

**FOUNDATION INVESTIGATION REPORT
FOR COFFERDAM AND UNWATERING AT MOLLIE RIVER
CULVERT
SITE 46-244, NEW LISKEARD AREA
AGREEMENT NO.: 5007-E-0065
ASSIGNMENT No. 8**

**January 21, 2010
GS-TB-011097**

MTO GEOCRES NO. 41P-42

**Prepared For:
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North Bay, Ontario P1B 9S9**

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1 Copy	- Ministry of Transportation, Downsview, ON
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**FOUNDATION INVESTIGATION AND DESIGN RECOMMENDATION FOR
COFFERDAM AND UNWATERING MOLLIE RIVER CULVERT
SITE 46-244, NEW LISKEARD AREA
AGREEMENT NO.: 5007-E-0065, ASSIGNMENT No. 8**

PART 1: FACTUAL INFORMATION

1.0 INTRODUCTION

DST Consulting Engineers Inc. (DST) has been retained by the Ministry of Transportation Ontario (MTO) to conduct a geotechnical investigation and provide geotechnical recommendations for the rehabilitation of a culvert located at Mollie River, identified as Site 46-224 New Liskeard Area, located along Highway 144, approx. 2.7 km north of the intersection with highway 560, in Benneweis Township, District of Sudbury, Ontario. This work was carried out under Agreement No.: 5007-E-0065 - Geotechnical Retainer - Assignment No.8.

The purpose of this investigation was to evaluate existing site conditions and provide geotechnical engineering recommendations for cofferdam construction and dewatering of the Mollie River culvert. This report addresses the field investigation, laboratory test program, factual report on conditions (Part 1) and recommendations for the design and construction for the proposed culvert replacement (Part 2).

This report is prepared for the sole use of the MTO. Any use of this report, or any portions thereof, or any reliance on it by any other party, is the responsibility of the parties listed above.

2.0 SITE DESCRIPTION

The culvert section is located on Highway 144, approximately 2.7 km north of Highway 560, in Benneweis Township, District of Sudbury, in the MTO Northeastern Region.

It is understood that the existing culvert is an SPCSPA corrugated steel pipe with dimensions of 7.9 m x 4.9 m x 22.3 m. According to previous report information from William Trow Associates Limited (Trow, 1967) the subsoil at the site consists, at upper levels, of a layer of rounded boulders of approximately 15 to 30 cm in diameter and approximately 3 m in thickness. Beneath this stratum is a compact to very dense alluvial medium to coarse grained sand deposit. A nearby beaver dam to the west of the structure was also identified.

The embankment at the existing culvert location is approximately 7 m in height. The height of cover material above the existing culvert is approximately 2.5 m.

A site visit was made on October 27, 2009 by a geotechnical specialist from DST. There was approximately one inch of snow cover at the site during this visit. The site vegetation consists of shrubs and trees at both sides of culvert inlet and outlet and mixed forest around the river up and downstream as well as at the discharge pond perimeters. The surrounding area is heavily wooded with areas of exposed bedrock. The northeast side of the culvert is difficult to access with a bedrock outcrop at this side. The northwest side of the culvert is heavily vegetated of shrubs and trees on swampy ground and needs excessive clearing to be accessible for construction, however less clearing effort is needed for the southwest side of the culvert. The southeast side slopes upward from the river. Pictures of the site are shown below. The photographs were taken on October 16th and 27th, 2009.



Photo 1: Looking northwest at outlet from southeast bank



Photo 2: Looking southeast at inlet from northwest bank



Photo 3: Looking southwest at outlet from northeast bank



Photo 2: Looking northeast from southwest bank



Photo 5: Looking northeast at outlet (showing Bedrock Outcrop)



Photo 6: Looking southwest at inlet showing vegetation

3.0 INVESTIGATION PROCEDURES AND LABORATORY TESTING

Site work was carried out between October 26 and 28, 2009 utilizing a track mounted CME 850 drill rig equipped for geotechnical drilling, operated by Landcore and supervised by DST. Hand augers were also used to advance boreholes in areas inaccessible to the track mounted equipment at the northeast side of the culvert outlet. A total of three boreholes were advanced to depths ranging from 5.9 to 6.7 m using the CME 850 and one borehole was advanced to a depth of 0.3 m using hand equipment. Termination depths of the boreholes were notified to the MTO during field operations together with difficulties encountered during advancement.

Borehole locations and a stratigraphic section are shown on the Borehole Location Plan, Drawing 1. Borehole 1 is located approximately 4 m south and 2.5 m west of the culvert inlet. Borehole 2 is located approximately 4.5 m south and 10 m east of the culvert outlet. Borehole 3 is located approximately 4 m north and 7 m west of the culvert inlet. Borehole 4 is located approximately 5.3 m north and 4 m east of the culvert outlet. These locations were identified in the terms of reference by the MTO and are consistent with attempts to be advanced near the embankment toe as close as possible to the water and as far as possible from the beaver dam.

Boreholes 1 and 2 were advanced with 108 mm inside diameter hollow stem augers to depths of 3 and 1.5 m and continued with wash boring techniques using diamond drilling bit and NW casing to 6.7 and 6.4 m respectively. Borehole 3 was also advanced with wash boring techniques using diamond drilling bit and NW casing to a depth of 5.9 m. Borehole 4 was advanced using hand operated equipment to a depth of 0.3 m. Boreholes were backfilled with auger cuttings.

Soil samples were obtained from the auger flights as well as sludge return from wash boring and from the split spoon sampler used for the standard penetration test (SPT). The SPT involves driving a 51 mm diameter thick-walled sampler into the soil under the energy of a 63.5 kg weight falling

through 760 mm. The number of blows required to drive the sampler 305 mm is known as the standard penetration blow count (N) which provides an indication of the condition or consistency of the soil. Representative soil samples are obtained from within the sampler.

The ground surface elevations at the borehole locations were surveyed by DST personnel and referenced to MTO BM 748134 located on the exposed bedrock approximately 170 m north of the gravel road to Dividing Lake and 20 m to the east of the centreline. The benchmark has UTM coordinates of Grid 17T, E436474.313 and N5260755.631 with an orthometric elevation of 378.855 m, as reported by the MTO.

The fieldwork was supervised on a full-time basis by DST personnel who located the boreholes in the field, performed sampling and in-situ testing, and logged the boreholes. The soil sample identifications were estimated in the field and placed in labelled containers and transported to DST's laboratory in Ottawa for further analysis.

Classification and index tests were subsequently performed in the laboratory on samples collected from the boreholes to aid in the selection of engineering properties. Laboratory tests included natural moisture contents and particle size analyses. Laboratory test results are presented on the Boreholes Logs in Enclosures 1 to 4, and plotted in Enclosure 5.

Ground profile of the site from a previous investigation and design drawing of the existing culvert (Trow, 1967) are appended to this report.

4.0 DESCRIPTION OF SUBSURFACE CONDITIONS

4.1 Stratigraphy Overview

The general stratigraphy of the proposed culvert site, shown in Drawing 1, is based on the conditions encountered in Boreholes 1 through 4 as well as information previously documented by William Trow Associates Limited (Trow, 1967). The general stratigraphy consists of surficial sands with high concentrations of gravel, cobbles and boulders in the top 4 m. These overly a very loose to dense sand layer with decreasing cobble and boulder size and content. Borehole logs are illustrated in Enclosures 1 to 4.

4.2 Topsoil

Topsoil was noted at surface in Boreholes 1 through 3 up to 50 mm in thickness.

4.3 Sand and Gravel (Containing Cobbles and Boulders)

A stratum of sand and gravel with cobbles and boulders (interstices filled with varying percentages of brown silt, sand and gravel) was encountered in Boreholes 1 through 3. The cobble and boulder content is difficult to accurately assess from borehole data and may be considerable. This layer was found to be approximately 3.7 m thick at Borehole 1 and increased to approximately 5.2 m thick at Borehole 3.

SPT values are between 8 and 47 blows per 0.3 m indicating a loose to dense state of compactness. SPT values of >100 were also encountered in Borehole 1 at 0.8 m, Borehole 2 at 0.8m, 2.3 m and 3.0 m and Borehole 4 at 0.3 m. The variability of the SPT values are likely due to the concentrations of gravel, cobbles and boulders, and they may not be representative of the state of compactness of the soil matrix between the cobbles and boulders.

Gradation analyses conducted on samples from boreholes indicate interstices gravel, sand and fines contents from 1% to 30%, 59% to 62% and 7% to 40% respectively. Grainsize distributions are reported on the Borehole Logs and are plotted in Enclosure 5. The moisture contents of samples range from 10% to 23%.

4.4 Sand

A sand layer with trace to with gravel and trace silt was encountered from underlying the cobbles and boulders to a depth of up to 6.7 m. Within this stratum a higher concentration of cobbles and boulders are found near the top with decreasing size and content as depth increased, based on a qualitative assessment.

SPT values are between 2 and 41 blows per 0.3 m indicating a very loose to dense state of compactness. An SPT value of >100 was also encountered in Borehole 2 at 6.4 m. The variability of the SPT values are likely due to the concentrations of cobbles and boulders.

Gradation analyses conducted on samples from boreholes indicate gravel, sand and fines contents from 1% to 11%, 87% to 96% and 2% to 3% respectively. Grainsize distributions are reported on the Borehole Logs and are plotted in Enclosure 5. The moisture contents of samples range from 9% to 37%.

4.5 Groundwater Levels

The existing culvert invert elevations at the west inlet and east outlet were measured to be 374.63 m and 374.60 m respectively. The river level at the time of the investigation at the culvert inlet and outlet were at elevations 375.68 m and 375.57 m.

The water levels in Boreholes 1 through 3 were 376.58 m, 375.76 m and 375.86 m respectively. The water level in Borehole 4 was not noted.

These levels observed before borehole backfilling are indicated on the Borehole Logs and Drawing 2 and are not intended to represent accurate information with respect to the water table or groundwater flow. The water table is expected to be close to the river level. Groundwater levels will fluctuate seasonally and in response to climatic conditions and river level.

Table 4.1 Groundwater Elevations – October 26th-28th, 2009

Borehole Location	Ground Surface Elevation	Static Groundwater Elevation	Depth to Water Level
BH 09-1	376.90 m	376.58 m	0.32 m
BH 09-2	376.04 m	375.76 m	0.28 m
BH 09-3	376.14 m	375.86 m	0.28 m

LIMITATIONS OF REPORT

A description of limitations which are inherent in carrying out site investigation studies is given in Appendix 'A', and this forms an integral part of this report.

For DST CONSULTING ENGINEERS INC.

Prepared by:

Reviewed by:



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C.Geol, C. Eng, Eur Geol, Eur Eng
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Hesham Dief

Hesham Dief, Ph.D (P. Eng, Nfld)
Geotechnical Specialist

Mike Fabius, P. Eng.
Principal

APPENDIX A

LIMITATIONS OF REPORT

LIMITATIONS OF REPORT

GEOTECHNICAL STUDIES

The data, conclusions and recommendations which are presented in this report, and the quality thereof, are based on a scope of work authorized by the Client. Note that no scope of work, no matter how exhaustive, can identify all conditions below ground. Subsurface and groundwater conditions between and beyond the testholes may differ from those encountered at the specific locations tested, and conditions may become apparent during construction which were not detected and could not be anticipated at the time of the site investigation. Conditions can also change with time. It is recommended practice that DST Consulting Engineers be retained during construction to confirm that the subsurface conditions throughout the site do not deviate materially from those encountered in the testholes. The benchmark and elevations used in this report are primarily to establish relative elevation differences between the testhole locations and should not be used for other purposes, such as grading, excavation, planning, development, etc.

