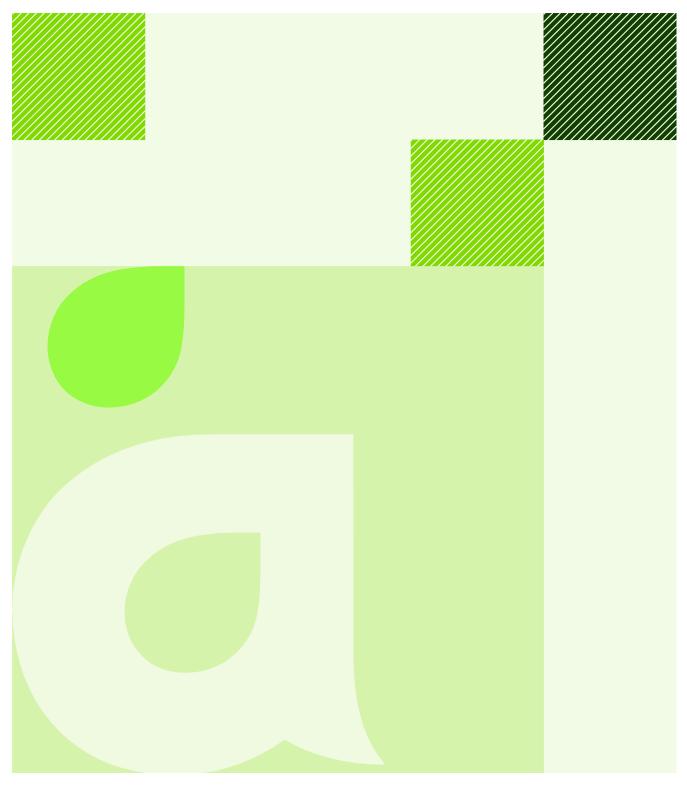


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# **Rosemerryn Subdivision, Lincoln**

Stages 10 to 18 Geotechnical Investigation Report

Fulton Hogan Land Development Limited

25 September 2015 Revision: 3 Reference: 224464

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# **Document control record**

Document prepared by:

#### **Aurecon New Zealand Limited**

Unit 1, 150 Cavendish Road Casebrook Christchurch 8051 PO Box 1061 Christchurch 8140 New Zealand

- T +64 3 366 0821
- **F** +64 3 379 6955
- E christchurch@aurecongroup.com
- W aurecongroup.com

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Name	Tim Plunket	Name	Dr Jan Kupec		
Title	Geotechnical Engineer	Title	Technical Director – Ground Engineering		

# Contents

Exe	ecutiv	re Summary	1
1	Intro	oduction	4
2	Site	Conditions	5
	2.1	Site Description	5
	2.2	Regional Geology	5
	2.3	Seismicity	5
	2.4	Recorded Earthquake Damage	6
	2.5	MBIE Land Classification	6
3	Geo	technical Review and Site Investigations	7
	3.1	General	7
	3.2	Environment Canterbury GIS Data	8
	3.3	Canterbury Geotechnical Database	8
	3.4	Cone Penetration Testing	9
	3.5	Test Pit Excavations	9
	3.6	Boreholes	10
	3.7	MASW Soundings	10
	3.8	Ground Water	11
4	Eng	ineering Considerations	12
	4.1	General	12
	4.2	Geotechnical Ground Model	12
	4.3	Site Flexibility	13
	4.4	Liquefaction Assessment	13
	4.5	Liquefaction Mitigation	23
	4.6	Soft to Firm Clayey Silty Soils	25
	4.7	Council Vested Infrastructure	26
5	Ass	essment Against the RMA	28
6	Refe	erences	29
7	Limi	itations	31

# **Appendices**

Appendix A

Figures

Appendix B

Provided Davis Lovell Smith Drawings

# Appendix C

ECan Borehole Logs

# Appendix D

CGD Borehole Log

# Appendix E

**CPT** Logs

# Appendix F

Test Pits Logs

# Appendix G

Borehole Logs

# Appendix H

MASW Soundings

# Appendix I

Summary of Liquefaction Results

# **Tables**

Table 1: Summary of ECan borehole logs	8
Table 2: Summary of CGD borehole logs	8
Table 3: Inferred ground profile – northern section of site	12
Table 4: Inferred ground profile – southern section of site	12
Table 5: Liquefaction deformation limits and house foundation implications	13
Table 6: Earthquake events for liquefaction analysis	15
Table 7: Summary of SPT based liquefaction analysis for sand lenses	16
Table 8: LSN descriptions	18
Table 9: Summary of liquefaction analysis for the 4 September 2010 Darfield Earthquake	19
Table 10: Summary of liquefaction analysis for the design level events	20

# **Executive Summary**

### Introduction

Fulton Hogan Land Development Limited is proposing to subdivide a 26.7ha area of rural land in Lincoln. It will be known as Rosemerryn Stages 10 to 18. The site is located in the central portion of the wider Rosemerryn Subdivision being undertaken by Fulton Hogan Land Development Limited, which when completed Rosemerryn Stages 10 to 18 will comprise 400 residential lots, reserves and associated roading.

Fulton Hogan Land Development Limited has engaged Aurecon to undertake a geotechnical investigation and assessment for the entire Rosemerryn subdivision, including these nine stages. The purpose of the investigation was to assess the suitability of the land for residential development, and in particular to characterise the risk of liquefaction and lateral spreading to the development.

#### **Geotechnical Investigations**

Based on the results of our geotechnical investigations the site is underlain by variable geology.

The northern section of the site is typically underlain by:

- 0.1 to 0.7m of topsoil.
- 0.1 to 6.2m of loose to medium dense Sands and Silty Sands interbedded with layers of soft to stiff Sandy Silts and Silts.
- Over 10m of medium dense to very dense Sandy Gravels and Gravels

The southern section of the site is typically underlain by:

- 0.2 to 0.5m of topsoil.
- 2.5 to 7.8m of loose to medium dense Sands and Silty Sands interbedded with layers of soft to stiff Sandy Silts and Silts.
- Over 10m of medium dense to very dense Sandy Gravels and Gravels

Based on groundwater measurements during testing which occurred between 2011 and 2015 and the ECan groundwater model we infer the groundwater level to be approximately between 1m and 3m depth in the northern section and 1m depth in the southern section. Groundwater levels will however vary seasonally or following prolonged rainfall.

#### Liquefaction Assessment

A liquefaction assessment has been carried out at the site. The assessment indicated the following:

- Based on the O'Rourke et. al. (2012) PGA model the site has been "sufficiently tested" (MBIE Guidelines (2012)) as the median value for the PGA for the 4 September 2010 event exceeded 170% of the SLS PGA (i.e. 1.7 x 0.13g = 0.22g). Therefore, we have considered ground damage observations at the site after the 4 September 2010 earthquake event to help refine our liquefaction assessment.
- GNS Science report on liquefaction in eastern Canterbury (GNS, 2012), review of aerial photography and site observations made by Aurecon and Fulton Hogan staff confirms there was no evidence of liquefaction observed at the site after the 4 September 2010 Darfield earthquake or any subsequent earthquakes part of the 2010 to 2012 Canterbury Earthquake Sequence.

- In all cases the liquefaction assessment calculated that lower levels of vertical settlement and ground damage will occur in a SLS earthquake event than those observed following the 4 September 2010 Darfield Earthquake.
- Due to current topography liquefaction induced lateral spreading is considered to be low.
- Based on our liquefaction assessment and observed damage we infer that minor to moderate land damage from liquefaction is possible in future large earthquakes at parts of the site.

Further information of the liquefaction assessment are outlined in Section 4.4 of this report.

#### **Technical Category Classification**

Based on our liquefaction assessment the site in its current form is considered consistent with a mixture of zones of **Technical Category 1 and 2 Classification**. Across Rosemerryn Stages 10 to 18 future land damage from liquefaction is unlikely in the Technical Category 1 area and possible in the Technical Category 2 area in future large earthquakes.

The locations of the various Technical Category zones are shown on Figure 8 in Appendix A.

Due to the potential liquefaction risk at the site, recommendations for the protection of Council vested infrastructure have been made in Section 4.6 of this report.

#### Soft to Firm Clayey Silty Soils

Soft to firm clayey silty soils may be encountered at relatively shallow depths in most of the southern side of the site and in isolated pockets of the northern side of the site. Based on investigation logs we have split the site into two Zones as follows:

- Zone A there is potential for soft silt layers being present at 2m depth with thicknesses between 0.3m and 1.0m. There is also another soft layer from 3m with thicknesses up to 2m.
- Zone B there is potential that soft silt layers will be present in isolated pockets across this part of the site.

The approximate areas of these zones are shown on Figure 9 in Appendix A.

Based on the available investigation logs it is unlikely that shallow bearing for a typical house foundation of 300kPa could be achieved in these areas. Therefore if these soils are encountered 'Good Ground' as per NZS3604 will not be met and specifically designed foundations will be required based on the building consent investigations.

However, based on our analysis typical TC2 type waffle or beam grid type systems should be suitable as foundation elements. The calculated long term consolidation settlement induced by foundation loading is likely to be within acceptable limits of the NZ Building Code (i.e settlement less than 25mm over 6m). However as this is a subdivision area wide geotechnical report and in line with MBIE guidelines bearing capacities must be confirmed during the detailed house design.

#### **RMA Section 106 Assessment**

The site is potentially susceptible to "subsidence" and "inundation" from seismically induced liquefaction. However, using appropriate liquefaction mitigation and remediation measures, as detailed in this report, we believe that the risk imposed by liquefaction will be reduced to an acceptable level. As such, the site will essentially be geotechnically stable land. Thus in our opinion, the proposed development will generally be free of "erosion," "falling debris," "subsidence," "slippage," and "inundation" and the proposed development satisfies the intent of RMA Section 106 1(a).

Provided that appropriate investigation and design inputs are made, as recommended in this report, subsequent use of the land following development is unlikely to accelerate, worsen, or result in

material damage to the land, other land, or structures. In our opinion therefore, the development will comply with the requirements of Clause 106 1(b) RMA.

The geotechnical investigation was aimed at assessing the site for geotechnical suitability for subdivision into residential lots with associated access roads and rights-of-way. Detailed design of house foundations has not been addressed in the report.

This Revision 3 report updates figures and incorporates Client and Council peer reviewer comment, finalise the site specific Technical Category classification and supersedes all previous revisions.

Our Limitations are attached as Section 7 of this report. This report shall be read as a whole.

# 1 Introduction

Fulton Hogan Land Development Limited is proposing to subdivide a 26.7ha area of rural land in Lincoln. It will be known as Rosemerryn Stages 10 to 18. The final layout has now been confirmed and will comprise 400 residential lots, reserves and associated roading. The site is located in the central portion of the wider Rosemerryn Subdivision being undertaken by Fulton Hogan Land Development Limited. See Figures 1 and 2 in Appendix A and the Davie Lovell Smith drawing in Appendix B.

Fulton Hogan Land Development Limited has engaged Aurecon to undertake a geotechnical investigation and assessment for the entire Rosemerryn subdivision, including Stages 10 to 18. The purpose of the investigation was to assess the suitability of the land for residential development, and in particular to better characterise the risk of liquefaction and lateral spreading to the development. The scope of the works undertaken was as follows:

- A detailed desk study of readily available geological and geotechnical information available for this site.
- A preliminary site walkover and reconnaissance.
- Review the existing geotechnical work carried out in the area by Aurecon.
- Undertake further geotechnical investigations comprising of three machine drilled boreholes, five cone penetration tests and MASW soundings.
- Undertake an updated and revisited liquefaction hazard assessment based upon the results of the geotechnical data.
- Provide recommendations on potential liquefaction remediation options for the site.
- Provide recommendations for further testing (if required).
- Assess the site against Sections 106 1a) and 1b) of the RMA.
- Prepare this factual and interpretive geotechnical for Rosemerryn Subdivision stages 10 to 18.

This Revision 3 report updates figures and incorporates Client and Council peer reviewer comment, finalise the site specific Technical Category classification and supersedes all previous revisions.

Our limitations are attached as Section 7 of this report. This report shall be read as a whole.

# 2 Site Conditions

# 2.1 Site Description

The site is located in the central portion of the wider Rosemerryn subdivision (See Figures 1 and 2 in Appendix A and the Davie Lovell Smith drawing in Appendix B). The main site features are:

- The site has an approximate area of 26.7ha.
- The site is made from two irregularly shaped rectangles, a northern rectangle and a southern rectangle which we have denoted the northern and southern section respectively.
- The site is bound to the north by rural land, to the west by rural land and previous stages of the Rosemerryn subdivision, to the south by previous stages of the Rosemerryn subdivision and Edward Street and to the east by future stages in the Rosemerryn subdivision which is currently used for farming activities.
- There is a small stream which runs through the Rosemerryn subdivision and divides the northern section from the southern section. The stream is approximately 0.5m deep and 2m to 3m wide with no significant bank.
- It is understood that there will be not stormwater basins or stormwater channels built as part of the subdivision.
- The site is currently being used for pastoral and cropping farming activities and is covered in barley and grass.
- Current drainage is inferred to be via direct soakage to the ground or via runoff to the small stream.

# 2.2 Regional Geology

The regional geology of the site is described in the Institute of Geological and Nuclear Sciences (GNS) QMaps (as shown on the Canterbury Geotechnical Database (CGD, 2015) as *"Modern river floodplain / low-level degradation terrace. Unweathered, variably sorted gravel / sand / silt / clay. Surfaces <2 degree slope (Q1a)".* 

# 2.3 Seismicity

The GNS Science Active Fault System database (GNS, 2011a) indicates that the site is located approximately 12km south-east of the eastern extension of the Greendale Fault. Movement on the Greendale Fault was responsible for the Magnitude M<sub>w</sub>7.1 Darfield (Canterbury) Earthquake on 4 September 2010.

The site is also located:

- 16km south-west of the epicentre of the Magnitude M<sub>w</sub>6.2 Christchurch Earthquake on 22 February 2011 (GNS, 2011b);
- 21km south-west of the epicentre of the Magnitude  $M_{\rm w}6.0$  major aftershock on 13 June 2011 (GNS, 2011b); and
- 23km south-west of the epicentre of the Magnitude  $M_w$ 5.9 major aftershock on 23 December 2011 (GNS, 2011b).

Based on the O'Rourke et. al. (2012) (as shown on the CGD, 2015) peak ground accelerations of approximately 0.34g were experienced at the site during the 4 September 2010 Darfield Earthquake.

# 2.4 Recorded Earthquake Damage

Based on the GNS Science report "Review of liquefaction hazard information in eastern Canterbury, including Christchurch City and parts of Selwyn, Waimakariri and Hurunui" (GNS, 2012), as shown on Canterbury Maps (2015), there was no observed liquefaction induced damage after the 4 September 2010 or 22 February 2011 earthquakes. But there were minor observed areas within 500m of the site. The locations of observed damage are shown in Figures 3 and 4 in Appendix A.

Following reviews of aerial photography, discussions with Fulton Hogan staff that are familiar with the site, and Aurecon site walk overs in 2011, 2012, 2013 and 2015, no surface expression or manifestation of liquefaction induced ground damage was observed. This confirms the lack of observations noted in the GNS Science report.

# 2.5 MBIE Land Classification

The current land classification for the site, according to the Ministry of Business Innovation and Employment (MBIE) Technical Categories map (as shown on the CGD, 2015), is "*N/A – Rural & Unmapped*". But to the east of the site on the eastern side of Elsmere Road it is classified as "*Technical Category 2*" and to the west of the site it is classified as "*Technical Category 1*". "*N/A – Rural & Unmapped*" means that normal consenting procedures apply in these areas. "*Technical Category 1*" means that future land damage from liquefaction is unlikely, and ground settlements are expected to be within normally accepted tolerances. Standard foundations (NZS 3604) are acceptable subject to shallow geotechnical investigation. "*Technical Category 2*" means that minor to moderate land damage from liquefaction is possible in future large earthquakes. Lightweight construction or enhanced foundations are likely to be required such as enhanced concrete raft foundations (i.e. stiffer floor slabs that tie the structure together).

# 3 Geotechnical Review and Site Investigations

# 3.1 General

The objective of the geotechnical review and site investigation was to investigation the ground and groundwater conditions across the site in order to assess the suitability of the site for subdividing into residential sections.

An initial geotechnical assessment investigation was carried out across the wider site between August and September 2011. Additional testing on these stages was undertaken between April 2012 and January 2015 to provide information for detailed liquefaction risk assessment as part of the subdivision consenting and design process.

The geotechnical review and investigation comprised the following:

- A review of publically available geotechnical information from Environment Canterbury and the Geotechnical Database.
- Cone Penetrometer Testing supervised by Engineering Geologists and Geotechnical Engineers from Aurecon.
- Excavation and logging of test pits by Engineering Geologists from Aurecon.
- Borehole drilling and logging by Engineering Geologists and Geotechnical Engineers from Aurecon.
- Undertaking of Multi-channel Analysis of Surface Waves (MASW) profiling to generate shear wave velocity profiles.

This section of the report describes the geotechnical testing undertaken on the site.

# 3.2 Environment Canterbury GIS Data

A review of the Environment Canterbury GIS Database (ECan, 2015) indicates five Environment Canterbury boreholes with logs on the site. The borehole logs, locations, and depths are summarised in Table 1 below.

Borehole	Location	Depth	Summary of Stratigraphy
M36/8672	In eastern side of southern section	6.0m	<ul> <li>0 to 0.2m – Topsoil</li> <li>0.2 to 6.0m – Silty Sand, Silt Sandy, Clayey Silt and Silty Clay</li> </ul>
M36/8673	To the west of the southern section	6.0m	<ul> <li>0 to 0.2m – Topsoil</li> <li>0.2 to 6.0m – Clayey Silt and Silty Clay</li> </ul>
M36/8677	In the south- eastern side of the northern section	5.2m	<ul> <li>0 to 0.2m – Topsoil</li> <li>0.2 to 2.8m – Silt and Silty Clay</li> <li>2.8 to 5.2m – Gravel</li> </ul>
M36/8678	In the western side of the northern section	5.2m	<ul> <li>0 to 0.2m – Topsoil</li> <li>0.2 to 1.0m – Silty Clay</li> <li>1.0 to 1.8m – Sandy Gravel and Silty Gravel</li> <li>1.8 to 2.8m – Silty Clay with no to some Gravel.</li> <li>2.8 to 5.2m – Silty Gravel</li> </ul>
M36/8681	In the northern side of the northern section	4.5m	<ul> <li>0 to 0.2m – Topsoil</li> <li>0.2 to 1.8m – Silt and Silty Sand mixed with Gravel</li> <li>1.8 to 4.5m – Gravel</li> </ul>

# Table 1: Summary of ECan borehole logs

The locations of the ECan borehole logs are presented in Figure 5 in Appendix A and the borehole logs are presented in Appendix C.

# 3.3 Canterbury Geotechnical Database

A review of the Canterbury Geotechnical Database (CGD, 2015) indicates one borehole log near to the site. As the site is in Lincoln there is no other applicable information is available on the Canterbury Geotechnical Database. The borehole log, location, and depth are summarised in Table 2 below.

Table 2: Summary	of CGD	borehole logs
------------------	--------	---------------

Borehole	Location	Depth	Summary of Stratigraphy
BH_33771 (Borehole 3)	To the west of the northern section	10.5m	<ul> <li>0 to 0.5m – Topsoil</li> <li>0.5 to 3.1m – Silty Sand</li> <li>3.1 to 3.7m – Sand</li> <li>3.7 to 10.5m – Sandy Gravel with a sand lens between 5.0 and 5.15m.</li> </ul>

The location of CGD log is presented in Figure 5 in Appendix A and the borehole log is presented in Appendix D.

# 3.4 Cone Penetration Testing

69 Cone Penetration Tests (CPT) were undertaken in the vicinity of Stages 10 to 18 of the Rosemerryn Subdivision to effective refusal (a sustained tip bearing over 30MPa) at depths between 0.7m and 10.2m depth. The locations of the CPTs are shown in Figure 6 in Appendix A and the logs are presented in Appendix E.

The CPT logs indicate:

## Northern section of the site

- Surface to 0.4-6.5m Interbedded layers Sands to Silty Clays
- 0.4-6.5m onwards Sandy Gravels

## Southern section of the site

- Surface to 3.0-8.0m Interbedded layers Sands to Silty Clays
- 3.0-8.0m onwards Sandy Gravels

# 3.5 Test Pit Excavations

45 test pit excavations were undertaken in the vicinity of Stages 10 to 18 of the Rosemerryn Subdivision to a maximum achievable depth of 2.0m and 4.2m due to the test pits collapsing or encountering very dense gravels. The test pits were logged in accordance with the New Zealand Geotechnical Society's field description of soil and rock (NZGS, 2005). The locations of the test pits are shown in Figure 6 in Appendix A and the logs are presented in Appendix F together with an explanatory sheet outlining the terms and symbols on the logs.

The test pits logs indicate:

#### Northern section of the site

- Surface to 0.2-0.5m Topsoil
- 0.2-0.5m to 0.4-3.7m Sand, Silty Sand, Sandy Silt, Silt
- 0.4-3.7m onwards Gravel and Sandy Gravel

#### Southern section of the site

- Surface to 0.3-0.4m Topsoil
- 0.3-0.4m onwards Sand, Silty Sand, Sandy Silt, Silt

# 3.6 Boreholes

Five machine boreholes with Standard Penetrometer Testing (SPT) were drilled in the vicinity of Stages 10 to 18 of the Rosemerryn Subdivision. The boreholes were drilled to the target depth between 10.5m and 15.2m and were logged in accordance with the New Zealand Geotechnical Society's field description of soil and rock (NZGS, 2005). The locations of the boreholes are shown in Figure 6 in Appendix A and the Aurecon and McMillan logs are presented in Appendix G.

The test pits logs indicate:

## Northern section of the site

- Surface to 0.1-0.7m Topsoil
- 0.1-0.7m to 0.1-3.8m Interbedded Sand, Silty Sand, Sandy Silt and Silt
- 0.1-3.8m onwards Predominately Sandy Gravel and Gravel with minor sand lenses up to 1.5m thick.

## Southern section of the site

- Surface to 0.4m Topsoil
- 0.4 to 6.8m Silt and Silty Sand
- 6.8m onwards Sandy Gravel

# 3.7 MASW Soundings

A series of 12 Multi-channel Analysis of Surface Waves (MASW) profile lines were undertaken by Southern Geophysical Limited. These profile lines total 3.1km in length and comprise individual MASW soundings at approximately 10m centres. From the MASW soundings, shear wave velocity profile sections have been produced for the upper 25m of the soil profile. The MASW soundings were undertaken to obtain information between the physical control points (CPT, borehole and test pits) and in particular it provided information on the start of the gravel layer in both sections and sand lens in the gravel layer though the upper profile in the northern section. The locations of the profile lines are shown in Figure 7 in Appendix A and the velocity profiles are presented in Appendix H.

The shear wave velocity (Vs) profiles when calibrated to the CPT, test pit and borehole logs indicate:

#### Northern section of the site

- Upper Sands and Silts V<sub>s</sub> < 180m/s</li>
- Gravels (Upper 10m)  $180m/s < V_s < 350 m/s$
- Sand Lenses 200m/s <  $V_{\rm s}$  < 250 m/s
- Gravels (Deeper) 350m/s < Vs

#### Southern section of the site

- Upper Sands and Silts V<sub>s</sub> < 180m/s
- Gravels (Upper 10m)  $180m/s < V_s < 250 m/s$
- Gravels (Deeper) 250m/s < Vs

# 3.8 Ground Water

Groundwater levels have been recorded from the four sources as follows:

- After the CPTs water measurements have been taken, where possible, when the rods have been removed these show water at approximately 1.9m depth in the northern section.
- From the test pit logs groundwater was encountered at depths between 2.0m and 3.6m on the northern section and between 2.0m and 3.8m on the southern section.
- During the drilling of the machine boreholes static ground water was observed between 1.8m and 3.8m on the northern section and 1.2m in the southern section.
- Groundwater level has been recorded in the CGD borehole by the northern section at 2.1m depth.

Groundwater levels are expected to vary seasonally or with periods of high or low precipitation.

# 4 Engineering Considerations

# 4.1 General

Fulton Hogan Land Development Limited is proposing to subdivide 26.7ha area of rural land in Lincoln. It will be known as Rosemerryn Stages 10 to 18 and comprises 400 residential lots and reserve areas. To fulfil the Ministry of Business, Innovation and Employment (MBIE, 2012) guidelines on residential development, the liquefaction risk at the site needs to be quantified. Once this liquefaction risk is quantified then appropriate mitigation measures (if required) can be developed as part of the physical site development.

This section of the reports outlines details of our liquefaction assessment, and presents our recommendations for liquefaction mitigation options as part of the site development.

# 4.2 Geotechnical Ground Model

Based on the results of our geotechnical site investigation we infer a ground profile as presented in Table 3 and 4.

Unit	Depth to Start of Layer	Depth to End of Layer	Material
1	Surface	0.1 to 0.7m	Topsoil
2	0.1 to 0.7m	0.4 to 6.5m	Loose to medium dense Sands and Silty Sands interbedded with layers of soft to stiff Sandy Silts and Silts
3	0.4 to 6.5m	15m onwards	Predominately medium dense to very dense Sandy Gravels and Gravel with occasional sand lenses up to 1.5m thick

## Table 3: Inferred ground profile – northern section of site

# Table 4: Inferred ground profile - southern section of site

Unit	Depth to Start of Layer	Depth to End of Layer	Material
1	Surface	0.2 to 0.5m	Topsoil
2	0.2 to 0.5m	3.0 to 8.0m	Loose to medium dense Sands and Silty Sands interbedded with layers of soft to stiff Sandy Silts and Silts. With a 0.5m to 2m soft to firm Clayey Silt starting approximately 2m depth.
3	3.0 to 8.0m	15m onwards	Medium dense to very dense Sandy Gravels and Gravels

Based on our ground investigations and the ECan groundwater model we infer groundwater levels to be approximately between 1m and 3m below ground level on the northern section of the site and to be approximately 1m below ground level on the southern section of the site.

Groundwater levels are expected to vary seasonally or with period of high or low precipitation.

# 4.3 Site Flexibility

We have assessed the site flexibility based on the following:

- Site stratigraphy comprises approximately sands and silts underlain by gravels to at least 15m depth (maximum depth investigated at the site).
- Clause 3.1.3 and Table 3.2 of NZS 1170.5:2004.

We consider that the site subsoil category in terms of NZS 1170.5:2004 Clause 3.1.3 is Class D (Deep soil site).

# 4.4 Liquefaction Assessment

## 4.4.1 General

Under cyclic loading (i.e. during an earthquake) loose, non-cohesive materials such as gravels, sands, silty-sands, tend to decrease in volume. This tendency to decrease in volume is much greater in loose than in dense soils. When loose non-cohesive soils are saturated and rapid loading occurs under undrained conditions, the soils densification causes pore water pressure to increase. The increase in pore water pressure results in a loss of soil strength due to a decrease in effective stress and eventually liquefaction occurs when the effective stress drops to zero. Liquefaction can lead to large displacements of foundations, flow failures of slopes and ground surface settlement, sand boils, and post-earthquake stability failures.

This assessment quantifies the risk of future liquefaction in terms of the technical category classification system outlined in the MBIE (2012) guidelines. This classification system is divided into three technical categories that reflect both the liquefaction experience to date and future performance expectations. The categories and corresponding criteria are summarised as follows:

- **Technical Category 1 (TC1)** Future land damage from liquefaction is unlikely, and ground settlements are expected to be within normally accepted tolerances.
- **Technical Category 2 (TC2)** Minor to moderate land damage form liquefaction is possible in future large earthquakes.
- **Technical Category 3 (TC3)** Moderate to significant land damage from liquefaction is possible in future large earthquakes.

MBIE (2012) has indicated the following liquefaction and lateral spreading deformation limits for house foundations as summarised in Table 5 below:

Technical	Index Liqu	efaction Def	ormation I	_imits	Likely Implication for House	
Category	Vertical		Lateral Spread		Foundations (subject to individual assessment)	
	SLS	ULS	SLS	ULS		
TC1	15mm	25mm	Nil	Nil	Standard NZS3604 type foundations with tied slabs	
TC2	50mm	100mm	50mm	100mm	MBIE enhanced foundation solutions	
ТС3	>50mm	>100mm	>50mm	>100mm	Site specific foundation solution	

#### Table 5: Liquefaction deformation limits and house foundation implications



In determining the liquefaction potential at the site, the main factors to be considered are:

- How has the site performed during the major seismic events of the Canterbury earthquake sequence?
- Which layers have liquefied?
- What is the likelihood of further liquefaction in the future?
- How the potential liquefaction affects the development?

Each of these is considered below.

## **Observations after Previous Major Earthquake Events**

As outlined in Section 2.4 there is no evidence of liquefaction observed at the site after the 4 September 2010 Darfield earthquake or any subsequent earthquakes part of the 2010 to 2012 Canterbury Earthquake Sequence. This suggests that limited potential for soil liquefaction at the site.

# **Potential for Liquefaction**

Three primary factors contribute to liquefaction potential:

- Soil grading and density.
- Groundwater.
- Earthquake intensity and level of ground shaking.

Each of these is discussed below.

## Soil Grading and Density

The CPT logs show layers of loose to medium dense sands, silty sands and sandy silts. These layers are considered to be potentially susceptible to liquefaction from a soil grading and density perspective.

#### Groundwater

We have adopted a groundwater table between 1m and 3m below ground level for the northern section and a groundwater table at 1m below ground level for the southern section. Therefore, soils are potentially liquefiable from a depth of 1m to 3m from a saturation criterion. It should be noted that groundwater levels are subject to seasonal changes.

# Earthquake Intensity and Level of Shaking

The level of ground shaking is one of the key factors in determining whether liquefaction will or will not occur. For this study, we have assessed the three design levels of shaking outlined in the MBIE Guidelines plus two peak ground acceleration cases of the 4 September 2010 earthquake event. We have considered the 4 September 2010 Darfield earthquake as there is PGA data available for the site which shows the levels of shaking was larger than an SLS event. Therefore the 4 September 2010 earthquake provides an upper bound indicator of ground damage and settlements likely to occur in an SLS event. The levels of shaking used are as follows:



Earthquake Event	Magnitude	Peak Ground Acceleration
4 September 2010-a	M <sub>w</sub> 7.1 <sup>(1)</sup>	0.34g <sup>(1)</sup>
4 September 2010-b	M <sub>w</sub> 7.1 <sup>(1)</sup>	0.20g <sup>(2)</sup>
ULS	M <sub>w</sub> 7.5	0.35g
SLS-a	M <sub>w</sub> 7.5	0.13g
SLS-b	M <sub>w</sub> 6.0	0.19g

#### Table 6: Earthquake events for liquefaction analysis

- (1) Magnitude and peak ground acceleration from O'Rourke et. al. (2012) (as shown on the CGD 2014)
- (2) Approximately 65% (1/170%) of the peak ground acceleration of the O'Rourke et. al. (2012) to account for uncertainty of PGA model

For an Ultimate Limit State (ULS) earthquake buildings are expected to retain their structural integrity and form during a ULS earthquake event and not endanger life. Some plastic deformation of structural elements within the structure is expected to occur but ideally the damage can be repaired and the structure can be returned to service after the event, although repair may be uneconomical.

For a Serviceability Limit State (SLS) earthquake buildings are expected to perform well for the SLS event and be returned to service after limited repair.

# 4.4.2 Liquefaction Potential Assessment

The ground investigations show that the site is directly underlain by sandy and silty soils which in turn is underlain by predominately gravels with some sand lenses. Based on the geotechnical ground investigations the gravels have been assessed to be non-liquefiable in design level events due to the recorded relative densities and partial size. Therefore to define the liquefaction hazard at the site we need to assess the liquefaction potential of the upper soils as well as the sand lenses within the gravel layers. To assess the liquefaction potential of the upper soils we have used a cone penetration test (CPT) assessment and to assess the liquefaction potential of the sand lenses we have considered the relative density of the sandy layers from the SPT and shear wave velocity data.

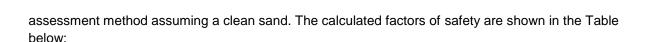
As the Bradley and Hughes (2012a, b) ground shaking model does not extend into Lincoln area we have considered the O'Rourke et al (2012) PGA model. Based on this PGA model and the MBIE Guidelines (2012) the site has been 'sufficiently tested' as the median value for the PGA for the 4 September 2010 event exceeded 170% of the SLS PGA (i.e.  $1.7 \times 0.13g = 0.22g$ ). Therefore, we have also considered ground damage observations at the site after the 4 September 2010 earthquake event to help refine our liquefaction assessment.

#### Liquefaction in the Deeper Soils

A sand lens was encountered in a borehole BH102 as well as other sand lenses being inferred in the MASW soundings. For this reason in our liquefaction assessment we have considered the liquefaction hazard of these layers.

To assess liquefaction of these sand lenses we have considered an SPT undertaken in this layer and shear wave velocity profile obtained from the MASW sounding and well as the mechanism of liquefaction occurring, the likely damage from it occurring and the previous observed damage or lack thereof.

Using the single SPT (BH102 at 4.56m depth) we have in a sand lens we have assessed the liquefaction potential of this layer based on the Boulanger and Idriss (2014) SPT based liquefaction



Earthquake Event	Calculated Factor of Safety Against Liquefaction
4 September 2010-a	0.4
4 September 2010-b	0.7
SLS-a	1.0
SLS-b	0.8
ULS	0.4

Table 7: Summary of SPT based liquefaction analysis for sand lenses

From this SPT based liquefaction assessment, sand lens are assessed as being is highly liquefiable even at relatively low levels of shaking with the factor of safety against liquefaction for 4 September 2010 event calculated to have a factor of safety between a SLS and ULS design event.

To supplement this SPT we have also considered the shear wave velocity obtained from the MASW soundings. Based on the method outlined in Idriss and Boulanger (2008) the maximum shear wave velocity for liquefiable soils is 215m/s. Therefore in the initial liquefaction analysis for the site we have considered that all soils with shear wave velocities less than 200m/s are potentially liquefiable in a design level event. This shows that there is limited potential for liquefaction to occur within in these sand lenses.

These two assessments show differing results. For this reason we have considered the mechanism of the liquefaction process. When loose non-cohesive soils are saturated and rapid loading occurs under undrained conditions, the soils densification causes pore water pressure to increase. The increase in pore water pressure results in a loss of soil strength due to a decrease in effective stress and eventually liquefaction occurs when the effective stress drops to zero. However, as these sand lenses as surrounded by gravel drainage effects may occur, limiting and reducing the build-up of excess pore water pressure, thus limiting liquefaction occurring. Therefore the liquefaction hazard of these sand lenses will be reduced.

The effects of these sand lenses liquefying also required to be considered. Borehole BH102 shows 4.5m of medium to very dense gravels overlying the potentially liquefiable sand lens. The MASW profiles suggest that this layer of medium dense to very dense gravels is as thin as 3m in some areas. Therefore based on observations in Christchurch if these sand layers were to liquefy the damage to shallow founded structures will likely be suppressed due to this medium dense to very dense gravel layer.

Lastly no significant differential damage, including settlement, was observed across areas with sand lens and areas without. Which suggests that either theses layers did not liquefy or the upper gravel layer has supressed the liquefaction induced damage in these areas.

For these reasons we consider the liquefaction or liquefaction effects occurring in these deeper sand lenses to be limited concerns to shallow founded domestic structures and therefore we have not considered it further in our assessment. Instead we have only considered liquefaction in the upper soils as the main driving mechanism of the site liquefaction hazard.

### Liquefaction in the Upper Soils Methodology

The ability for the subsoils to resist the effect of ground shaking associated with the design level earthquakes has been assessed from the upper subsoil information obtained from the CPTs.

The liquefaction assessment was carried out using the methods outlined in Boulanger and Idriss (2014) in line with the recent amendments to the MBIE Guidelines (2014). The fines content fitting parameter has been set as 0 as no laboratory testing has been undertaken on the soils at the site.

Some of the upper soils were inferred to be clayey silts to organic silts ( $I_c$  greater than 2.6). As limited laboratory testing has been carried out to aid in determining a liquefaction cut off on the soils underlying the site, soils have been assumed to be non-liquefiable where the CPT Soil Character Index,  $I_c$ , is greater than 2.6.

#### **Upper Liquefaction Effects**

Liquefaction can have a number of effects on buildings and land. In this assessment we have considered the following effects:

- Liquefiable layers.
- Liquefaction induced reconsolidation settlement.
- Liquefaction induced ground damage.

These are discussed in the following sections:

#### **Liquefiable Layers**

The layers which may liquefy in a design level event are critical in regards to the foundation performance. The Boulanger and Idriss (2014) method has been used in this assessment and it has been assumed that soils are liquefiable when the factor of safety is below one.

#### **Liquefaction Induced Settlement**

The method of Zhang et. al. (2004) was used for calculating the potential liquefaction induced reconsolidation settlements in the CPT analysis. Settlements have been calculated over the entire CPT profiles (up to 15m depth), as well as over the upper 10m of the profile ("index settlement" in terms of the MBIE Guidelines).

#### **Liquefaction Induced Ground Damage**

We have used two methods to assess the potential for liquefaction induced ground damage as outlined below:

a) Published information (after Ishihara, 1985) can be used to assess the potential for surface expression of liquefaction and hence the likelihood of inducing damage. Ishihara's method is for a single non-liquefiable layer overlying a single liquefiable layer only. The liquefaction analysis indicates multiple liquefiable layers within the CPT profiles and to account for this we have taken the thickness of the non-liquefied crust as the thickness from the ground surface to the top of the uppermost critical liquefiable layer, and the thickness of the critical liquefied layer as the sum of the thicknesses of all critical liquefiable layers.

Ishihara's plots do not explicitly indicate ground damage curves for specific PGAs such as 0.13g which is the SLS level PGA. To simplify the analysis we have used following curves to assess the ground damage:

- The 0.20g curve when assessing damage under SLS design levels of ground shaking and the lower bound 4 September 2010 Darfield Earthquake.
- The 0.40g curve when assessing damage under ULS design level of ground shaking and the 4 September 2010 Darfield Earthquake.

b) Tonkin & Taylor (T&T) developed the Liquefaction Severity Number (LSN) (Tonkin & Taylor 2013) based on investigation data and observations made following major earthquake events in Christchurch. The LSN uses the settlements calculated from the Idriss and Boulanger (2008) method with the Robertson and Wride (1998) fines content method and the Zhang et. al. (2004) settlement method to assess the expected ground damage that could be caused by liquefaction in future earthquakes. The level of ground damage associated with LSN numbers is summarised in Table 8 below.

#### Table 8: LSN descriptions

LSN Range	Predominate Performance
0-10	Little to no expression of liquefaction, minor effects
10-20	Minor expression of liquefaction, some sand boils
20-30	Moderate expression of liquefaction, with sand boils and some structural damage
30-40	Moderate to severe expression of liquefaction, settlement can cause structural damage
40-50	Major expression of liquefaction, undulations and damage to ground surface, severe total and differential settlement of structures
>50	Severe damage, extensive evidence of liquefaction at surface, severe total and differential settlement affecting structures, damage to services

#### **Upper Liquefaction Results**

The result of the liquefaction assessment for the 4 September 2010 event are summarised in Table 9 and the results of the design level events are summarised in Table 10. The liquefaction outputs are presented in Appendix I.

Earthquake Event	Earthquake Effects	Northern Section	Southern Section
4 September 2010 Darfield Earthquake (M <sub>w</sub> 7.1, 0.34g)	Liquefiable Layers <sup>(1)</sup>	Unit 2 below the water level	Unit 2 below the water level
	Settlement <sup>(2)</sup>	0 to 50mm	35 to 145mm
	Ground Damage <sup>(3)</sup>	Yes over half of the site	Yes
	LSN	0 to 16	21 to 56
	Comments	The analysis indicates minor to moderate damage	The analysis indicates moderate to major damage
4 September 2010 Darfield Earthquake (M <sub>w</sub> 7.1, 0.20g)	Liquefiable Layers <sup>(1)</sup>	Some of the sandy layers of Unit 2 below the water table	Unit 2 below the water level
	Settlement <sup>(2)</sup>	0 to 35mm	15 to 130mm
	Ground Damage <sup>(3)</sup>	No	Yes over half of the site
	LSN	0 to 14	8 to 50
	Comments	Not assessed	The analysis indicates minor to major damage

# Table 9: Summary of liquefaction analysis for the 4 September 2010 Darfield Earthquake

(1) Due to the inherent uncertainty in calculating liquefiable layers, the calculated layers are indicative only. Actual positions and thickness of liquefiable layers could vary from those above.

(2) Settlements are calculated over the full CPT profile. Settlements are presented to the nearest 5mm. Due to the inherent uncertainty in calculating liquefaction induced settlements, the calculated settlements are indicative only and actual settlements will vary from those above.

(3) Ground damage based upon published information after Ishihara (1985).



Earthquake Event	Earthquake Effects	Northern Section	Southern Section
ULS (1 in 500 year event) (M <sub>w</sub> 7.5, 0.35g)	Liquefiable Layers <sup>(1)</sup>	Unit 2 below the water level	Unit 2 below the water level
	Settlement <sup>(2)</sup>	0 to 50mm	35 to 150mm
	Ground Damage <sup>(3)</sup>	Yes over half of the site	Yes
	LSN	0 to 16	21 to 56
	Comments	The analysis indicates minor to moderate damage. This is similar to or greater than what is calculated in the 4 September 2010 earthquake.	The analysis indicates moderate to major damage. This is similar to or greater than what is calculated in the 4 September 2010 earthquake.
SLS-a (1 in 25 year	Liquefiable Layers <sup>(1)</sup>	Limited layers	Some of the sandy layers of Unit 2 below the water table
event) (M <sub>w</sub> 7.5,	Settlement <sup>(2)</sup>	0 to 15mm	0 to 105mm
0.13g)	Ground Damage <sup>(3)</sup>	No	No
	LSN	0 to 6	2 to 41
	Comments	The analysis indicates minor damage. This is less than that calculated for the 4 September 2010 Earthquake.	The analysis indicates minor to major damage. This is less than that calculated for the 4 September 2010 Earthquake.
SLS-b (1 in 25 year event) (M <sub>w</sub> 6.0, 0.19g)	Liquefiable Layers <sup>(1)</sup>	Some of the sandy layers of Unit 2 below the water table	Unit 2 below the water level
	Settlement <sup>(2)</sup>	0 to 30mm	10 to 125mm
	Ground Damage <sup>(3)</sup>	Predominately No	Yes over 1/6 of the site
	LSN	0 to 5	2 to 40
	Comments	The analysis indicates minor damage. This is less than that calculated for the 4 September 2010 Earthquake.	The analysis indicates minor to major damage. This is less than that calculated for the 4 September 2010 Earthquake.

# Table 10: Summary of liquefaction analysis for the design level events

(1) Due to the inherent uncertainty in calculating liquefiable layers, the calculated layers are indicative only. Actual positions and thickness of liquefiable layers could vary from those above.

(2) Settlements are calculated over the full CPT profile. Settlements are presented to the nearest 5mm. Due to the inherent uncertainty in calculating liquefaction induced settlements, the calculated settlements are indicative only and actual settlements will vary from those above.

(3) Ground damage based upon published information after Ishihara (1985).

#### Discussion

The MBIE guidelines divide flat land into three technical categories that reflect both the liquefaction experience to date and future performance expectations. The categories and corresponding criteria are summarised as follows:

- **Technical Category 1 (TC1)** Future land damage from liquefaction is unlikely, and ground settlements are expected to be within normally accepted tolerances.
- **Technical Category 2 (TC2)** Minor to moderate land damage form liquefaction is possible in future large earthquakes.
- **Technical Category 3 (TC3)** Moderate to significant land damage from liquefaction is possible in future large earthquakes.

As the Bradley and Hughes (2012a, b) does not extend into Lincoln we have considered the O'Rourke et. al. (2012) PGA model. Based on the MBIE Guidelines (2012) the site has been 'sufficiently tested' as the median value for the PGA for the 4 September 2010 event exceeded 170% of the SLS PGA (i.e.  $1.7 \times 0.13g = 0.22g$ ). No damage was observed on the site due to liquefaction after the 4 September 2010 earthquake event. Based upon this actual site response we infer that the liquefaction assessment method over estimates likely settlement under future large earthquakes. Therefore, we have calibrated the liquefaction assessment based on observations from the previous 4 September 2010 Darfield earthquake event.

It is not possible to compare the calculated and actual settlements for the 4 September 2010 Darfield earthquake event at the site because there is no quality information on actual ground settlements. We can however make the following comments based on observations, calculated settlements and ground damage for the three design earthquakes:

- For the northern part of the site the calculated ULS settlements are between 0mm and 50mm and the calculated SLS settlements are between 0mm 30mm which is consistent with MBIE TC1 and TC2 classifications. The analysis indicates that in a ULS event minor to moderate damage and in a SLS event minor damage.
- For the southern part of the site the calculated ULS settlements are between 35mm and 150mm and the calculated SLS settlements are between 0mm 125mm which is consistent with MBIE TC2 and TC3 classifications. The analysis indicates that in a ULS event moderate to major damage which is similar to or greater than what is calculated in the 4 September 2010 event, and in a SLS event minor to major damage which is less than that calculated for the 4 September 2010 Earthquake.
- Based on the GNS Science (2012) report on liquefaction in eastern Canterbury, discussions with a Fulton Hogan staff that are familiar with the site, review of aerial photography and Aurecon site walkovers in 2011, 2012, 2013 and 2015 no liquefaction induced damage was noted on the site.
- The MBIE prescribe liquefaction assessment methodology indicates that in the southern section of the site moderate to major ground damage should have occurred in the 4 September 2010 Darfield earthquake, which is not supported by field observations.
- In the southern section of the site the liquefaction assessment calculated that lower levels of vertical settlement and ground damage will occur in a SLS earthquake event than the 4 September 2010 Darfield Earthquake.

For the southern section of the site the liquefaction assessment overstates the liquefaction risk when compared to actual site performance as only limited to minor damage was observed at and around the site after the 4 September 2010 earthquake event.

Hence, based on our liquefaction assessment and observed damage we infer that minor to moderate land damage from liquefaction is possible in future large earthquakes at parts of the site. Therefore we conclude based on our liquefaction assessment:

- The northern section of Stage 10 to 18 is consistent with the classifications of **Technical** Category 1 (TC1) and Technical Category 2 (TC2).
- The southern section is consistent with the classification of Technical Category 2 (TC2).

The areas of TC1 and TC2 are shown in Figure 8 in Appendix A.

# 4.4.3 Liquefaction Induced Lateral Spreading

Lateral spreading occurs in the surface soils move downslope or towards a free edge, such as a river or basin. Lateral spreading can occur during an earthquake under seismic loading and following the earthquake until the excess pore water pressure caused by ground shaking dissipate and the soil regains strength.

When assessing liquefaction induced lateral spreading we considered the following:

- There is a small stream which runs through the site which is approximately 0.5m deep and 2m to 3m wide with no significant bank.
- No other significant rivers or significant changes in height are in close proximity to the site.
- The site is relatively level and we understand that there will be no significant change in this once the development is undertaken.
- We understand that no stormwater basins or open channels will be built as part of this development.

Based on the site topography we consider that the global lateral and lateral stretch potentials across the site is considered to be low and will not govern the MBIE Technical Category assessment. As such no further assessment of lateral spreading has been undertaken.

# 4.4.4 Summary of MBIE Technical Category Liquefaction Assessment

The liquefaction analysis indicates the following:

- Based on the O'Rourke et. al. (2012) PGA model the site has been "sufficiently tested" (MBIE Guidelines (2012)) as the median value for the PGA for the 4 September 2010 event exceeded 170% of the SLS PGA (i.e. 1.7 x 0.13g = 0.22g). Therefore, we have also considered the lack of ground damage observations at the site after the 4 September 2010 earthquake event to help refine our liquefaction assessment.
- GNS Science report on liquefaction (GNS, 2012), review of aerial photography and site observations made by Aurecon and Fulton Hogan staff confirms there was no evidence of liquefaction observed at the site after the 4 September 2010 Darfield earthquake or any subsequent earthquakes part of the 2010 to 2012 Canterbury Earthquake Sequence.
- In all cases the liquefaction assessment calculated that lower levels of vertical settlement and ground damage will occur in a SLS earthquake event than the 4 September 2010 Darfield Earthquake.
- Liquefaction induced lateral spreading is considered to be low.
- Based on our liquefaction assessment and observed damage we infer that minor to moderate land damage from liquefaction is possible in future large earthquakes at parts of the site.

• Therefore we conclude based on our liquefaction assessment and accounting for groundwater levels and depth to underlying gravels, the northern section of Stage 10 to 18 is consistent with the classifications of **Technical Category 1 (TC1) and Technical Category 2 (TC2)** and the southern section is consistent with the classification of **Technical Category 2 (TC2)**. See Figure 9 in Appendix 9 for further details.

# 4.5 Liquefaction Mitigation

# 4.5.1 General

It is considered that the site in its current assessment state is susceptible to varying degrees of seismically induced liquefaction in a future major seismic event.

In terms of liquefaction hazard mitigation there are four basic approaches as follows:

## 1. Accept Liquefaction Risk

Design a structure with no regards to the liquefaction risk. This approach would only be used where there is effectively no to very little risk from seismically induced liquefaction (i.e. in Technical Category 1 areas).

## 2. Building Strengthening

Structurally design the building to accommodate the effects of liquefaction. Examples of this include using raft or piled foundations. These methods do not remove the liquefaction hazard but reinforce the structure in such a way that it maintains stability during a liquefaction event.

#### 3. Ground Improvement

Improve the soil at the site so that it is less susceptible to seismically induced liquefaction. This general approach can be divided into three categories:

**1.** Densify the soil so that soil grain skeleton will not collapse under earthquake loading. Examples of this include compaction and replacement (refilling with material which will not liquefy).

**2.** Soil reinforcement. Examples include stone columns, driven piles to densify and stiffen the soil, deep soil mixing, soil cement columns etc.

**3.** Allow dissipation of excess pore water pressure so that liquefaction is reduced. Examples of this include installation of drains, drainage blankets, and or stone columns.

#### 4. Alternative Land Use

Use the site for non-residential housing activities, such as reserve areas, playing fields etc.

The recommended approach for liquefaction mitigation in each Technical Category classification zone is discussed below.

# 4.5.2 Technical Category 1

As per the MBIE (2012) Guidelines with TC1 sites *"Future land damage from liquefaction is unlikely, and ground settlements from liquefaction effects are expected to be within normal accepted tolerances"*. Therefore, only shallow geotechnical testing is required at the building consent stage of residential development. If *'Good Ground'* test is met, NZS3604 *'Timber Framed Buildings'* type foundations can be used.

For the TC1 area we are effectively using an 'Acceptance of Liquefaction' solution as the risk is sufficient low to warrant this approach.

# 4.5.3 Technical Category 2

The sites are consistent with the deformation characteristics of TC2 and do not meet the intent of the definition of 'Good Ground' as per the New Zealand Standards (NZS3604 'Timber Framed Buildings' and NZS4229 'Concrete Masonry Buildings not requiring Specific Engineering Design'). These standards are typically used to design the structural components of residential dwellings. Due to a TC2 equivalent classification the generic foundation options presented in these standards cannot generally be used.

The principal objectives of the foundation design at the site should be to provide sufficient stiffness for the house to remain in a near flat plane in a future earthquake, and to be capable of being re-levelled if differential settlement does occur. To achieve these objectives the foundation system will need to go beyond the lightly reinforced slab-on grade floor system permitted by NZS3604 which is too flexible and lacks the strength to resist ground movement without significant damage. The chosen foundation system should be designed to be able to accommodate settlement of ground beneath the house and to be capable of resisting imposed loads and stresses from differential settlement.

The above comments are in line with the guidance advice made by the MBIE (2012). The foundation options in the MBIE guidelines are house specific and will need to be selected and design during two categories: shallow foundations, and deep foundations. Each of these is discussed below. For the TC2 area we are effectively using a '*Building Strengthening*' type approach to liquefaction mitigation where the foundations are strengthened to withstand the effects of liquefaction.

It should be noted that this report provides guidance only on residential foundation design and should not be taken as detailed design. Other foundation solutions are available (i.e ground improvement to achieve TC1 site characteristics etc.). However these options are unlikely to be economic relative to the options below and are not recommended at this stage.

#### **Shallow Foundations**

A shallow foundation, such as a raft, is intended to tie the superstructure together and to minimise structural damage if there is any ground movement during or following a future major seismic event. A properly detailed raft foundation is unlikely to prevent settlement of the dwelling but will reduce differential settlement and will also allow the house to be re-levelled if required. Raft foundations are generally suitable for dwellings with concrete floor slab only.

Raft foundations can take several forms, including:

- A gravel raft (either with or without geogrid reinforcement) with a reinforced concrete slab formed on top of the gravel raft.
- A double reinforced concrete raft case onto the in situ ground.
- A reinforced ground beam grid with slab foundation case onto the in situ ground (rib raft).

An alternative shallow foundation option is to use a suspended wooden floor with short piles and ring foundations as given in NZS3604. However, with this option, the site foundation soils must have 300kPa rupture bearing capacity and the building must have lightweight cladding and roofing systems.

#### **Deep Foundations**

Deep foundations such as piles will transfer structural loads from the structure to deeper and stronger non-liquefiable soil layers which will minimise any structural damage associated with ground liquefaction and settlement during and after a major seismic event. Piled foundations will minimise both total and differential settlements. Piled foundations for a residential house typically comprise driven piles and can be either concrete (typically used if a concrete floor system is to be used), or timber (typically used if a timber floor and sub-floor system is to be used). A piled foundation system does not require any special soil preparation, but will require site specific investigation and design. Based upon the results of the ground testing, pile foundations would likely be founded well into the sandy gravel material at typically 4m to 5.5m below the finished ground level.

### **Discussion and Recommendations**

The recommendations above are based on Section 5 of the MBIE (2012) guidelines. Schematics and typical cross sections of these foundation systems are presented in the guideline.

The raft foundation options are likely to be cheaper than the piled foundation options but piled foundations are often recommended for residential housing as piled foundations minimise settlement and damage during a large seismic event.

If piled foundations are adopted, then the floor slab should be well reinforced to provide continuity across the building floor and foundation elements. The objective is to provide additional capacity in the floor slab and enhance its ability to redistribute loads, if necessary, during large seismic events. All pile heads need to be adequately tied into the floor slab. An alternative approach could be to utilise the NZS3604 suspended wooden floor system founded directly onto the deep driven timber piles.

During detailed foundation design particular attention should be given to detailing the connections of buried services (water and sewer pipes, power conduits, etc.) between the house foundation and the in situ ground. The design should allow sufficient movement and ductility to account for seismic shaking and liquefaction induced movement, and to allow for easy reinstatement in the event of future damage.

Due to the depth of gravel layer on the southern section, we do not currently recommend using deep piles in this area.

To provide site specific geotechnical information for use in foundation design in TC2 areas it is recommended that a site specific geotechnical assessment be carried out by suitability qualified chartered engineer with experienced in residential house development in accordance with the MBIE guidelines.

# 4.6 Soft to Firm Clayey Silty Soils

Soft to firm clayey silty soils may be encountered at relatively shallow depths in most of the southern side of the site and in isolated pockets of the northern side of the site. Based on investigation logs we have split the site into two Zones as follows:

- Zone A there is potential for soft silt layers being present at 2m depth with thicknesses between 0.3m and 1.0m. There is also another soft layer from 3m with thicknesses up to 2m.
- Zone B there is potential that soft silt layers will be present in isolated pockets across this part of the site.

The approximate areas of these zones are shown on Figure 9 in Appendix A.

Based on the available investigation logs it is unlikely that shallow bearing for a typical house foundation of 300kPa could be achieved in these areas. Therefore if these soils are encountered 'Good Ground' as per NZS3604 will not be met and specifically designed foundations will be required based on the building consent investigations.

However, based on our analysis typical TC2 type waffle or beam grid type systems should be suitable as foundation elements. The calculated long term consolidation settlement induced by foundation loading is likely to be within acceptable limits of the NZ Building Code (i.e settlement less than 25mm

over 6m). However as this is a subdivision area wide geotechnical report and in line with MBIE guidelines bearing capacities must be confirmed during the detailed house design.

# 4.7 Council Vested Infrastructure

For the area identified as TC1 no specific liquefaction mitigation measures are required for Council vested infrastructure. The potential effects of liquefaction will need to be considered when designing the Council vested infrastructure in TC2 areas.

This section describes the proposed liquefaction mitigation measures for the infrastructure at Rosemerryn Stages 10 to 18 in the areas classified as TC2 only (see Figure 8). The proposed liquefaction mitigation measures are in line with the Christchurch City Council Capital Programme Group Technical Memorandum *Earthquake Learnings – Amendments to the IDS and the CSS for Pipes Infrastructure in Christchurch City, to Mitigate Against Future Earthquake Damage*'.

# 4.7.1 Buried Structures

In order to minimise lifting / floatation all buried services founded below design groundwater level as manhole risers, pump station chamber, etc. should be designed to have neutral buoyancy and to resist the uplift forces associated with liquefied soil, not just groundwater buoyancy forces. Spaces around buried structures should be backfilled with free draining, granular, non-liquefying fill in order to alleviate pore water pressure build up during a large seismic event thereby reducing the potential for liquefaction in the soils immediately surrounding the buried structure.

Manhole inverts and pipe entry and exit levels should be designed to accommodate liquefaction induced differential settlements. The hydraulic design of the pipes entering and exiting the manhole risers should be designed to accommodate up to 50mm on the northern section and 115mm on the southern section of vertical movement both up and down. Manhole risers should have strap rings to hold the manhole riser sections together in order to reduce lateral displacement of the manhole risers. Additionally, manhole connectors with greater than 90mm sealing lengths should be used to minimise the potential for joint pull-out.

It is recommended that the finalised design of each buried service (manhole riser, pump station, etc.) is confirmed on a case by case basis during construction once the site specific ground conditions are identified, in particular if the infrastructure element is being founded directly into gravel.

# 4.7.2 Pipe and Service Conduits

In line with the Christchurch City Council Capital Programme Group Technical Memorandum, all pipes and service conduits should be made from flexible material (e.g. plastic) where practicable. For gravity reticulated sewer lines, all pipe joints and intersections with manhole risers should be installed with short slip collars to allow greater capacity of joint movement and increase joint resilience. Pressurised sewer lines should be constructed from PE pipe and should have end restraints at pump stations. Well-designed end restraints combined with the PE pipe material itself will improve the resilience of the pressure line and help prevent damage.

As noted above, for hydraulic pipes (sewer, stormwater, and possibly reticulated water), the pipe sizes and gradients should be designed in such a way that they can accommodate post liquefaction differential settlement, both positive and negative. Differential settlements of 50 in the northern section and 115mm in the southern section should be used for design.

All pipes and conduits should be founded into the non-liquefiable crust material where possible. If the founding depth of the pipes and conduits extends down to liquefiable silty sandy material the service trenches should be backfilled with non-liquefiable geotechnically competent fill.

All service trenches located below the water table should be lined with a geosynthetic filter fabric material (i.e. Bidim A19 or similar) to separate potentially liquefiable soils from non-liquefiable granular bedding and backfill material. For shallow service trenches founded above the water table, a filter fabric is not required but is generally recommended.

By providing a filter fabric and filling the service trenches with non-liquefiable geotechnically competent fill the trench backfill is non-liquefiable and will therefore limit liquefaction induced settlement or flotation. Additionally, if a pipe was to rupture, by having a filter fabric encasing the bedding material there is less likelihood of sand material infiltrating into and blocking the pipeline.

## 4.7.3 Pavements

At this stage it is inferred that the pavement is unlikely to be significantly affected by seismically induced liquefaction. However, to ensure robustness of the pavement following a liquefaction inducing major earthquake it is recommended that the pavement be designed to accommodate the potentially adverse effect of seismically induced liquefaction. The pavement should be designed in such a way that it can bridge any localised voids / settlements that may be caused by seismically induced liquefaction, and prevent liquefiable soil from penetrating into the pavement structure.

If subsoil drains are to be installed as part of the subdivision development for stormwater control, then it is recommended extending the subsoil drainage under the foot print of the roading network. Drainage will increase the thickness of non-liquefied crust below the pavement areas as well as the residential sections, thereby minimising the likelihood of liquefaction induced damage.

A geosynthetic filter fabric (i.e. Bidim A29 or similar) should be placed directly onto the in situ subgrade material prior to the placement of the granular sub-base fill to limit fines migration from the subgrade to the sub-base during a liquefaction inducing seismic event and the potential loss of pavement strength.

# 5 Assessment Against the RMA

Section 106 of the Resource Management Act (RMA) states inter alia

... "a consent authority may refuse to grant a subdivision consent, or may grant a subdivision consent subject to conditions, if it considers that:

- a) the land in respect of which a consent is sought, or any structure on the land, is or is likely to be subject to material damage by erosion, falling debris, subsidence, slippage, or inundation from any source; or
- b) any subsequent use that is likely to be made of the land is likely to accelerate, worsen, or result in material damage to the land, other land, or structure by erosion, falling debris, subsidence, slippage, or inundation from any source; or
- c) sufficient provision has not been made for legal and physical access to each allotment to be created by the subdivision."

No erosion was observed on the site. However the silty soils that directly underlie the site are inferred to be potentially susceptible to erosion when left unvegetated. We infer that the site is not susceptible to falling debris or slippage due to the topographical location.

It is noted that issues surround stormwater discharge are being dealt with in the detailed civil engineering design by Davie Lovell-Smith and any potential "inundation" susceptibility due to stormwater is being addressed as part of the detailed subdivision civil engineering design.

Due to the potential for seismically induced liquefaction, we infer that parts of the site are potentially susceptible to varying degrees to subsidence and inundation from liquefaction. However, if the appropriate liquefaction mitigation measures, as outlined in this report, are undertaken, then the risk of subsidence and inundation from liquefaction is significantly reduced to an acceptable (TC1 or TC2) level as defined by the MBIE. Therefore, if appropriate liquefaction mitigation measures are implemented in or opinion the site will be free of "subsidence", or "inundation". The proposed subdivision development therefore generally complies with the intent of Section 106 (a).

The site is underlain by fine grained soils and there is potential for erosion and rilling from run-off or wind if vegetation cover is removed for prolonged periods of time from both stormwater runoff if it is not discharged in a controlled manner, and from the wind. The susceptibility to erosion of the silty soils can be minimised by using appropriate industry standard design measures during construction.

The site has been identified as being susceptible to seismically induced liquefaction and hence has the potential for "subsidence", "and "inundation." Provided that appropriate liquefaction mitigation measures are implemented, as recommended in this report, subsequent use of the land following development is unlikely to accelerate, worsen, or result in material damage to the land, other land, or structures. In our opinion therefore, the development will comply with the intent of section 106 (b).

Section 106 (c) is not directly relevant to a geotechnical appraisal and therefore has not been considered in detail in this report.

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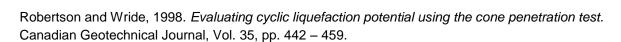
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# 7 Limitations

We have prepared this report in accordance with the brief as provided. The contents of the report are for the sole use of the Client and no responsibility or liability will be accepted to any third party. Data or opinions contained within the report may not be used in other contexts or for any other purposes without our prior review and agreement.

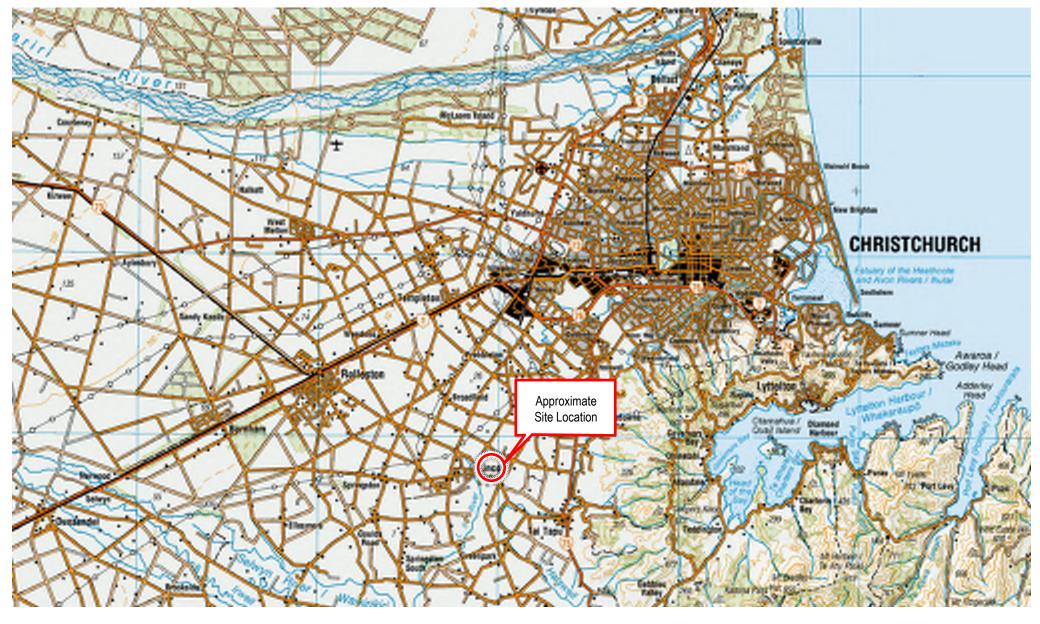
The recommendations in this report are based on data collected at specific locations and by using appropriate investigation methods with limited site coverage. Only a finite amount of information has been collected to meet the specific financial and technical requirements of the Client's brief and this report does not purport to completely describe all the site characteristics and properties. The nature and continuity of the ground between test locations has been inferred using experience and judgment and it must be appreciated that actual conditions could vary from the assumed model.

Subsurface conditions relevant to construction works should be assessed by contractors who can make their own interpretation of the factual data provided. They should perform any additional tests as necessary for their own purposes.

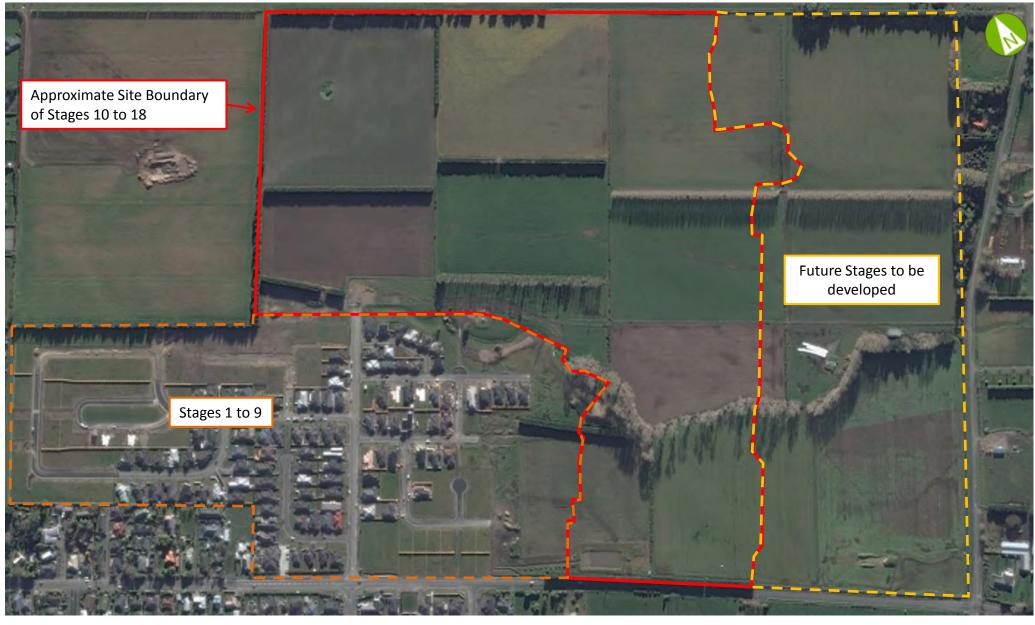
Subsurface conditions, such as groundwater levels, can change over time. This should be borne in mind, particularly if the report is used after a protracted delay.

