



**BLENHEIM URBAN GROWTH STUDY  
GEOTECHNICAL EVALUATION**

**SITE INVESTIGATIONS FACTUAL REPORT  
MARCH 2012**



# Blenheim Urban Growth Study Geotechnical Evaluation

## *Site Investigations Factual Report*

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## **1 Introduction**

Marlborough District Council is developing a strategy for the urban growth and development. The Council has identified a number of potential urban growth areas for Blenheim, that lie on the northern and eastern periphery of the city. Opus International Consultants Ltd (Opus) has been commissioned by the Council to carry out a geotechnical evaluation of the proposed growth areas.

A preliminary geotechnical appraisal of the ground conditions and geo-hazards in the Blenheim area has been carried (Opus, 2011). A key recommendation of this study was to carry out site investigations in the proposed growth areas to provide information to better characterise the ground conditions and assess the geotechnical issues, particularly relating to the hazard posed by liquefaction.

Site investigations have subsequently been carried out in January to February 2012. This report has been prepared as part of the investigation, and provides the factual results of the investigations and testing.

## **2 Site Description**

The site has previously been described in the preliminary geotechnical appraisal report (Opus, 2011). The following sections summarise the information on the site provided in that report.

### **2.1 Geomorphology**

The proposed urban growth areas are located on the outskirts of Blenheim's urban area, to the north (area Na:Nb) and to the east (areas E1, E2 and SE). The sites are situated on predominantly flat to gently undulating alluvial plains. The land is currently under agricultural use with few existing dwellings.

Opawa River forms the north western and south-western boundary of area E1 and the northern boundary of E2. Stop banks have been constructed along the Opawa River for flood protection.

### **2.2 Geology**

The geology of the Marlborough Area has been mapped at 1:25,000 scale by the New Zealand Geological Survey (NZGS, 1981) and at 1:250,000 scale by the Institute of Geological and Nuclear Sciences (IGNS, 2000).

The mapping shows the Blenheim area is underlain by Holocene age marine/estuarine silts and sands of the Dillons Point Formation and alluvial gravels and sands of the Rapaura Formation. These strata are underlain by older, clay-bound alluvial gravels of the Speargrass Formation (NZGS, 1981; Landcare Research, 1995; MCRWB, 1987; Davidson and Wilson, 2011).



## 2.3 Groundwater

Mapping of historic river and drainage features in the lower Wairau valley shows the area to the east and southeast of Blenheim (development areas E1, E2 and SE) consisted of swamps prior to development of the town (MCRWB, 1987).

A study by Marlborough District Council (Davidson and Wilson, 2011) provides a thorough description of the groundwater regime of the lower Wairau Valley. As part of this study, a series of boreholes in the Blenheim area show the static shallow groundwater table in this area to be approximately 2 m below ground level, and flowing from west to east.

## 3 Geotechnical Investigations

### 3.1 Boreholes

Three boreholes (BH1 – BH3) were drilled by CW Drilling and Investigation Ltd, between 31 January and 3 February 2012. All boreholes were 125mm sized, drilled by rotary percussive (concentrix) drilling. The locations and depths of the boreholes are given in Table 1; their locations are shown on Figure 2.

The boreholes were carried out to provide information to characterise the thickness, composition and strength of the Dillons Point Formation strata. Samples were collected from the boreholes to provide information on the grading of the soils, which has an important effect on the potential for liquefaction and ground damage.

The boreholes were drilled to depths between 15.00 m and 18.45 m. Standard Penetration Tests (SPTs) were carried out in the boreholes at 1 m intervals.

Engineering geologists from Opus logged the samples recovered from the boreholes. All samples were logged in accordance with the New Zealand Geotechnical Society (2005) Guidelines.

The borehole logs are presented in Appendix A and the driller's logs are provided in Appendix B.

**Table 1 Borehole summary table**

Borehole	Location	Easting <sup>1</sup>	Northing <sup>1</sup>	Depth (m)
BH1	Waipuna Road	2589324	5967551	12.45
BH2	Dillons Point Road	2591525	5966269	18.45
BH3	Alabama Road	2590848	5963951	15.00

Notes <sup>1</sup> Coordinates are in NZ Map Grid projection and are accurate to approximately ± 5 m

### 3.2 Cone Penetration Tests

Twelve Static Cone Penetration Tests (CPTs) were carried out across the project site between 31 January and 2 February 2012. The CPTs were carried out to provide geotechnical data on the strength and thickness of the strata, for use in assessing the liquefaction susceptibility of the soils.

The locations and depths of the CPTs are summarised in Table 2. The test results are provided in Appendix C.

**Table 2 Cone Penetration Test summary table**

Test No	Location	Easting <sup>1</sup>	Northing <sup>1</sup>	Depth (m)
CPT1	Thomsons Ford Road	2587790	5967843	2.72
CPT2	Old Renwick Road	2588080	5967450	2.59
CPT3	Old Renwick Road	2588572	5967530	2.79
CPT4	Old Renwick Road	2589010	5981320	4.00
CPT5	Dillons Point Road	2591730	5966067	5.98
CPT6	Dillons Point Road	2591212	5965988	17.21
CPT7	SH1 - Blenheim	2591334	5965411	17.54
CPT8	SH1 - Blenheim	2591953	5965358	5.96
CPT9	SH1 - Blenheim	2591857	5965014	19.65
CPT10	Alabama Road	2591397	5964534	18.53
CPT12	Alabama Road	2591691	5964245	19.39
CPT13 <sup>2</sup>	Alabama Road	2590960	5964183	16.41

Notes <sup>1</sup> Coordinates are in NZ Map Grid projection and are accurate to approximately  $\pm 5$  m

<sup>2</sup> coordinates have been approximated from aerial maps

### 3.3 Laboratory Tests

Laboratory soil classification tests were performed on samples collected from the boreholes. The tests were carried out by Opus Central Laboratories in Gracefield in accordance with NZS4402:1986.

The tests were carried out to provide data to characterise the soils and provide information for use in the liquefaction assessment.

The results of the laboratory tests are included in Appendix D and are summarised in Table 3.

**Table 3 Laboratory test summary table**

Borehole	Sample depth (m)	Particle size distribution (%)			
		Clay	Silt	Sand	Gravel
BH1	4.0 - 4.45	7	34	59	-
BH2	6.0 - 6.45	4	13	83	-
BH2	9.0 - 9.45	-	2	98	-
BH3	4.0 - 4.45	4	21	75	-

### 3.4 Groundwater

Groundwater was encountered in all three boreholes and in all of the CPTs. The depths at which groundwater was encountered across the project area are summarised in Table 4.

**Table 4 Groundwater levels encountered during the site investigations**

Test No	Easting <sup>1</sup>	Northing <sup>1</sup>	Hole Depth (m)	Depth to Groundwater (m b.g.l.) <sup>2</sup>
BH1	2589324	5967551	12.45	1.4
BH2	2591525	5966269	18.45	3.4
BH3	2590848	5963951	15.00	1.0
CPT1	2587790	5967843	2.72	1.96
CPT2	2588080	5967450	2.59	1.30
CPT3	2588572	5967530	2.79	1.30
CPT4	2589010	5981320	4.00	2.10
CPT5	2591730	5966067	5.98	1.50
CPT6	2591212	5965988	17.21	4.00
CPT7	2591334	5965411	17.54	1.20
CPT8	2591953	5965358	5.96	1.51
CPT9	2591857	5965014	19.65	2.96
CPT10	2591397	5964534	18.53	2.95
CPT12	2591691	5964245	19.39	3.00
CPT13 <sup>3,4</sup>	2590960	5964183	16.41	1.10

Notes <sup>1</sup> Coordinates are in NZ Map Grid projection and are accurate to approximately  $\pm 5$  m

<sup>2</sup> metres below ground level

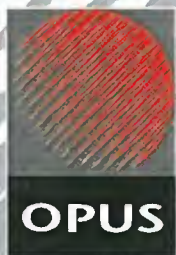
<sup>3</sup>CPT11 was moved and replaced by CPT13

<sup>4</sup>coordinates have been approximated from aerial maps

## **4 References**

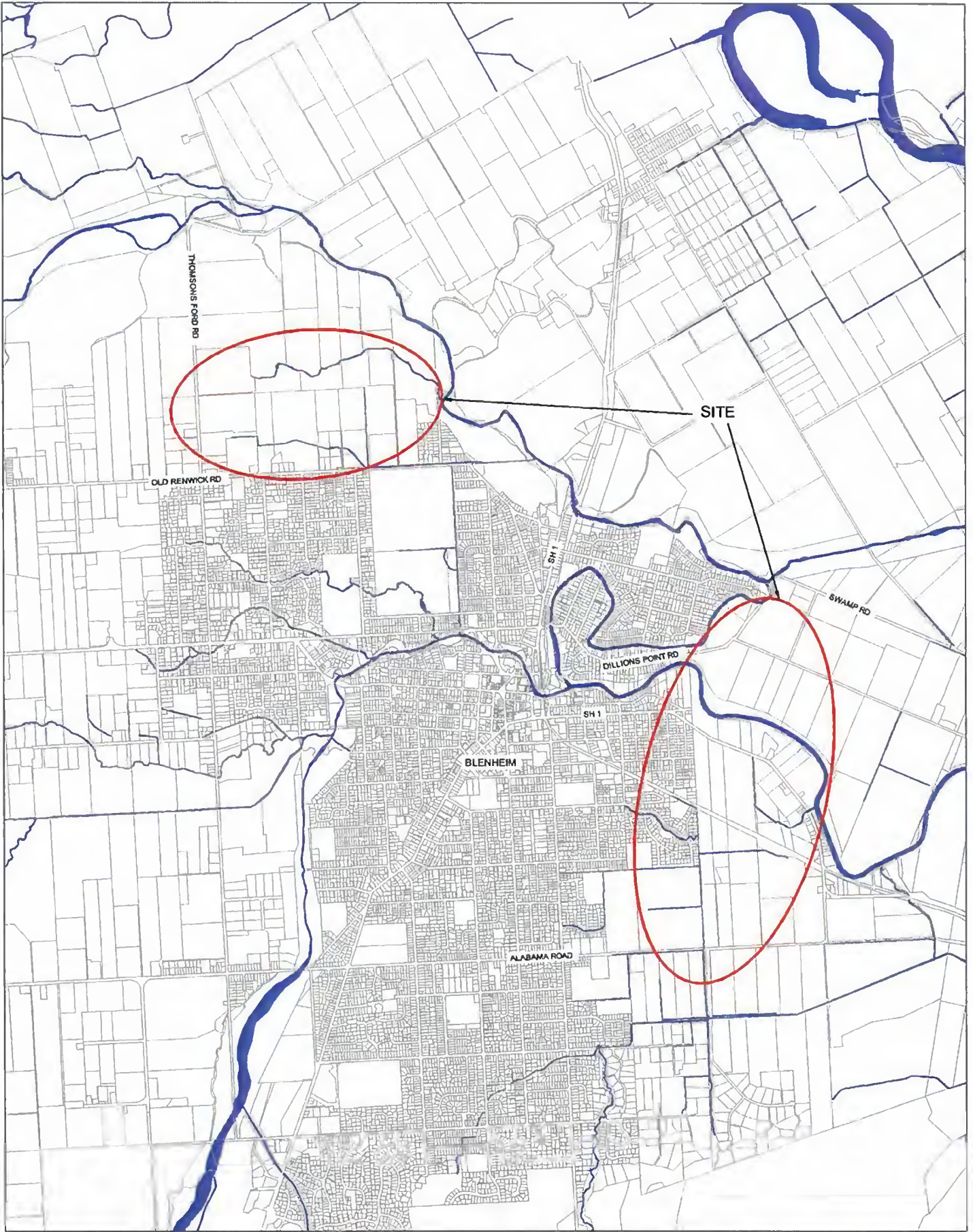
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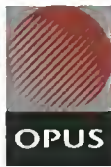
## FIGURES





Prepared for:

Prepared by:



Title:

Site Location Plan

Project:

Blenheim Urban Growth Geotechnical Evaluation  
Site Investigation Factual Report

Scale:

Not to Scale

Date:

March 2012

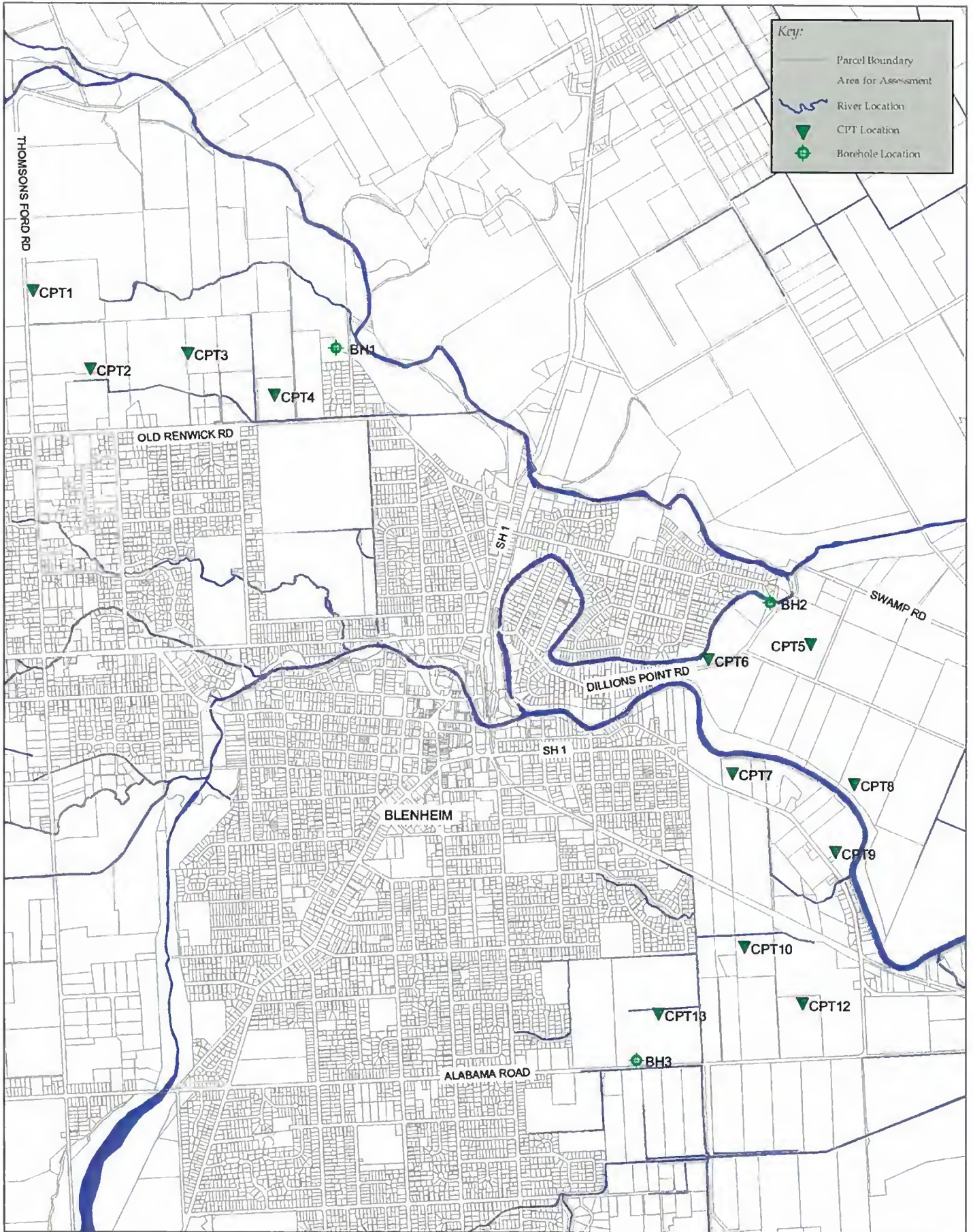
Project No:

5C2128.00

Figure:

1





**Key:**

- Parcel Boundary
- Area for Assessment
- River Location
- CPT Location
- Borehole Location

Prepared for:		Prepared by:		Title:	
				Site Investigation Location Plan	
				Project: Blenheim Urban Growth Geotechnical Evaluation Site Investigations Factual Report	
Scale:	Date:	Project No:	Figure:		
1:25,000 (A4)	March 2012	5C2128.00	2		





# APPENDIX A

BOREHOLE LOGS





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# BOREHOLE LOG

HOLE NO.

**BH1**

PROJECT

**Blenheim Urban Growth Study - Geotechnical Evaluation**

CO-ORD.

**2589324.00 mE 5967551.00 mN**

R.L.