The design recommendations given in this report are applicable only to the project described in the text and then only if constructed substantially in accordance with details stated in this report. Since all details of the design may not be known, we recommend that we be retained during the final stage to verify that the design is consistent with our recommendations, and that assumptions made in our analysis are valid.

Unless otherwise noted, the information contained herein in no way reflects on environmental aspects of either the site or the subsurface conditions.

The comments given in this report on potential construction problems and possible methods are intended only for the guidance of the designer. The number of testholes may not be sufficient to determine all the factors that may affect construction methods and costs, e.g. the thickness of surficial topsoil or fill layers may vary markedly and unpredictably. The contractors bidding on this project or undertaking the construction should, therefore, make their own interpretation of the factual information presented and draw their own conclusion as to how the subsurface conditions may affect their work.

Any results from an analytical laboratory or other subcontractor reported herein have been carried out by others, and DST Consulting Engineers Inc. cannot warranty their accuracy. Similarly, DST cannot warranty the accuracy of information supplied by the client.

EXPLANATION OF TERMS USED IN THIS REPORT

Soil Classification (Based on Amounts by Weight)

Noun	Gravel, sand, silt, clay	>35% and main fraction
“and”	And gravel, and silt, etc.	>35%
Adjective	Gravely, sandy, silty, clayey, etc.	20% - 35%
“some”	Some sand, some silt, etc.	10% - 20%
“trace”	Trace sand, trace silt, etc.	1% - 10%

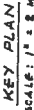
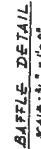
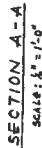
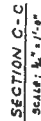
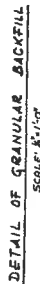
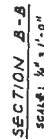
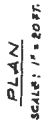
Consistency and Shear Strength of Cohesive Soils

CONSISTENCY	UNDRAINED SHEAR STRENGTH (kPa)
Very Soft	<12
Soft	12 - 25
Firm	25 - 50
Stiff	50 - 100
Very stiff	100 - 200
Hard	>200

Compactness Condition of Sands from Standard Penetration Tests

COMPACTNESS CONDITION	SPT N-INDEX (blows per 0.3 m)
Very loose	0 - 4
Loose	4 - 10
Compact	10 - 30
Dense	30 - 50
Very dense	Over 50

APPENDIX B
EXISTING DRAWINGS



NOTES:

Q. B. M. NO 2320 ELEV. 1156.875
HENDERSON BAY CO. STORE, TABLET IN SOUTH CONCRETE
FOUNDATION WALL, 15 FT. FROM SOUTHWEST CORNER
1 FT. BELOW WOODWORK.

CLASS OF CONCRETE
3000 P.S.I.

CONSTRUCTION NOTES

LIST OF DRAWINGS

[illegible]DEPARTMENT OF HIGHWAYS ONTARIO
BRIDGE DIVISION

MOLLIE RIVER PIPE ARCH

SOUTH OF COCAMA
KING'S HIGHWAY No. 144
TWP. 68N R15E S17E
DIST. No. 14

GENERAL PLAN

APPROVED <i>[Signature]</i>		SITE No. 46-244		W.P. No. 247-66	
DESIGN	D.S.M.	CHECK	W.T.H.	CONTRACT	
DRAWING	P.C.K.	CHECK	W.T.H.	No.	67-244
DATE	MAY 1967	ISSUED	MAY 20-67	DRAWING	D-6181-1

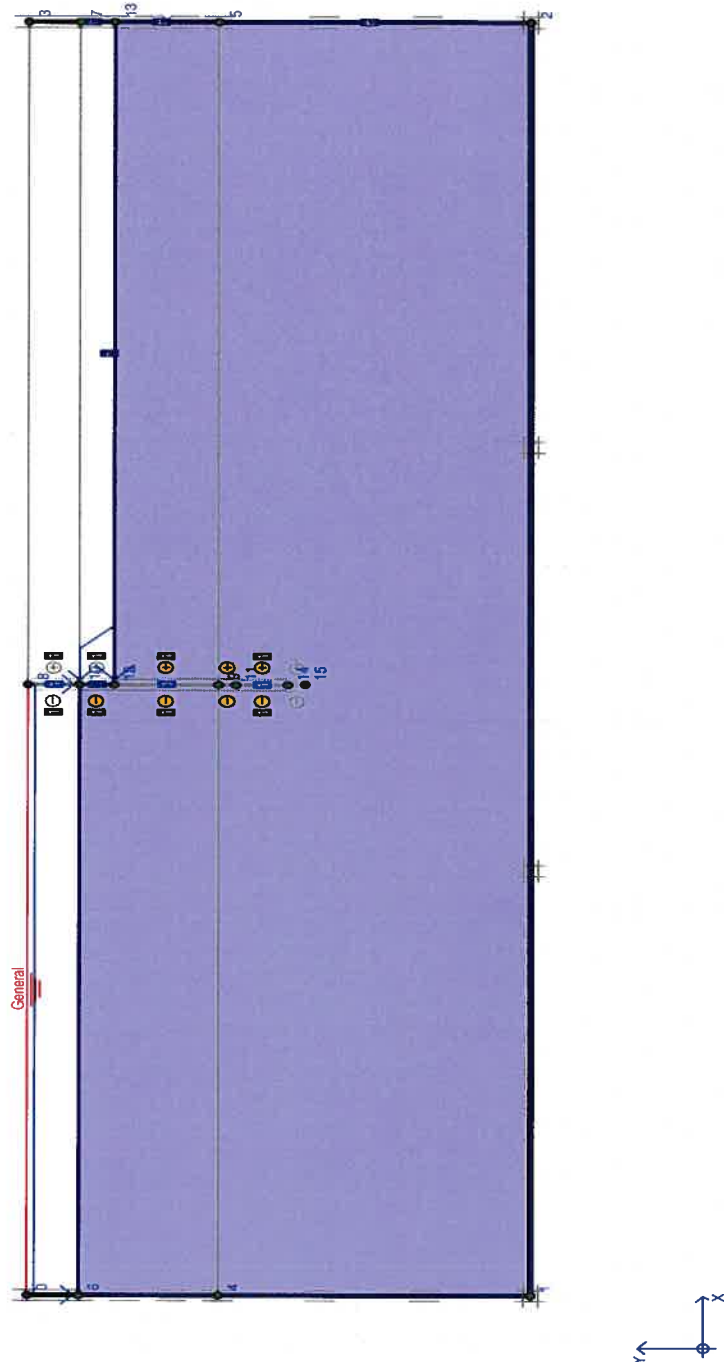
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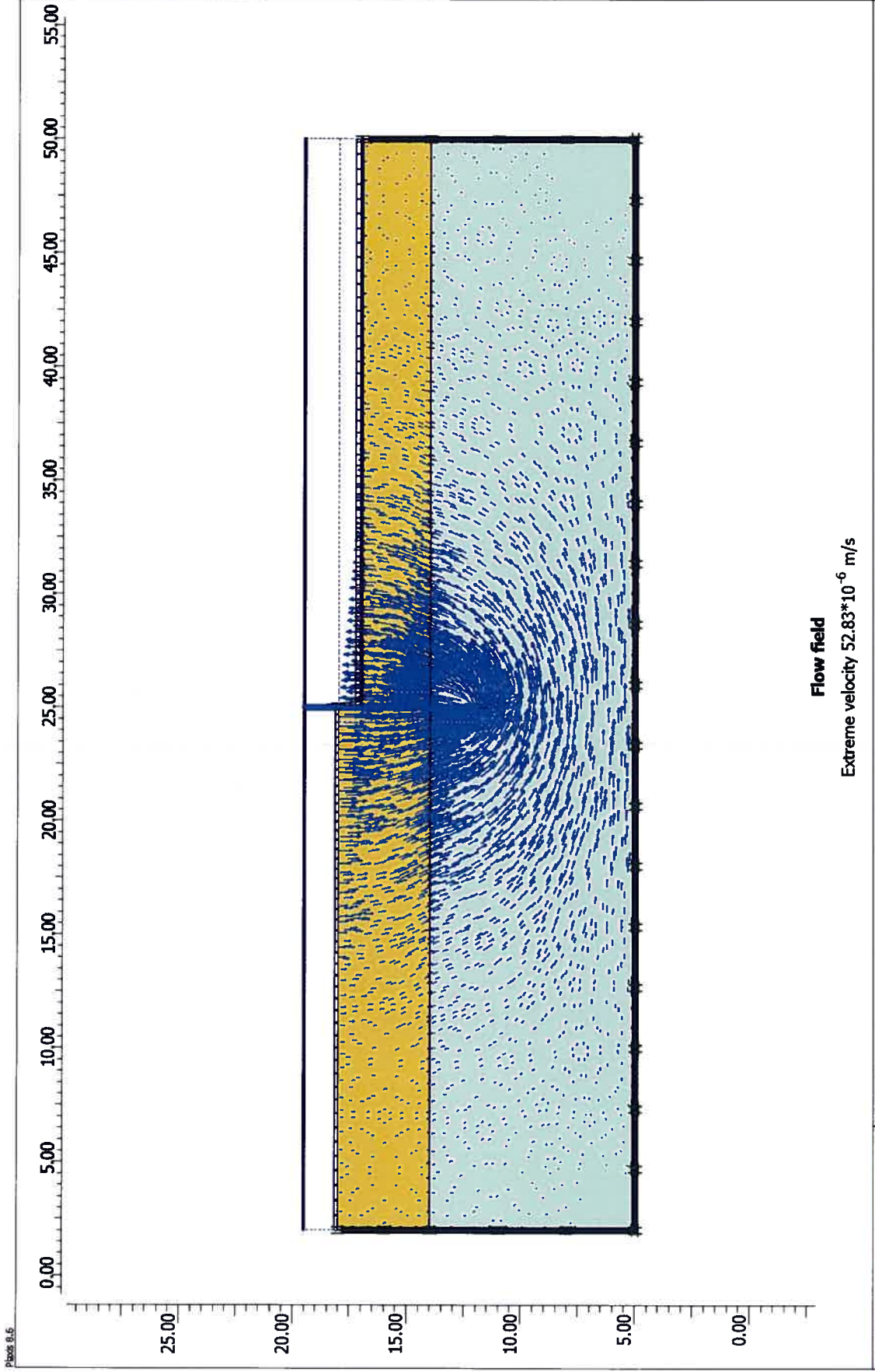
APPENDIX “C”