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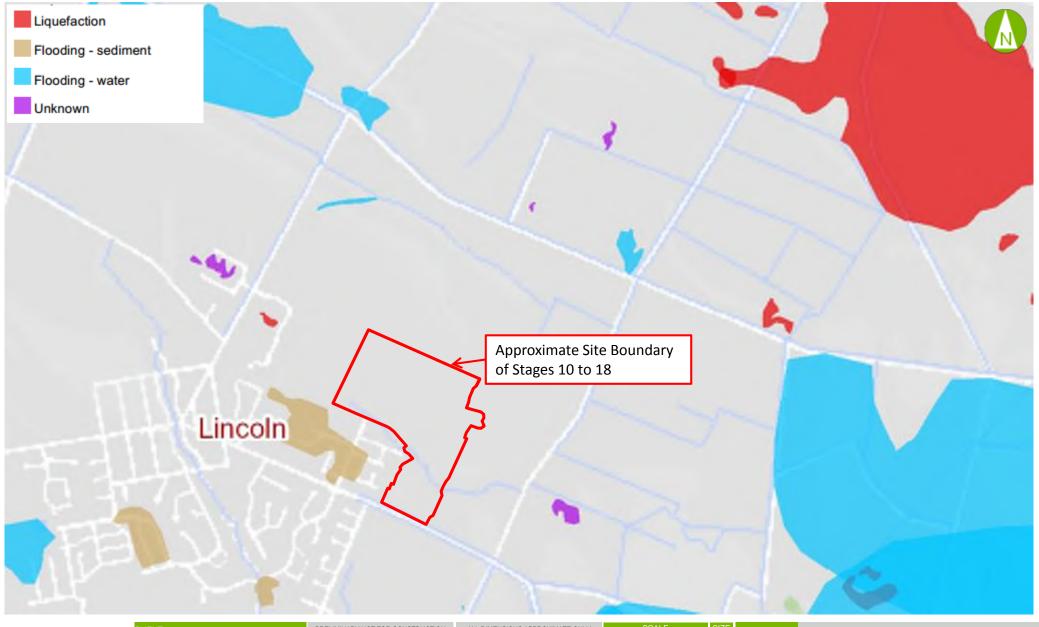
# Appendix A Figures



CLIENT	PRELIMINARY NOT	FOR CONSTRUCTION	ALL DIMENSIONS APPROXIMATE ONLY	SCALE	SIZE					TION		
				NTS	A4	TITLE	REGIONAL LOCATION PLAN					
aurecon Fulton Hogan	FIGURE		FIGURE 1				BACKGROUND SOURCED FROM LINZ CROWN COPYRIGHT					
				APPROVED J. KUPEC		REFERENCE	RESERVED					
www.aurecongroup.com	PROJECT	ROSEMERRY	XYN STAGES 10 TO 18	DATE		FIGURE No.	PROJECT	WBS	TYPE	DISC	NUMBER	REV



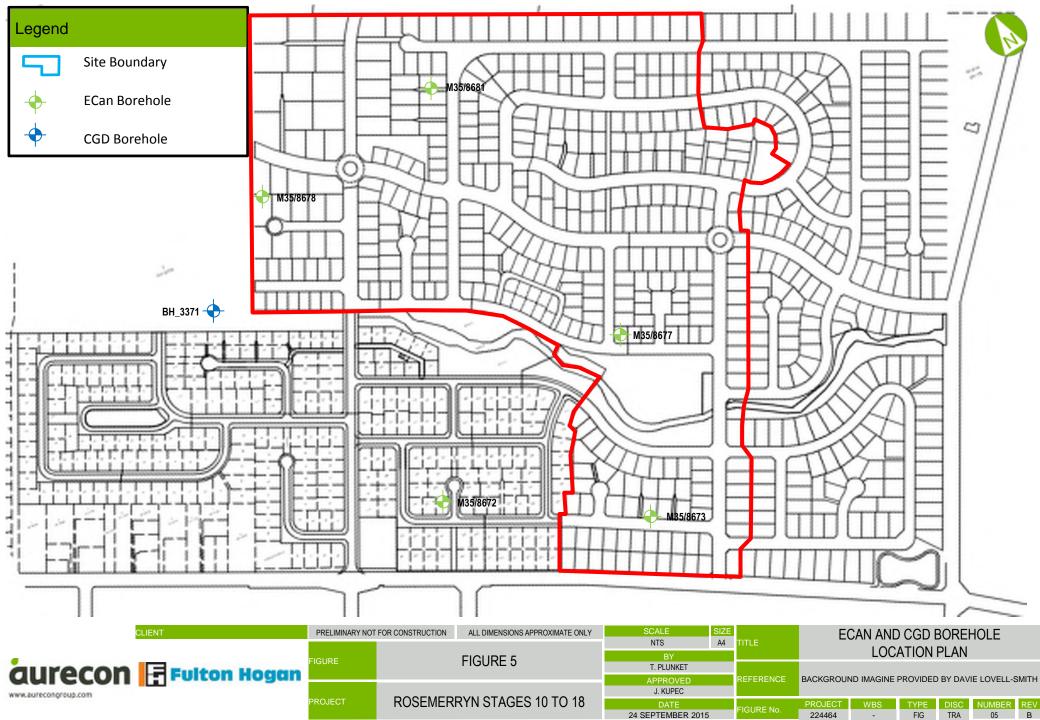
	CLIENT	PRELIMINARY NOT	FOR CONSTRUCTION	ALL DIMENSIONS APPROXIMATE ONLY	SCALE	SIZE								
	CON Fulton Hogan				NTS	A4	TITLE	SITE OVERVIEW						
		FIGURE		FIGURE 2				BACKGROUND IMAGINE SOURCED FROM CANTERBURY MAPS.						
aurecon					APPROVED		REFERENCE							
www.aurecongroup.com		PROJECT			J. KUPEC			COFTRIGHT RESERVED. IMAGE TAKEN ON 23 FEBRUART 2011.						
			RUSEMER	RYN STAGES 10 TO 18	DATE		FIGURE No.	PROJECT	WBS	TYPE	DISC	NUMBER	REV	
					24 SEPTEMBER 2015	5	HOULE NO.	224464	-	FIG	TRA	02	В	

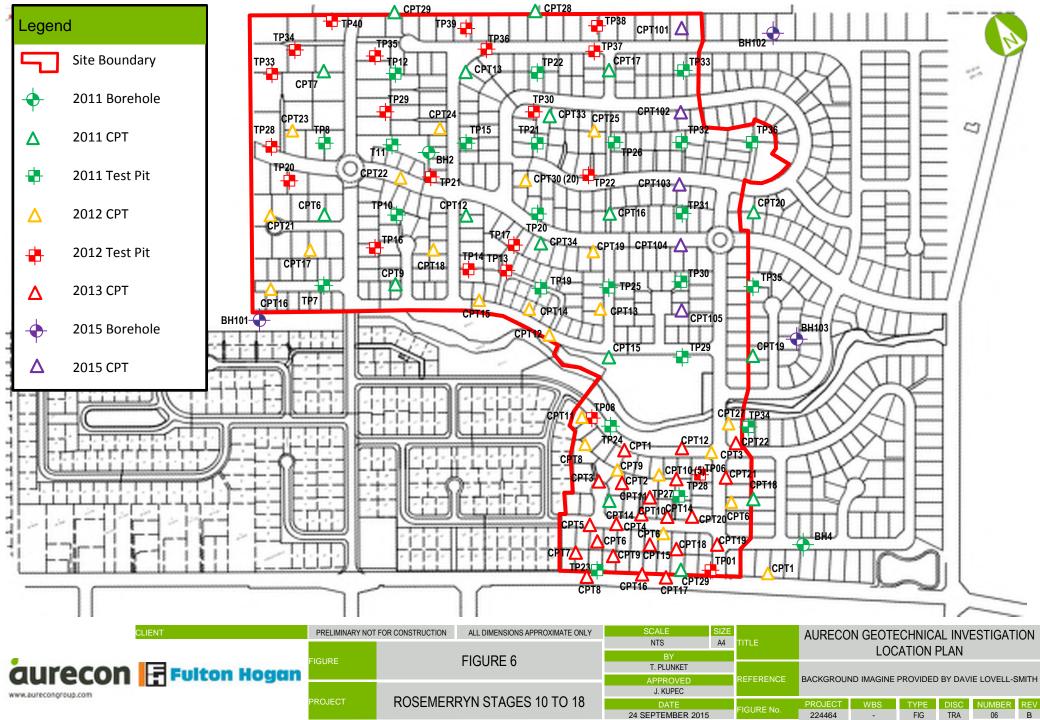


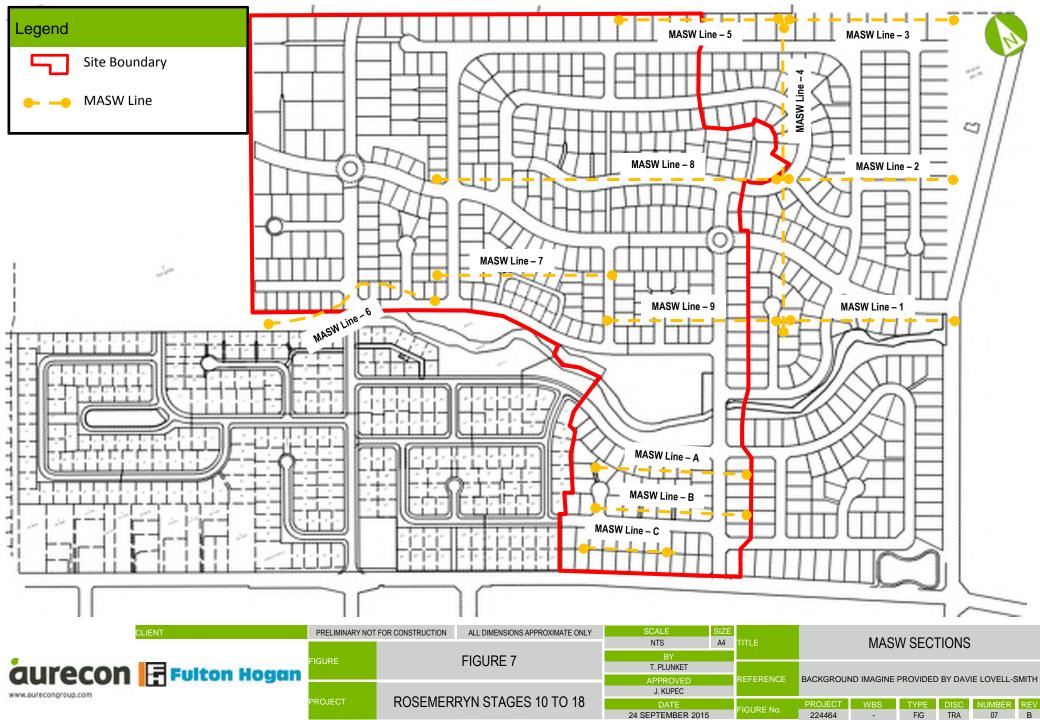
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	Fulton Hogan		FIGURE 3		NTS	A4	TITLE	THE 4 SEPTEMBER 2010 EARTHQUAKE						
aurecon		FIGURE			T. PLUNKET			BACKGROUND IMAGINE SOURCED FROM CANTERBURY MAPS.						
www.aurecongroup.com		PROJECT			APPROVED J. KUPEC		REFERENCE	COPYRIGHT RESERVED						
			ROSEMERRYN STAGES 10 TO 18		-	FIGURE No.	PROJECT	WBS	TYPE	DISC	NUMBER	REV		

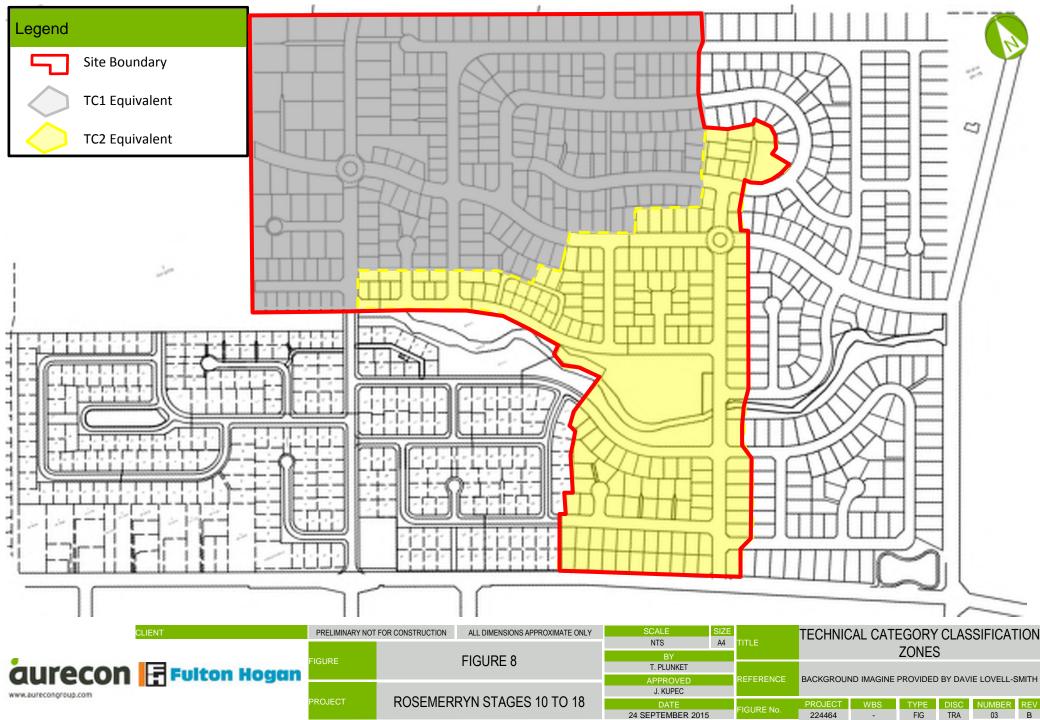


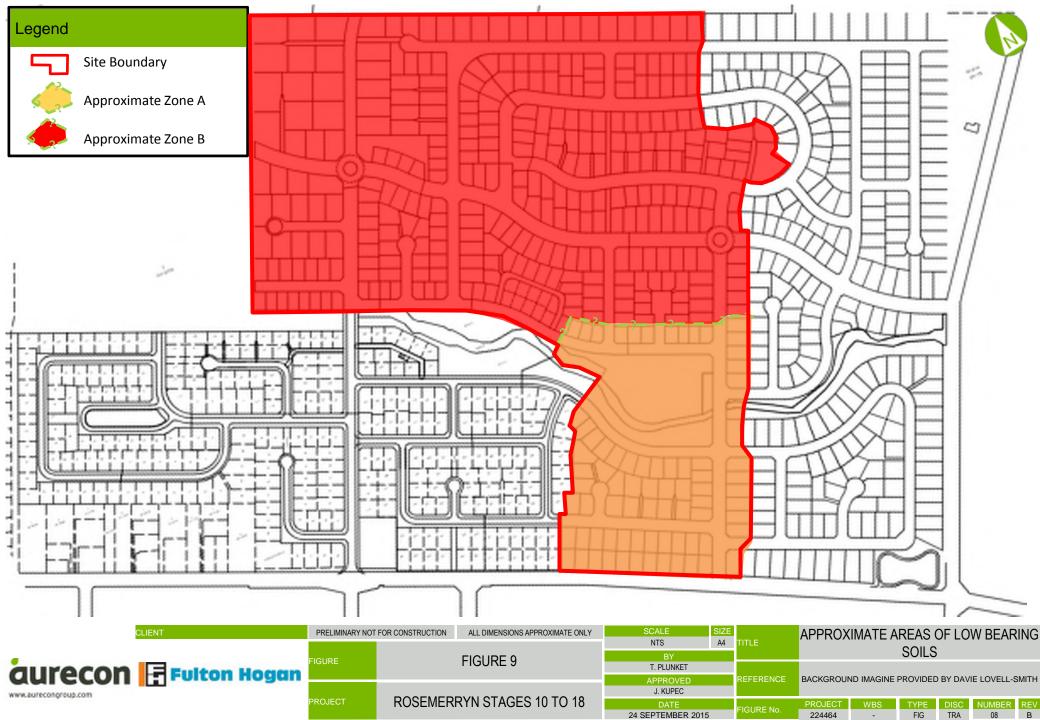
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					NTS	A4	TITLE	THE 22 FEBRUARY 2011 EARTHQUAKE					
	Eulton Hogen	FIGURE		FIGURE 4				BACKGROUND IMAGINE SOURCED FROM CANTERBURY MAPS.					
	E Porton nogun				APPROVED J. KUPEC		REFERENCE	COPYRIGHT RESERVED					
		PROJECT	ROSEMERRYN STAGES 10 TO 18		DATE		FIGURE No.	PROJECT	WBS	TYPE	DISC	NUMBER	REV
				24 SEPTEMBER 201	5	FIGURE NO.	224464	-	FIG	TRA	05	В	



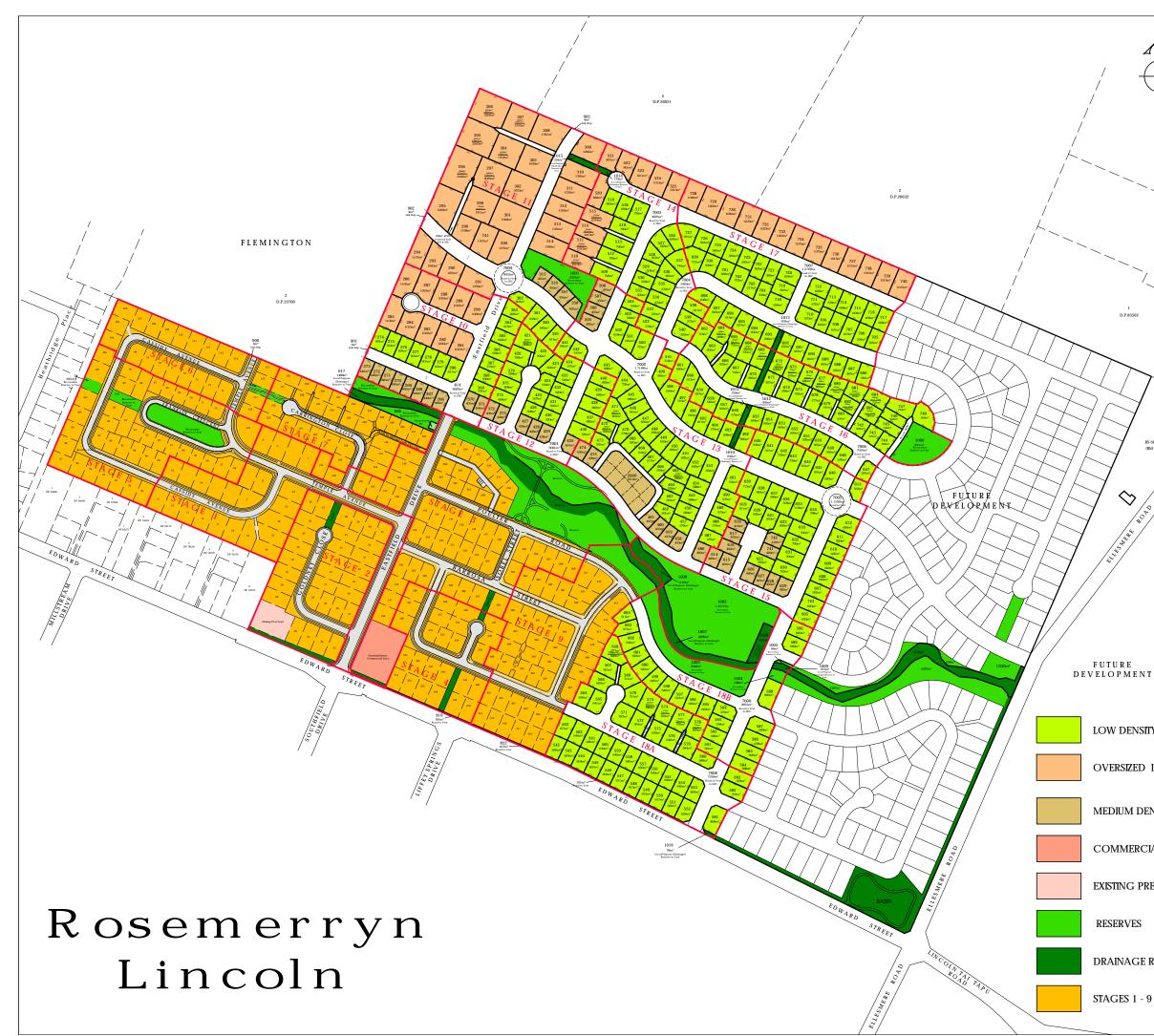








# Appendix B Provided Davis Lovell Smith Drawings



#### NOTES :

- 1) Areas and dimensions are subject to final survey and deposit of plans.
- 2) Service easements to be created as required.
- This plan has been prepared for subdivision consent purposes only. No liability is accepted if the plan is used for any other purpose.
- Any measurements taken from information which is not dimensioned on the electronic copy are at the risk of the recipient.
- 5) This plan is subject to the granting of subdivision and/or resource consents and should be treated as a proposal until such time as the necessary consents have been granted by the relevant authorities.

	No of Lots	Total Area	Average
Large Lot/Oversized	58	7.1630ha	1235m²
Low Density	290	18.1243ha	624.9m²
Medium Density	52	2.2169ha	426.3m²

	STAGES 1-9	STAGES 10-18B	FUTURE DEVELOPMENT			
TOTAL AREA	25.9302ha	40.7332ha	25.0592ha			
NET AREA	24.5204ha	39.9733ha	23.7586ha			
LOTS	267	400	241			
LOTS/ha	10.888	10.006	10.143			
OVERALL LOTS/ha	10.288 Sites /ha					

STAGES 10-18B SCHEDULE OF A	REAS
Description	Area
Residential Lots	27.5042ha
Roading	9.6245ha
Reserve	2.5360ha
Drainage Reserve	6167m <sup>2</sup>
Right of Way	3589m <sup>2</sup>

40.6403ha

Total Area: 91.7226ha

Comprised in: CFR 608420





 116 Wrights Road
 P O Box 679
 Christchurch 8140.
 New Zealand

 Telephone: 03 379-0793
 Website: www.dls.co.nz
 E-mail: office@dls.co.nz

JOB TITLE :

Fulton Hogan Limited Edward Street, Lincoln

SHEET TITLE :

Proposed Subdivision of Lot 703 DP 461935

DRAWING STATUS

Density F	Purposes
-----------	----------

	SCALE : 1:5000@A3 1:2500@A1 DATE : July 2015						
Е	CAD FILE: J:\17001\S17001 STAGING PLAN_R18.dwg REVISION :						
	DRAWING No :	SHEET No :	<b>D10</b>				
	S.17001		R18				

LOW DENSITY LOTS

RS 6016 (BM 73)

 $\diamondsuit$ 

OVERSIZED LOTS

MEDIUM DENSITY SITES

COMMERCIAL SITE

EXISTING PRESCHOOL

RESERVES

DRAINAGE RESERVES

STAGES 1 - 9 COMPLET

# Appendix C ECan Borehole Logs

Borelog for well M36/8672 Gridref: M36:69507-29314 Accuracy : 2 (1=high, 5=low) Ground Level Altitude : 9.45 +MSD Driller : not known Drill Method : Rotary/Percussion Drill Depth : -6m Drill Date : 9/10/2008



Scale(m)	Water Level Depth(m)	Full Drillers Description	Formation Code
	-0.20m	Dark Grey loamy topsoil	
0.2		Grey mottled with yellow silty clay mixed with grey silty	
0.4		sand	
0.6			
0.8			
-11	-1.00m _	Grey puggy silt mottled with orange/yellow rust	
-1.2		discoluration	
-1.4			
1.6			
1.8			
-22			
2.2	-2.20m		
	-	Grey sandy silt mixed with grey clayey silt. Clay faction increasing	
2.4		literedening	
2.6			
2.8			
-33			
-3.2			
-3.4			
-3.6			
-3.8			
-44			
4.2			
4.4			
4.6			
4.8	-4.80m		
-55	-	Grey mottled with orange brown clayey silt with pieces of timber <100mm diameter	
5.2			
-5.6			
-5.8			
	-6.00m _		

Borelog for well M36/8673 Gridref: M36:69764-29180 Accuracy : 2 (1=high, 5=low) Ground Level Altitude : 8.67 +MSD Driller : not known Drill Method : Rotary/Percussion Drill Depth : -6m Drill Date : 9/10/2008



Scale(m)	Water Level	Depth(m)		II Drillers Description	Format Co
0.2	-	0.20m	Da	ark grey loamy topsoil	
		_	So	ft light grey, mottled with orange, silty clay	
0.4					
0.6					
0.8					
-11	-	1.00m _			
1.2			So cla	ft light grey silty clay mixed with soft orange silty ay. Clay content more distict, very soft	
1.4					
-1.6					
-1.8					
-22					
2.2	-	-2.20m		ry coff arey, checkled with erenge, city eley. Mixed	
2.4				ry soft grey, speckled with orange, silty clay. Mixed the minor patches of orange/brown coarse sand.	
2.6			≝` <b>≡</b> =•.* = = = = = = •.•, ≡ ≡ =		
2.8					
			≡≡=∙∙=== ≣テテ・ <u>・・</u> ≡ <u>═</u>		
-33					
-3.2					
3.4					
3.6			===·=== =·====		
-3.8					
-44					
4.2			=•====•		
4.4			≡≡=•,`=== ===•,•,≡≡≡		
4.6			▋▋▋₽・ブ、■■ ■・・・■■■■		
4.8					
-55					
5.2					
5.4					
			≡≡=•;=== ===•,•,≡≡		
5.6					
-5.8			===:•.=== ==••===		
$\bigsqcup$	-	-6.00m _			

Borelog for well M36/8677 Gridref: M36:69828-29433 Accuracy : 2 (1=high, 5=low) Ground Level Altitude : 8.67 +MSD Driller : not known Drill Method : Rotary/Percussion Drill Depth : -5.2m Drill Date : 9/10/2008



Scale(m)	Water Level	Depth(m)		Full Drillers Description	Formatior Code
				Dark grey loamy topsoil	
0.2	-	-0.20m _			
			333333	Grey & yellow silt speckled with orange	
0.4			777777		
0.6		-0.60m	3333333		
0.0		_		Soft grey silty clay speckled with orange	
0.8					
		-1.00m			
-11				Soft blue grey silty clay with pieces of timber	
1.2					
-1.4					
1.6					
-1.0					
1.8					
-22					
2.2					
2.4					
		-2.60m			
2.6				Soft brown yellow silty clay	
2.8	-	-2.80m _			
				Grey gravel	
-33					
3.2					
-0.2					
3.4					
3.6					
3.8					
-44					
4.2					
4.4					
4.6					
4.8					
-4.0					
-55					
		5 20~			
	·	-5.20m _			
l .					

Borelog for well M36/8678 Gridref: M36:69444-29810 Accuracy : 2 (1=high, 5=low) Ground Level Altitude : 10.14 +MSD Driller : not known Drill Method : Rotary/Percussion Drill Depth : -5.2m Drill Date : 9/10/2008



Scale(m)	Water Level Depth(i	m)	Full Drillers Description	Format Co
		2222	Dark grey loamy topsoil	
	-0.20m	m	Light grey & yellow silty clay	
0.4				
_				
0.6				
0.8				
	-1.00m			
-11		0:0:0:	Sandy gravel <70mm diameter	
-1.2				
1.4	-1.40m	D.0.0.1		
		0=0=0=	Silty gravel	
-1.6		1 <u>2020</u>		
1.8	-1.80m			
		0==0==0=	Yellow & grey silty clay with some gravel	
-22		<u>D==0==0==0</u>		
2.2		0==0==0=		
2.4		p==0==0==q		
-2.4		0==0==0==		
2.6	-2.60m		Soft brown yellow silty clay	
2.8	-2.80m			
		0==0==0=	Grey silty gravel	
-33				
3.2		==0==0==d		
3.4		0=0=0=		
		<u> </u>		
3.6				
3.8		0==0==0		
		<u>≕0</u> ≕0≕q		
-44		0==0==0==d		
4.2		0=0=0=		
4.4		b==0==0==d		
-4.4		0=0=0=		
4.6		0=0=0		
4.8		=0=0=d		
_		0==0==0=		
-55		0==0==0==0		
	-5.20m	0-0-0-0		

Borelog for well M36/8681 Gridref: M36:69726-29855 Accuracy : 2 (1=high, 5=low) Ground Level Altitude : 10.14 +MSD Driller : not known Drill Method : Rotary/Percussion Drill Depth : -4.5m Drill Date : 9/10/2008



Scale(m)	Water Level	Depth(m)		Full Drillers Description	Formation Code
				Dark grey loamy topsoil	
0.2		-0.20m _	0==0==0=	Grey & brown silt mixed with gravel. Dry. No sand or small	
0.4			==0==0==d	gravel particles. Max. Gravel size 80mm	
			0==0==0= ==0==0		
0.6			0==0==0=		
0.8			0==0==0 0==0==0		
-11			==0==0==d		
		1.00	0==0==0==0 ==0==0		
1.2		-1.20m _	00.0.	Grey silty sand mixed with gravel. Dry	
-1.4			od		
1.6			0:.0:0.		
			<u>,.ood</u>		
1.8		-1.80m _	<u>0</u>	Grey sandy gravel becoming wet	
-22			0.00		
2.2			2:0:0:		
-2.2			0.0.0		
2.4			0.00		
2.6					
2.8			0.0.0		
2.0			0.00		
-33					
3.2			0.00		
3.4					
3.6					
3.8			0.0.0		
			0.0.0		
-44			0.0.0		
4.2			0 0 0		
4.4			0 0 0		
		-4.50m _			

## Appendix D CGD Borehole Log

		Job Number		
Flie	Unit 4, 502 Wairakei Road, Christchurch		) 181	
LIIO	Unit 4, 502 Wairakei Road, Christchurch PO Box 4597, Christchurch N.Z.	Date Tested	_	
	surveyors   engineers   planners         Ph. (03) 379-4014         Fax. (03) 365-2449			
ourreyere	Tong moore T plannore	Page	v-2012 1 of 2	
CI.		D.P <b>33700</b>	•	
51	SITE INVESTIGATION RECORD			
	Client NZ Plant & Food Research			
	Site: 581 Birches Road, Lincoln	Bore	hole 3	
DEPTH				
[m]	Borehole log		SPT Data	
GL 0.0 - X X X			(uncorrected)	
	Greyish Brown SILT, highly plastic, soft, moist		-	
0.4 -* × ×			-	
- ×				
0.8 <del>-</del> **××	Brownish Grey Mottled Orange Silty SAND.		_	
-,* × × 1.2 - × × ∵ ×	brownish drey motified of ange sinty SAND.		_	
			N=4 (C) 1.5m	
1.6 - x <sup>*</sup> ×			1, 1/ 1, 1, 1, 1	
$-x_{\chi}$			75mm	
2.0 - X × ×	$\nabla$ Water table at 2.1m depth .		_	
$-x \frac{1}{x} x$	<del></del>		_	
2.4 - X × ×			_	
XXX			_	
2.8 - x				
			N=3 (C) 3.0m 0, 1/ 0, 1, 0, 2	
3.2 –	Grey fine-medium SAND, moist-wet.		75mm —	
3.6			-	
			-	
4.0 - 0			-	
0000	Brownish Orange coarse Sandy GRAVEL up to 70mm, some Silt, moist-wet.		_	
4.4			_	
0000			N=30(C) 4.5m	
4.8 - 0 0	Greyish Brown medium-coarse Sandy Gravel, moist-wet		5, 10/ 8, 7, 8, 7	
	Greyish Brown fine-medium-SAND, moist-wet.		75mm	
5.2 - 0 0			_	
	Brownish Grey medium-coarse Sandy GRAVEL up to 70mm.		_	
5.6 - 000			_	
a a a			–	
6.0 – <u>5</u> 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5	See attached test location plan Comments			
Sile Fidii	See attached test location plan Comments			
	Civil Engineer	Date:		

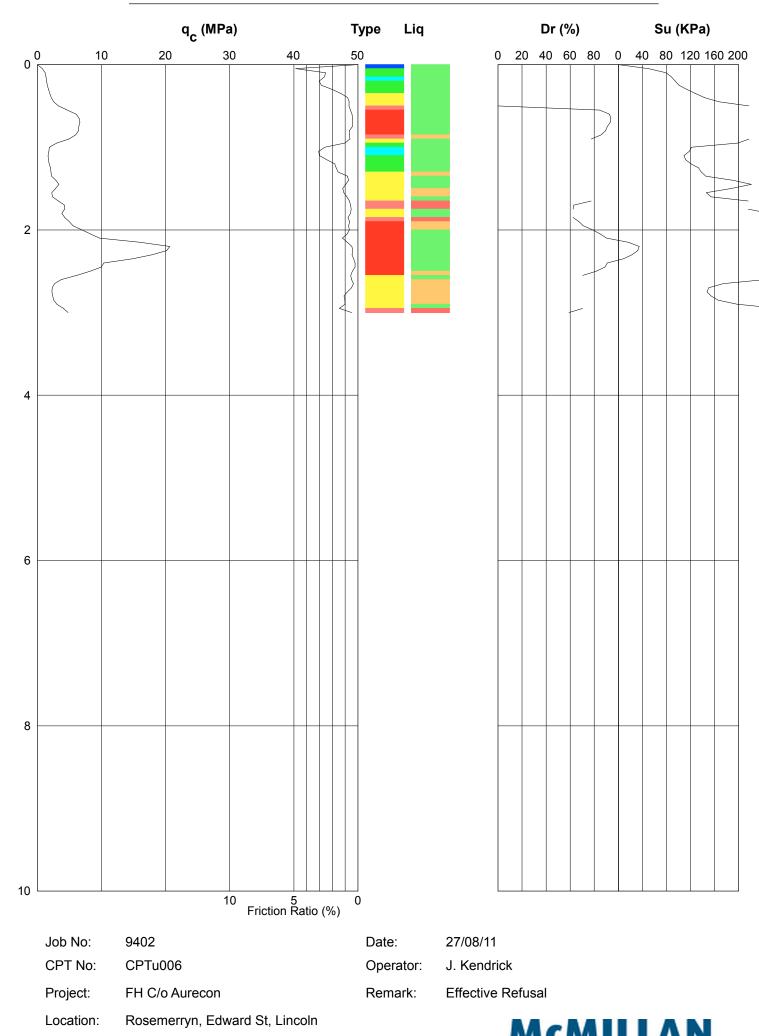
#### Job Number **Eliot Sinclair** 359181 Unit 4, 502 Wairakei Road, Christchurch PO Box 4597, Christchurch N.Z. Date Tested surveyors | engineers | planners 8-Nov-2012 Ph. (03) 379-4014 Fax. (03) 365-2449 Page 2 of 2 D.P 33700 SITE INVESTIGATION RECORD Lot 2 Client NZ Plant & Food Research Project No. Borehole 3

Site: 581 Birches Road, Lincoln

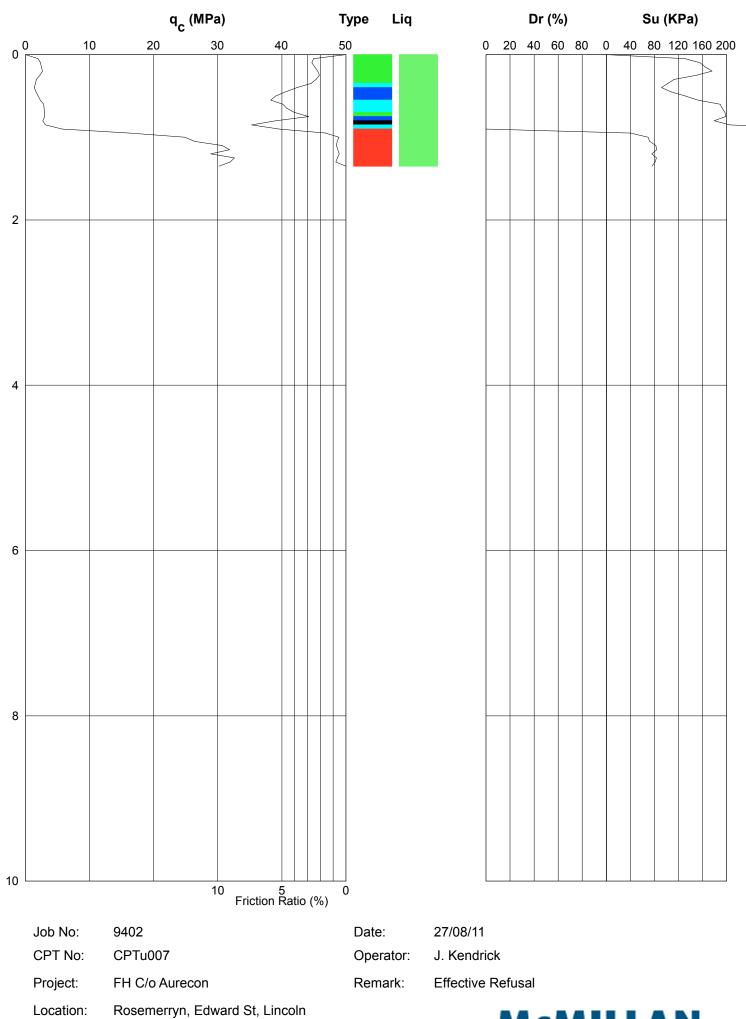
DEPTH

[m]		Borehole log			SPT Data	
GL					(uncorrected)	
6.0 -	Dab Dab					
-	0000				_	
6.4 -	000				N=42 (C) 6.0m	
<u> </u>	1000				4, 8/ 8, 7, 8, 7 75mm	
6.8 -	000				-	
7.2 -	000				-	
	000	Brownish Grey medium Sandy GRAVEL up to 80mm.				
7.6 -	0000				N=24 (C) 7.5m 4, 6/ 7, 6, 4, 7	
_					75mm	
8.0 -					-	
	000				-	
8.4 -	0000				_	
	0000				_	
8.8 -	0000				_	
_	000				-	
9.2 -	000				N=36(C) 9.0m	
9.6 -	000				2, 5/ 9, 8, 10, 9	
9.0	000				75mm	
10.0 -	0000				-	
_	0000				-	
10.4 -					-	
_	0000.				N=49(C) 10.5m	
10.8 -		End of Log at 10.5m depth			7, 9/ 11, 12, 14, 12	
_					75mm	
11.2 -					_	
-					-	
11.6 -					-	
					-	
Site Pl	lan		Comments			
	See attached test location plan					
			Civil Environm	Detc		
l			Civil Engineer	Date:		

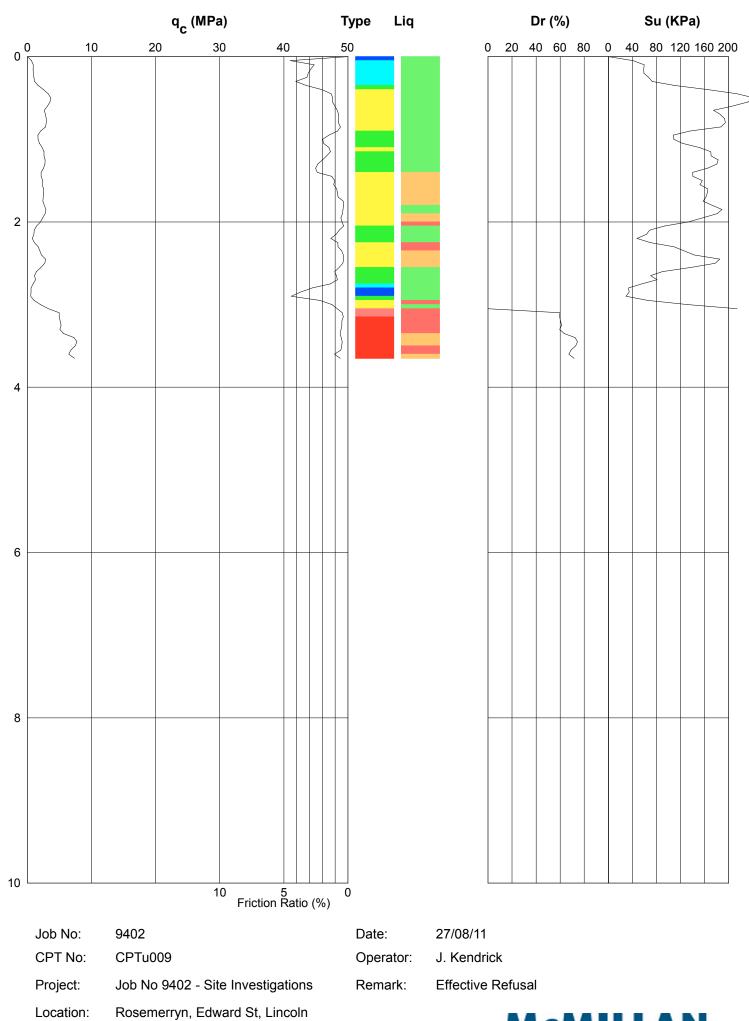
Appendix E CPT Logs



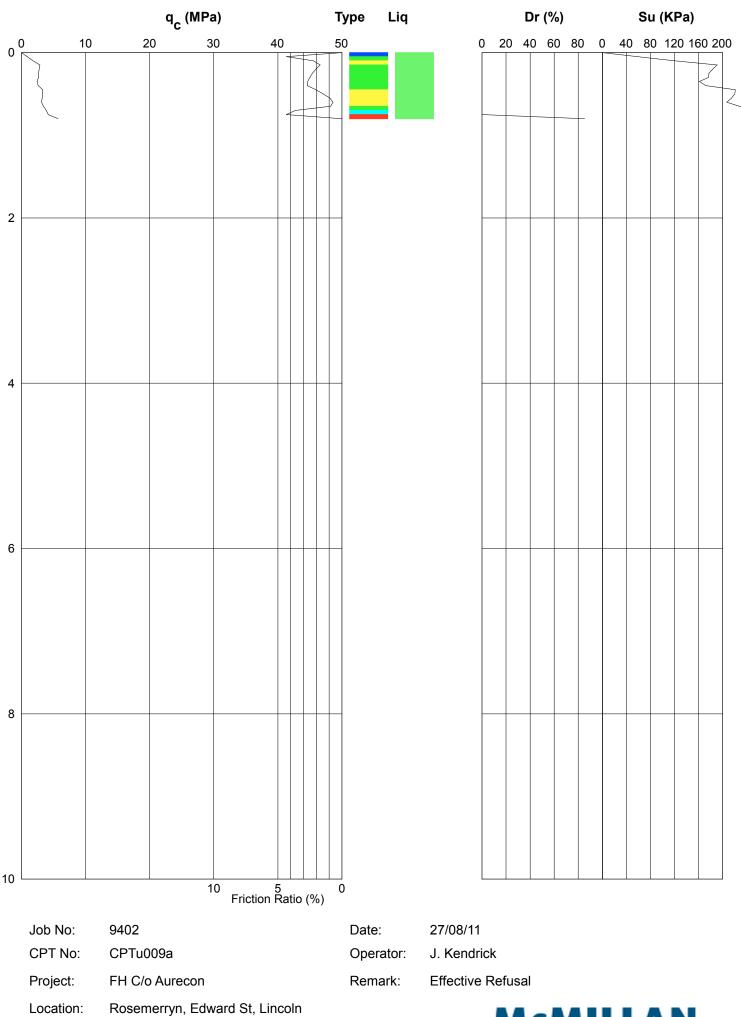
DRILLING SERVICES



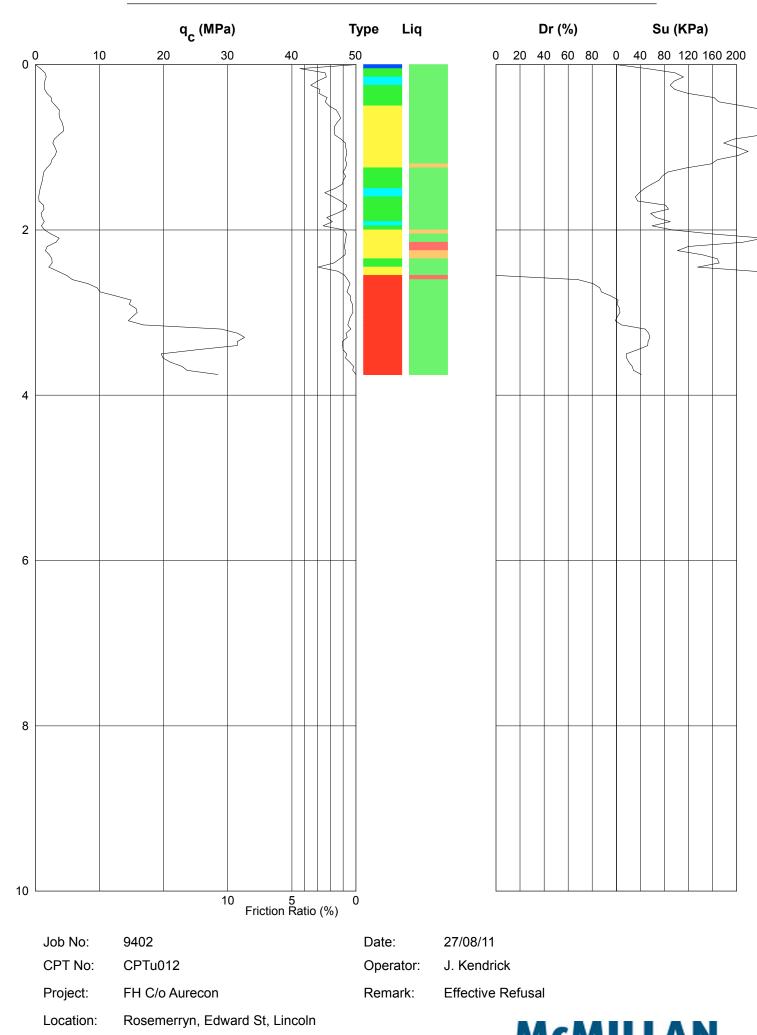
MCMILLAN DRILLING SERVICES



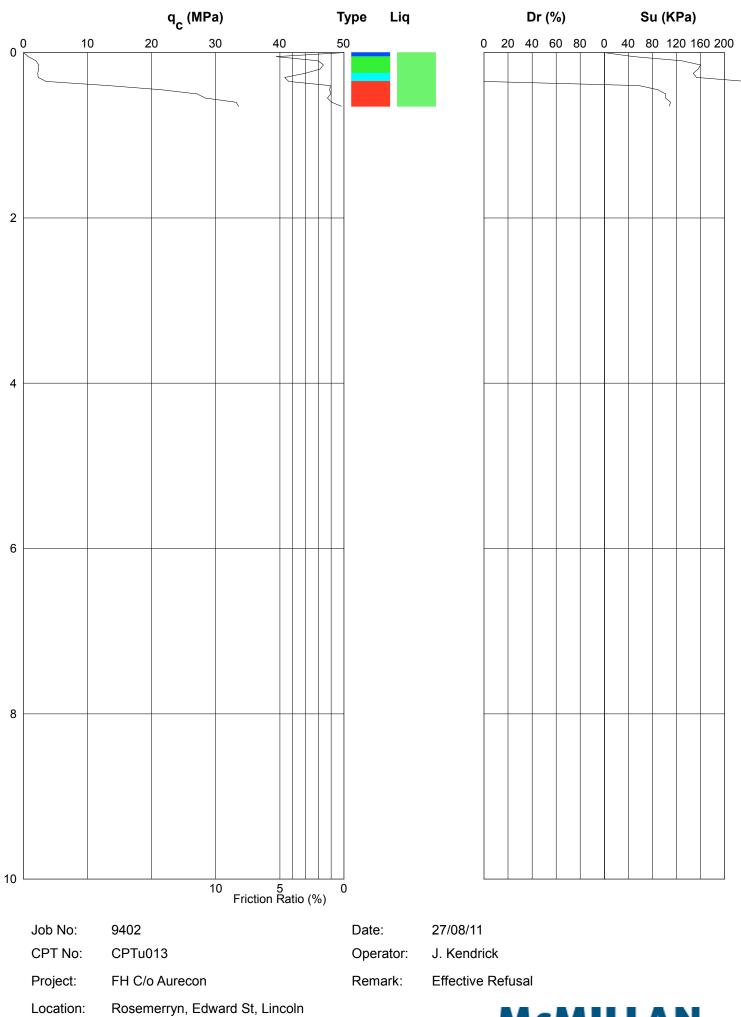




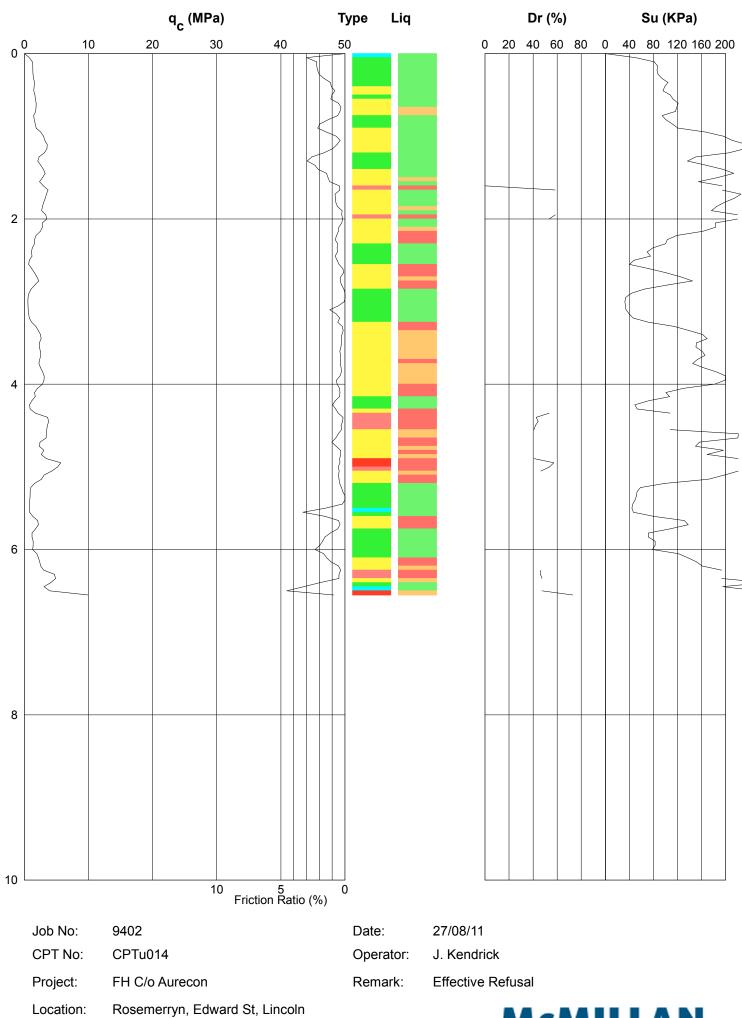
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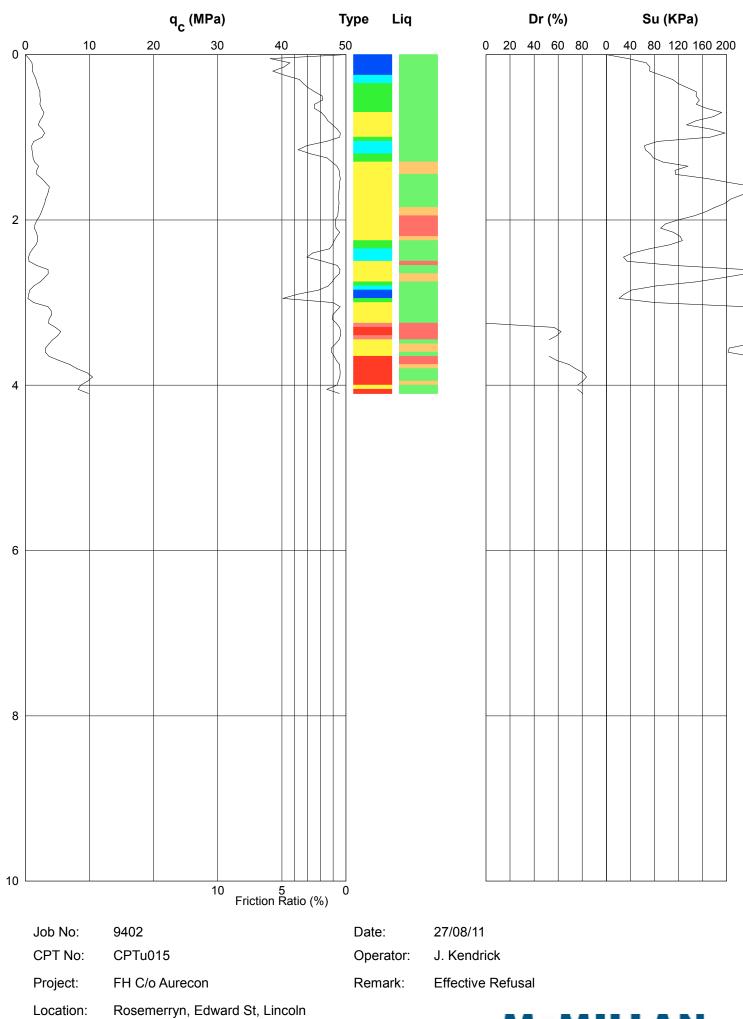
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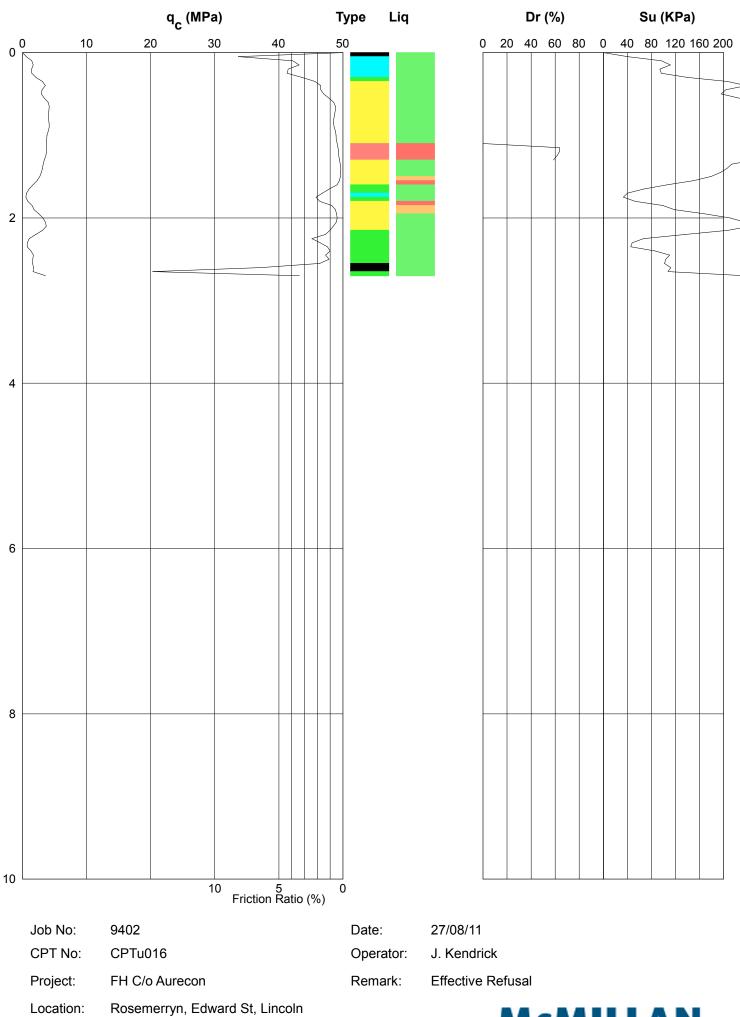




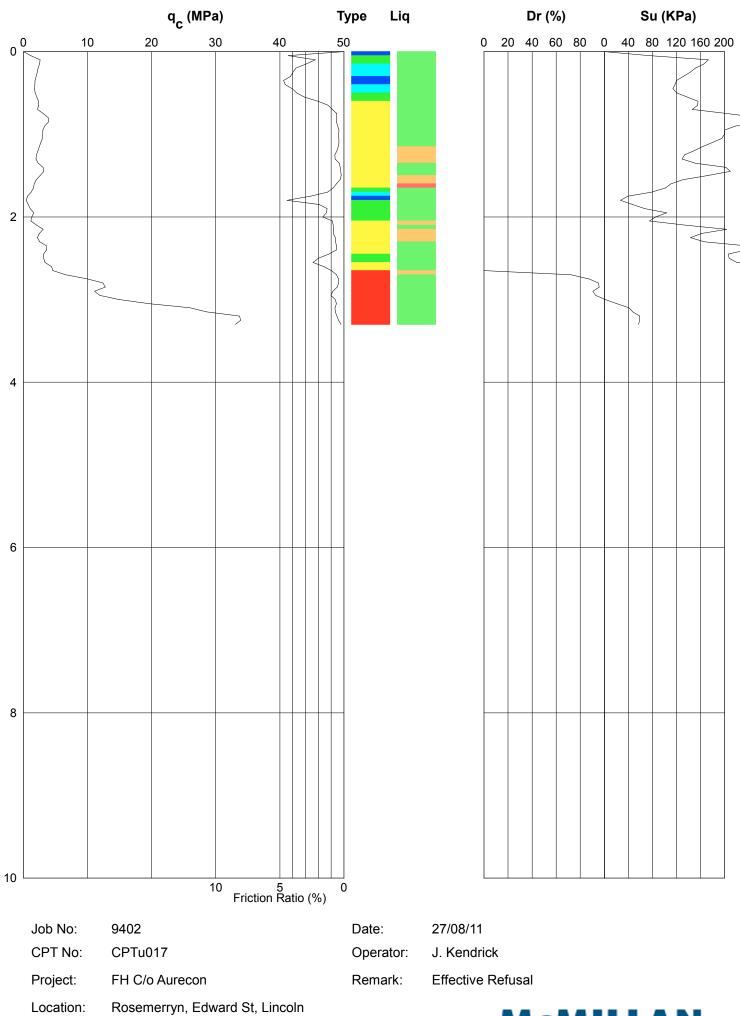




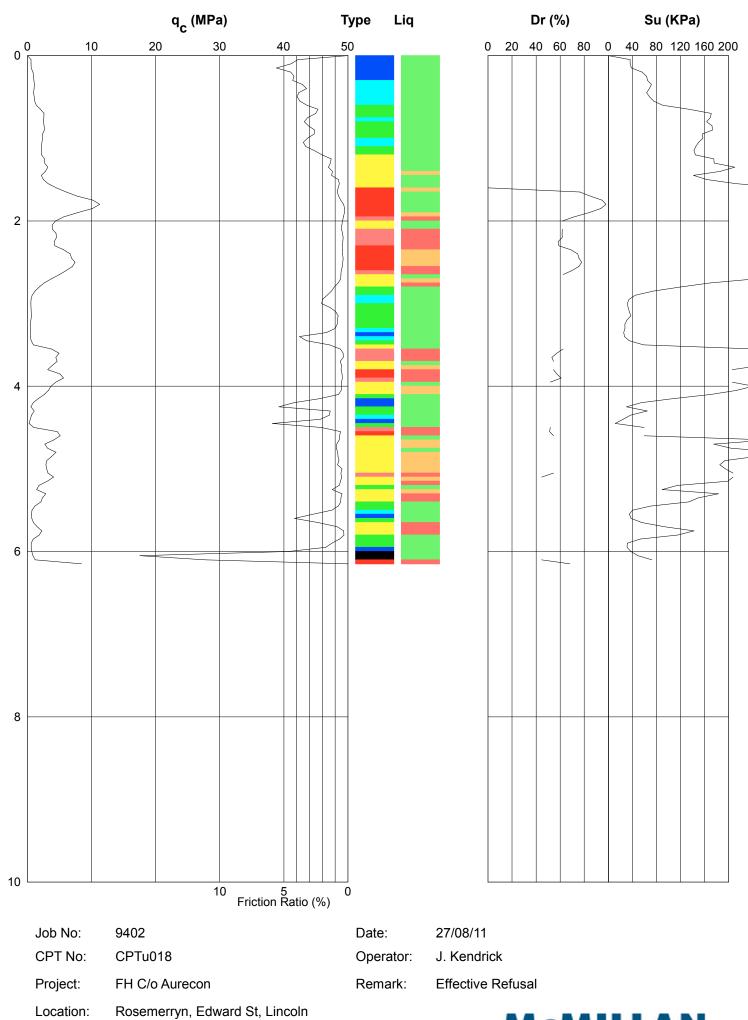




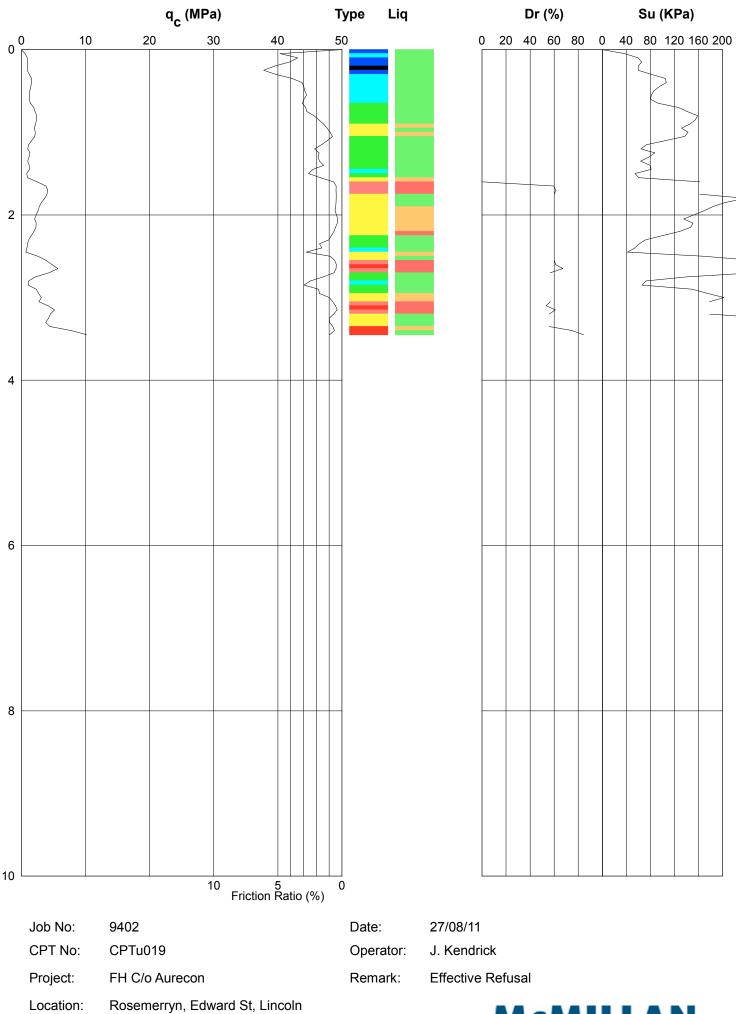
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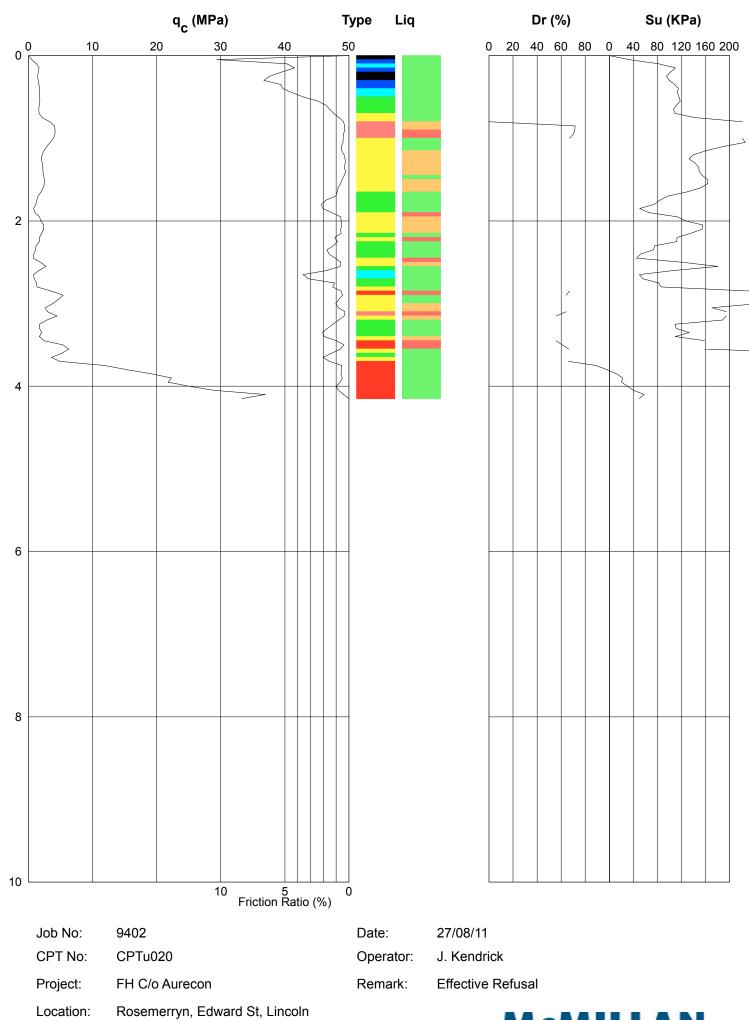




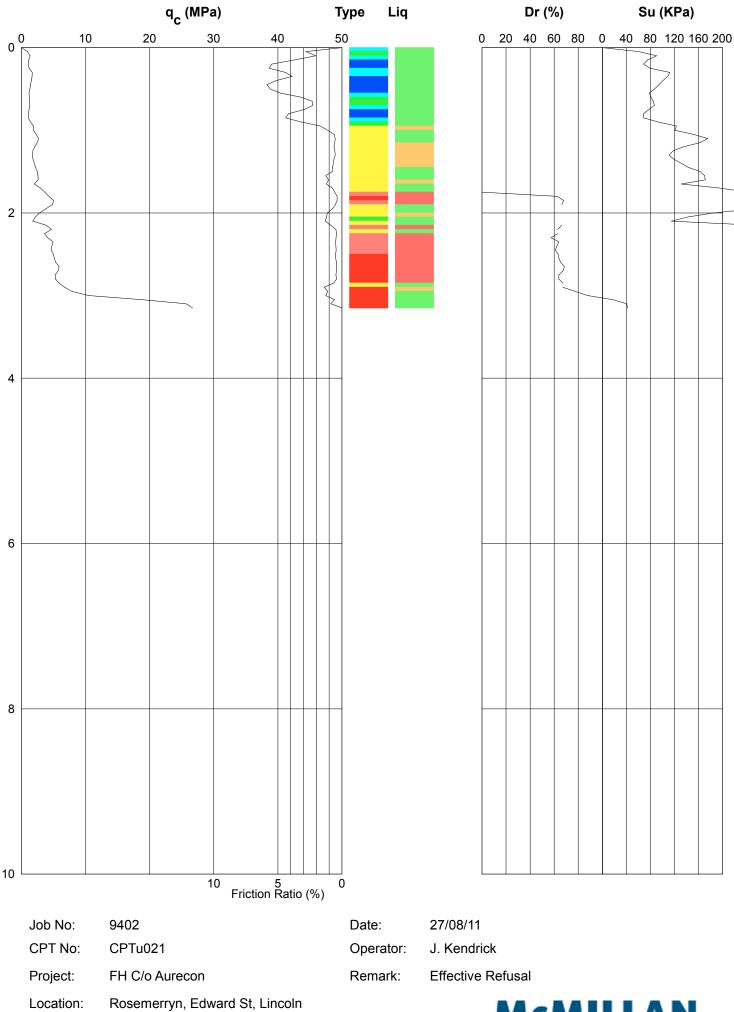




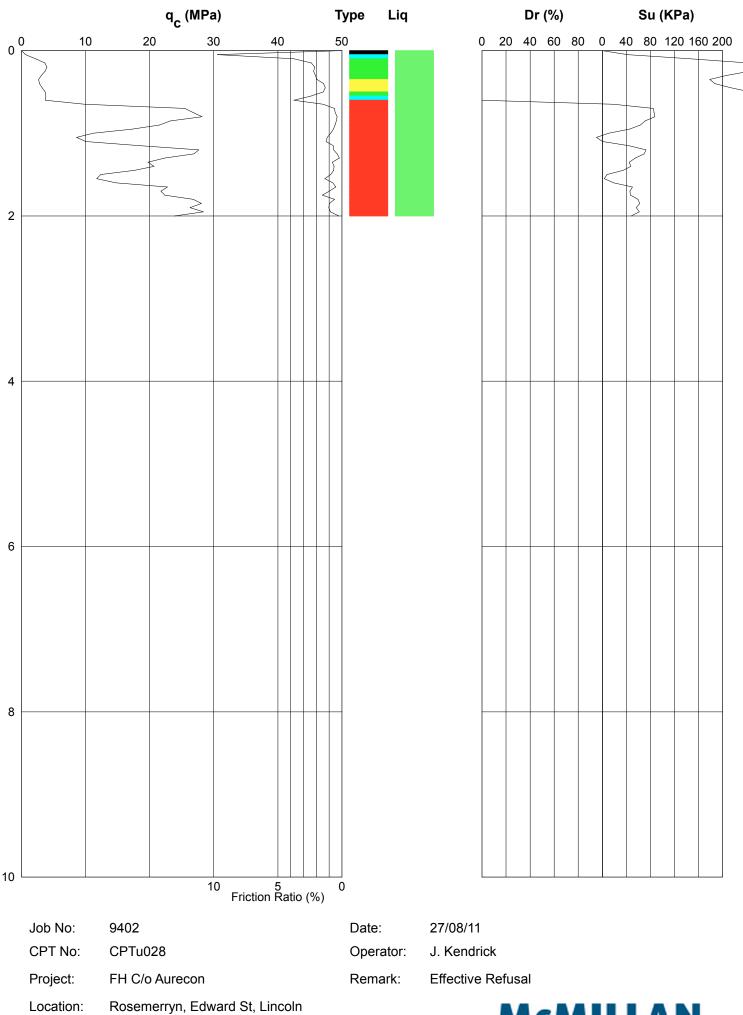
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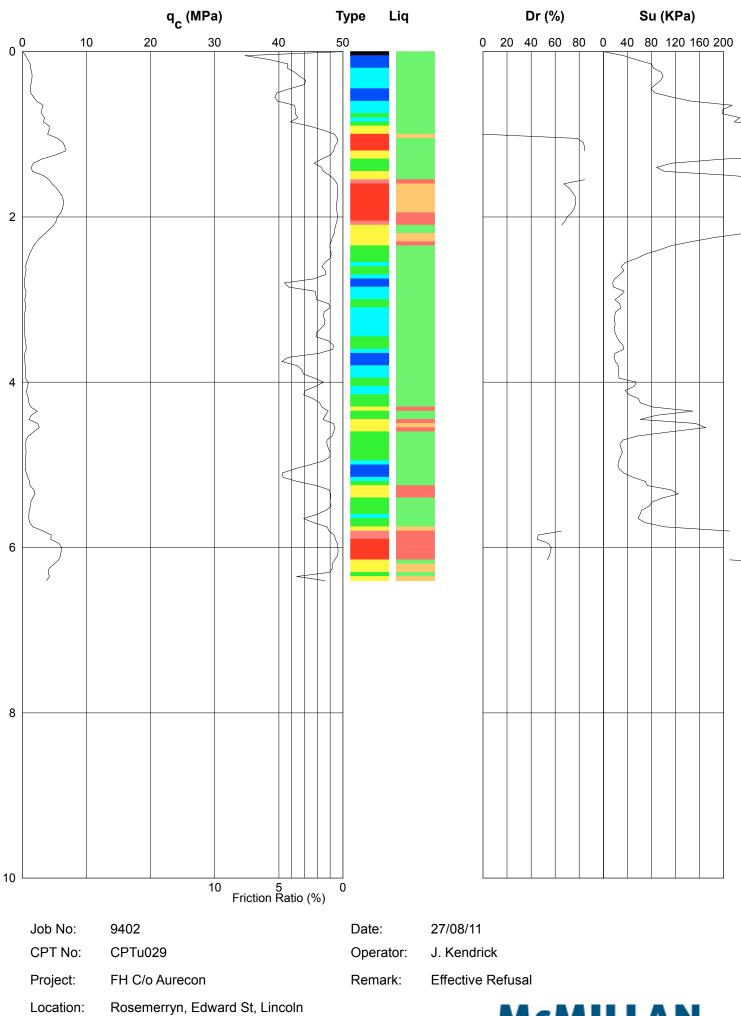




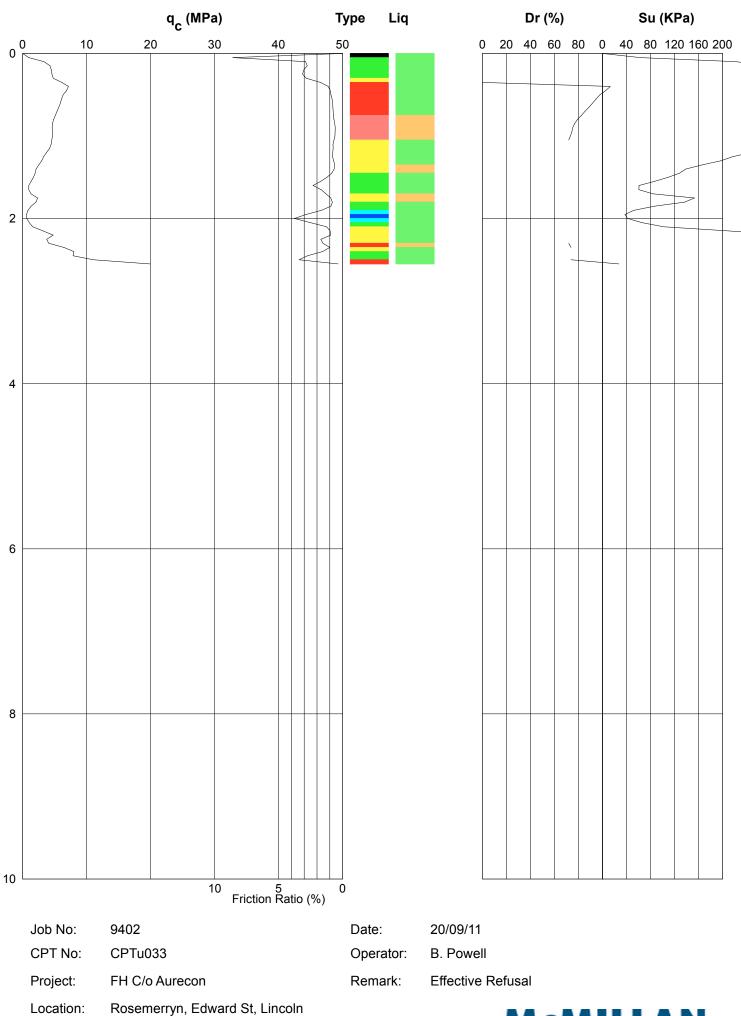
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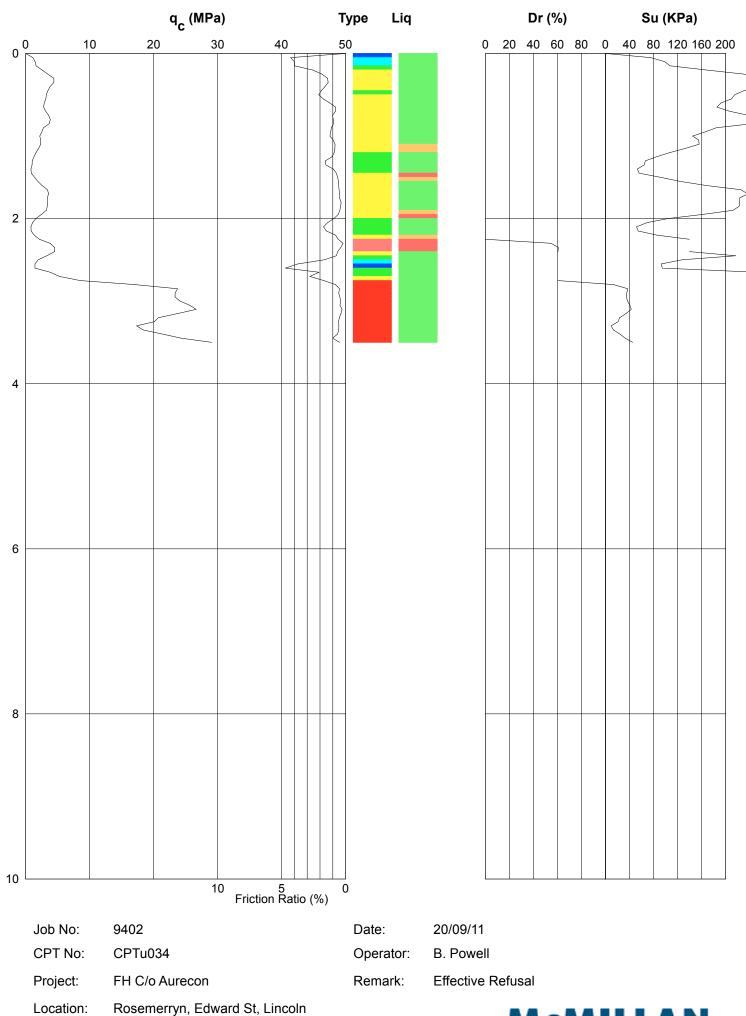