SHEET

**1 of 1**

LOCATION

Waipuna Road

REF. GRID

New Zealand Map Grid

DATUM

HOLE LENGTH

**12.45 m**

GEOLOGY/UNIT	MAIN DESCRIPTION	R.L. (m)	DEPTH (m)	GRAPHIC LOG	TESTS			ROCK WEATHERING	DEFECT SPACING	DIP degrees 90	DETAILED DESCRIPTION	CORE			DRILLING			PIEZOMETER DETAILS	OTHER INSTRUMENTATION	
					SPT N° VALUE	SPT BLOW COUNTS OR SHEAR VALUE	ROCK STRENGTH					ROD (%)	TOTAL CORE RECOVERY (%)	SAMPLE TYPE	DRILLING METHOD	DRILLING FLUID LOSS	CASING			BASE OF HOLE & WATER LEVEL
Rapaura Formation	SILT with some sand, light grey/brown, dry, non-plastic.										Silt possibly very soft to soft, low plasticity when wet. Rootlets									
	Clayey SILT, mottled brown & grey, very soft to soft, moist to wet, low to moderate plasticity.		1		4	1/1/1/1/1					Pockets of high plasticity clay			DHH						
			2		6	1/1/2/1/2								SPT						
			3		9	2/1/1/1/1/6								PT						
	Becoming firm.		4		13	3/1/3/3/4								DHH						
	Silty SAND, dark grey, medium dense to dense, moist to wet.		5		37	3/7/9/10/11								SPT						
	Becoming saturated.		6		50+	11/10/14/15/11 =55mm						Gravels are slightly weathered greywacke sandstone, well rounded, well graded to ~3cm. Dark red & grey clasts. Matrix consists of sand.			DHH					
	Sandy GRAVEL, dark red-brown, very dense, moist to wet.		7		50+	17/11/12/13/12 =45mm								SPT						
	Becoming dark brown.		8		50+	13/16/30/14 =14mm						Driller recorded heaving sands at 8m.			DHH					
	Becoming dark grey.		9		36	19/11/10/6/9						Gravels have quartz veins and are smaller ~0.5-2cm			SPT					
	Becoming dense.		10		17	3/2/3/6/6						High amount of organic matter; wood fragments			DHH					
	SAND with some silt, dark grey, medium dense, moist to wet.		11		50	7/6/7/18/19						Gravels are slightly weathered, subrounded, <2cm			SPT					
Sandy GRAVEL, dark brown, dense to very dense, wet to saturated.		12		50	14/10/12/12/16									DHH						
		13												SPT						
		14																		

**NOTES**

DHH - Down Hole Hammer  
SPT - Standard Penetration Test  
PT - Push lube (100mm diameter)

STARTED	31/01/2012	FINISHED	1/02/2012
DRILLER	Barclay Moir	DRILLING CO.	CW Drilling
INCLINATION/AZIMUTH	-90°	DRILLING RIG	MP100
LOGGEO	E Williamson	CHECKED	D Mason
CLIENT	Marlborough District Council	JOB NO.	5C2128.00

**BH1**

LOGGED IN ACCORDANCE WITH NZ GEOTECHNICAL SOCIETY (2005) GUIDELINES

SEE ATTACHED KEY SHEET FOR EXPLANATION OF SYMBOLS

BOREHOLE\_LOG\_A3\_GENERAL\_BLENHEIM\_SIFPJ\_OPUS\_WLG\_REV090408\_GDT\_190312



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# BOREHOLE LOG

HOLE NO.  
**BH2**  
SHEET  
1 of 2  
HOLE LENGTH  
18.45 m

PROJECT  
**Blenheim Urban Growth Study - Geotechnical Evaluation**  
LOCATION  
Dillons Point Road, Bank of Opawa River

CO-ORD.  
2591525.00 mE 5966269.00 mN  
REF. GRID  
New Zealand Map Grid

R.L.  
DATUM

GEOLOGY/UNIT	MAIN DESCRIPTION	R.L. (m)	DEPTH (m)	GRAPHIC LOG	TESTS				ROCK WEATHERING	DEFECT SPACING	DIP degrees 30	DETAILED DESCRIPTION	CORE		DRILLING				PIEZOMETER DETAILS	OTHER INSTRUMENTATION	
					SPT N° VALUE	SPT BLOW COUNTS OR SHEAR VALUE	ROCK STRENGTH	ROQ (%)					TOTAL CORE RECOVERY (%)	SAMPLE TYPE	DRILLING METHOD	DRILLING FLUID LOSS	CASING	BASE OF HOLE & WATER LEVEL			
Made Ground	Sandy SILT, light brown, very soft to soft, dry, non plastic.		1		4	1/1/1/1/1						Minor amounts of rootlets throughout.			DHH						
	1		2		4	3/1/1/2/0									SPT						
	Becoming moist.		3		3	3/1/1/1/0									PT						
	2		4		3	1/1/1/1/0									DHH						
	Silty SAND, dark brown, very loose, moist.		5		6	1/1/1/2/2						Zone of loose material.			SPT						
	3		6		1	1/1/0/0/0									DHH						
Dillons Point / Rapaura Formation	Sandy GRAVEL with some silt, dark grey, very dense, moist to wet.		7		50	9/1/1/3/9						Medium gravels are well rounded, <2cm, unweathered greywacke sandstone, well graded. Coarse sand matrix.			SPT						
	4		8		9	1/1/1/2/5								DHH							
	Sandy SILT, dark grey, firm, moist to wet.		9		7	1/1/1/5/0								SPT							
	Becoming soft.		10		46	4/5/9/14/18						Gravels are well rounded, <2cm, unweathered, well graded. Abundant shells within sand.			DHH						
	5		11		50	4/5/13/15/17								SPT							
	6		12		49	11/14/12/17/6								DHH							
	Sandy GRAVEL, dark grey, dense, wet.		13		10	2/2/3/2/3						Abundant shells, densely packed.			SPT						
	7		14		8	2/2/3/3/0								DHH							
Sandy SILT, dark grey, firm, moist.														SPT							
8														DHH							
Less sand.														SPT							
														DHH							

**NOTES**

STARTED	1/02/2012	FINISHED	2/02/2012
DRILLER	Barclay Moir	DRILLING CO.	CW Drilling
INCLINATION/AZIMUTH	-90°	DRILLING RIG	MP100
LOGGED	E Williamson, M Loach	CHECKED	D Mason
CLIENT	Marlborough District Council	JOB NO.	5C2128.00

**BH2**

BOREHOLE LOG A3 GENERAL, BLENNHEIM, SI.GPJ OPUS WLG REV00408.GDT, 18/03/12



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 www.opus.co.nz

# BOREHOLE LOG

HOLE NO.

**BH2**

PROJECT

**Blenheim Urban Growth Study - Geotechnical Evaluation**

CO-ORD.

**2591525.00 mE 5966269.00 mN**

R.L.

SHEET

2 of 2

LOCATION

**Dillons Point Road, Bank of Opawa River**

REF. GRID

**New Zealand Map Grid**

DATUM

HOLE LENGTH

**18.45 m**

GEOLOGY/UNIT	MAIN DESCRIPTION	R.L. (m)	DEPTH (m)	GRAPHIC LOG	TESTS				DIP degrees	DETAILED DESCRIPTION	CORE			DRILLING				PIEZOMETER DETAILS	OTHER INSTRUMENTATION	
					SPT 'N' VALUE	SPT BLOW COUNTS OR SHEAR VALUE	ROCK STRENGTH	ROCK WEATHERING			DEFECT SPACING	ROD (%)	TOTAL CORE RECOVERY (%)	SAMPLE TYPE	DRILLING METHOD	DRILLING FLUID LOSS	CASING			BASE OF HOLE & WATER LEVEL
Dillons Point / Rapaura Formation	Sandy SILT, dark grey, firm, moist.				14	4/1/2/4/7			0	Abundant shells, densely packed.			SPT	Rotary percussive (concentric) drilling				-m 2/02		
	Becoming stiff.				28	9/1/6/5/7/9							DHH							
			16																	
			17																	
			18										SPT							
			19																	
			20																	
			21																	
			22																	
			23																	
			24																	
			25																	
			26																	
			27																	
			28																	
			29																	

**NOTES**

STARTED	1/02/2012	FINISHED	2/02/2012
DRILLER	Barclay Moir	DRILLING CO.	CW Drilling
INCLINATION/ AZIMUTH	-90°	DRILLING RIG	MP100
LOGGED	E Williamson, M Loach	CHECKED	D Mason
CLIENT	Marlborough District Council	JOB NO.	5C2128.00
			<b>BH2</b>

LOGGED IN ACCORDANCE WITH NZ GEOTECHNICAL SOCIETY (2005) GUIDELINES

SEE ATTACHED KEY SHEET FOR EXPLANATION OF SYMBOLS

BOREHOLE LOG\_A3\_GENERAL\_BLENHEIM\_SIGPJ\_OPUS\_V1.G REV:08/04/08 GDT 19/03/12

Scale 1:50.0



# BOREHOLE LOG

HOLE NO  
**BH3**

PROJECT  
**Blenheim Urban Growth Study - Geotechnical Evaluation**

CO-ORD.  
**2590848.00 mE 5963951.00 mN**

R.L.  
**1 of 1**

LOCATION  
**Alabama Road**

REF. GRID  
**New Zealand Map Grid**

DATUM  
**HOLE LENGTH 15 m**

GEOLOGY/UNIT	MAIN DESCRIPTION	R.L. (m)	DEPTH (m)	GRAPHIC LOG	TESTS				DIP	DETAILED DESCRIPTION	CORE		DRILLING			PIEZOMETER DETAILS	OTHER INSTRUMENTATION	
					SPT N° VALUE	SPT BLOW COUNTS OR SHEAR VALUE	ROCK STRENGTH	ROCK WEATHERING			DEFECT SPACING	ROD (%)	TOTAL CORE RECOVERY (%)	SAMPLE TYPE	DRILLING METHOD			DRILLING FLUID LOSS
Dillons Point Formation	Clayey SILT, light brown/grey, firm, dry.		1	[Graphic Log]	11	6/13/3/2/3			0 degrees			DHH						
	Becoming moist.		2	[Graphic Log]	7	2/1/2/2/2						SPT						
	Fine sandy SILT, blueish grey, firm, wet.			3	[Graphic Log]	8	3/1/3/2/2						DHH					
				4	[Graphic Log]	6	1/1/1/1/1/3						PT					
				5	[Graphic Log]	10	4/1/3/3/3						DHH					
				6	[Graphic Log]	17	4/2/8/2/5						SPT					
Rapaura Formation	Sandy, silty GRAVEL, dark grey, dense, wet.		7	[Graphic Log]	36	5/8/10/9/9						DHH						
			8	[Graphic Log]	29	5/4/8/8/9						SPT						
		9	[Graphic Log]	37	7/11/9/11/6							DHH						
		10	[Graphic Log]	10	6/2/1/2/5							SPT						
		11	[Graphic Log]	37	9/7/10/9/11							DHH						
		12	[Graphic Log]	50	17/14/12/12/12							SPT						
		13	[Graphic Log]	50	24/14/13/11/12							DHH						
		Silty GRAVEL with some clay. Dark grey, dense, wet to saturated.		14	[Graphic Log]	36	10/7/11/9/9						SPT					

**NOTES**

STARTED	2/02/2012	FINISHED	3/02/2012
DRILLER	Barclay Moir	DRILLING CO.	CW Drilling
INCLINATION/AZIMUTH	-90°	DRILLING RIG	MP100
LOGGED	E Williamson, M Loach	CHECKED	D Mason
CLIENT	Marlborough District Council	JOB NO.	5C2128.00

**BH3**





# APPENDIX B

DRILLER'S LOGS



CLIENT Opus International Ltd PROJECT NAME Blenheim Liquifaction Study

PROJECT NUMBER Liq 1 PROJECT LOCATION Adjacent to Waipuna Road in paddock

DATE STARTED 31/1/12 COMPLETED 1/2/12 GROUND ELEVATION \_\_\_\_\_ HOLE SIZE 125

DRILLING CONTRACTOR CW Drilling GROUND WATER LEVELS:

DRILLING METHOD Concentrix AT TIME OF DRILLING ---

LOGGED BY Barclay Moir CHECKED BY James Chapman AT END OF DRILLING 1.40 m

NOTES Geolech Investigation Borehole AFTER DRILLING ---

DEPTH (m)	SAMPLE TYPE NUMBER	REMARKS	GRAPHIC LOG	MATERIAL DESCRIPTION	WELL DIAGRAM
2		Steel casing removed and 80mm upvc liner left in hole. steel lobby box installed at surface.		Light brown Silt	<p>Natural pack backfill 80mm PN15 upvc blank pipe</p> <p>Washed Gravel pack 80mm Machine slotted upvc wellscreen</p>
			3.00	Dark Grey Marine silts, some organic material	
4			3.90	Grey Sand	
			4.45	Grey sand, saturated	
6			5.35	Grey, well graded sandy Gravels, some iron staining	
8					
10			10.00	Grey sandy silt	
			10.40	Grey Sandy Silt, some organic material	
			11.30	Grey, well graded sandy Gravels	
12			12.00	Bottom of hole at 12.00 m.	

GENERAL BH / TP / WELL OPUS BLENHEIM LIQUIFACTION 1 GPJ CW DRILLING GDT 4/2/12



CLIENT Opus International Ltd PROJECT NAME Blenheim Liquifaction Study  
 PROJECT NUMBER Liq2 PROJECT LOCATION In Vinyard adjacent to Dillions Point Road  
 DATE STARTED 1/2/12 COMPLETED 2/2/12 GROUND ELEVATION \_\_\_\_\_ HOLE SIZE 125  
 DRILLING CONTRACTOR CW Drilling GROUND WATER LEVELS:  
 DRILLING METHOD Concentrix AT TIME OF DRILLING ---  
 LOGGED BY Barclay Moir CHECKED BY James Chapman ▽ AT END OF DRILLING 3.40 m  
 NOTES Geotech Investigation Borehole AFTER DRILLING ---

DEPTH (m)	SAMPLE TYPE NUMBER	REMARKS	GRAPHIC LOG	MATERIAL DESCRIPTION
2		Bore hole backfilled upon completion		Light brown silty sand
3.00				▽ Grey silty sand
4				Grey Sand
4.00				Grey silty sand
5.00				Grey well graded sandy Gravels
6				Grey sand
7.00				Grey, well graded sandy Gravels some shells
8				Grey Silt
8.00				Grey Sand some shells
9.50				Grey Silt
10				Grey Sand some shells
12				Grey Silt
13.00				Grey Sand some shells
14				Grey Silt
15.50				Grey Sand some shells
16				Grey Silt
17.20				Grey Sand some shells
18				Grey Silt
18.00			Bottom of hole at 18.00 m.	

GENERAL BH / TP / WELL OPUS BLENHEIM LIQUIFACTION 2 GPJ CW DRILLING GDT 4/2/12





CLIENT Opus International Ltd PROJECT NAME Blenheim Liquifaction Study  
 PROJECT NUMBER Liq3 PROJECT LOCATION In Paddock adjacent to Alabama Road

DATE STARTED 2/2/12 COMPLETED 3/2/12 GROUND ELEVATION \_\_\_\_\_ HOLE SIZE 125  
 DRILLING CONTRACTOR CW Drilling GROUND WATER LEVELS:  
 DRILLING METHOD Concentrix AT TIME OF DRILLING \_\_\_\_\_  
 LOGGED BY Barclay Moir CHECKED BY James Chapman ▽ AT END OF DRILLING 1.00 m  
 NOTES Geotechnical Investigation Borehole AFTER DRILLING \_\_\_\_\_

DEPTH (m)	SAMPLE TYPE NUMBER	REMARKS	GRAPHIC LOG	MATERIAL DESCRIPTION	
		Borehole backfilled upon completion		Dark Brown Silt	
2				1.90	Light brown silt
				2.80	Light grey silt, saturated at 2.5m
4				5.00	Blue/grey sandy silt, some shells
				7.20	Grey well graded sandy Gravels
8				9.20	Grey well graded Gravels silty matrix
				14.00	Grey Silt
				14.30	Grey well graded sandy Gravels
				15.00	Bottom of hole at 15.00 m.

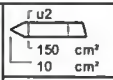
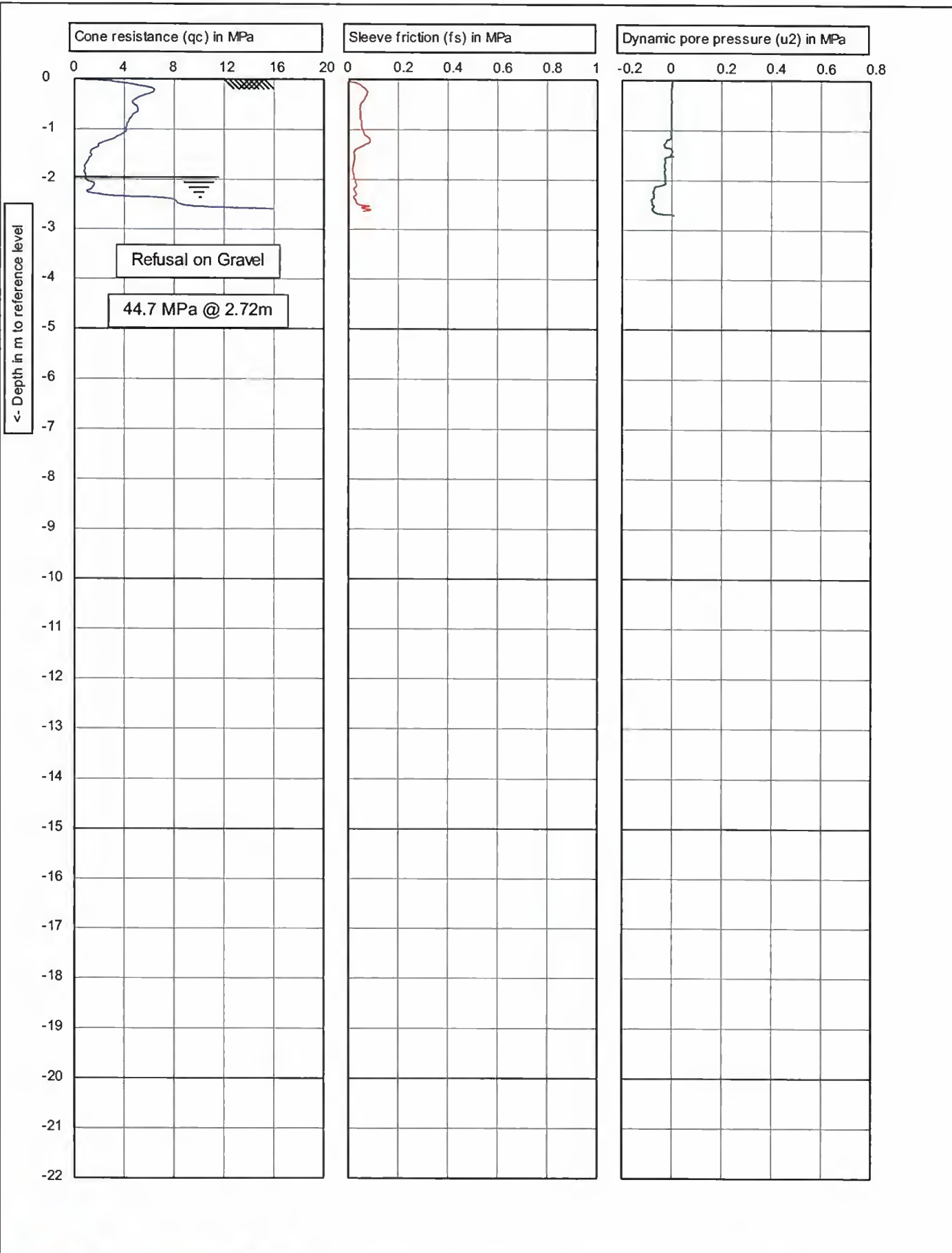
GENERAL BH / TP / WELL OPUS BELNHEIM LIQUIFACTION 3.GPJ CW DRILLING GDT 4/2/12