PLAXIS FINITE ELEMENT MODELLING

INPUT MODEL FOR COFFERDAM ANALYSIS

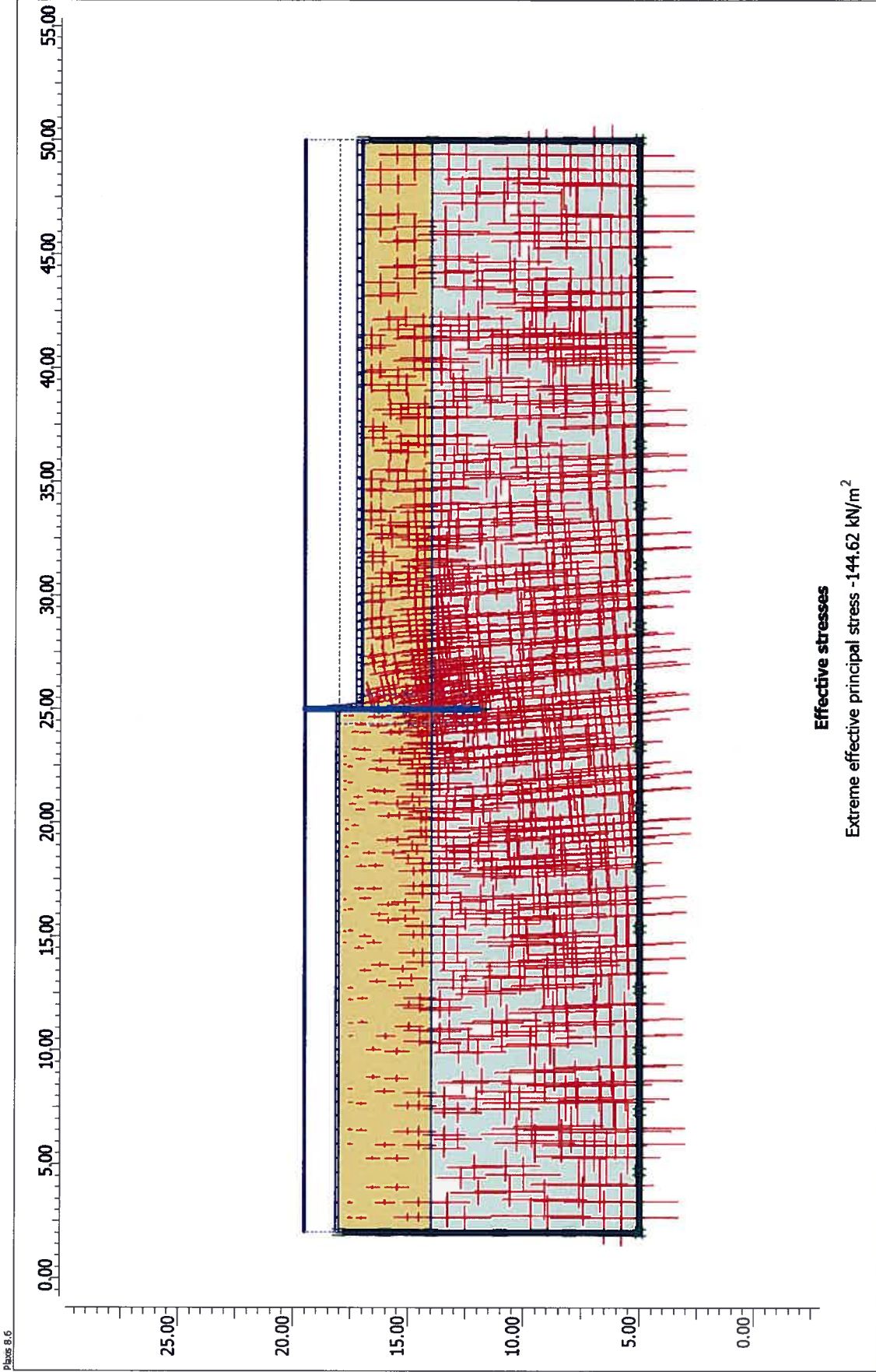


SEEPAGE ANALYSIS OF COFFERDAM WITH PU12 SHEET PILE (5m PENETRATION)



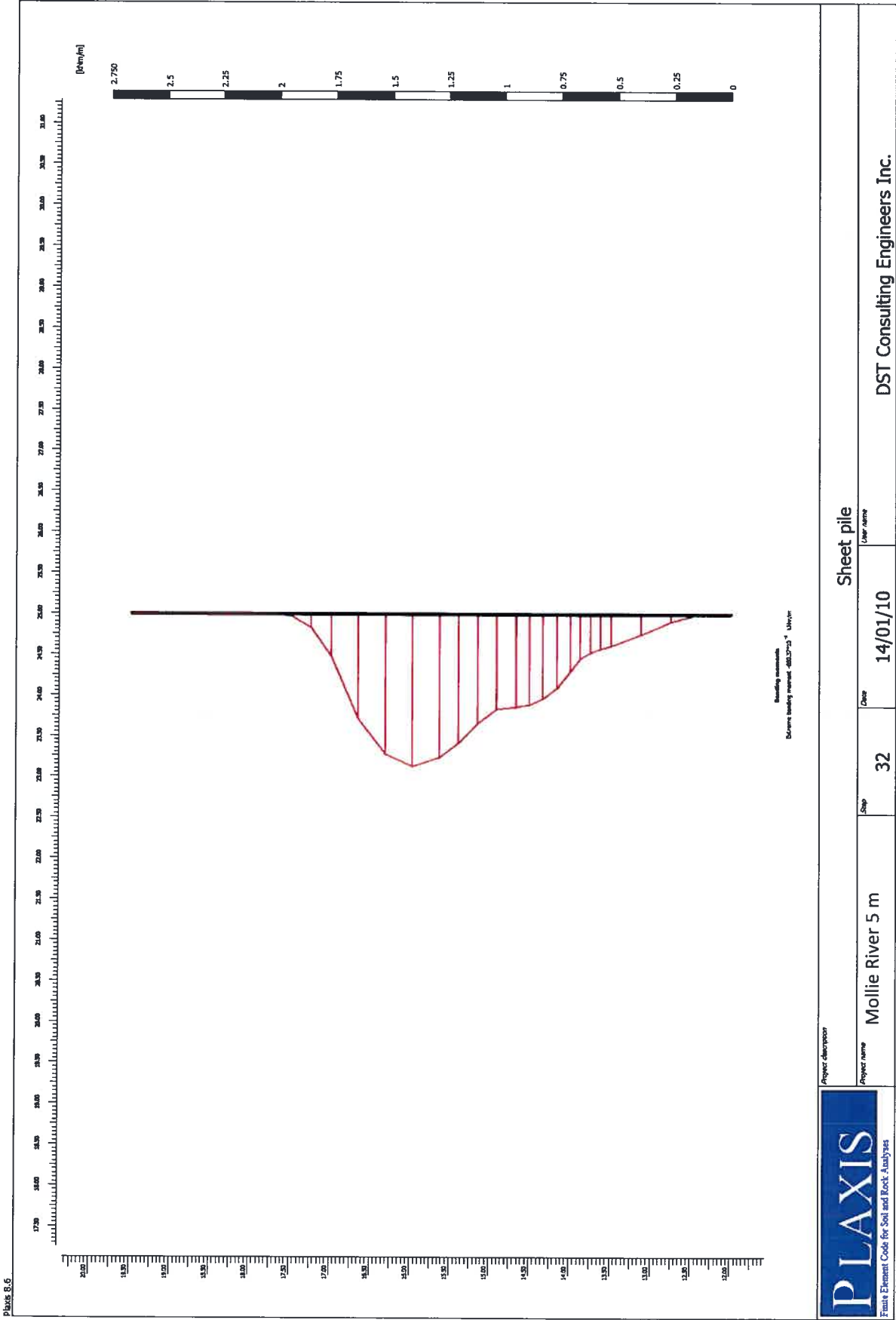
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Project name Mollie River 5 m		Date 14/01/10		User name DST Consulting Engineers Inc.

EFFECTIVE STRESS DIAGRAM WITH PU12 SHEET PILE (5m PENETRATION)

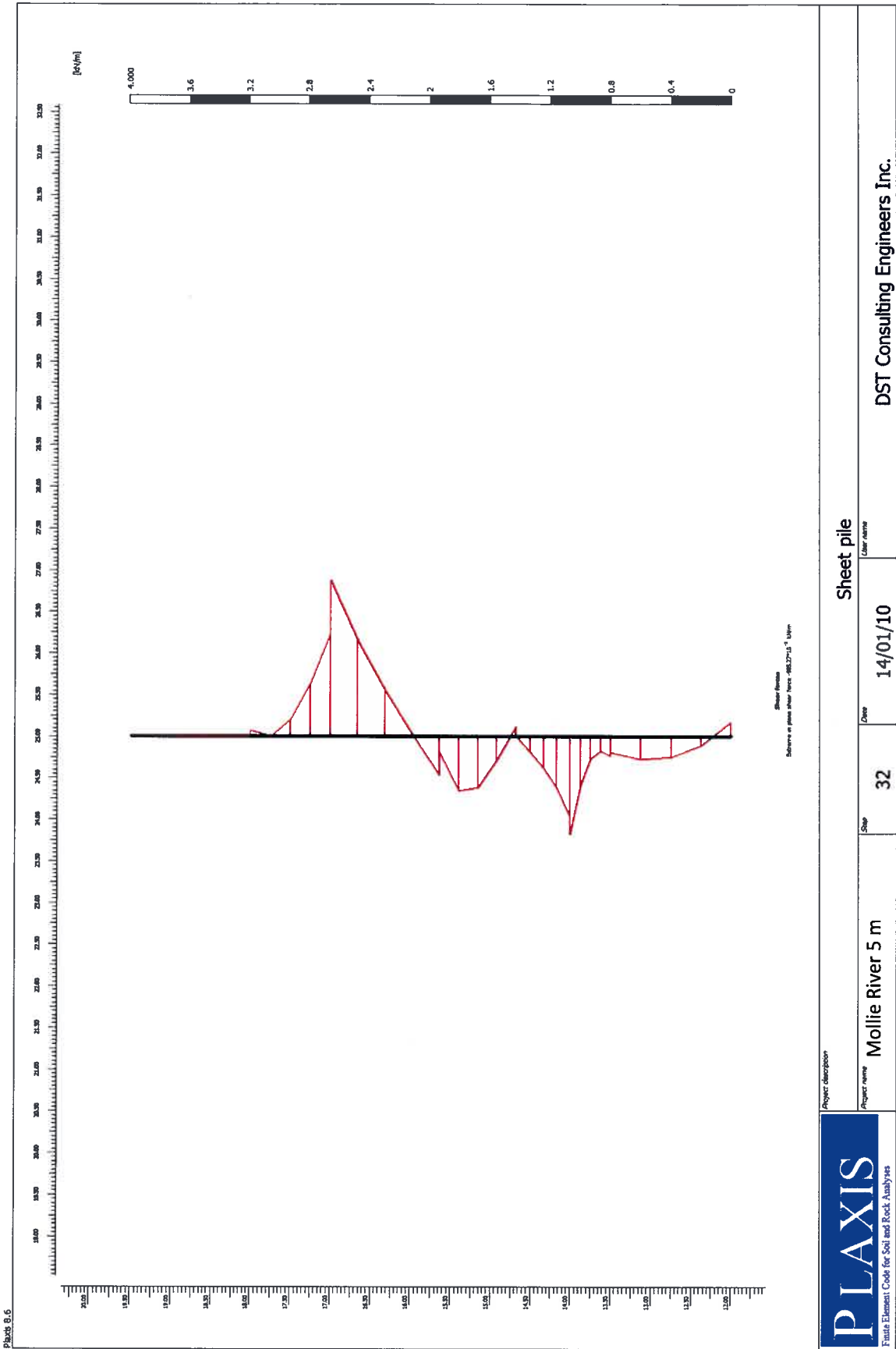


Project description		Sheet pile	
Project name	Mollie River 5 m	Step	32
Client		Date	14/01/10
User name			DST Consulting Engineers Inc.