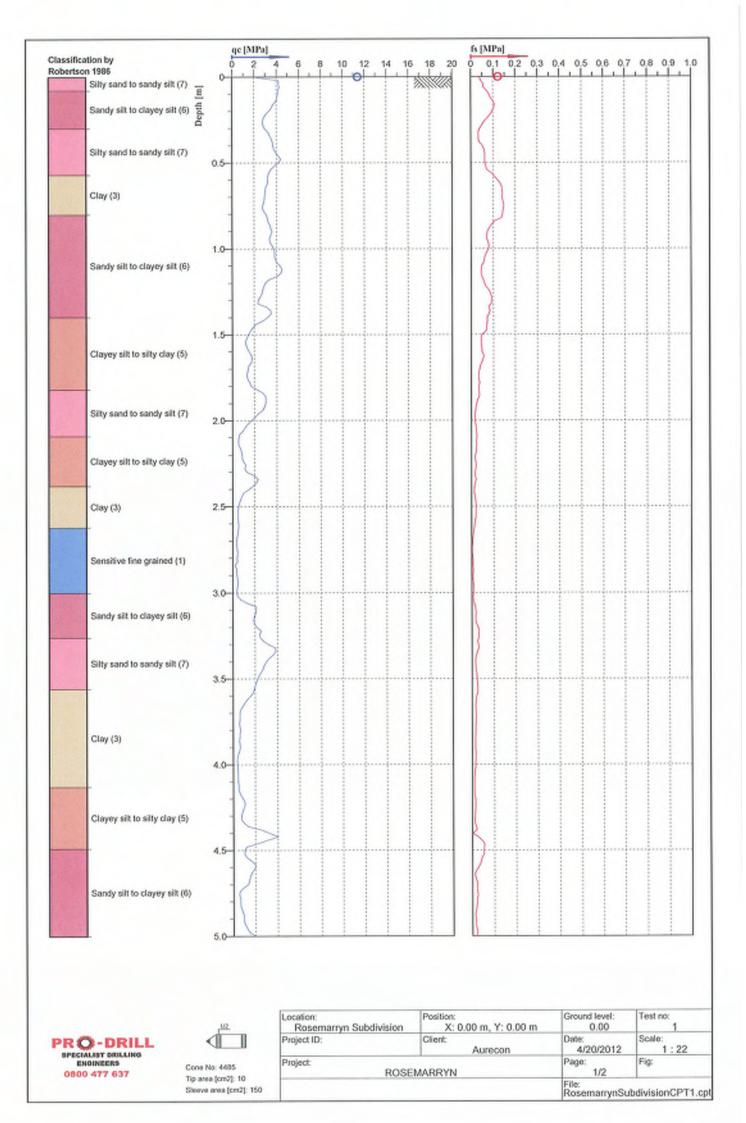
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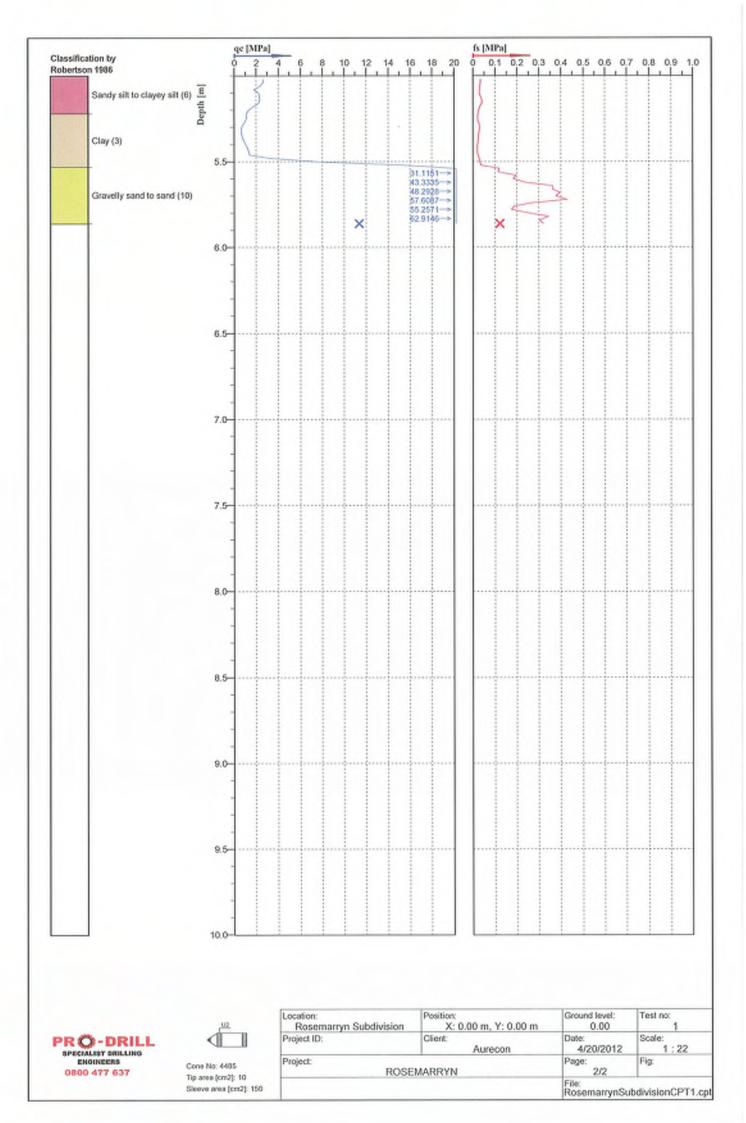