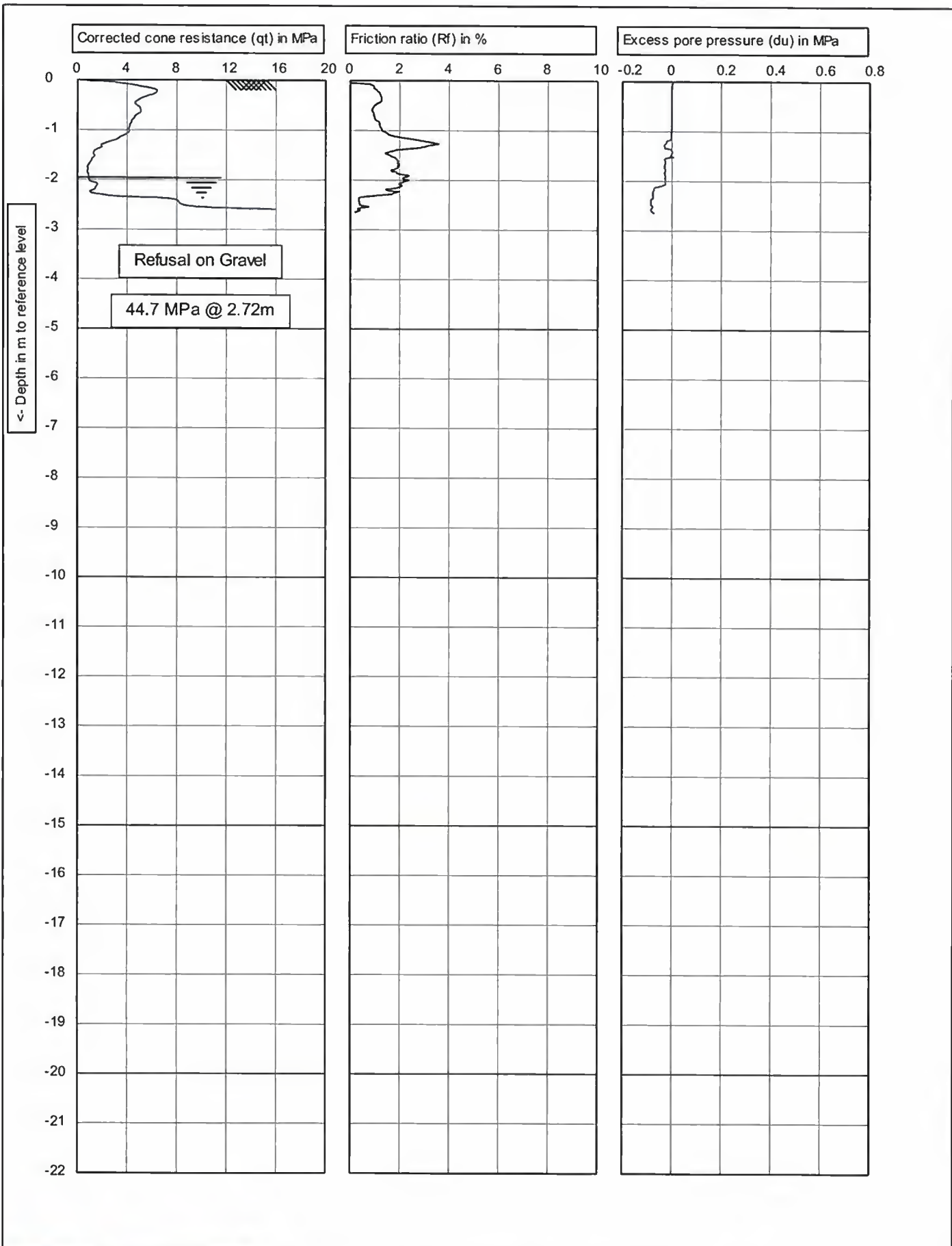
## APPENDIX C

CONE PENETRATION TEST RESULTS

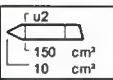


Test according to A.S.T.M standard D-5778-07		Predrill :	0	
G.L. 0	W.L.: -1.96	Date:	31/01/2012	
Project:	Geotechnical Investigation		Cone no.:	C10CFIP.E09
Location:	34 Thomsons Ford Road		Project no.:	Blenheim001
Position:	CPT no.:	CPT01	1/6	

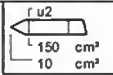
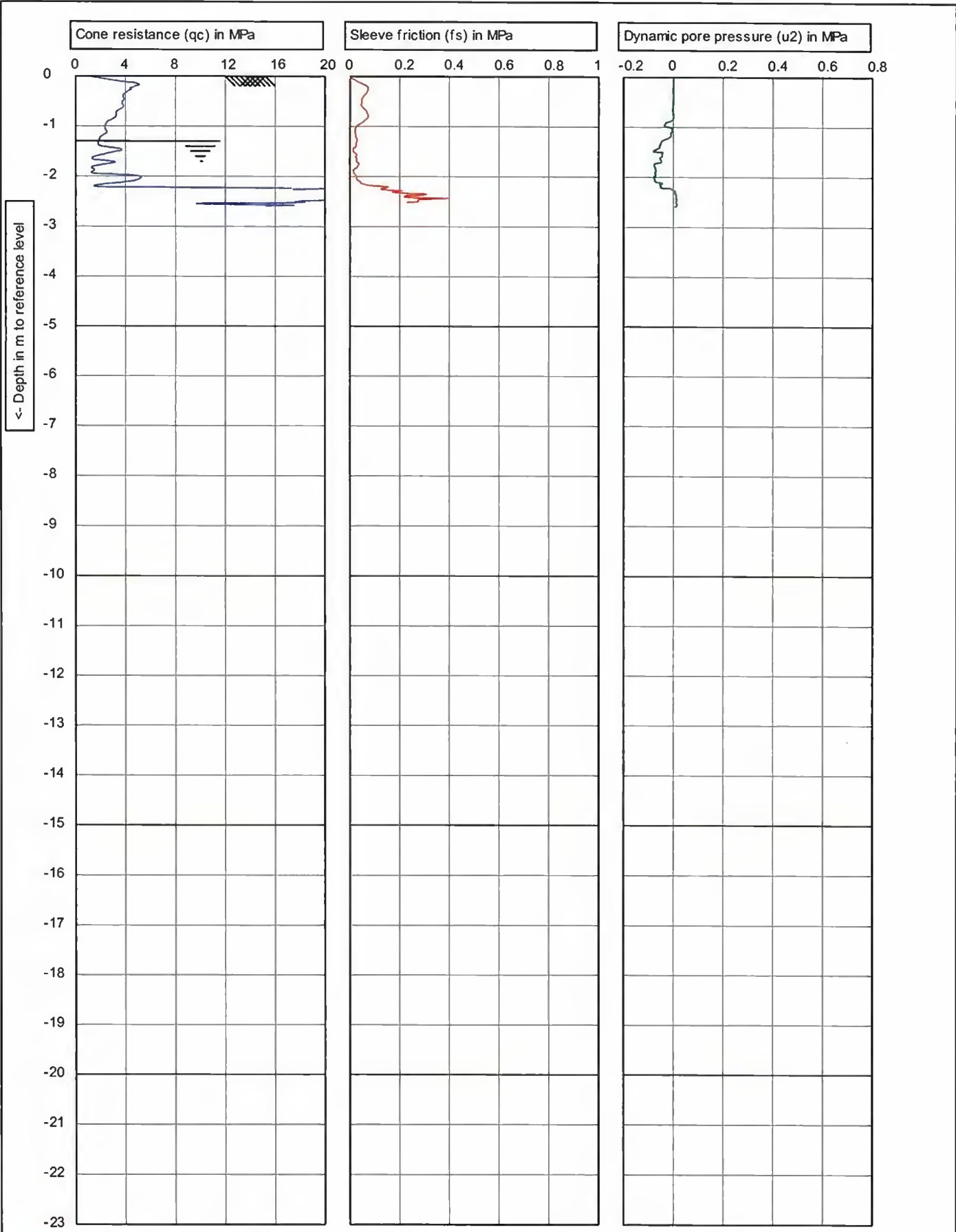
CPTask V1.20



CPT Test V1.20



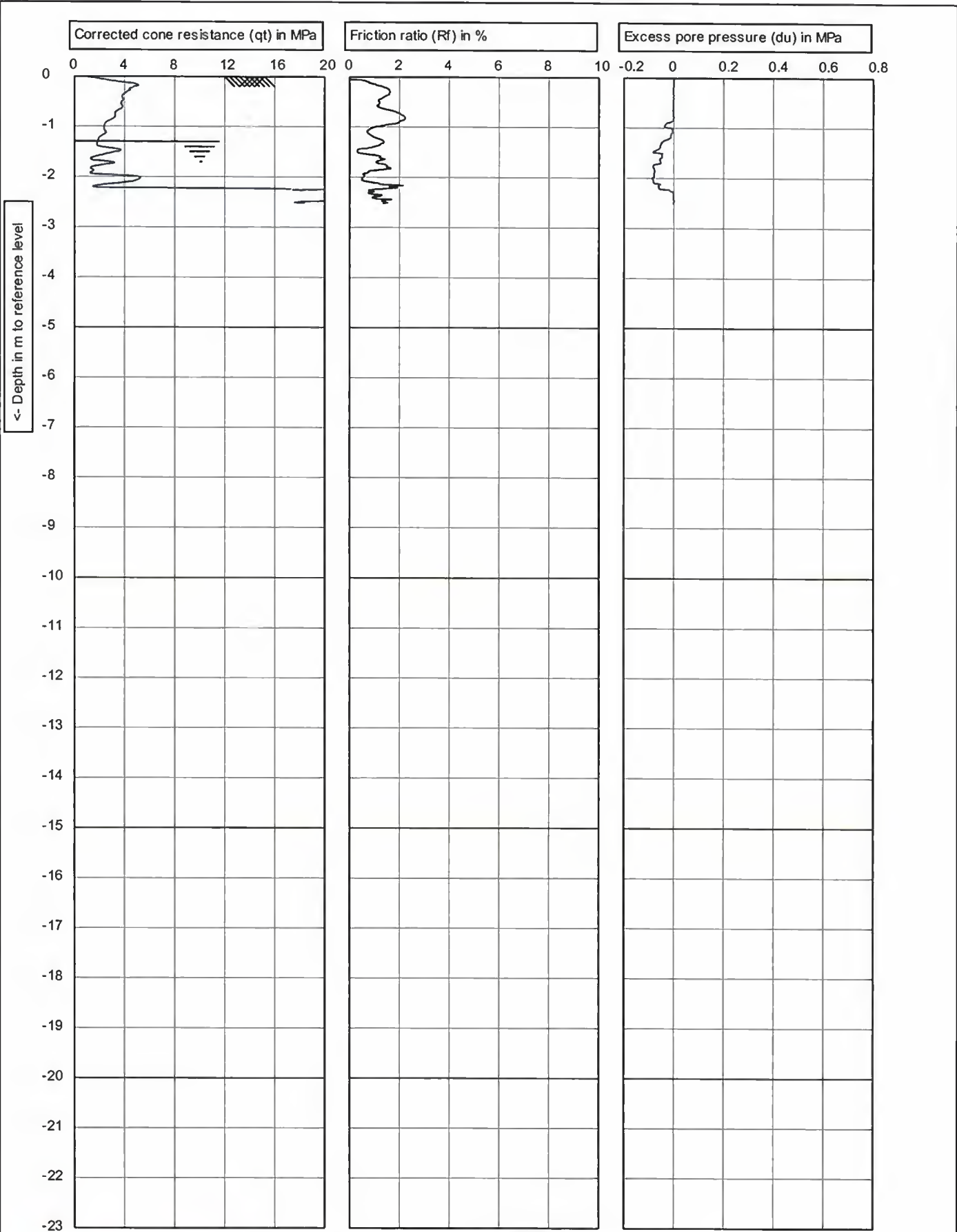
Test according to A.S.T.M standard D-5778-07		Predrill :	0
G.L. 0	W.L.: -1.96	Date:	31/01/2012
Project: Geotechnical Investigation		Cone no.:	C10CRIP.E09
Location: 34 Thomsons Ford Road		Project no.:	Blenheim001
Position:		CPT no.:	CPT01
			2/6



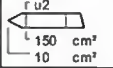
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G.L. 0	W.L.: -1.3	Date:	1/02/2012
Project:	Geotechnical Investigation	Cone no.:	C10CFIP.E09
Location:	Old Renwick Road	Project no.:	Blenheim001
Position:		CPT no.:	CPT02
			1/6

CPT02.V1.20





CPTask-V1.20



Test according to A.S.T.M standard D-5778-07

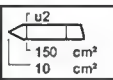
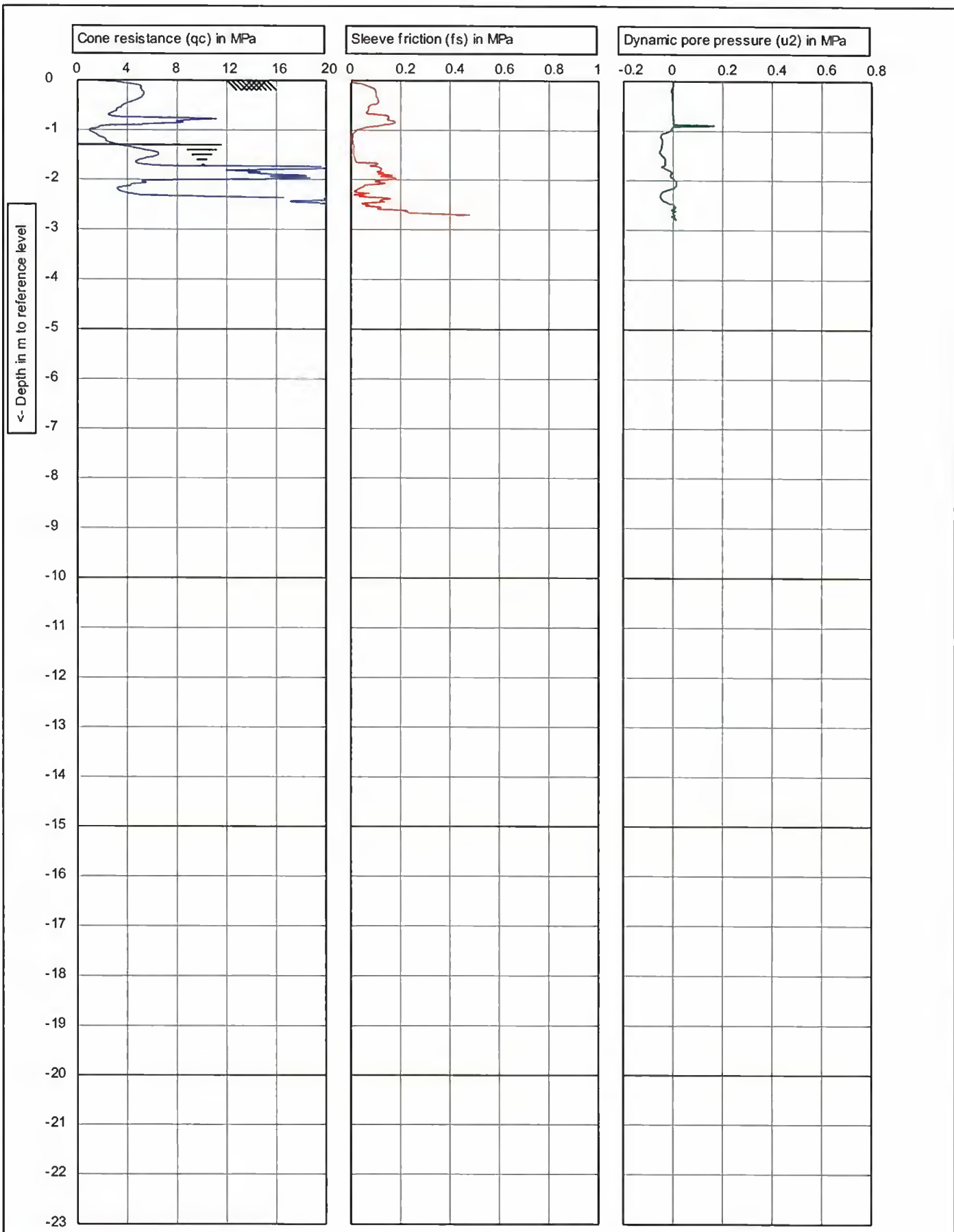
G.L. 0      W.L.: -1.3

Project: **Geotechnical Investigation**

Location: **Old Renwick Road**

Position:

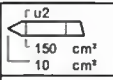
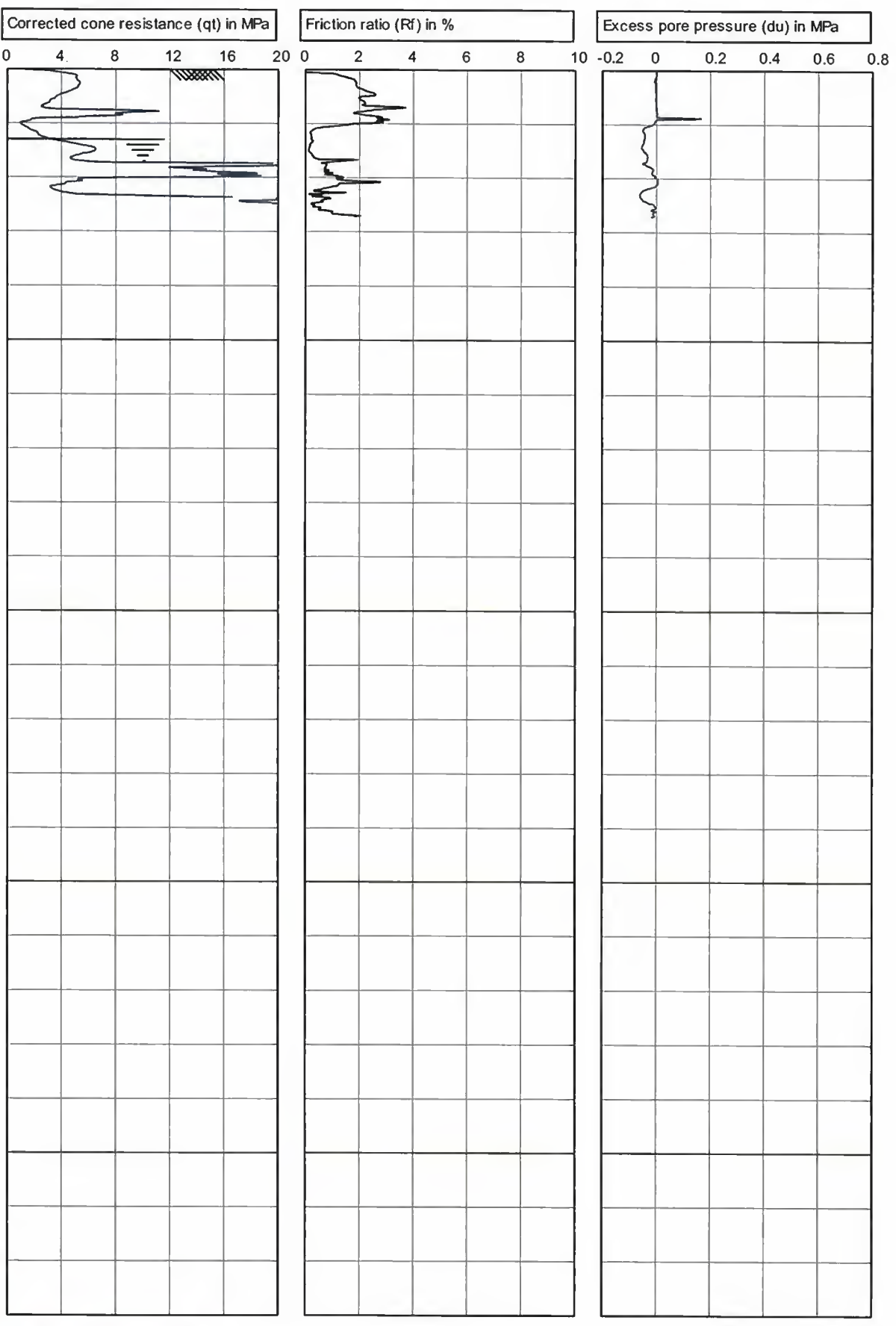
Predrill :	0
Date:	1/02/2012
Cone no.:	C10CRIP.E09
Project no.:	Blenheim001
CPT no.:	CPT02
	2/6