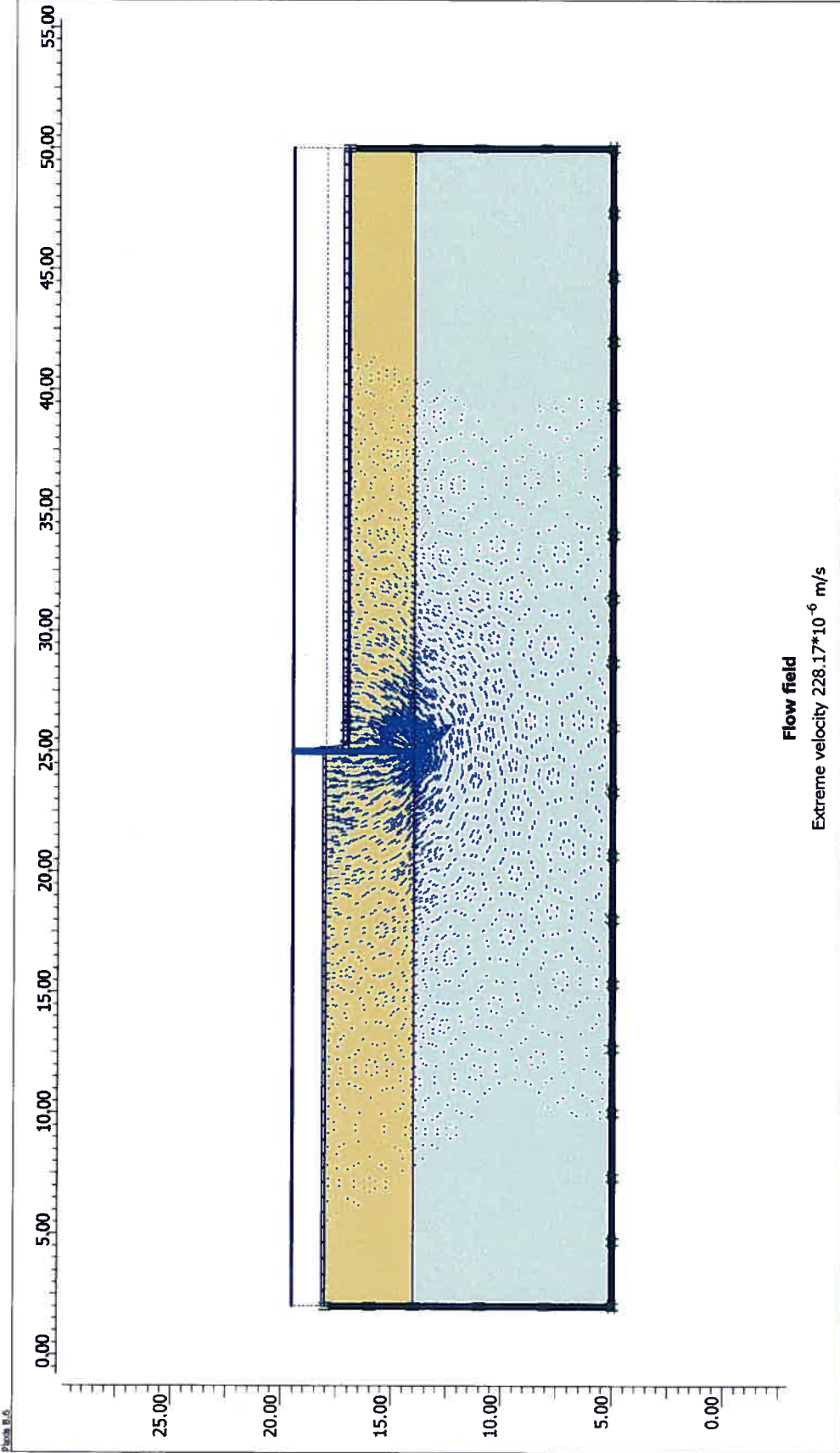
BENDING MOMENT PROFILE WITH PU12 SHEET PILE (5m PENETRATION)




SHEAR FORCES PROFILE WITH PU12 SHEET PILE (5m PENETRATION)

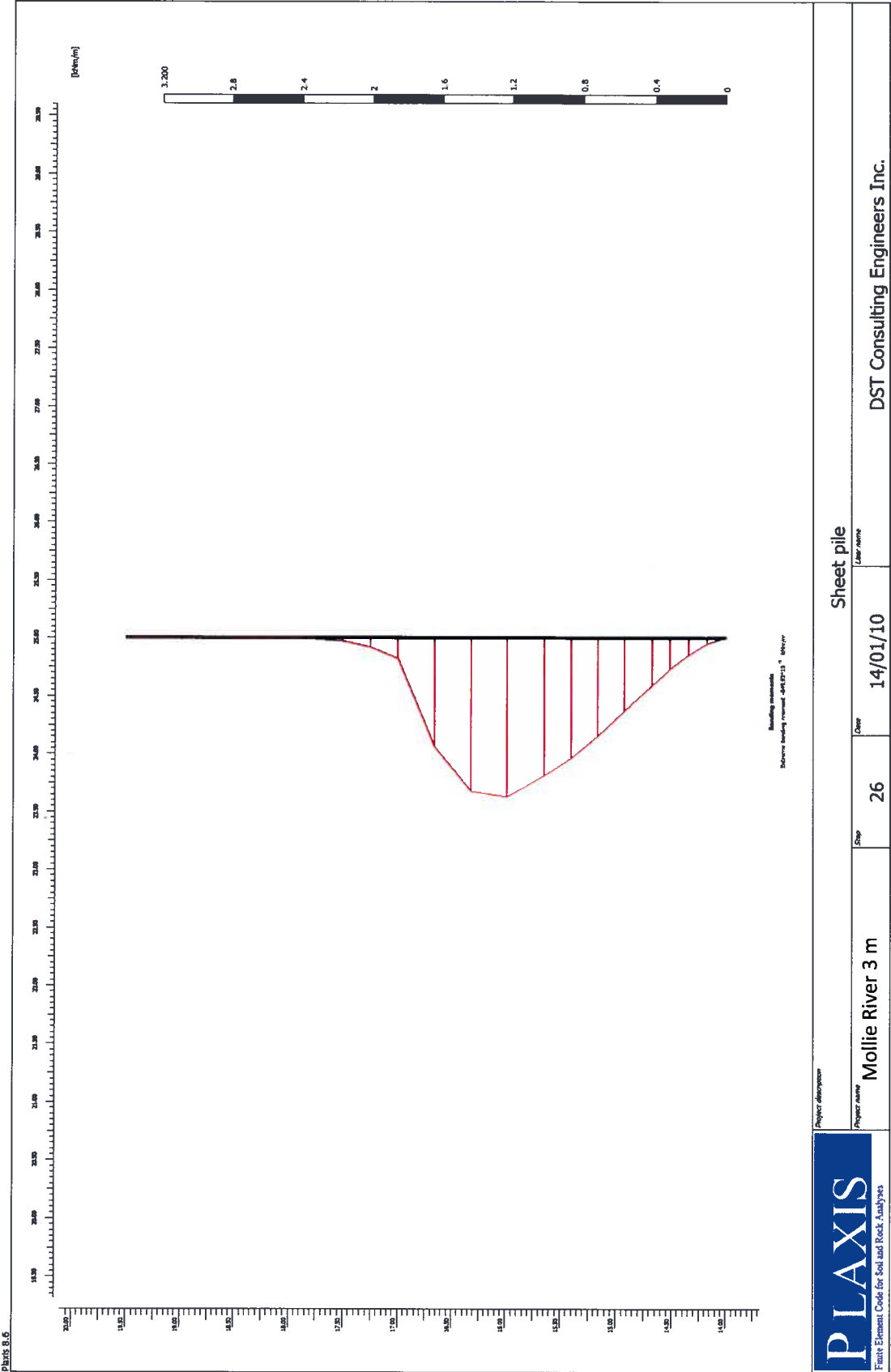


SEEPAGE ANALYSIS OF COFFERDAM WITH PU12 SHEET PILE (3m PENETRATION)