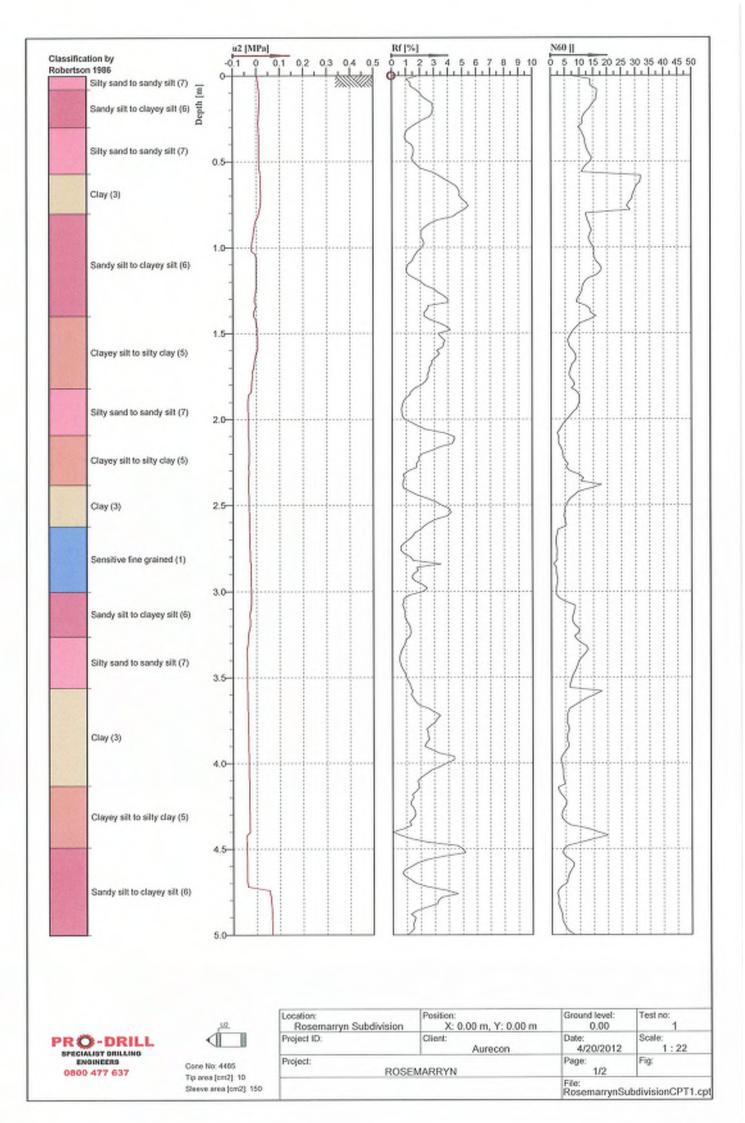
MCMILLAN DRILLING SERVICES

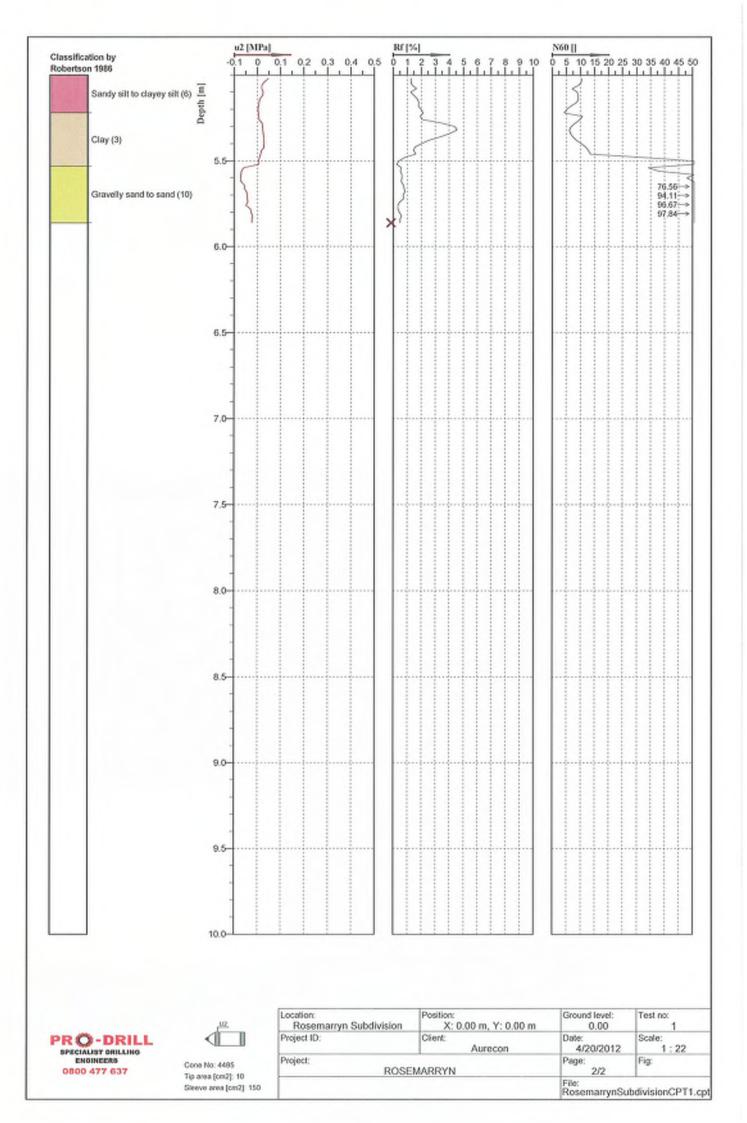


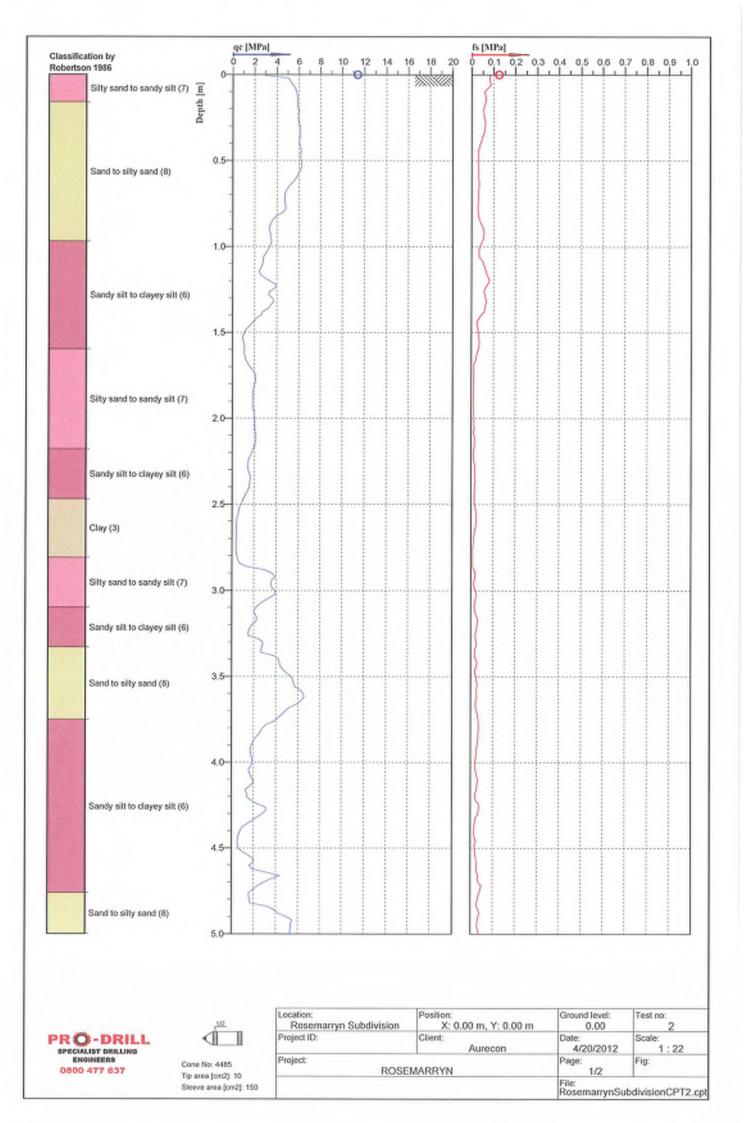


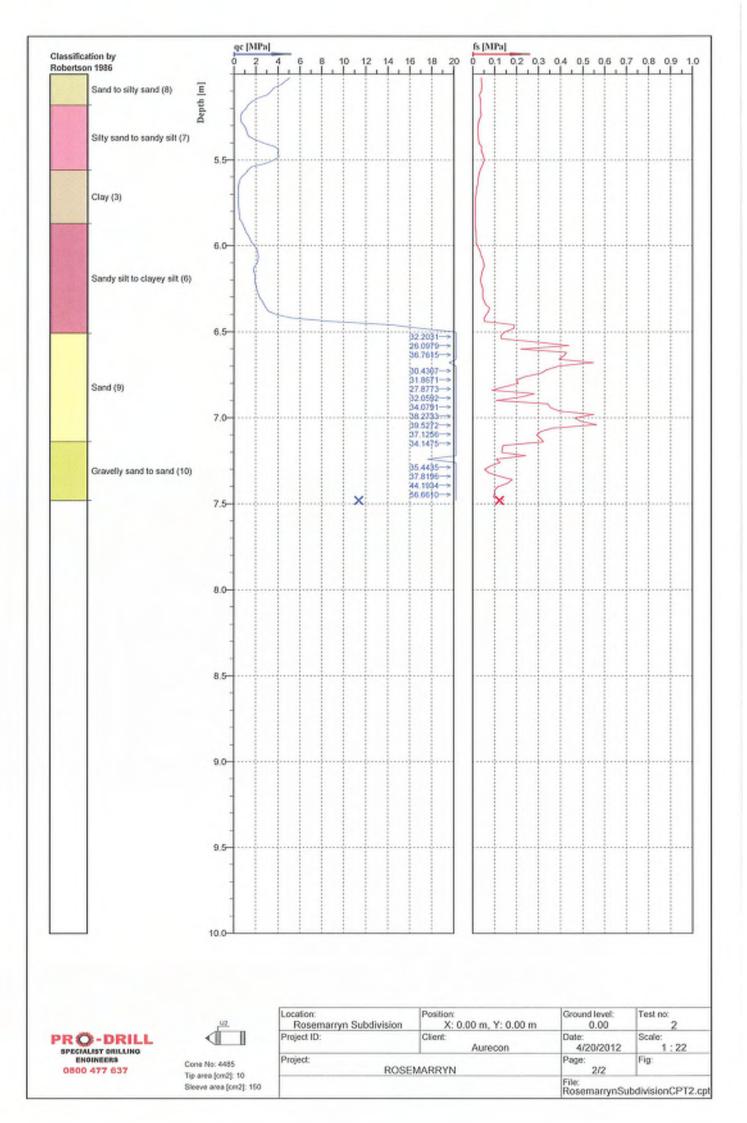


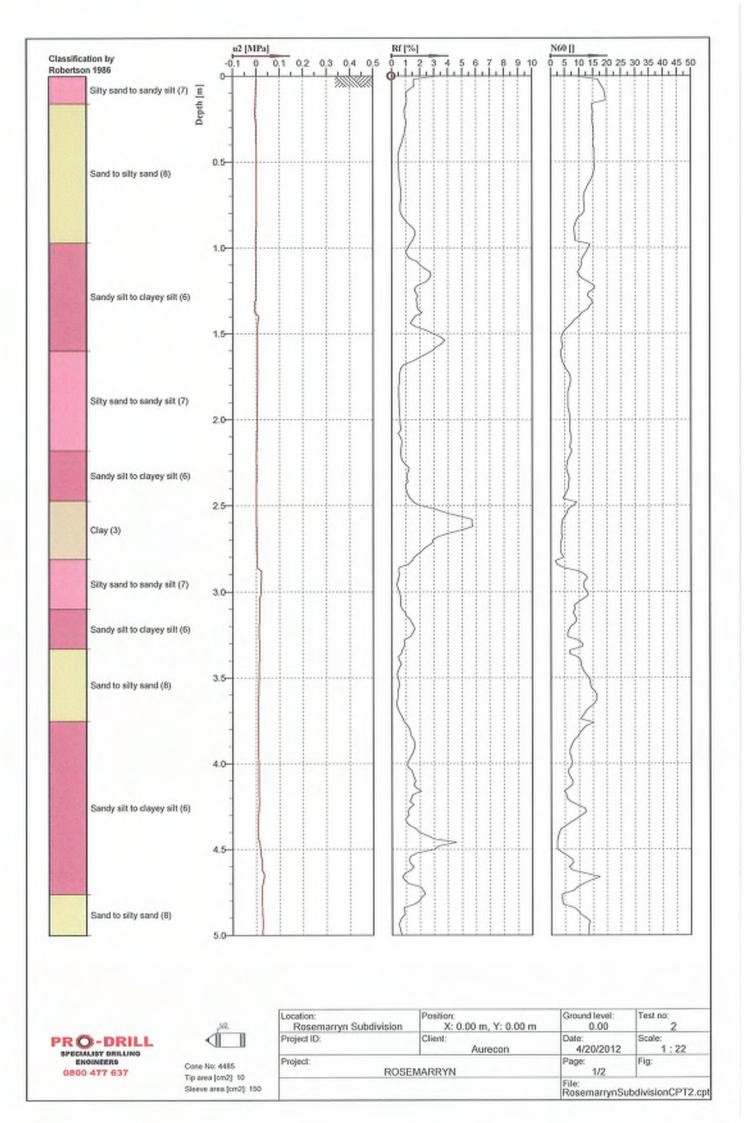


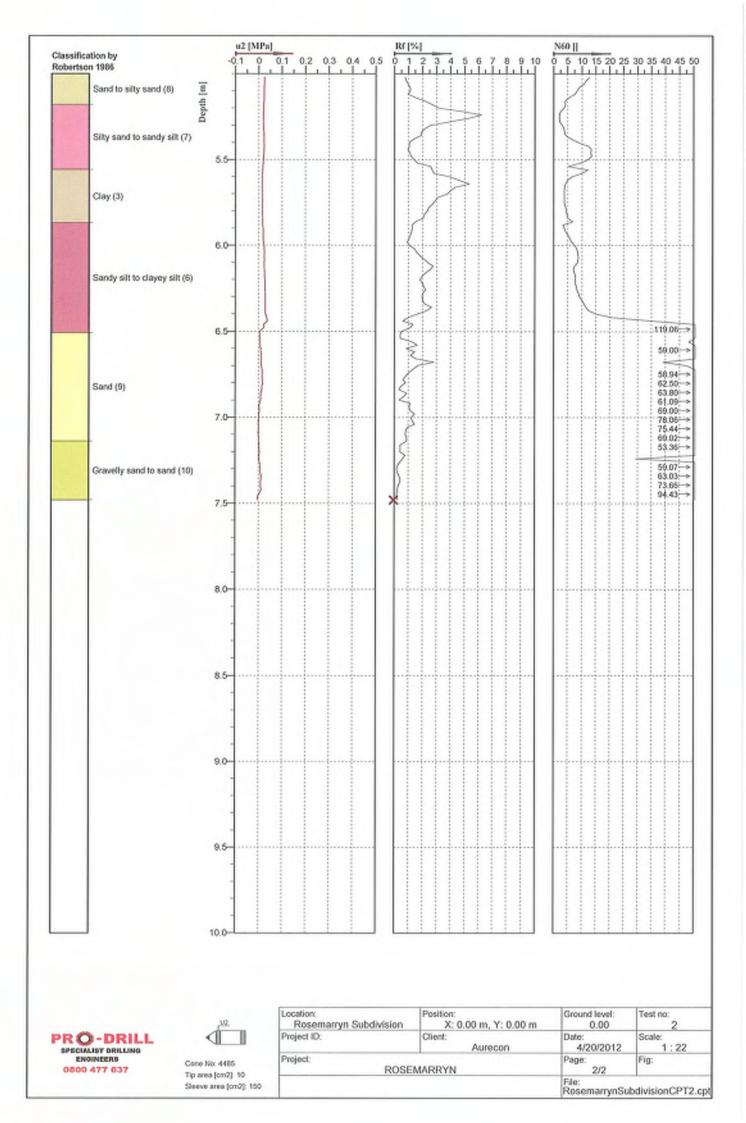


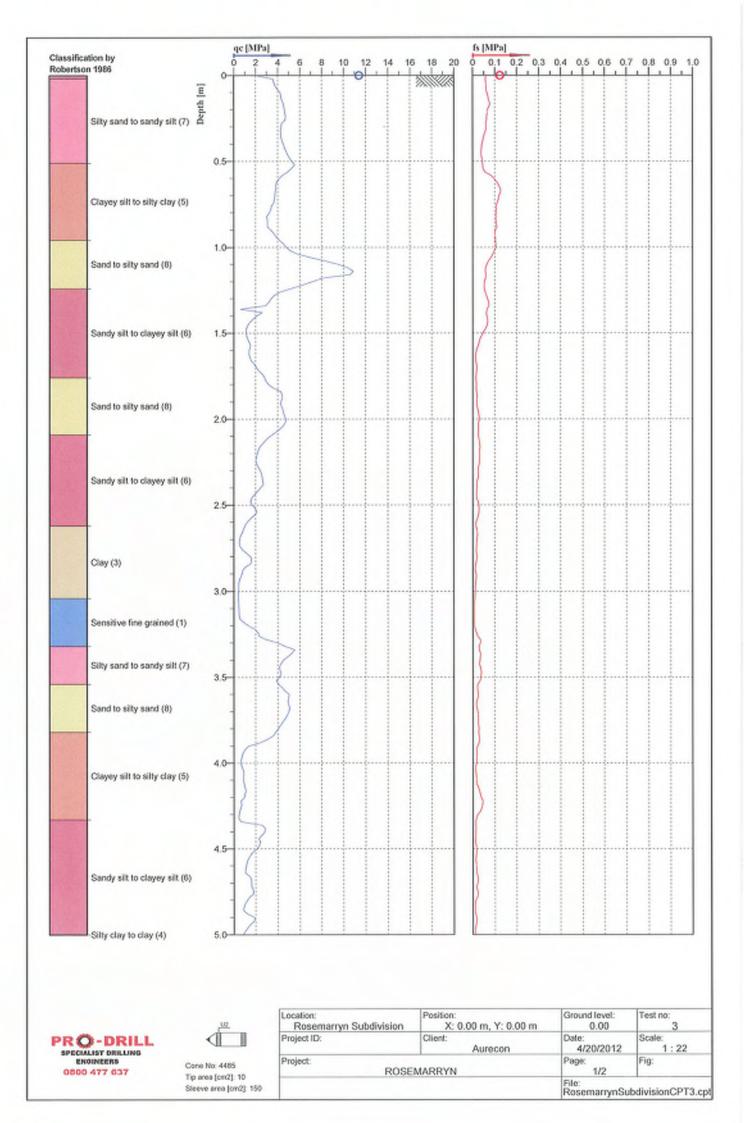


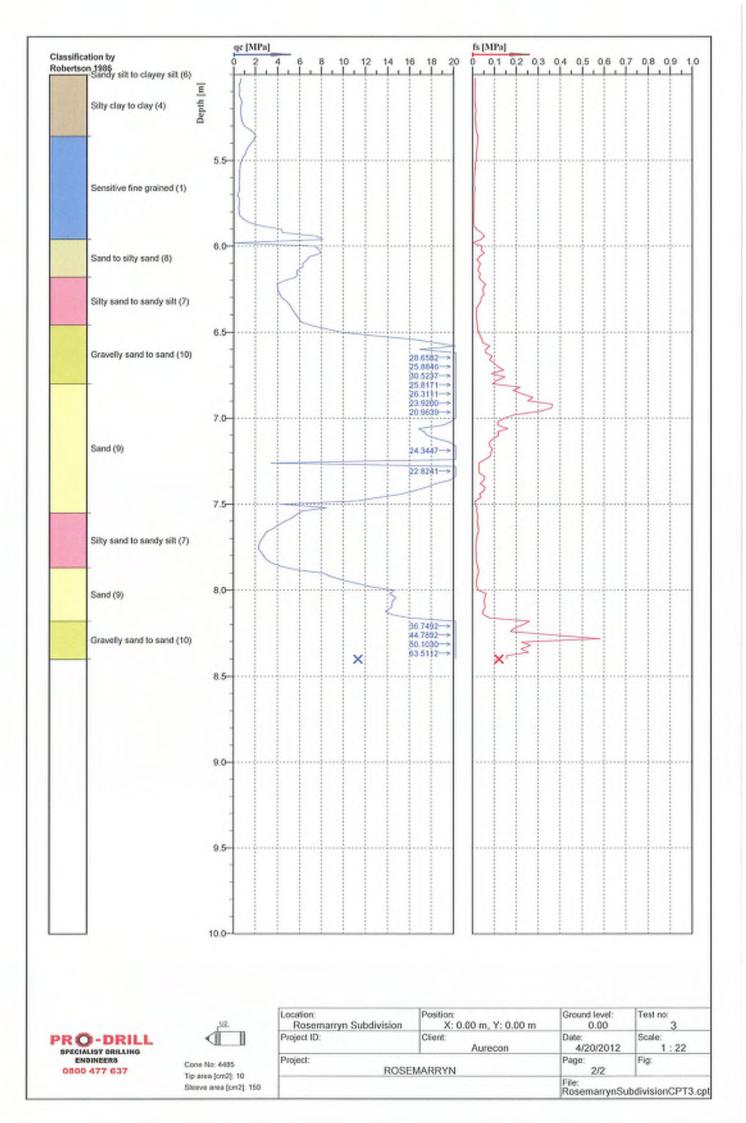


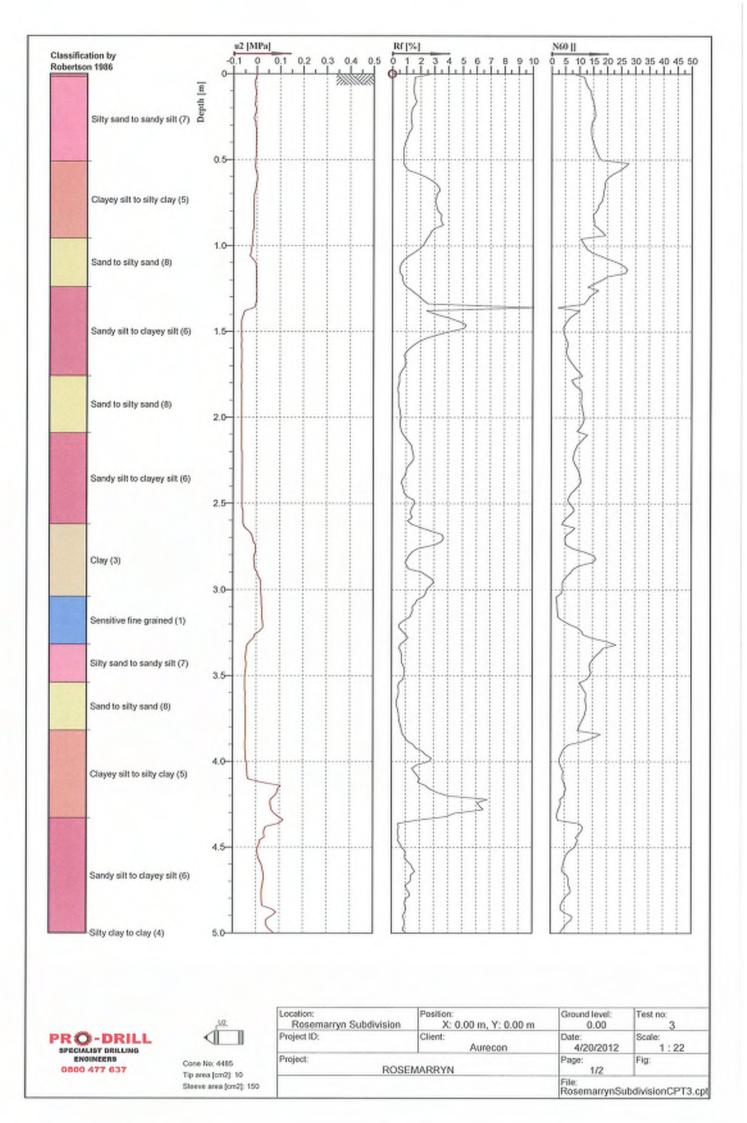


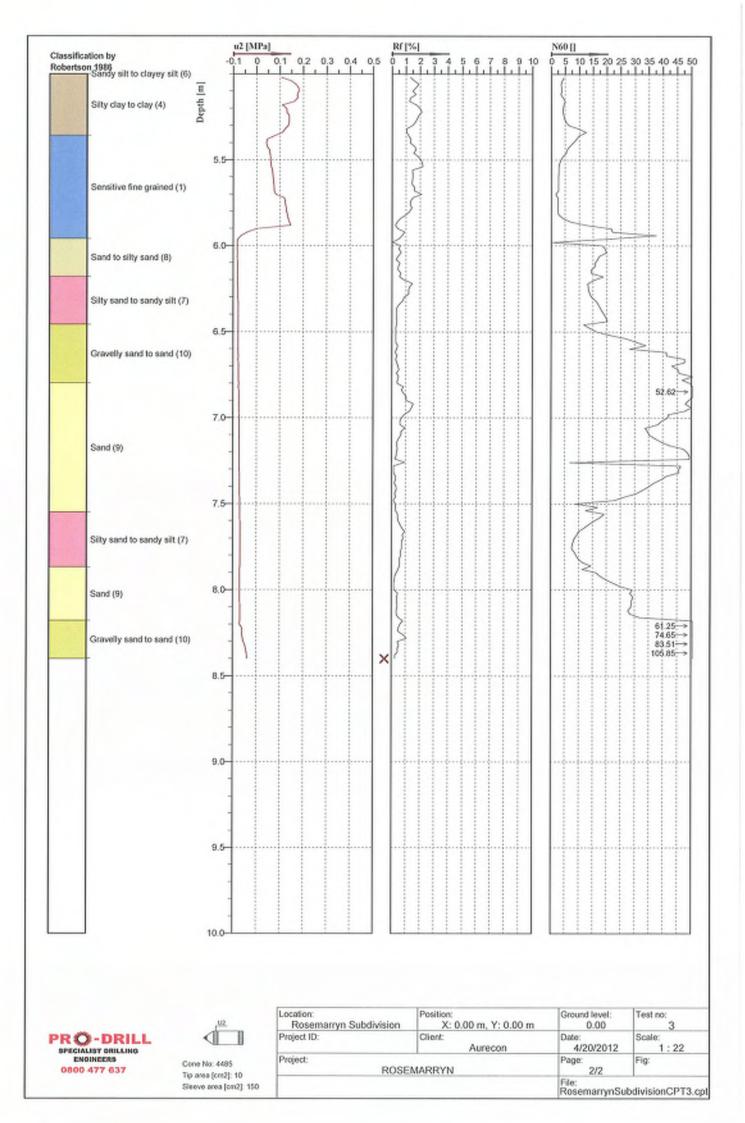


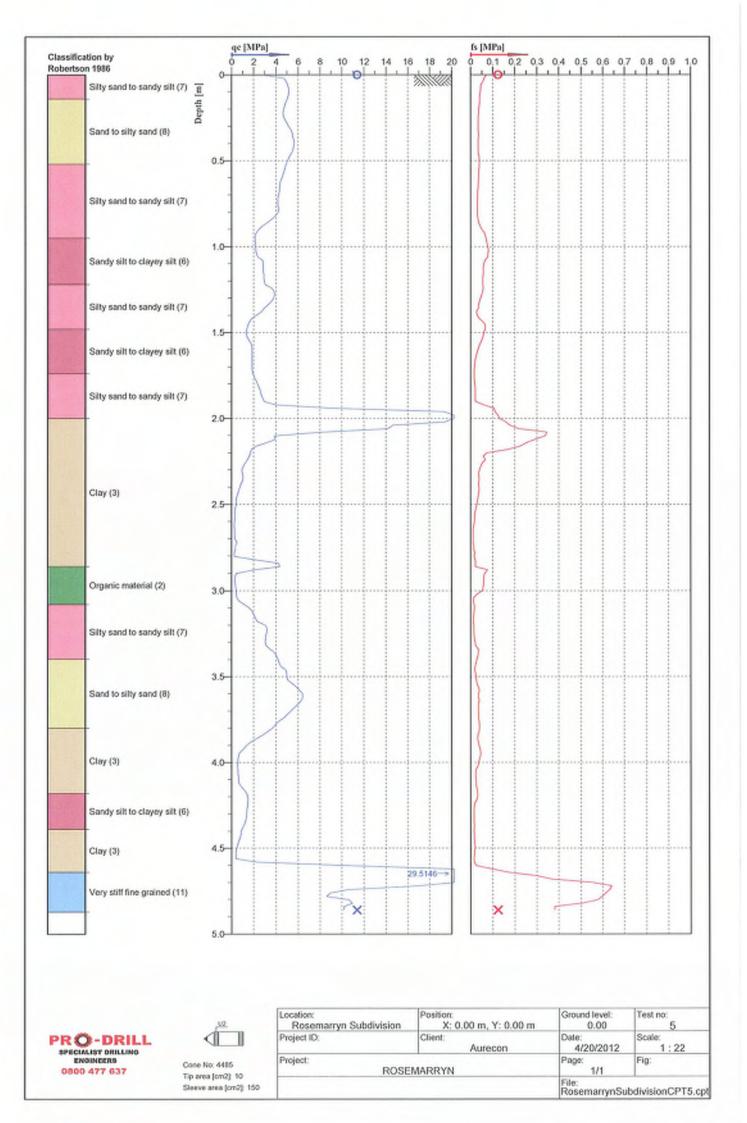


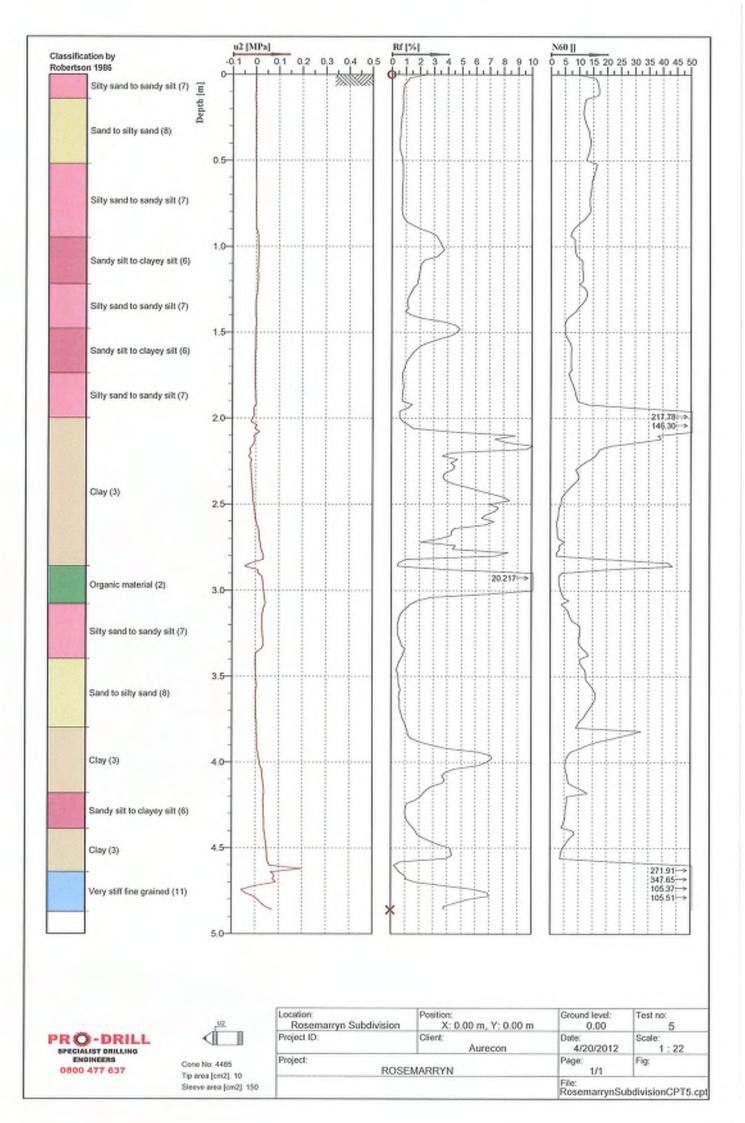


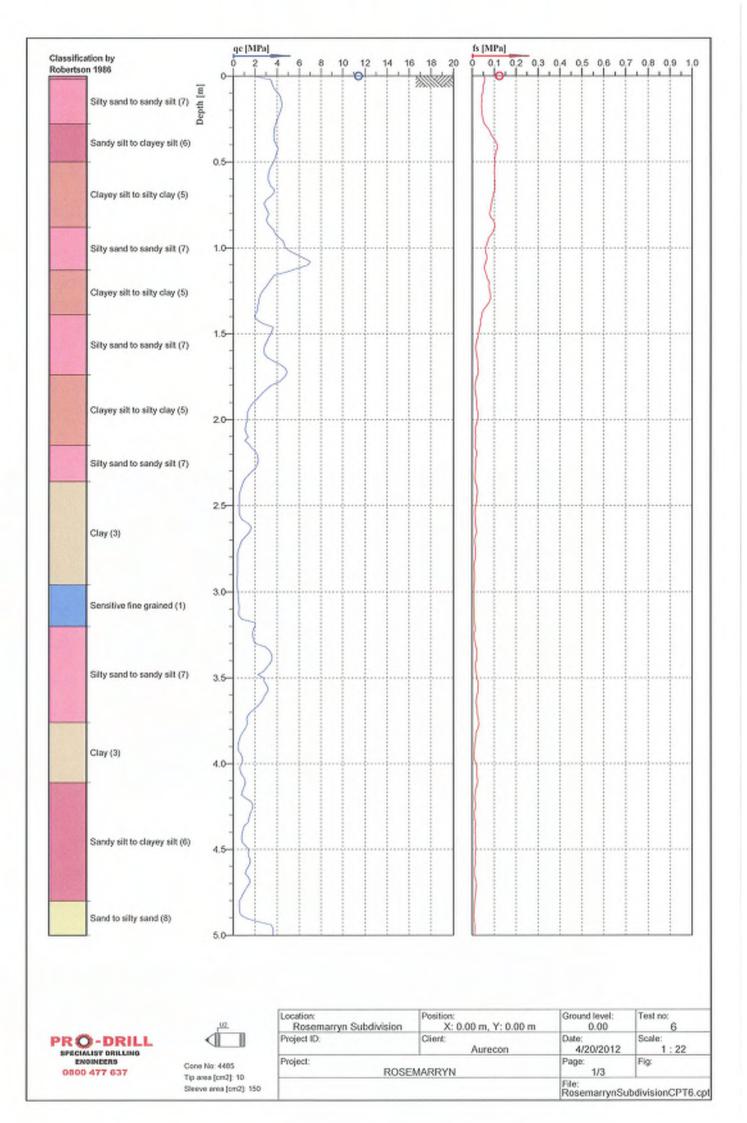


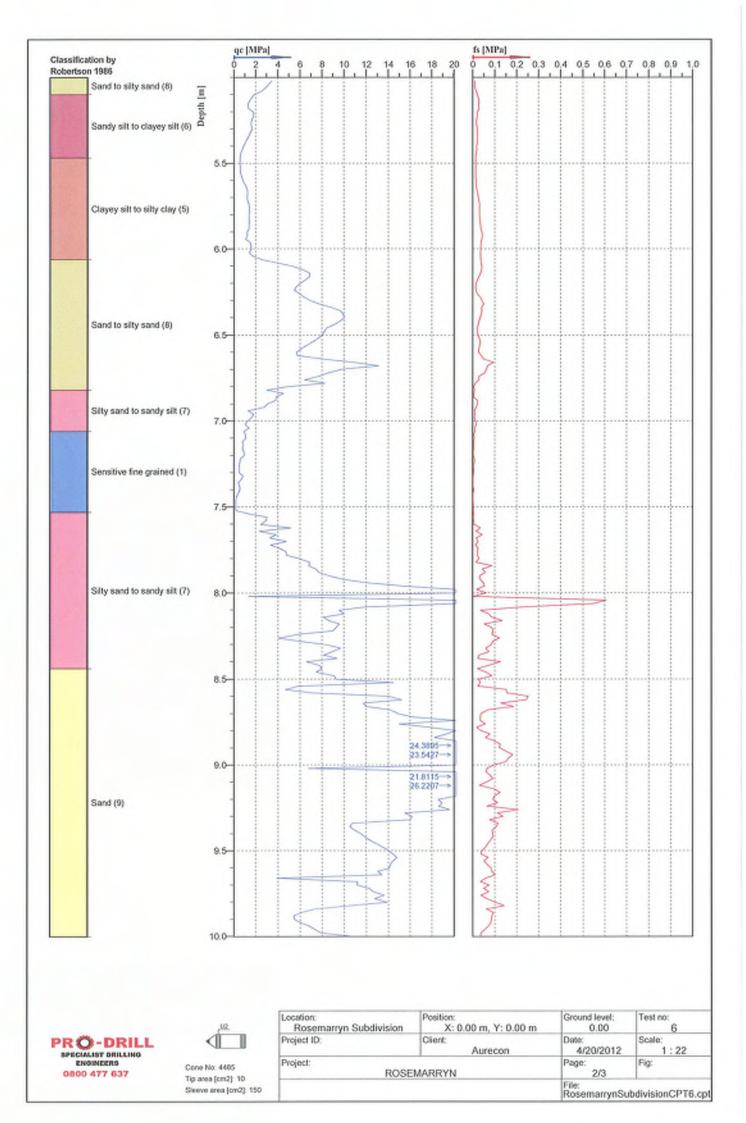


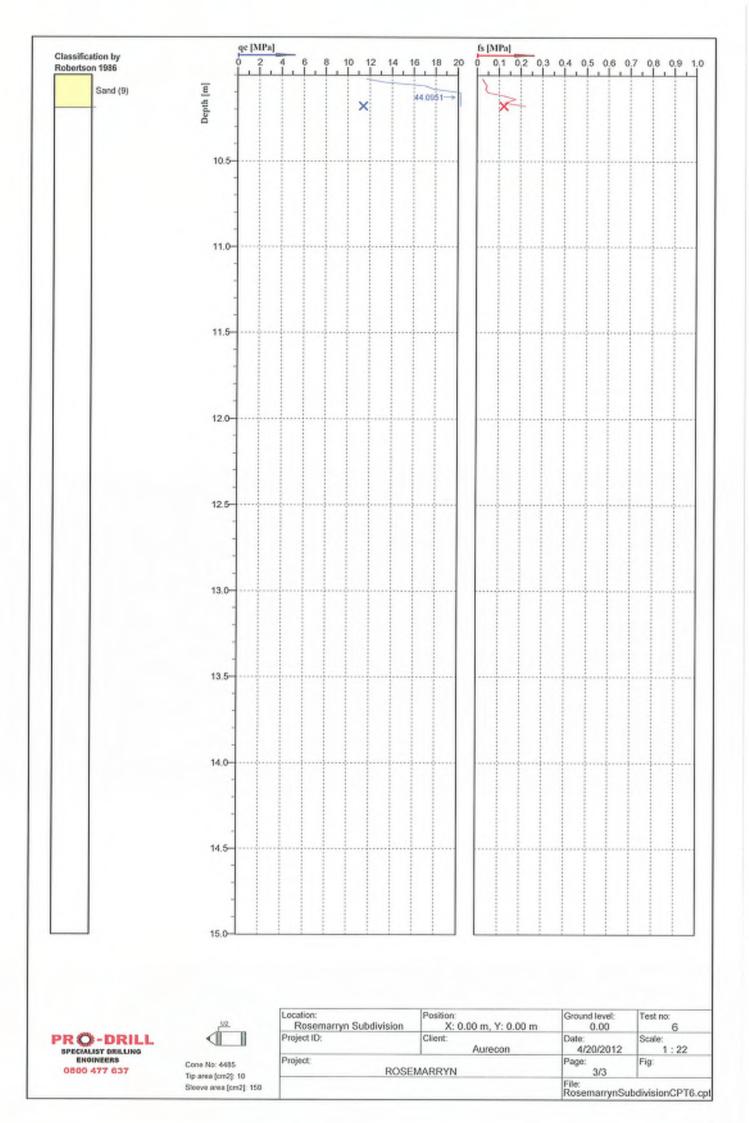


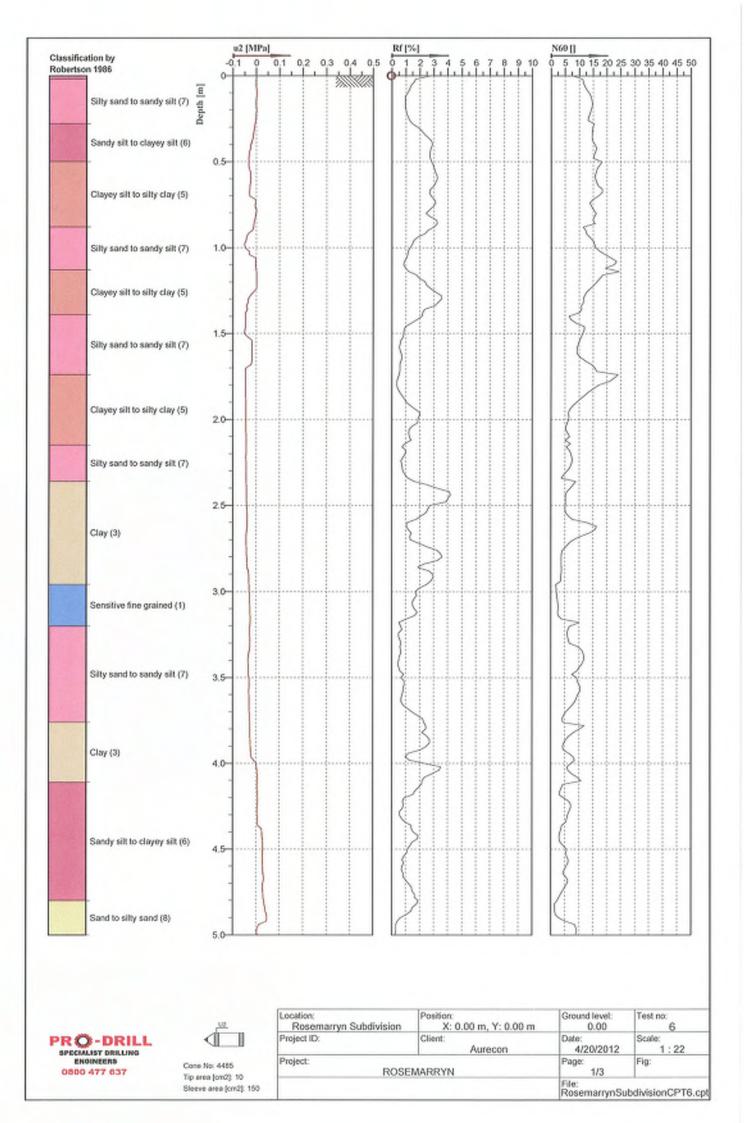


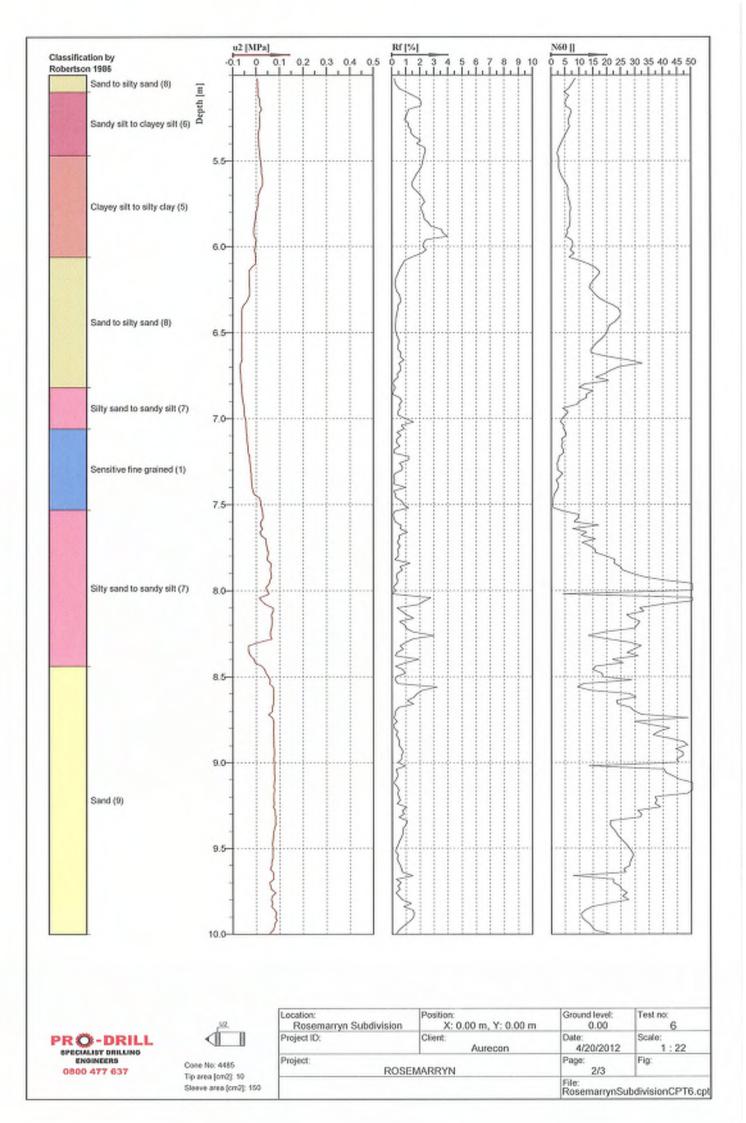


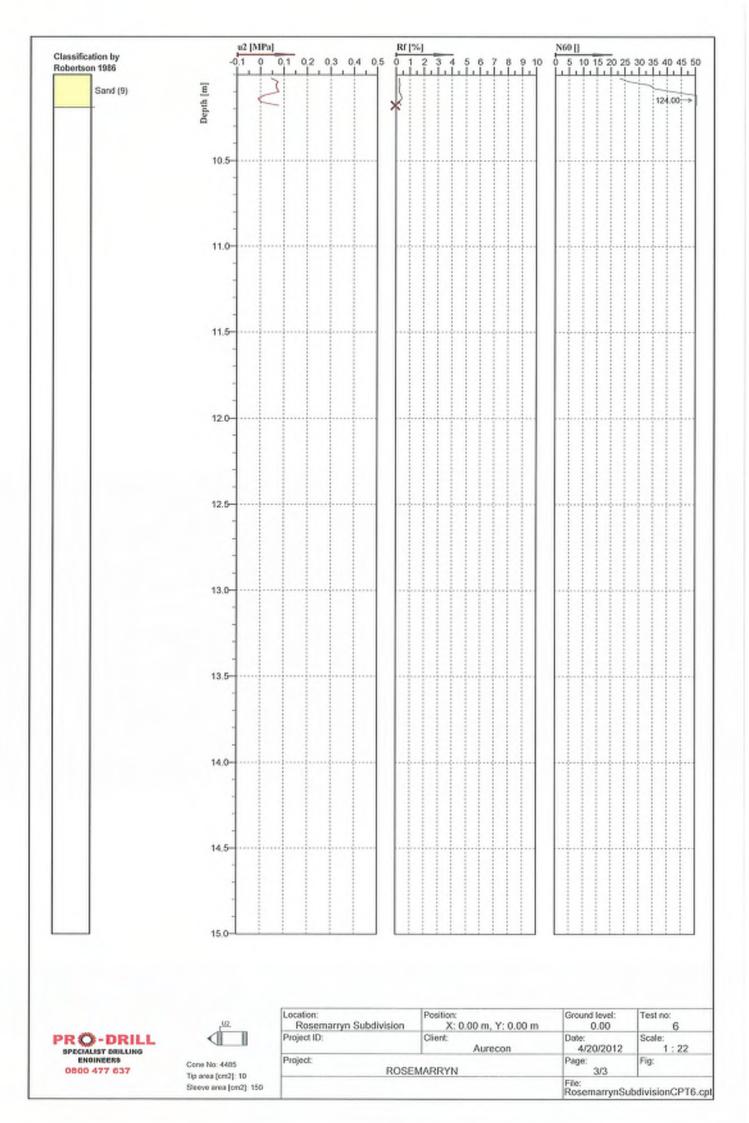


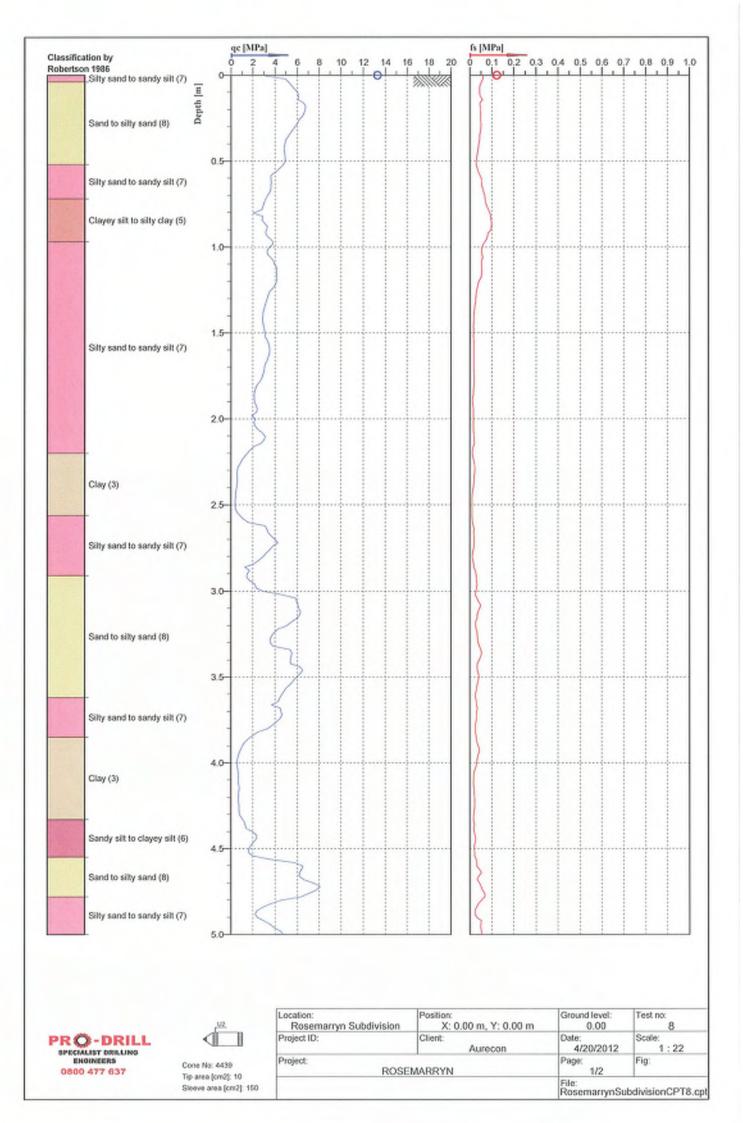


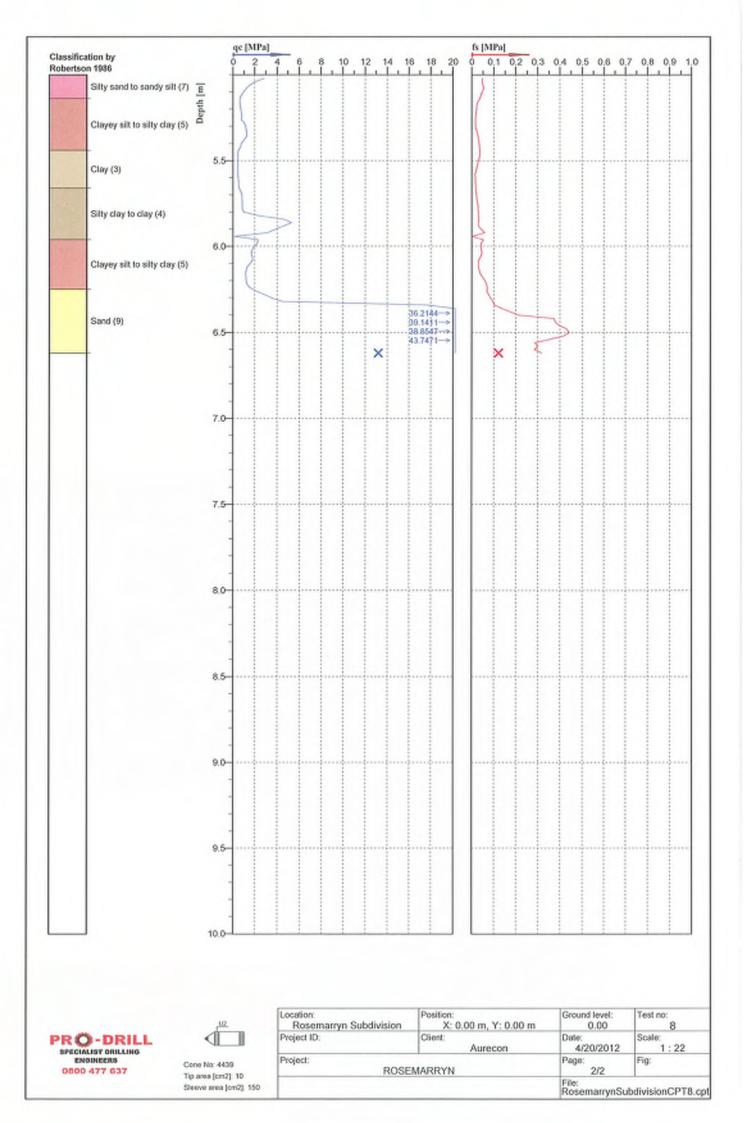


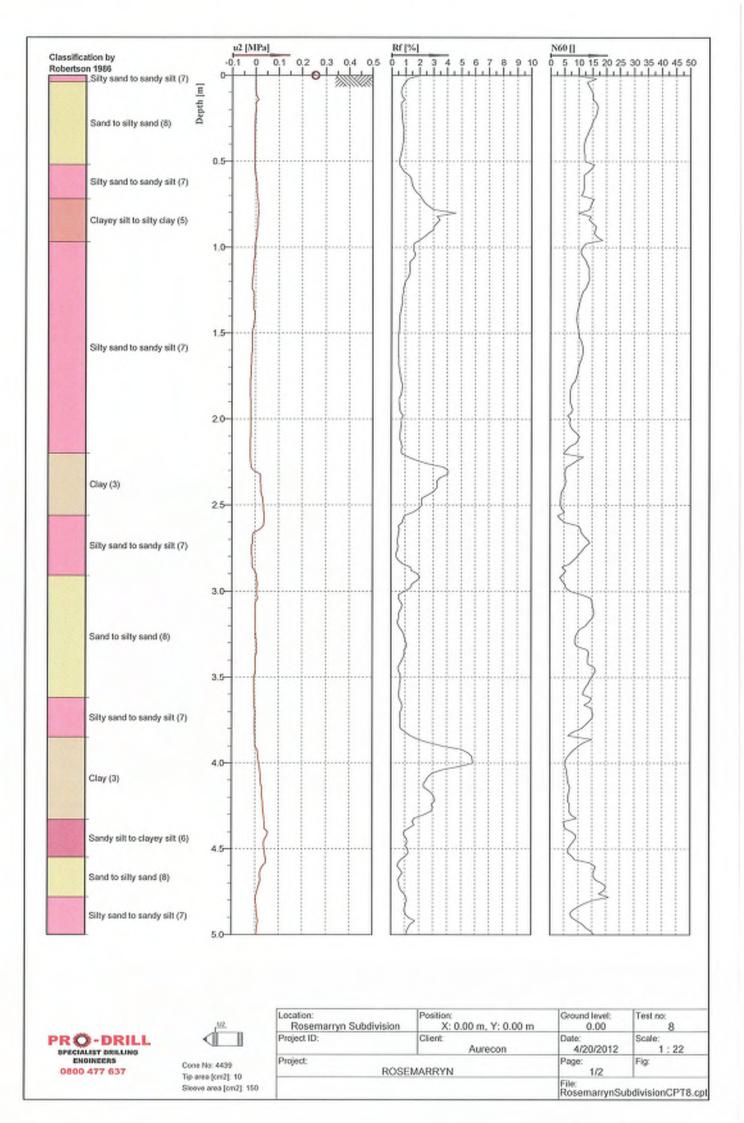


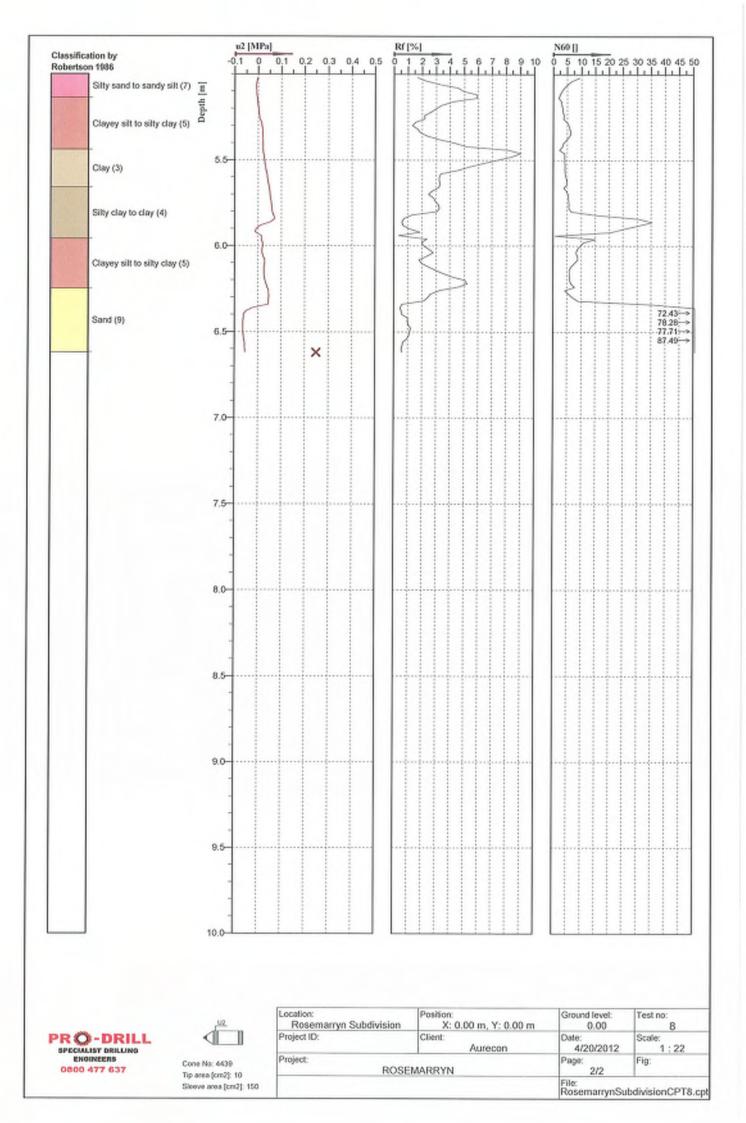


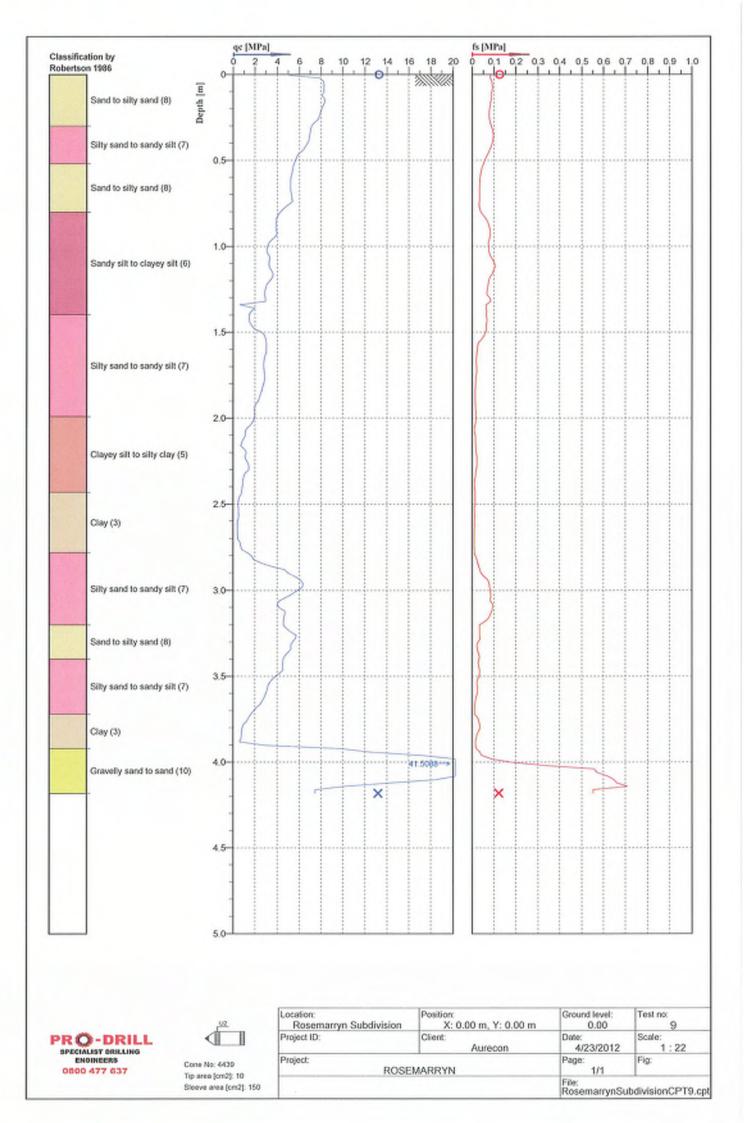


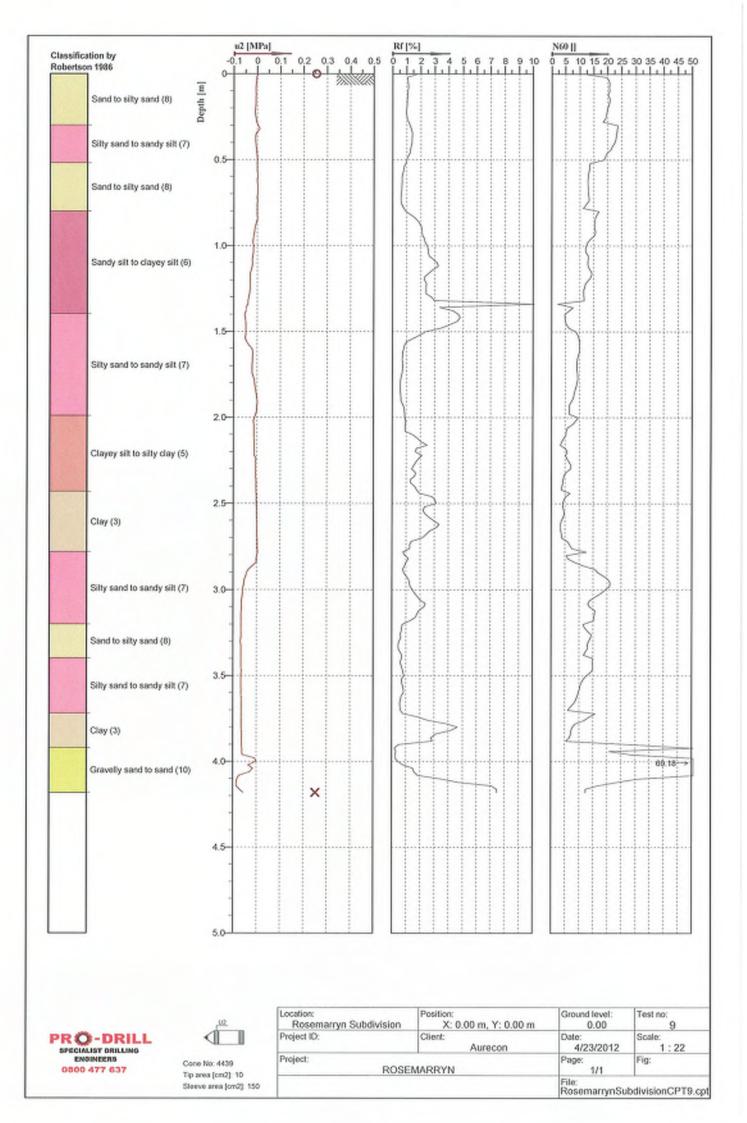


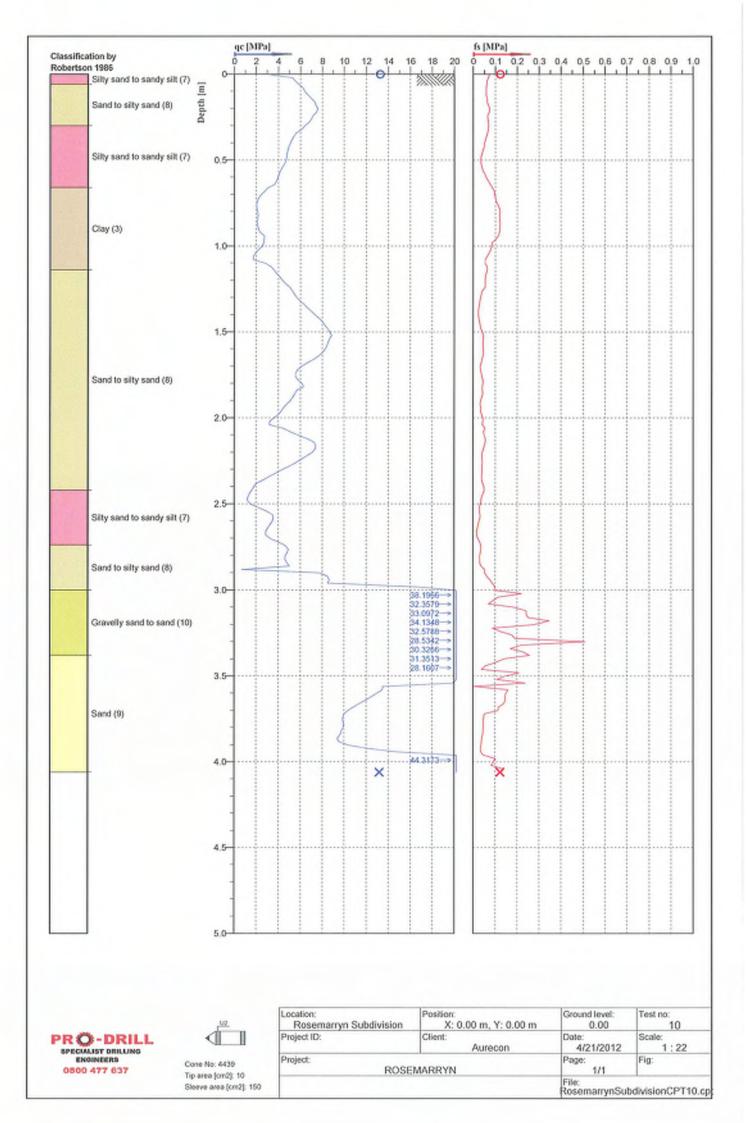


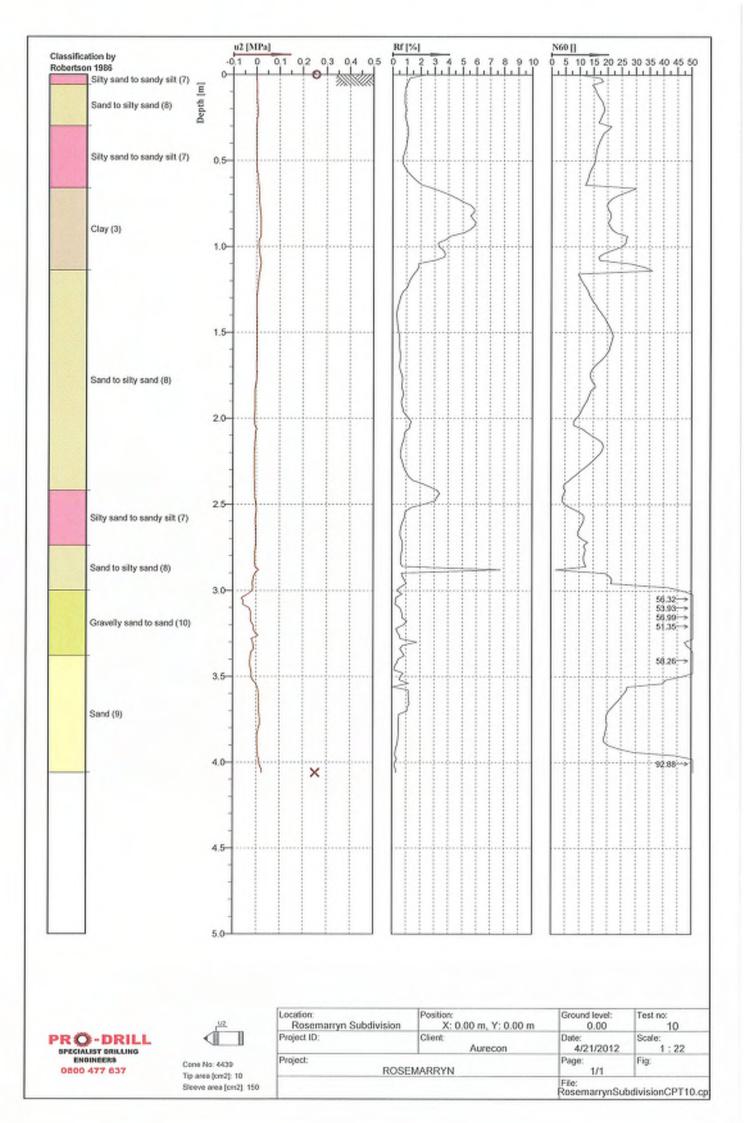


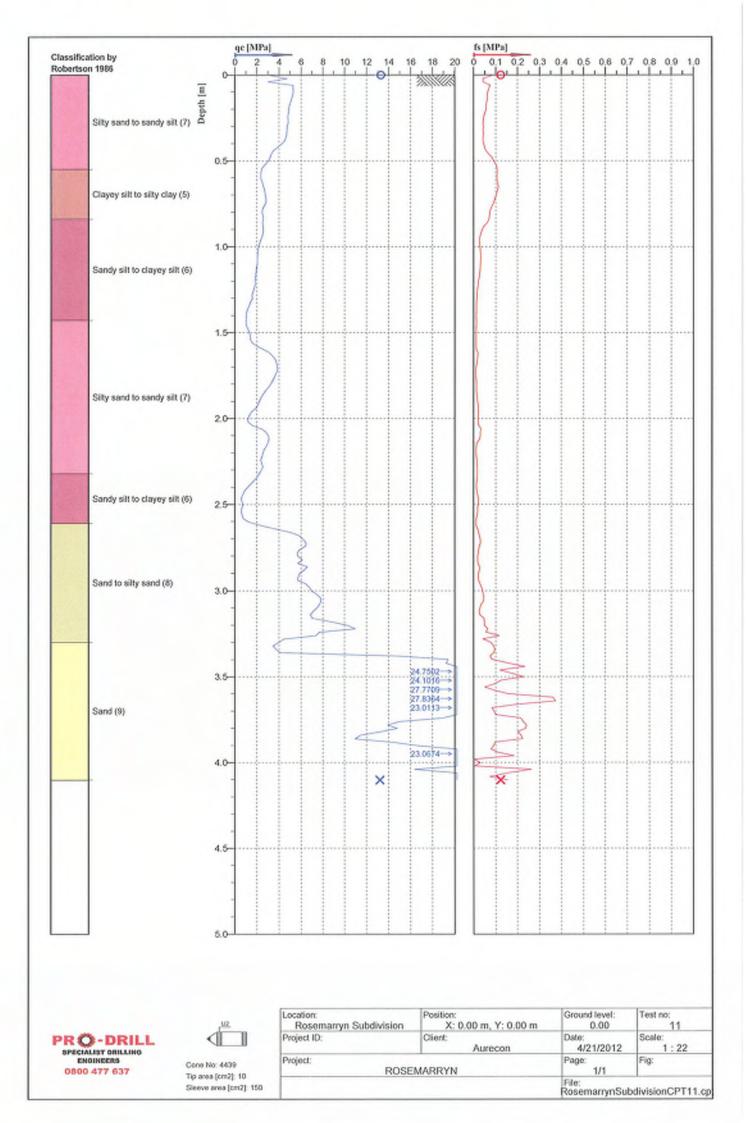


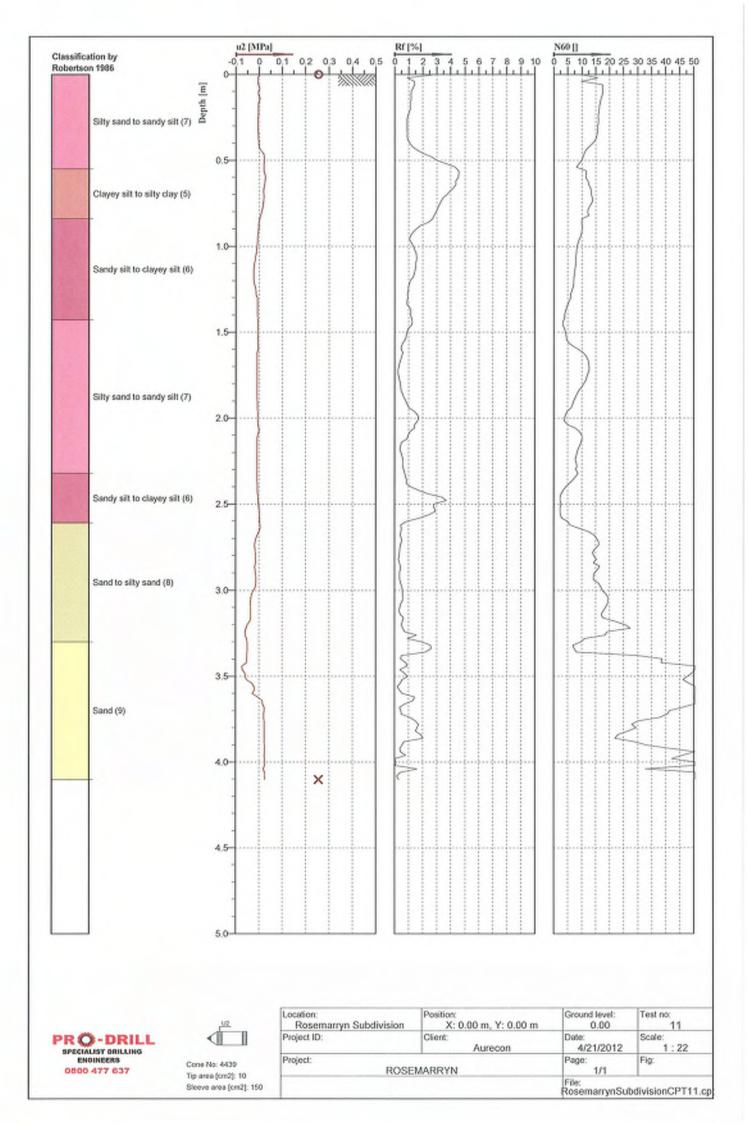


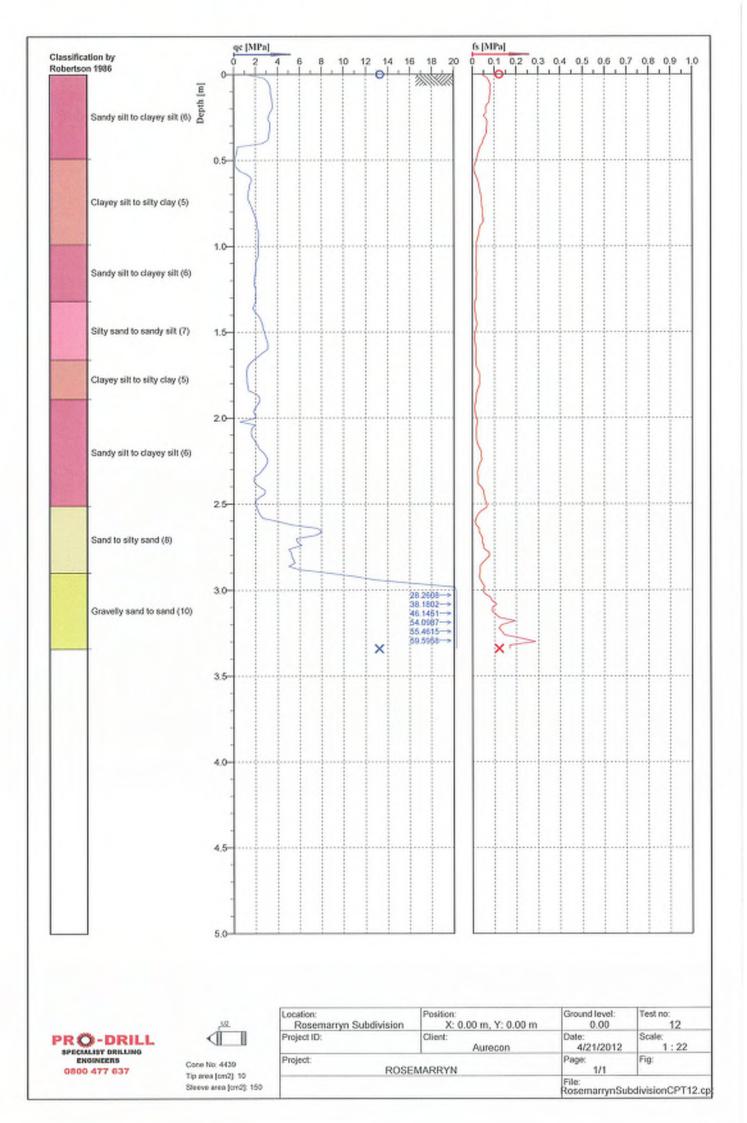


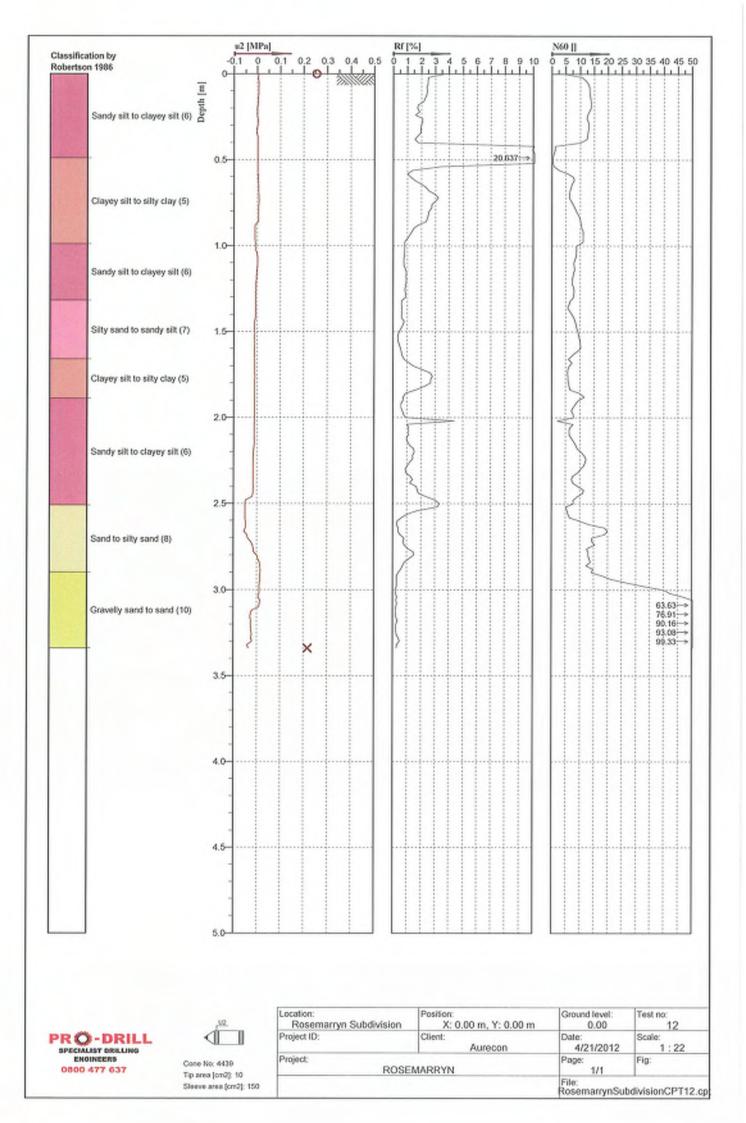


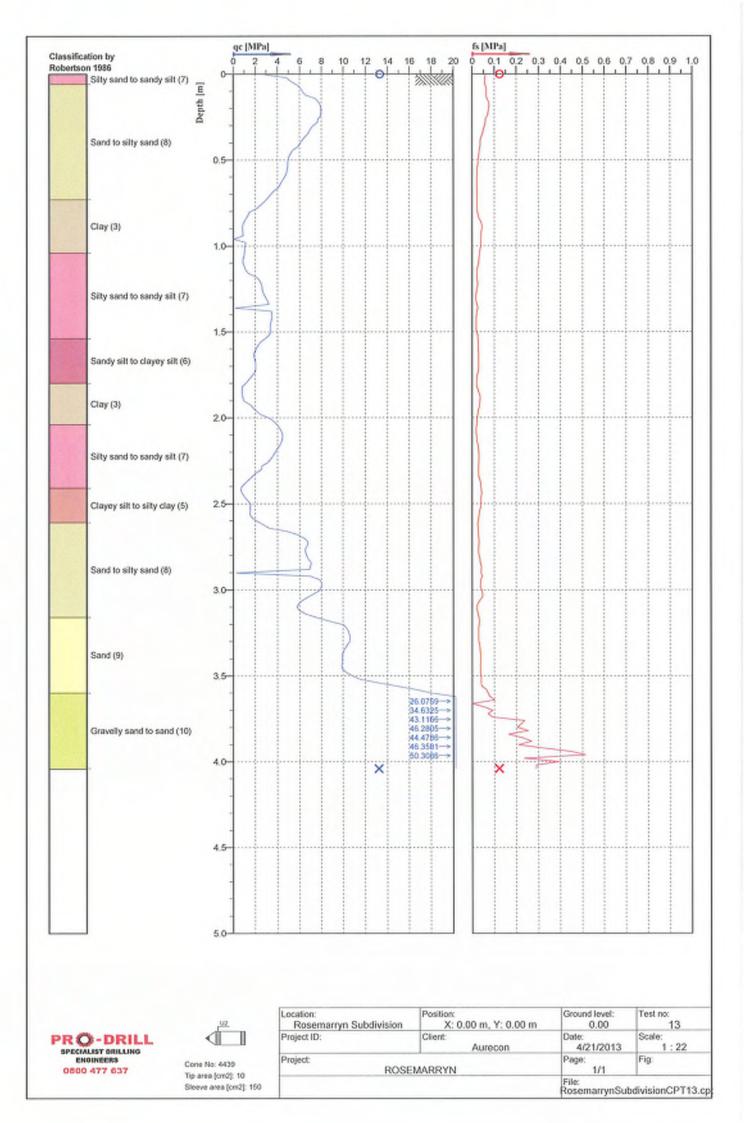


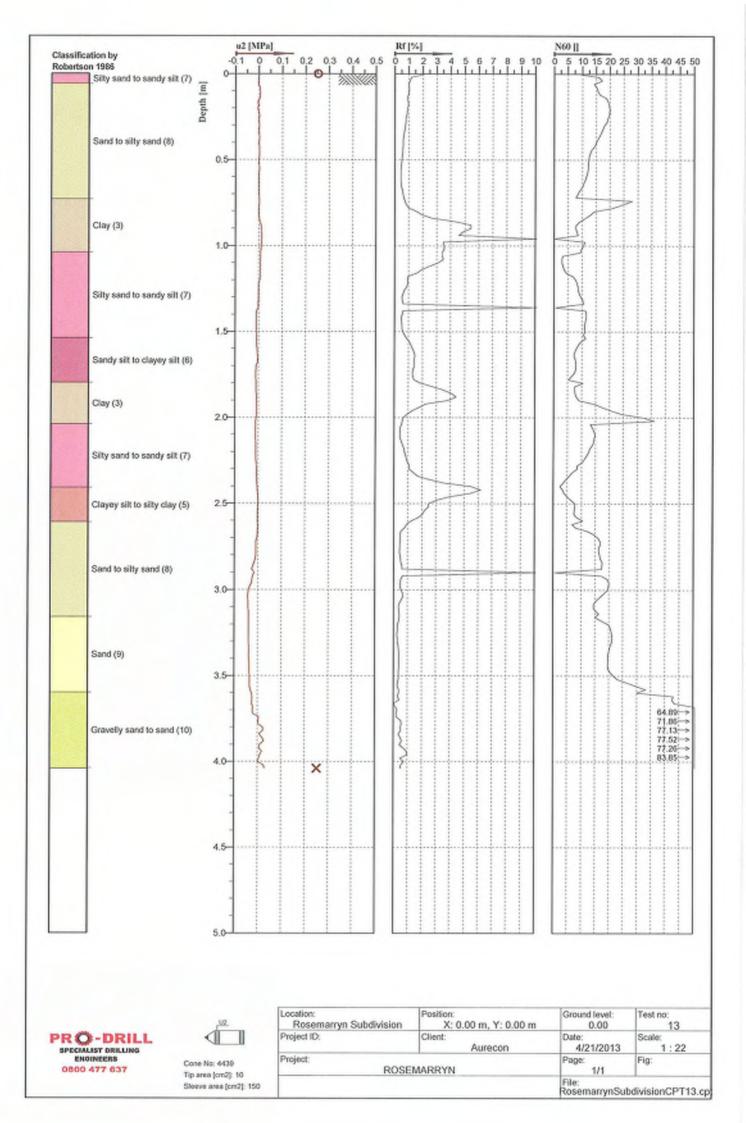


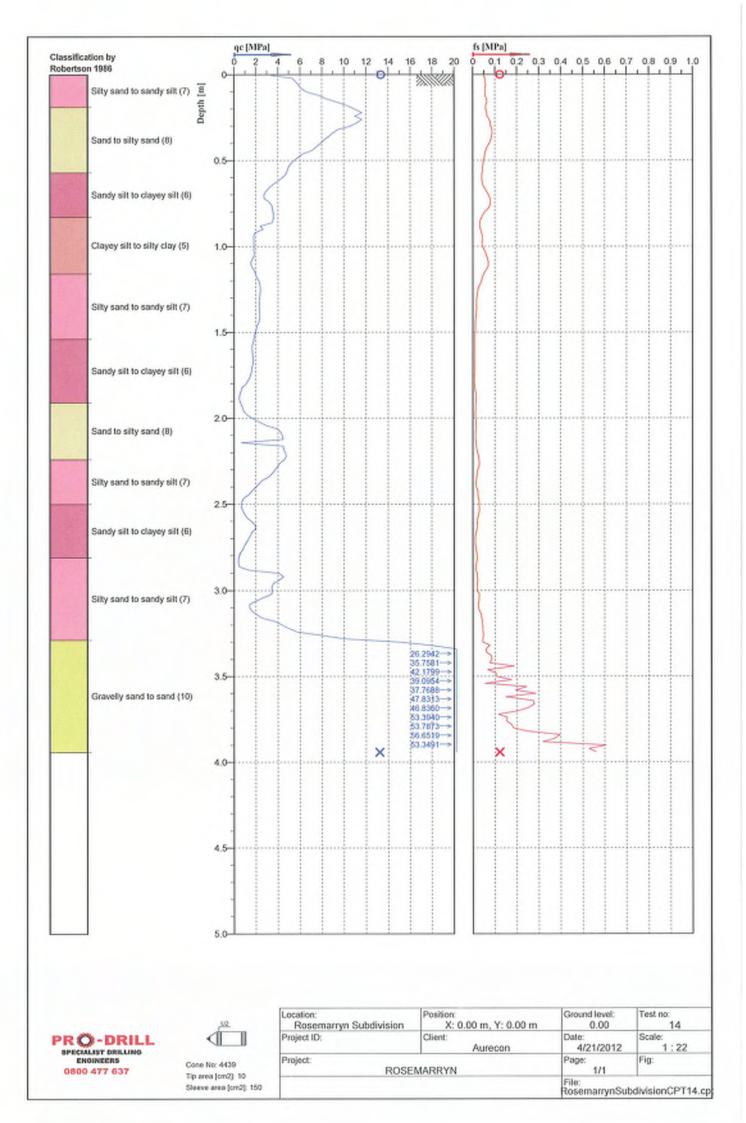


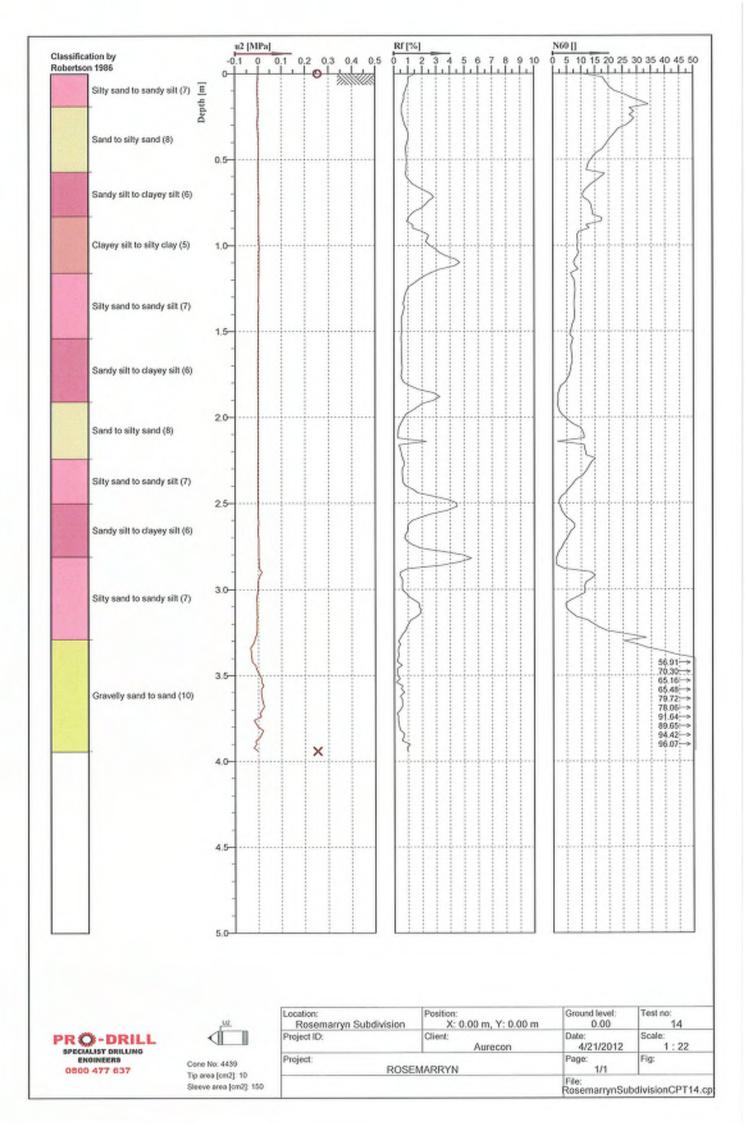


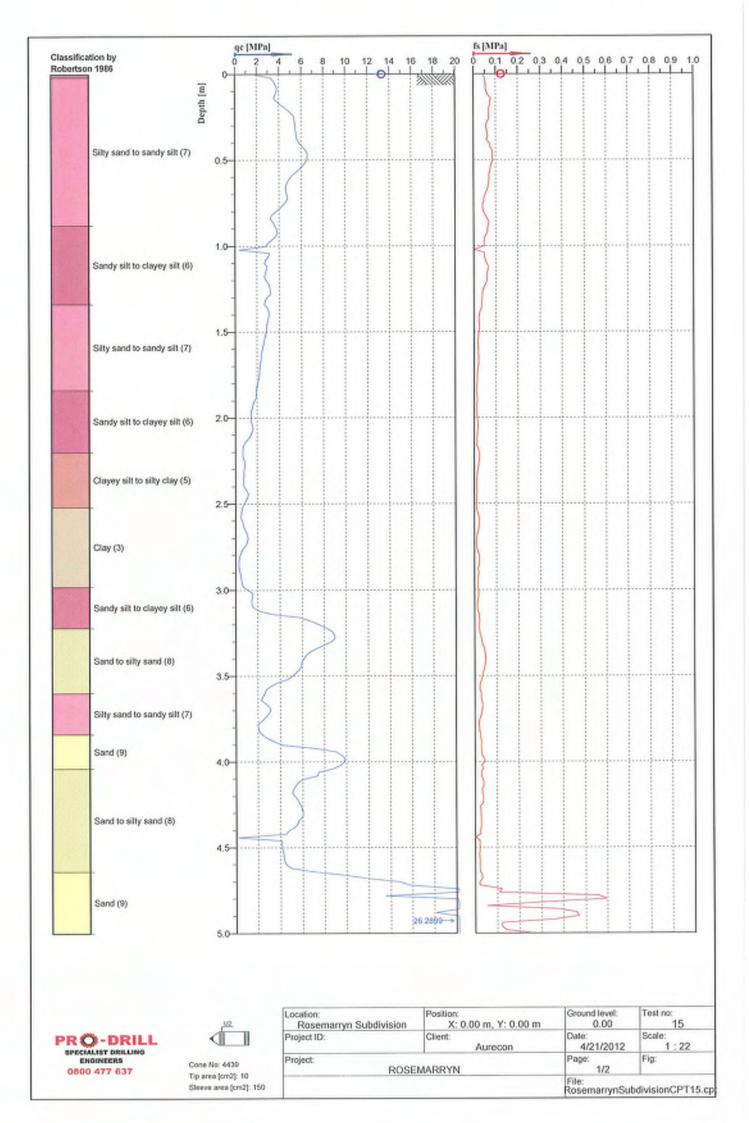


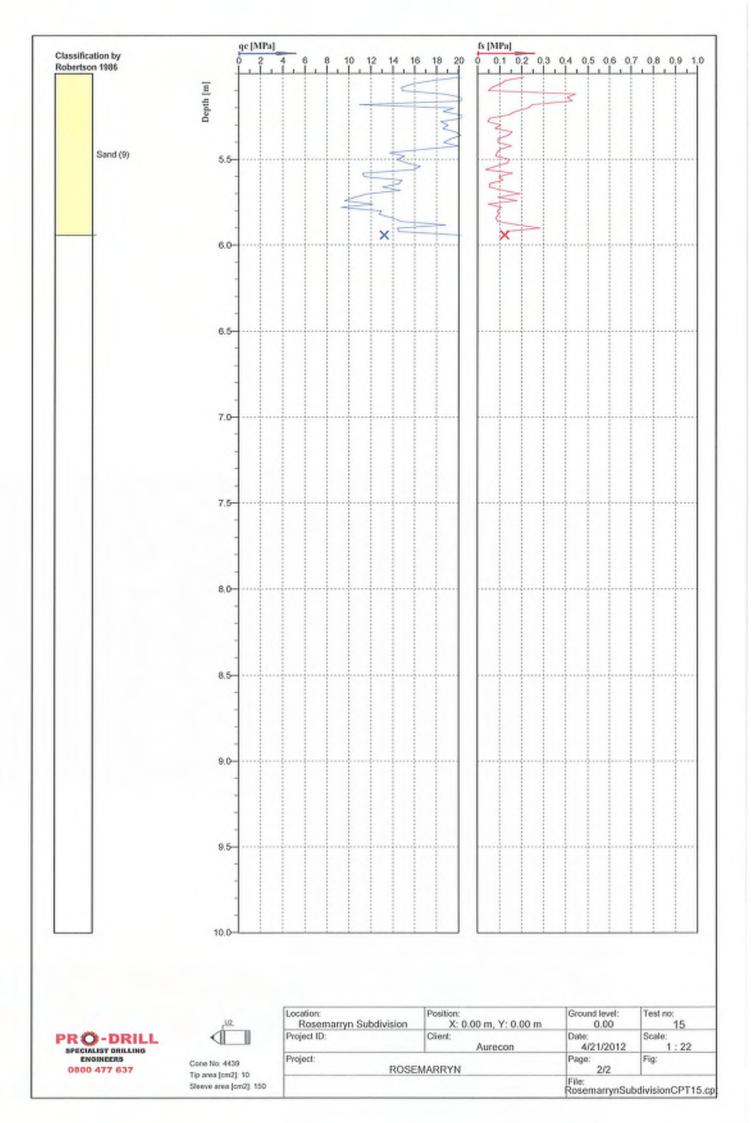


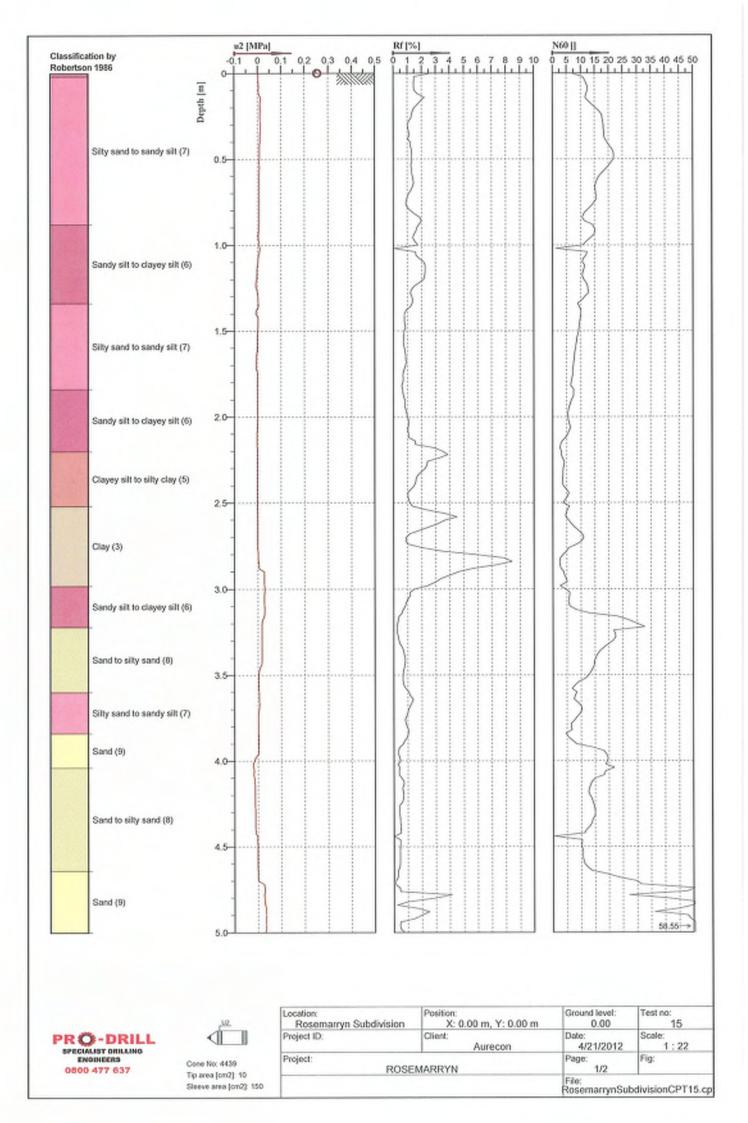


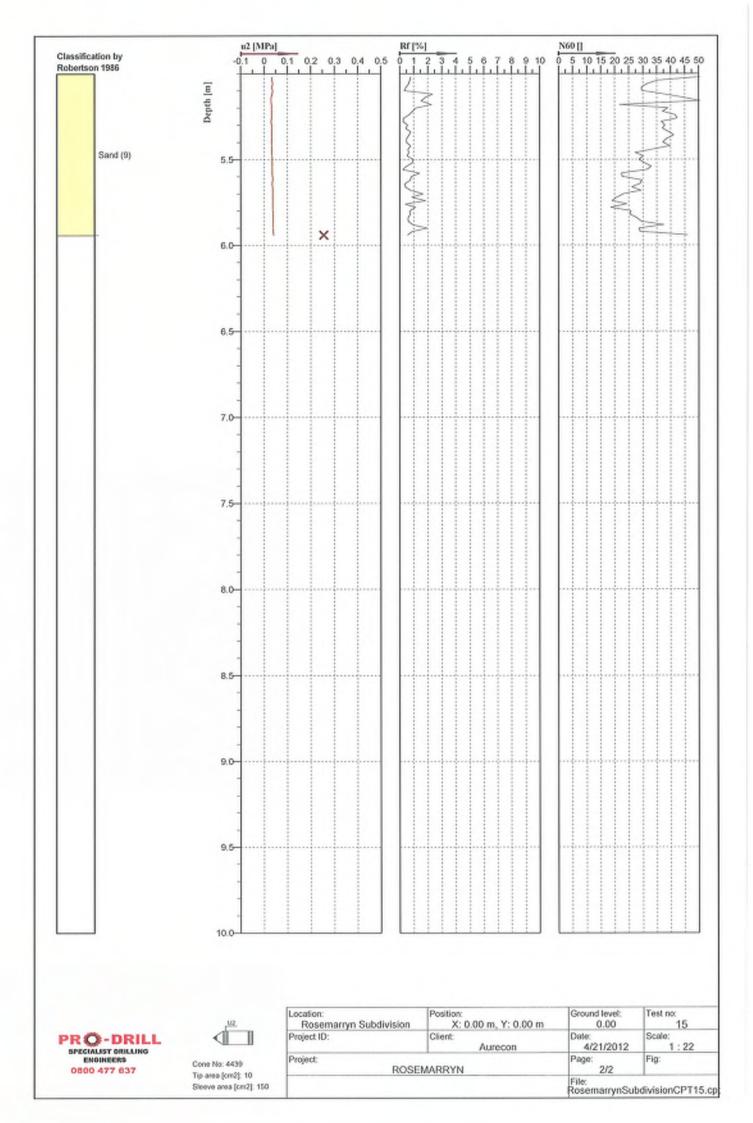


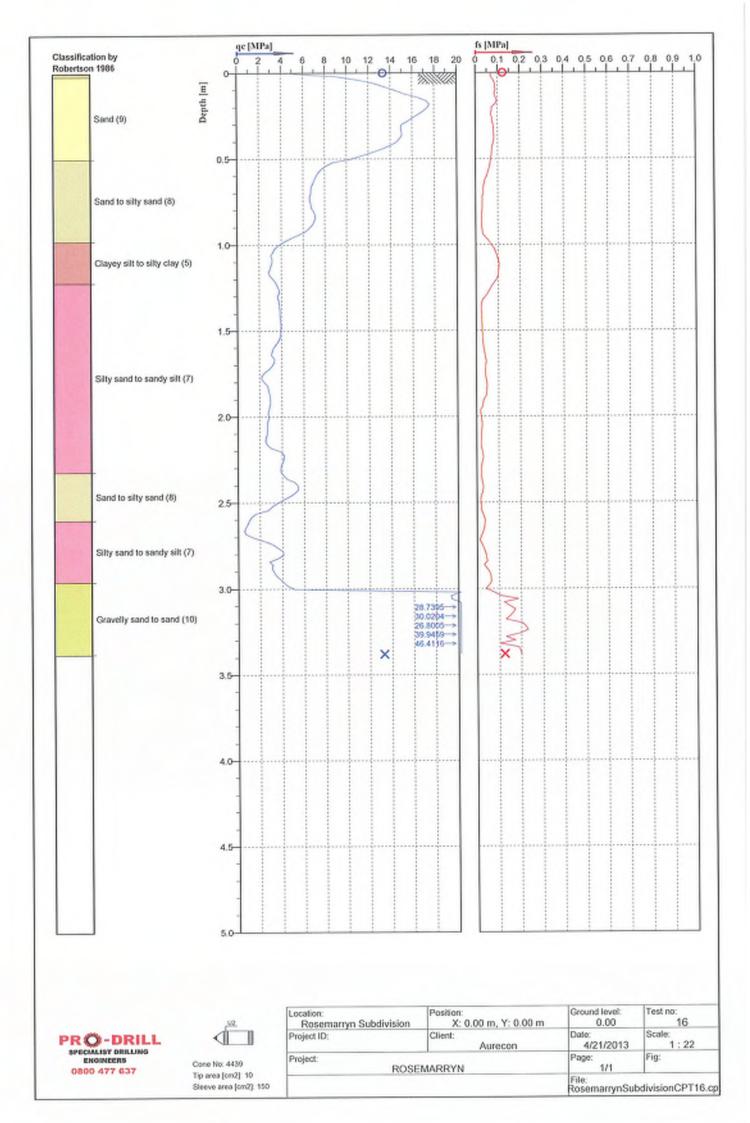


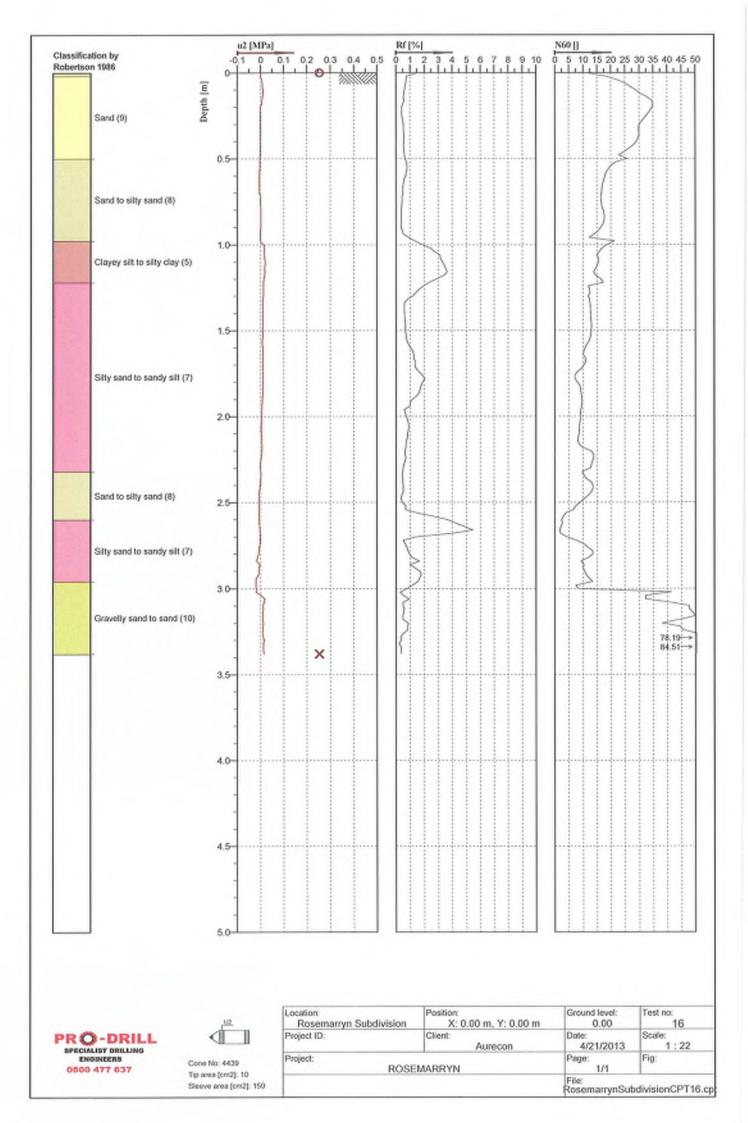


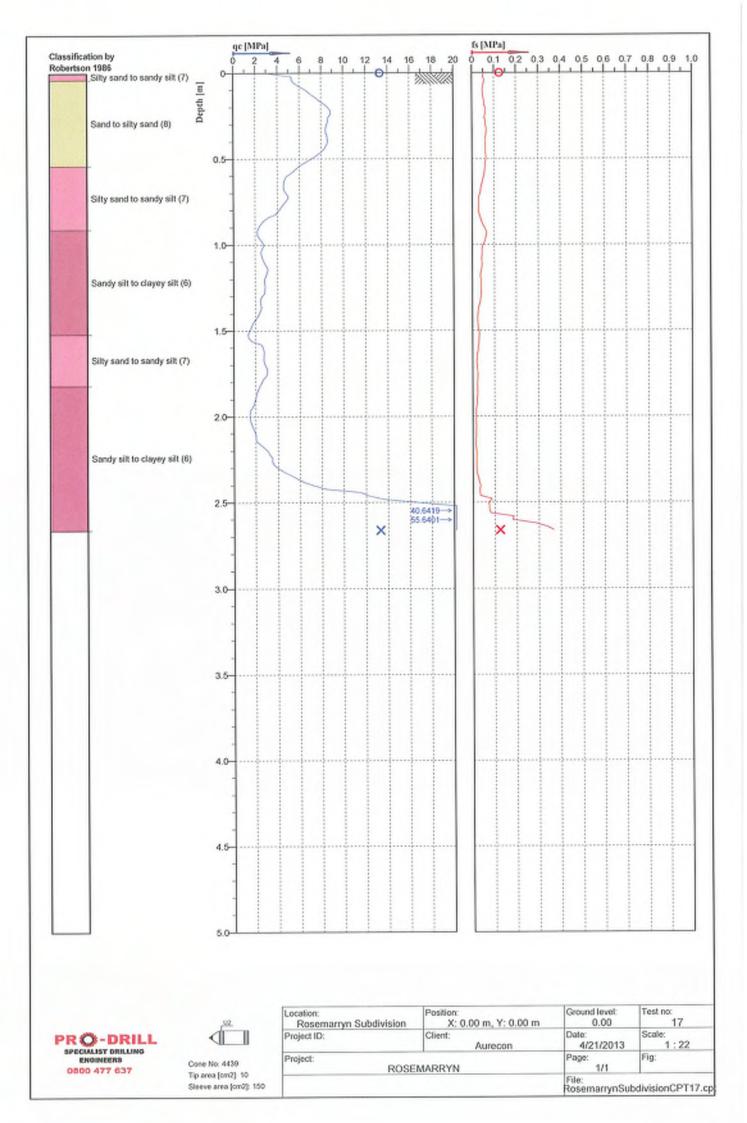


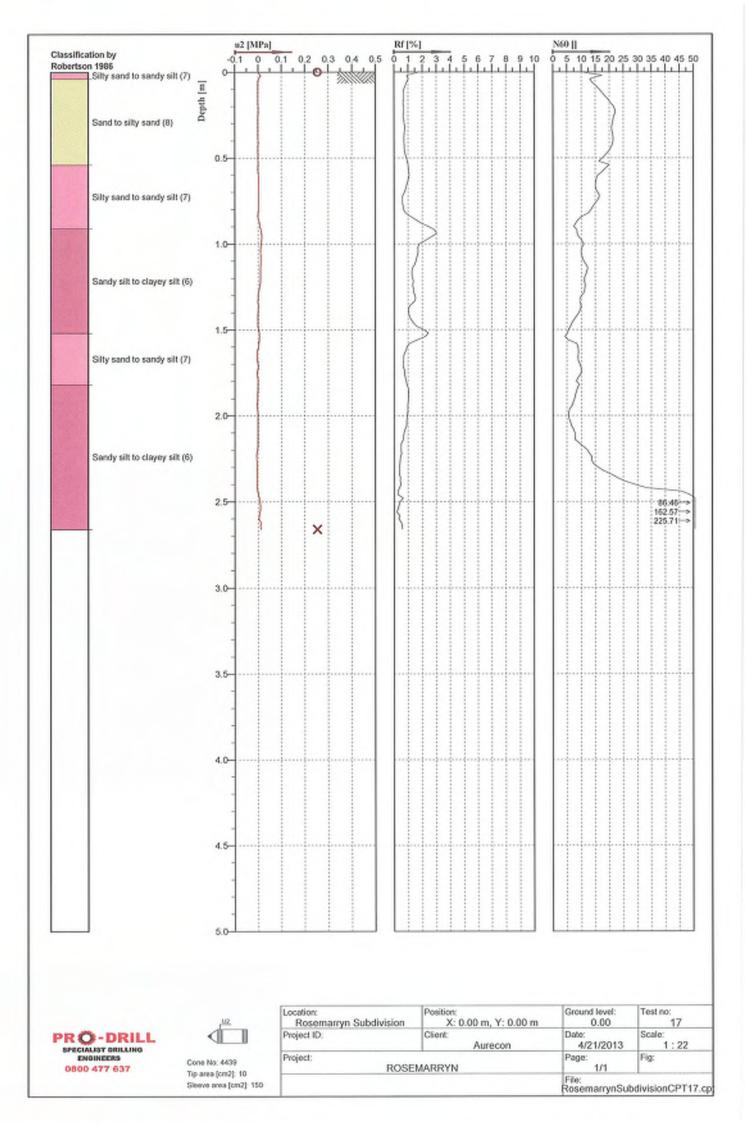


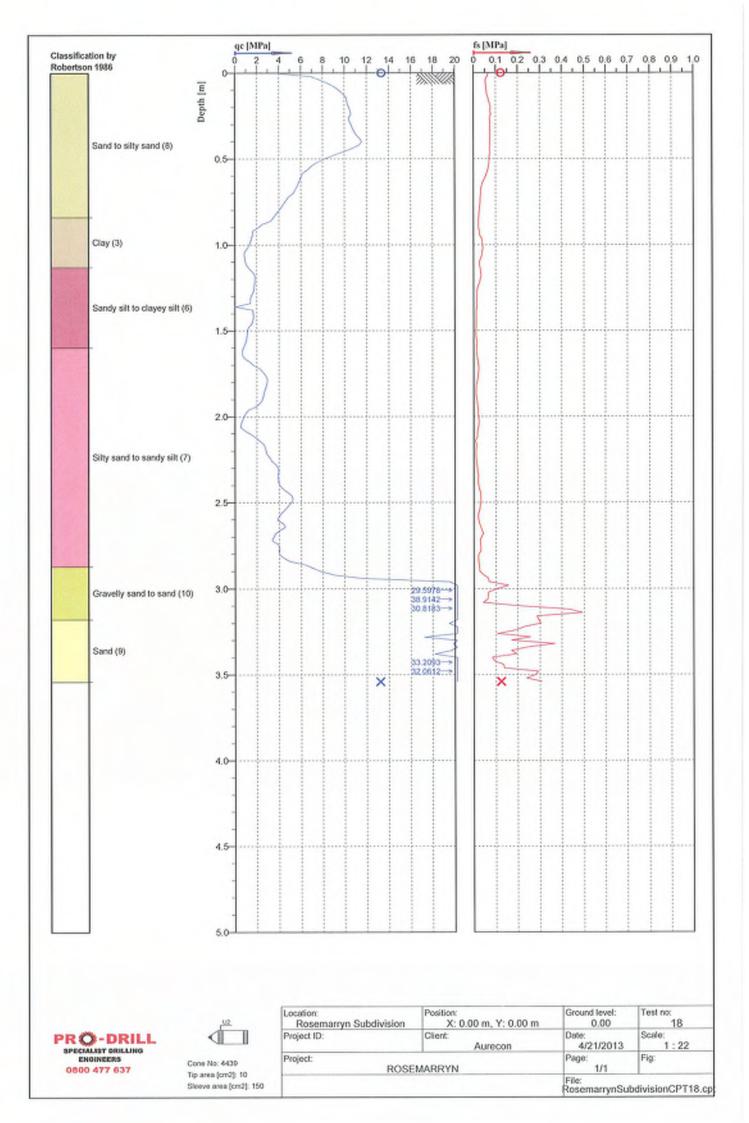


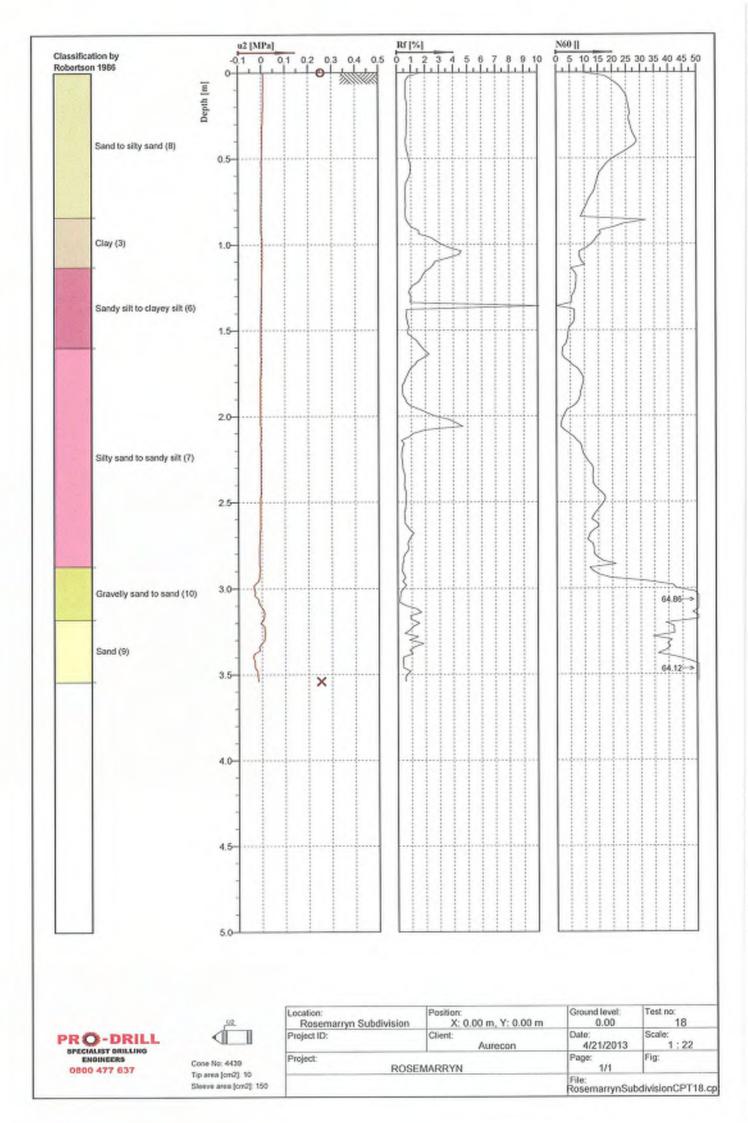


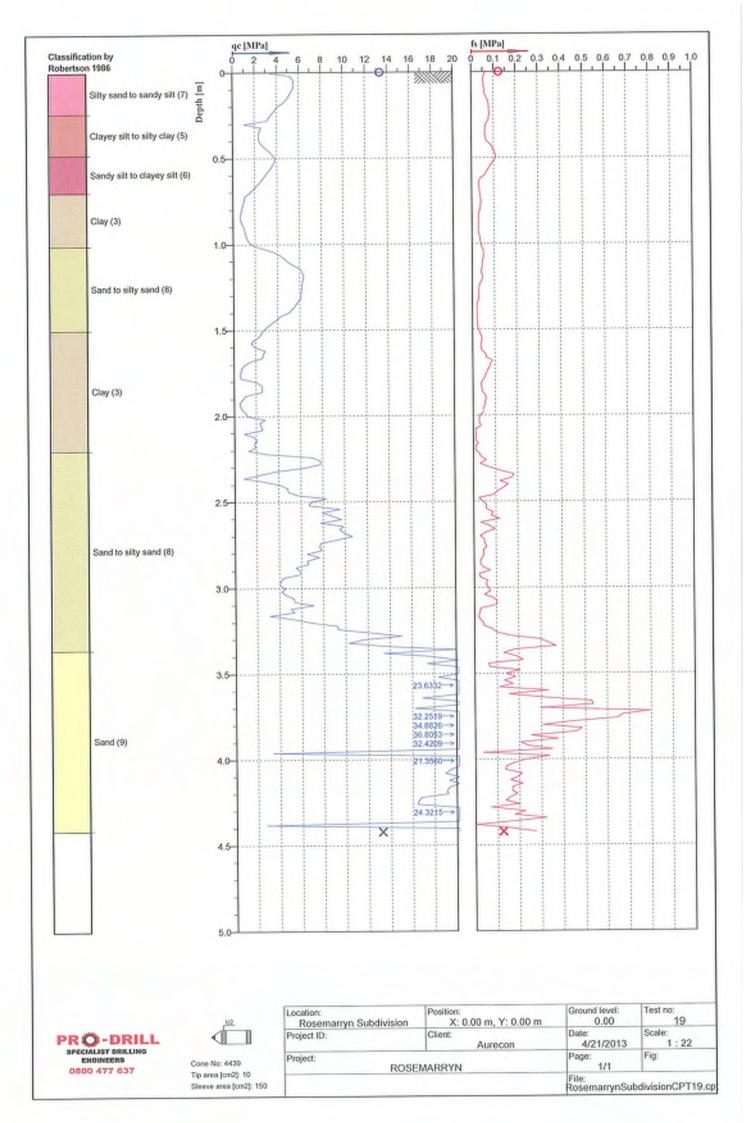


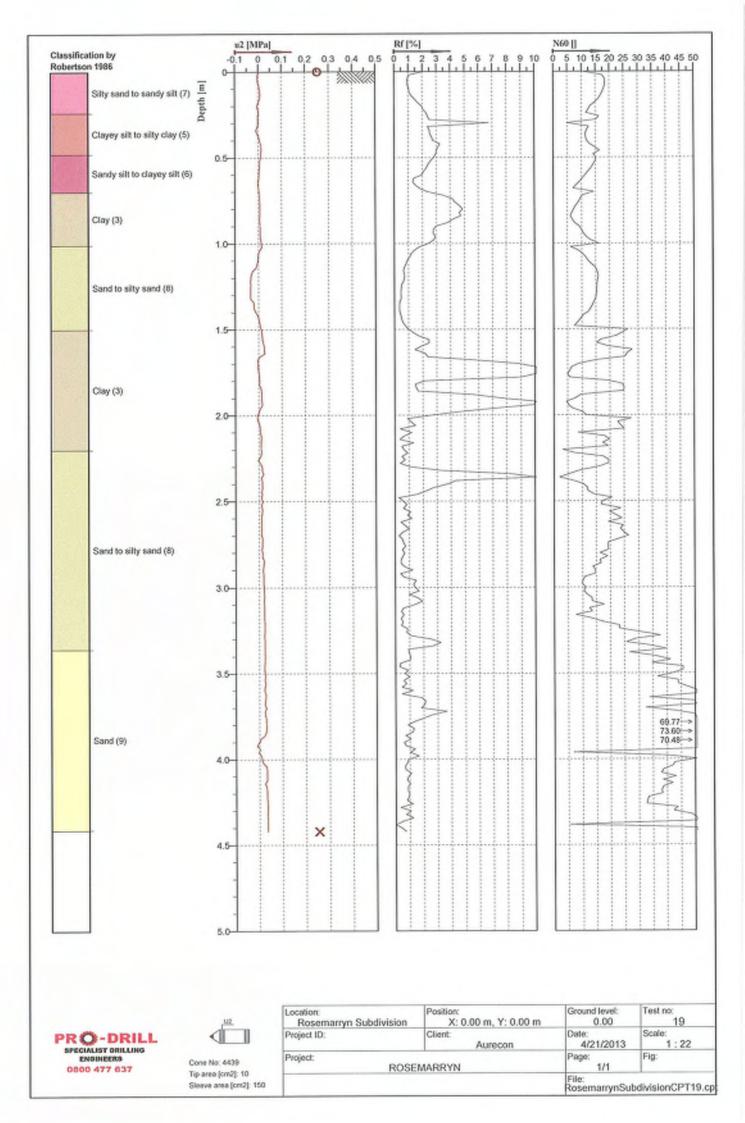


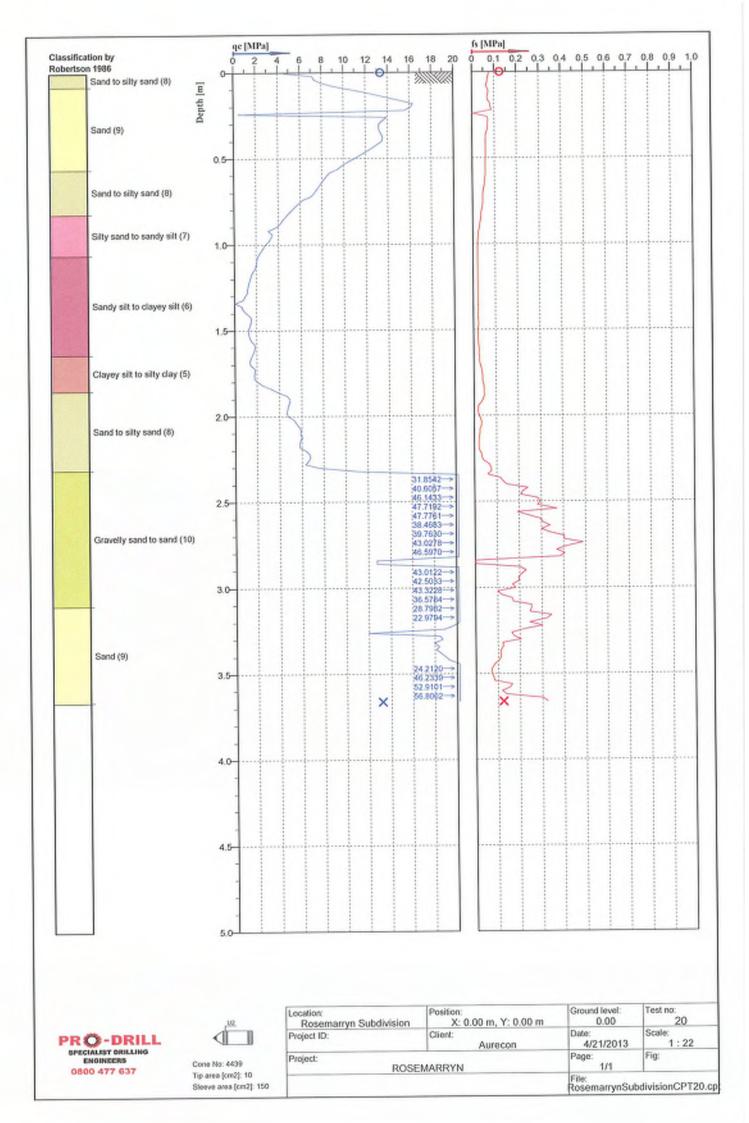


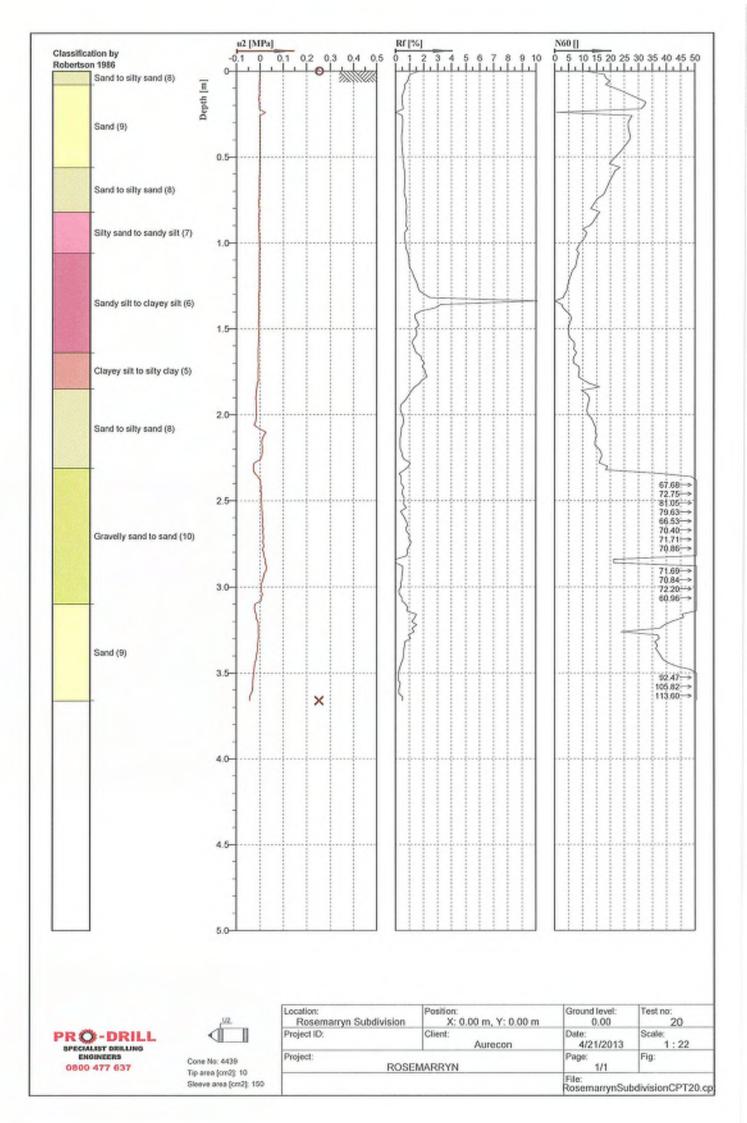


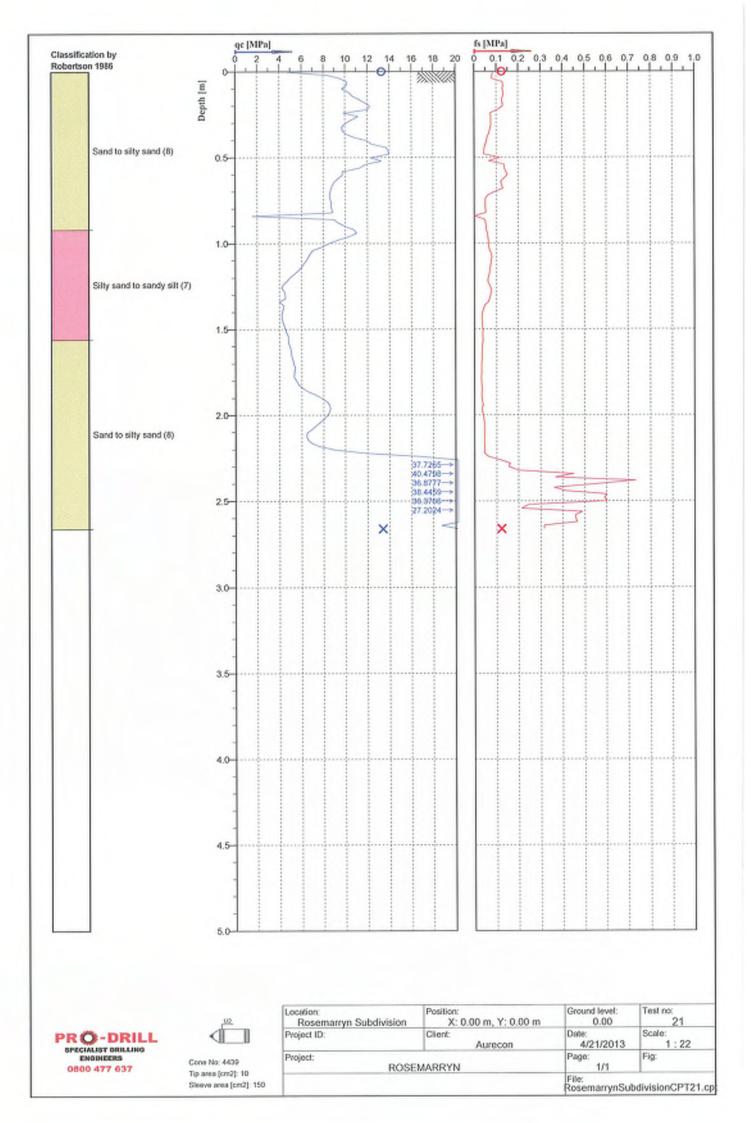


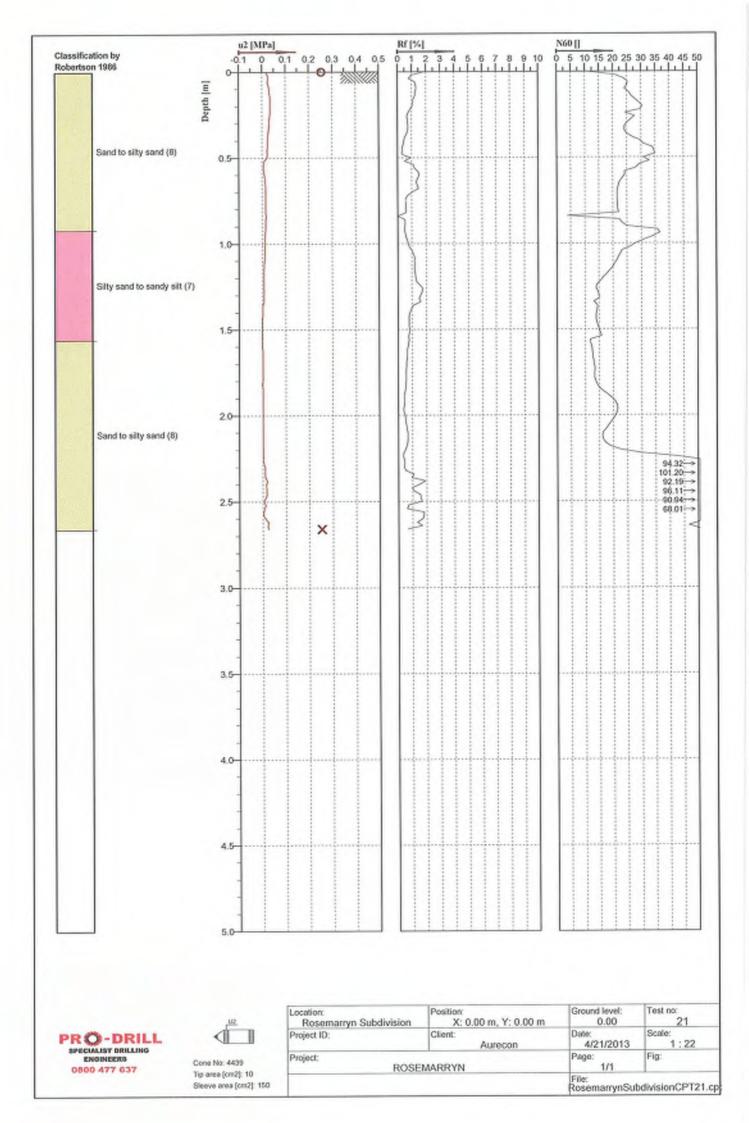


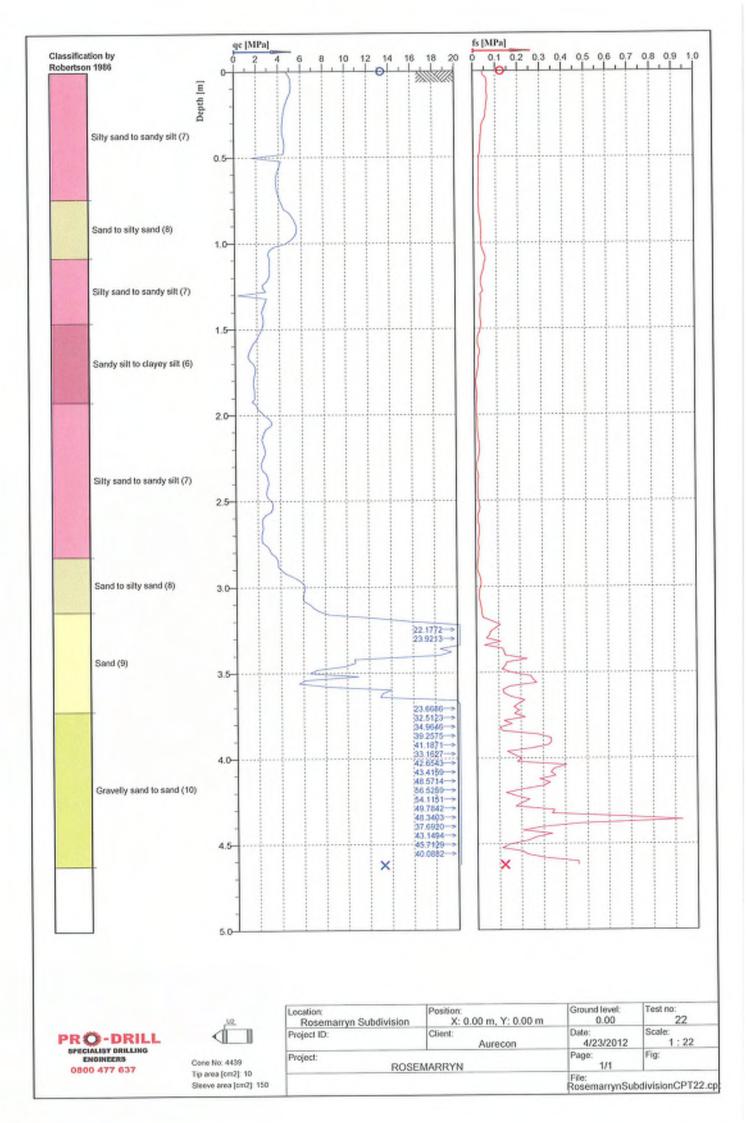


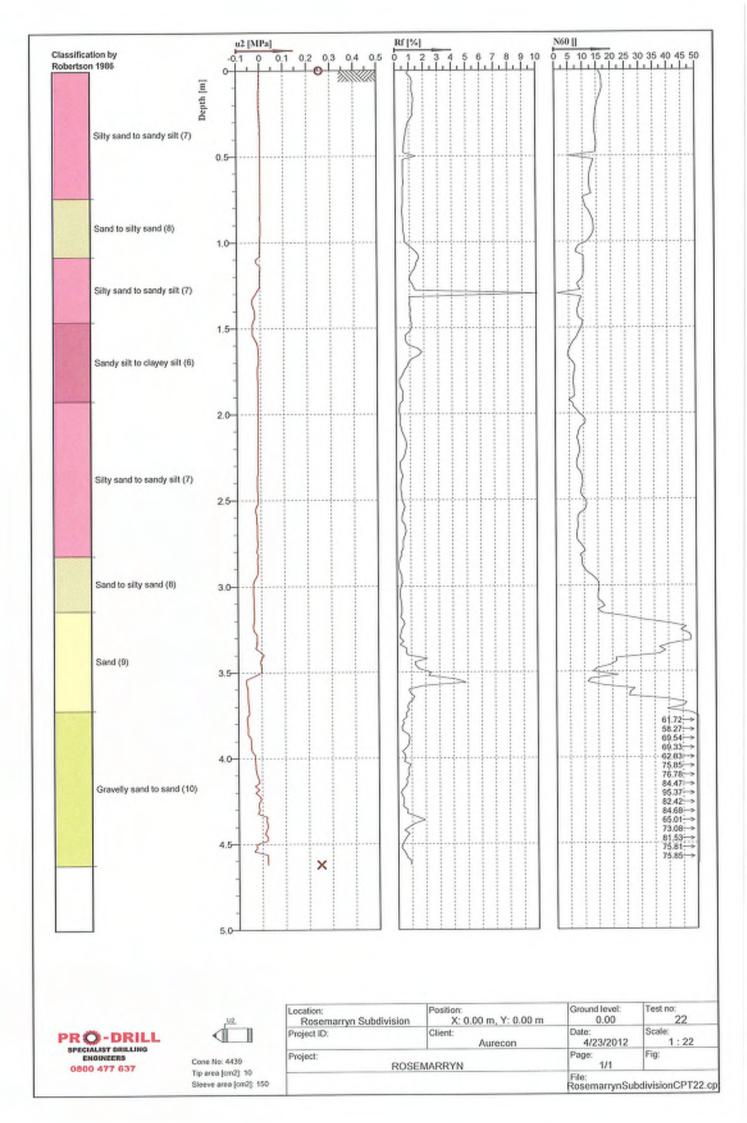


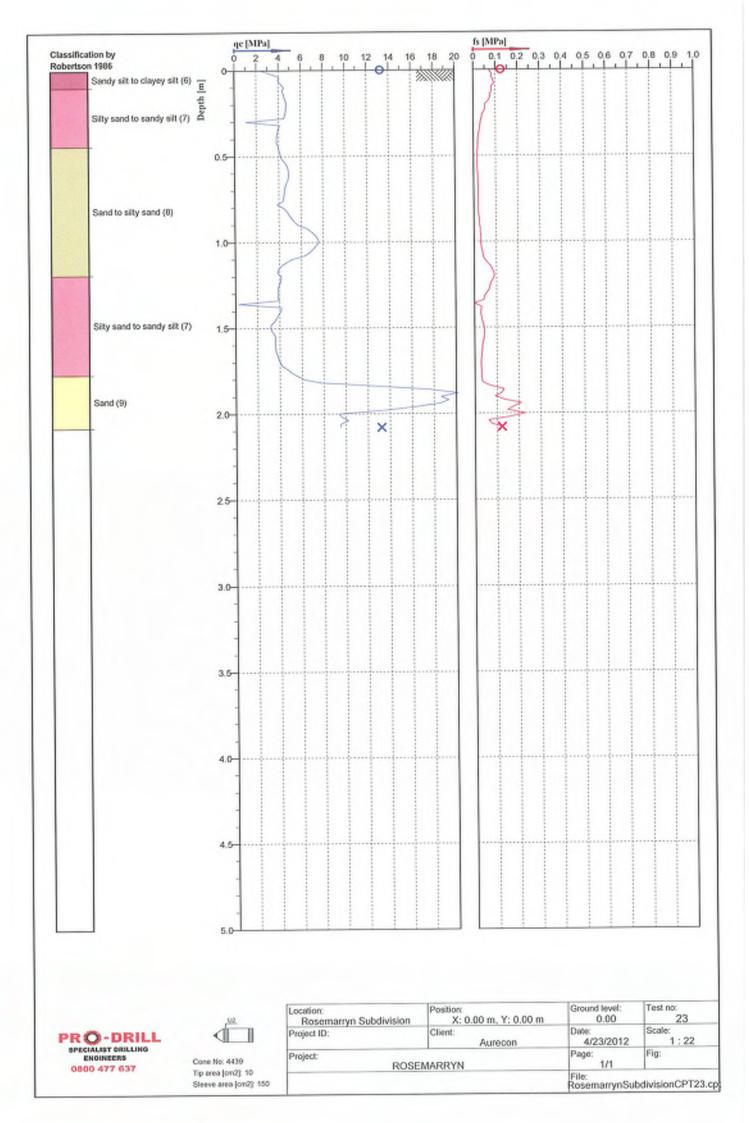


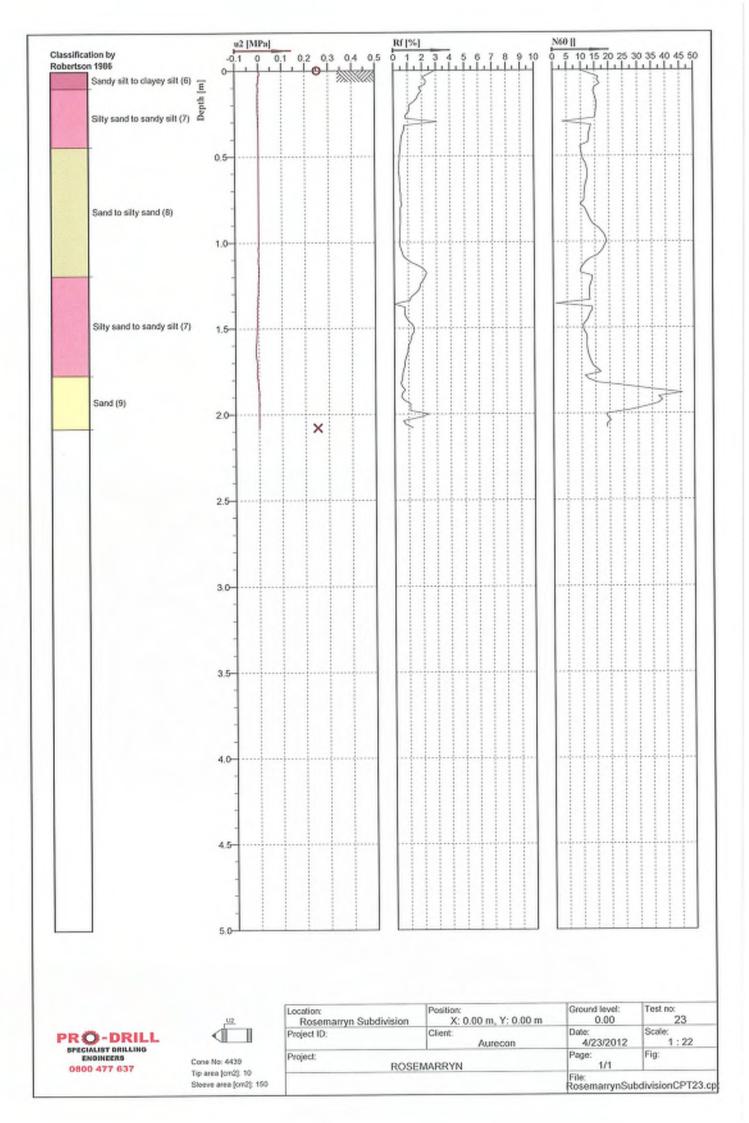


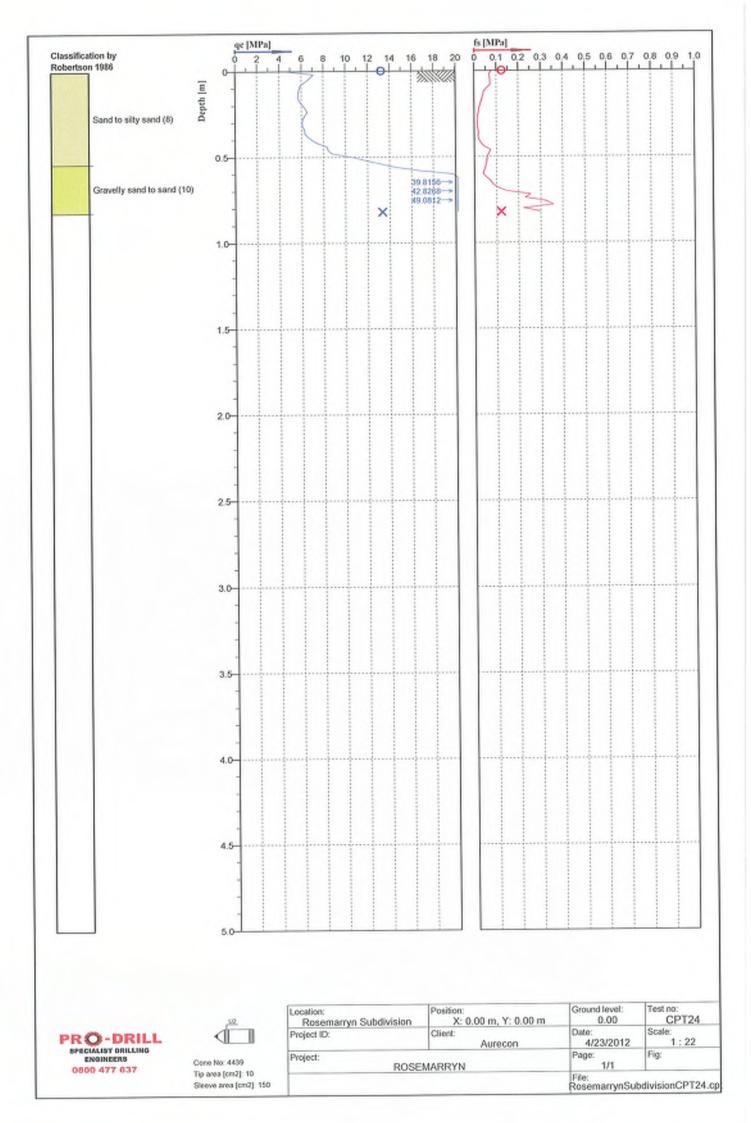


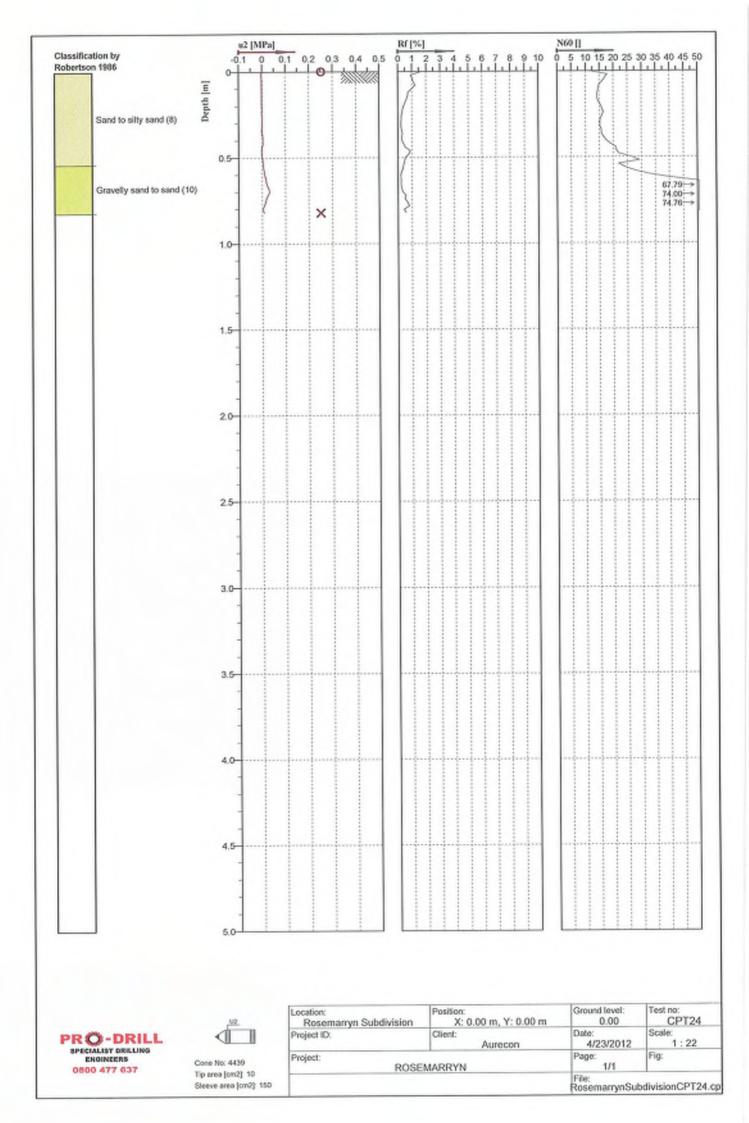


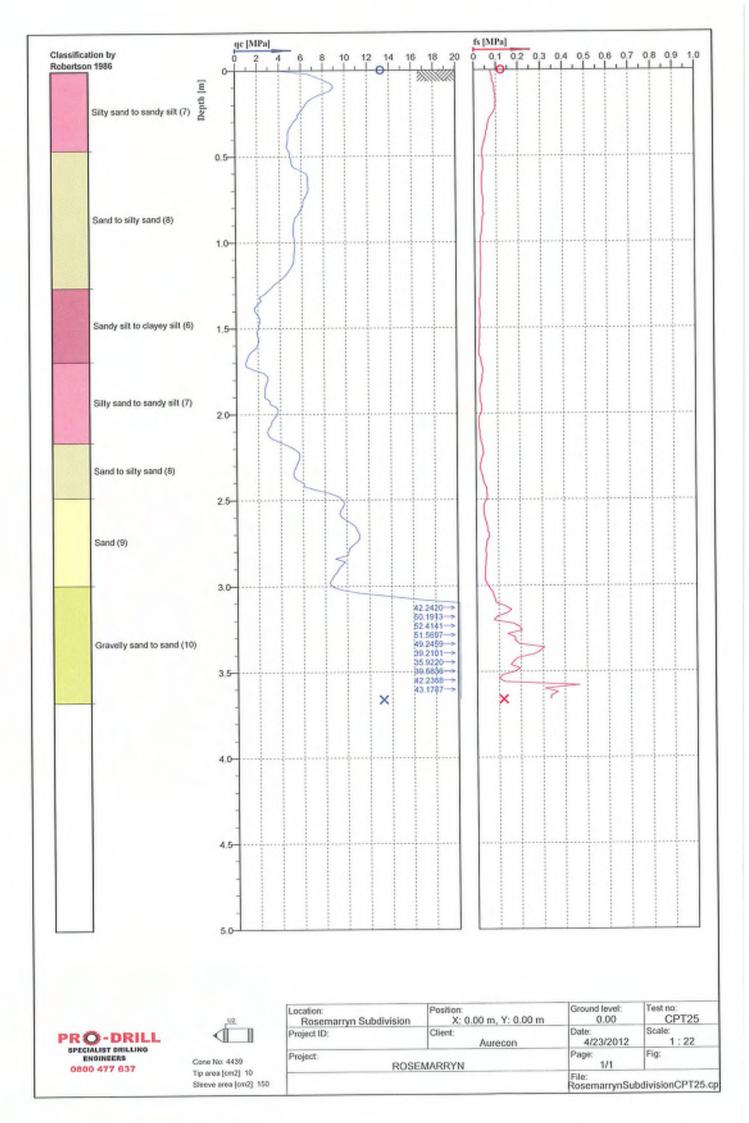


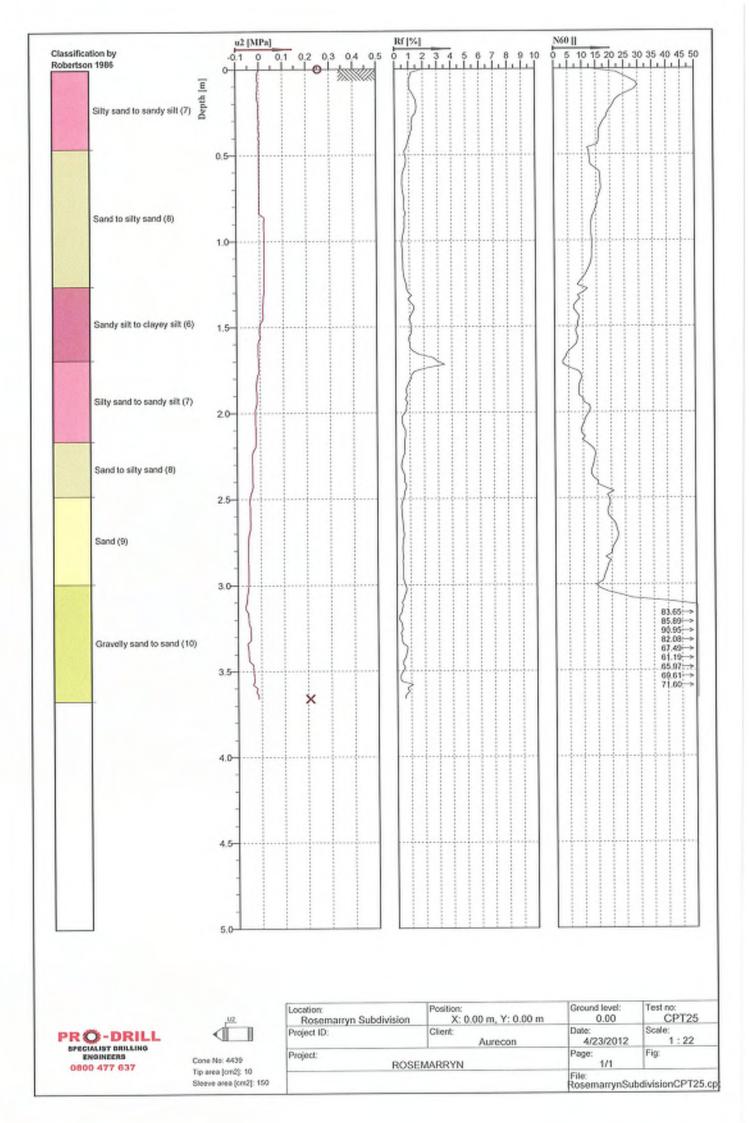


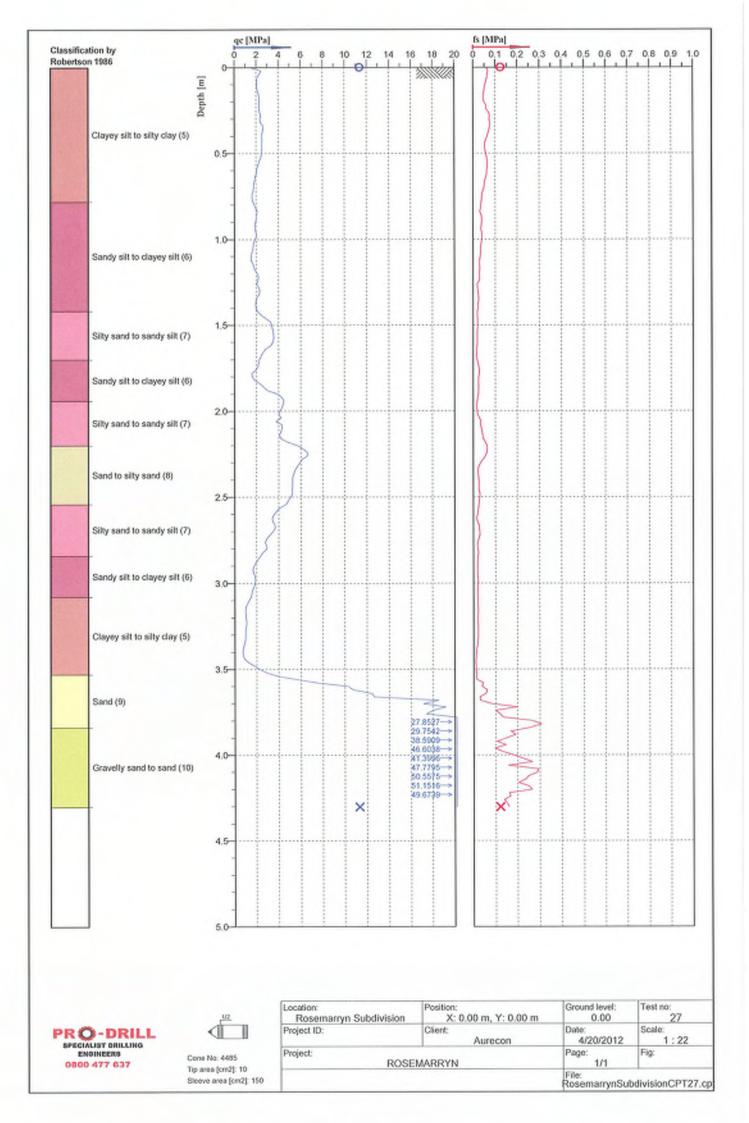


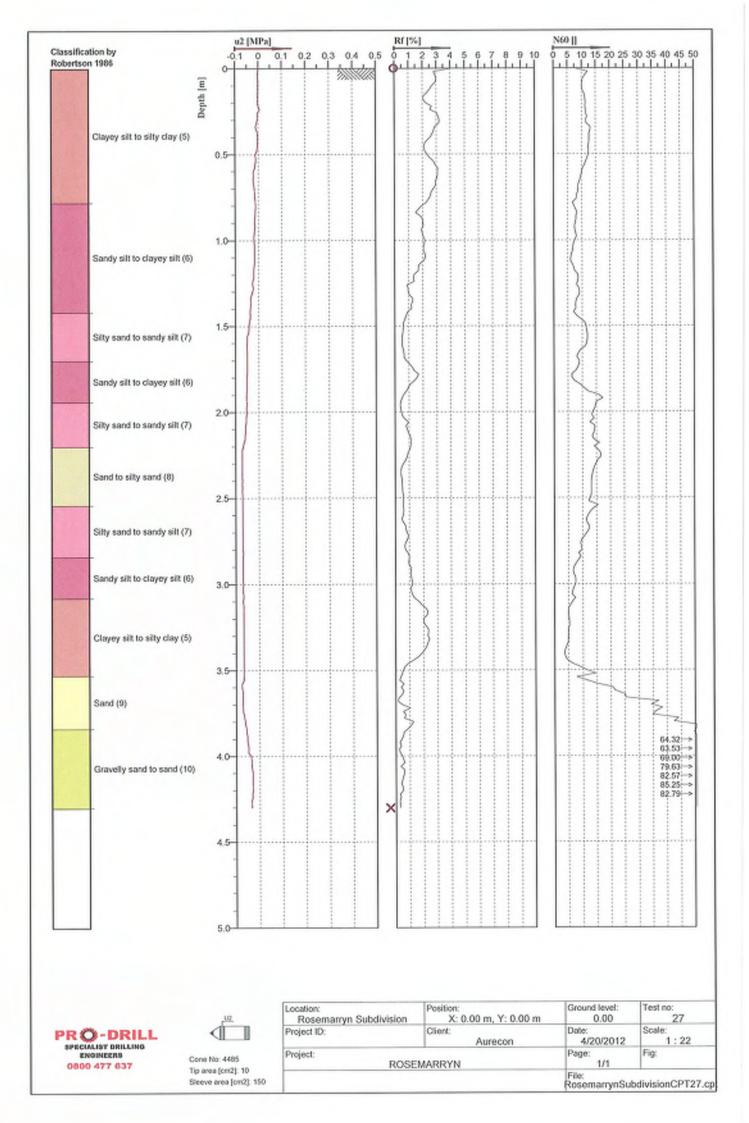


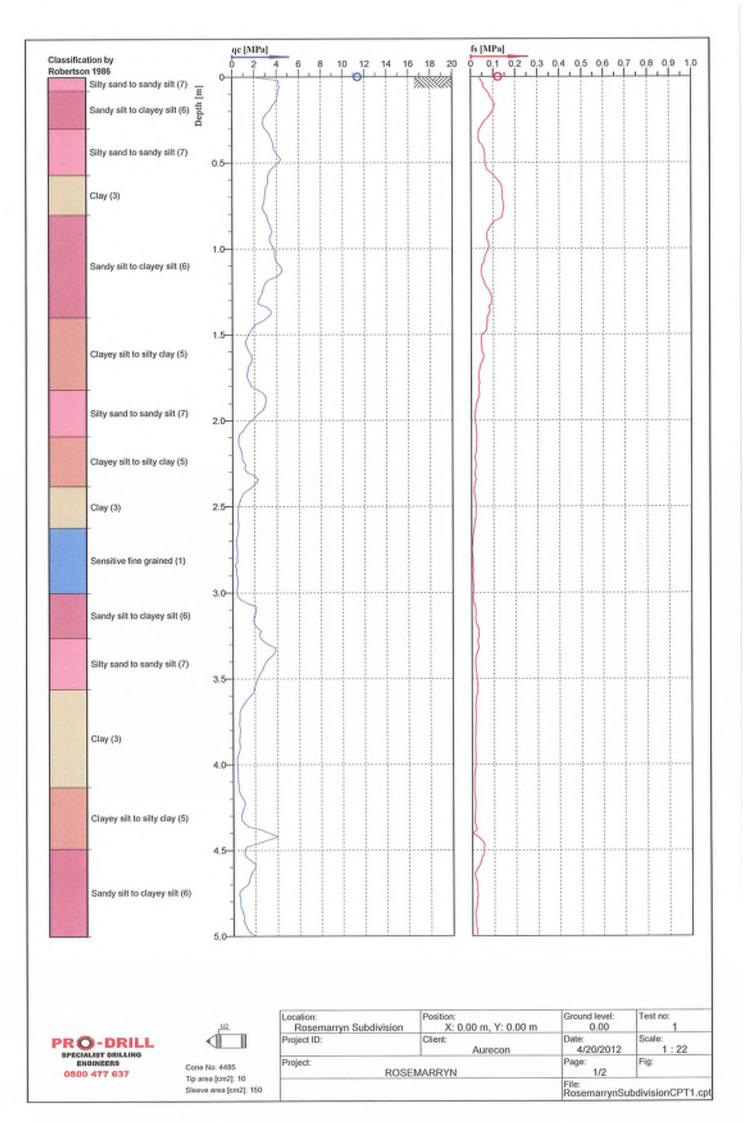


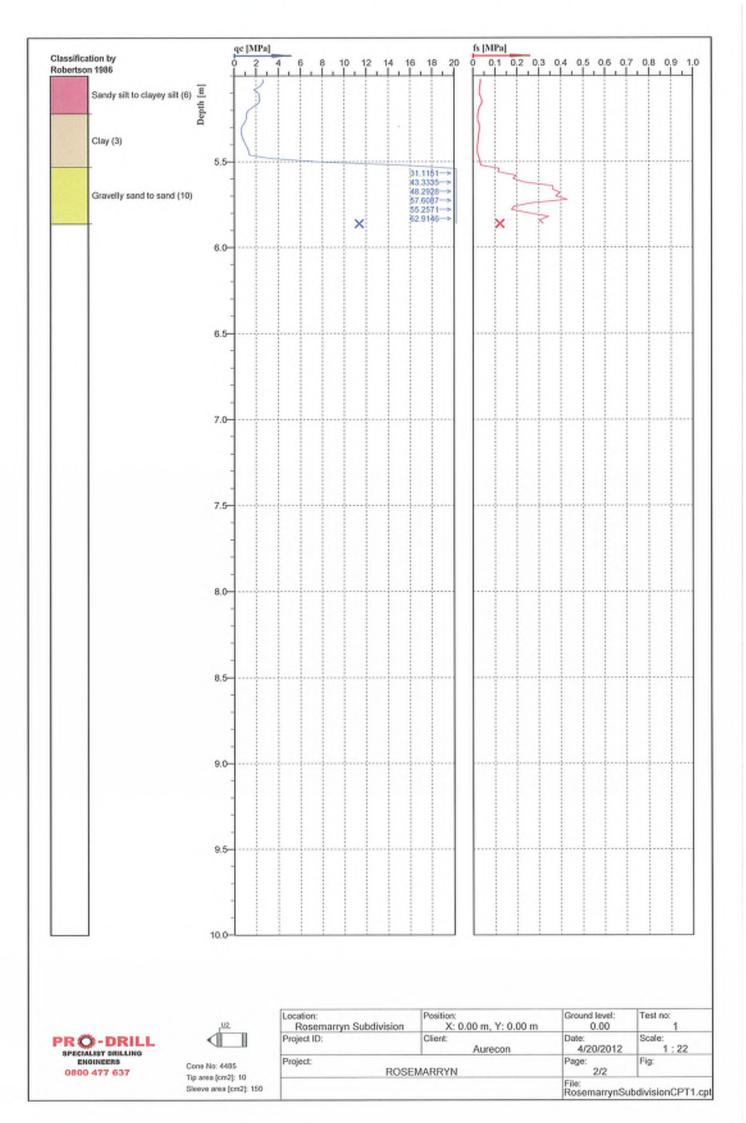


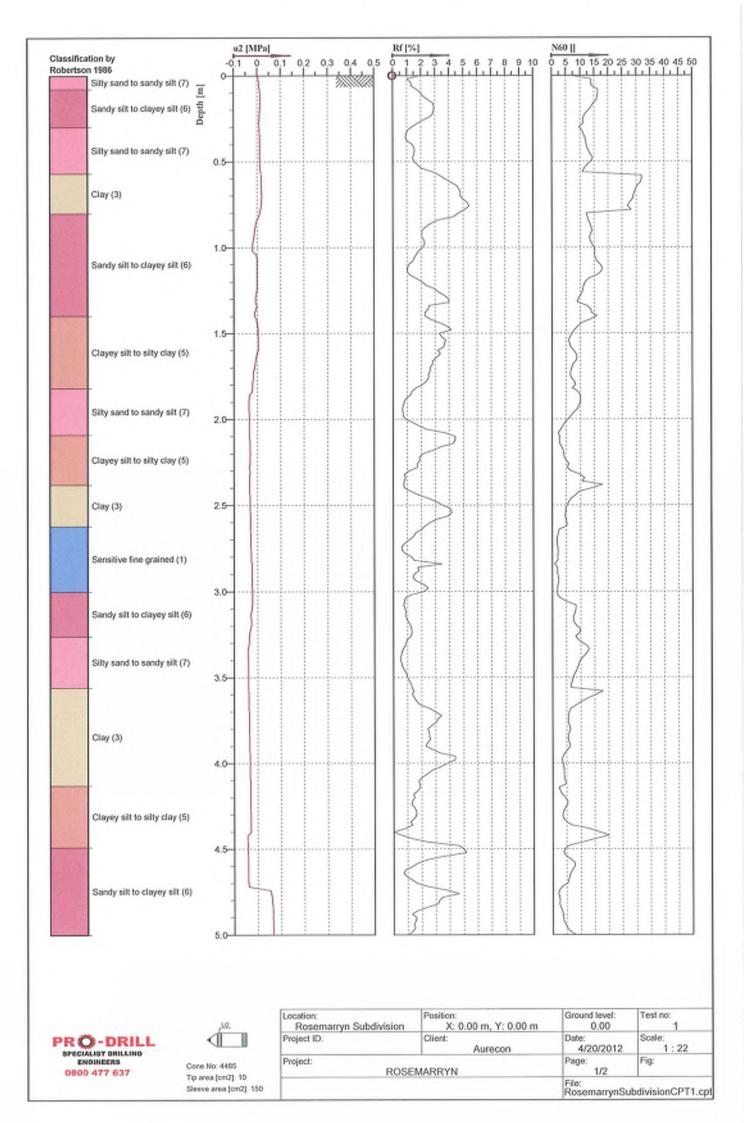


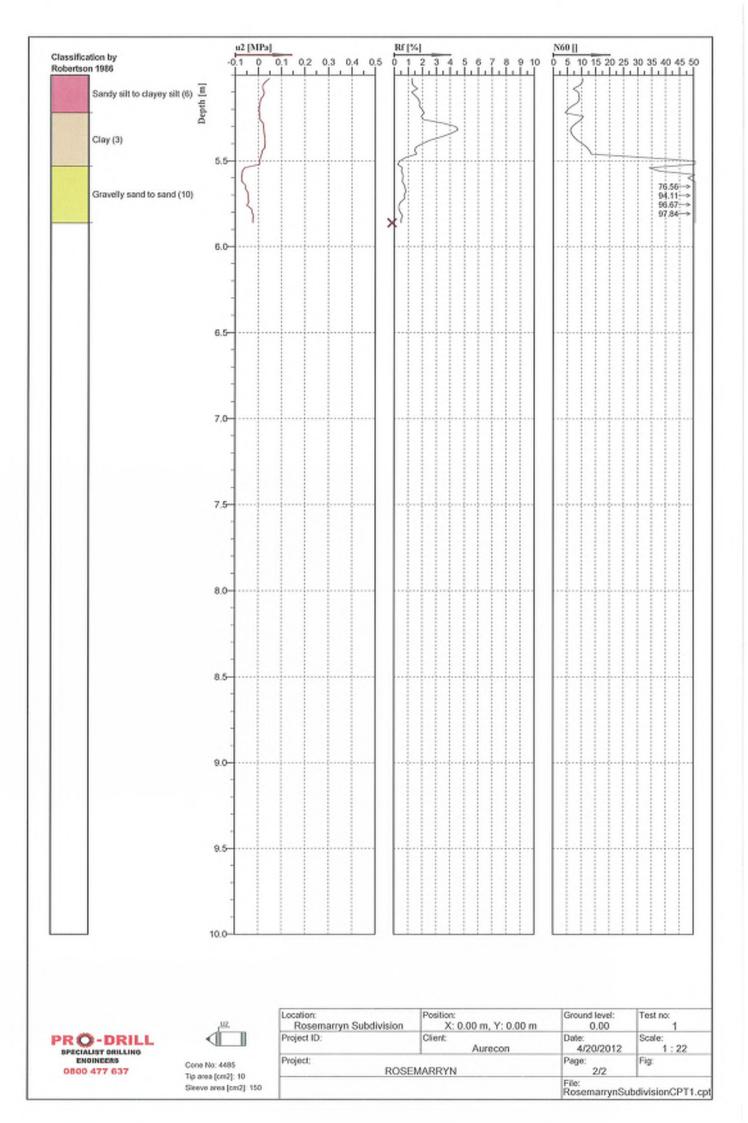


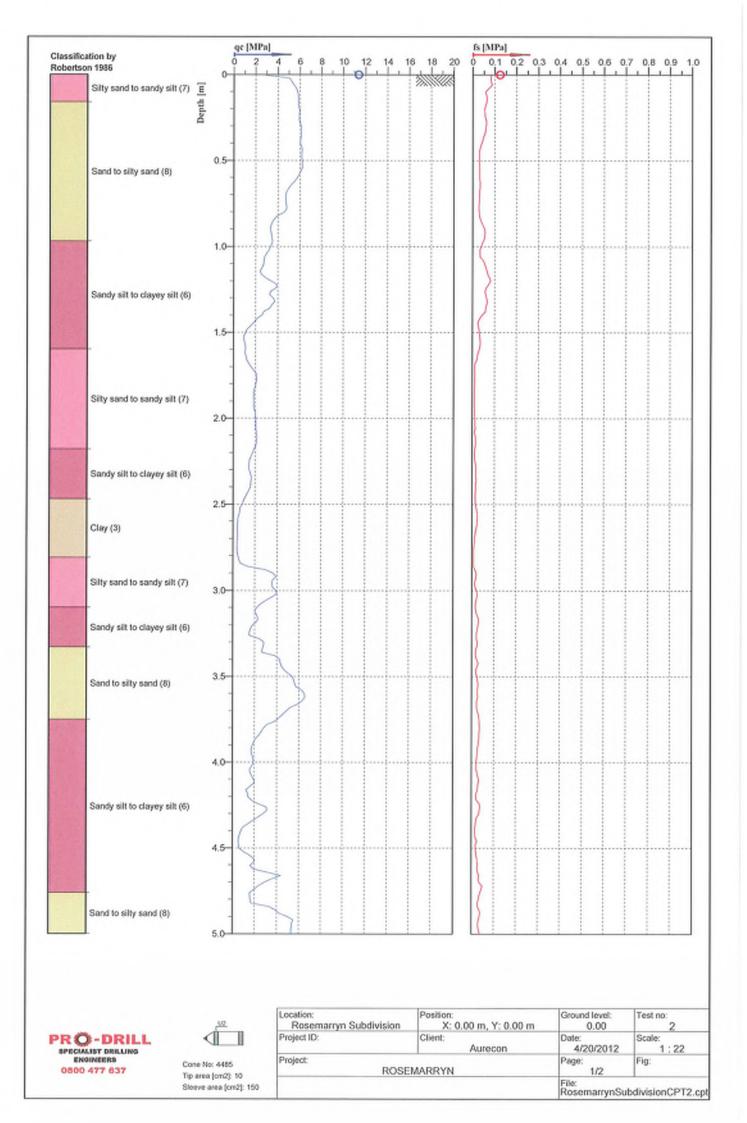


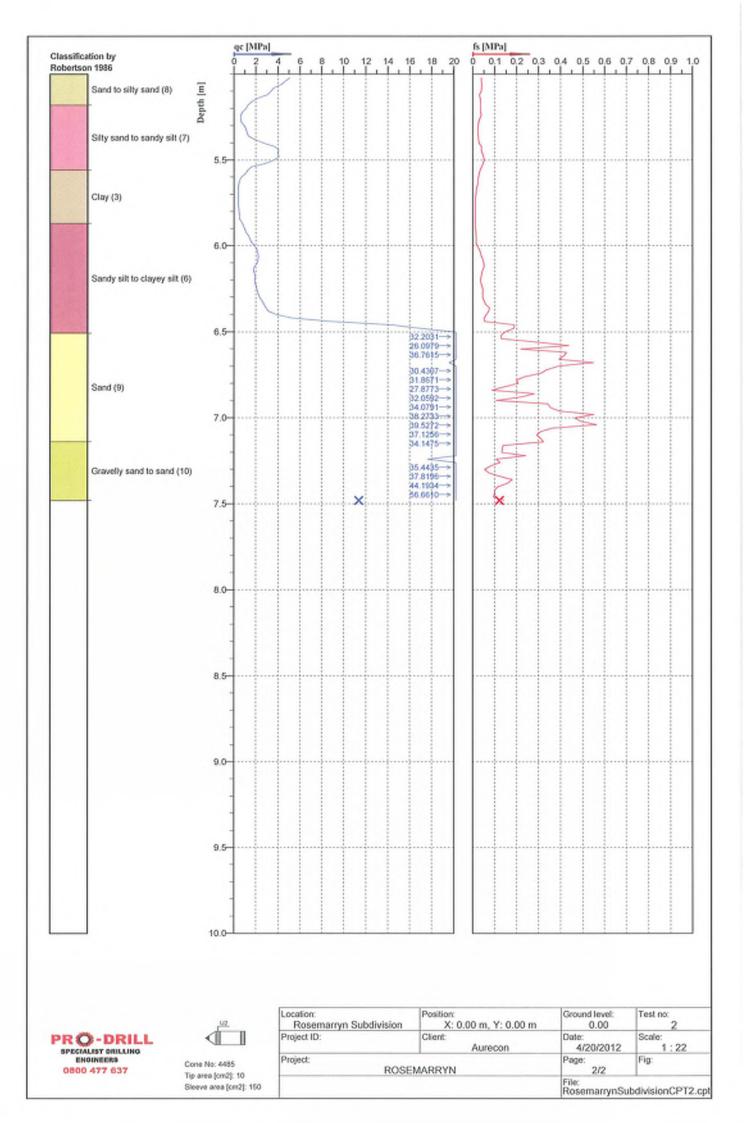


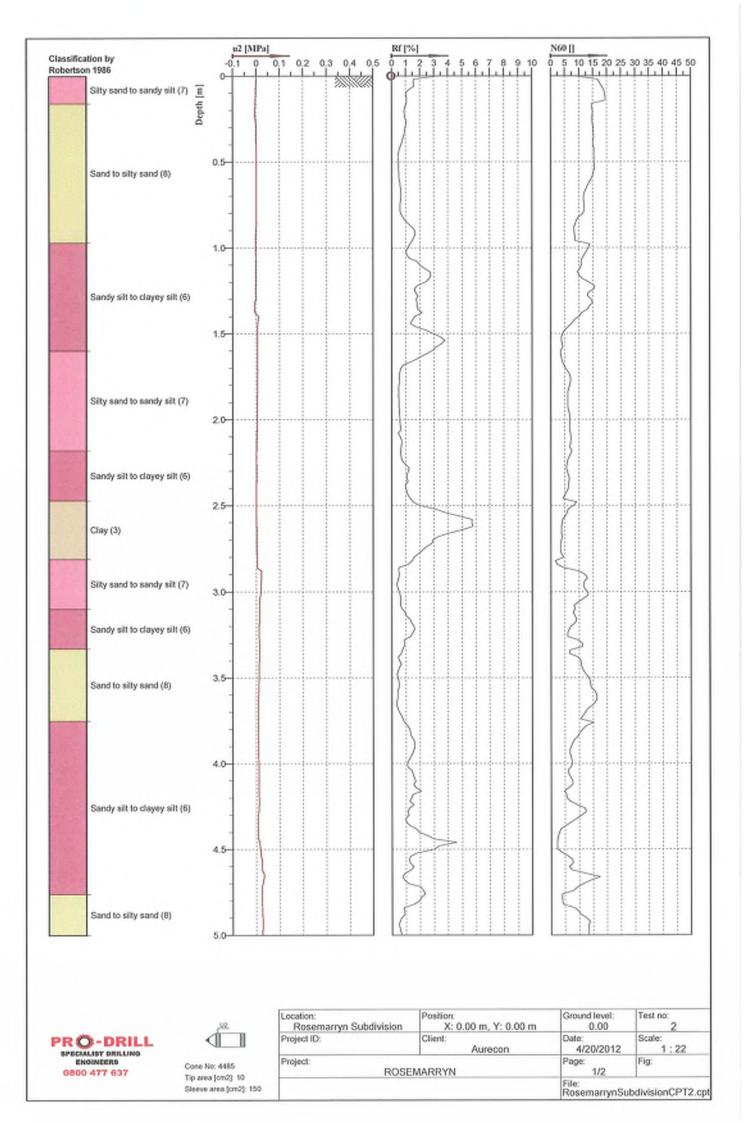


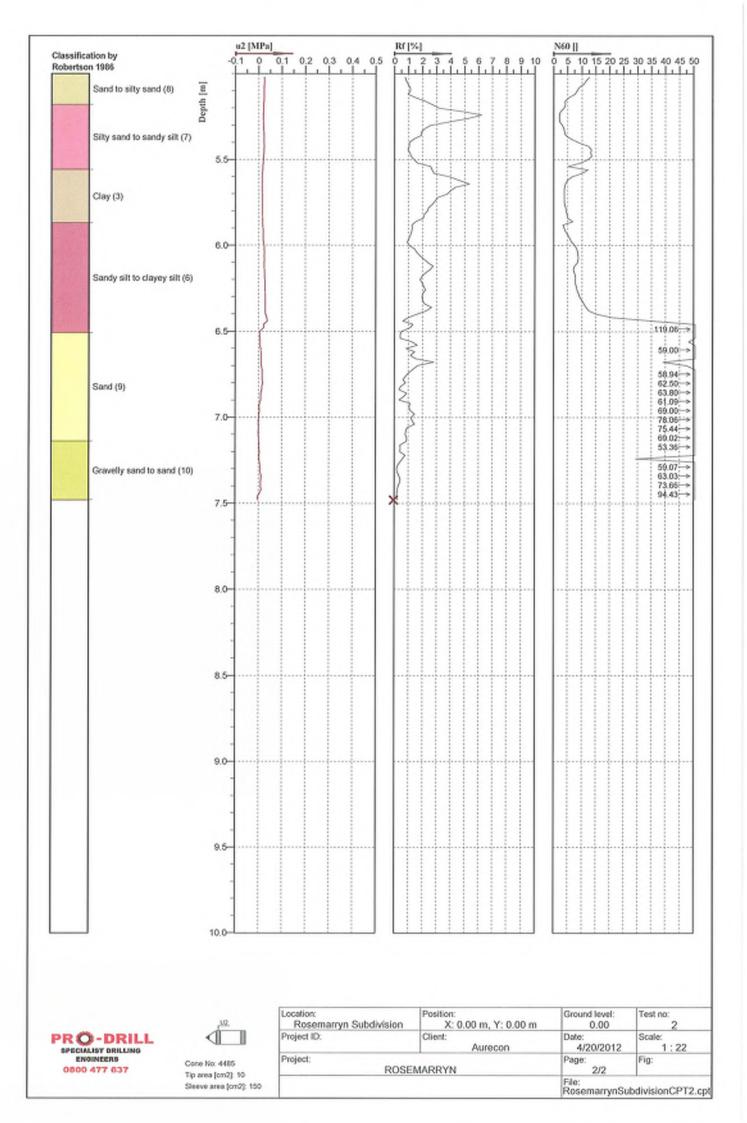


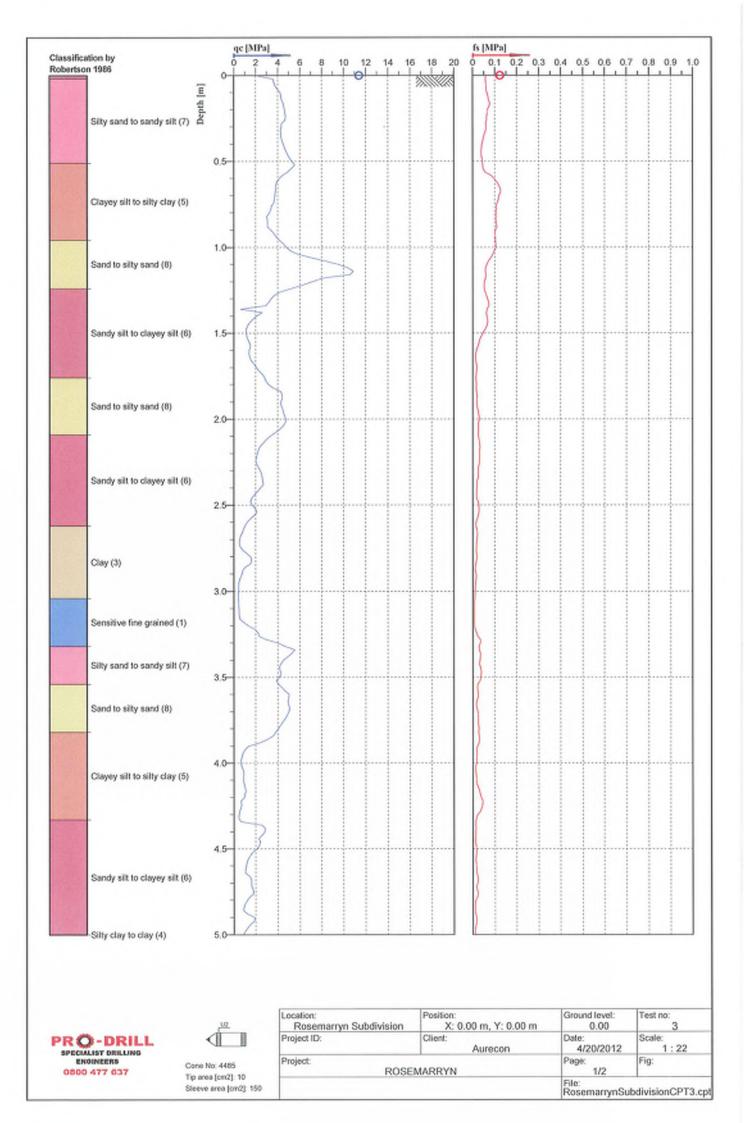


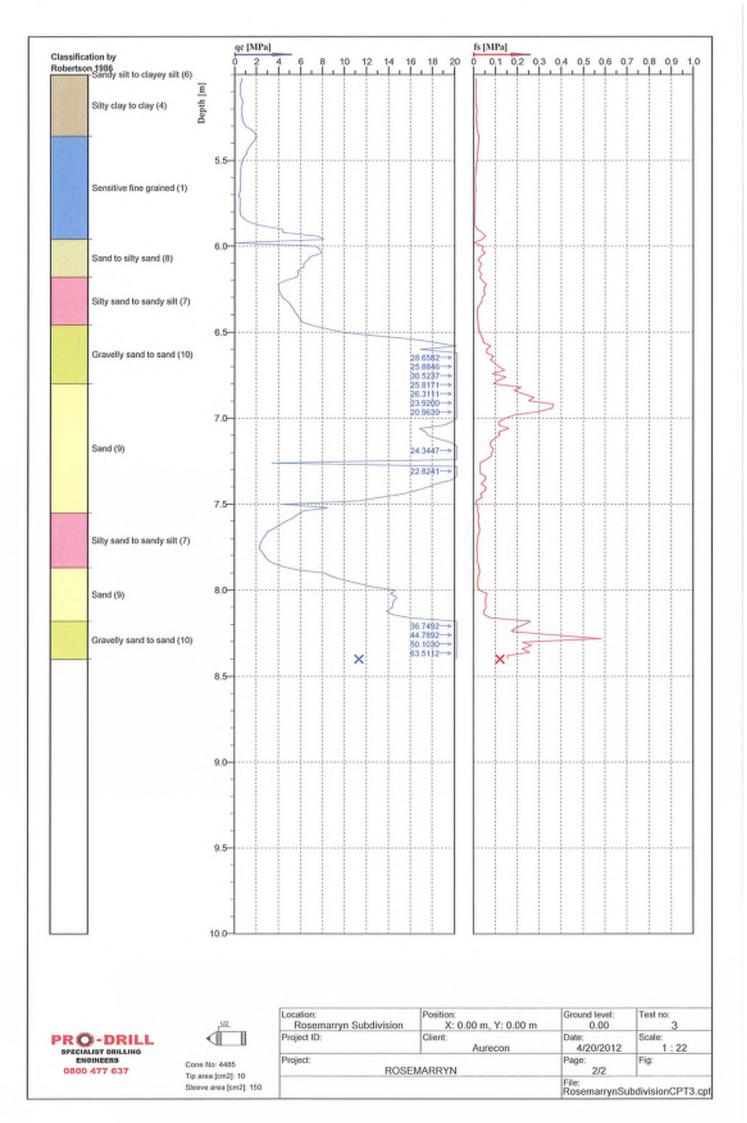


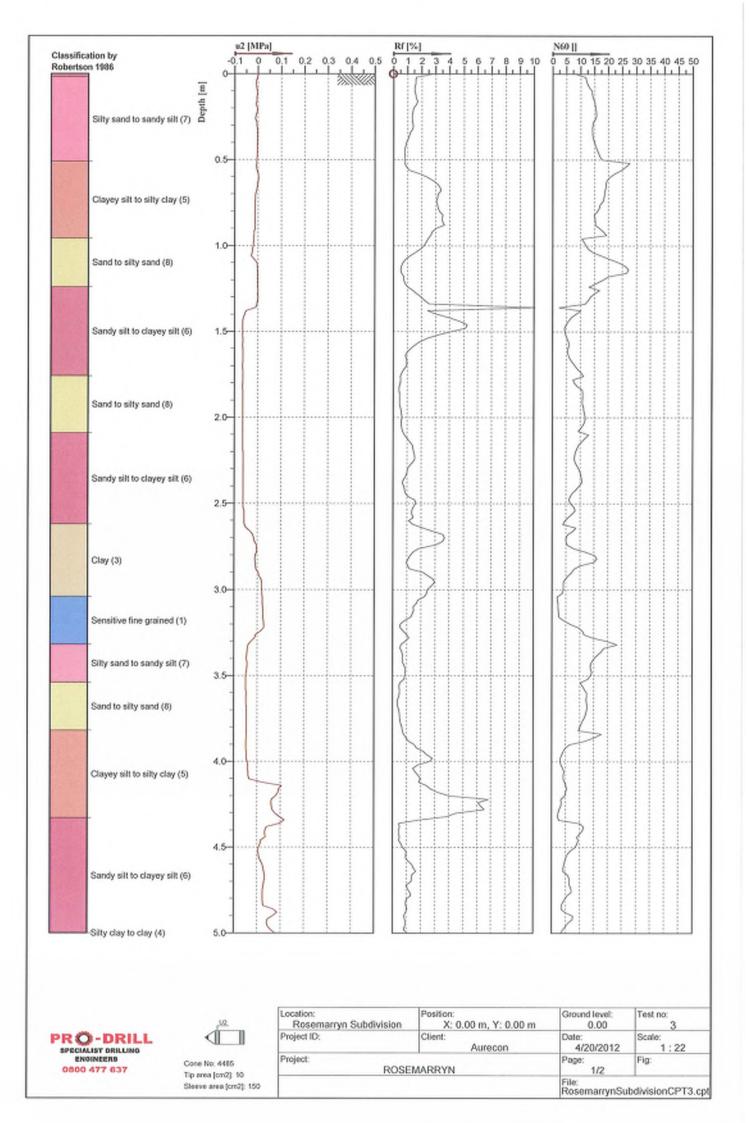


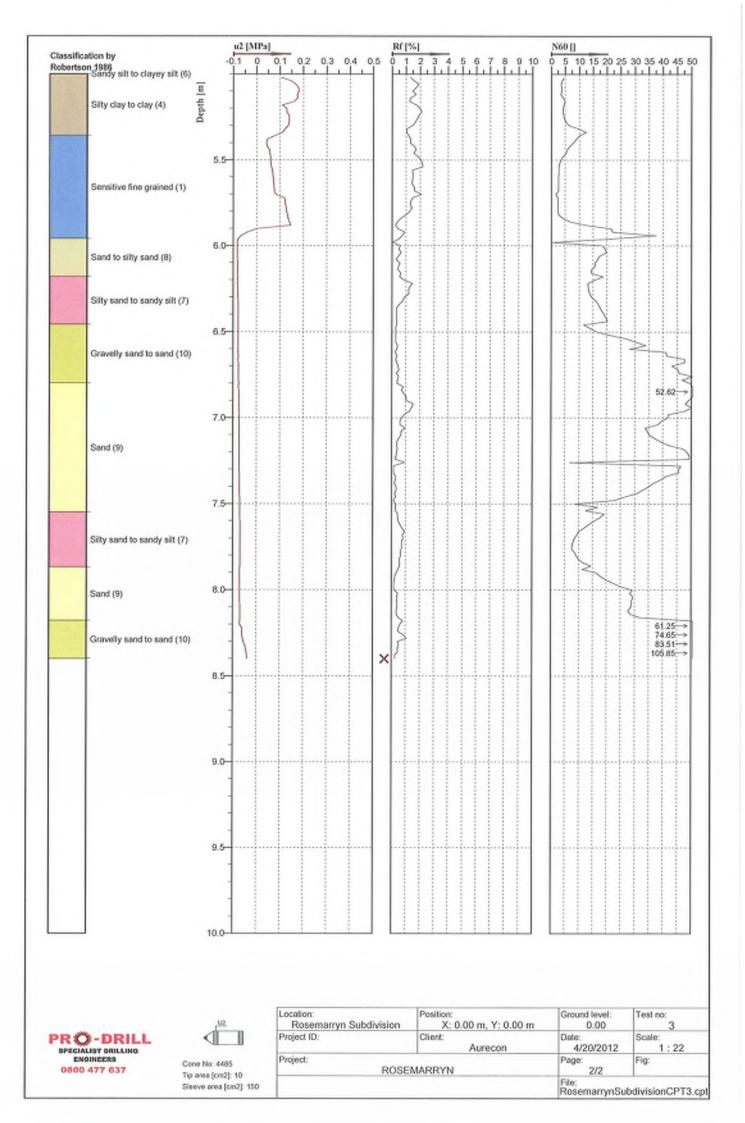


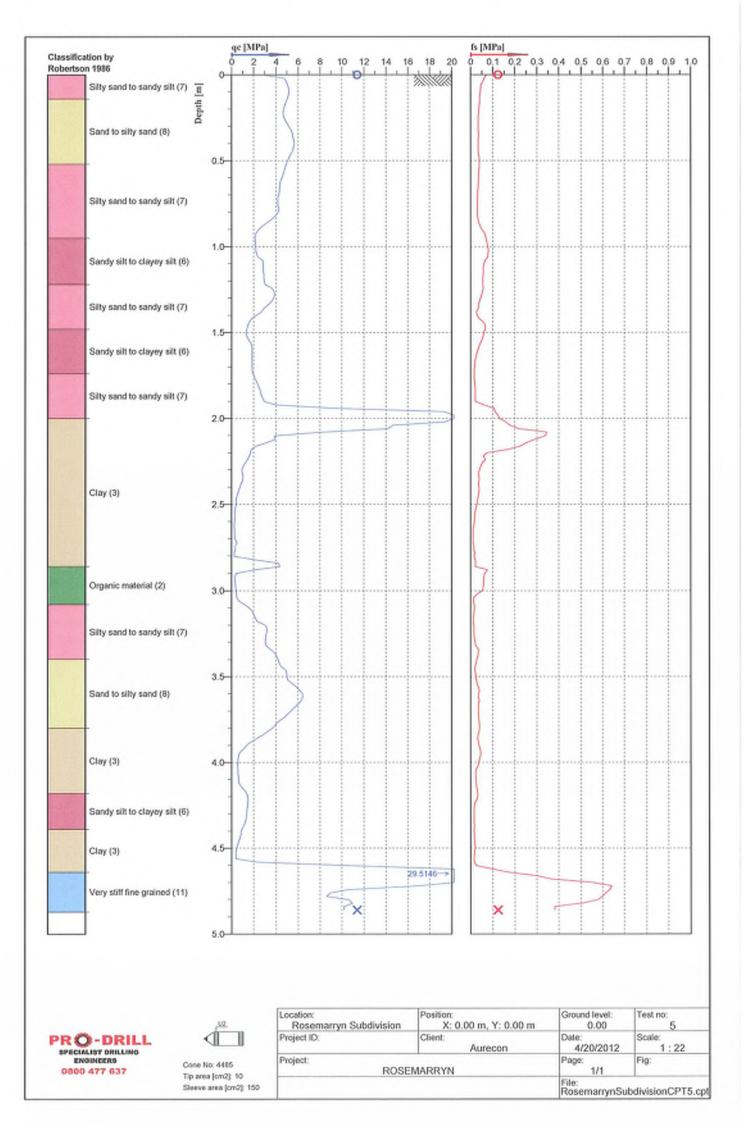


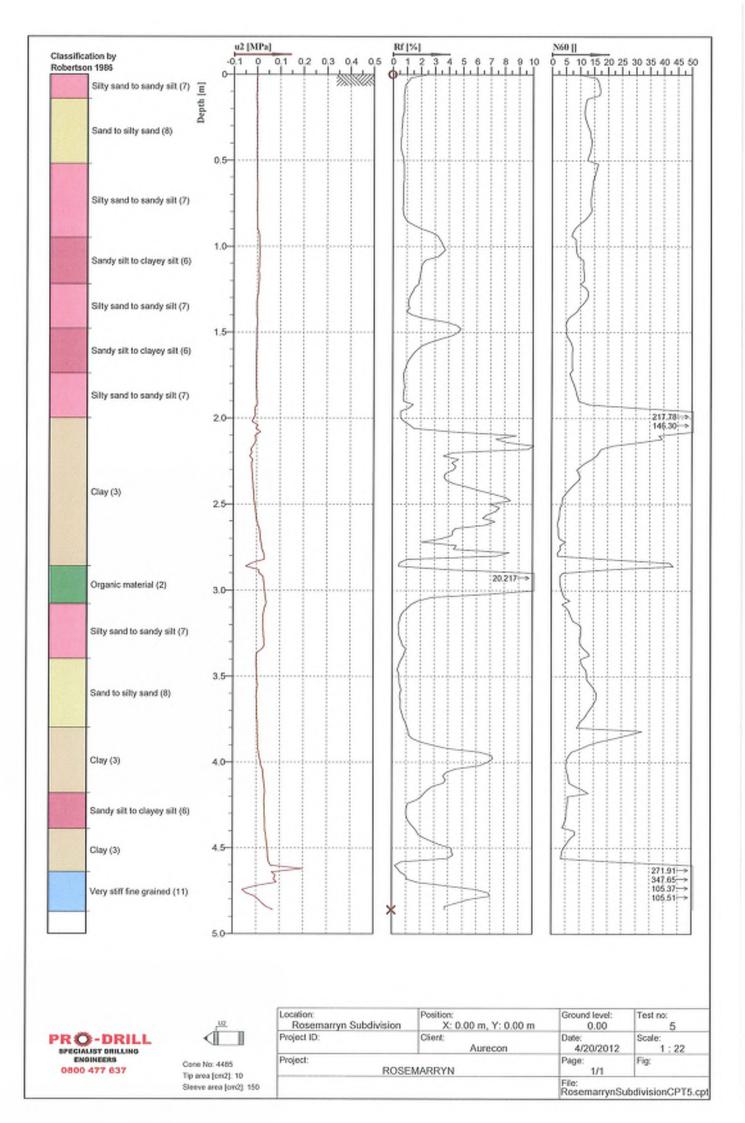


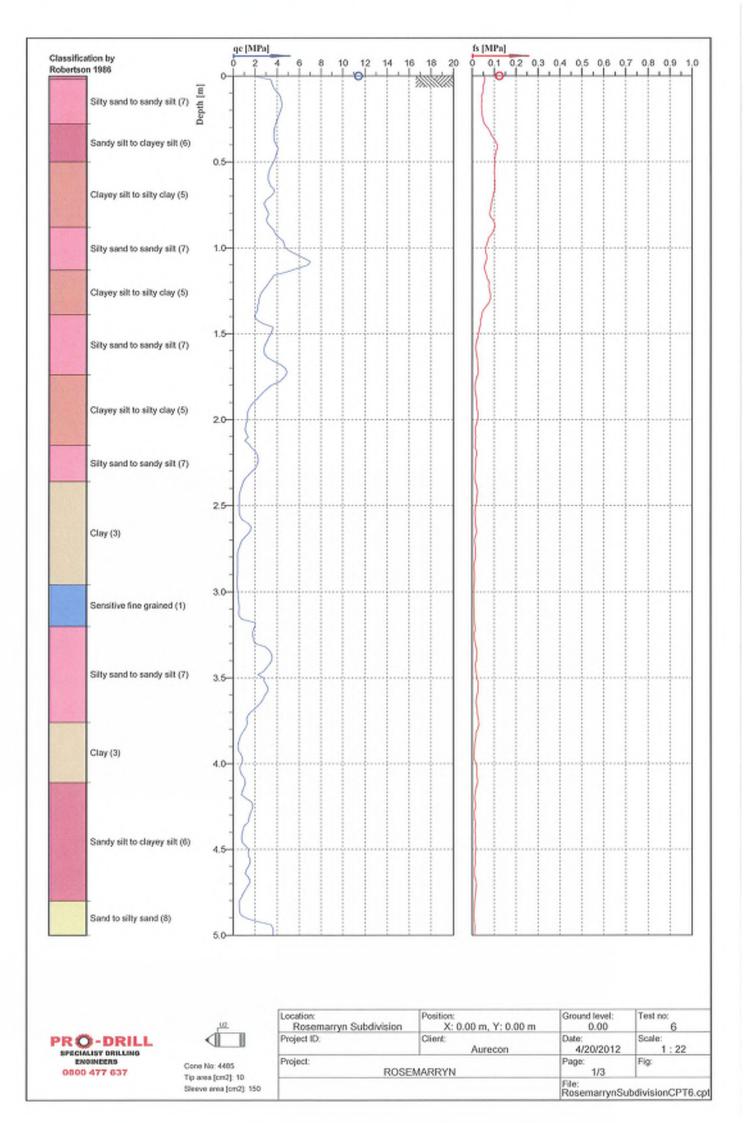


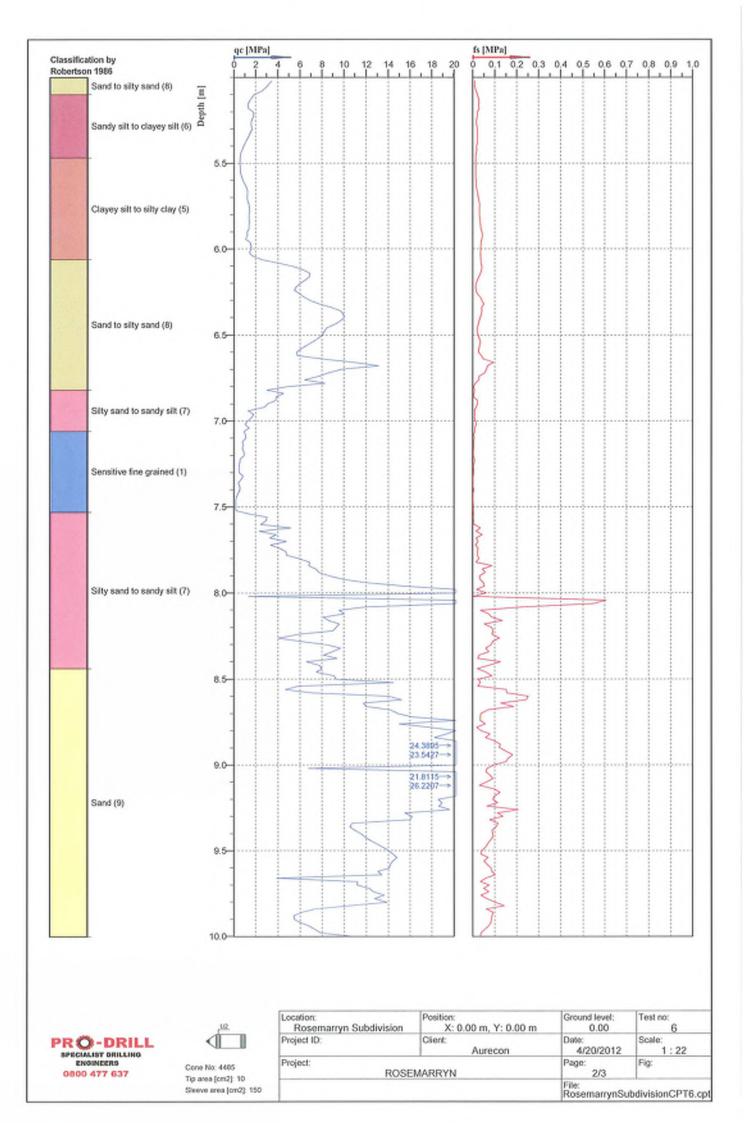


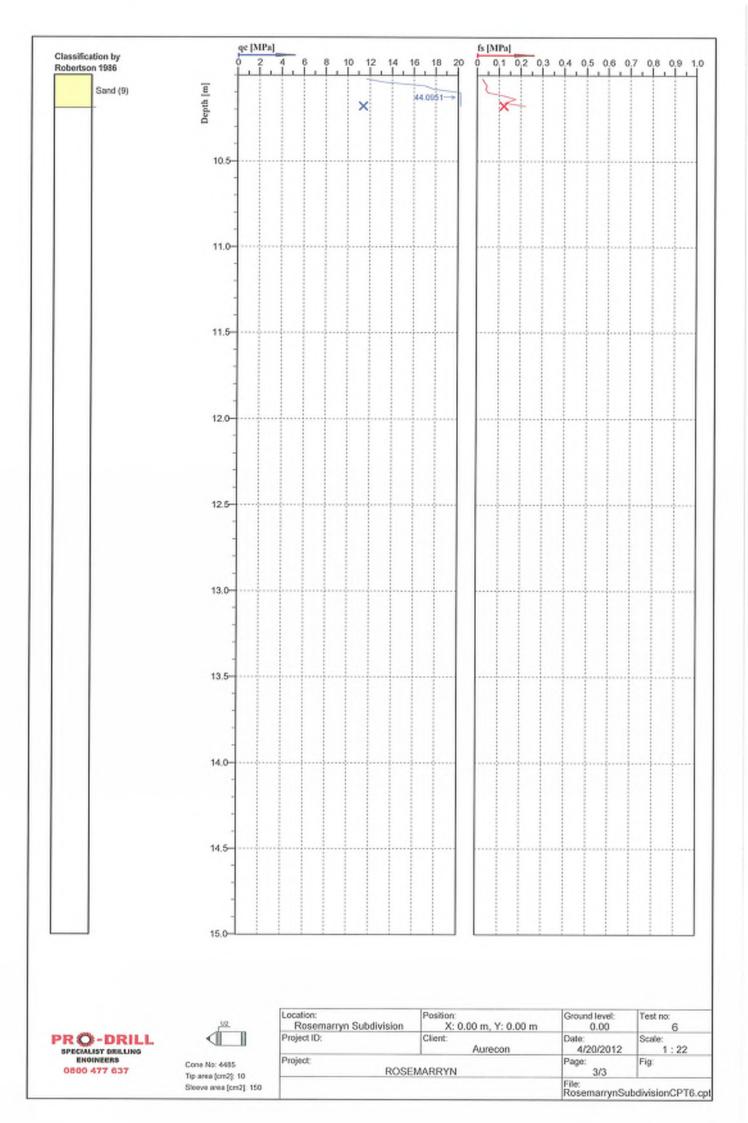


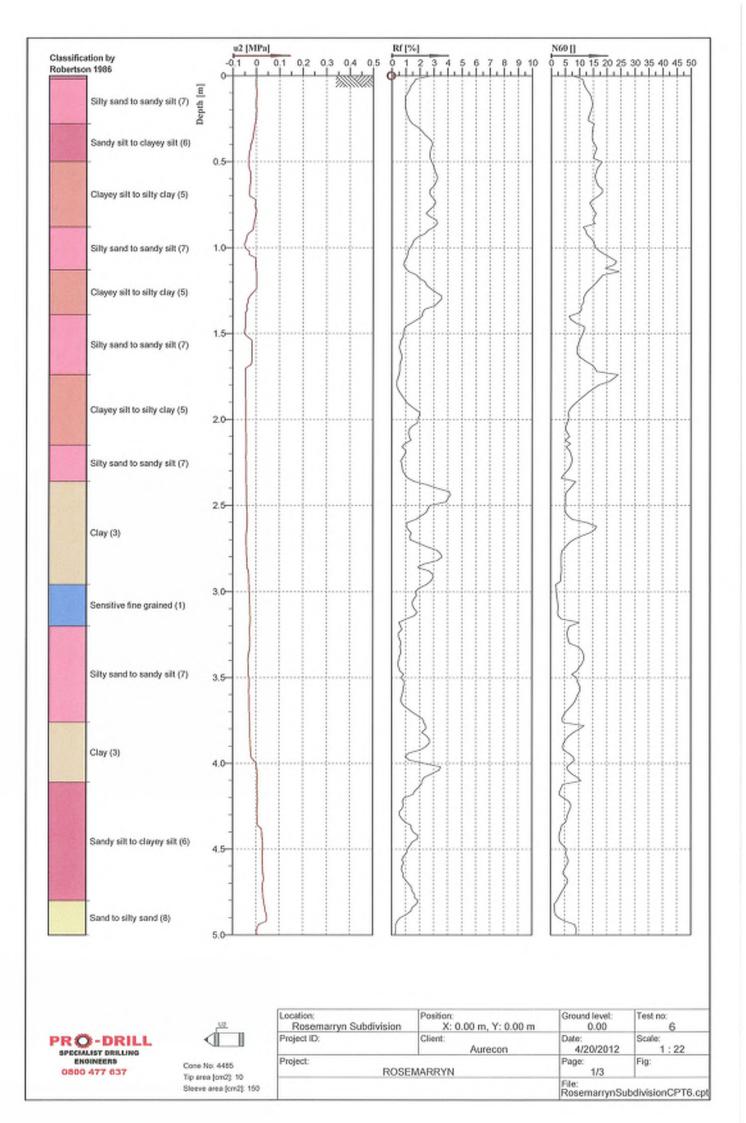


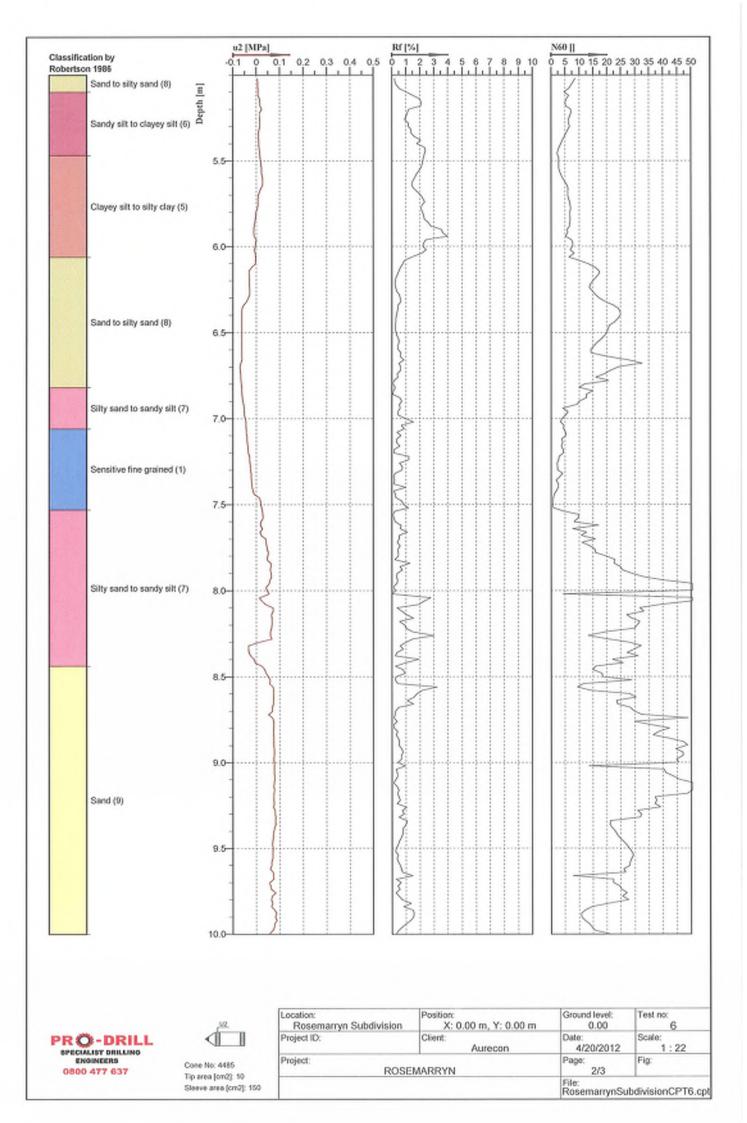


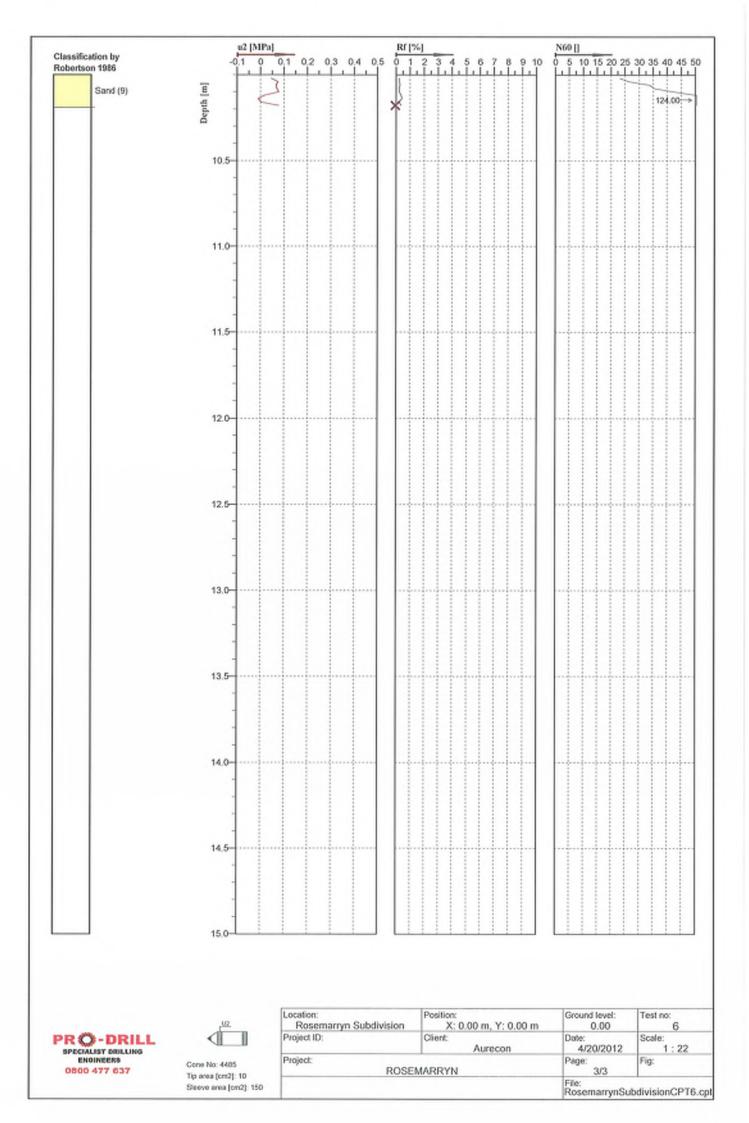


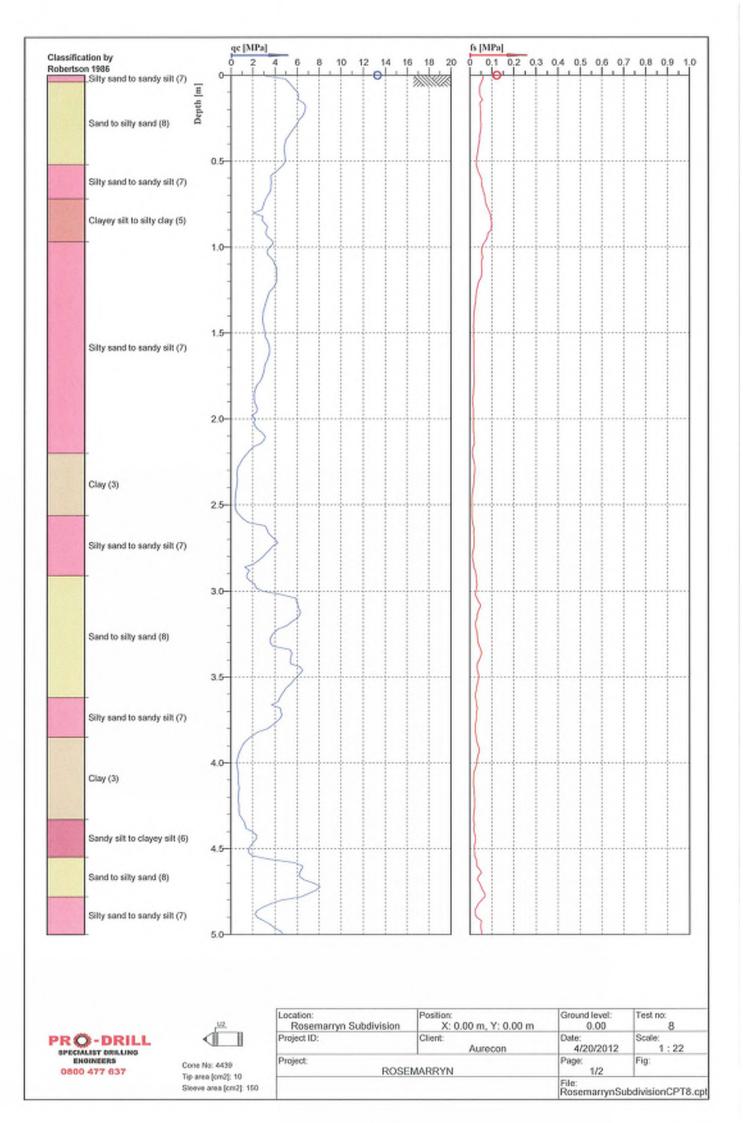


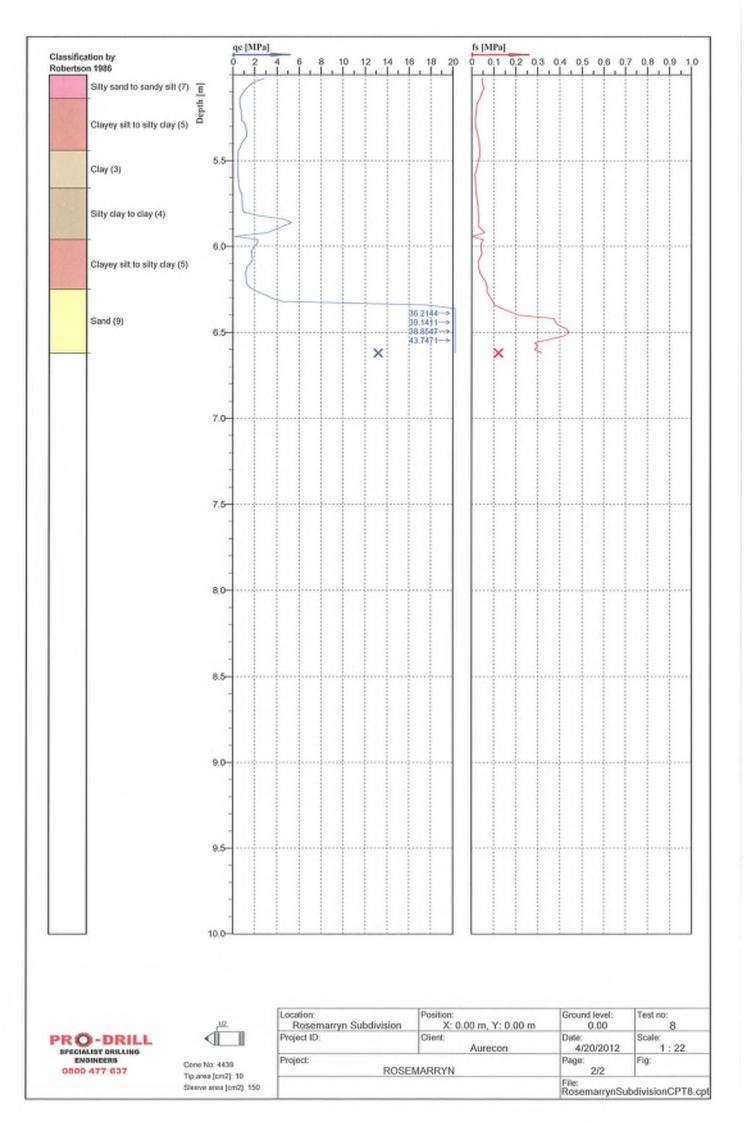


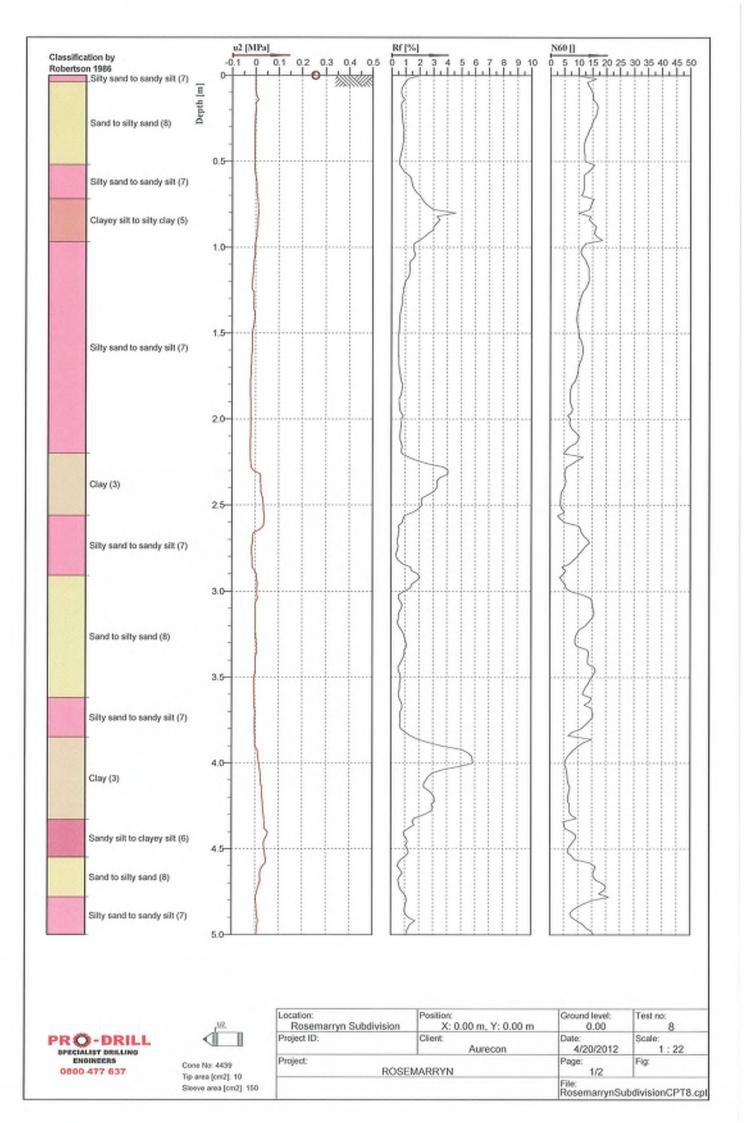


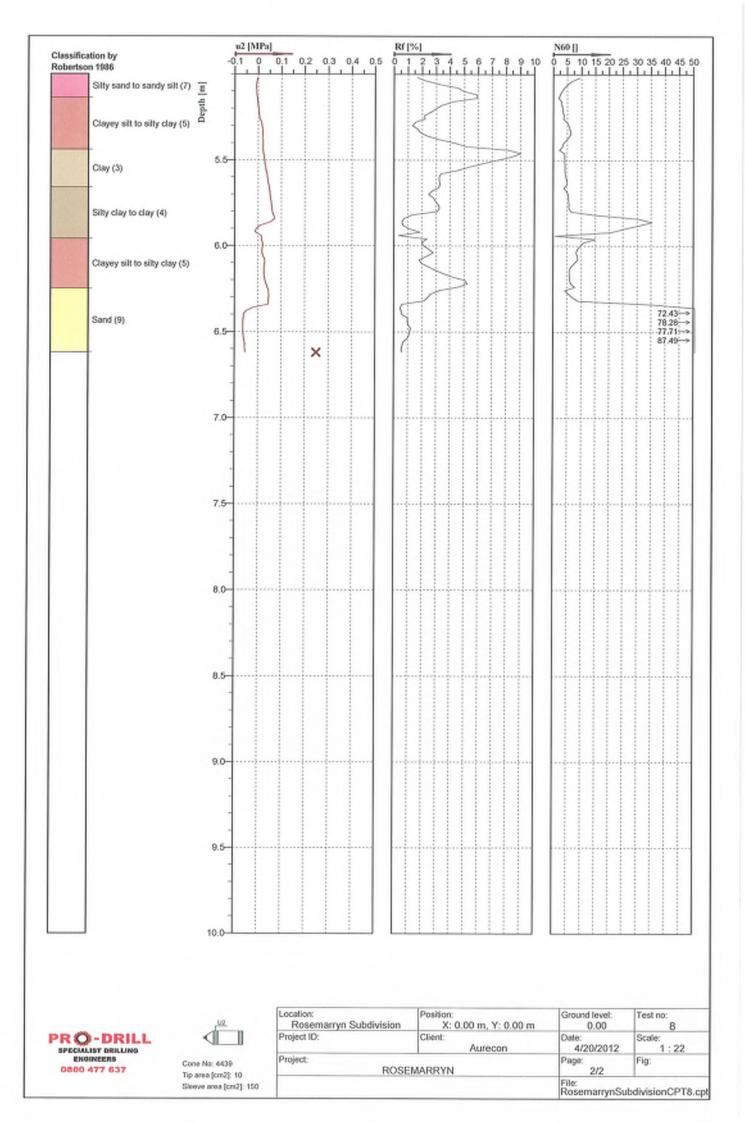


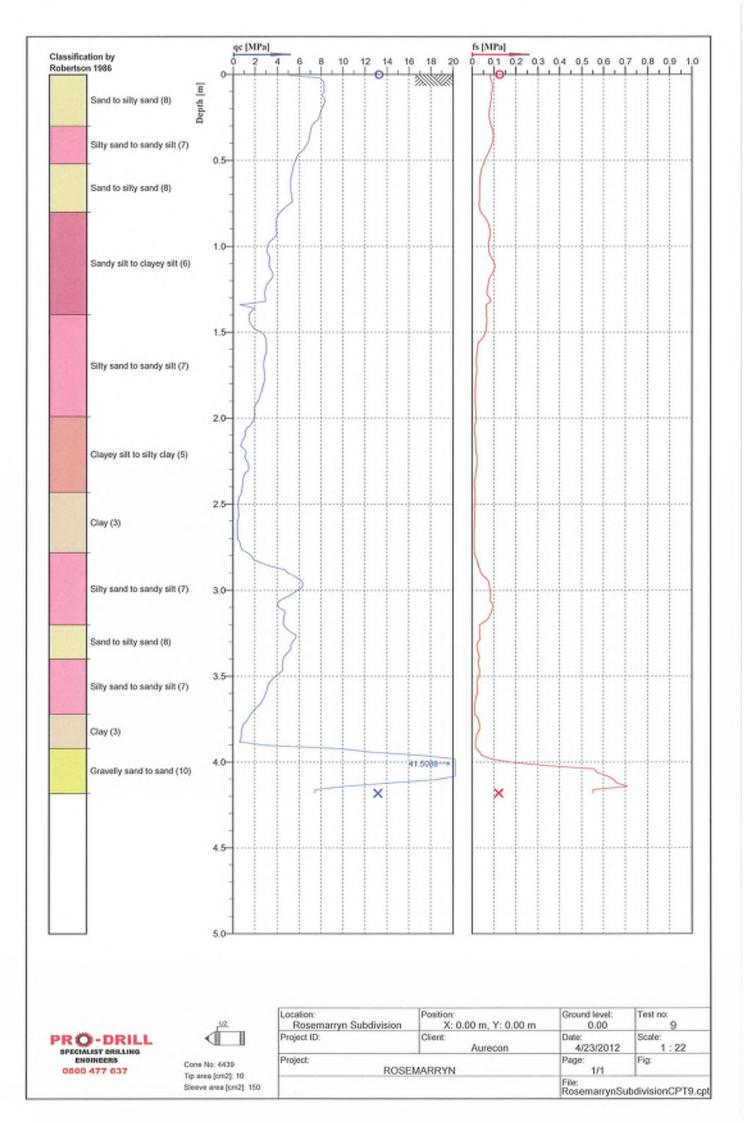


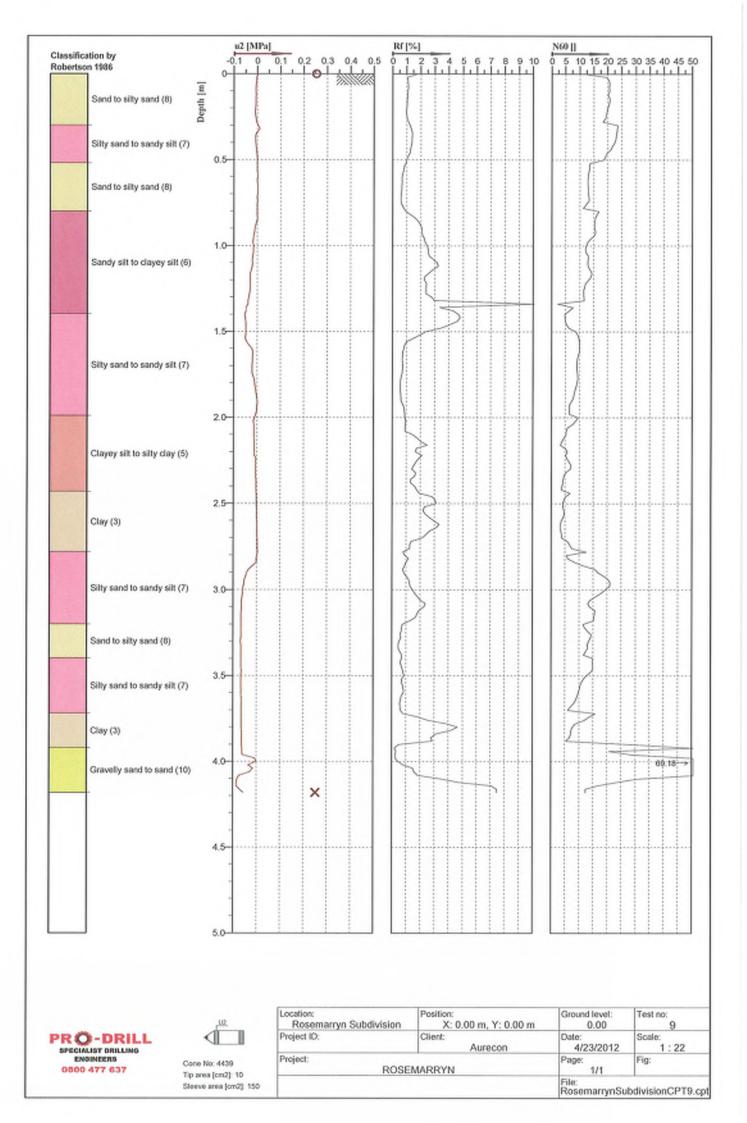


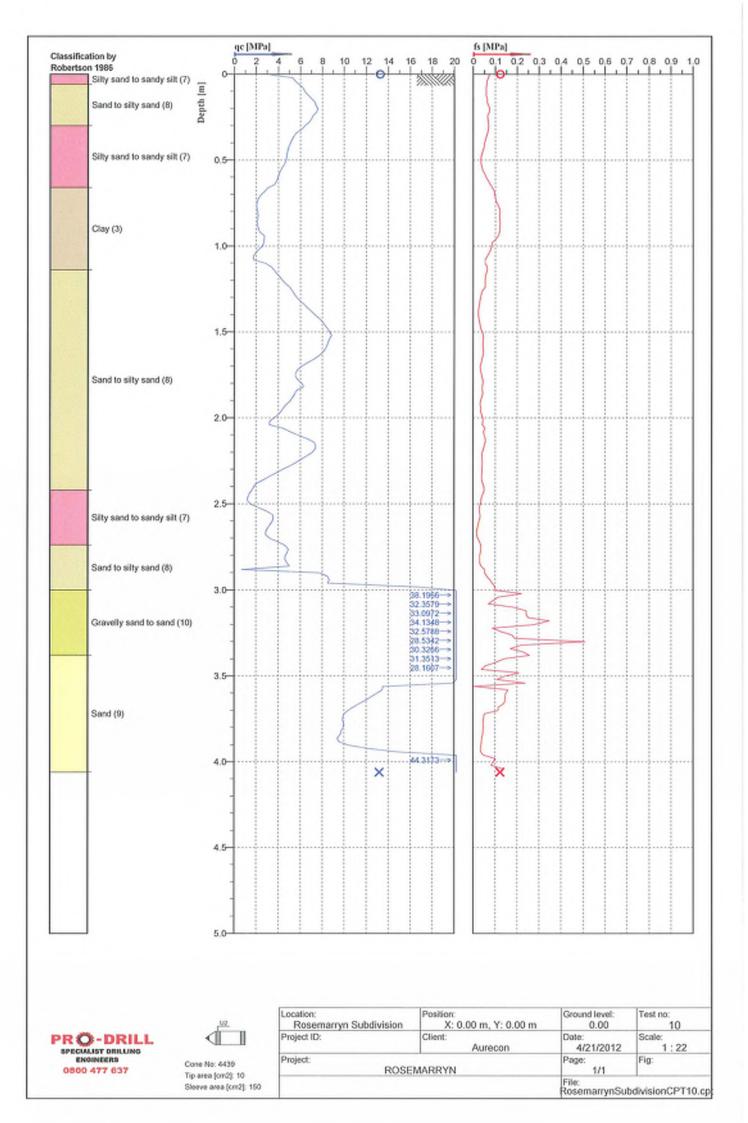


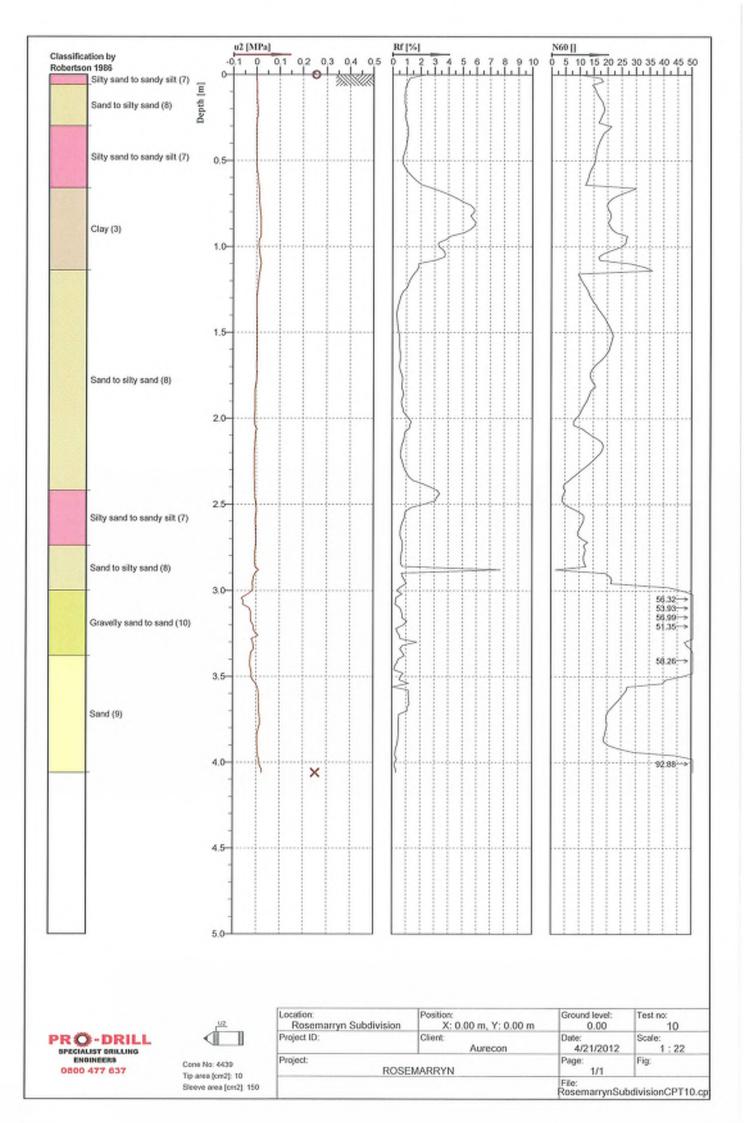


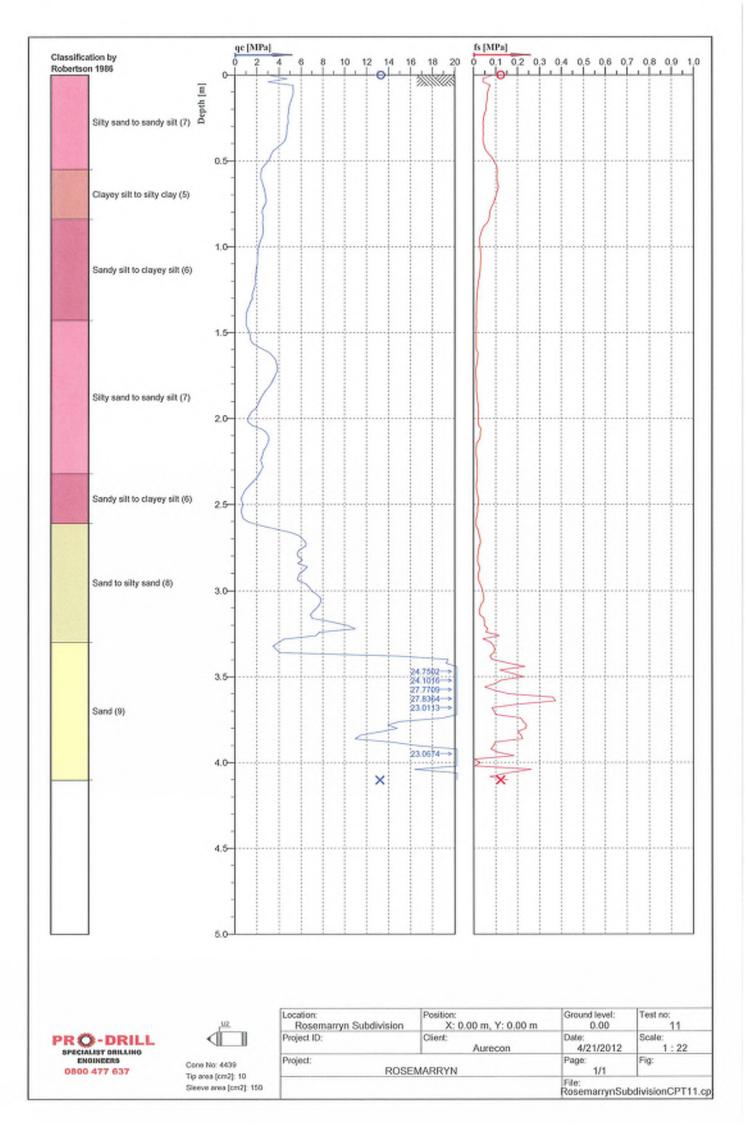


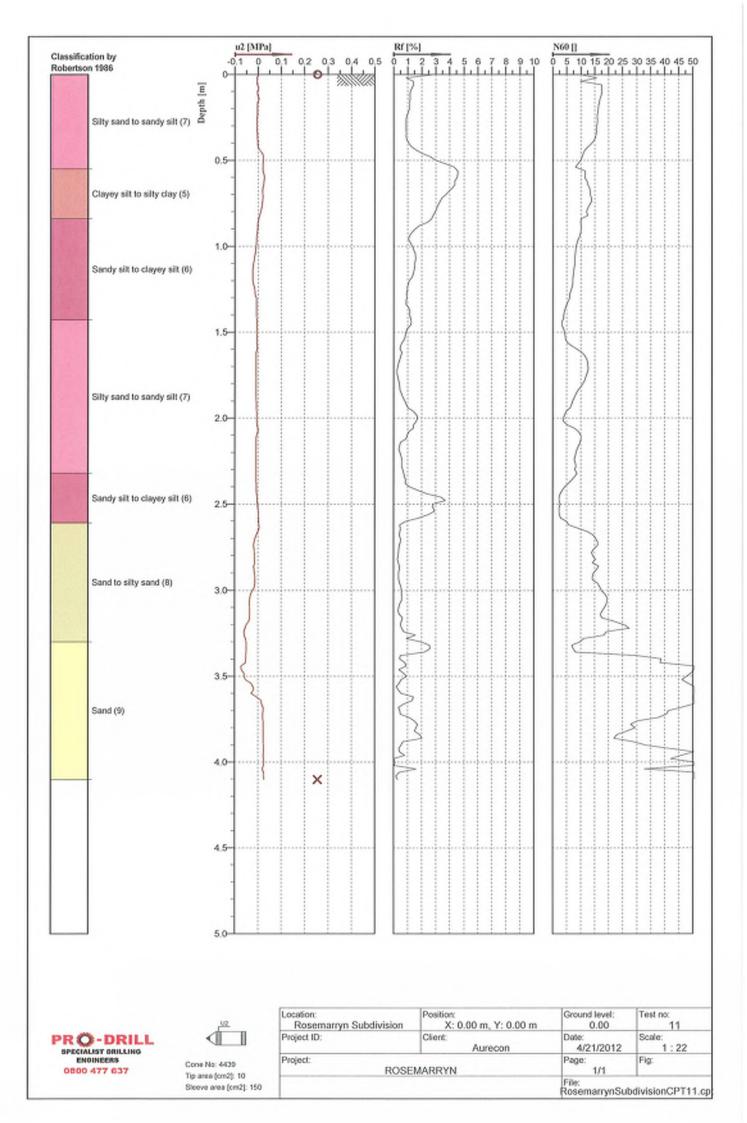


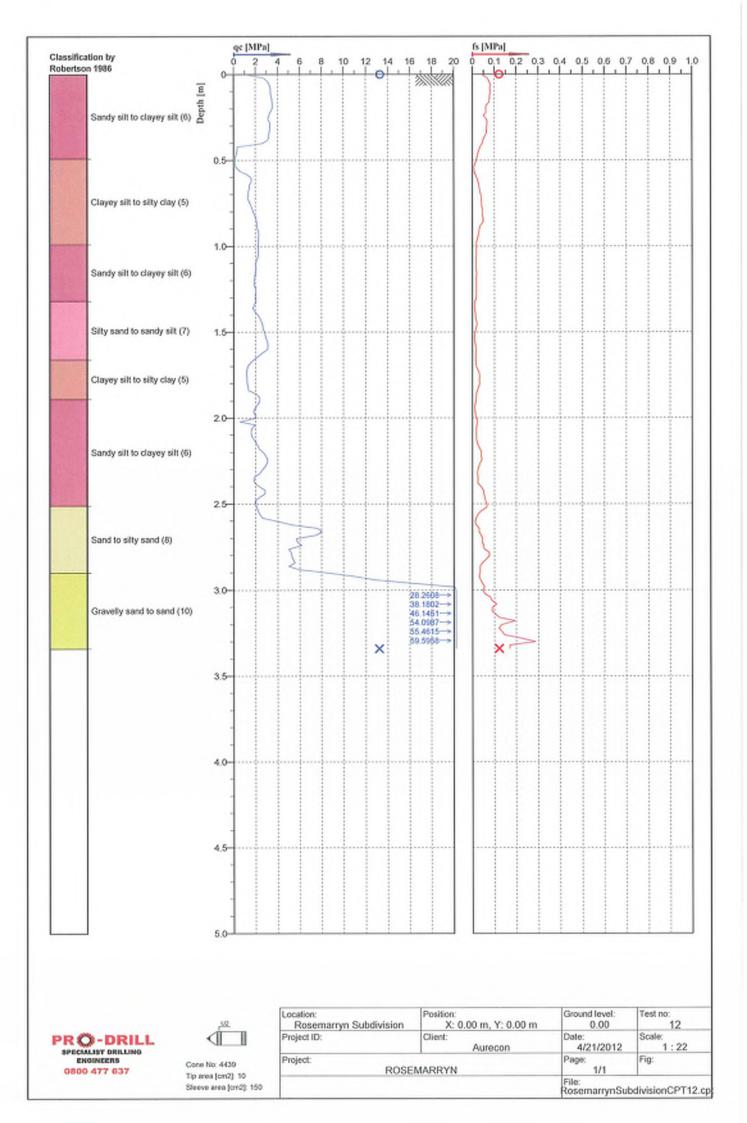


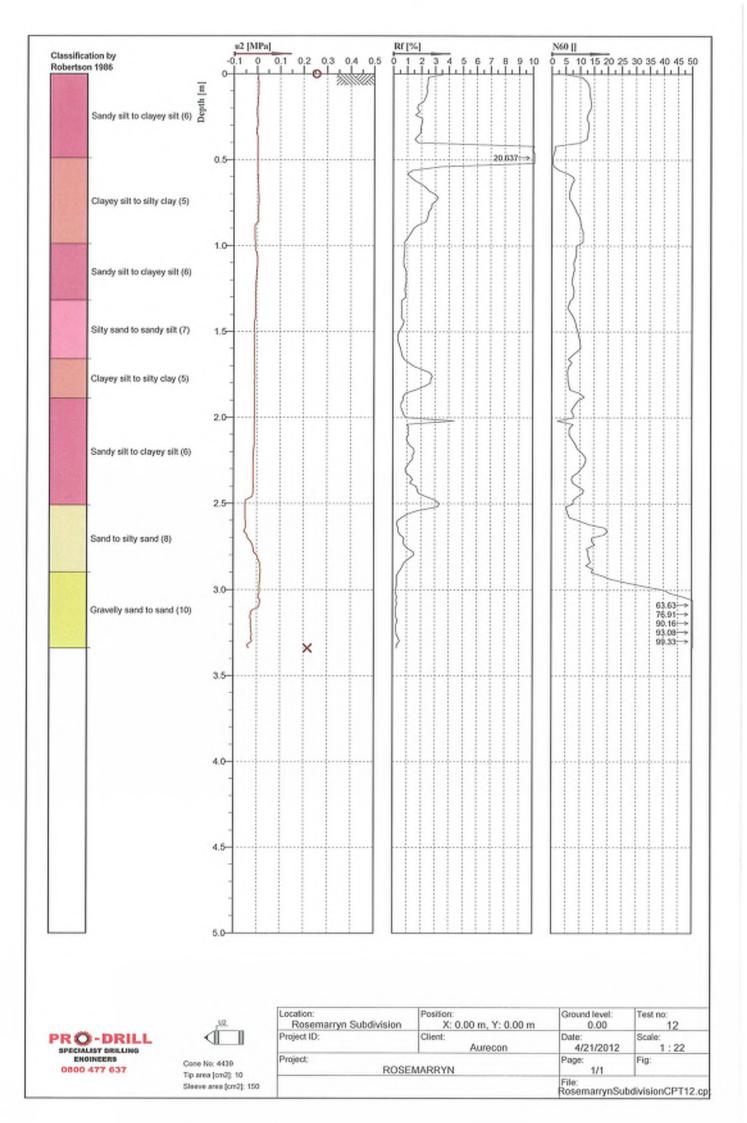


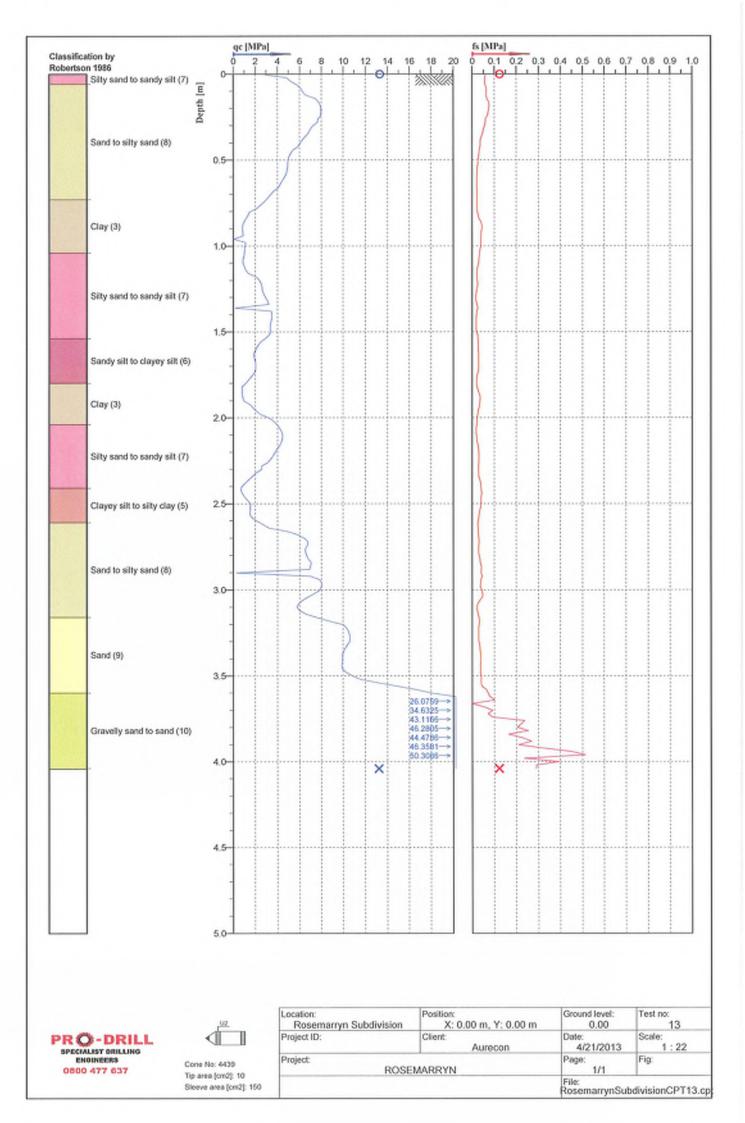


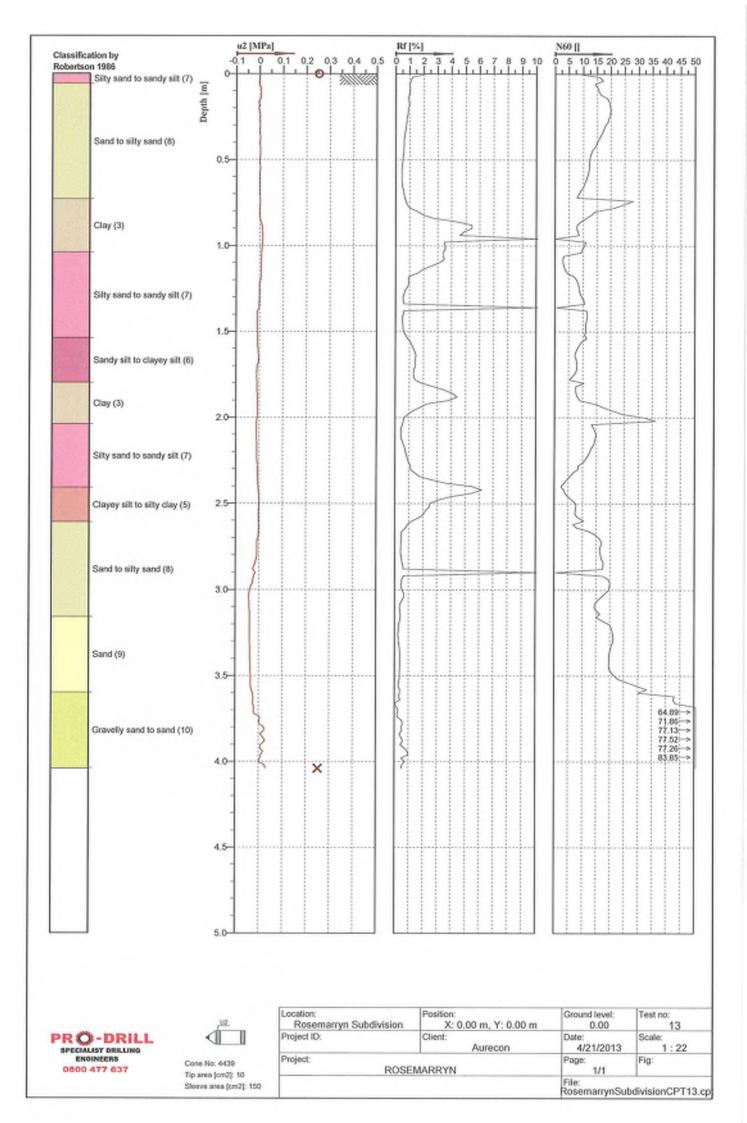


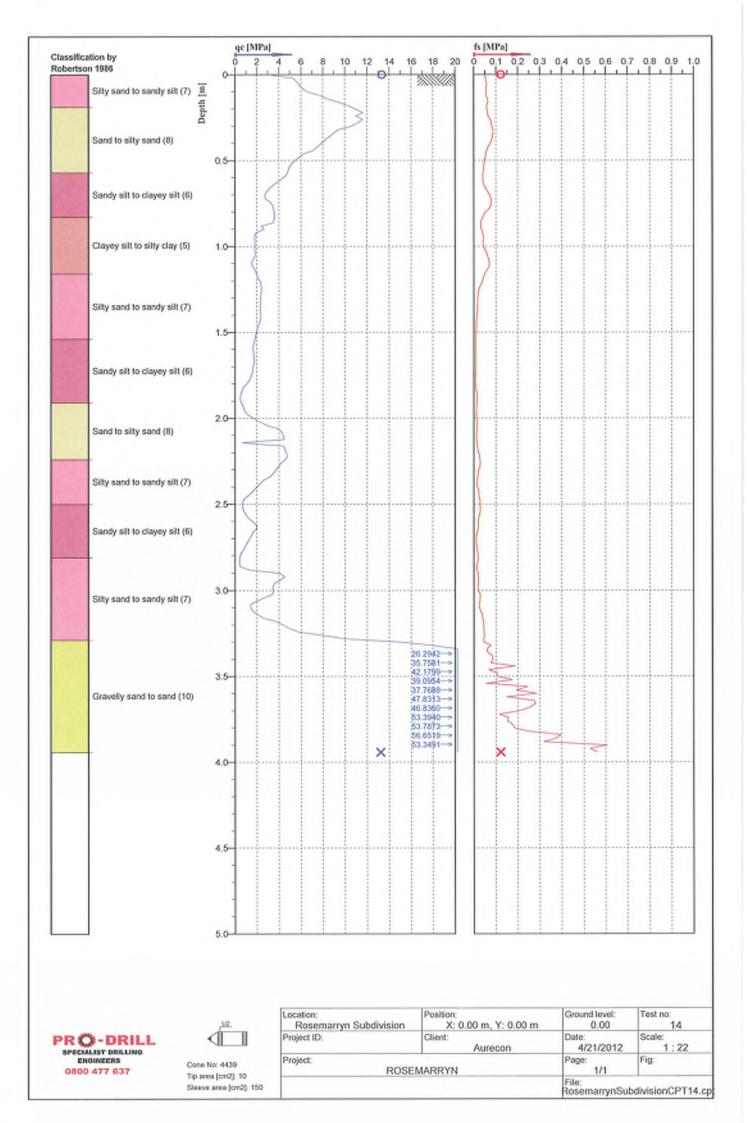


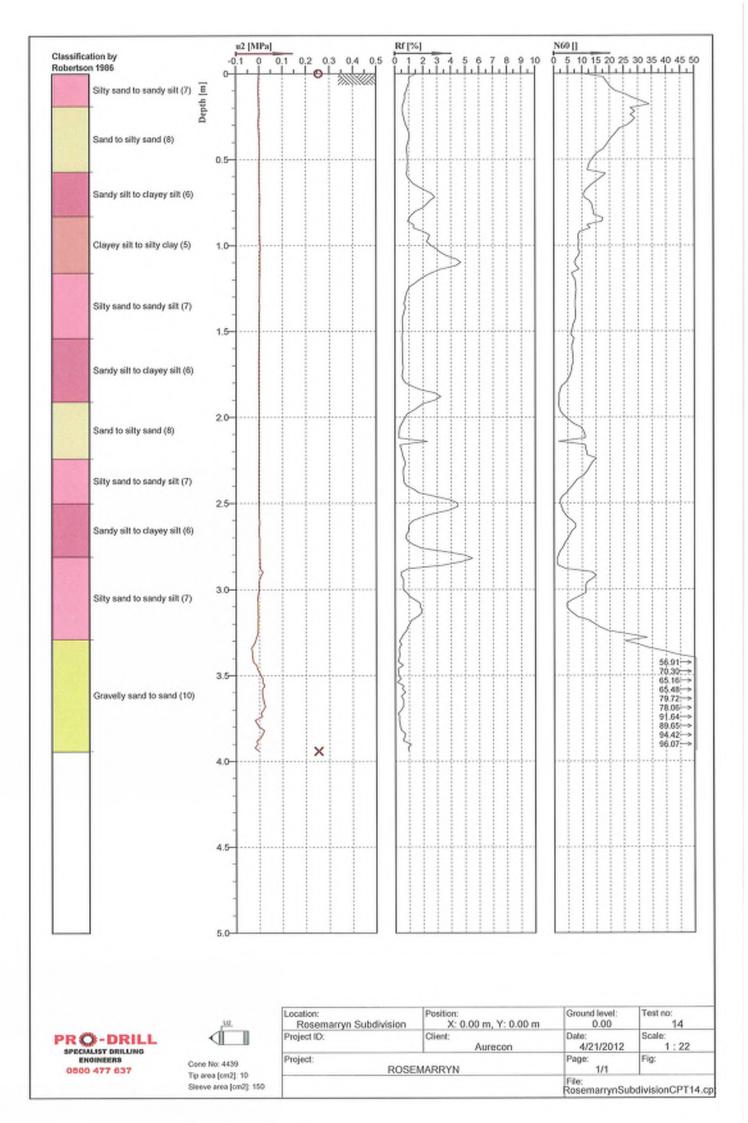


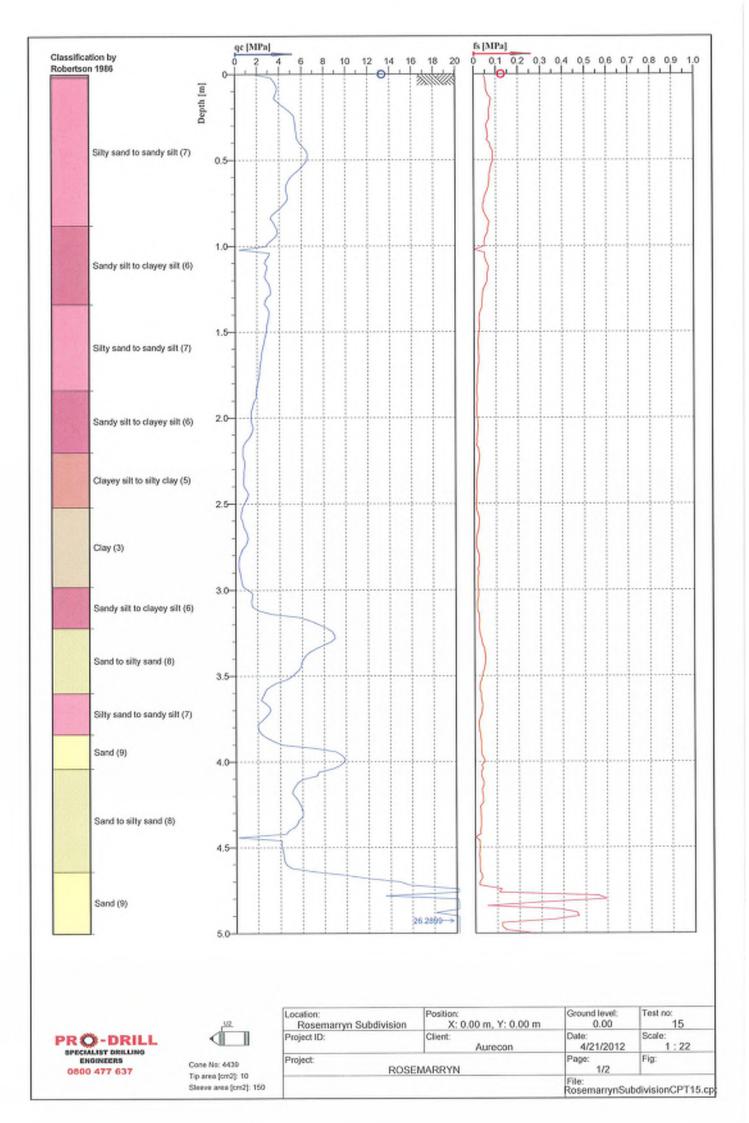


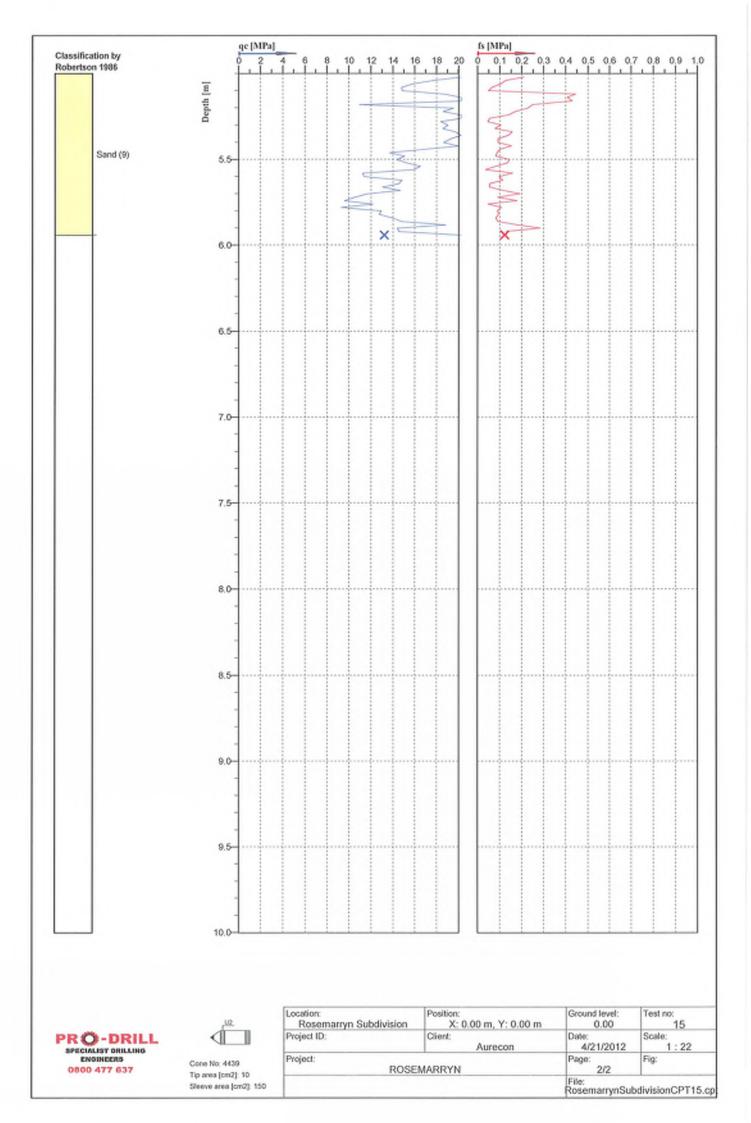


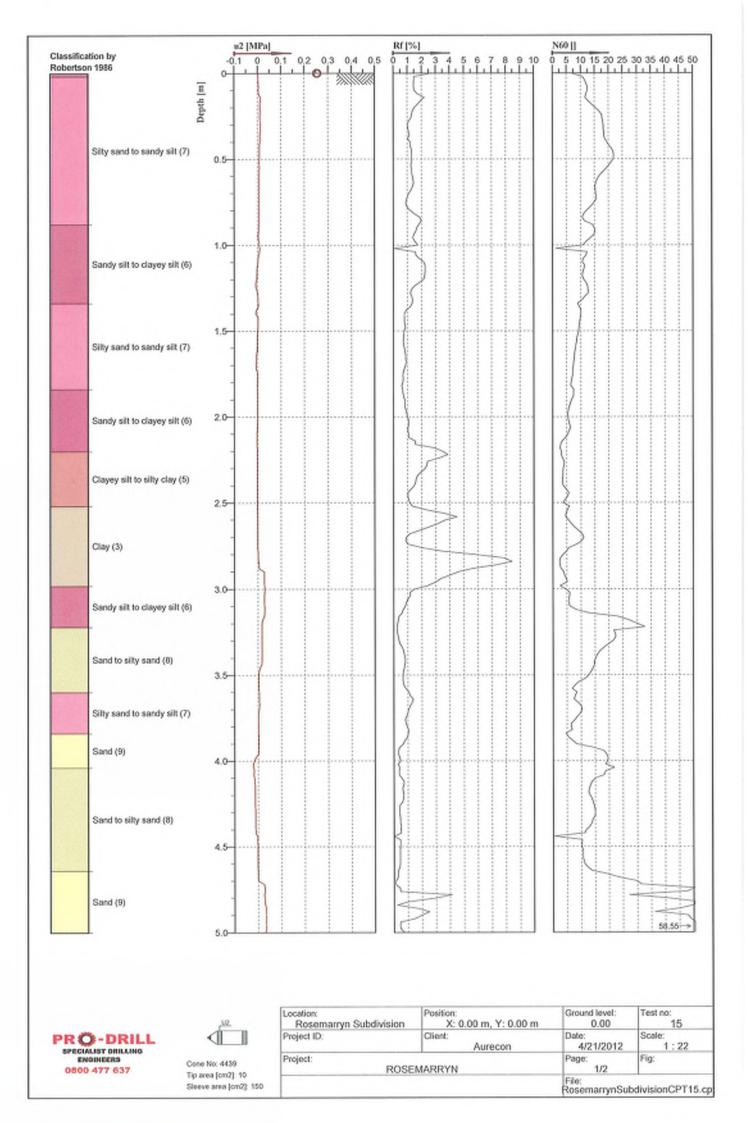


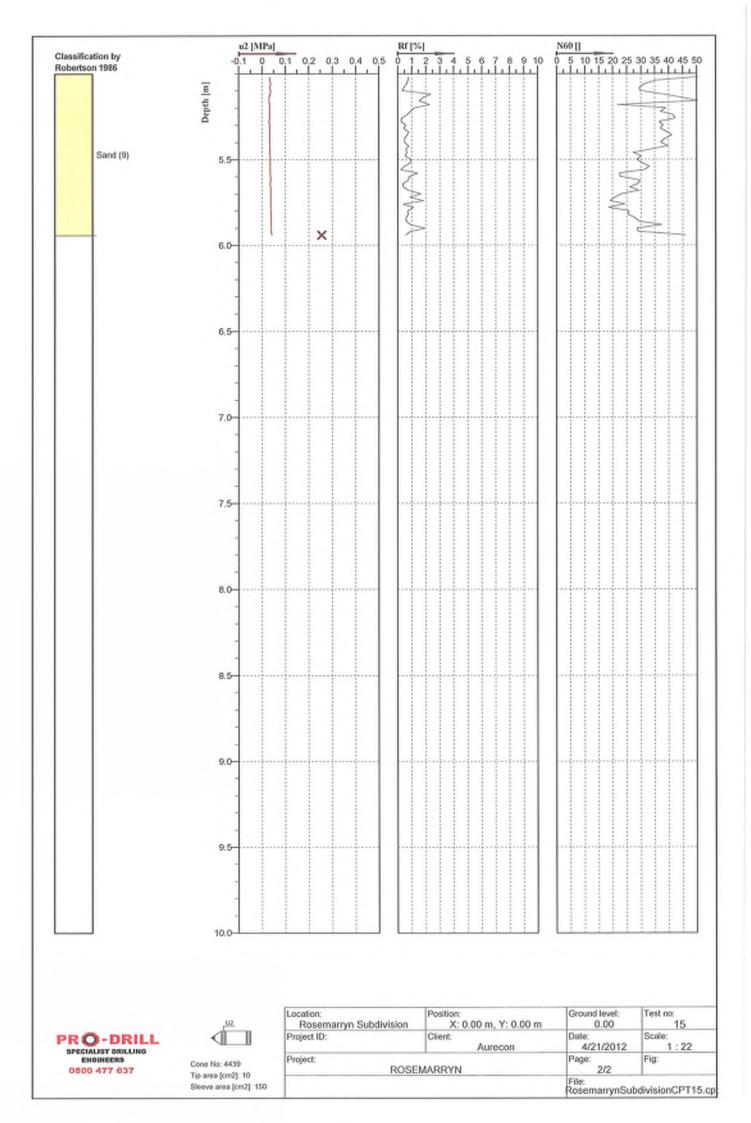


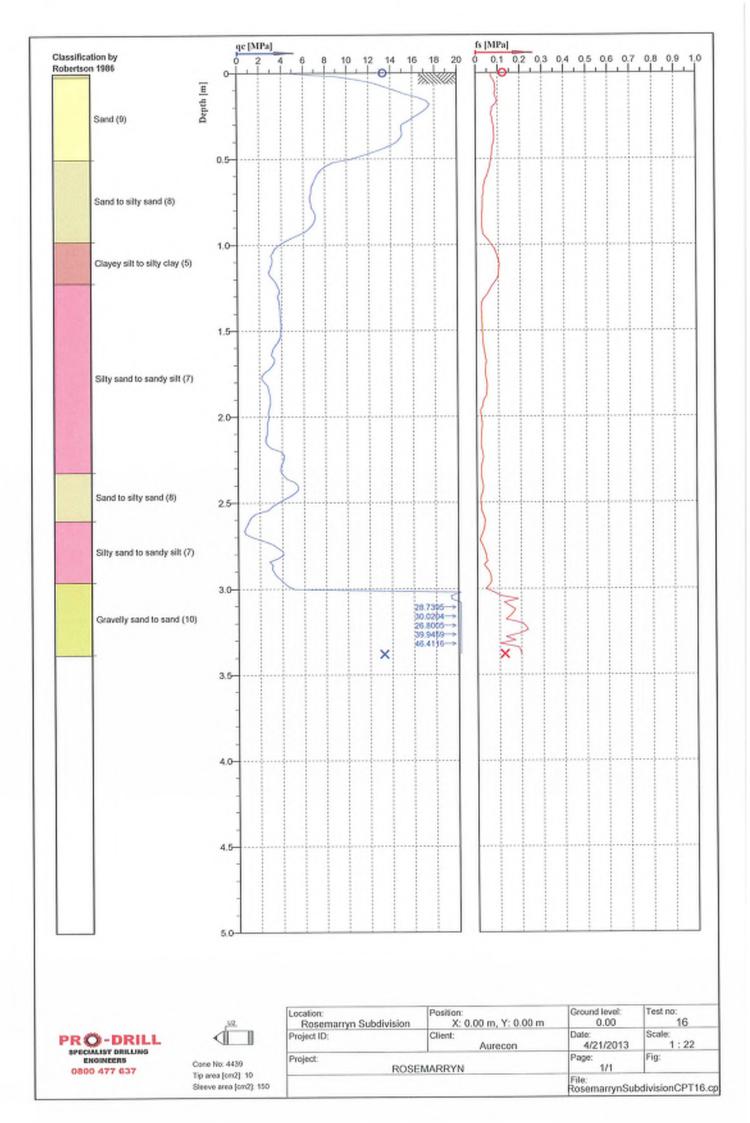


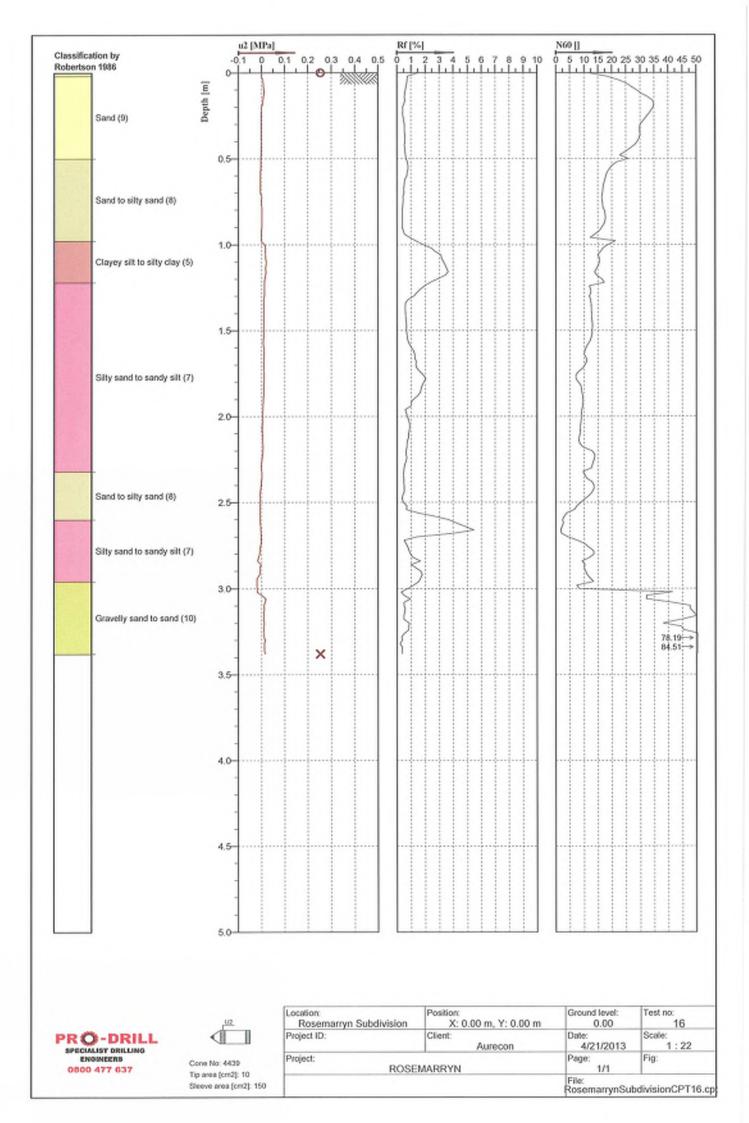


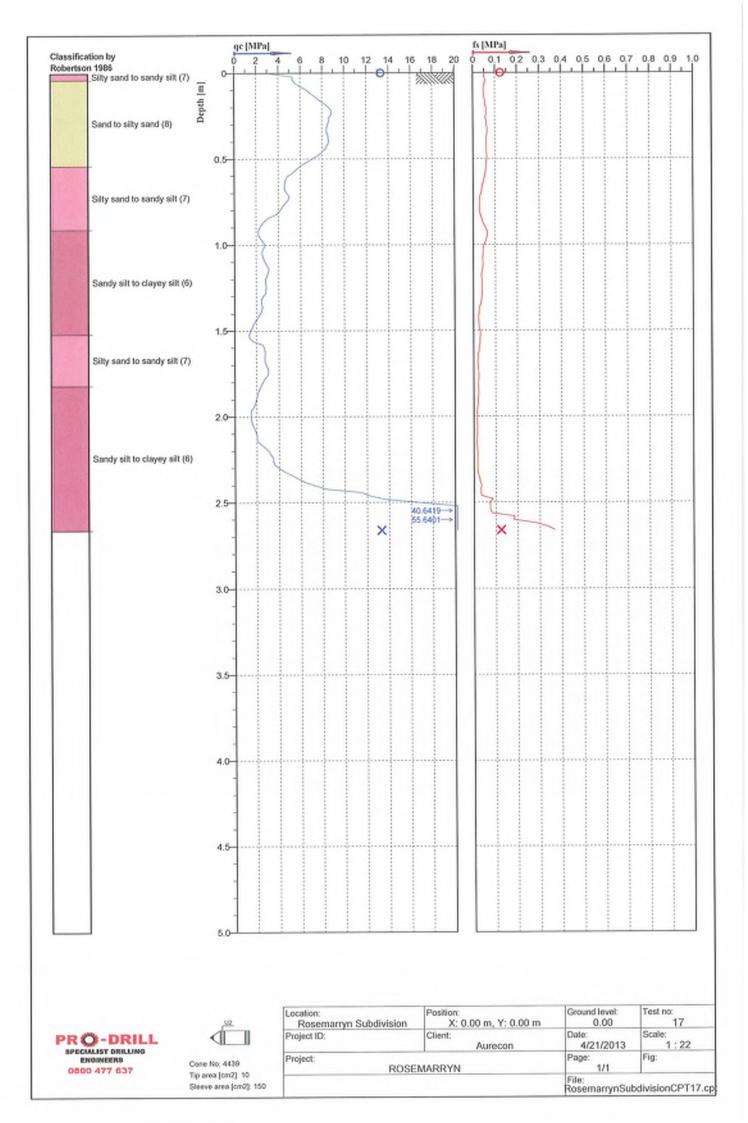


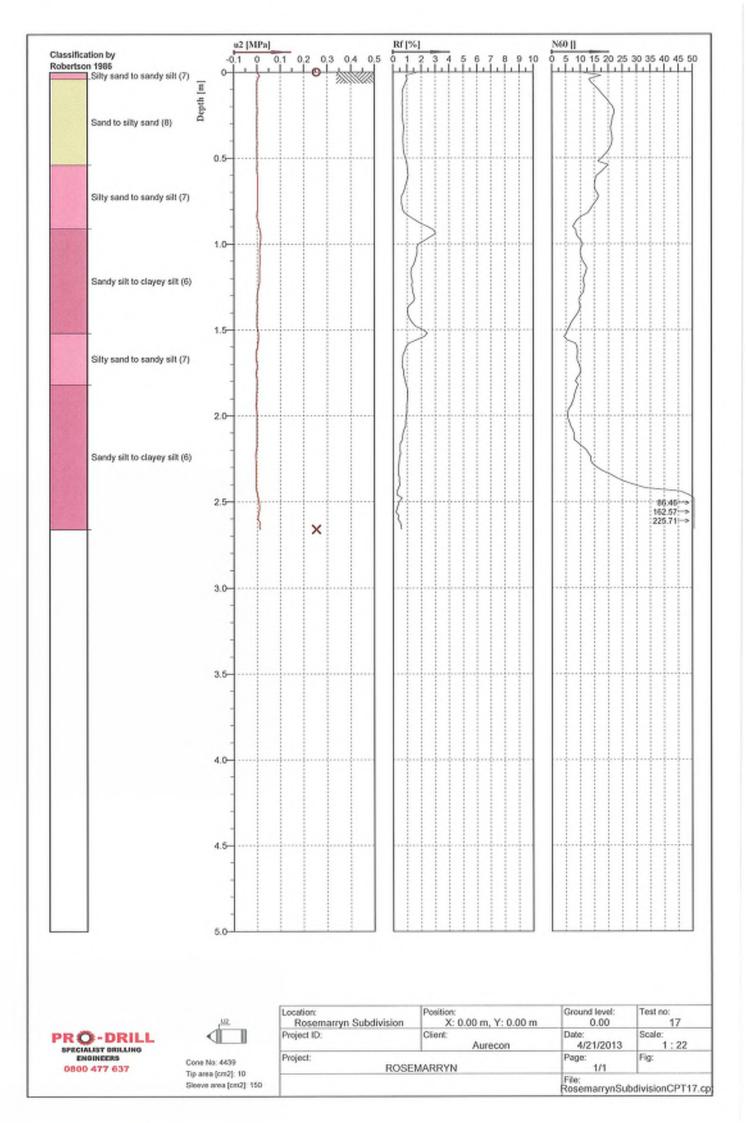


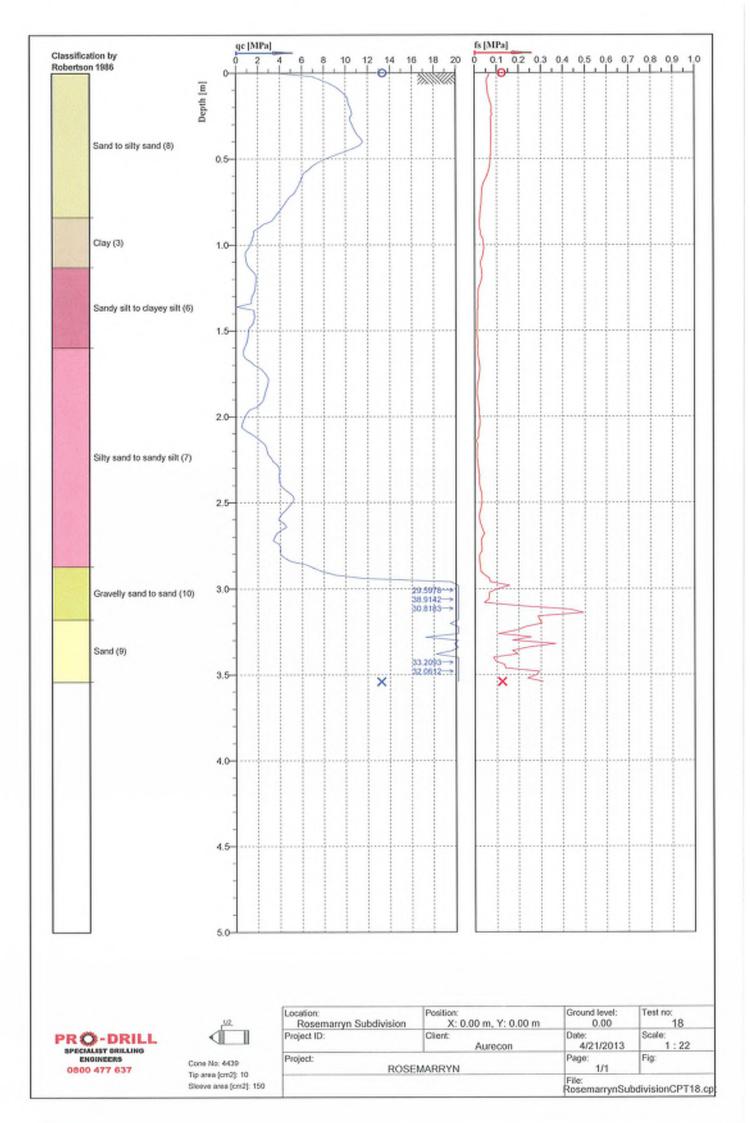


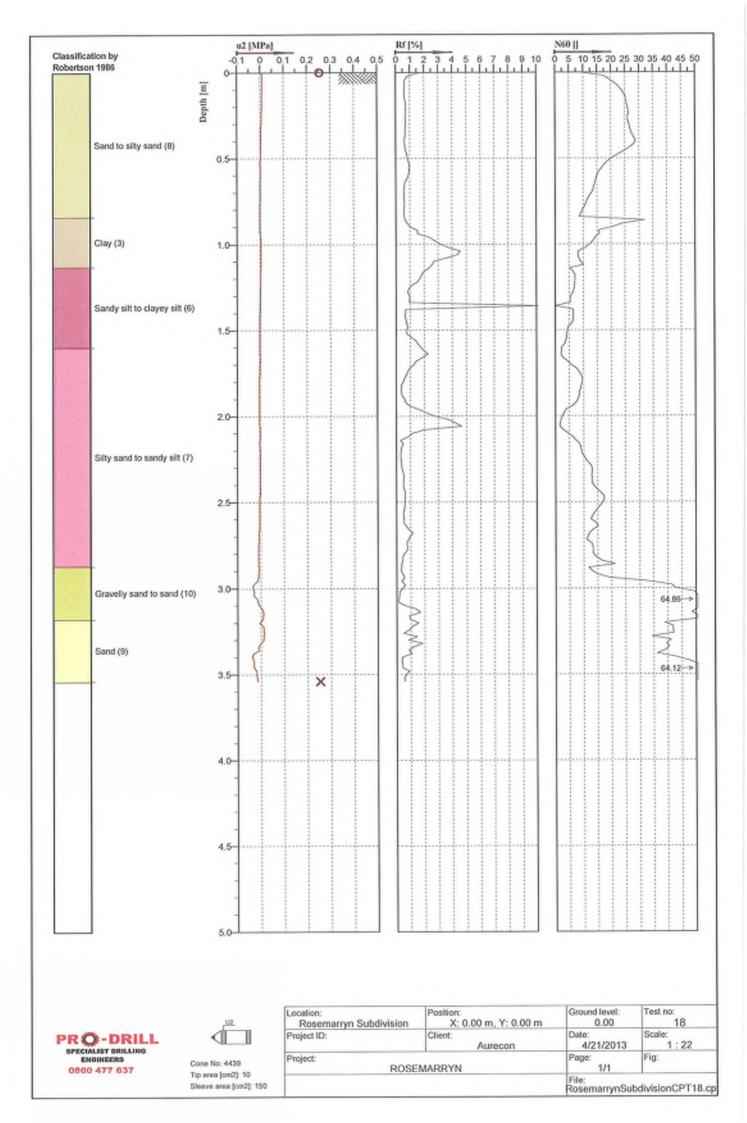


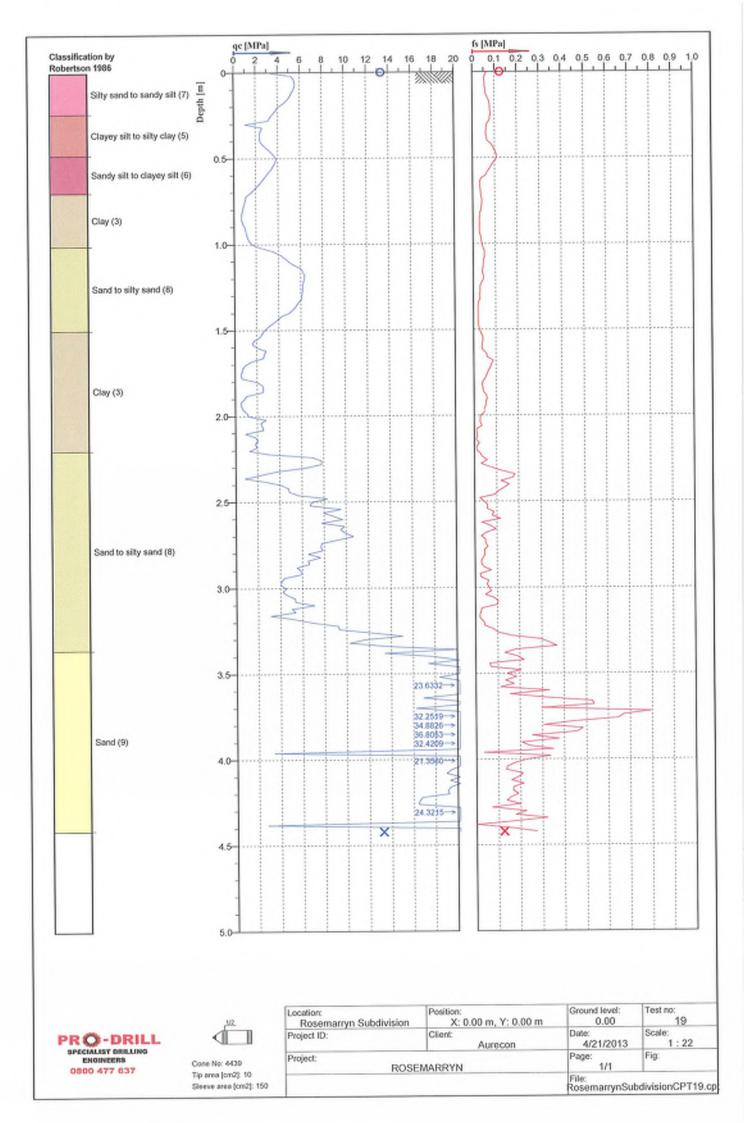


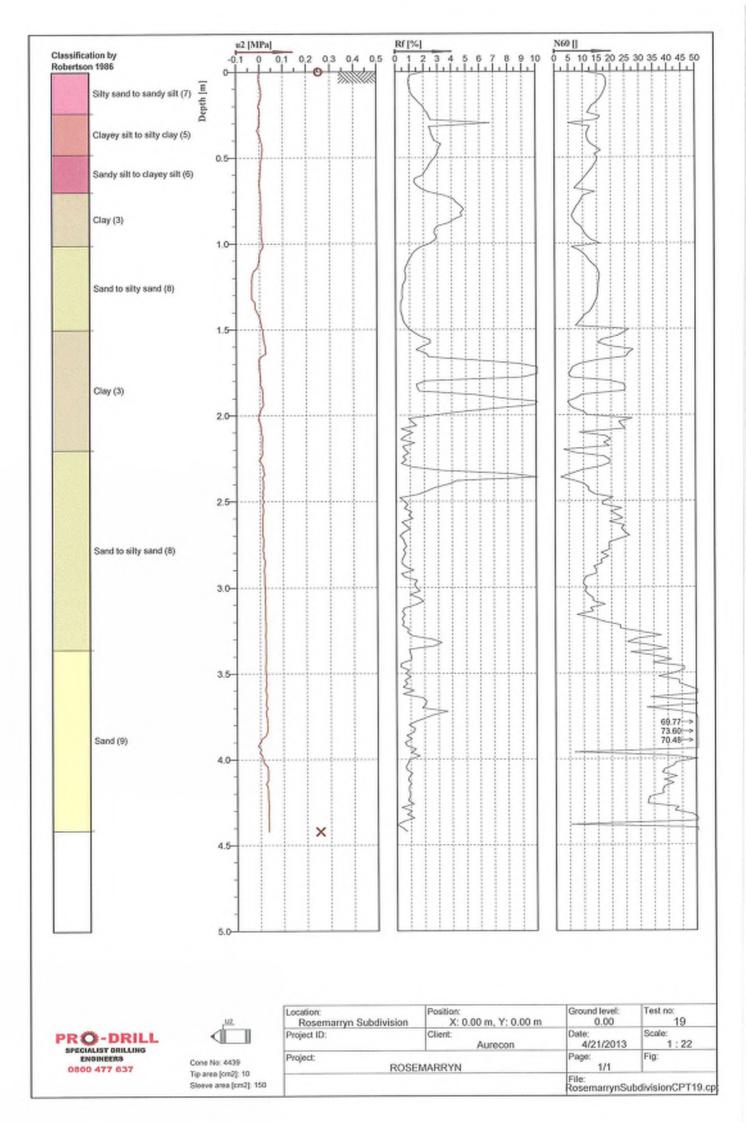


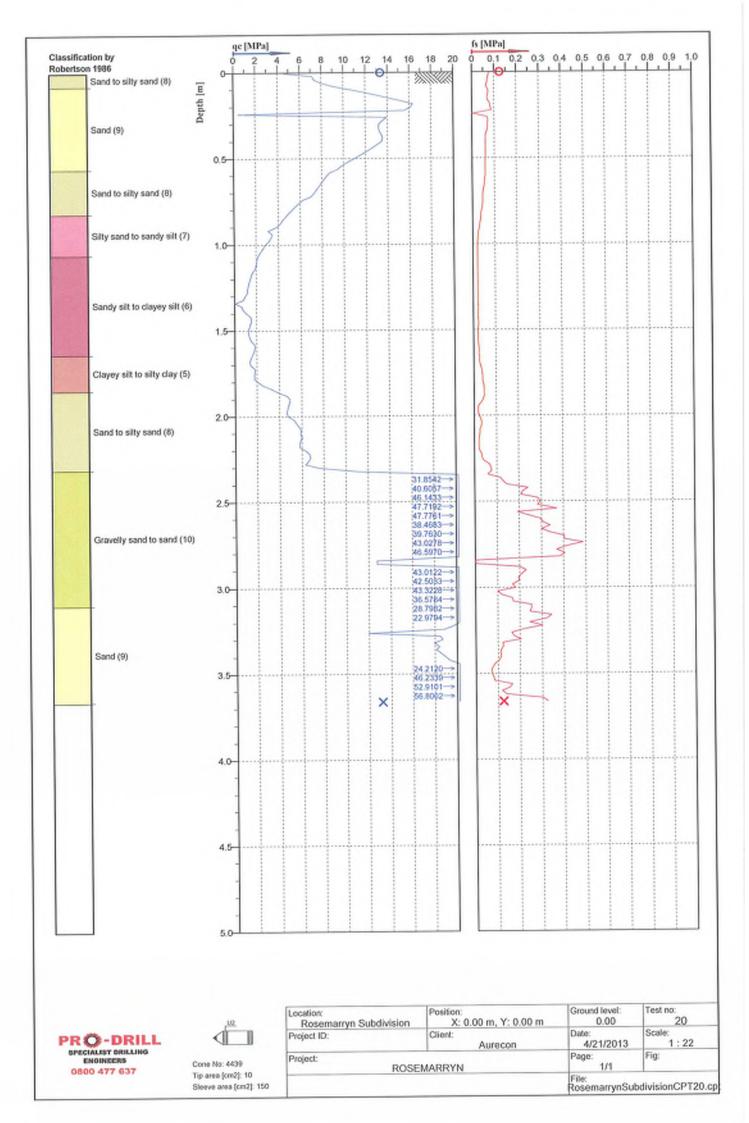


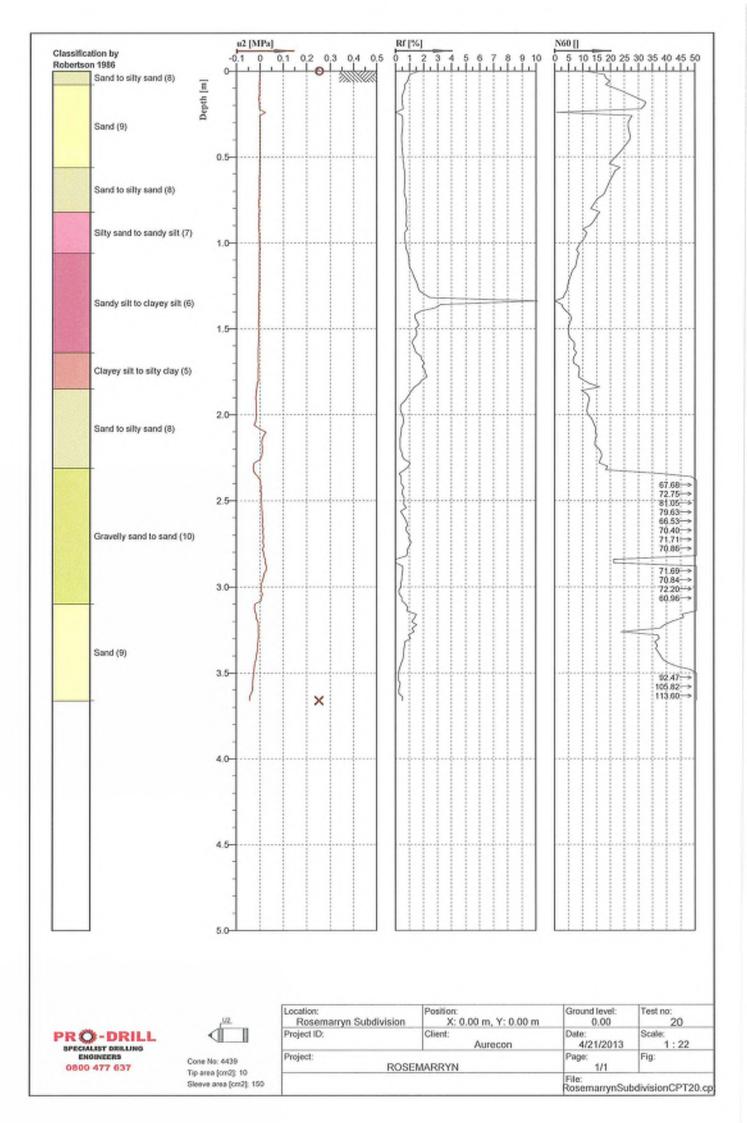


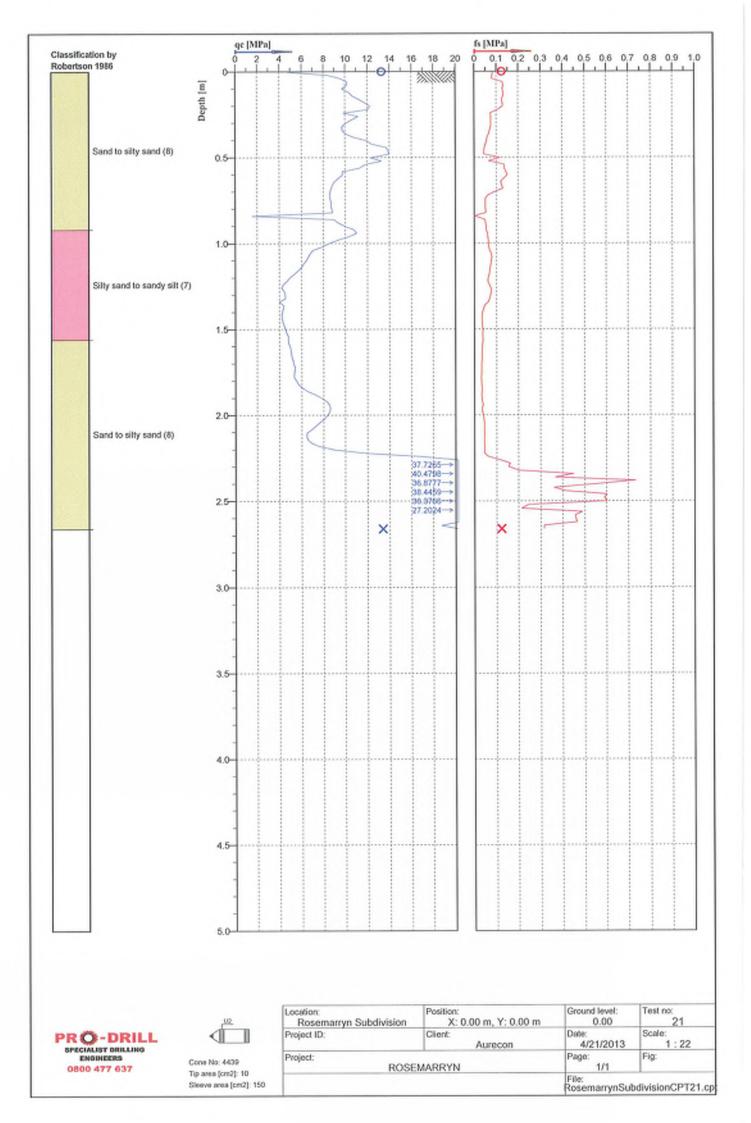


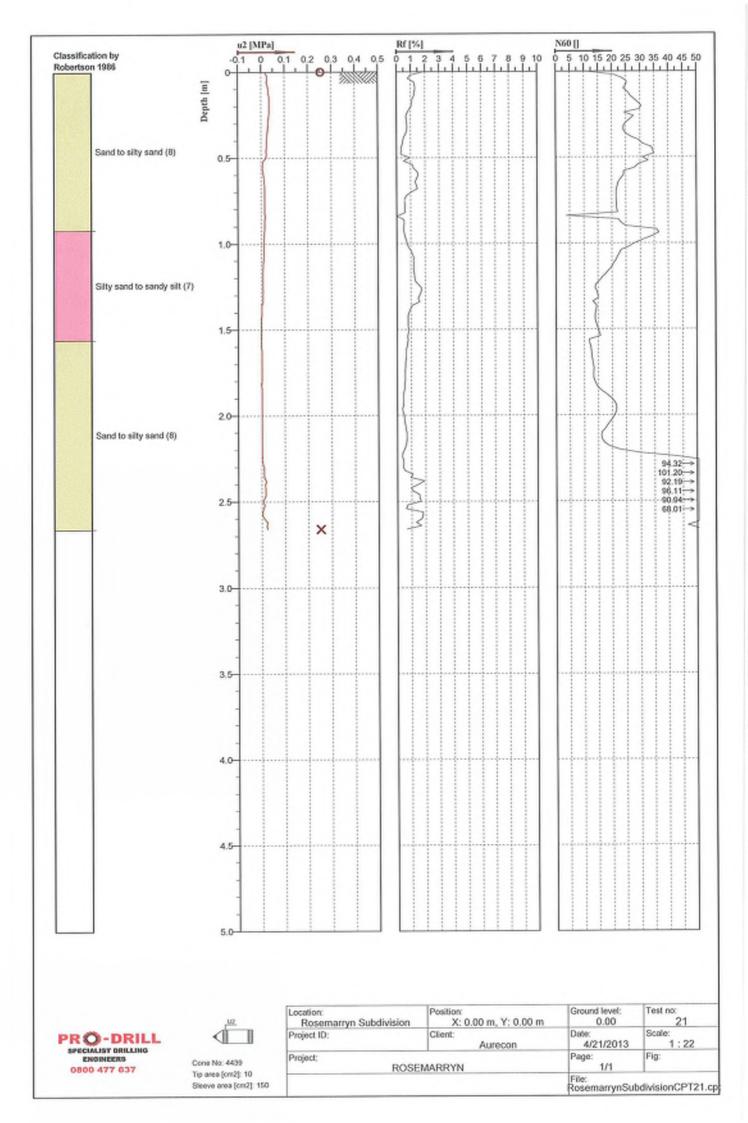


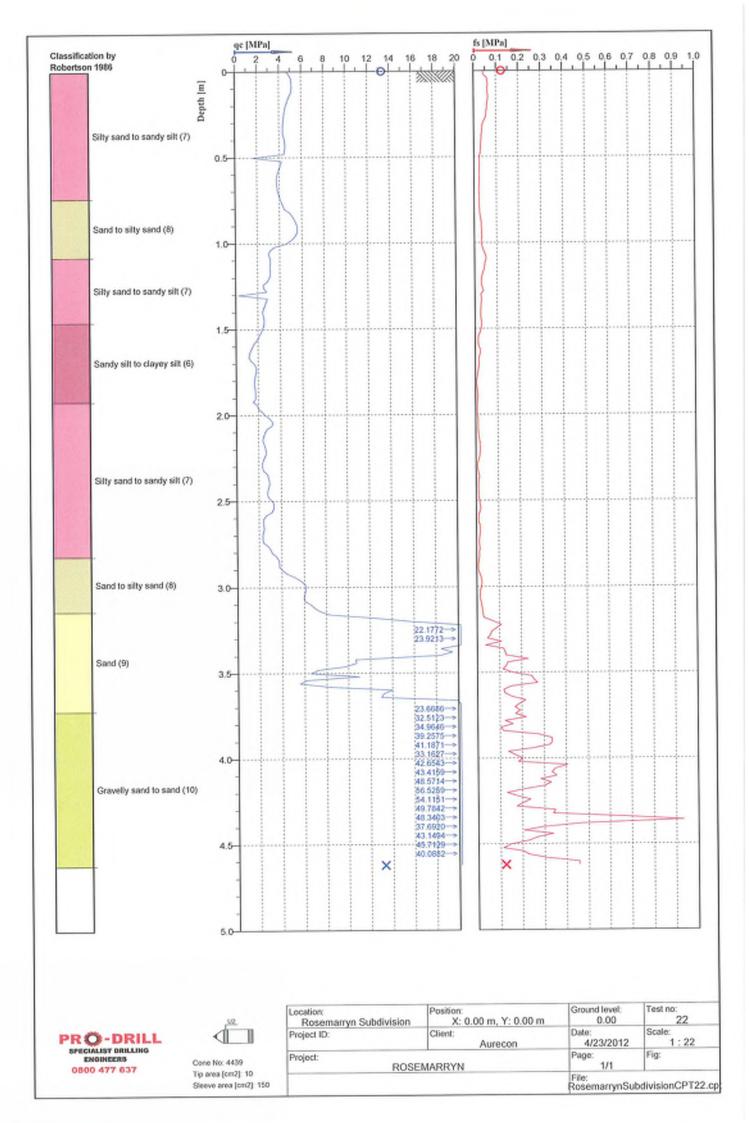


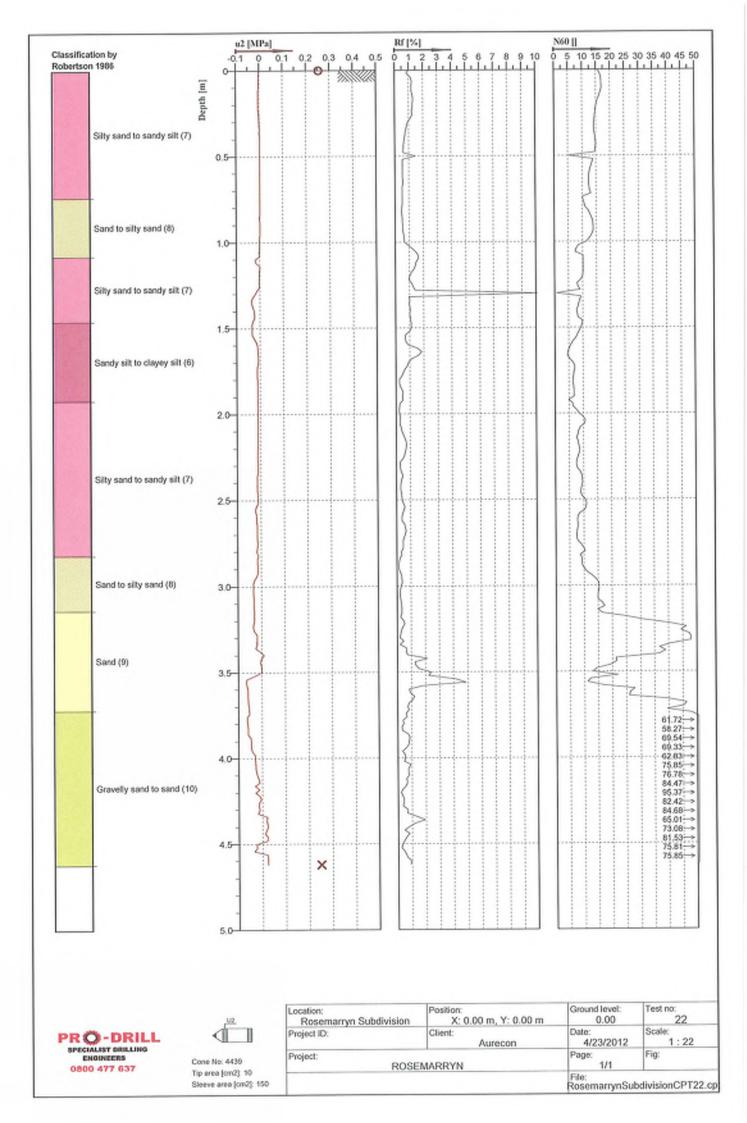


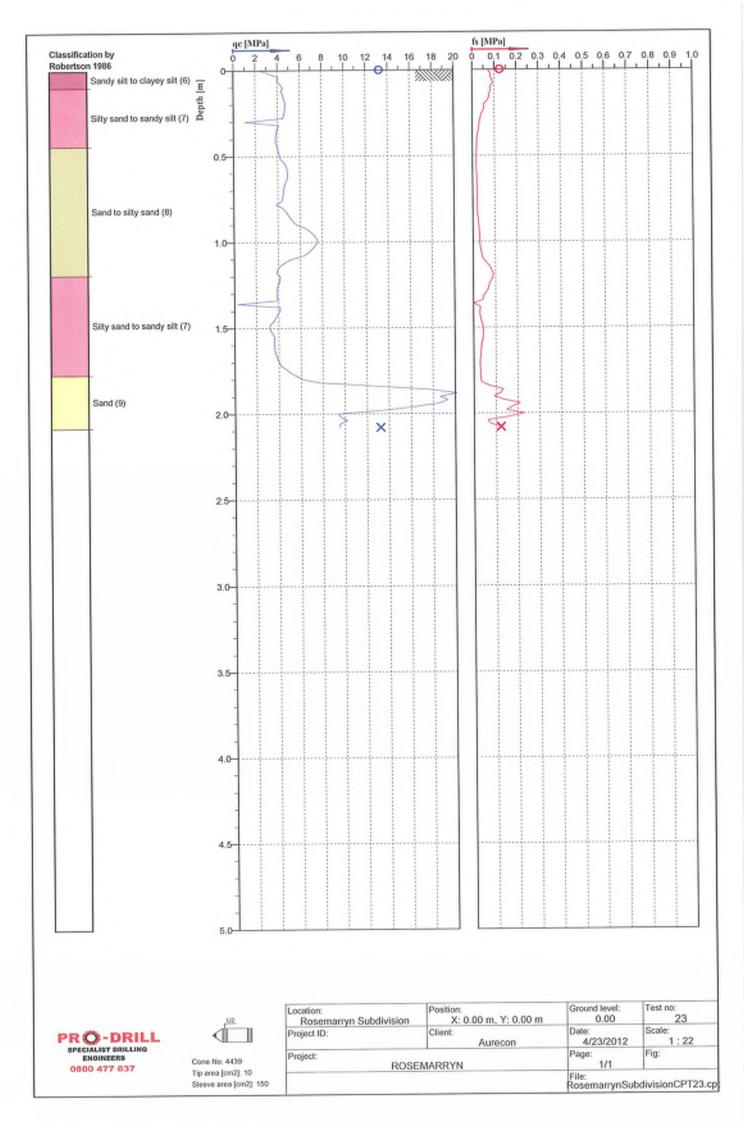


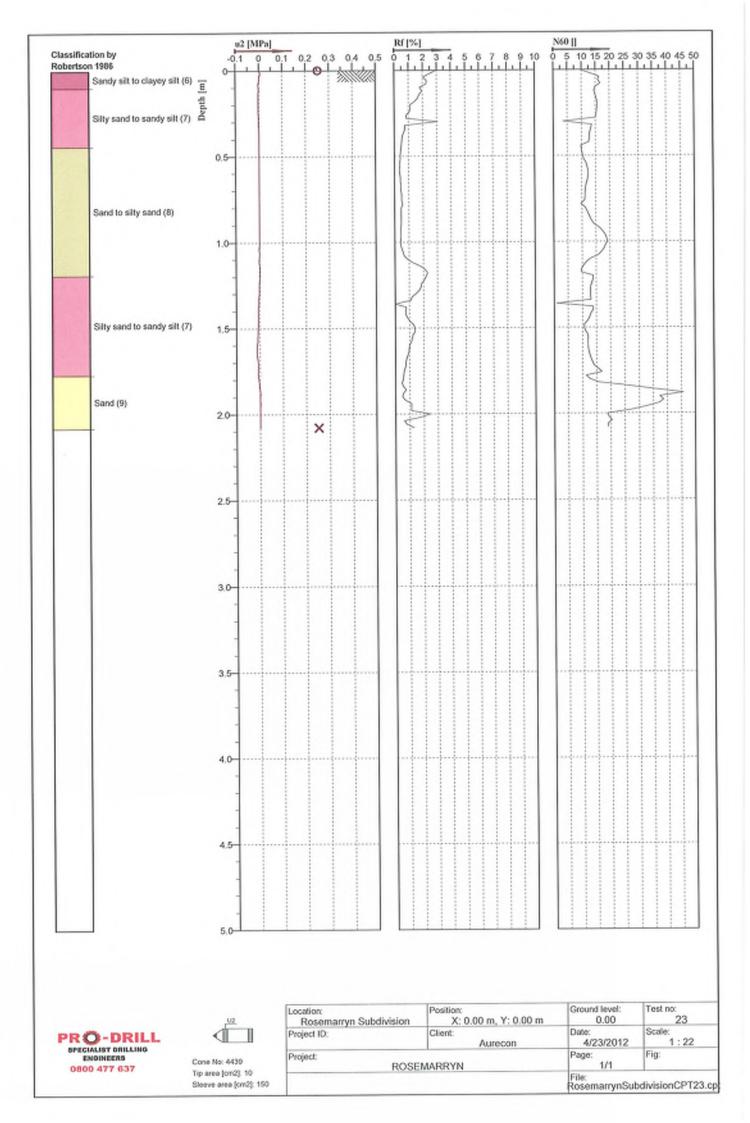


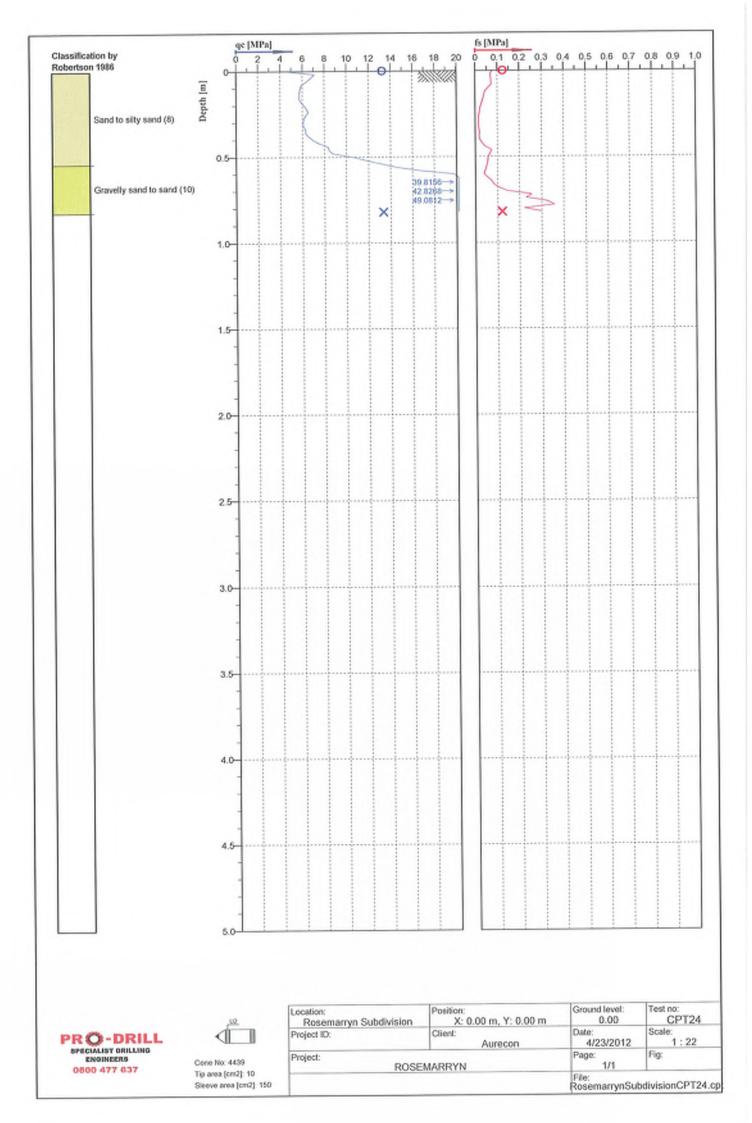


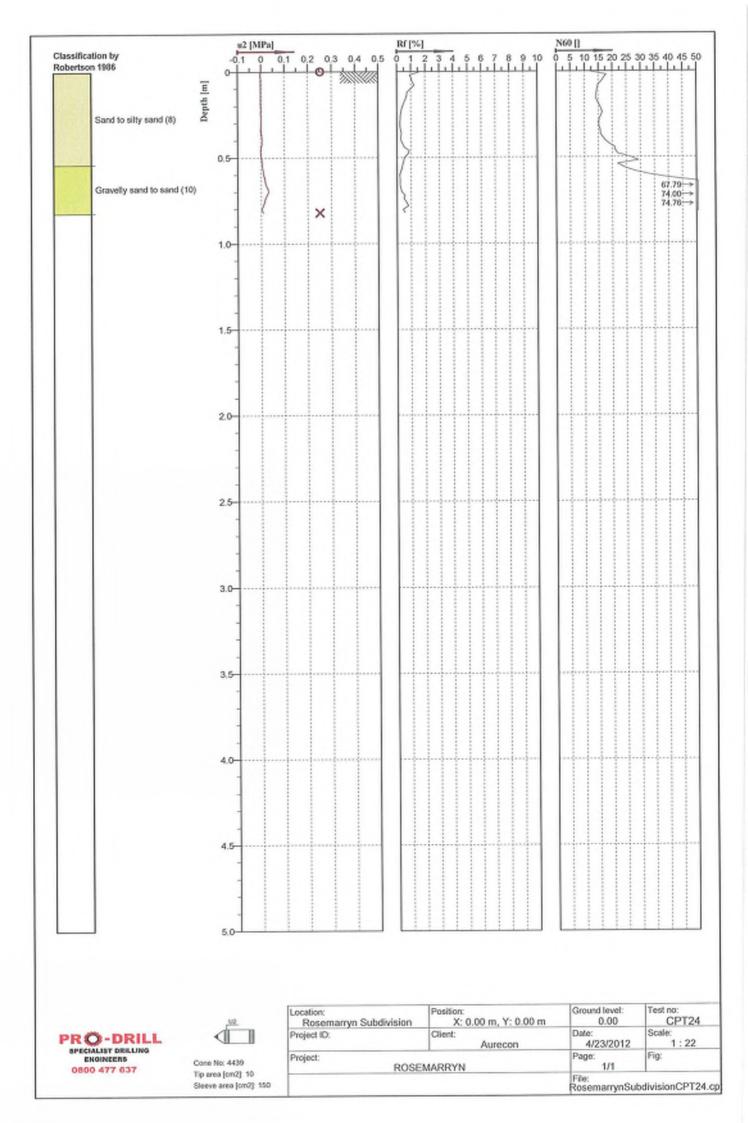


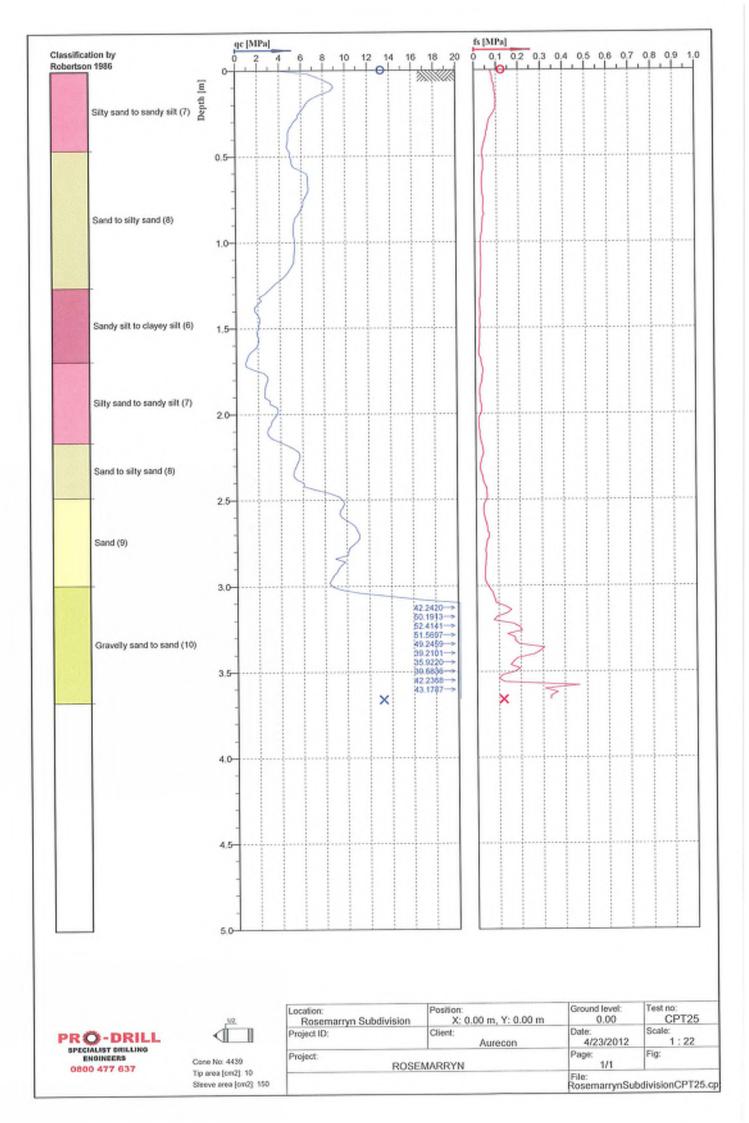


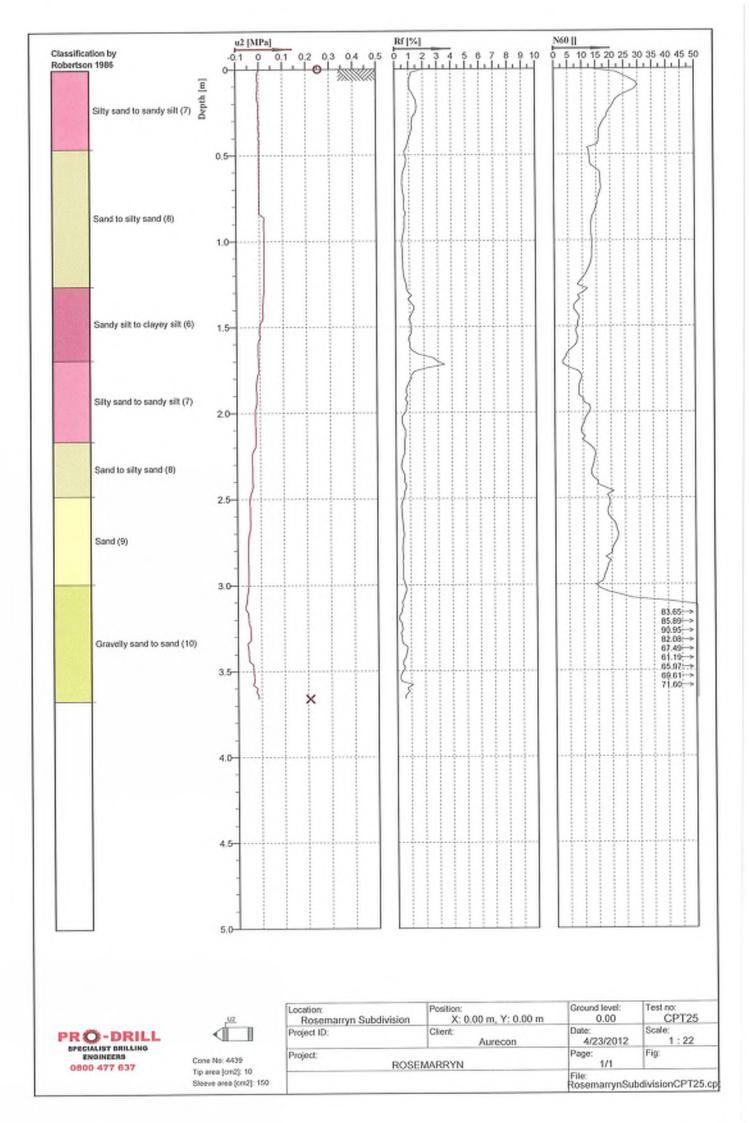


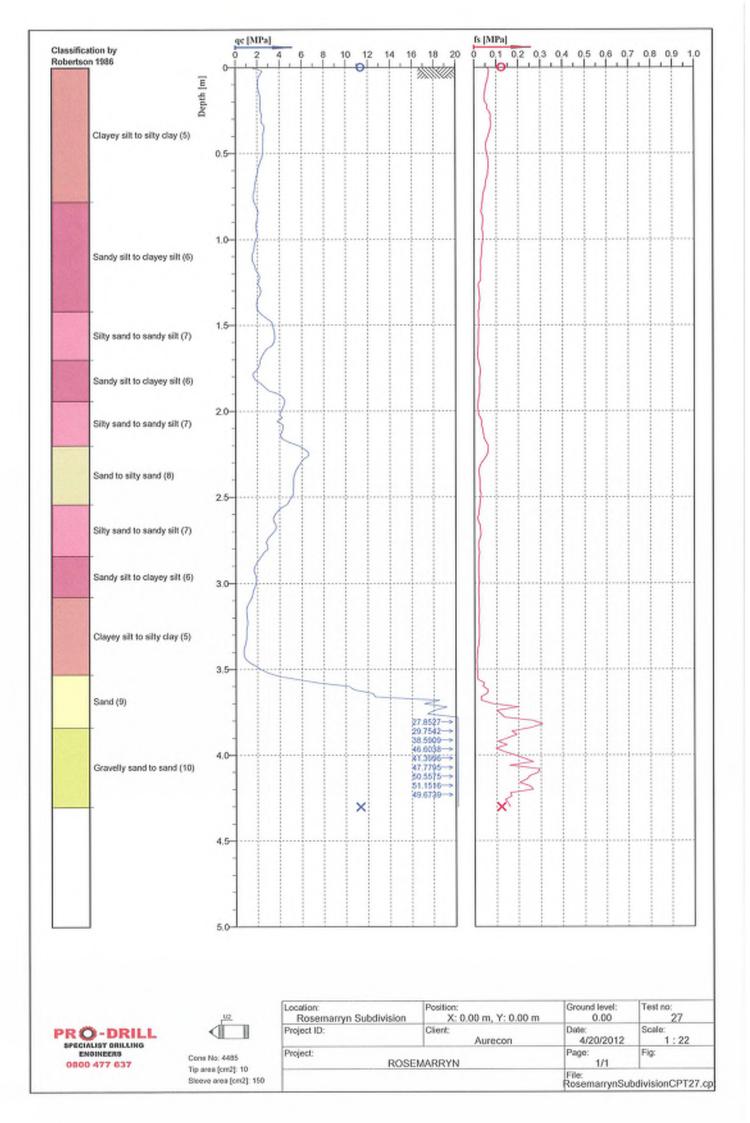


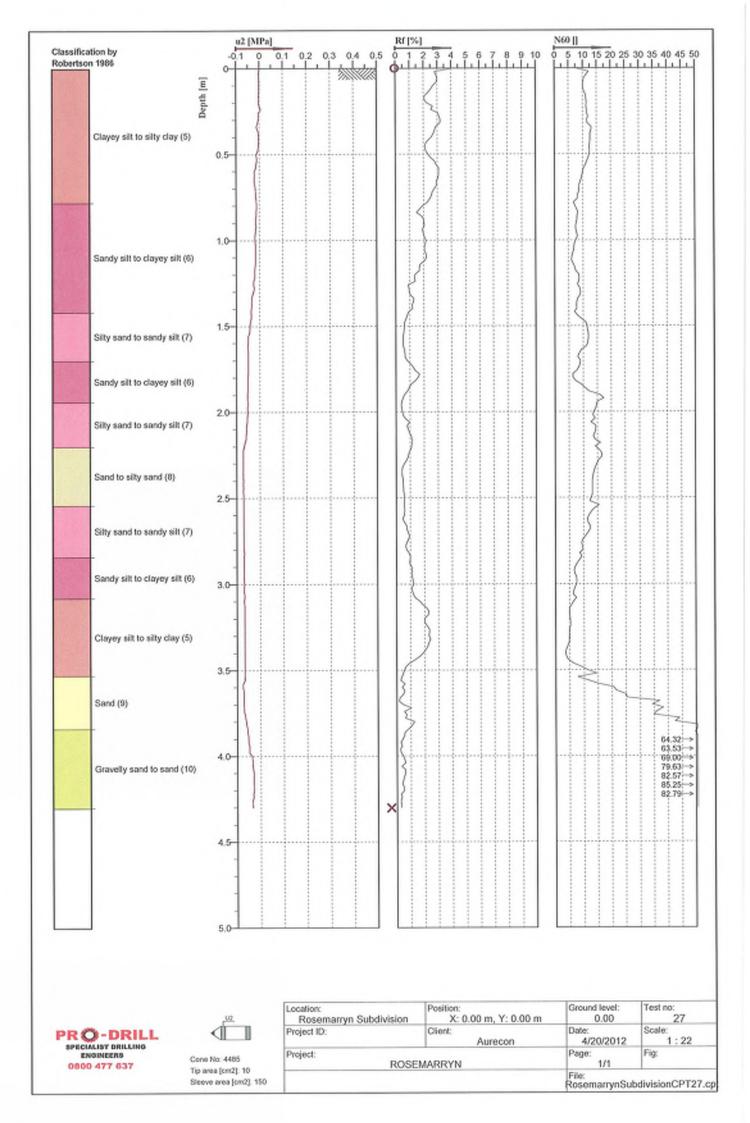


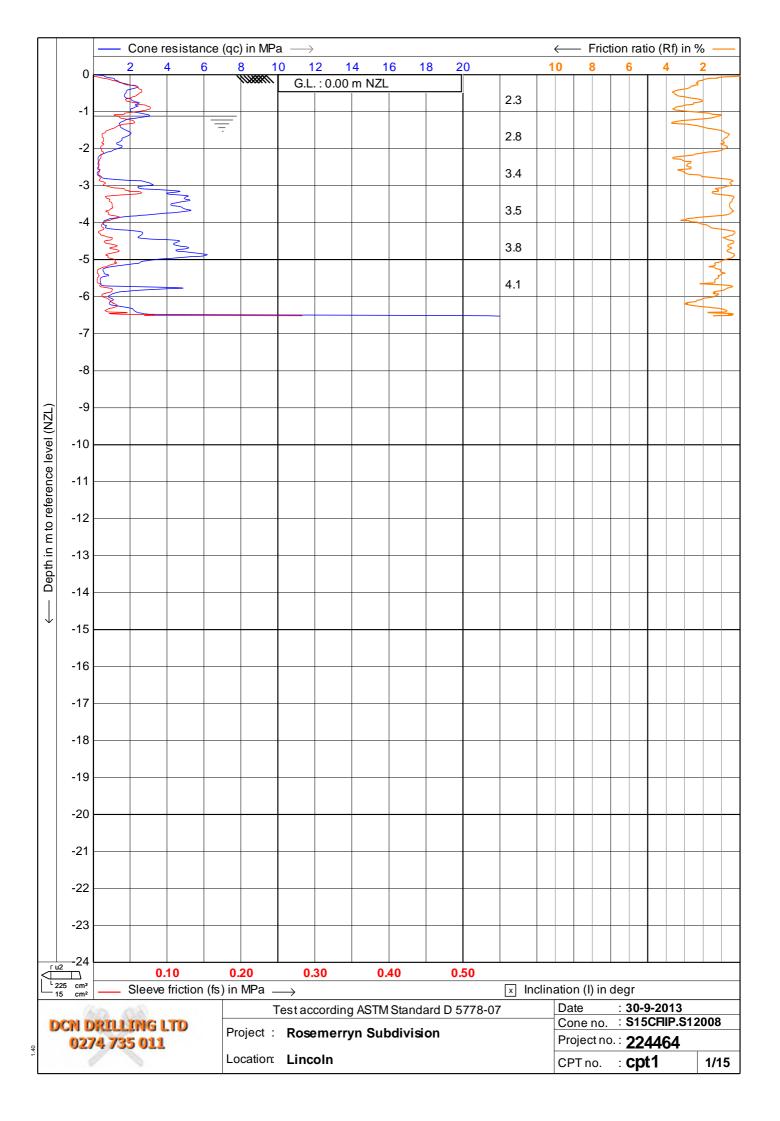


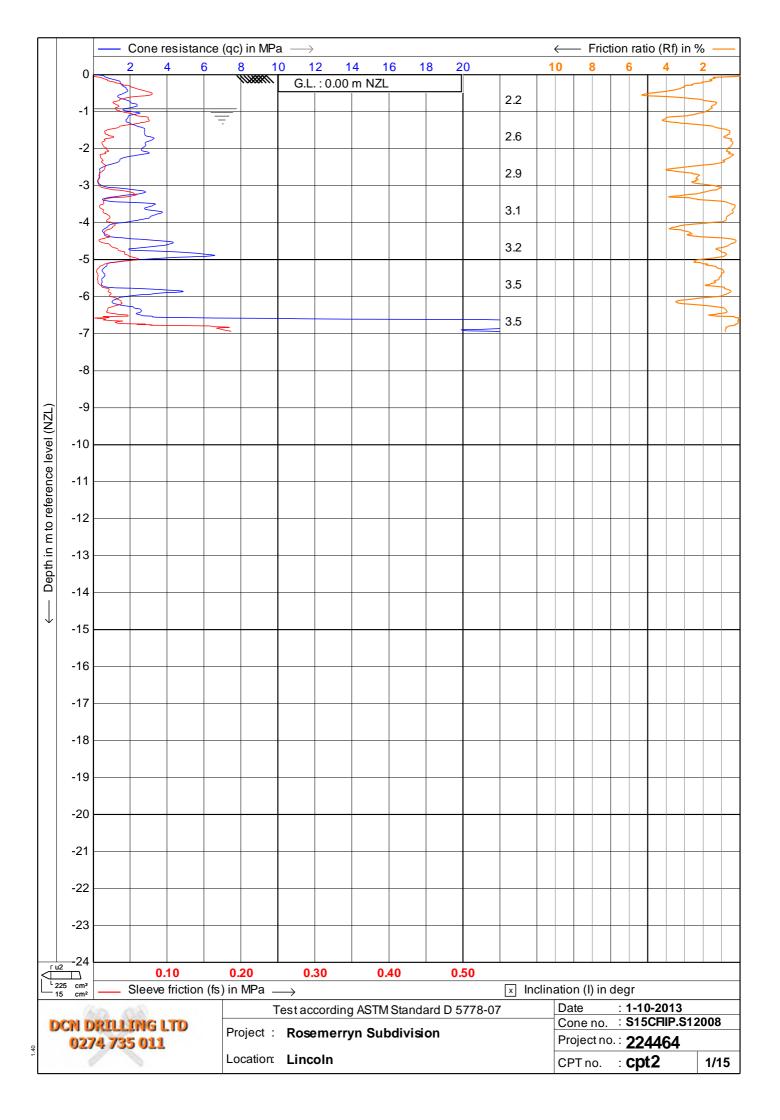


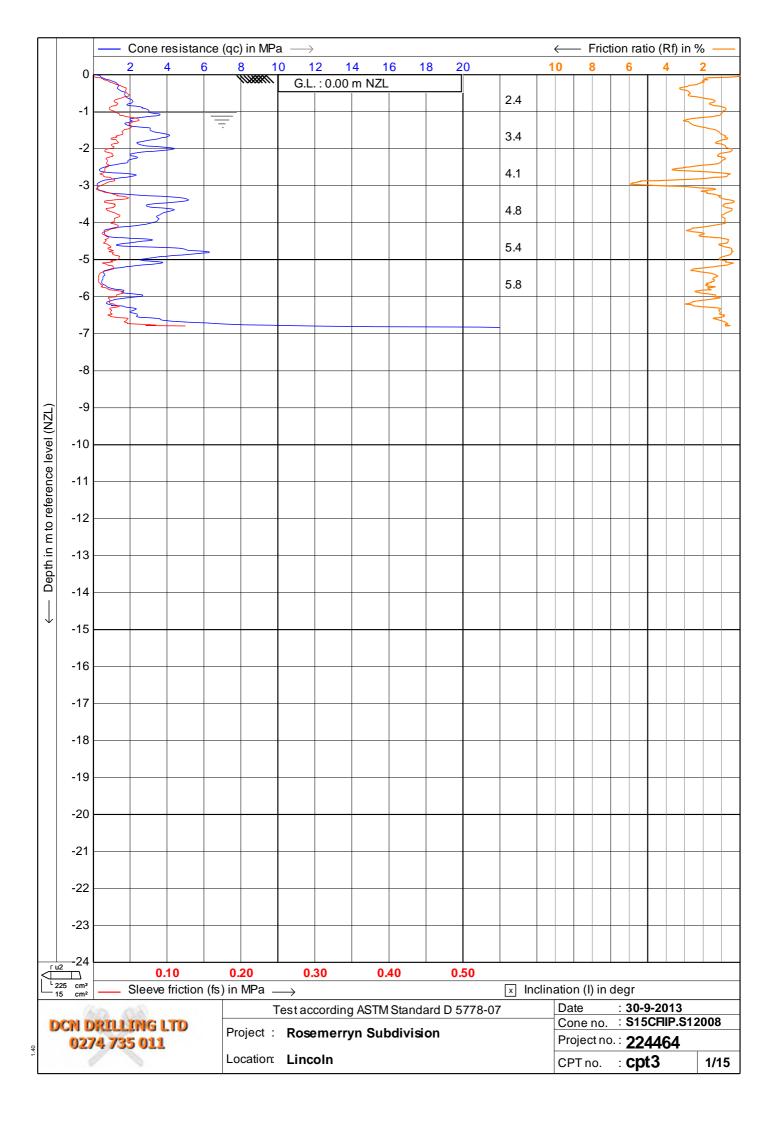


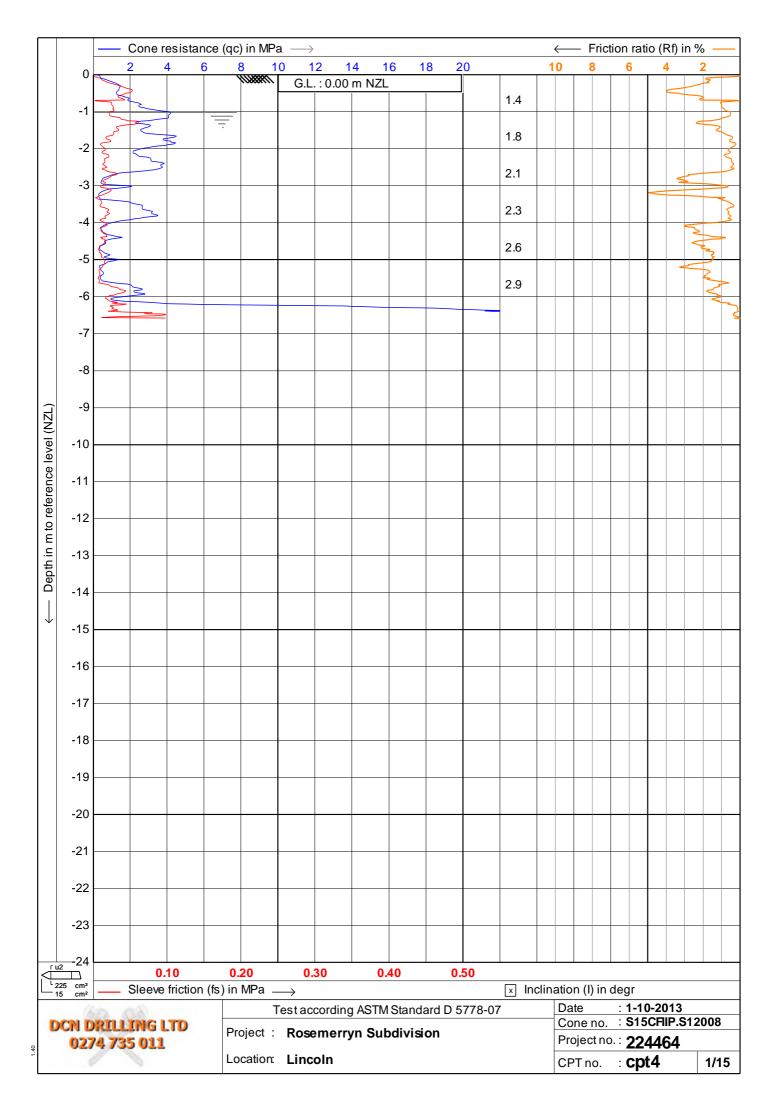


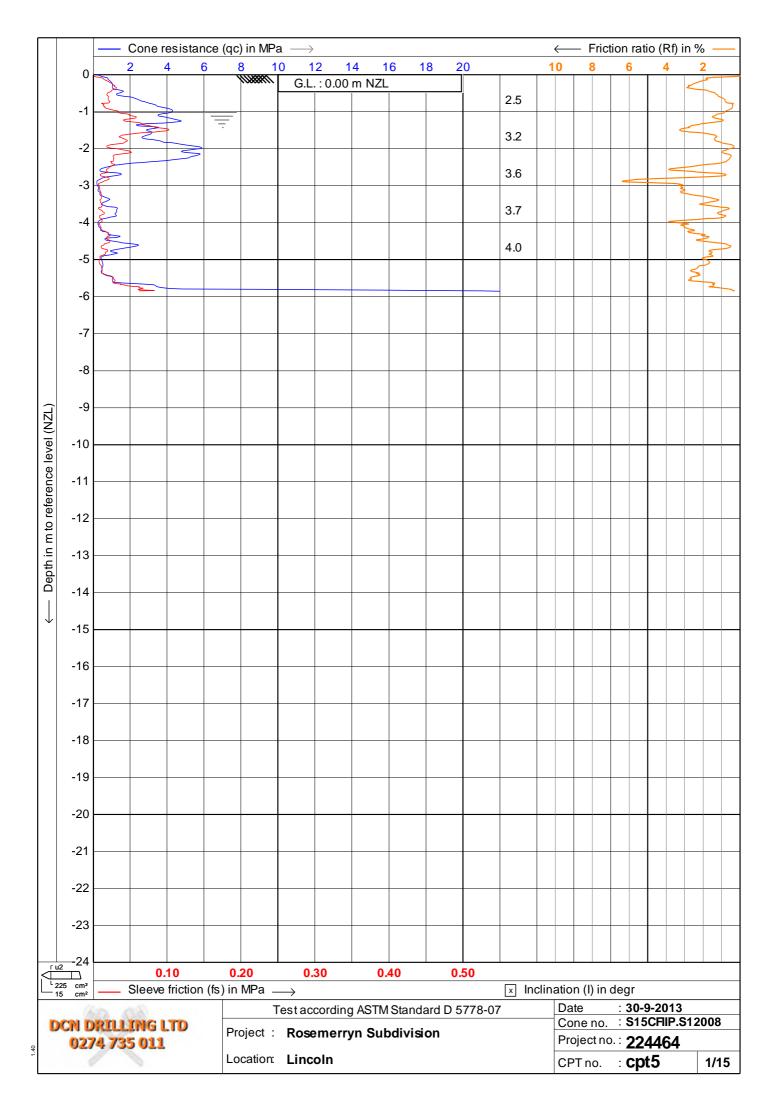


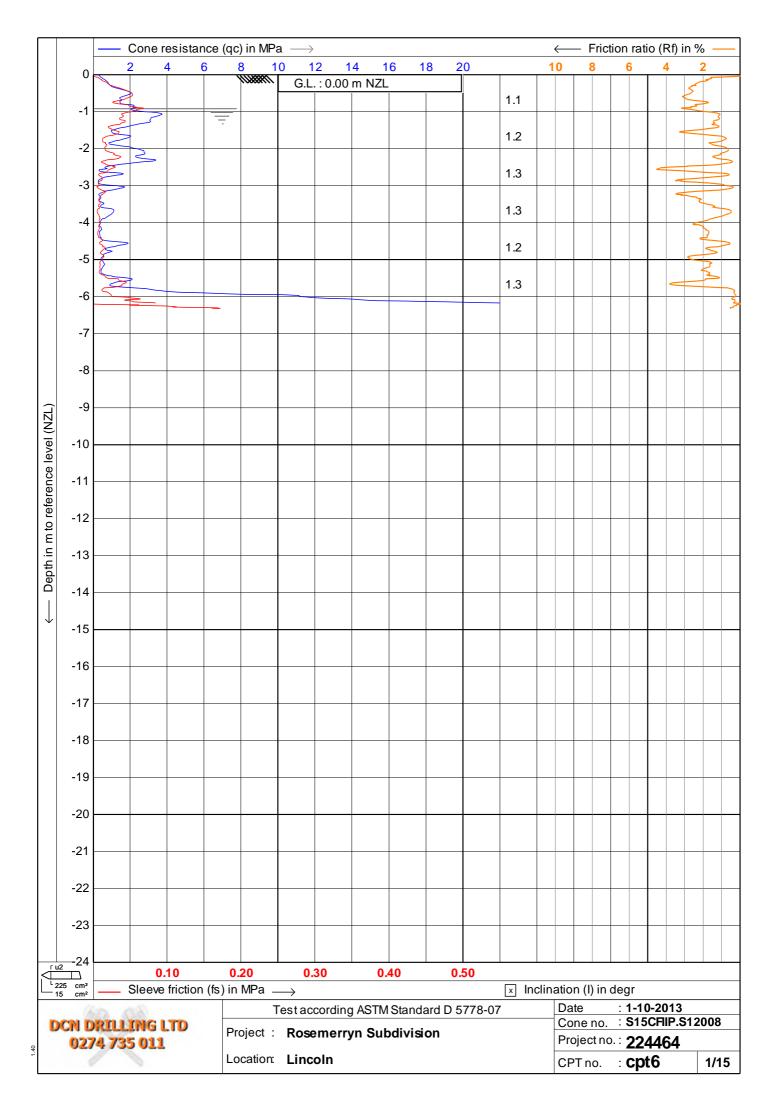


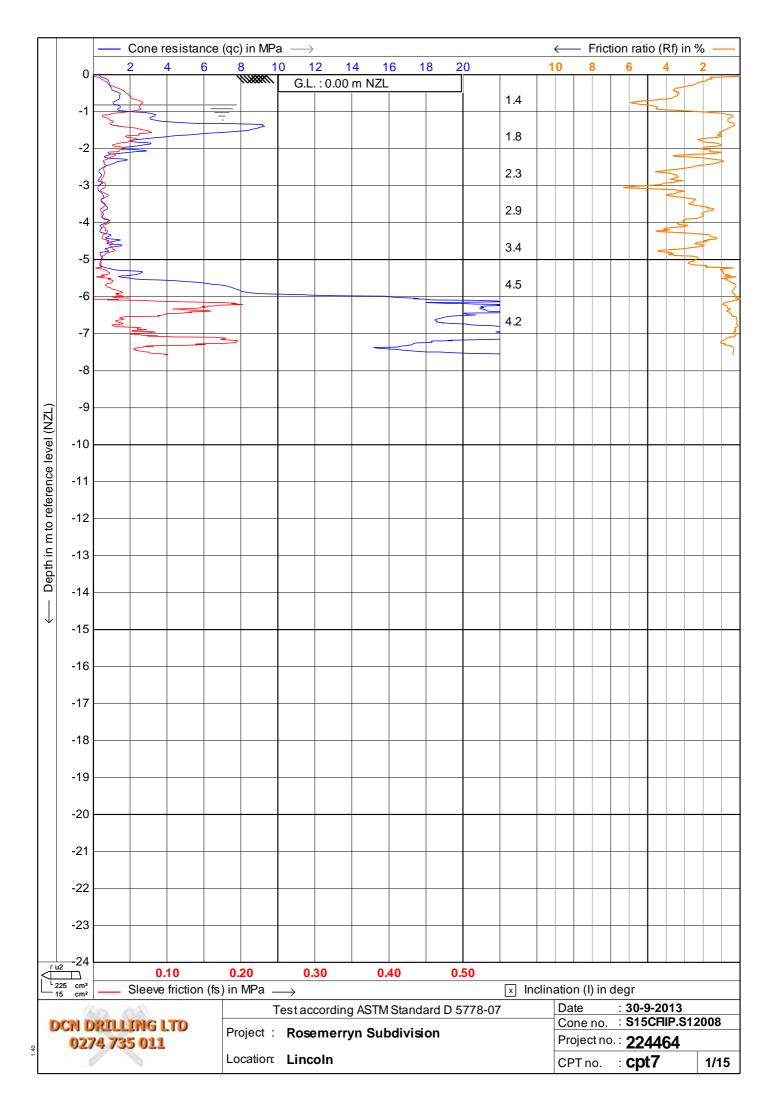


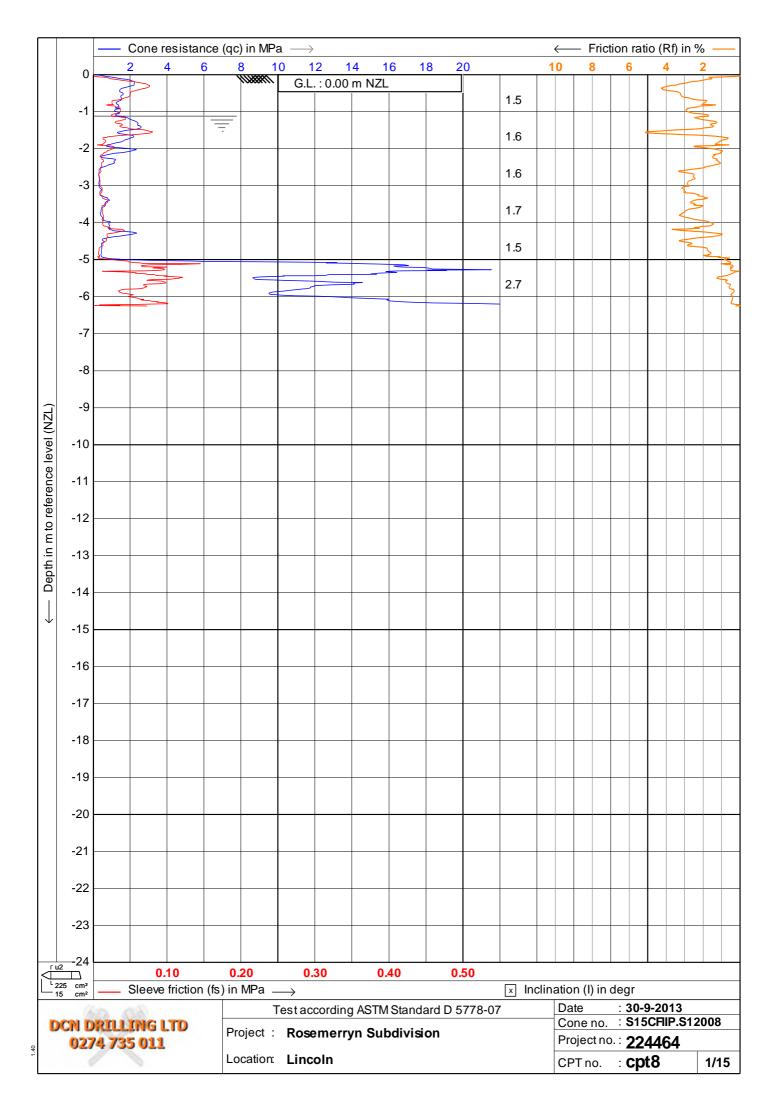


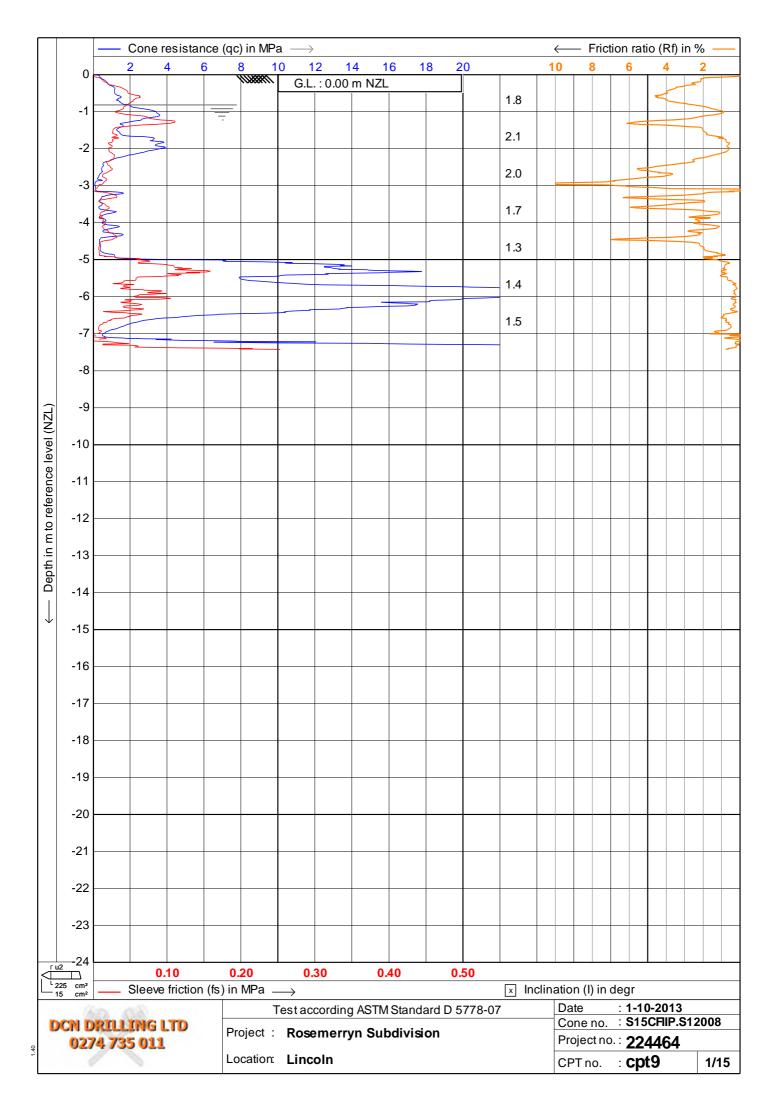


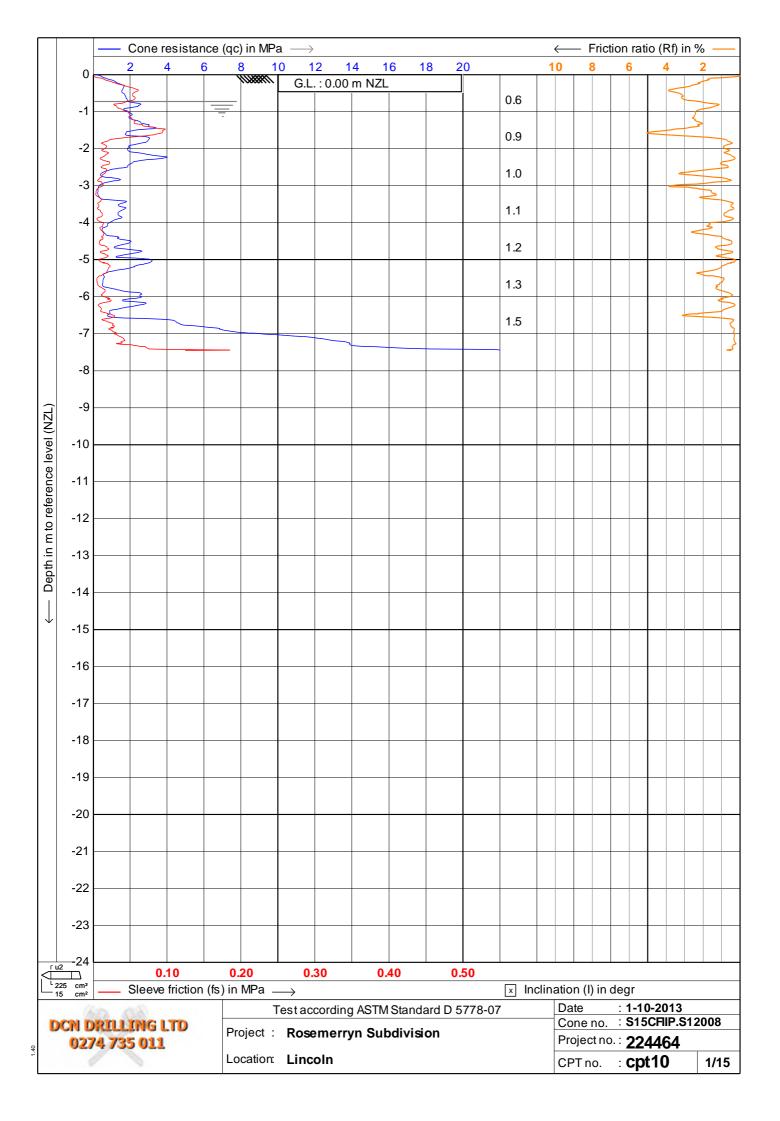


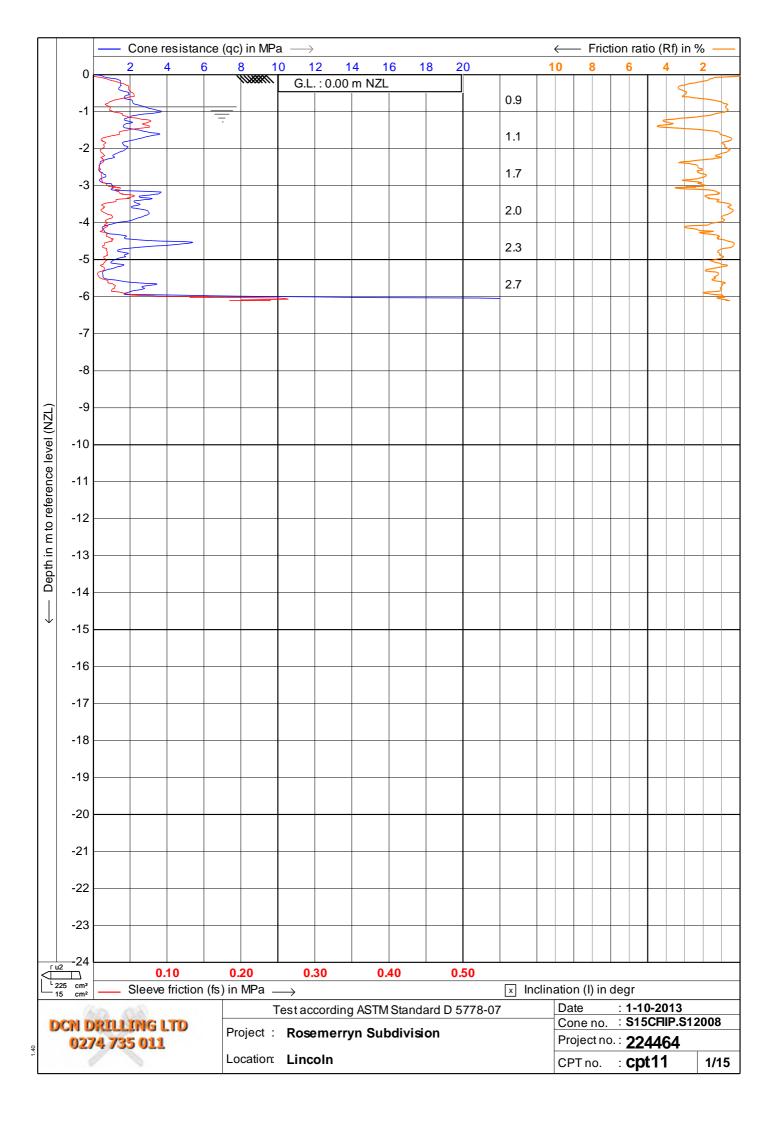


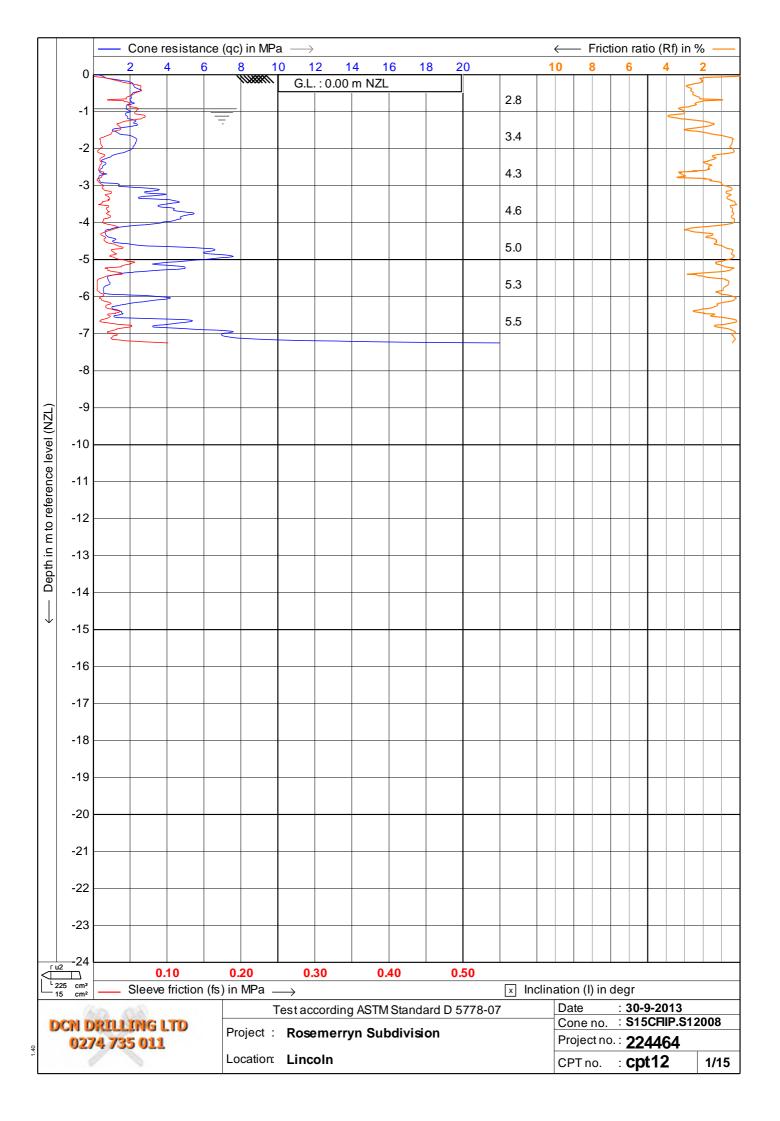


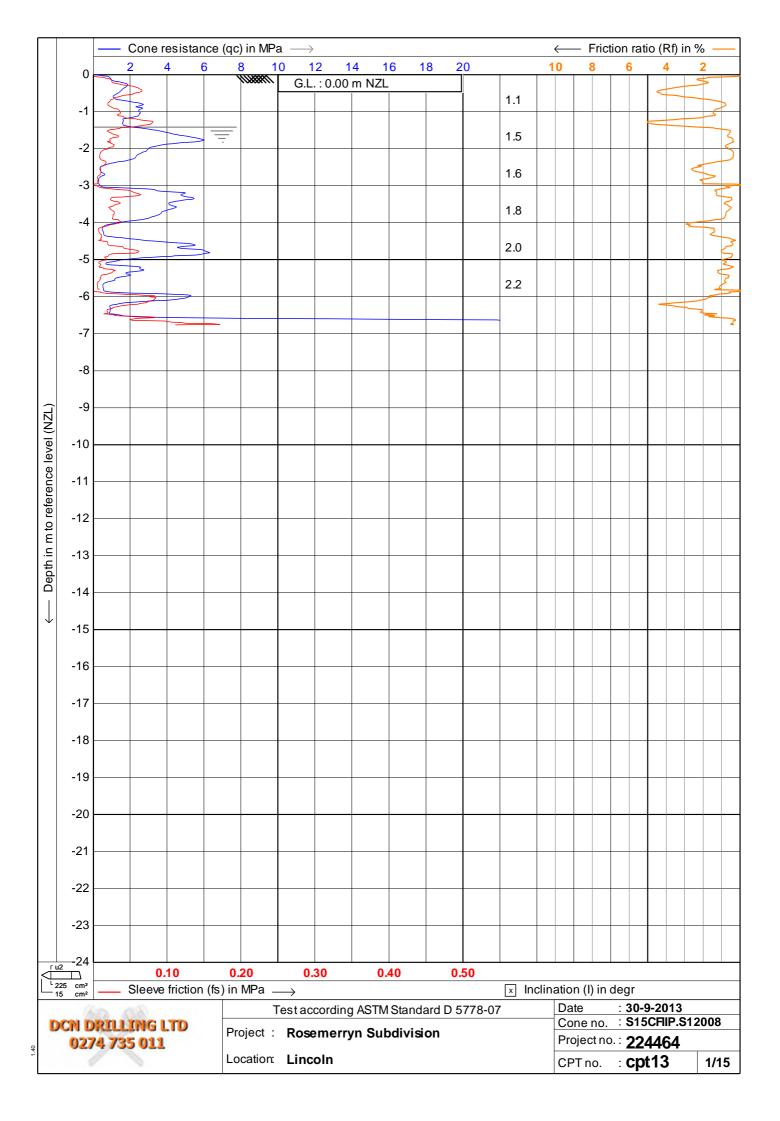


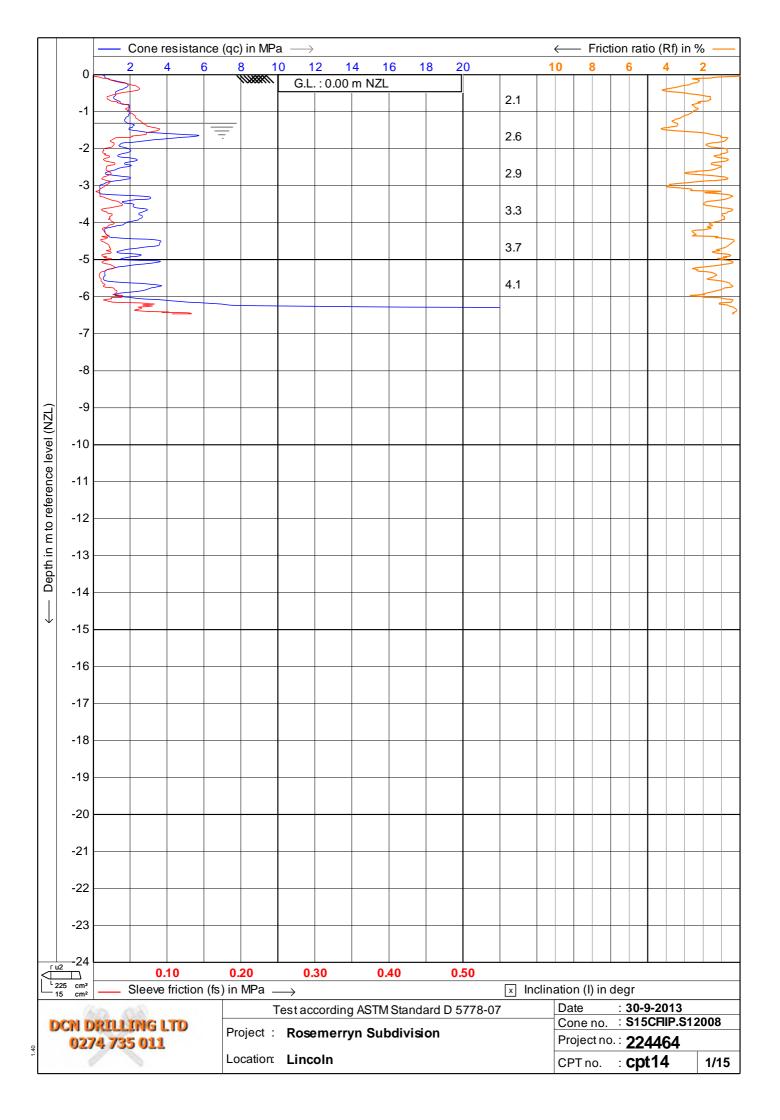


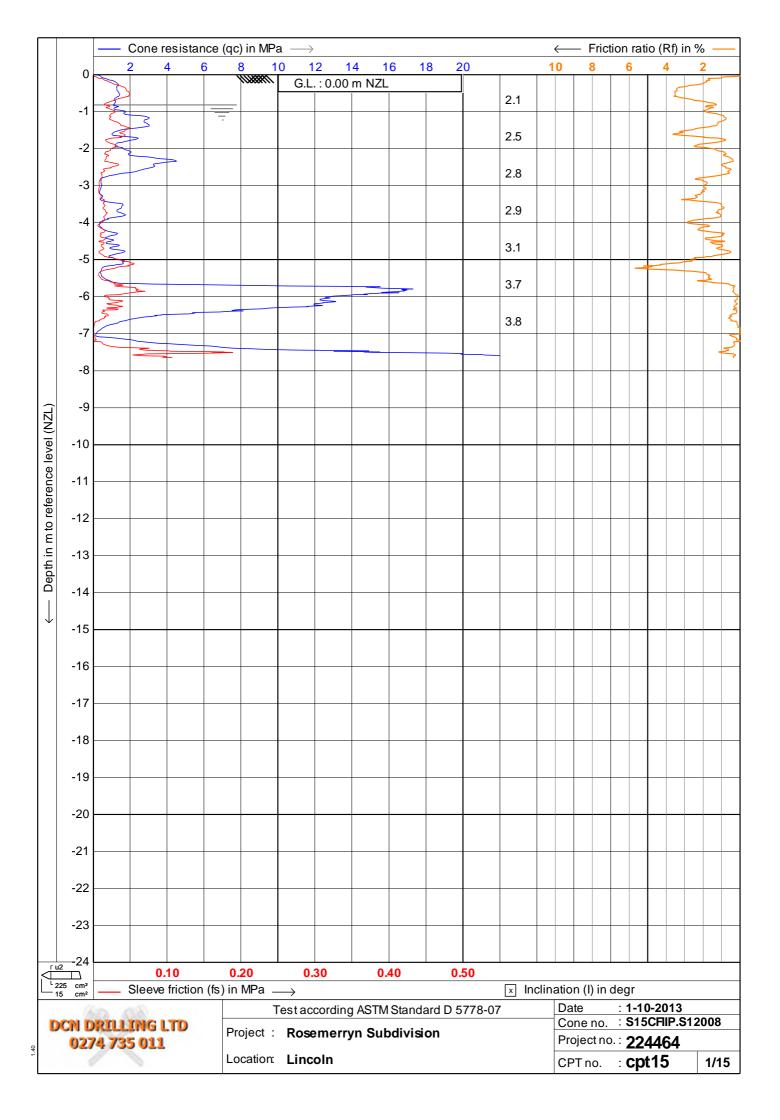


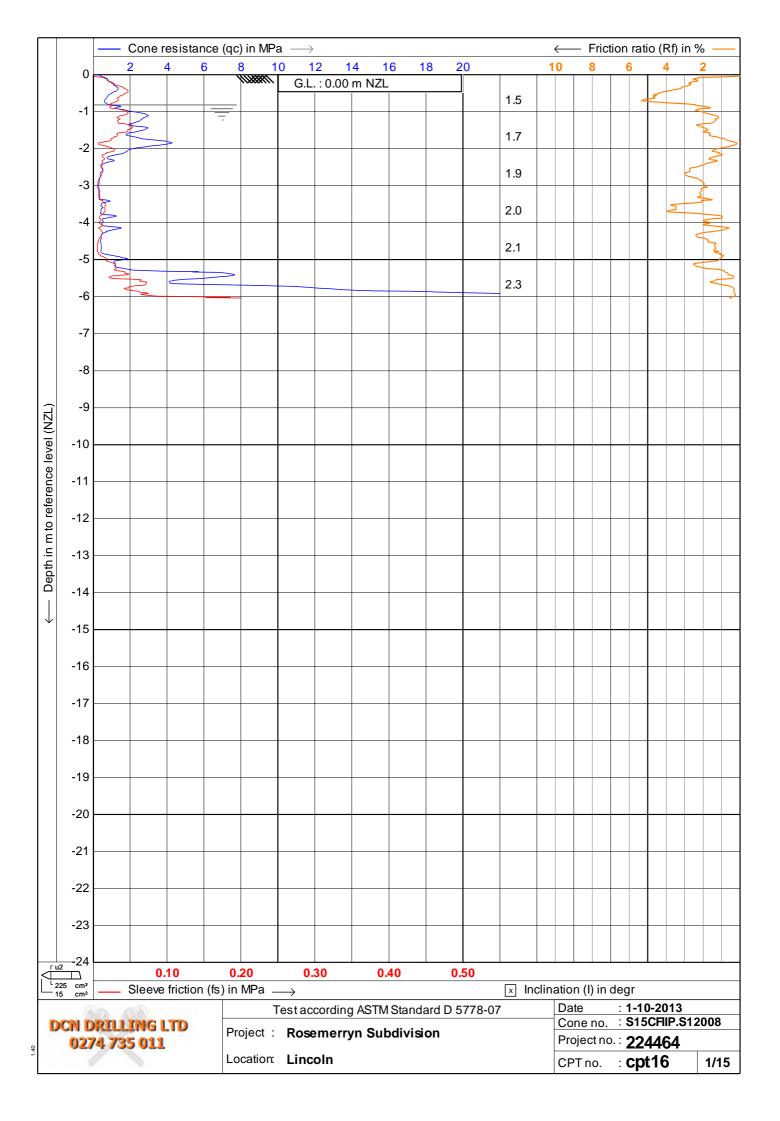


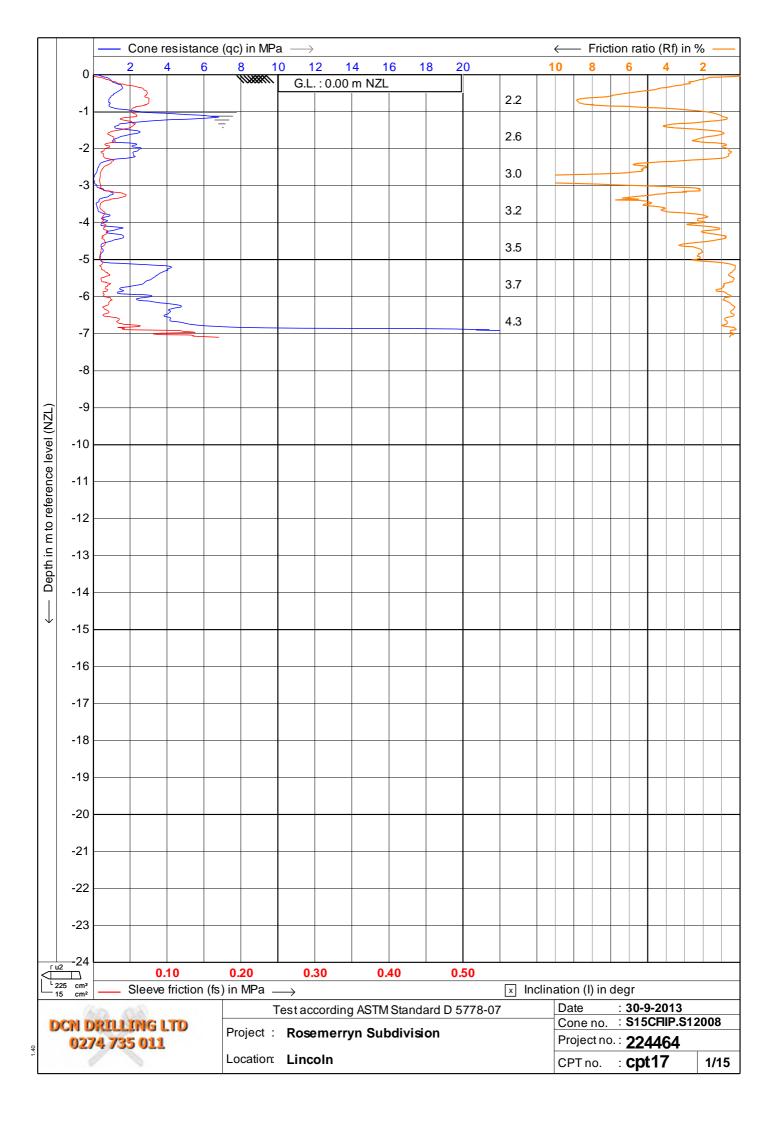


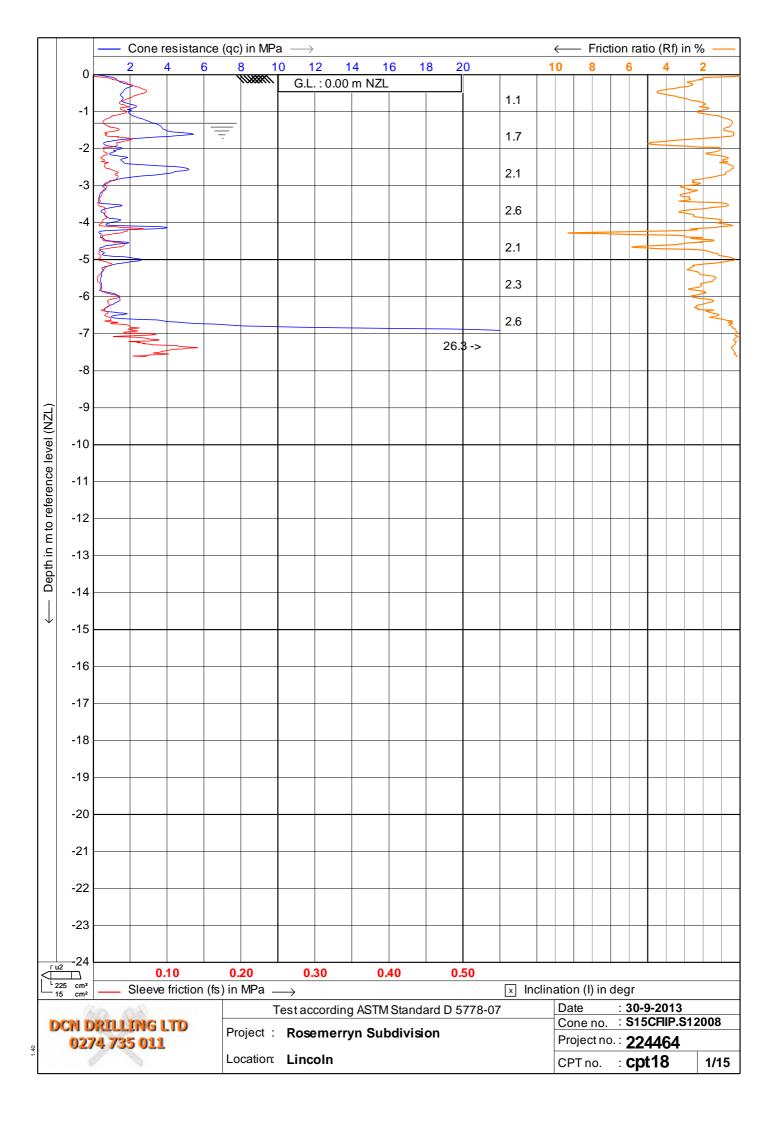


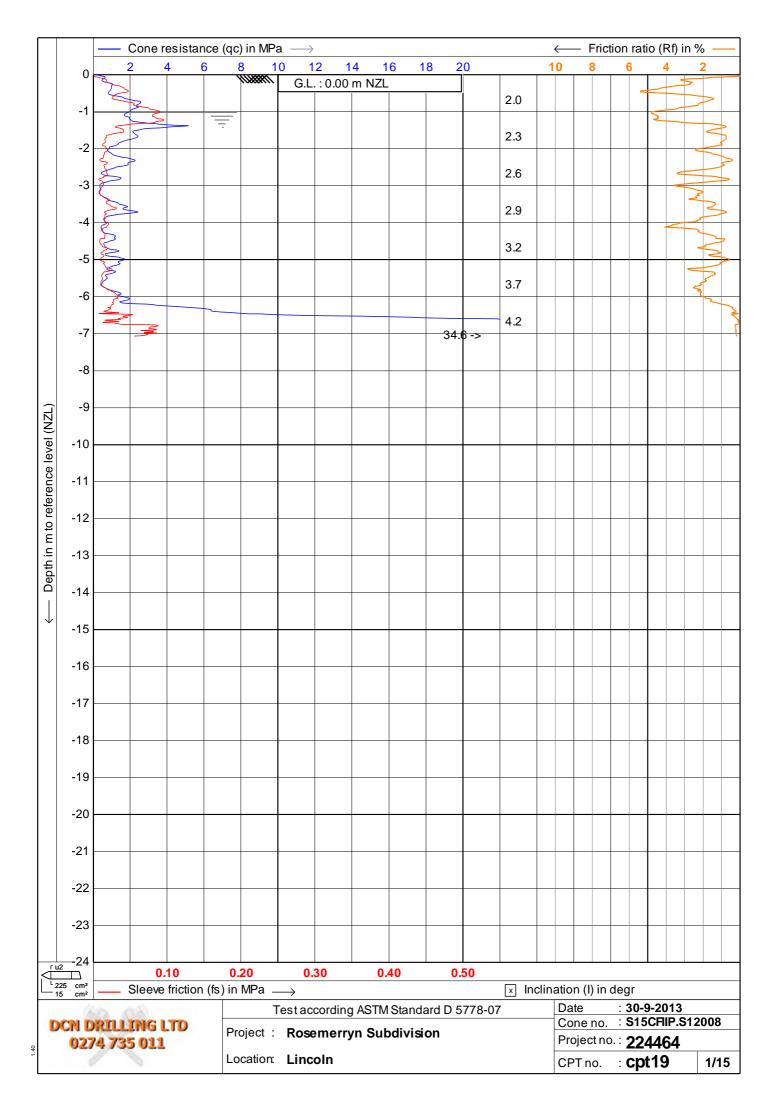


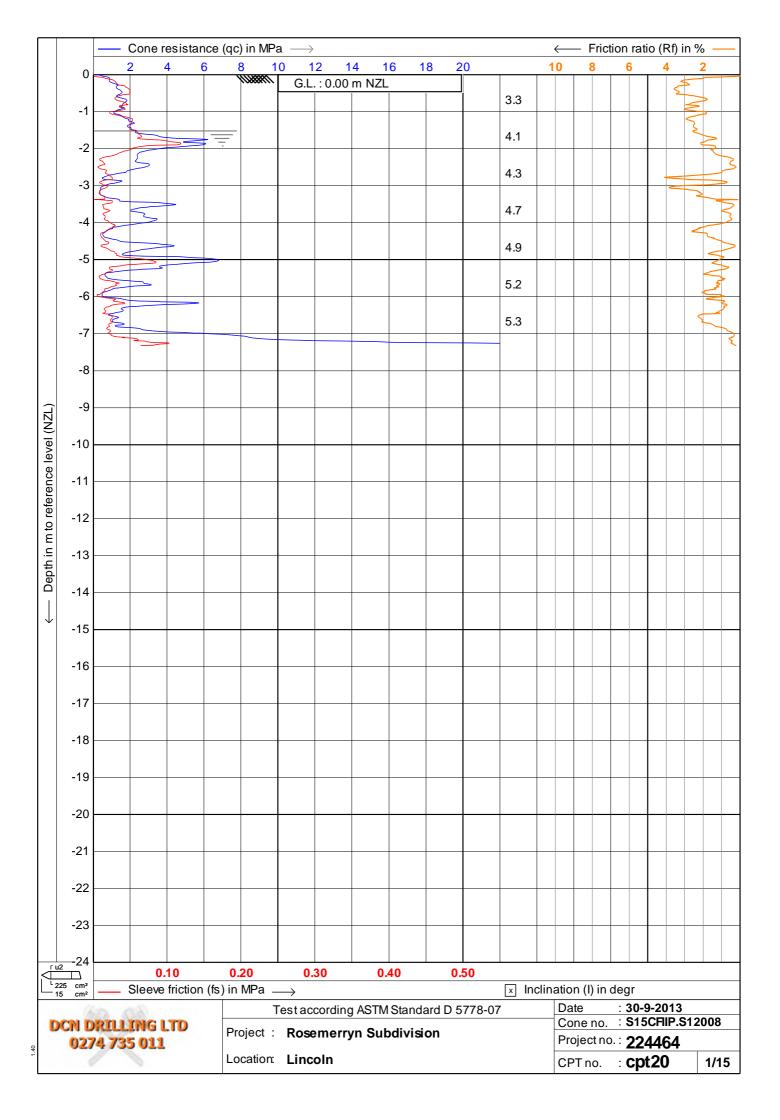


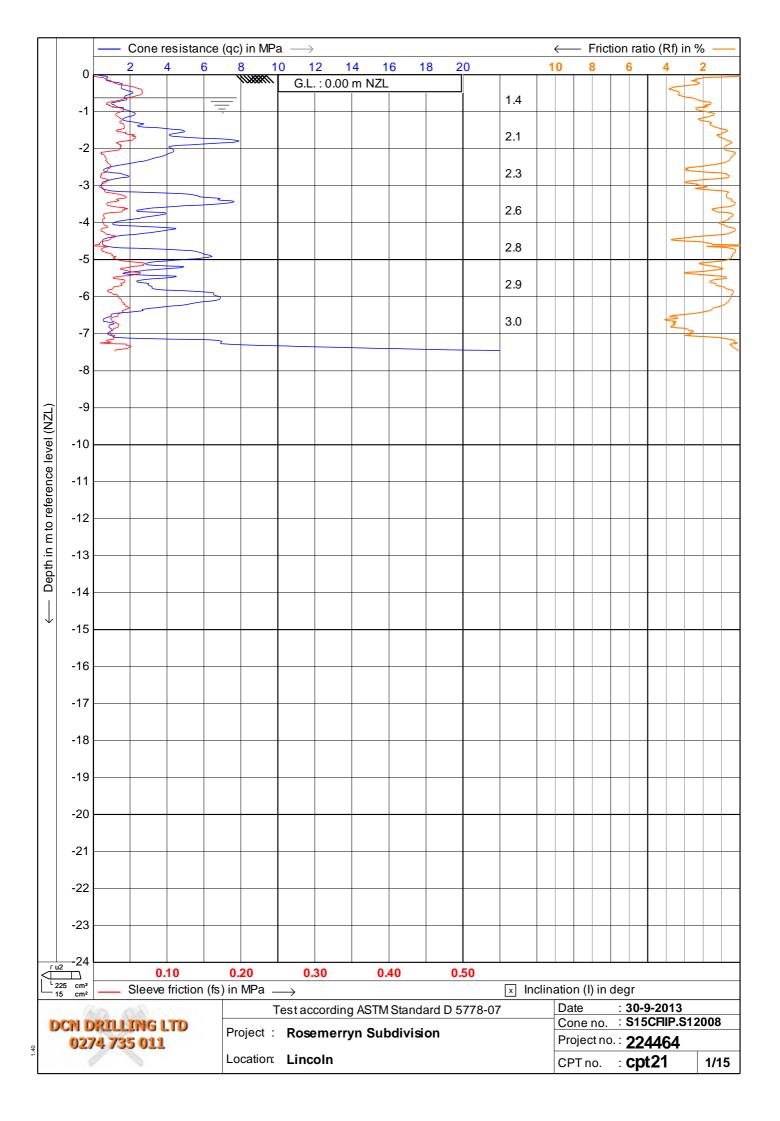


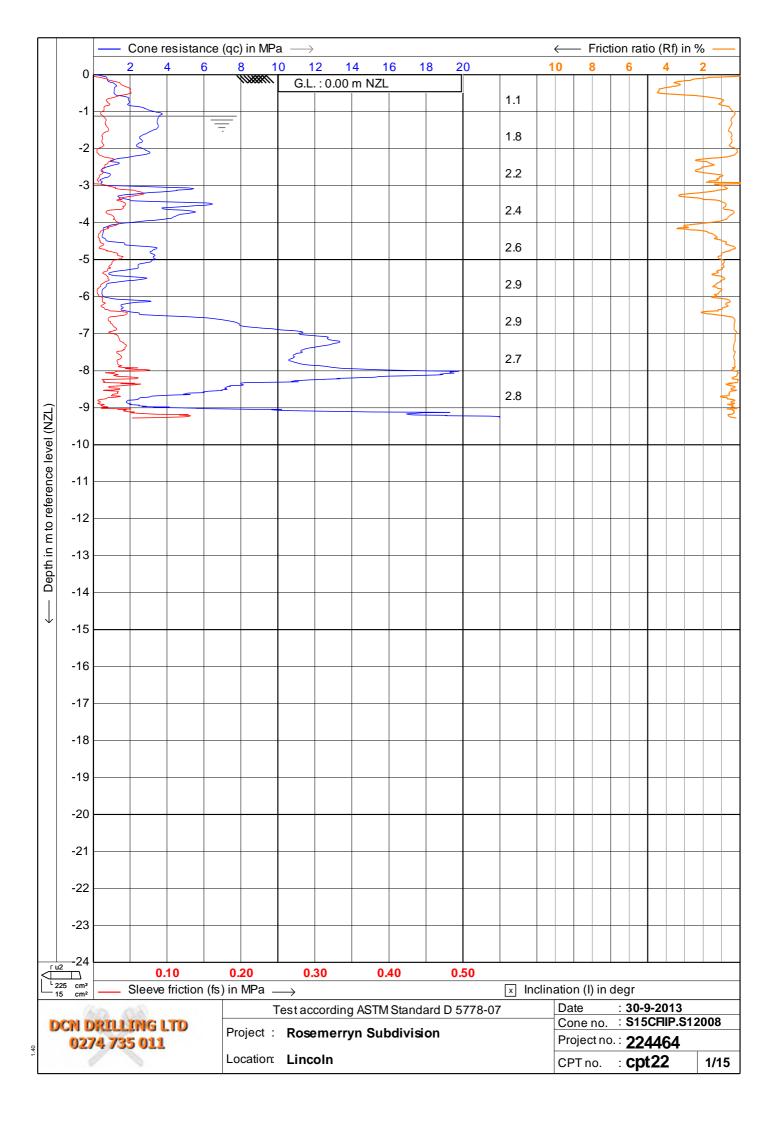












# Appendix F Test Pits Logs

**curecon** Leading. Vibrant. Global.

# Aurecon (New Zealand) Limited Unit 1, 150 Cavendish Rd

Last Generated: 27/10/2011 5:55:40 p.m.

# Client: FULTON HOGAN LAND DEVELOPMENT Project Name: ROSEMERRYN FARM SUBDIVISION

PO BOX 1 Christchur New Zeala www.aure Email: chr	rch 8140	Facsimil	ne: +64 3 366 0821 e: +64 3 379 6955 o.com		on: <b>SEE</b>   ct Referen	PLAN ce: 224464		S	heet 1 of 1
xcavator est Pit D	Type: 30 imensions r: Fulton	ot Excav	ator		<b>CO-ORDINATI</b> Easting: Northing: Ground Level:	1559471 m 5168052 m	Date Started: 6/09/2011 Date Completed: 6/09/2011	Logged by: Input by: Checked by: Verified by:	LFS LFS JSM JK
Depth (m)	Sample	Water Level (m)	Graphic Log	Shear Vane Tests	Pocket Penetrometer Tests		Soil Description		Elevation (m)
-			$\frac{\langle \mathbf{y}, \mathbf{f}_{2} \rangle \langle \mathbf{y}, \mathbf{f}_{2} \rangle \langle \mathbf{y}}{ \mathbf{f}_{2} \rangle \langle \mathbf{y}, \mathbf{f}_{2} \rangle \langle \mathbf{y}} $			plasticity. Sa	LT with trace sand and rootlets; Dark brown nd fine grained. n. Loose. Moist. Sand fine grained.	. Firm. Moist. Low	
.5 –									
.0			× × × × × × × × × ×	Shear vane a 1m: 59/30kPa	ıt	<sup>1.00</sup> SILT; Grey w	vith orange brown mottling. Very stiff. Moist.	Non plastic.	
5 -			× × × × × × × × × × × × × ×	Shear vane a 1.5m: 41/30kPa	ıt				
0			$\begin{array}{c} \times & \times \\ \end{array}$			2.20 SAND with m	ninor silt; Light blue grey. Medium dense. Sa	iturated Sand fine	
5 -						grained.			
0			× × × × × ×			3.00 SILT with mir	nor peat inclusions. Light blue grey. Wet. Lo	ow plasticity.	
5 -		Ţ				3.50	lue grey. Stiff. Wet. Low plasticity. Pit at 3.5m (GW Reached)		
0									
5 -									
-									
emarks Groundv	s: vater read	ched @	3.5m					Logged by: LFS Input by: LFS Checked by: JSI Verified by: JK	5 M
								Sh	eet 1 of 1

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And and the second	

# Client: FULTON HOGAN LAND DEVELOPMENT Austanti (New Zealaste) Luminor Austanti (New Zealaste) Luminor Christianti 1900 Generation Ros Christianti 1900 Generation Ros

Sheet 1 of 1

Depth (m) Sample Water Level (m)	Shear Vane Tests Pooket Penstrometer Tests	Soil Description	(m) no
207.2	7.5		Elevation (m)
.5		TOPSOIL silt with trace sand and occaisional rootlets; Dark brown. Firm. Moist. Low plasticity. Sand fine grained. Gravelly SAND; Brown. Loose. Molst. Gravel fine to medium grained, sub rounded. Sand medium grained.	
.0 0 .0 0 .5 0 .5 0 .5 0 .6			;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;