Test according to A.S.T.M standard D-5778-07		Predrill :	0	
G.L. 0	W.L.: -1.3	Date:	1/02/2012	
Project:	Geotechnical Investigation		Cone no.:	C10CFIP.E09
Location:	Old Renwick Road		Project no.:	Blenheim001
Position:		CPT no.:	CPT03	1/6

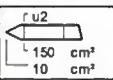
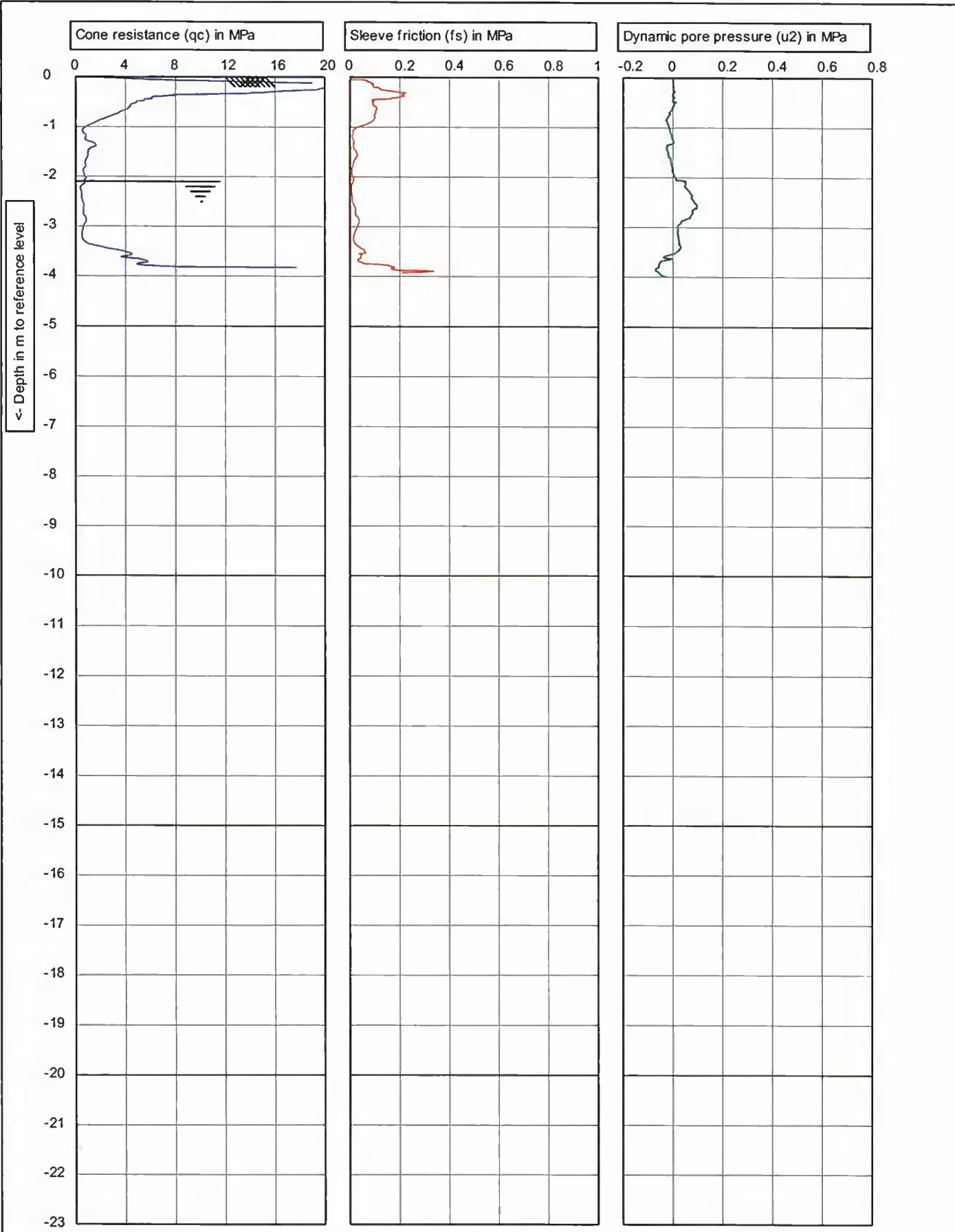
CPT03-VI.20

← Depth in m to reference level



Test according to A.S.T.M standard D-5778-07		Predrill :	0
G.L. 0	W.L.: -1.3	Date:	1/02/2012
Project: Geotechnical Investigation		Cone no.:	C10CFIP.E09
Location: Old Renwick Road		Project no.:	Blenheim001
Position:		CPT no.:	CPT03
			2/6

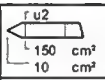
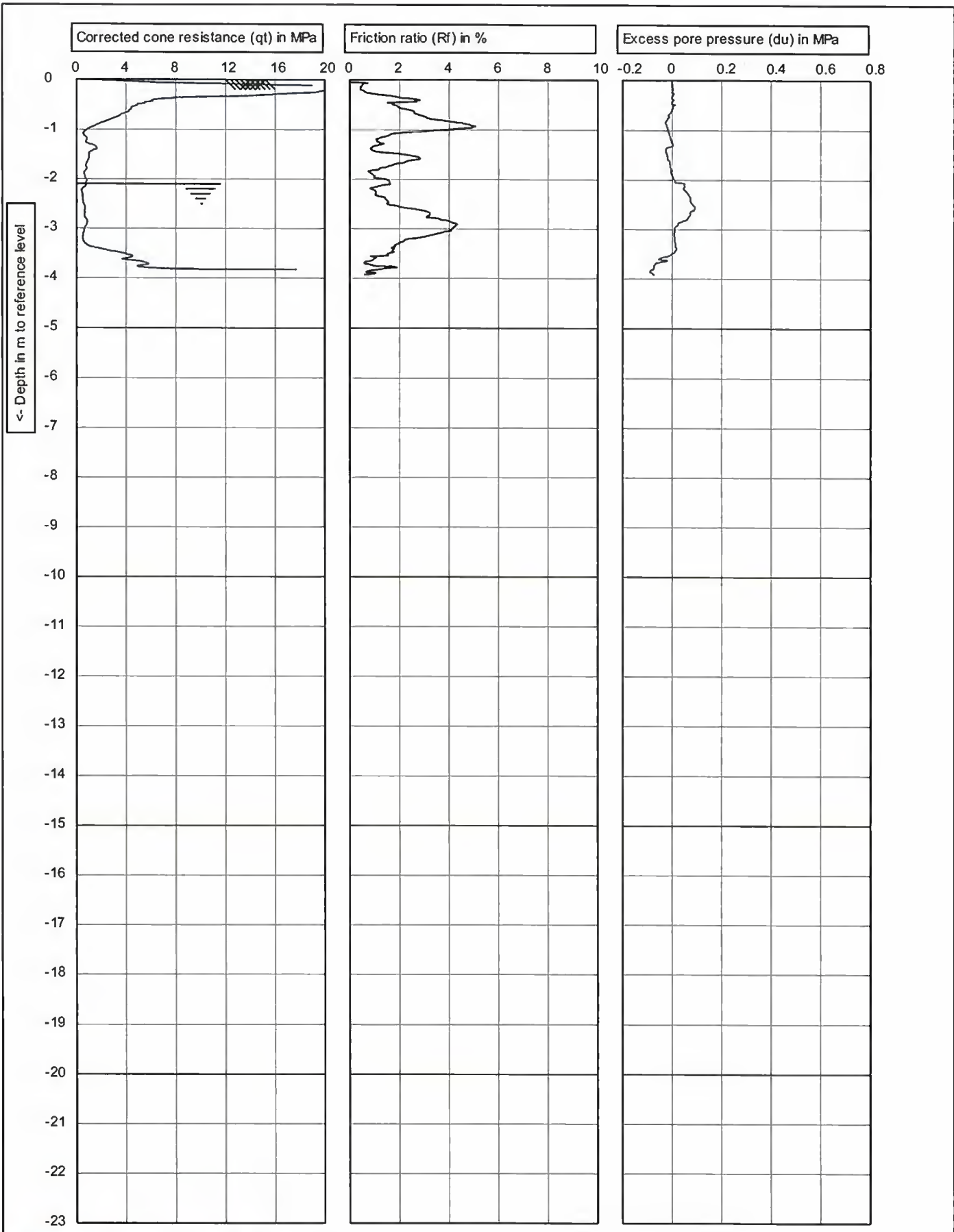
CPTask V1.20



Test according to A.S.T.M standard D-5778-07		Predrill :	0
G.L. 0	W.L.: -2.1	Date:	1/02/2012
Project: Geotechnical Investigation		Cone no.:	C10CFIP.E09
Location: Old Renwick Road		Project no.:	Blenheim001
Position:		CPT no.:	CPT04
			1/6

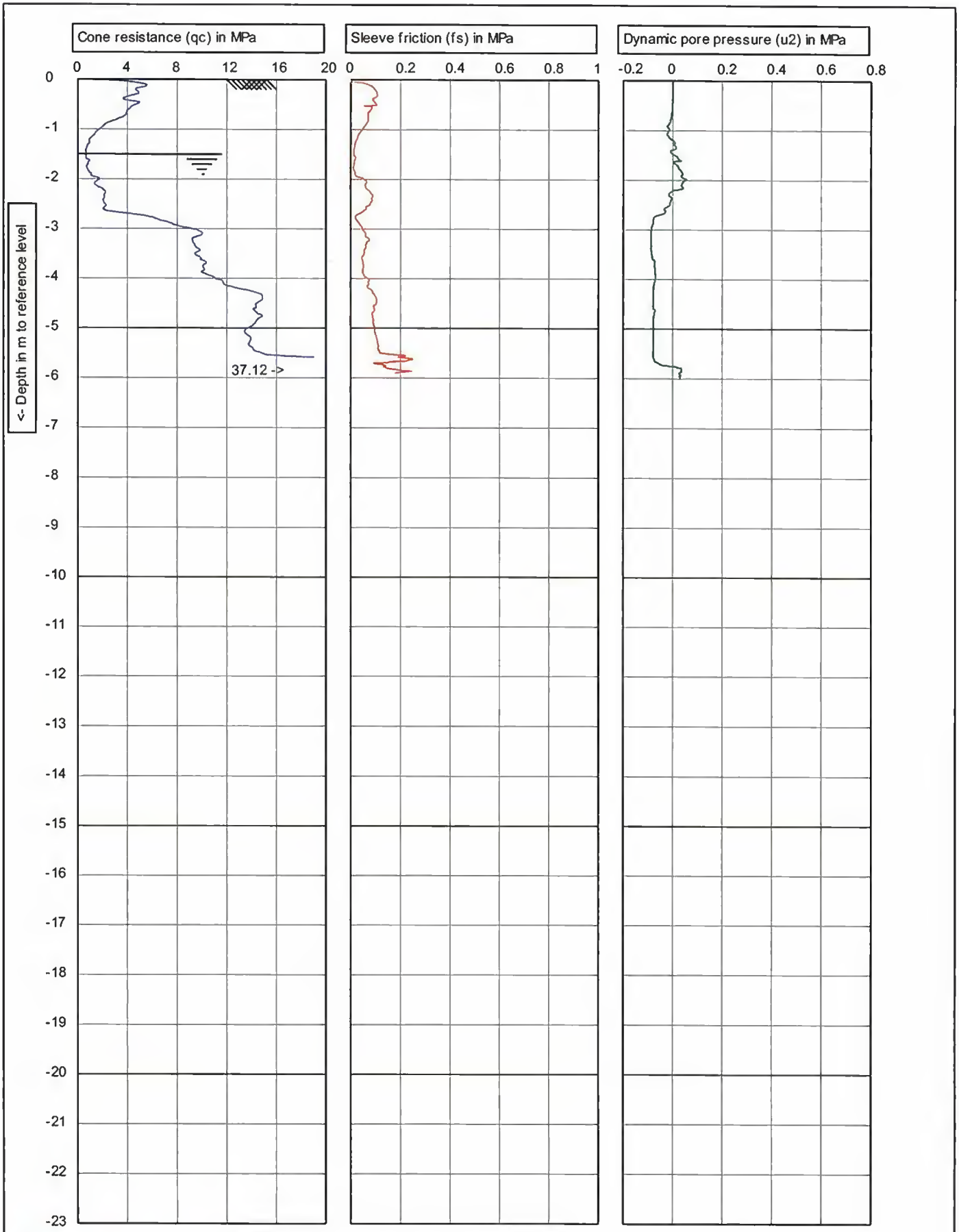
CPTtest V1.20





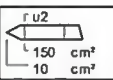
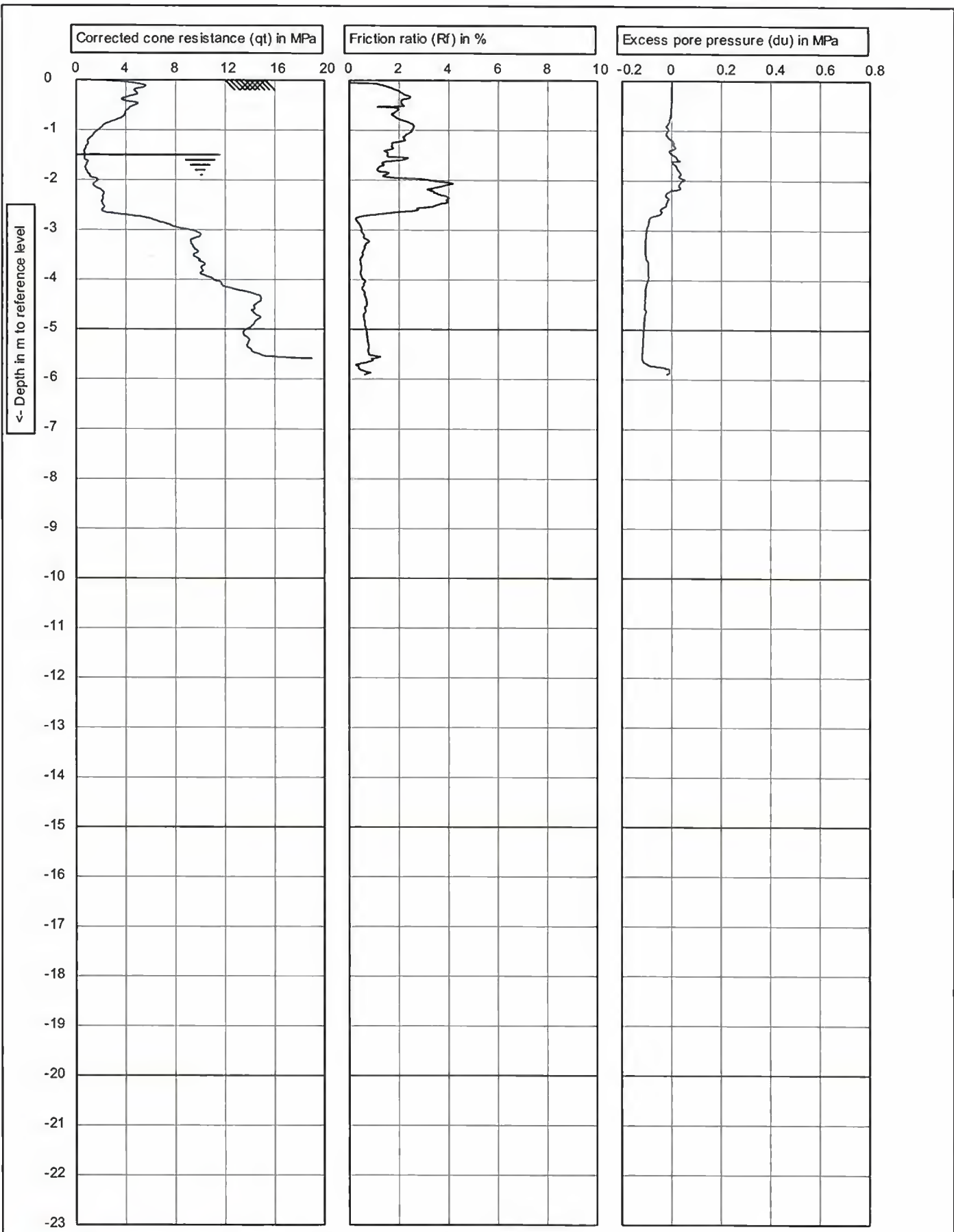
Test according to A.S.T.M standard D-5778-07		Pedr# :	0
G.L. 0	W.L.: -2.1	Date:	1/02/2012
Project: Geotechnical Investigation		Cone no.:	C10CFIP.E09
Location: Old Renwick Road		Project no.:	Blenheim001
Position:		CPT no.:	CPT04
			2/6