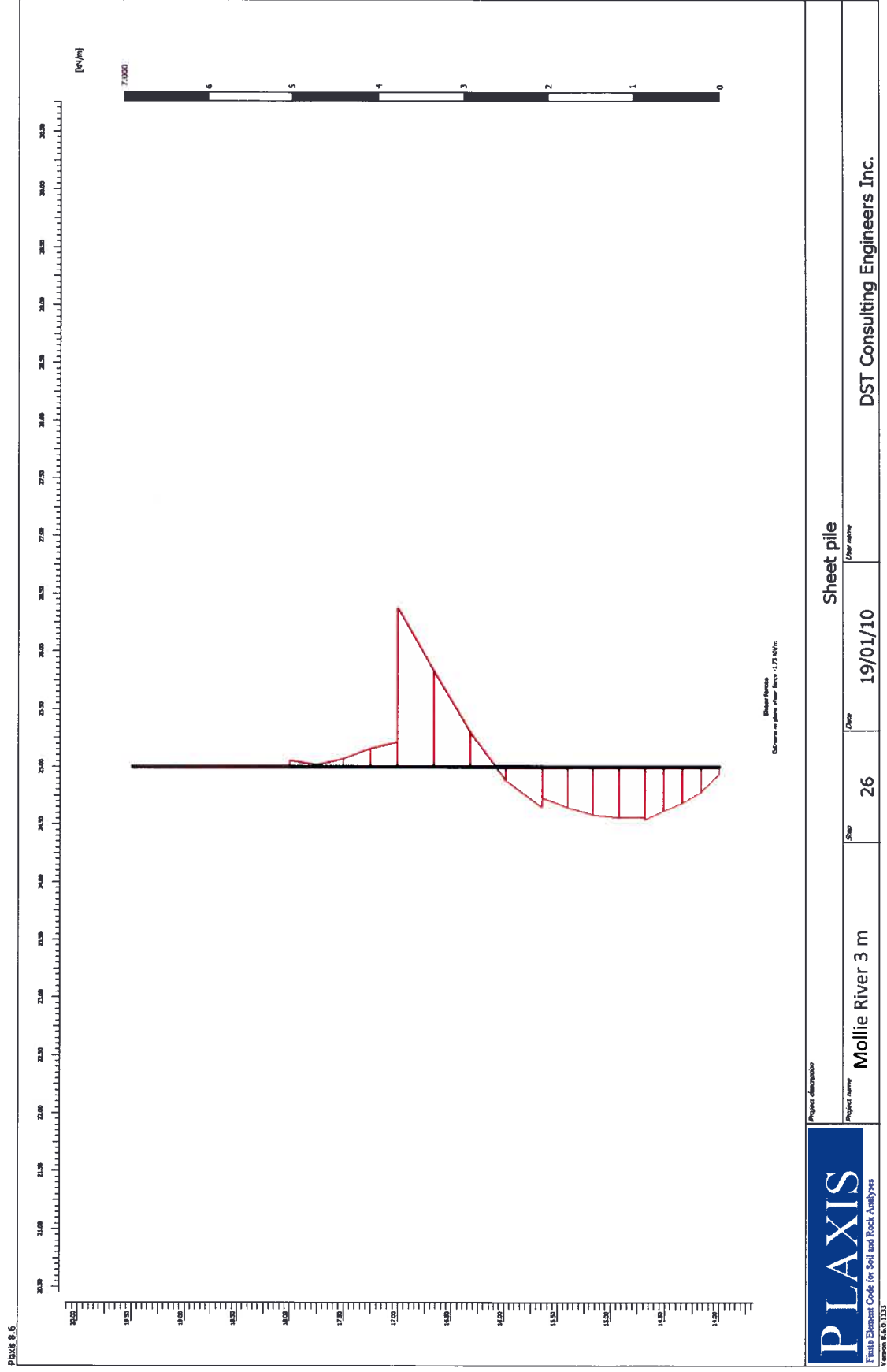


 Finite Element Code for Soil and Rock Analyses Version 8.6.13.37	Project description		Sheet pile	
	Project name	Date	User name	
	Mollie River 3 m	14/01/10		DST Consulting Engineers Inc.

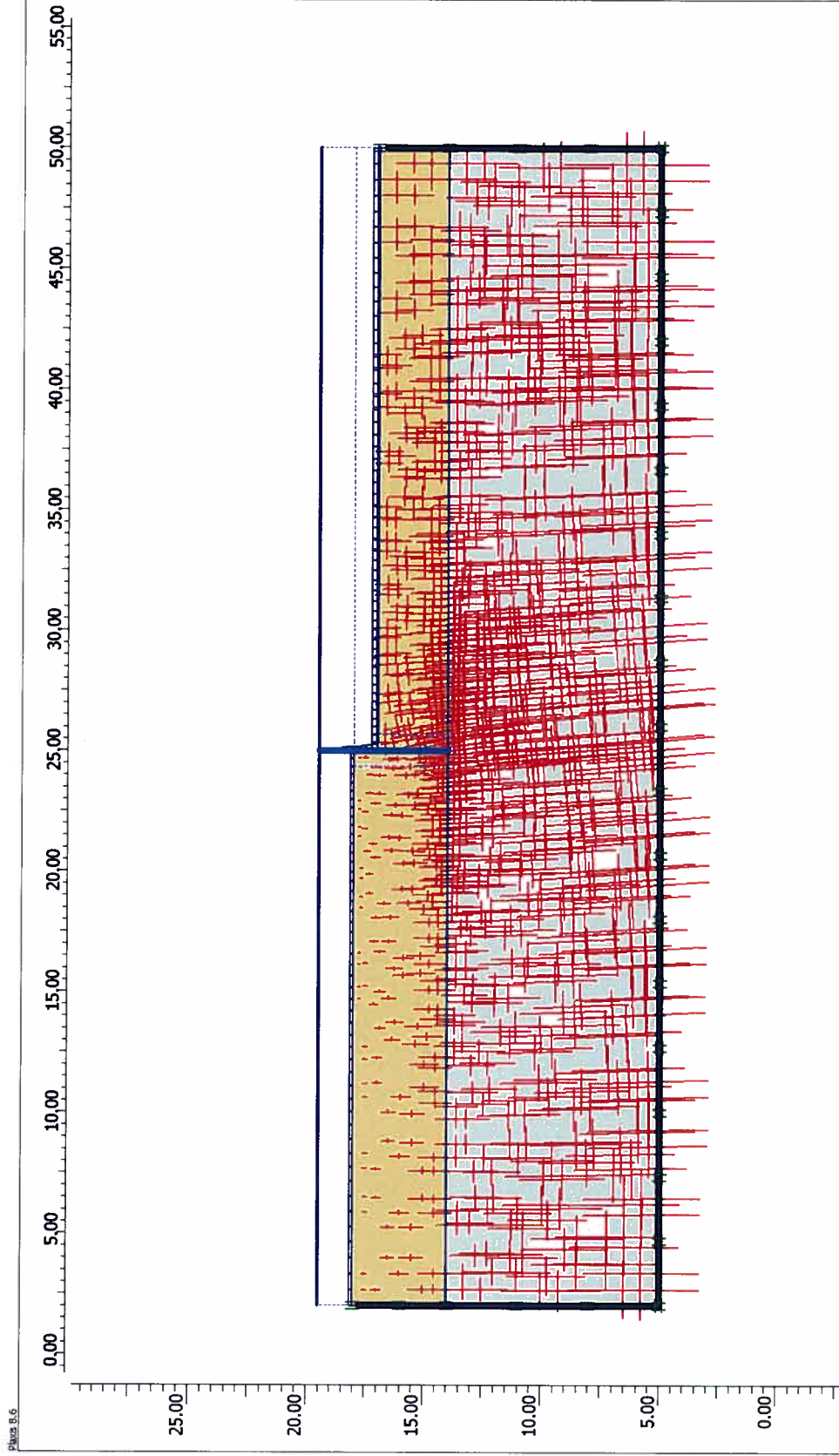
BENDING MOMENT PROFILE WITH PU12 SHEET PILE (3m PENETRATION)



SHEAR FORCE PROFILE WITH PU12 SHEET PILE (3m PENETRATION)

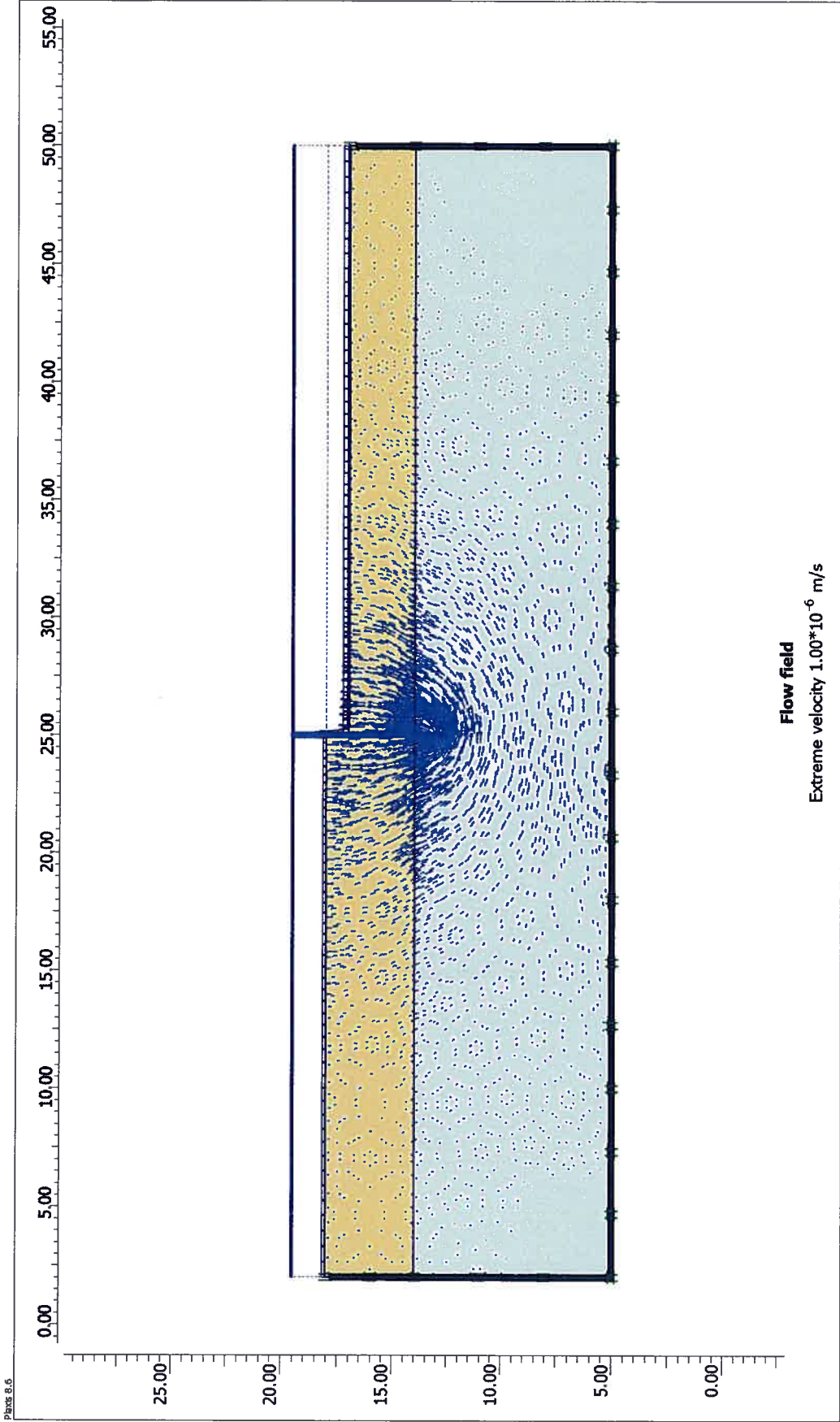


EFFECTIVE STRESS DISTRIBUTION WITH PU12 SHEET PILE (3 m PENETRATION)