.0	<u>8. 200 8. 200 8. 200 8. 200 8. 200 8. 200 8. 200 8. 200 8. 200 8. 200 8. 200 8. 200 8. 200 8. 200 8. 200 8. 20</u>	Sandy GRAVEL; Brown. Loose. Moist. Gravel fine to medium grained, sub rounded. Sand medium grained.	-
	0 b 0 0 b 0 0 b 0 0 b 0 0 b 0 b 0 b 0 b		
.5 -	<u>eo</u>	End of Test Pit at 3.6m (GW Reached)	
0 -			
5 -			
emarks: roundwater reactied @ 3.6m		Logged by: LFS input by: LFS Checked by: JSM Verified by: JK	

Unix 5, 50 PO 9000 Ondatata Nam: Zani a-WUMN	ach 4140	l Taiachta Facairtía	na ≻ 64 a 368 De51 a → 64 a 368 De51 xers	Projec Locati	it Name: on: SEE P	ROSEMERRY	ND DEVELOPMENT N	TP	et 1 of 1
EST PIT xcavato ast Pit D	r Type: 30 Ir Type: 30 Xmensions XC Fulton	ATION Of Excev				1559602 m 5166105 m	Date Started: 6/09/2011 Date Completed: 6/09/2011	Logged by: Lf Input by: Lf Checked by: Jf Vertiled by: Jf	FS SM
Depth (m)	Sample	Water Level (m)	Graphic Log	Shear Vans Tasts	Pockst Penerometer Tests		Soil Description		Elevation (m)
5			100 000 000 100 000 000 100 0000 100 000 100 000 100 000 100 000 100 000 100 000 100	Simer are at Crac 104 12kPa		Moist, Low pla SILT; Grey with SAND; Brown,	with trace sand and occalsional rootled sticity. Sand fine grained. h orangle brown mottling. Very stiff, Mol Loose to medium dense. Molst. Mediur y. Soft. Moist. Low plasticity.	st, Non plastic.	
5 0 5				Shear wine 14 1.5m. 50% 6kPg Shear wine #1 2m: CortSkPa	-	<sup>200</sup> SAND with mir plasticity.	y, sont Moist, Low plasticity, for silt, Blue grey, Medium dense, Satur some roots, Light blue grey, Wet, Low	-	
0			× × ↔ × × × × × × × × × × × × × × × × × ×			Non plastic. W GRAVEL send	y with trace silts; Grey, Loose, Wet, Fin eli graded. y with trace silts; Light brown orange, Li d. Non plastic, Well graded. at 3.3m (GW Reached)	_	
0									
5									
emarks o groun	: ndwater en	icountei	red			t - 14		Logged by: LFS Input by: LFS Checked by: JSM Verified by: JK	

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## FULTON HOGAN LAND DEVELOPMENT Client: Autorofi (New Zeland) (mithel Vial 1, 150 Overspech Rd PODCV 1061 Childdawer 8140 New Zakend United Vial 1, 150 Overspech Rd Project Name: ROSEMER Location: SEE PLAN Project Reference: 224464 Enal: enterthurflighe surveying corr Project Name: ROSEMERRYN Location: SEE PLAN

CO-ORDINATES N/A Easting: 1559641 m Northing: 5168197 m Ground Level: N/A

Sheet 1 of 1

**TP11** 

	TEST PIT INFORMATION
	TEST PIT INFORMATION Excavator Type: 30t Excavator
	Test Pit Dimensions:
	Test Pit Dimensions: Contractor: Fulton Hogan
ł	

Date Started: 7/09/2011 Date Completed: 7/09/2011

Logged by: LFS input by: LFS Checked by: JSM Verified by: JK

Depth (m)	Sample	Water Level (m)	Graphic Log	Shear Vane Tests	Pocket Penetrometer Tests	Soil Description	Elevation (m)
0.5			<u>24</u> 24 3 5 56 35 24 36 3			TOPSOIL SILT with trace sand and occaisional rootlets; Dark brown. Firm. Moist. Low plasticity. Sand fine grained. SAND; Brown with orange mottling. Loose. Moist. Sand fine grained.	
1.0 —							
1.5 -							
2.0			× × * × * ×			Silty SAND; Dark grey. Loose. Moist. Sand fine grained.	
2.5 -						2.50 SILT; Dark grey blue. Soft. Wel. Low plasticity.	
3.0		Ţ	× × × × × × × × × × × × × × × × × × ×			End of Test Pit at 2.9m (GW Reached)	
3.5 -							
4.0		- - -					
4.5							
Remarks	s: water read	ched @	2.9m			Logged by: LFS input by: LFS Checked by: JSM Verified by: JK	
100							et 1 of 1

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# Client: FULTON HOGAN LAND DEVELOPMENT Project Name: ROSEMERRYN Location: SEE PLAN Arrent (New Zealard) Limited Units, 150 Causadala Ra Po 3025 V35 Causadalard Ra Project Name: ROSEMER Location: SEE PLAN Project Reference: 224464

Sheet 1 of 1

TEST PIT INFORM/ Excavator Type: 31 Test Pit Dimensions Contractor: Fulton	DI Excav	alot		CO-ORDINATE Easting: Northing: Ground Level:	1559680 m 5168289 m	Date Started: 6/09/2011 Date Completed: 6/09/2011	Logged by: LFS input by: LFS Checked by: JSM Verified by: JK	
Depth (m) Sample	Water Level (m)	Graphic Log	Shear Vane Tests	Penetrometer/Tests		Soil Description		Elevation (m)
0.5					Moist. Low pla SAND with sc grained. Sandy GRAV medium grain Sandy SILT: 1 Sandy GRAV medium grain	T with trace sand and occalsional root asticity. Sand fine grained. me silt: Brown. Loose to medium dense led, sub rounded. Sand medium grained light brown. Firm. Wet. Low plasticity. S EL; Light grey. Loose to medium dense led, sub rounded. Sand medium grained it at 2.9m (GW Reached)	e. Moist. Sand fine . Moist. Gravel fine to d. Sand fine grained. . Moist. Gravel fine to	
4.5								
Remarks: Groundwater read	: :hed 2.5	)m			,		Logged by: LFS Input by: LFS Checked by: JSM Verified by: JK	

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# FULTON HOGAN LAND DEVELOPMENT Client: Autom (New Zevend) Limited Unit 1.150 Owwardor Rd PD Box 1081 Caladatwork 1810 New Zevendor Rd Telefonter: 1913 3033 0821 Project Name: ROSEMER Location: SEE PLAN Project Reference: 224464 Email: christharth@pas.weeggroup.com Project Name: ROSEMERRYN Location: SEE PLAN

Sheet 1 of 1

**TP15** 

TEST PIT IN	FORMATION
Excavator T	ype: 30t Excavalor
Test Pit Dim	ensions:
Contractor:	Fulton Hogan

epth (m)

Sample i

CO-ORDINATES N/A Easting: 1559733 m Northing: 5168158 m Ground Level: N/A Logged by: LFS Inpul by: LFS Checked by: JSM Verified by: JK Dale Started: 7/09/2011 Dale Completed: 7/09/2011 Pockel etrometer Tests er Level (m) evation (m) aphic Log ar Vane Tests Soil Description ł

Depth (	Sampl	Water Lev	Graphic	Shear Vane	Pockel	Soil Description	Elevation
			<u> 255-257-2</u> 26- <u>256-254</u> -2			TOPSOIL SILT with trace sand and occalsional rootlets; Dark brown. Firm. Moist. Low plasticity. Sand fine grained. SAND; Grey with orange brown mottling. Loose. Moist. Sand fine grained.	
0.5							2
1.0 _			× × × × × ×			SILT; Dark grey. Soft. Molst. Low plasticity.	
1.5 -			× × × × × × × × × × × × × × × × × × ×				
2.0			× × × × × × × × × × × × × × × × × × ×			CRAVEL with come cand. Grey and dark proppe brown Danse. Wet to	
2.5 – -						<sup>230</sup> GRAVEL with some sand; Grey and dark orange brown. Dense. Wet to saturated. Gravel fine grained, rounded to sub-rounded. Sand fine grained. End of Test Pit at 2.3m (GW Reached)	r
3.0 — -							
3.5 -							
I.0 —					ar		
4.5							
Remarks	s: vs @ 1.5i	m	<u>}</u>			Logged by: LFS Input by: LFS Checked by: JSM Verified by: JK	

# Aureon (New Zealand) Limited Unit 1,50 Cavendish Rd PO BOX 1061 Chierdwurch R140

Last Generated: 27/10/2011 5:55:42 p.m.

# Client: FULTON HOGAN LAND DEVELOPMENT Project Name: ROSEMERRYN FARM SUBDIVISION Location: SEE PLAN

New Zeal: www.aure Email: ch		Telephon Facsimile	e: +64 3 366 0821 a: +64 3 379 6955 com	Proje	ct Referer	nce: <b>224464</b>		Shee	et 1 of 1
TEST PIT Excavator Test Pit D	TINFORMA Type: 30 Nimensions Nr: Fulton I	TION t Excave			<b>CO-ORDINAT</b> Easting: Northing: Ground Level:	1559747 m 5167935 m	Date Started: 6/09/2011 Date Completed: 6/09/2011	Logged by: LF Input by: LF Checked by: JS Verified by: JK	S M
Depth (m)	Sample	Water Level (m)	Graphic Log	Shear Vane Tests	Pocket Penetrometer Tests		Soil Description		Elevation (m)
0.5 -			$\begin{array}{c ccccccccccccccccccccccccccccccccccc$			plasticity. Sand fine	trace sand and rootlets; Dark brow grained. oft. Moist. Low plasticity.	n. Firm. Moist. Low	_
1.0			× × × × × × × × × × × × × × × × × × ×			grained.	; Light brown. Loose to medium de d; Grey with brown mottling. Stiff. M grained.		_
1.5 -			$\begin{array}{cccc} & \times & \times & \times \\ & \times & \times & \times \\ & \times & \times & \times$			1.70 1.80 SILT with some peat	inclusions; Light blue grey. Wet. L	ow plasticity.	
2.0 —						2.00	to medium dense. Wet. Fine graine e to medium dense. Wet. Fine grai		
2.5 -		¥				2.80			
3.0 —						End of Test Pit at 2.8	3m (GW Reached)		
3.5 -									
4.0 —									
4.5 - -									
-									
Groundy Tree roo	anch @ 1.8 water seep ot @ 2.5m	bage @	1.7m ed at 2.8m					Logged by: LFS Input by: LFS Checked by: JSM Verified by: JK	
								Sheet	1 of 1

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Autecon (New Zeeland) United Usit 1, 150 Coronalisti Nd PO BOX 1684 Christohurch 3140

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# Client: FULTON HOGAN LAND DEVELOPMENT Project Name: ROSEMERRYN Location: SEE PLAN

Now Zeal WWW.purs Email: di	pand seorgroup,com sidk/surd+Qino	Factions	na +64 3 366 0821 le: +6± 2 379 3955 j.com	Projec	t Referen	ice: 224464				SI	heet 1 of 1
Excavato Test Pit D	INFORM Type: 3 Imension: r: Fullon	Ot Excar Si	vator		CO-DRDINATI Easting: Northing: Ground Level:	1559786 m 5168027 m		Dale Started: 6/09/2011 Dale Completed: 6/09/2011		Logged by: Inpul by: Checked by: Verified by:	LFS LFS JSM JK
Depth (m)	Sample	Water Level (m)	Graphic Log	Shear Varie Tests	Pockel Penetrometer Tests			Soil Description			Elevation (m)
			<u>52</u> 52 5 6 56 56			Moist. Low plat	slicity. Sa	e sand and occaisional n nd fine grained.			· · · · ·