CPTask\_V1.20



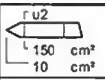
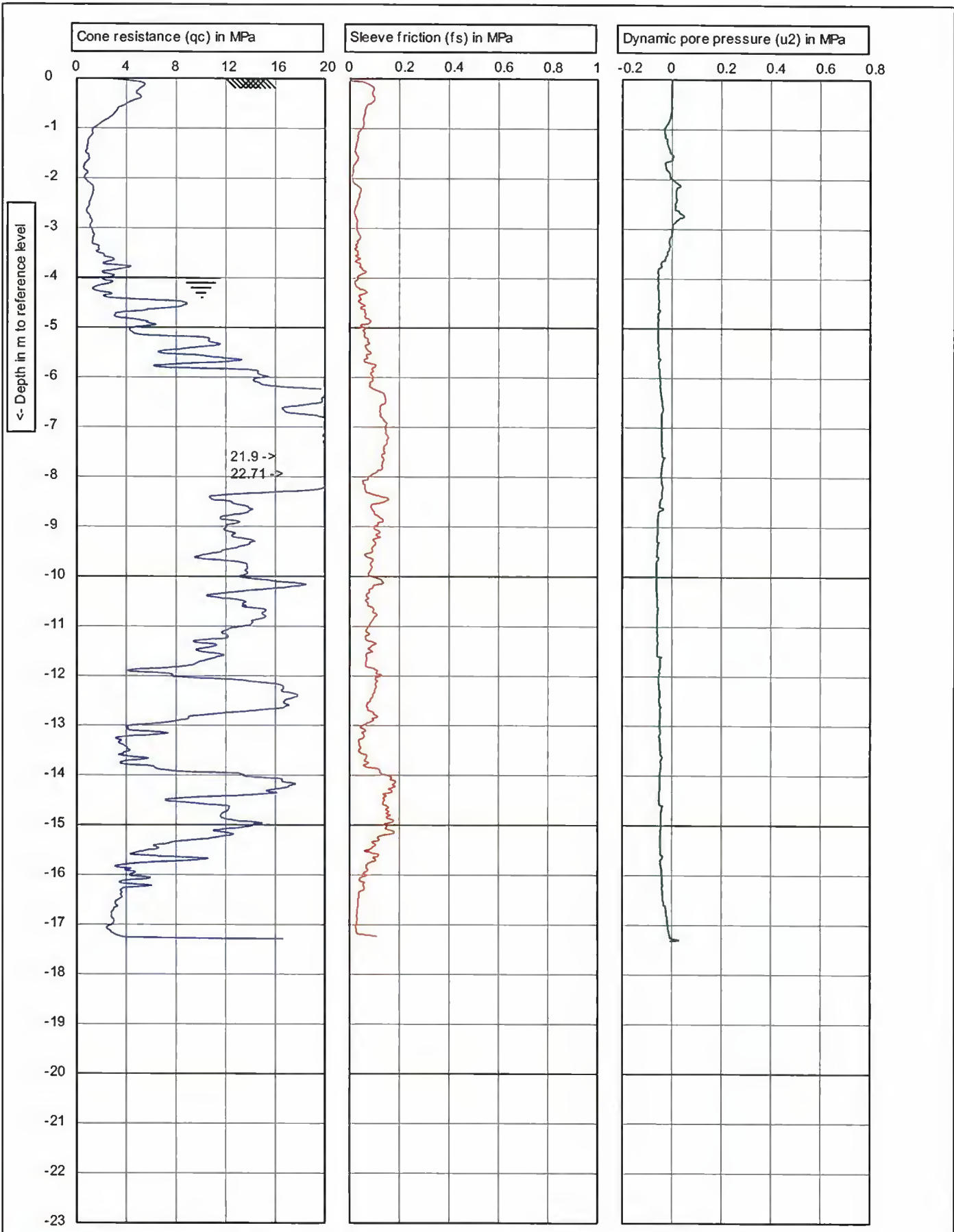
	Test according to A.S.T.M standard D-5778-07		Predrill : 0
	G.L. 0	W.L.: -1.5	Date: 1/02/2012
Project: Geotechnical Investigation	Cone no.: C10CHIP.E09		Project no.: Blenheim001
Location: 132 Dillions Point Road	CPT no.: CPT05		
Position:			1/6

CPT05.V1.20



Test according to A.S.T.M standard D-5778-07		Predrill :	0
G.L. 0	W.L.: -1.5	Date:	1/02/2012
Project: Geotechnical Investigation		Cone no.:	C10CRIP.E09
Location: 132 Dillions Point Road		Project no.:	Blenheim001
Position:		CPT no.:	CPT05
			2/6

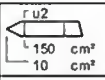
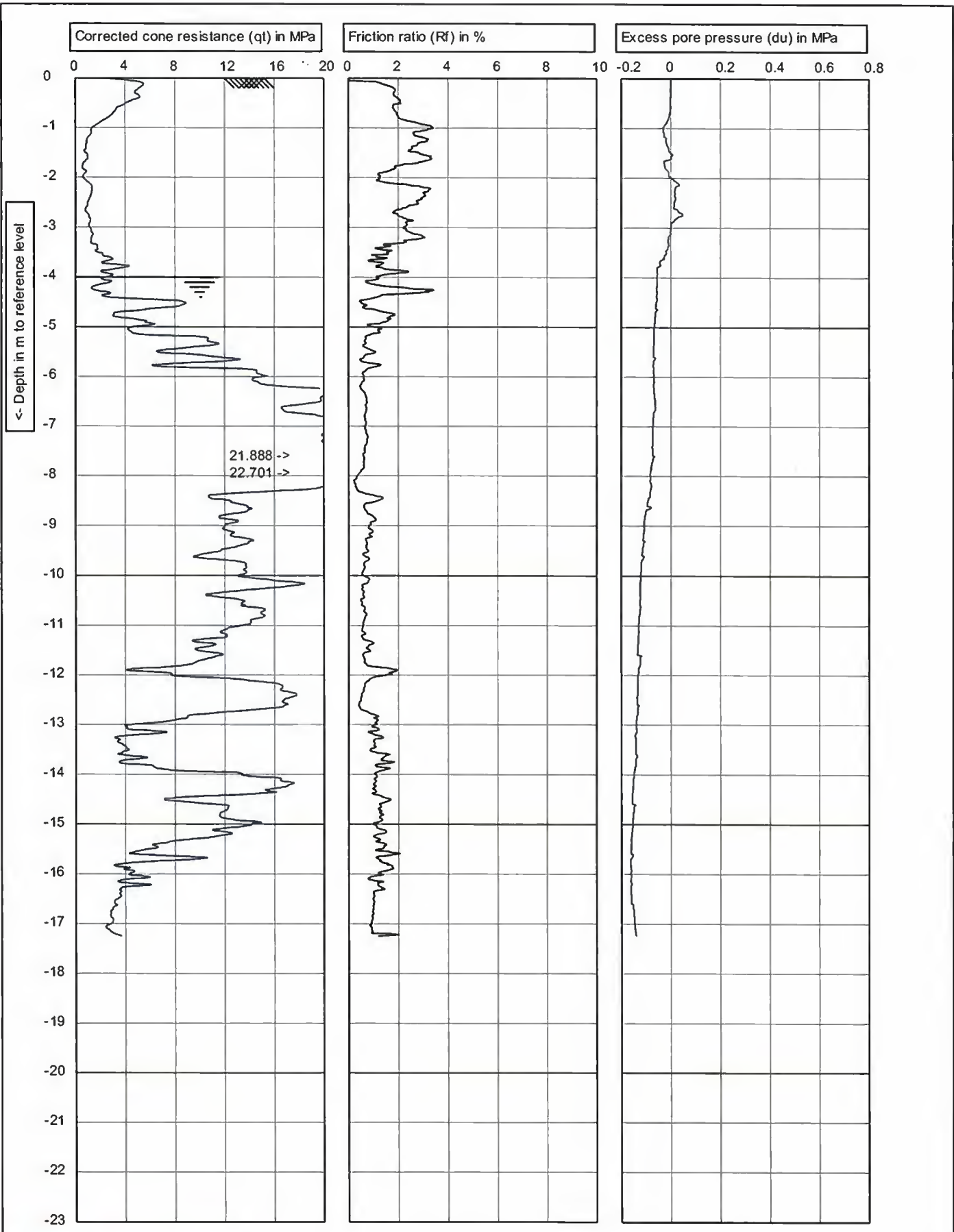
CPT05-V1.20



Test according to A.S.T.M standard D-5778-07		Predrill :	0
G.L. 0	W.L.: -4	Date:	1/02/2012
Project: Geotechnical Investigation		Cone no.:	C10CRIP.E09
Location: PO BOX 321		Project no.:	Blenheim001
Position:		CPT no.:	CPT06
			1/6

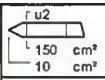
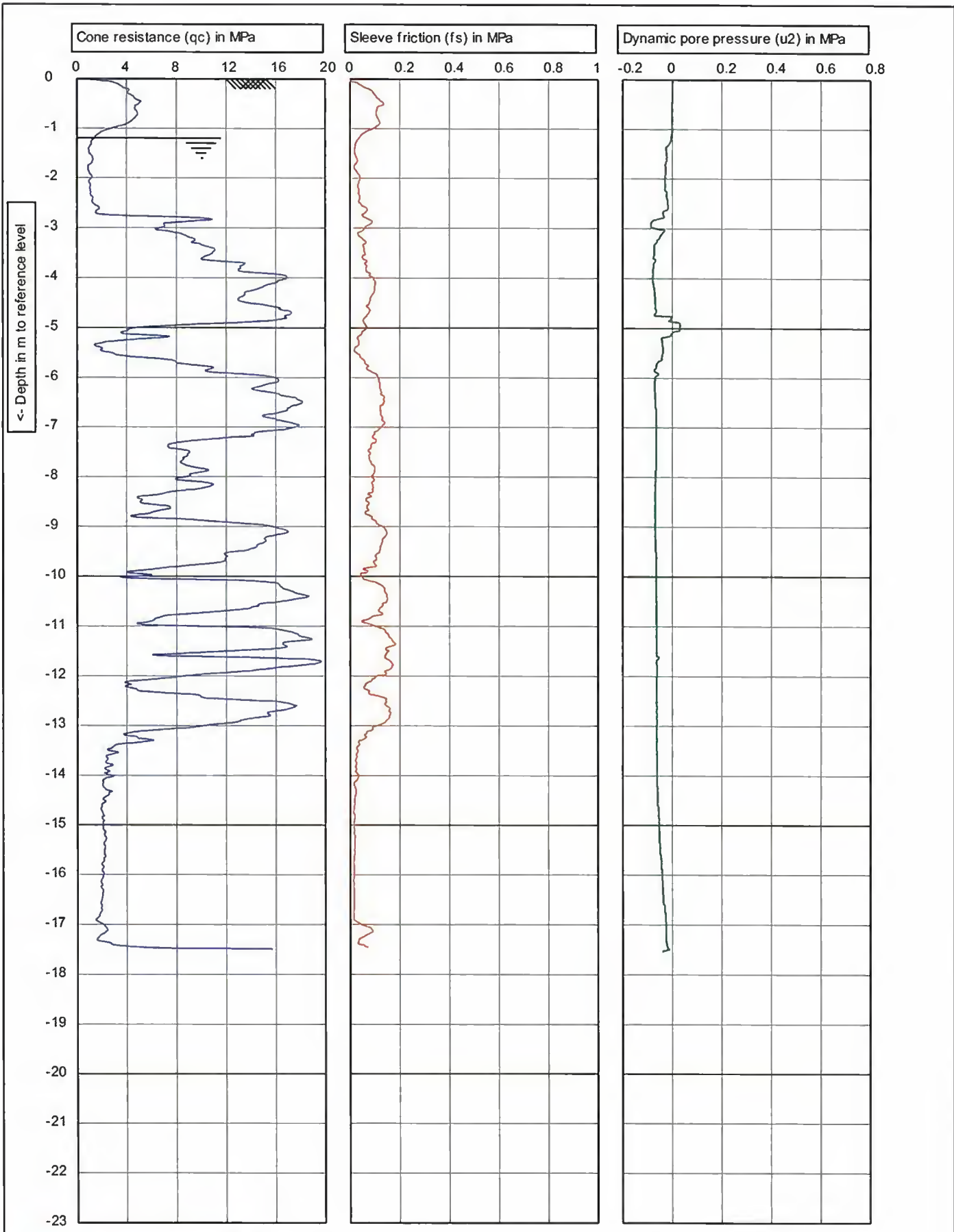
CPTask V1.20





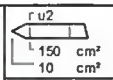
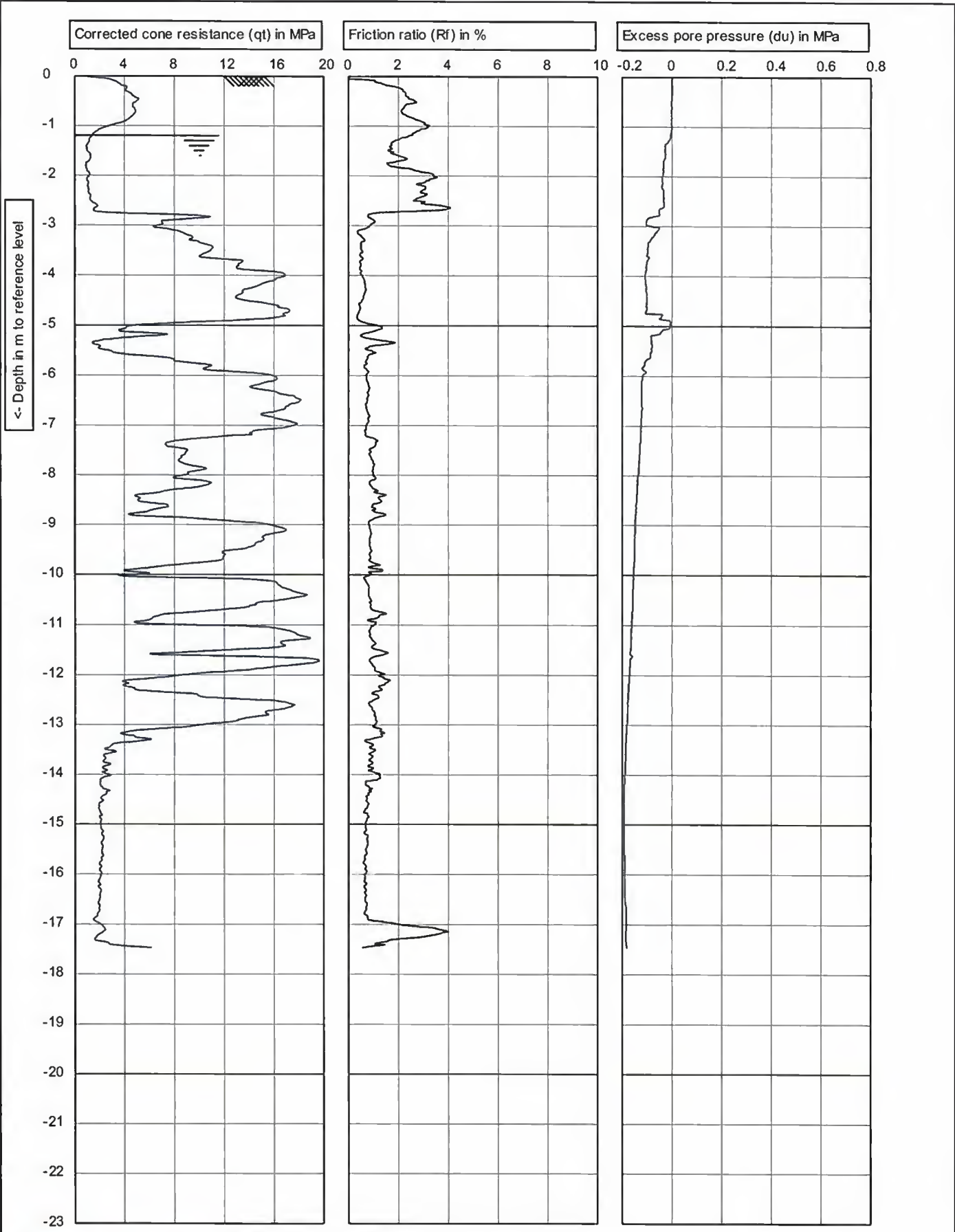
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G.L. 0	W.L.: -4	Date:	1/02/2012
Project: Geotechnical Investigation		Cone no.:	C10CFIP.E09
Location: PO BOX 321		Project no.:	Blenheim001
Position:		CPT no.:	CPT06
			2/6

CPTask V1.20



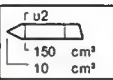
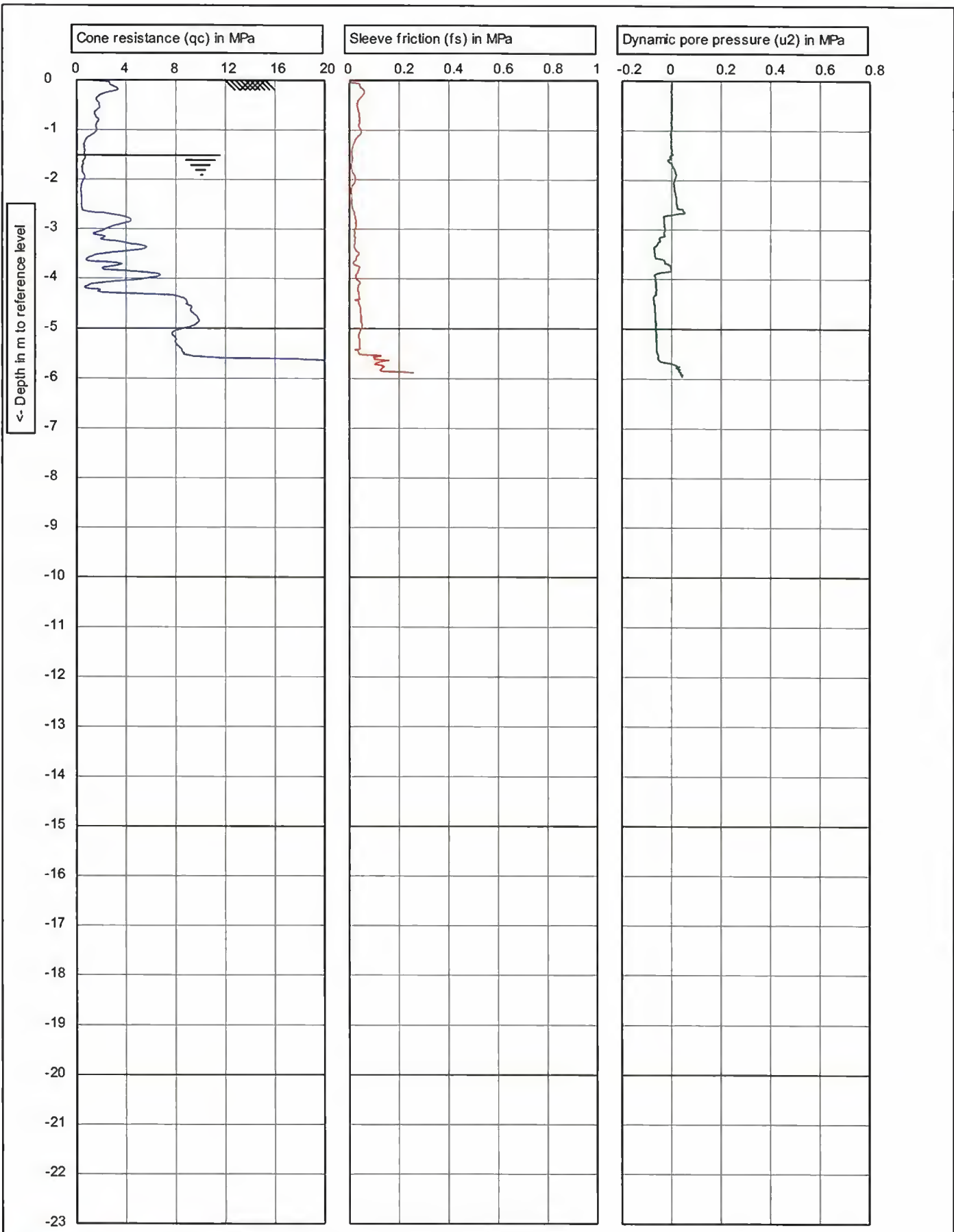
Test according to A.S.T.M standard D-5778-07		Predrill :	0	
G.L. 0	W.L.: -1.2	Date:	1/02/2012	
Project:	Geotechnical Investigation		Cone no.:	C10CFIP.E09
Location:	2998 St Andrews SH1		Project no.:	Blenheim001
Position:		CPT no.:	CPT07	1/6