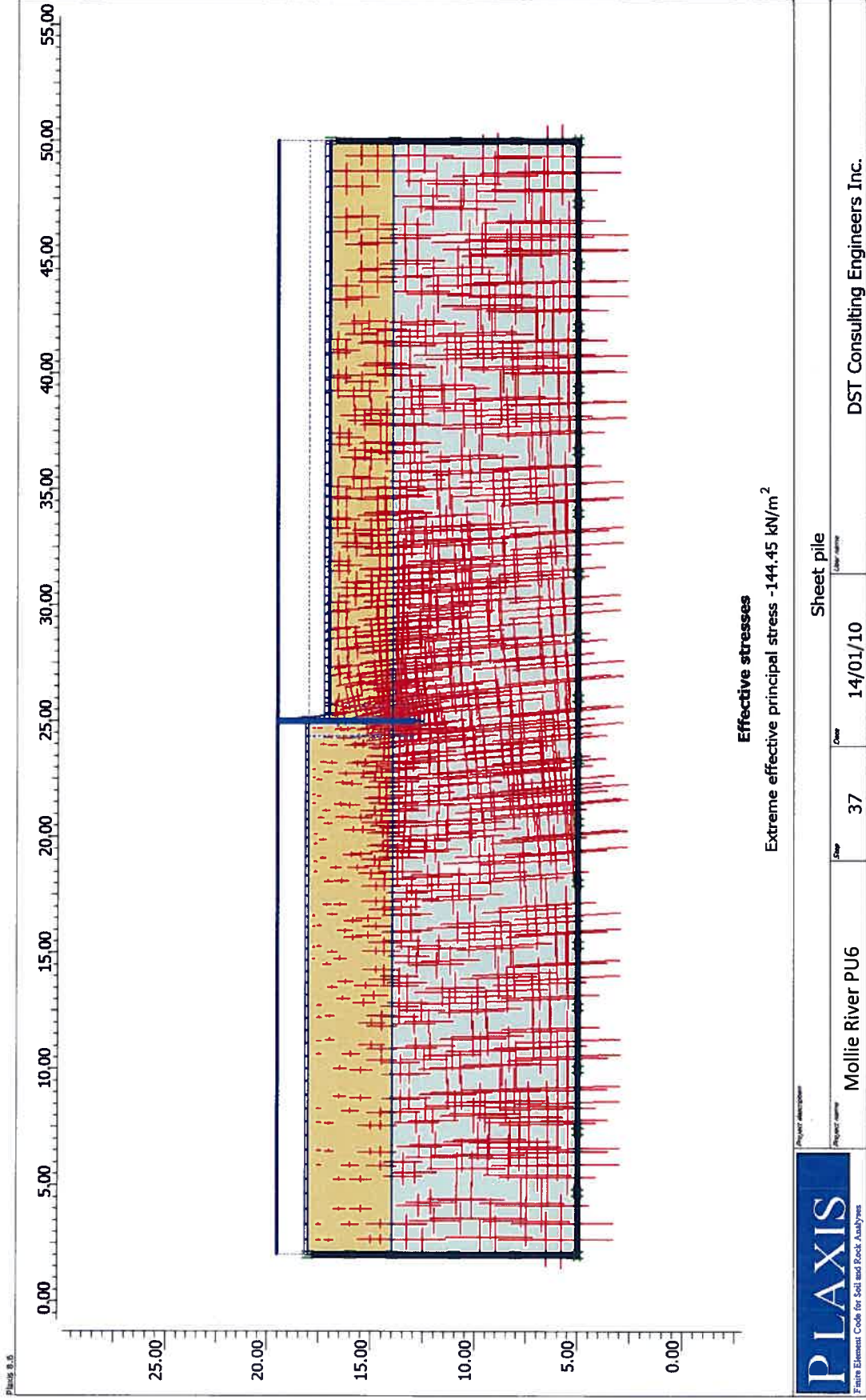
Project description		Sheet pile	
Project name	Mollie River 3 m	Date	14/01/10
Project number	26	Client name	DST Consulting Engineers Inc.

SEEPAGE ANALYSIS OF COFFERDAM WITH PU 6 SHEET PILE (4m PENETRATION)

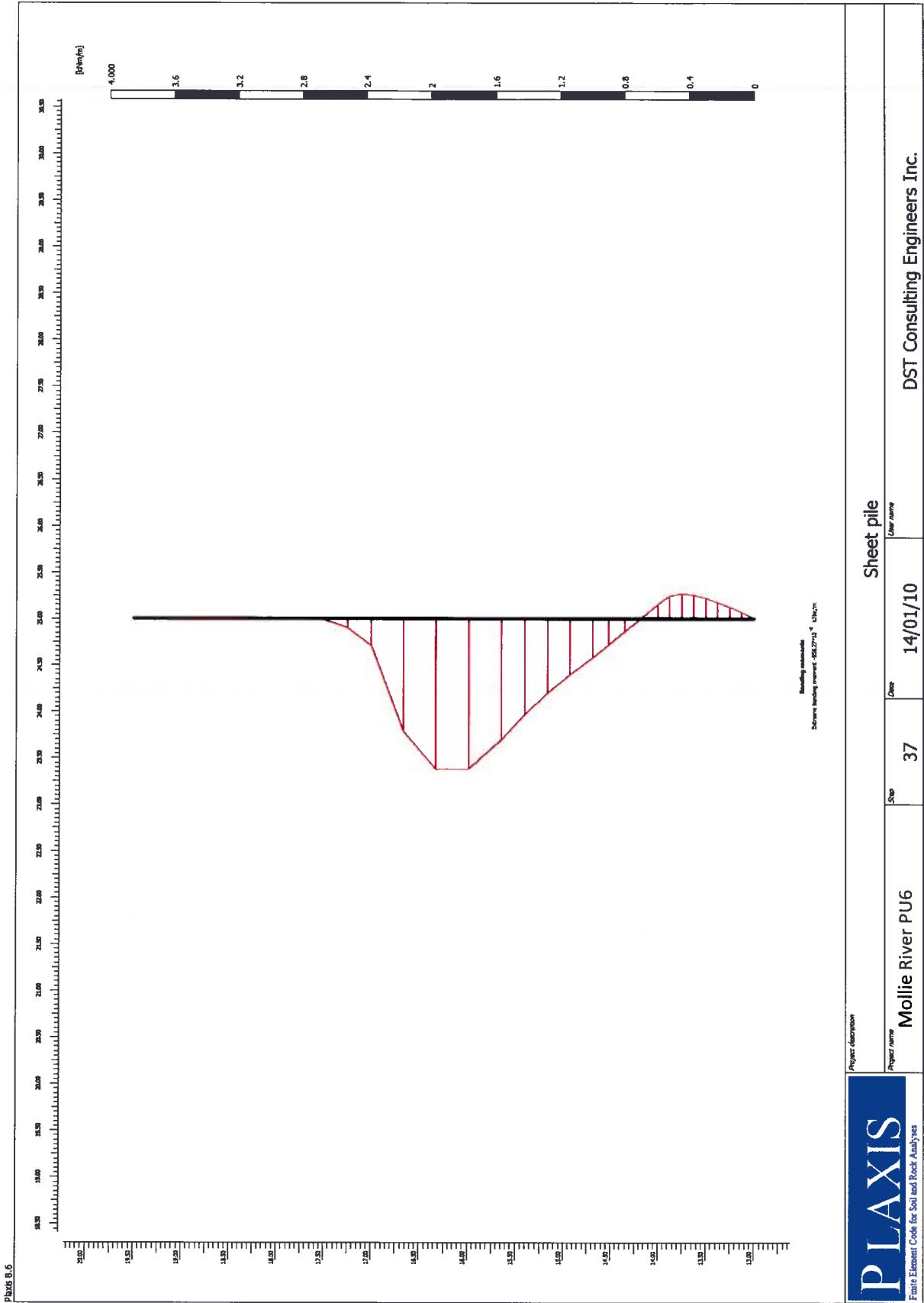


PLAXIS Finite Element Code for Soil and Rock Analyses Version 8.6.0.133		Project description	Sheet pile	
Project name		Date	Date name	
Mollie River PU6		14/01/10		DST Consulting Engineers Inc.

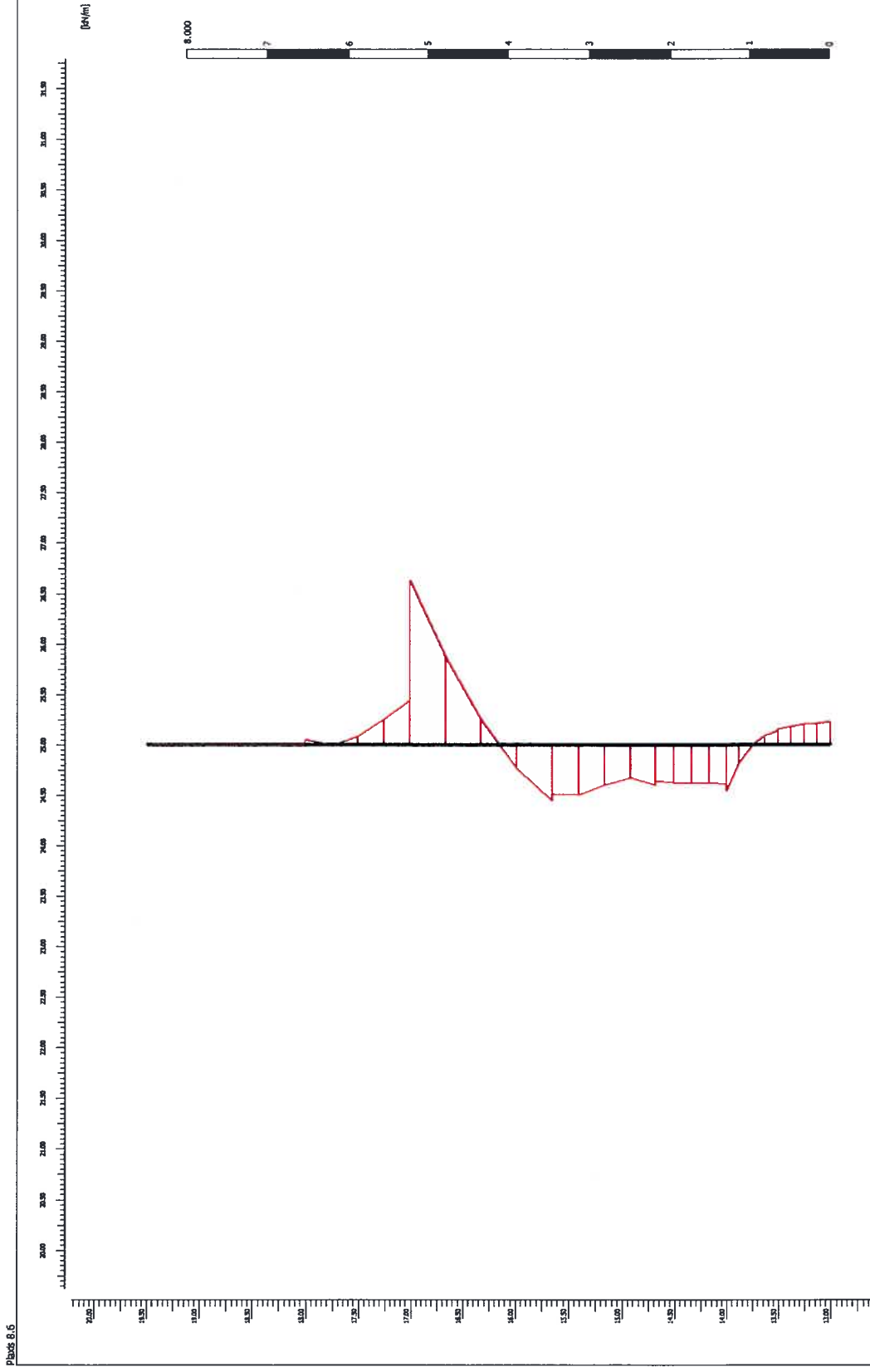
EFFECTIVE STRESS DISTRIBUTION WITH PU6 SHEET PILE (4m PENETRATION)




BENDING MOMENT PROFILE WITH PU6 SHEET PILE (4m PENETRATION)



Platz 8.6

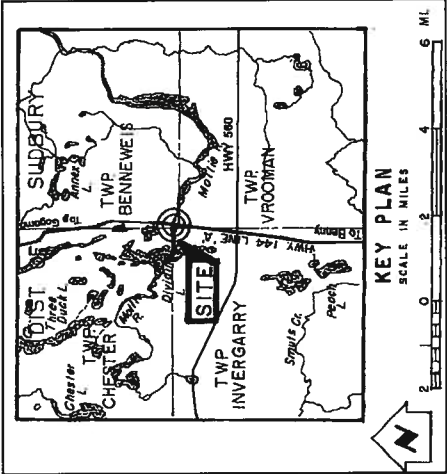


Stress levels
Columns in place then force = 2.11 kN/m

		Project description		Sheet pile	
Finite Element Code for Soil and Rock Analyses Version 8.4.0.1133		Project Name	Step	Date	User Name
		Mollie River PU6	37	14/01/10	DST Consulting Engineers Inc.