0.5 -			××××			grained. Silty SAND; Gr	rey with o	own. Loose to medium d			st.
-			x x x x x x x x x x			Sand fine grain	ned.				
1.0			× × × × × × × × ×								
1.5 -			× × × × × × × × × × × × × × × × × × ×								-
2.0			* × × × × × × ×			2.05					
						SIL I with tree f	foots: Gre	ey with brown mottling. So	π. wet. Low pla	sticity.	
2.5 -			× × × × × × × × × × × × × × × × × × ×								
3.0 —		Ţ	× ×			Gravelly SAND and medium to coal End of Test Pit	irse graine	pose. Wet. Sand fine to n ed and sub rounded.	nedium grained.	Gravel	
-								, , , , , , , , , , , , , , , , , , ,			
3,5 -											
4.0 —											
-											
4.5 -	:										
Remarks Groundw		e reach	eci at 3.0m						Logged Input by Checked Verified	LFS by: JSN	
										She	et 1 of 1

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# Client: FULTON HOGAN LAND DEVELOPMENT Project Name: ROSEMERRYN Location: SEE PLAN Autocon (New Zahlandi ) initial On (1. 180 Caverdeb Rd PO 80X 1051 Childmarks dista New Zahlandi (Initial De Caverdeb Rd PO 80X 1051 Teleprone: -04 3 380 0821 Facilitati - 164 3 380

Sheet 1 of 1

Entati cirilachuidh@en Arexolegoup.com TEST PHT INFORMATION Excavator Type: 30t Excavator Test Pit Dimensions: Contractor: Fulton Hogan			CO-ORDINATES N/A         Date Started:         9/09/2011           Easting:         1559825 m         Date Completed:         9/09/2011           Northing:         5168119 m         Date Completed:         9/09/2011           Ground Level:         N/A         N/A         Date Completed:         9/09/2011					Logged Input by Checke Verified	r: LFS ⊄by:JSM			
Depth (m)	Sample	Water Level (m)	Graphic Log	Shear Vane T <del>e</del> sts	Pocket Penetrometer Tests			Soil Desc	ription			Elevation (m)
).5 -			<u>Sur . Sur S</u> <u>In Sur Sur</u>			Moist. Low p	lasticity. Sa	e sand and occa nd fine grained. e brown mottling.				
.0 —		-	× × × × × × × × × × × × × × ×			SILT; Dark g	grey, Soft. N	loist. Low plastici	ty.			
.5 -	January and an and an and a second from		x x x x x x x x x x x x x x x x x x x x		i i i i i i i i i i i i i i i i i i i	Silty SAND; grained.	Dark blue (	rey. Loose to me	dium dense. M	oist. Sand fine		
— 0.		¥	× × × × × × × × × × × ×			230						
.5 -	-	_	<b>a</b>					nd dark orange bi nded to sub-roun (GW Reached)	rown. Dense. W Ided. Sand fine	Vet to saturated grained.		
. 0.	-											
.5 -												
.0 —												
.5 –												
	- -									Logged by: Input by: Checked by: Verified by:	LFS LFS JSM JK	

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	3. PM	
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## FULTON HOGAN LAND DEVELOPMENT Client: Aureon (Here Zeidenb) Linded Unit 1. 136 Cavenage Rd Den Schurch 3140 New Seident New Seident Technik: 143 379 6955 New Seident Project Name: ROSEMERRYN Location: SEE PLAN

Sheet 1 of 1

End: christianichilike aussecongroup.com TEST PIT INFORMATION Excavator Type: 301 Excavator Test Pit Dimensions: Contractor: Fullion Hogan				CO-ORDINATE Easting: Northing: Ground Level:	1559864 m	Date Started: 9/09/2011 Date Completed: 9/09/2011	Logged by: LFS input by: LFS Checked by: JSM Ven5ed by: JK	
Depth (m)	Sample	Water Level (m)	Graphic Log	Shear Vane Tasts Pocket		Soil Description		Elevation (m)
3.5					Moist, Low	ILT with trace sand and occaisional rootlets; D plasticity. Sand fine grained. y with orange brown mottling. Loose, Moist. Sa		
.0 -		5						
- 0. -				An				
.5 -					GRAVEL w Gravel fine	ith some sand; Grey with brown sand. Dense. to medium grained, rounded to sub-rounded.	Wet to saturated. Sand fine grained.	
.0		<b>.</b>			End of Tes	t Pit at 2.9m (GW Reached)		
.5 –	1				-			
0. -	- -				and a second			
.5 - -	ا مسلم المحمد المحم							
Remark No grou	ks: undwater	encoun	tered		<u> </u>		Logged by: LFS nput by: LFS Checked by: JSM Verified by: JK	1
							Sheet 1	l of 1

Aurecon (New Zealand) Limited Unit 1, 150 Cavendish Rd PO BOX 1061 Christchurch 8140 New Zealand www.aurecongroup.com

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# Client: FULTON HOGAN LAND DEVELOPMENT Project Name: ROSEMERRYN FARM SUBDIVISION Location: SEE PLAN Telephone: +64 3 366 0821 Economical 4 4 3 376 0855 Project Reference: 224464

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TEST PIT II Excavator T Test Pit Din Contractor:	ype: 30	)t Excava :	ator			1559684 m 5167528 m	Date Started: 9/09/2011 Date Completed: 9/09/2011	Logged by: Input by: Checked by Verified by:	LFS y: JSM
Depth (m)	Sample	Water Level (m)	Graphic Log	Shear Vane Tests	Pocket Penetrometer Tests		Soil Description		Elevation (m)
0.5			$\frac{\langle \mathbf{v} \cdot t_{\mathbf{i}} - \langle \mathbf{v} \cdot t_{\mathbf{j}} - \langle $			plasticity. Sand fi	vith trace sand and rootlets; Dark bro ne grained. v. Loose to medium dense. Moist. Sa		· · · · · · · · · · · · · · · · · · ·
1.0 —			12 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1			<sup>1.00</sup> Silt with some pe	at inclusions. Light blue grey. Soft. V	Net. Low plasticity.	
1.5 –						1.70	pose to medium dense. Moist. Sand pse to medium dense. Wet. Sand me		
2.0 -			× × × × × × × × × × × ×			200 Silty SAND; Grey	v. Loose to medium dense. Wet. San	d medium grained.	
2.5 -			× × × × × × × × × × × × × × × × × × ×			2.70 Silty SAND with t grained.	ree roots; Light blue grey. Medium d	lense. Wet. Sand fine	3
3.5 -			× × × × × ×						
4.0 —						End of Test Pit a	t 4m (Pit Collapse)		
4.5 -									
Remarks: Tree roots Tree roots No ground	s @ 3.0r	n	ered					Logged by: LF Input by: LF Checked by: JS Verified by: Jk	FS SM

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## FULTON HOGAN LAND DEVELOPMENT Client: Project Name: ROSEMERRYN FARM SUBDIVISION Location: SEE PLAN Aurecon (New Zealand) Limited Unit 1, 150 Cavendish Rd PD 80X 1661 Chrischurch 8140 New Zealand www.aurecongroup.com Email: chrischurch@ap.aurecongroup.com

Sheet 1 of 1

**TP24** 

CO-ORDINATES NZTM Easting: 1559762 Northing: 5167712 Ground Level: N/A Date Started: 9/09/2011 Date Completed: 9/09/2011 Logged by: LFS Input by: LFS Checked by: JSM Verified by: JK TEST PIT INFORMATION Excavator Type: 30t Excavator Test Pit Dimensions: 1559762 m 5167712 m Contractor: Fulton Hogan -evel (m) cket ieter Tests hic Log ine Tests th (m) nple Soil Description

Depth (m)	Sample	Water Level (m)	Graphic Log	Shear Vane Tests	Pocket Penetrometer Tests	Soil Description	Elevation (m)
			<u>NI, NI, S</u>			TOPSOIL SILT with trace sand and rootlets; Dark brown. Firm. Moist. Low <sup>0.20</sup> plasticity. Sand fine grained.	
0.5 -				Shear vane at 0.5m: 104/18kPa		Sandy SILT; Grey with orange brown mottling. Stiff. Moist. Low plasticity. Sand fine grained.	
1.0 -			× × × × × × × × × × × × × × × × × × ×	Shear vane at 1m: 44/27kPa			p
1.5 -				Shear vane at 1.5m: 30/27kPa			
2.0 —	- - - -					Sandy SILT with tree roots; Dark blue grey. Stiff. Saturated. Low plasticity. Sand fine grained.	
2.5 -							
3.0 —						3.10 SAND; Brown. Loose to medium dense. Saturated. Sand medium grained.	
3.5 -		Ţ				380 End of Test Pit at 3.8m (GW Reached)	
4.0 —	- - -						
4.5 -							
Remarks		ountere	d @ 3.8m	<u> </u>	<u> </u>	Logged by: LFS Input by: LFS Checked by: JSM Verified by: JK	
						Sheet 1	of <b>1</b>

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# Aurceor (New Zealand) Limited Upit 1, 150 Caused and Limited P 0 BOX 1061 Christhurth 8140 New Zaeland Telephone: +64 3 365 0821 New Zaeland Telephone: +64 3 365 0821 Email: christhurth@ap.aurceorgroup.com FULTON HOGAN LAND DEVELOPMENT Project Name: ROSEMERRYN FARM SUBDIVISION Location: SEE PLAN

Sheet 1 of 1

TEST PIT INFORMATION     CO-ORDINATES NZTM     Date Started:     6/09/2011     Logged by:     LFS       Excavator Type:     30t Excavator     Easting:     1559840 m     Date Completed:     6/09/2011     Input by:     LFS       Test Pit Dimensions:     Northing:     5167896 m     Ground Level:     N/A     Verified by:     JSM									LFS JSM		
Depth (m)	Sample	Water Level (m)	Graphic Log	Shear Vane Tests	Pocket Penetrometer Tests			Soil Description			Elevation (m)
- - - 0.5 -			$\begin{array}{c} \underbrace{(1,1)}_{1} & \underbrace{(1,1)}_{2} & \underbrace{(1,1)}_{2} \\ \underbrace{(1,1)}_{2} & \underbrace{(1,1)}_{2} & \underbrace{(1,1)}_{2} \\ \underbrace{(1,1)}_{2} & \underbrace{(1,1)}_{2} & \underbrace{(1,1)}_{2} \\ \underbrace{(1,1)}_{2} & \underbrace{(1,1)}_{2} \\ \\ \\ \\ \\ \\ \\ \\ \\ \\ \\ \\ \\ \\ \\ \\ \\ \\ \\$			0.30		otlets and minor silt; Dark br . Moist. Low plasticity.	own. Moist. L	ow plastici	ity.
1.0 —			×××			SAND w grained.		ght brown. Loose to mediun	n dense. Mois	st. Fine	
1.5 -						SAND w dense. \	vith some silt; G Net. Fine grain	rey with orange brown mottli ed.	ing. Loose to	medium	
2.0 —			× × × × × × × × × × × × × × × × × × ×				ght blue grey. S	oft. Wet. Low plasticity.			
2.5 -		Ţ	× ×			2.80		Loose. Wet. Sand medium (GW Reached)	grained.		