CPTask V1.20



Test according to A.S.T.M standard D-5778-07		Predrill :	0
G.L. 0	W.L.: -1.2	Date:	1/02/2012
Project: Geotechnical Investigation		Cone no.:	C10CFIP.E09
Location: 2998 St Andrews SH1		Project no.:	Bienheim001
Position:		CPT no.:	CPT07
			2/6

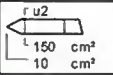
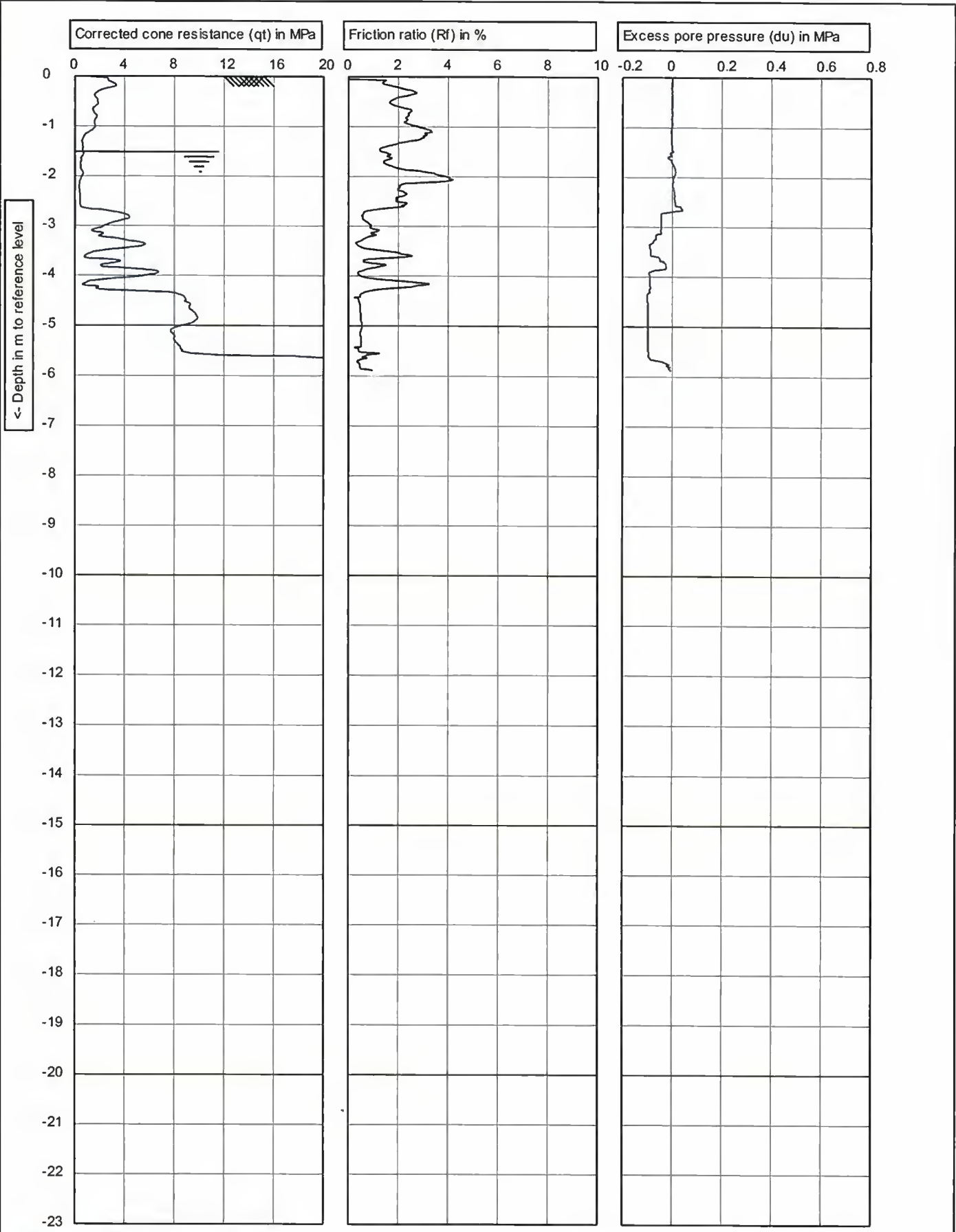
CPTask V1.20



Test according to A.S.T.M standard D-5778-07		Predrill :	0
G.L. 0	W.L.: -1.51	Date:	1/02/2012
Project: Geotechnical Investigation		Cone no.:	C10CFIP.E09
Location: 3069 State Highway 1 RD4		Project no.:	Blenheim001
Position:		CPT no.:	CPT08
			1/6

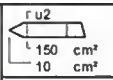
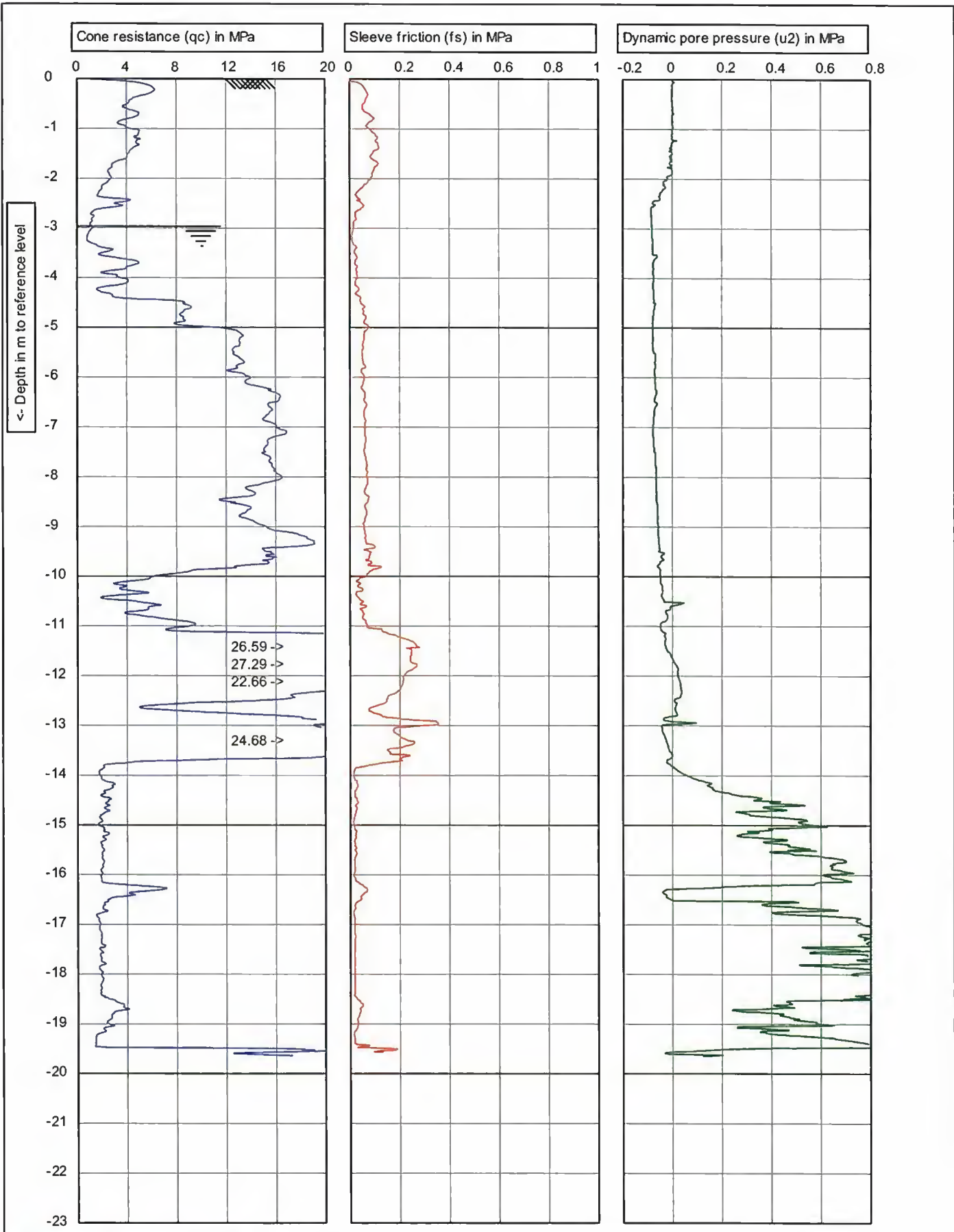
CPT08.v1.20





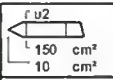
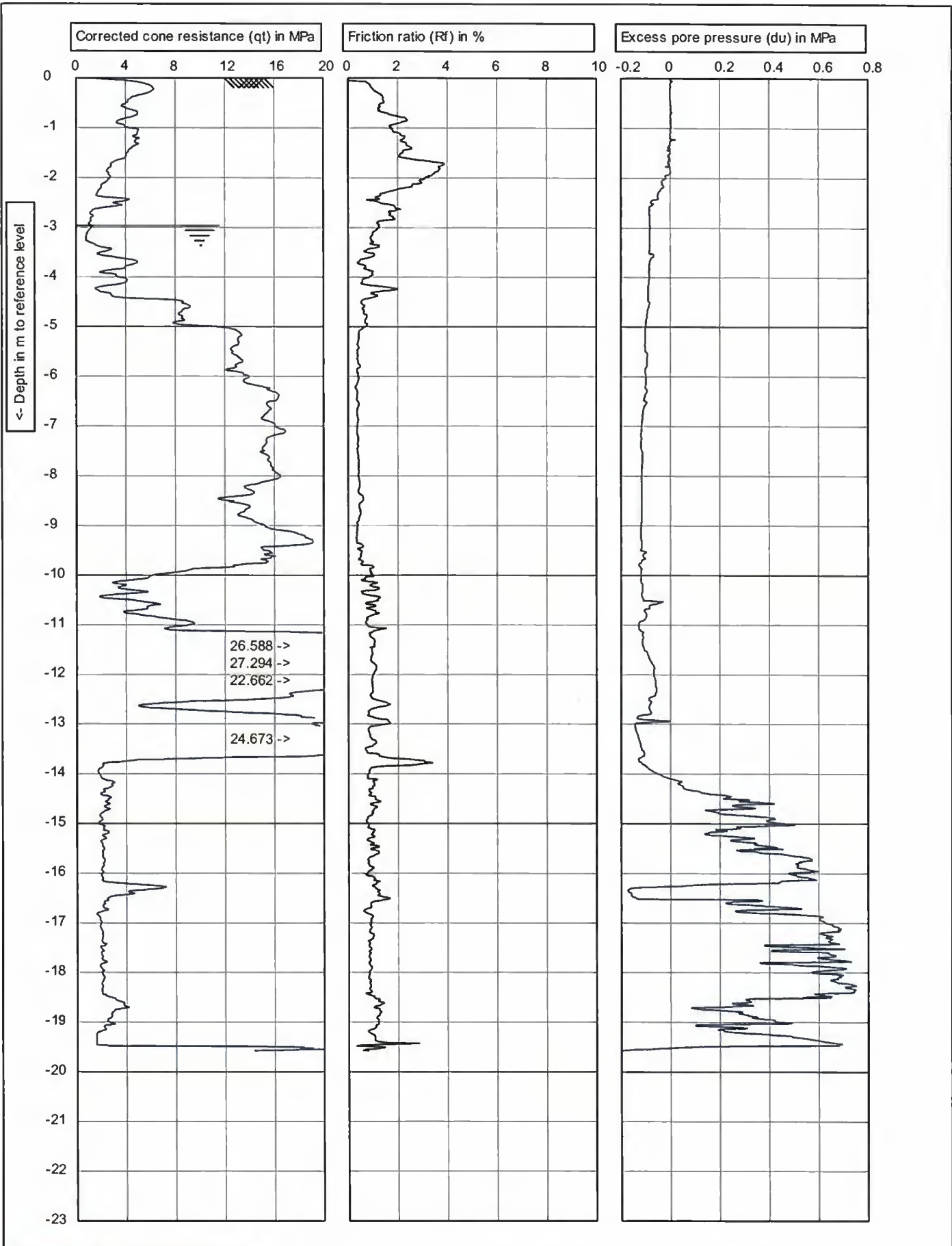
Test according to A.S.T.M standard D-5778-07		Predrill :	0
G.L. 0	W.L.: -1.51	Date:	1/02/2012
Project: Geotechnical Investigation		Cone no.:	C10CFIP.E09
Location: 3069 State Highway 1 RD4		Project no.:	Blenheim001
Position:		CPT no.:	CPT08
			2/6

CPT08-V1.20



Test according to A.S.T.M standard D-5778-07		Predrill :	0	
G.L. 0	W.L.: -2.96	Date:	2/02/2012	
Project:	Geotechnical Investigation		Cone no.:	C10CFIP.E09
Location:	SH1- Blenheim		Project no.:	Blenheim001
Position:		CPT no.:	CPT09	1/6

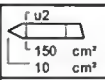
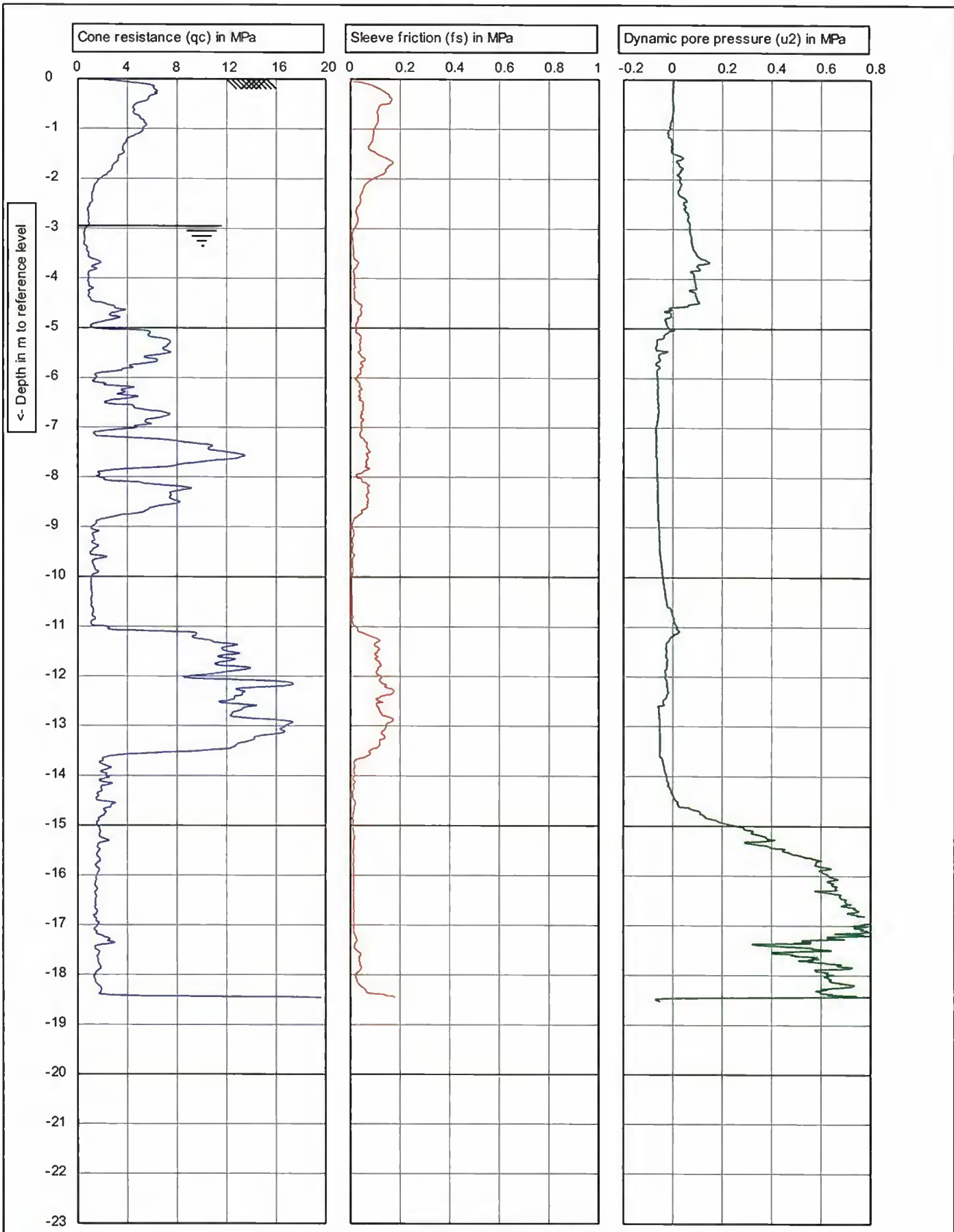
CPT09.V1.20



Test according to A.S.T.M standard D-5778-07		Predrill :	0
G.L. 0	W.L.: -2.96	Date:	2/02/2012
Project:	Geotechnical Investigation	Cone no.:	C10CRIP.E09
Location:	SH1- Blenheim	Project no.:	Blenheim001
Position:		CPT no.:	CPT09
			2/6

