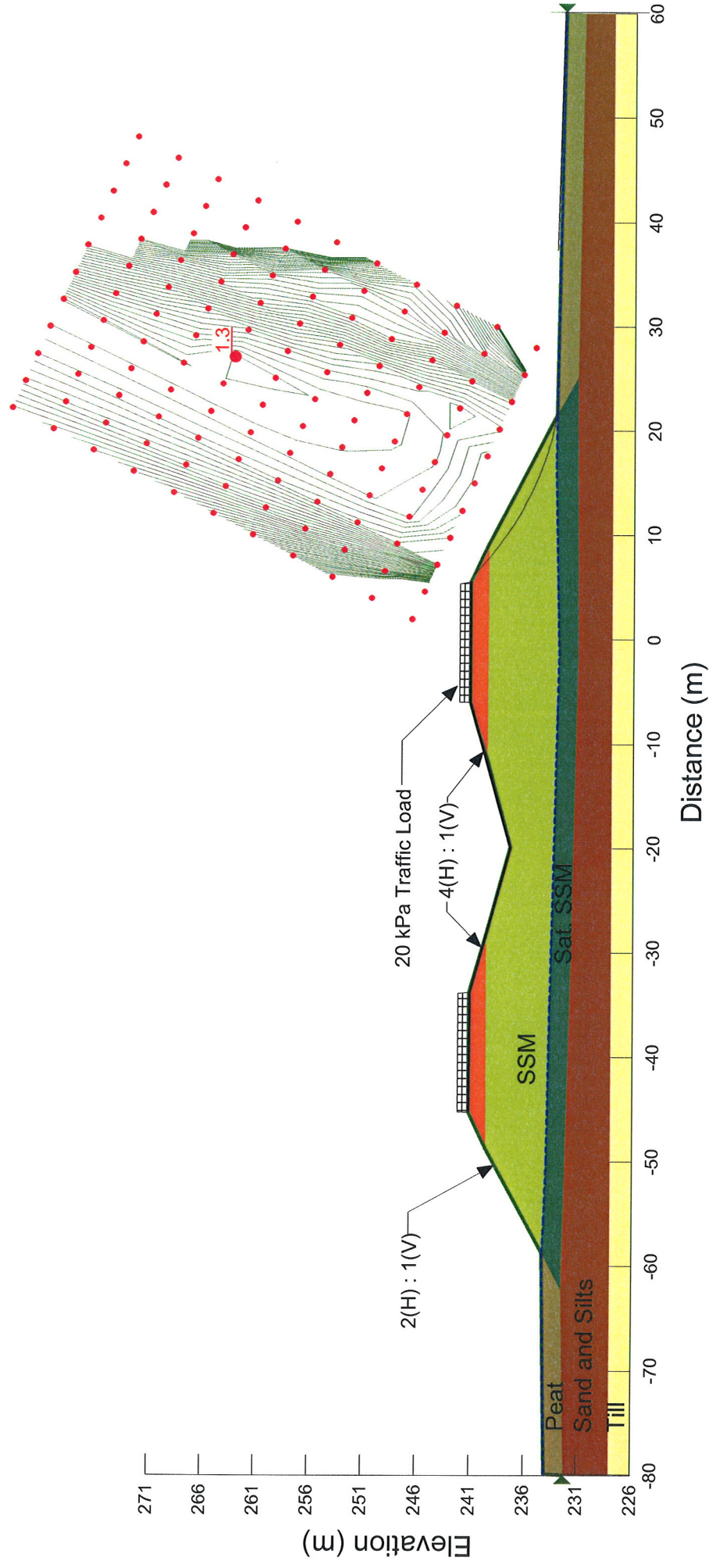
Title: Highway 11/17 Zone 1
Comments: Slope Stability Analysis
Name: Hwy 11/17 Four Lining Slope at 4 to 1 Final.gsz
Method: Morgenstern-Price
Horz Seismic Load: 0
PWP Option: PiezometricLine
Factor of Safety: 2.2



Title: Highway 11/17 Zone 1
Comments: Slope Stability Analysis
Name: Hwy 1117 Four Lining Slope at 3 to 1 Final.gsz
Method: Morgenstern-Price
Horz Seismic Load: 0
PWP Option: PiezometricLine
Factor of Safety: 1.8



Title: Highway 11/17 Zone 1
Comments: Slope Stability Analysis
Name: Hwy 1117 Four Lining Slope at 2 to 1 Final.gsz
Method: Morgenstern-Price
Horz Seismic Load: 0
PWP Option: PiezometricLine
Factor of Safety: 1.3



Title: Highway 11/17 Zone 1
Comments: Slope Stability Analysis
Name: Hwy 11/17 Four Laneing Slope at 1.25 to 1.gsz
Method: Morgenstern-Price
Horz Seismic Load: 0
PWP Option: PiezometricLine
Factor of Safety: 1.3