3.0 — - - 3.5 —											
4.0 —											
4.5											
-											
Remarks Groundv	s: vater seep	bage @	2.2						Logged Input by Checke Verified	/: LFS edby: JSN	6
										Sh	eet 1 of 1

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Auesco (Mwr 2046/00/United Uuris, 116 Cowadat R6 PO BDX 1051 Chiakkiunok 8140 New Zealond Teleptones: 464 3 365 0871 Www.astroprop.com Fachtilis: +66 3 759 6955 Evel: christerunti@se Buildcomptut.com

### Client: FULTON HOGAN LAND DEVELOPMENT Project Name: ROSEMERRYN Location: SEE PLAN Project Reference: 224464



File: TEST PTIS, GP4. Library: COPY OF CHCH LIBRARY MARCH 2011; GLB. Data template: CHCH IMTIX-TEMPLATIE NOVZ 2019; GEH: 4:4894 EH1021211

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**TP26** 

CO-ORDINATES N/A Easting: 1559917 m TEST PIT INFORMATION Date Started: Date Completed: 9/09/2011 Logged by: LFS LFS Excavator Type: 30I Excavator Test Pit Dimensions: Contractor: Fulton Hogan Input by: LFS Checked by: JSM Verified by: JK Northing: 516 Ground Level: N/A 5168080 m Pocket Penetrometer Tests Water Level (m) Vane Tests Graphic Log Elevation (m) Depth (m) Sample Soil Description Stiear V TOPSOIL SILT with trace sand and occalsional rootlets; Dark brown. Firm. stj. Moist. Low plasticity. Sand fine grained. J. 0.29 Sandy SILT; Brown, Firm, Moist, Low plasticity, Sand fine grained. × × ¥ × × 0.5× Shear vane st 0.5m; 69/212Pa × × :× × × SAND; Brown with orange mottling. Loose to medium dense. Moist. Sand fine grained. 1.0 1.5 SAND with some silt; Dark blue grey. Loose to medium dense. Wet. Sand fine grained. s pa 2.0 SILT with some tree roots; Dark blue grey. Soft. Wet. Low plasticity. 2.5 Gravelly SAND; Grey and dark orange brown. Dense. Wet to saturated. Gravel fine grained, rounded to sub-rounded. Sand fine grained.  $\cap$ V End of Test Pit al 2.8m (GW Reached) 3.0 3.5 4.0 4.5 Logged by: Input by: LFS Remarks: LFS Checked by: JSM No groundwater encountered Verified by: JK Sheet 1 of 1

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# FULTON HOGAN LAND DEVELOPMENT Client: Aurecon (New ZAMandy Linitide: Unit 1, 15: Conversion Rid Po BOX 1051 Converting to Reversion Rid New Zealand International Automation Reversion R Project Name: ROSEMERRYN Location: SEE PLAN

Sheet 1 of 1

TEST PIT INFOF Excevelor Type: Test Pit Dimensi Contractor: Full	MATION 301 Ex68 ons: on Hogan	/ BLOF	CO-OR Easiing Northin Ground	DINATES N/A 1: 1999819 m g: 5167561 m Level: N/A	Date Started: 9/09/2011 Date Completed: 9/09/2011	Logged by: LFS Ingut by: LF8 Checked by: JSM Verified by: JK	
Depth (m) Sample	Water Level (m)	Graphic Log	Shear Vane Tests	Paretrometer Tests	Soil Description		Elevation (m)
0.5				Sandy SIL Sandy SIL fine grained	SILT with trace sand and occaisional rootlets; plasticity. Sand fine grained. ; Grey with orange brown mottling. Stiff. Moi ;	st. Low plasticity. Sand	
3.0 -		× × × × × ×		SAND; Darl	k blue grey. Loose to medium dense. Satural	ed. Sand fine grained.	
4.0 —				End of Test	Pit at 4m (Pit Collapse)		
4.5							
Remarks: Groundwater se	eepage @	<u>   </u> 3.0m	<u> </u>	I		Logged by: LFS Input by: LFS Checked by: JSM Verified by: JK	
						Sheet 1 o	of <b>1</b>

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### FULTON HOGAN LANO OEVELOPMENT Client: Project Name: ROSEMERRYN Location: SEE PLAN Talaphane. 51 5 368 0621 Pacsimile 104 3 379 6955 Project Reference: 224464

Sheet 1 of 1

**TP28** 

Entel: crite EST PIT I Excavalor est Pit Dir Contractor:	Type: 30 mensions	ATION JI Excay			CO-ORDINATE Easting: Northing: Ground Level: 1	1559854 m 5167673 m	Date Slarted. 9/09/2 Date Completed: 9/09/2		Input by: Checked by:	LFS LFS JSM JK
Depth (m)	Sampie	Water Level (m)	Graphic Log	Shear Vane Tests	Pocket Penetrometar Tests		Sóil Descript	tion		Elevation (m)
D.5 -			1         1			Moist. Low p	LT with trace sand and occalsic lasticity. Sand fine grained. ith orange brown mottling. Stiff			
1.0	;	: 	x x x x x x x x x x x x x x x x x x x			SILT; Grey. 5	Soft. Wet: Low plasticity.			
2.0 —							grey. Loose. Wet. Sand fine gr ree roots; Light grey. Medium d		nedium	
2.5			× × × * * * * * * * * * * * * * * * * *			250	Brown. Medium dense. Moist. S	Sand fine grained.		
3.0 _		Ţ				End of Test I	Pit at 3m (GW Reached)			
3.5 -										
4.0										
4.5										
Remarks Groundw		.0m	1		<u>l</u>	<u></u>		Logge Input I Check Verifie	by: LFS ted by: JSM ed by: JK	

### Sheet 1 of 1

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## Client: FULTON HOGAN LAND DEVELOPMENT Project Name: ROSEMERRYN Location: SEE PLAN Aurector (New Zaskerd) Limited Unit 1 40 Cawnodsh Ha PO BOX 1031 Obucatuuch 61:40 New Zaskerd pospace Enal. chickthrach Qac Auromotopy con Enal. chickthrach Qac Auromotopy con



Sheet 1 of 1

EST PIT I xcavalor est Pil Din ontractor:	Type: 30 mensions	)t Excav :	vator			1559893 m 5167765 m	Dale Started: 9/99 Date Completed: 9/09	9/2011 9/2011	Logged by: Input by: Checked by: Verified by:	LFS LFS JSM JK
Depth (m)	Sample	Water Level (m)	Graphic Log	Shear Vane Tests	Pocket Penetrometer Tests		Soil Descri	iption		Elevation (m)
.5 -				Shear vano i G.Sm. G236xP2 Shear vane i Im: R6/15xPa.		Moist. Low pla.	with trace sand and occais sticity. Sand fine grained. ey with orange brown mottl ey with orange brown mottli	ling, Stiff, Moist, Low	plasticity. Sa	and
5			** * * * * * * * * * * * * * * * * *	Shear wing ( 1 Sec: 3045 kPg	xi 1	SAND; Light gr	oots; Dark blue grey. Soft. ey. Loose. Moist. Sand med oots; Dark blue grey. Soft.	dium grained.		
5 -			<u></u>			SAND: Light gr	ey, Loose. Moist. Sand med	škum grained.		
0 5		Ţ				sub-rounded. S	.; Brown. Dense. Saturatec and medium grained. at 3m (GW Reached)	I. Gravel fine to coars	e grained,	
0										
5						r				
Remarks: Tree roots Groundwa	; @ 1.9n	1 .0m						Logge input t Check Verifie	ed by: LFS ed by: JSM d by: JK	

Sheet 1 of 1

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Aurecon (New Zealand) Usnikel

Authorn (Intervalence) Lenner Luga (I. 560 Lenner) PO 8004 (164 Christiauca 8400 New Zeufen) Telephane: (64.3.36 www.aurecongoop.com Facennie: (64.3.3 Email: christiauca/geuere.com/group.com

### Client: FULTON HOGAN LAND DEVELOPMENT Project Name: ROSEMERRYN Location: SEE PLAN Telephone: 10130705755 Project Reference: 224464

Sheet 1 of 1

Excevator Test Pil D	INFORM r Type: 3 Dimension x: Fulton	i0l Excav	/alo:	E		1559932 m 5167857 m		Date Started: 9/0 Date Completed: 9/0	9/2011 9/2011	Logged by Input by: Checked by Verified by	LFS IV: JSM
Depth (m)	Sample	Water Level (m)	Graphic Log	Shear Vane Tests	Pocket Penetrometer Tests	- - - - - -		Soll Desc	iption		Efevation (m)
).5			<u>1997 - 2007 - 2</u> 26 - 2026 - 2026 2026 - 2026 - 20 2026 - 2026 - 20			Moist. Low	plasticity. S trace silts:	ce sand and occai and fine grained. Grey with orange n			
1.0 —							k grey. Loo	se to medium dens	e. Wet. Sand f	ine to medium	
1.5 -						grained.					
2.0 —			× × × × × × × × × × × × × × × × × × ×			SILT with s	ome tree ra	ots; Dark blue grey	/. Soft. Wet. Lo	w plasticity,	
2.5					- - - 	2.99 SAND; Dari	k brown. Lo	ose. Moist. Sand f	ine to medium	grained.	
3.0		Ţ				End of Test	Pit at 3m (	GW Reached)			
3.5 -	ويستعمل والمعالم المستعمل المستعمل المستعمل المستعمل المستعمل المستعمل المستعمل المستعمل المستعمل الم										
4.0	-										
4.5 -		. Viterror									
Remark Tree roo Ground	ks: ots @ 1.8 water @	5m 3.0 m								Input by: L Checked by: J Verified by: J	FS FS SM K Sheet 1 of 1

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## Client: FULTON HOGAN LAND DEVELOPMENT Project Name: ROSEMERRYN Location: SEE PLAN Project Reference: 224464

Sheet 1 of 1

TEST PIT INFORMATION Excavator Type: 301 Excavator Test Pit Dimensions: Contractor: Fulton Hogan	CO-ORDINATES N/A Easing: 1559971 m Northing: 5167949 m Ground Level: N/A	Date Started: 9/09/2011 Date Completed: 9/09/2011	Logged by: LFS input by: LFS Checked by: JSM Venfied by: JK
Depth (m) Sample Water Level (m) Graphic Log	Pocket Penetrometer Tests	Soil Description	Elevation (m)
0.5 -	Moist. Low plastic	ith trace sand and occaisional rootlets; Da city. Sand fine grained. silts; Grey with orange mottling. Loose. Mo	
1.0 -	SAND; Dark brow	m. Loose. Moist. Sand fine to medium gra	
		ee roots; Dark blue grey. Soft. Wet. Low p . Loose to medium dense. Wet. Sand fine	lasticity.
2.0	SILT with some tr	ee roots; Dark blue grey, Soft. Wet. Low p 2m (GW Reached)	Jasticity.
2.5 -			
3.0 -			
3.5 -			
4.0 —			
4.5 -			
Remarks: Groundwater @ 2.0m		lnr Cr	dasticity. to medium Masticity. gged by: LFS but by: LFS but by: LFS hecked by: JSM wrified by: JK Sheet 1 of 1

PO BOX Checkler Key 752 WW.501	urch 8140	inec Armil	na. +84 3 506 5824 a: +84 3 779 8955 	Location	Name: :: SEE F	ON HOGAN LAND DEVELOPMENT ROSEMERRYN PLAN ce: 224464	TP32 Sheet 1 of 1