DST CONSULTING ENGINEERS INC.

DRAWINGS



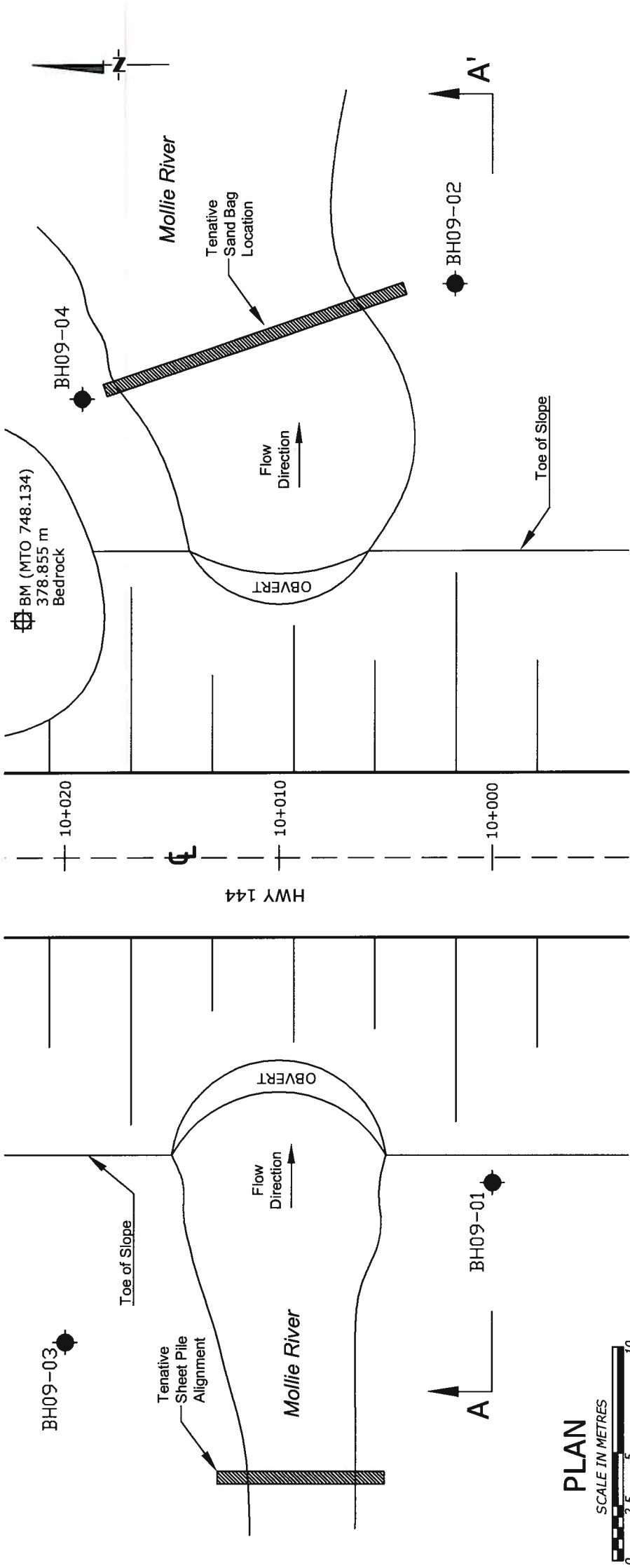
LEGEND			
	Borehole		Dynamic Cone Penetration Test (DCPT)
	Borehole with DCPT		Blows/0.3m (Std. Pen Test, 475 J/Blow)
	Water level at time of investigation		Benchmark
	Fill		Organics
	Topsoil		Till
	Sand & Gravel		Boulders & Cobbles
	Sand		Silt
	Clay		Sand & Gravel
	Boulders & Cobbles		Sand & Gravel
No.	Elevation	Station	Offset
1	376.00	10+000	15.0 m LT
2	376.04	10+002	27.0 m RT
3	376.14	10+020	23.0 m LT
4	375.72	10+019	21.5 m RT

- NOTES
- The cofferdam design should account for basal heave due to flow of water beneath the sheet piling
 - The presence of cobbles and boulders that may affect the installation of temporary excavation support system
 - Water level of the Mollie River presents the seasonal variation
 - Historical fluctuation of water level observed from the evidence at inlet and outlet side is EL.376.18 m and EL.376.07 m

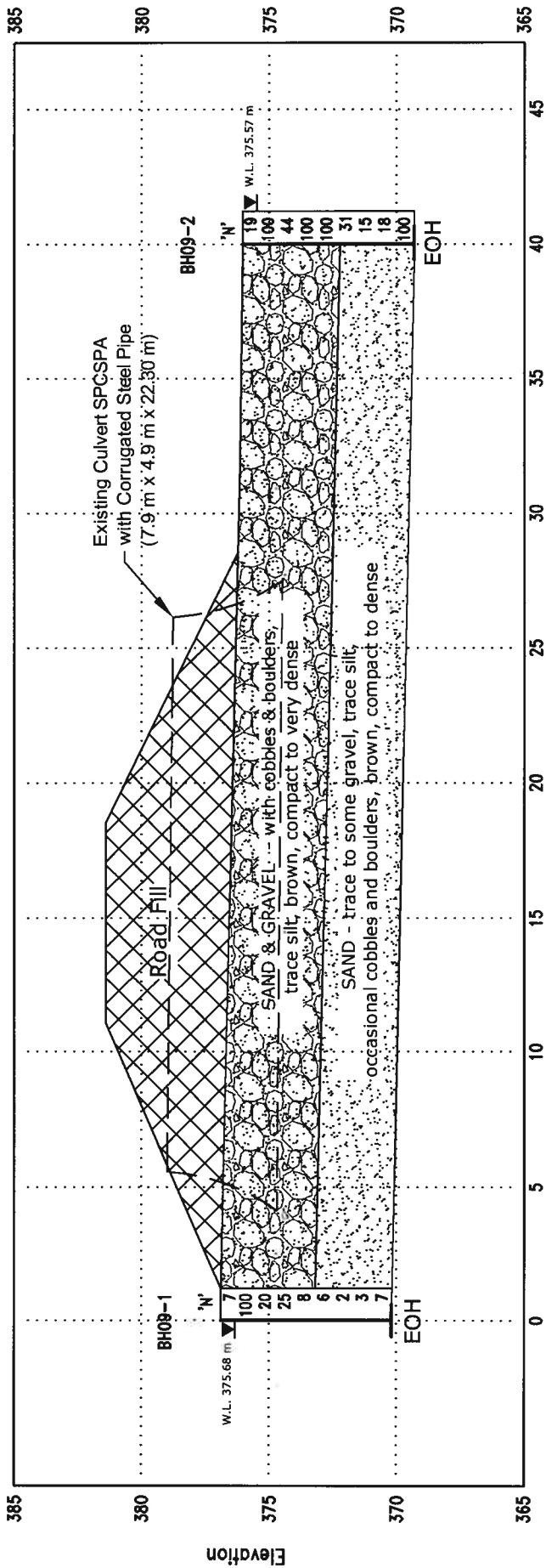
NOTE:
The boundaries between soil strata have been established only at borehole locations. Between boreholes the boundaries are assumed by interpolation and may not represent actual conditions.

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METRIC
DIMENSIONS ARE IN METRES
UNLESS OTHERWISE SPECIFIED
OR INDICATED OTHERWISE
IN PARAGRAPHS & NOTES



SECTION A-A'
Scale 1H:1V



METRIC
DRAWINGS ARE IN METERS
AND/OR MILLIMETERS UNLESS
OTHERWISE SPECIFIED
IN HEADINGS & NOTES

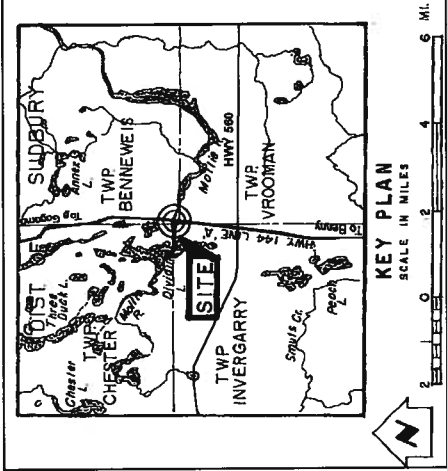
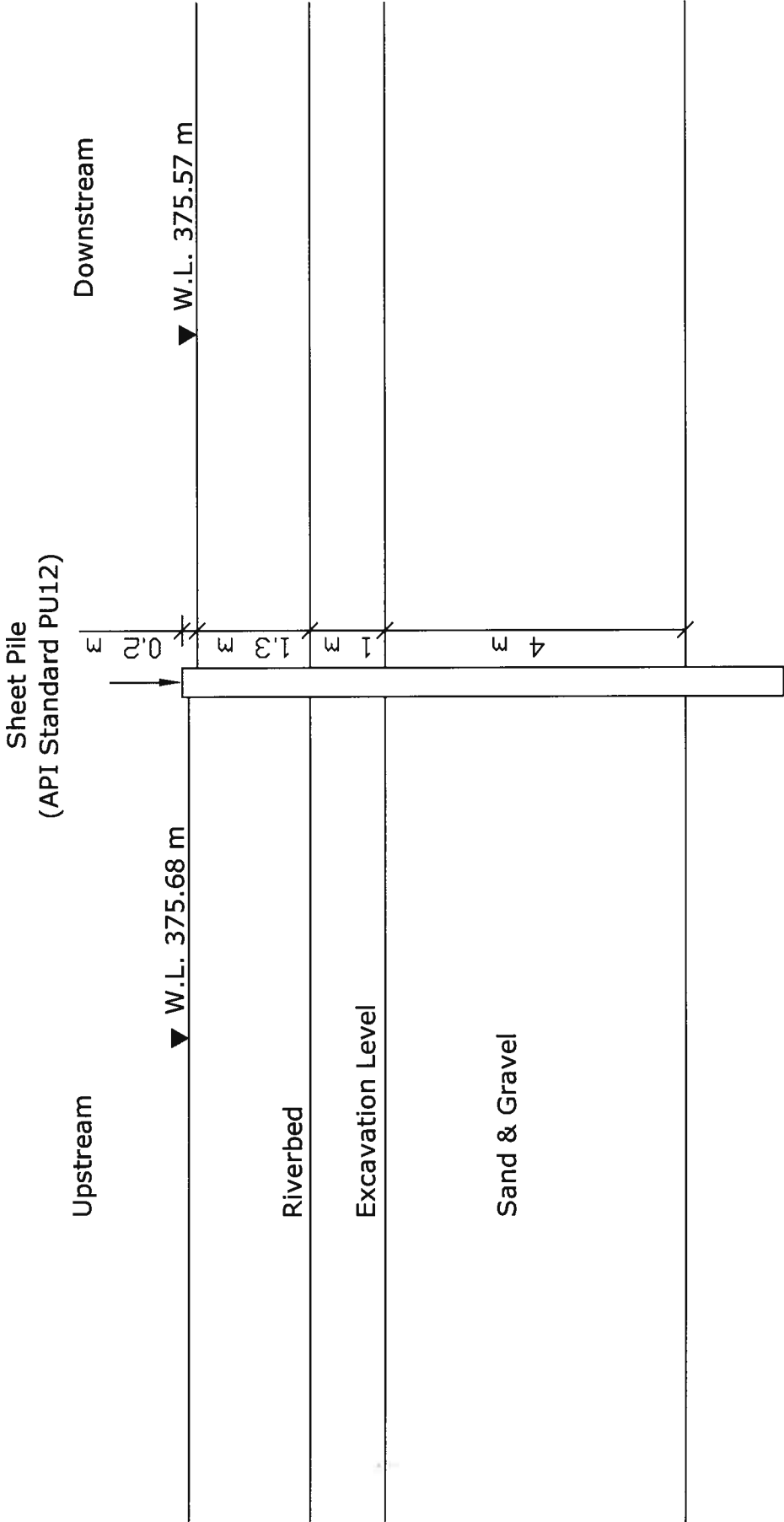
CONT No. 5007-E-0065
GEOCRES No. 41P-42
ASSIGNMENT No. 8