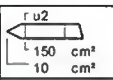
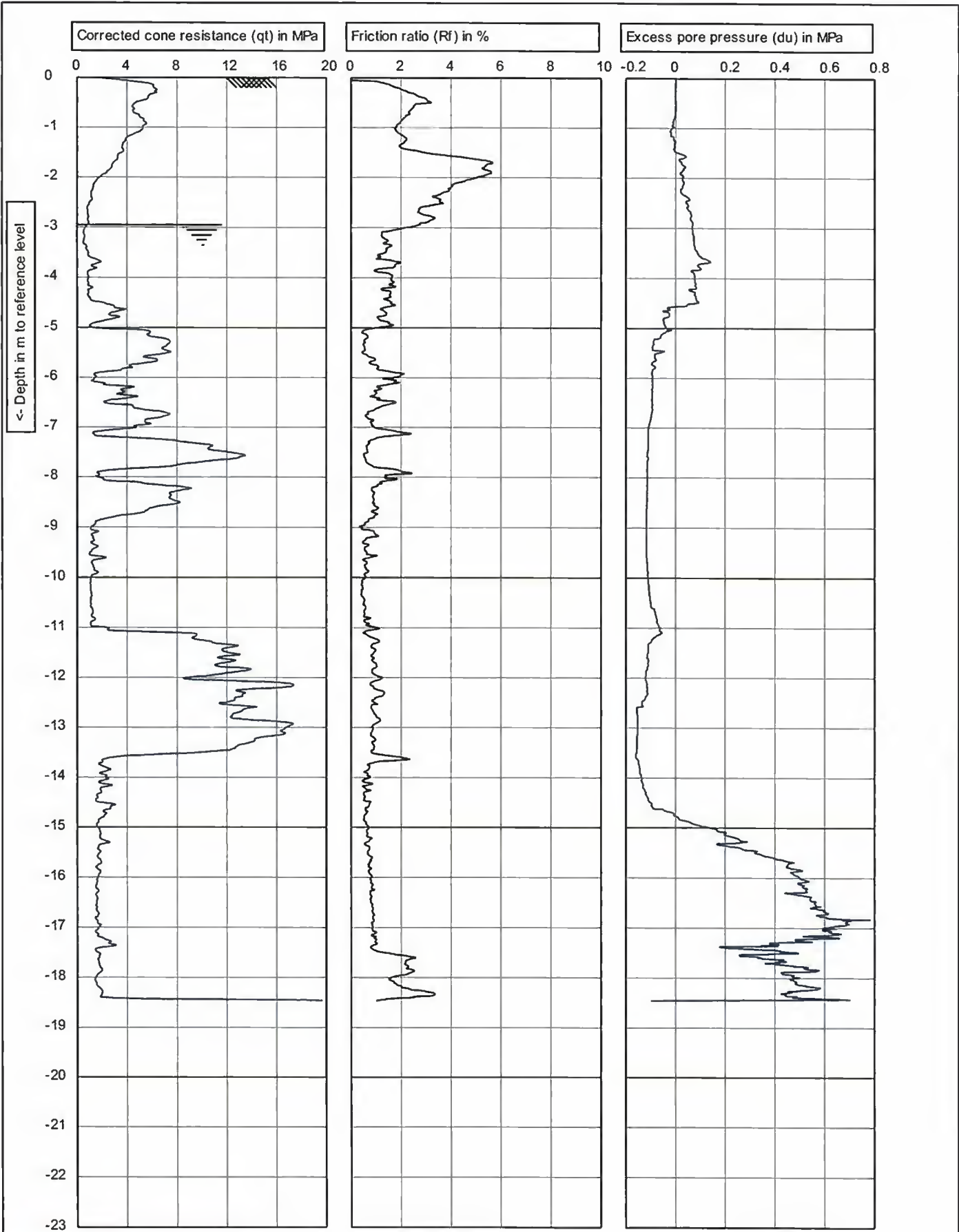
CPT09.V1.20





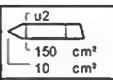
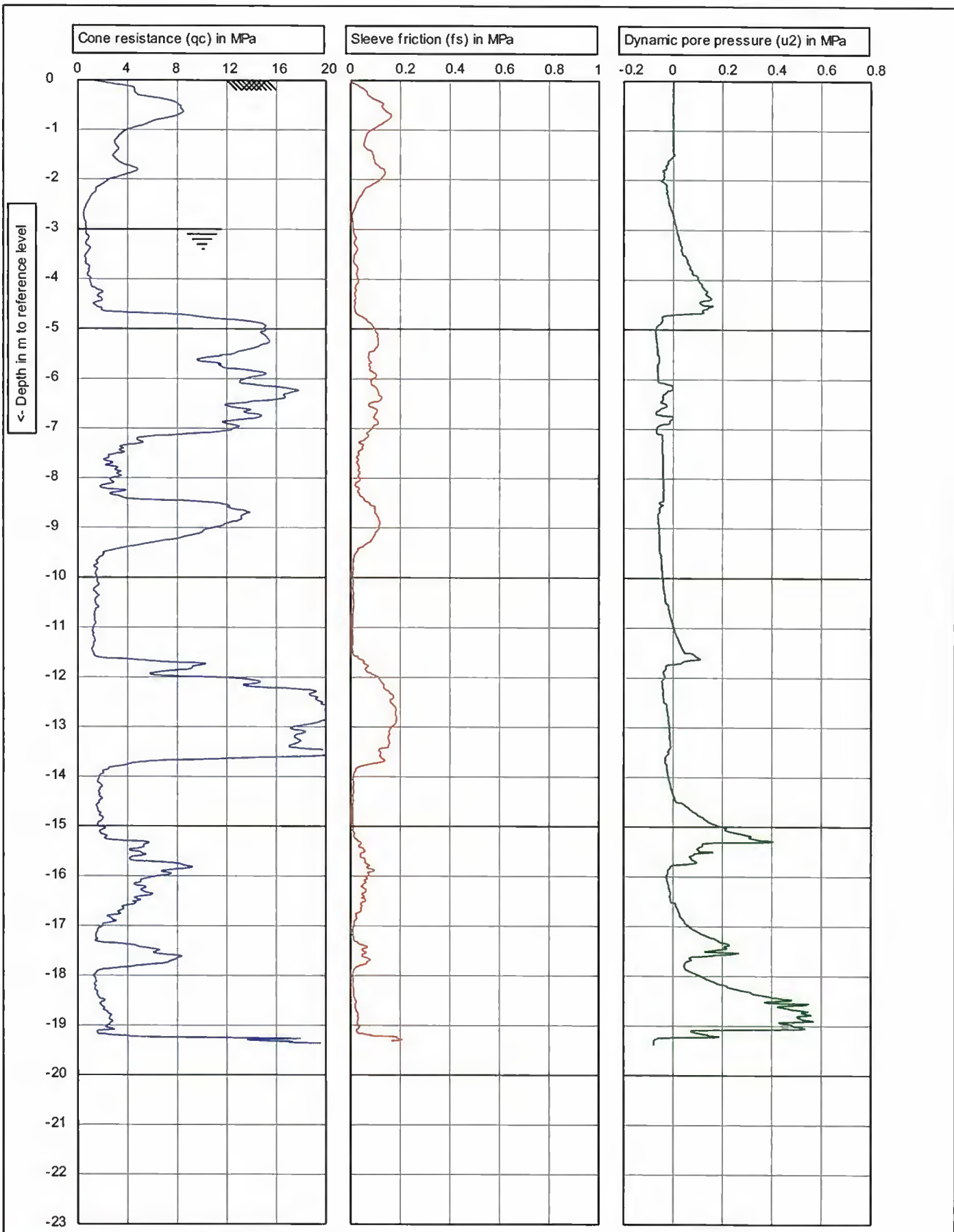
Test according to A.S.T.M standard D-5778-07		Predrill :	0
G.L. 0	W.L.: -2.95	Date:	1/02/2012
Project: Geotechnical Investigation	Cone no.: C10CFIP.E09		
Location: 279 Alabama Rd- RD4	Project no.: Blenheim001		
Position:	CPT no.: CPT10	1/6	

CPT10.v1.20



Test according to A.S.T.M standard D-5778-07		Predrill :	0
G.L. 0	W.L.: -2.95	Date:	1/02/2012
Project: Geotechnical Investigation		Cone no.:	C10CFIP.E09
Location: 279 Alabama Rd- RD4		Project no.:	Blenheim001
Position:		CPT no.:	CPT10
			2/6

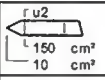
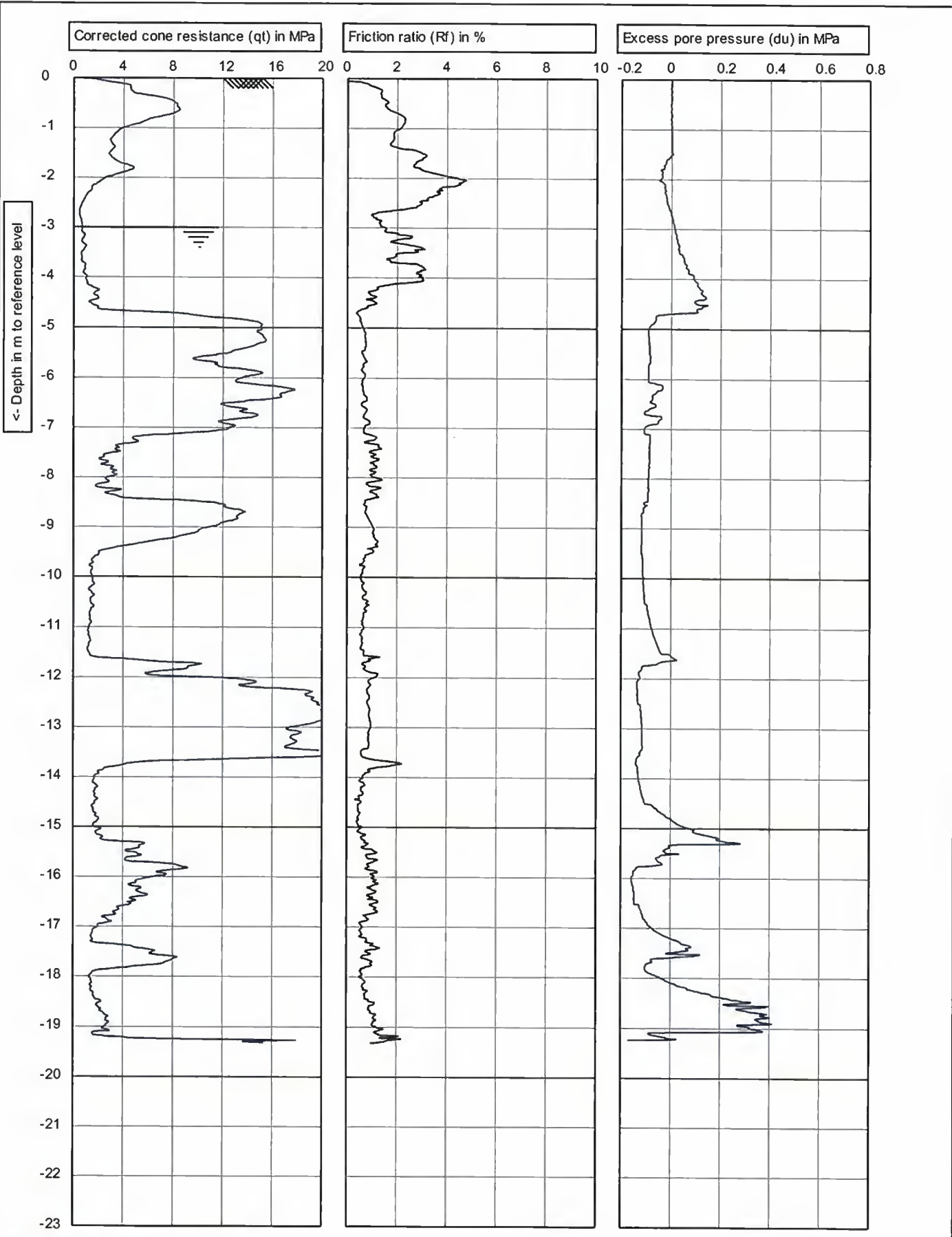
CPT10\_V1.20



Test according to A.S.T.M standard D-5778-07		Predrill :	0
G.L. 0	W.L.: -3	Date:	1/02/2012
Project: Geotechnical Investigation		Cone no.:	C10CFIP.E09
Location: Alabama Road		Project no.:	Blenheim001
Position:		CPT no.:	CPT12
			1/6

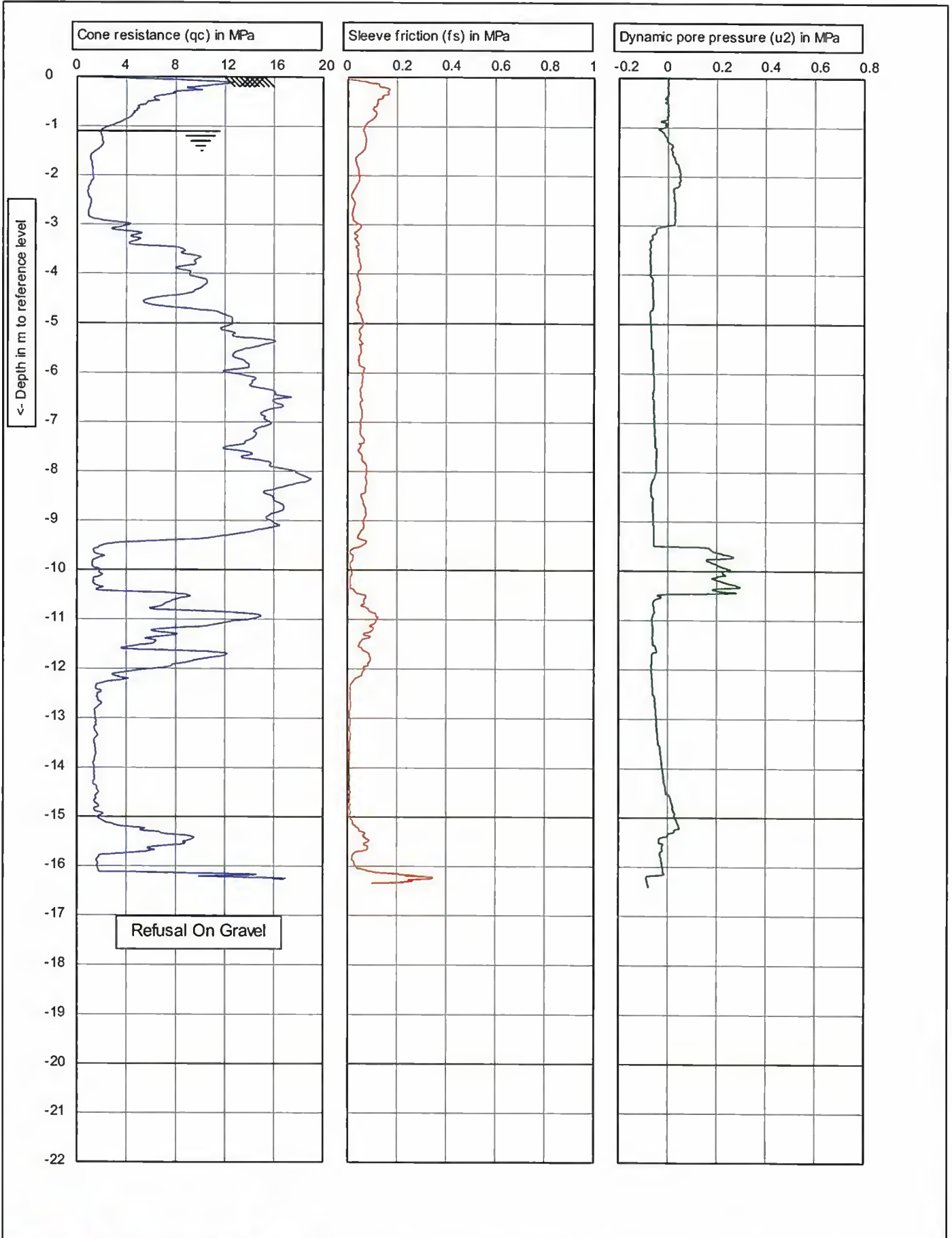
CPT12.V1.20


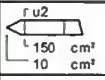




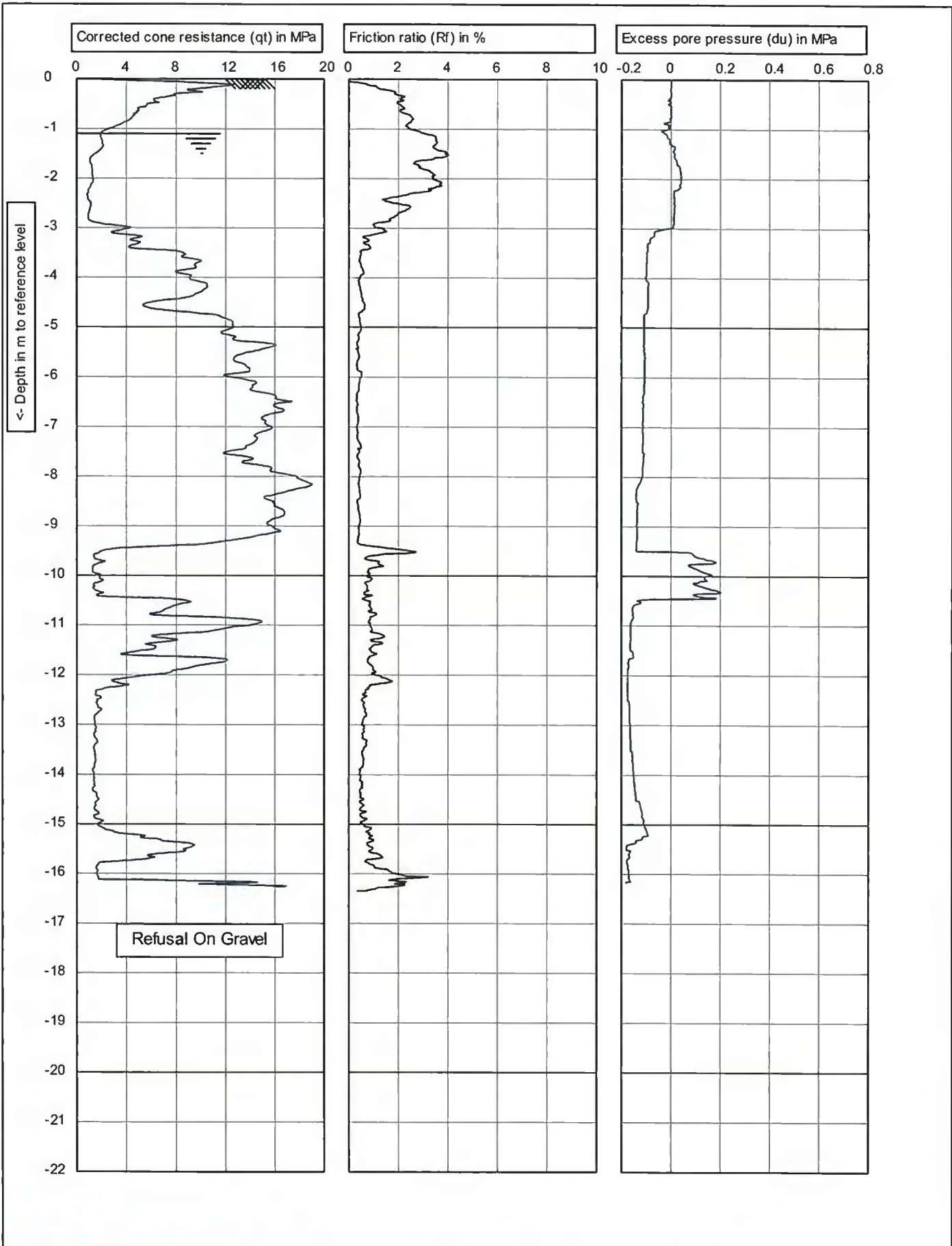
Test according to A.S.T.M standard D-5778-07		Predrill :	0
G.L. 0	W.L.: -3	Date:	1/02/2012
Project: Geotechnical Investigation		Cone no.:	C10CFIP.E09
Location: Alabama Road		Project no.:	Blenheim001
Position:		CPT no.:	CPT12
			2/6

CPTank V1.20

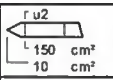


		Test according to A.S.T.M standard D-5778-07		Predrill : 0
		G.L. 0	W.L.: -1.1	Date: 1/02/2012
		Project: Geotechnical Investigation		Cone no.: C10CFIP.E09
		Location: 225 Alabama Rd		Project no.: Blenheim001
		Position:		CPT no.: CPT13

CPTmax V1.20



CPT13a\_V1.2b



Test according to A.S.T.M standard D-5778-07		Predrill :	0
G.L. 0	W.L.: -1.1	Date:	1/02/2012
Project: Geotechnical Investigation		Cone no.:	C10CFIP.E09
Location: 225 Alabama Rd		Project no.:	Blenheim001
Position:		CPT no.:	CPT13
			2/6



## APPENDIX D

LABORATORY TEST RESULTS



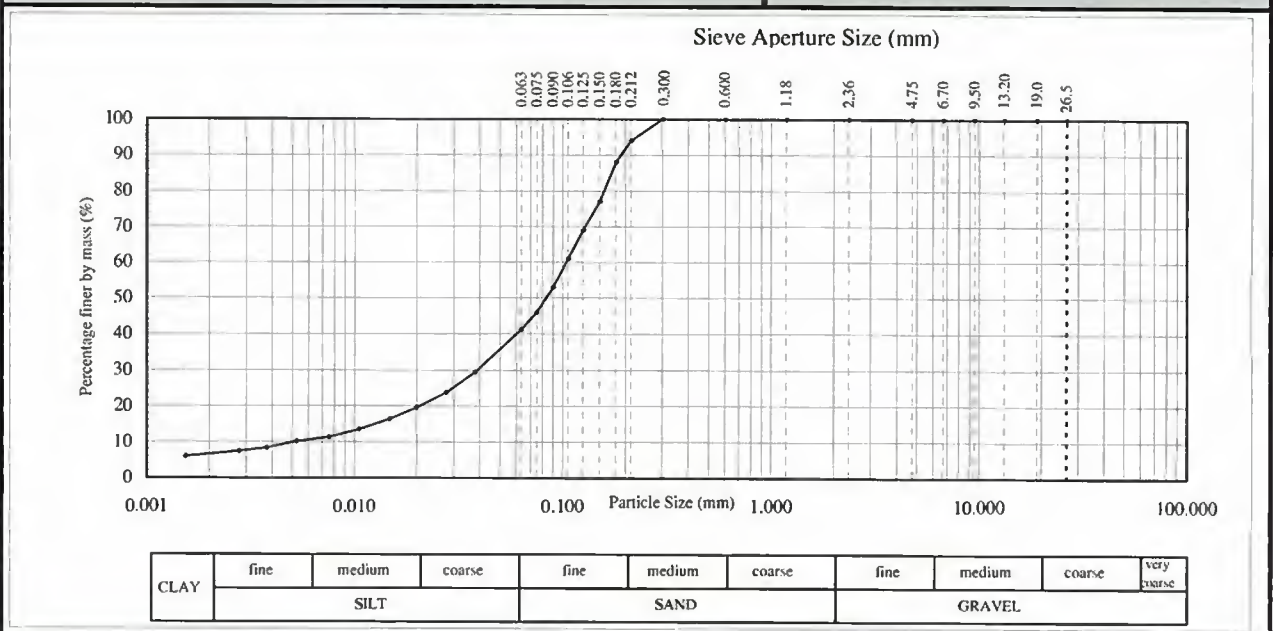
**PARTICLE SIZE ANALYSIS  
TEST REPORT**

Project: **Blenheim Urban Growth Study**  
 Location: **Blenheim**  
 Client: **Marlborough District Council**  
 Contractor: **CW Drilling Ltd**  
 Sampled by: **CW Drilling Ltd**  
 Date sampled: **31.1-3.2.12**  
 Sampling method: **SPT**  
 Sample source: **BH 1 4.0-4.45m**  
 Sample description: **Silty SAND: fine grain**  
 Sample condition: **As received**  
 Solid density: **2.65 t/m<sup>3</sup>** Assumed  
 Water content as rec'd: **23.8 %** whole



Report No: **522900/1027**  
 Sample No: **2-12/107**  
 Project No: **5C2128.00**

Sieve Analysis					Hydrometer Analysis				
Sieve Size (mm)	Passing (%)	Sieve Size (mm)	Passing (%)	Sieve Size (mm)	Passing (%)	Particle Size (mm)	Passing (%)	Particle Size (mm)	Passing (%)
26.5	100	2.36	100	0.150	77	0.0379	29	0.0053	10
19.0	100	1.18	100	0.125	69	0.0276	24	0.0038	8
13.20	100	0.600	100	0.106	61	0.0198	20	0.0028	7
9.50	100	0.300	100	0.090	53	0.0147	16	0.0015	6
6.70	100	0.212	94	0.075	46	0.0105	14		
4.75	100	0.180	88	0.063	41	0.0075	11		



Test Methods	Notes
Particle Size Analysis: NZS 4402 1986 Test 2.8.1 (Wet Sieve) Particle Size Analysis: NZS 4402 1986 Test 2.8.4 (Hydrometer)	History: Air dried Uncalibrated Sieve sizes: 0.212, 180, 0.125, 0.106, 0.090mm

Date Tested: 24.2-7.3.12  
 Date Reported: 7.3.12

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 Designation *Technical Officer (MJ McLachlan)*  
 Date: 7.3.12



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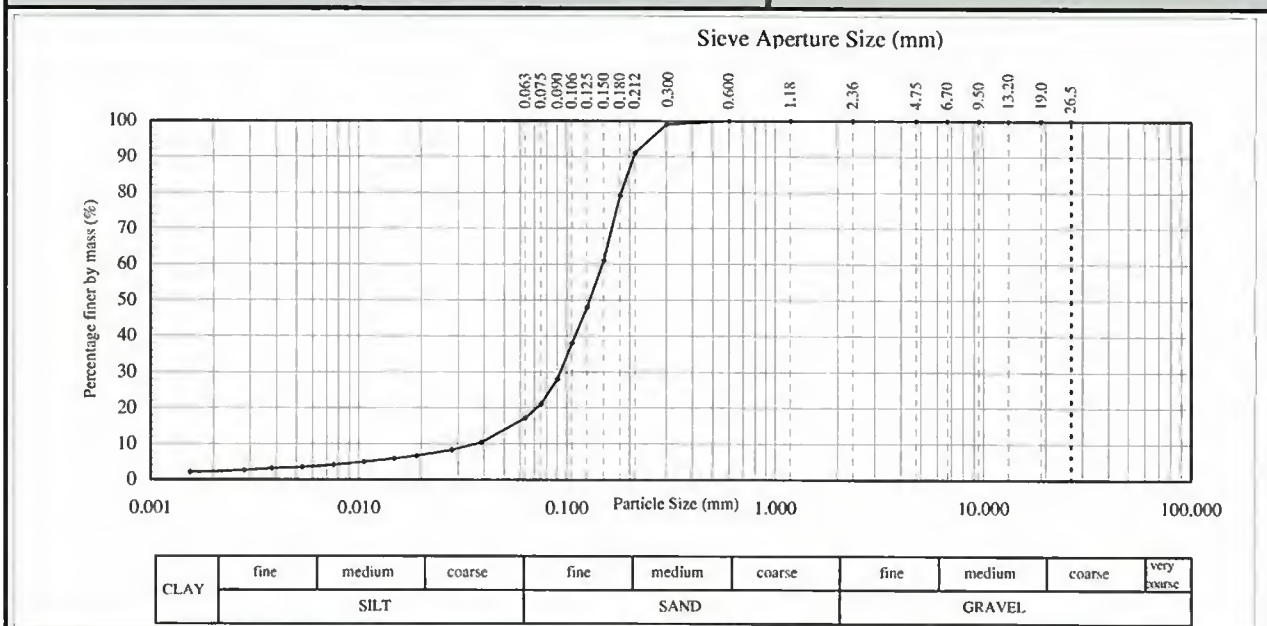
**PARTICLE SIZE ANALYSIS  
TEST REPORT**



Project: **Blenheim Urban Growth Study**  
 Location: **Blenheim**  
 Client: **Marlborough District Council**  
 Contractor: **CW Drilling Ltd**  
 Sampled by: **CW Drilling Ltd**  
 Date sampled: **31.1-3.2.12**  
 Sampling method: **SPT**  
 Sample source: **BH 2 6.0-6.45m**  
 Sample description: **SAND: fine grain**  
 Sample condition: **As received**  
 Solid density **2.65** t/m<sup>3</sup> **Assumed**  
 Water content as rec'd **24.2** % **whole**

Report No: **522900/1027**  
 Sample No: **2-12/108**  
 Project No: **5C2128.00**

Sieve Analysis					Hydrometer Analysis				
Sieve Size (mm)	Passing (%)	Sieve Size (mm)	Passing (%)	Sieve Size (mm)	Passing (%)	Particle Size (mm)	Passing (%)	Particle Size (mm)	Passing (%)
26.5	100	2.36	100	0.150	61	0.0388	10	0.0053	4
19.0	100	1.18	100	0.125	48	0.0281	8	0.0038	3
13.20	100	0.600	100	0.106	38	0.0190	7	0.0028	3
9.50	100	0.300	99	0.090	28	0.0148	6	0.0015	2
6.70	100	0.212	91	0.075	21	0.0106	5		
4.75	100	0.180	79	0.063	17	0.0076	4		



Test Methods	Notes
Particle Size Analysis: NZS 4402 1986 Test 2.8.1 (Wet Sieve) Particle Size Analysis: NZS 4402 1986 Test 2.8.4 (Hydrometer)	History: Air dried Uncalibrated Sieve sizes: 0.212, 180, 0.125, 0.106, 0.090mm

Date Tested: 24.2-7.3.12  
 Date Reported: 7.3.12

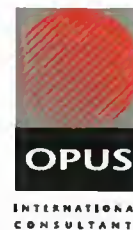
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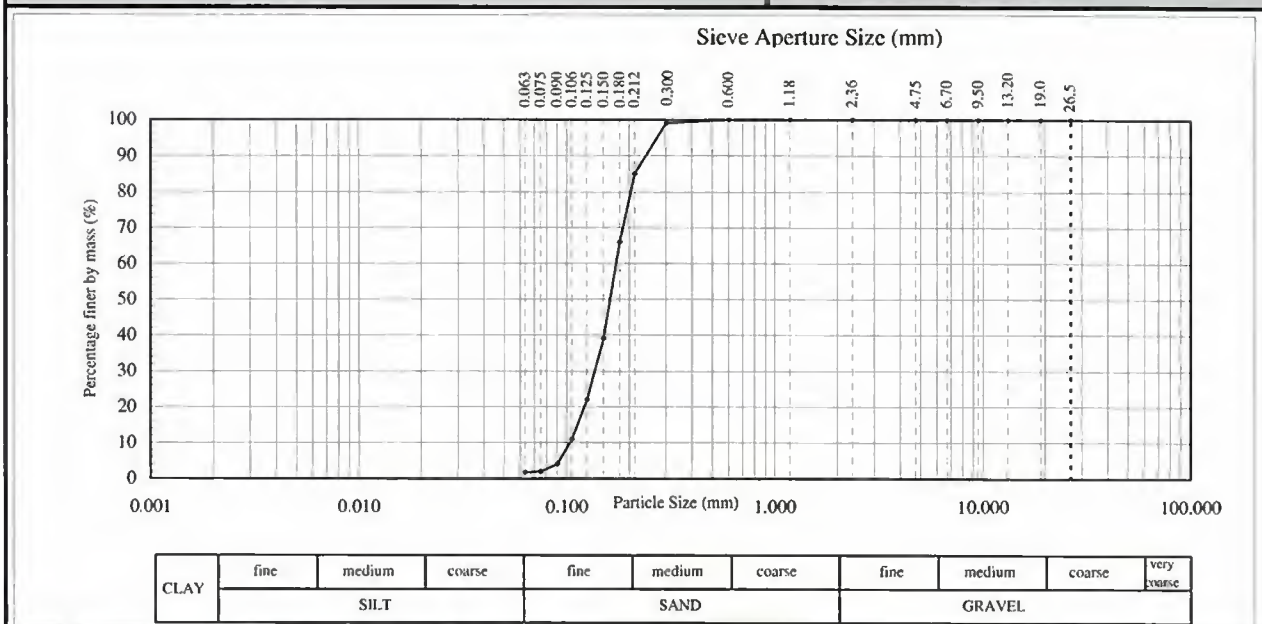
**PARTICLE SIZE ANALYSIS  
TEST REPORT**



Project: **Blenheim Urban Growth Study**  
 Location: **Blenheim**  
 Client: **Marlborough District Council**  
 Contractor: **CW Drilling Ltd**  
 Sampled by: **CW Drilling Ltd**  
 Date sampled: **31.1-3.2.12**  
 Sampling method: **SPT**  
 Sample source: **BH 2 9.0-9.45m**  
 Sample description: **SAND: fine grain**  
 Sample condition: **As received**  
 Solid density: **n/a t/m<sup>3</sup>**      **Assumed**  
 Water content as rec'd: **26.7 %**      **whole**

Report No: **522900/1027**  
 Sample No: **2-12/109**  
 Project No: **5C2128.00**

Sieve Analysis						Hydrometer Analysis			
Sieve Size (mm)	Passing (%)	Sieve Size (mm)	Passing (%)	Sieve Size (mm)	Passing (%)	Particle Size (mm)	Passing (%)	Particle Size (mm)	Passing (%)
26.5	100	2.36	100	0.150	39				
19.0	100	1.18	100	0.125	22				
13.20	100	0.600	100	0.106	11				
9.50	100	0.300	99	0.090	4				
6.70	100	0.212	85	0.075	2				
4.75	100	0.180	66	0.063	2				



Test Methods	Notes
Particle Size Analysis: NZS 4402 1986 Test 2.8.1 (Wet Sieve) Particle Size Analysis: NZS 4402 1986 Test 2.8.4 (Hydrometer)	History: Air dried Uncalibrated Sieve sizes: 0.212, 180, 0.125, 0.106, 0.090mm

Date Tested: 24.2-7.3.12  
 Date Reported: 7.3.12

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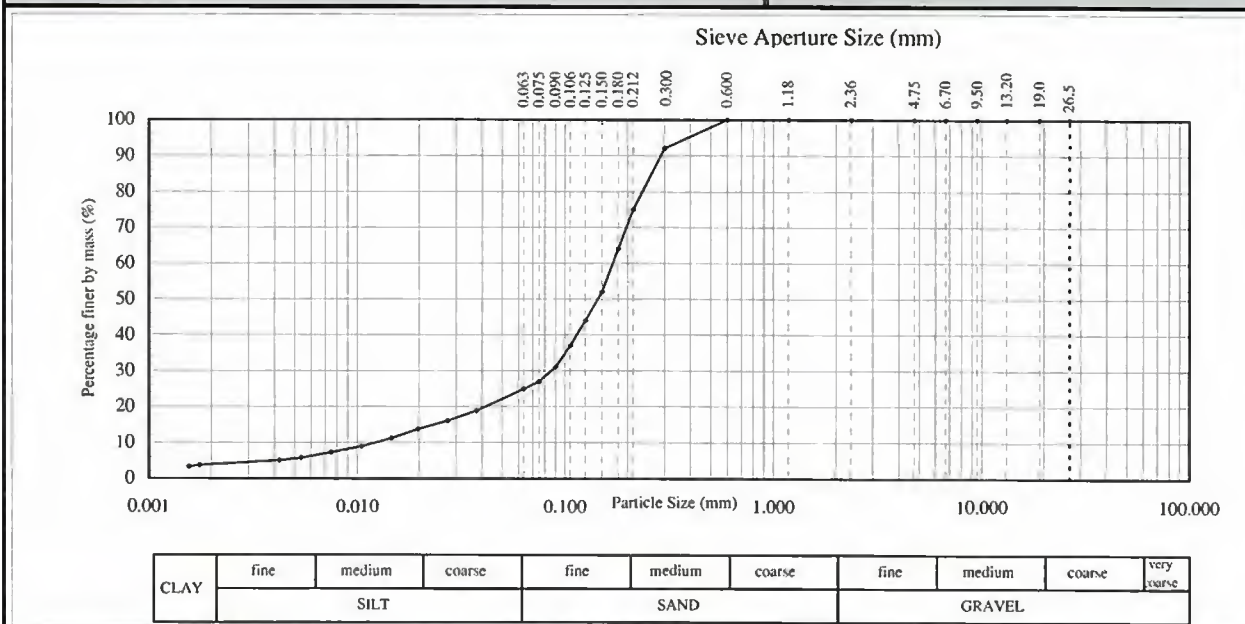
**PARTICLE SIZE ANALYSIS  
TEST REPORT**

Project: **Blenheim Urban Growth Study**  
 Location: **Blenheim**  
 Client: **Marlborough District Council**  
 Contractor: **CW Drilling Ltd**  
 Sampled by: **CW Drilling Ltd**  
 Date sampled: **31.1-3.2.12**  
 Sampling method: **SPT**  
 Sample source: **BH 3 5.0-5.45m**  
 Sample description: **Silty SAND: fine-medium grain**  
 Sample condition: **As received**  
 Solid density **2.65** t/m<sup>3</sup> **Assumed**  
 Water content as rec'd **22.6** % **whole**



Report No: **522900/1027**  
 Sample No: **2-12/110**  
 Project No:: **5C2128.00**

Sieve Analysis					Hydrometer Analysis				
Sieve Size (mm)	Passing (%)	Sieve Size (mm)	Passing (%)	Sieve Size (mm)	Passing (%)	Particle Size (mm)	Passing (%)	Particle Size (mm)	Passing (%)
26.5	100	2.36	100	0.150	52	0.0375	19	0.0054	6
19.0	100	1.18	100	0.125	44	0.0273	16	0.0042	5
13.20	100	0.600	100	0.106	37	0.0196	14	0.0018	4
9.50	100	0.300	92	0.090	31	0.0146	11	0.0016	3
6.70	100	0.212	75	0.075	27	0.0105	9		
4.75	100	0.180	64	0.063	25	0.0075	7		



Test Methods	Notes
Particle Size Analysis: NZS 4402 1986 Test 2.8.1 (Wet Sieve) Particle Size Analysis: NZS 4402 1986 Test 2.8.4 (Hydrometer)	History: Air dried Uncalibrated Sieve sizes: 0.212, 180, 0.125, 0.106, 0.090mm

Date Tested: 24.2-7.3.12  
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