HIGHWAY 144
Mollie River Culvert Replacement
Cofferdam Geometry

SHEET
2

Cofferdam Geometry



LEGEND			
◆	Borehole		
⊕	Dynamic Cone Penetration Test (DCPT)		
⊙	Borehole with DCPT		
'N'	Blows/0.3m (Std. Pen Test, 475 J/Blow)		
▼	Water level at time of investigation.		
⊕	Benchmark		
⊕	Fill	⊕	Sand
⊕	Organics	⊕	Silt
⊕	Topsoil	⊕	Clay
⊕	Till	⊕	Sand & Gravel
⊕	Boulders & Cobbles		

No.	Elevation	Station	Offset
1	376.00	10+000	15.0 m LT
2	376.04	10+002	27.0 m RT
3	376.14	10+020	23.0 m LT
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


ENCLOSURES

RECORD OF BOREHOLE No BH09-1

1 OF 1

METRIC

W.P. 5007-E-0065 (Assignment #8) LOCATION 10+000 (15 m LT) ORIGINATED BY CS
 DIST 20 m HWY 144 BOREHOLE TYPE Hollow Stem Auger/Washbore COMPILED BY ML
 DATUM Geodetic DATE 2009 10 26 CHECKED BY WS

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 □ QUICK TRIAXIAL	✕ FIELD VANE ★ LAB VANE	20	40	60						80	100		
376.9	SAND & GRAVEL - with cobbles and boulders, trace silt, brown, loose to compact		1	SS	7		376										Water level at 0.32 m on Nov. 3, 2009				
																			SPT Value 100 blows/75 mm		
			2	SS	100+																
			3	SS	20														24 69 (7)		
			4	SS	25														30 62 (8)		
	5	SS	8																		
373.2	SAND - trace to some gravel and silt, occasional cobbles and boulders, brown, very loose to loose							373	372										Auger Refusal at 3.7 m. Start Washboring.		
3.7			6	SS	6																1 96 (3)
			7	SS	2																
			8	SS	3																
	9	SS	7																		
370.2	End of Borehole at 6.71 m						371														
6.7																					

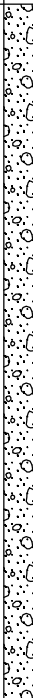


✕³, ★³: Numbers refer to Sensitivity ○ 3% STRAIN AT FAILURE

RECORD OF BOREHOLE No BH09-2

1 OF 1

METRIC

W.P. 5007-E-0065 (Assignment #8) LOCATION 10+002 (27 m RT) ORIGINATED BY CS
 DIST 20 m HWY 144 BOREHOLE TYPE Hollow Stem Auger/Washbore COMPILED BY ML
 DATUM Geodetic DATE 2009 10 27 CHECKED BY WS

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									
376.0							20	40	60	80	100									
	SAND & GRAVEL - with cobbles and boulders, trace silt, brown, compact to very dense		1	SS	19		376											Water level at 0.28 m below original surface grade on Nov. 3, 2009		
			2	SS	100+		375													SPT Value 100 blows/50 mm Auger Refusal at 1.5 m. Start Washboring. 17 blows/150 mm 14 blows/150 mm 30 blows/150 mm 100 blows/10 mm
			3	SS	44		374													
																	SPT Value 100 blows/25 mm			
4	SS	100+	373																	
			5	SS	100+			372												SPT Value 100 blows/50 mm
372.2	SAND - trace to some gravel, trace silt, occasional cobbles and boulders, brown, compact to dense																			
3.8			6	SS	31	372														
			7	SS	15	371														
			8	SS	18		370											11 87 (2)		
			9	SS	100+															
																		SPT Value 7 blows/150 mm 6 blows/150 mm 100 blows/0 mm		
369.3	End of Borehole at 6.71 m																			
6.7																				

\times^3, \star^3 : Numbers refer to Sensitivity \bigcirc 3% STRAIN AT FAILURE

RECORD OF BOREHOLE No BH09-3

1 OF 1

METRIC

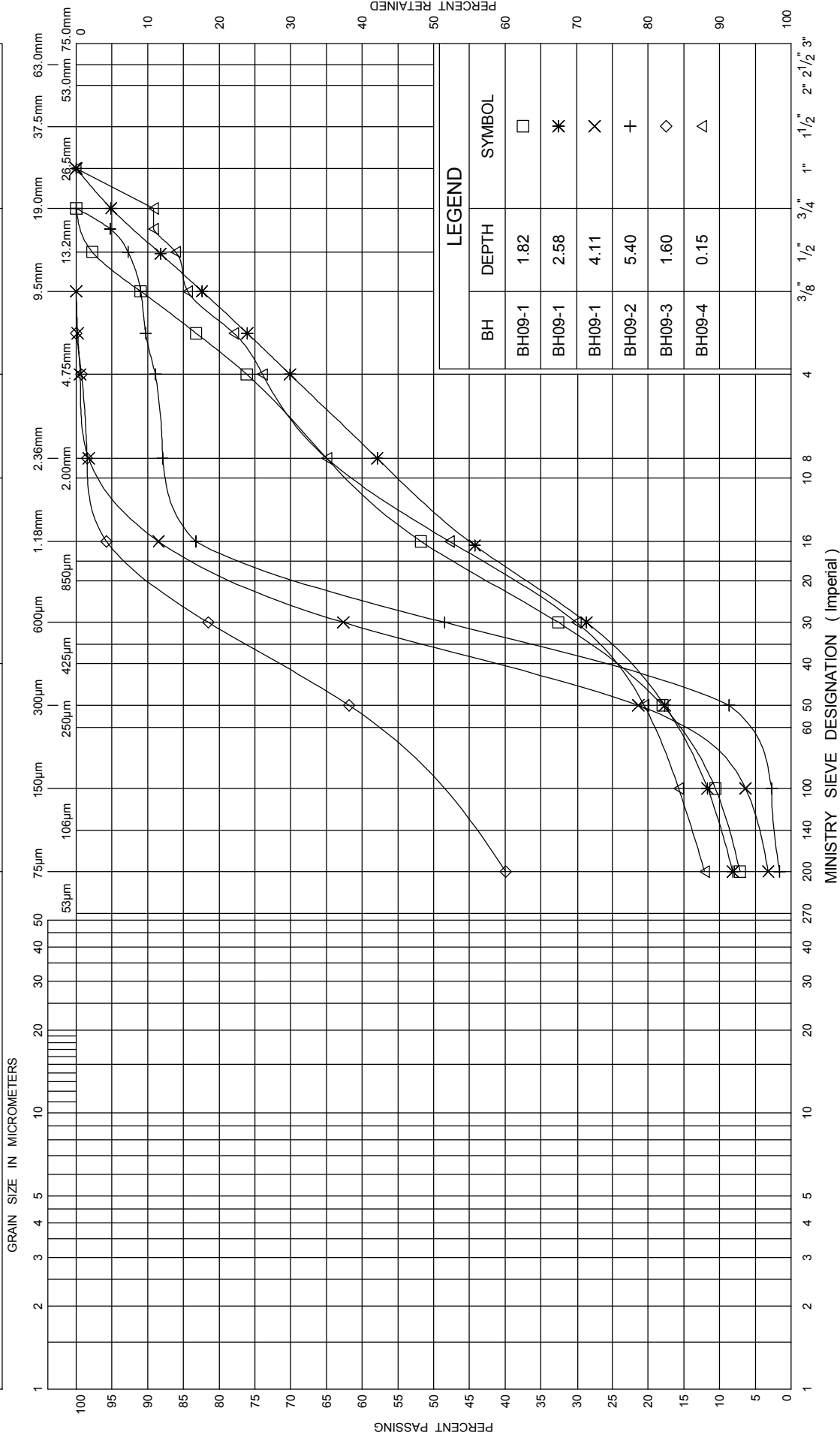
W.P. 5007-E-0065 (Assignment #8) LOCATION 10+020 (23 m LT) ORIGINATED BY CS
DIST 20 m HWY 144 BOREHOLE TYPE Hollow Stem Auger/Washbore COMPILED BY ML
DATUM Geodetic DATE 2009 10 28 CHECKED BY WS

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									
								○ UNCONFINED	✕ FIELD VANE	□ QUICK TRIAXIAL	★ LAB VANE	WATER CONTENT (%)					
376.1							20	40	60	80	100		20	40	60		GR SA SI CL
373.8 2.3	SAND & GRAVEL - with cobbles and boulders, trace silt, brown, compact to dense		1	SS	19		376										Water level at 0.28 m below original surface grade on Nov. 3, 2009 SPT Values 10 blows/150 mm 9 blows/150 mm 10 blows/150 mm 10 blows/0 mm
			2	SS	47		375										
			3	SS	13		374										
			4	SS	17		373										
	SAND - trace to some gravel, trace silt, occasional cobbles and boulders, brown, compact to dense						372										
5			SS	30	371												
6			SS	32													
7			SS	26													
370.2 5.9	End of Borehole at 5.94 m																

×³, ★³: Numbers refer to Sensitivity ○ 3% STRAIN AT FAILURE

UNIFIED SOIL CLASSIFICATION SYSTEM

CLAY & SILT			SAND			GRAVEL		
Fine			Medium			Fine		
Coarse			Coarse			Coarse		



GRAIN SIZE DISTRIBUTION

ENCLOSURE 5

5007-E- 0065 (Assignment #8)

HIGHWAY 144