TEST PI Excavato Test Pit f	TINFORM. or Type: 3 Dimensiona or: Fulton	ATION DI Excav		Ea No	D-ORDINATE sting: rthing: ound Level:	1560010 m Date Completed: 9/09/2011 5168041 m	Logged by: LFS Input by: LFS Checked by: JSM Verified by: JK
Depth (m)	Sample	Water Level (m)	Graphic Log	Shear Vane Tests	Pockel Penelromater Tests	Soil Description	Elevation (m)
0.5			$\begin{array}{c} \frac{316}{316} \\ \frac{316}{31$	కోతతా యాణ లి రిమా: 133730kPa		TOPSOIL SILT with trace sand and occaisional rootlets; I Moist. Low plasticity. Sand fine grained. <sup>939</sup> SILT; Grey with brown mottling. Fitm. Wet. Low plasticity.	
1.5			× × × × × × × × × × × × × × × × × ×			SAND; Dark brown. Loose. Moist. Sand fine to medium gi 1.52 SILT with some tree roots; Dark blue grey. Soft. Wet. Low 2006 SAND with some tree roots; Dark grey. Loose. Wet. Sand	plasticity.
2.5 -		Ţ				grained. <sup>240</sup> SAND: Dark brown. Loose. Moist. Sand fine to medium gr <sup>250</sup>	ained.
3.0 —						End of Test Pit at 2.8m (GW Reached)	
3.5							
4.0							
4.5							
Remarks Tree roo Groundw	s: Is @ 1.5m vater @ 2.	8m					ogged by: LFS nput by: LFS checked by: JSM /erified by: JK Sheet 1 of 1

Last Generated 6/10/2011 11/16:59 a.m.

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Last Generateo: 29/09/2011 10:02:29 a.m.

Autotoc (New Zusland) Limited Unit 1, 150 Cevensish Ro PC BOX 1061 Chriskhuich 6140 New Zevland Iv

# Client: FULTON HOGAN LAND DEVELOPMENT Project Name: ROSEMERRYN Location: SEE PLAN Project Reference: 224464

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End of the second s	cavator st Pil Dir	INFORM/ Type: 36 mensions : Fulton	Dt Excav	ator	CO-C Eastir North Grout	RDINATES 1 ng: 15 log: 51 nd Level: N/	N/A 60049 m 68133 m A	Date Sti Date Co	arted: 9/09/2011 impleted: 9/09/2011	Logged by: Input by: Checked by Verified by:	LFS LFS JSM JK
Moist Low plasticity. Sand line grained. Moist Low plasticity. Sand line grained. SAND; Grey with orange brown moltling. Loose. Moist. Sand fin Sandy GRAVEL: Grey with brown sand. Dense. Wet to saturate to medium grained, rounded to sub-rounded. Sand fine grained Sandy GRAVEL: Grey with brown sand. Dense. Wet to saturate to medium grained, rounded to sub-rounded. Sand fine grained Sandy GRAVEL: Grey with brown sand. Dense. Wet to saturate to medium grained, rounded to sub-rounded. Sand fine grained Sandy GRAVEL: Grey with brown sand. Dense. Wet to saturate to medium grained, rounded to sub-rounded. Sand fine grained Sandy GRAVEL: Grey with brown sand. Dense. Wet to saturate to medium grained, rounded to sub-rounded. Sand fine grained Sandy GRAVEL: Grey with brown sand. Dense. Wet to saturate to medium grained, rounded to sub-rounded. Sand fine grained Sandy GRAVEL: Grey with brown sand. Dense. Wet to saturate to medium grained, rounded to sub-rounded. Sand fine grained Sandy GRAVEL: Grey with brown sand. Dense. Wet to saturate to medium grained, rounded to sub-rounded. Sand fine grained Sandy GRAVEL: Grey with brown sand. Dense. Wet to saturate to medium grained, rounded to sub-rounded. Sand fine grained Sandy GRAVEL: Grey with brown sand. Dense. Wet to saturate to medium grained, rounded to sub-rounded. Sand fine grained Sandy GRAVEL: Grey with brown sand. Dense. Wet to saturate to medium grained, rounded to sub-rounded. Sand fine grained Sandy GRAVEL: Grey with brown sand. Dense. Wet to saturate to medium grained, rounded to sub-rounded. Sand fine grained Sandy GRAVEL: Grey with brown sand. Dense. Wet to saturate Sandy GRAVEL: Grey with brown sand. Dense. Wet to saturate Sandy GRAVEL: Grey with brown satur	Depth (m)	Sample	Water Level (m)	Graphic Log	Shear Vane Tests	Pocket Penetrometer Tests			Soil Description		
.5 - 0				<u>5</u>		<u>P</u>	_ Moist, Low p	plasticity. Sand fine	grained.		
.0	-						** Sandy GRA' to medium q	VEL; Grey with bro trained, rounded to	wn sand, Dense, W sub-rounded, Sanc	'et to saturated. Gravel fi d fine grained.	ne
0							87			-	
	0		—				End of Test	Pit at 2.8m (GW R	eached)		
	5 -										
	0 -										
	5 -										
temarks: Input			.8m	L 1		1		~		Logged by: LFS Input by: LFS Checked by: JSI Verified by: JK	S M

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a	u	re	CO	n

## Client: FULTON HOGAN LAND DEVELOPMENT Autoon (Nw Zesewc) Jimilad Dat 1, 150 Gewardsh Rd Project Name: ROSEMER Location: SEE PLAN Nw Zesimila (45 3 376 022) Festimila (45 3 376 022) Project Reference: 224464 Project Name: ROSEMERRYN Location: SEE PLAN

Sheet 1 of 1

**TP34** 

TEST PIT INFORMATION Excavator Type: 30t Excavator Test Pil Dimensions: Contractor: Fulton Hogan

CO-ORDINATES N/A Easting: 1559946 m Northing: 5167634 m Ground Level; N/A Logged by: LFS Input by: LFS Checked by: JSM Verified by: JK Dale Started: 9/09/2011 Dale Completed: 9/09/2011

	Depth (m)	Sample	Water Level (m)	Graphic Log	Sheat Vane Tests	Pocket Penetrometer Tests	Soli Description	Elevation (m)
				4 84 84 8 4 84 84 8			TOPSOIL SILT with trace sand and occalsional rootlets; Dark brown. Firm. Moist. Low plasticity. Sand fine grained.	
0	5 -			× × × × × × × × × × × × × × × × × × ×	Shee: vane at 0.5m 46/24xPa		SILT; Grey with orange brown moltling. Stiff. Moist. Low plasticity.	
	0 —	- - -		× × × × × × × × × × × × × × × × × × ×	Shoei vane e: 1m. 197/18kPe	· ·	Sandy SILT; Grey with orange brown mottling. Stiff. Moist. Low plaslicity. Sand fine grained.	
<b>4</b>	5			× × × × × × × × × × × × × × × × × × ×	Shear vane of 1.550: 27X 28Har		Sandy SILT; Blue grey. Soft. Saturated. Low plasticity. Sand fine grained.	
2.	0			× × × × × × × × × × × × × × × × × ×				
2.	5 -			× × × × × × × × × × × × × × ×				en e
3.	0		-	x x x x x x x x x	· · · · ·		End of Test Pit at 3.2m (Pit Collapse)	
3.	5 -							
4.1	)							
3 a.m. 41	5 -							
E Gr	emarks oundw se root	s: vater seep ts @ 1.8m	age @ *	1.6m			Logged by: LFS input by: LFS Checked by: JSM Verified by: JK Sheet 1	

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aurecon	
<b>UNICCOI</b>	
Number (Alaw Zeptanyi Li Janines	

Aurecon (New Zeeland) I-mileo Urgit 1, 150 Cavencish Rd PO DOX 1061 Christeturon 8140 New Zeutanta Telephone: 164 Eneli Christetunch@apa evicorgroup.com Eneli Christetunch@apa evicorgroup.com

## Client: FULTON HOGAN LAND DEVELOPMENT Project Name: ROSEMERRYN Location: SEE PLAN Project Reference: 224464

Sheet 1 of 1

TEST FIT INFORMATION Excavator Type: 30t Excavalor Test Pit Dimensions: Contractor: Fulton Hogan					Easting: 1560024 m Date Completed: 9/09/2011 Input by: Northing: 5167818 m Checked by			Logged by: LFS Input by: LFS Checked by: JSf Verified by: JK	S Vî
Depth (m)	Sample	Water Level (m)	Graphic Log	Shear Vane Tests	Pocket Pocket Penelrometer Tests		Soil Description		Elevation (m)
0.5 1.0 1.5 2.0 3.0 3.5 4.0						Molst. Low plasticity. S <sup>1:30</sup> SILT with minor sand. i plasticity. Sand fine gra SAND with minor silt. C fine grained. <sup>1:00</sup> SILT with minor sand a Wet. Low plasticity. Sa SAND. Grey. Loose to <sup>2:40</sup> SILT with minor sand a Wet. Low plasticity. Sa SAND; Brown. Loose to <sup>3:40</sup>	Grey with orange brown mottling ined. Friable. Frey with orange brown mottling. Ind tree roots. Grey with orange and fine grained. Medium dense. Wet. Sand fine of the fine grained. The medium dense. Moist. Sand fir o medium dense. Moist. Sand fir o medium dense. Moist. Sand fir	, Firm. Molst. Low Loose. Moist. Sand brown mottling. Firm. grained.	
4.5 -								I	
Last Generated 2909/2011 10/012:33 a.m. punous Nater Angel 2009/2011 10/012:33 a.m.	s: water seer	oage @	1.0m					Logged by: LFS Input by: LFS Checked by: JSM Verified by: JK Sheet	1 of 1

Aurocon ( Unit 1, 15 PO BOX Cansichu New Zapi Www.pure	rch 8140	Insited J Telepinan Facatadia	e; +64 3 386 බවදී 1 :   +64 3 379 8055 තෙත	Locatior	Name: n: <b>Stage</b>	Hogan Land Devel Rosemerryn Farm 7 to 15 ce: 224464	opment Limited Subdivision	Shee
TEST PIT	INFORM	ATION Tonne E	xcavalor		Eastin North		Date Started: 27/04/2012 Date Completed: 27/04/2012	Logged by: RS Input by: MJF Checked by: RS Verified by: WD
Depth (m)	Sample	Water Level (m)	Pocket Penetrometer Tests	Shear Vane Tests	Graphic Log		Soil Description	
0.5 -					10 10 11 1 10 10 11 X X X X X X X	grained (TOPSOIL)	ark brown. Stiff, moist, low plast own. Stiff, moist, low plasticity. S JVIAL DEPOSITS).	
1.0 —		. :				0.95m Becomes bro SAND with minor sift fine grained and poo	; brown mottled grey. Loosely p	acked, moist; sand is
1.5 -								
2.0 —						2.0m Becomes dark 2.2m Becomes with	grey mottled orange brown. some silt.	
2.5 -		Ţ	· · · · · · · · · · · · · · · · · · ·		× × × × × × × × × × × × × × × × × × ×	SILT with some sand grained.	l; dark grey. Moist, moderate pl	asticity; sand is fine
3.5				· · · · · · · · · · · · · · · · · · ·	^ × × × × × × × × × × × × × × × × × × ×			
4.0 -					× ×	End of Test Pit at 3.9	Im (Maximum Extention of Exca	avator.)
Remarks				· · · ·				
Groundw	ater at 2.	7m	•	· · .				

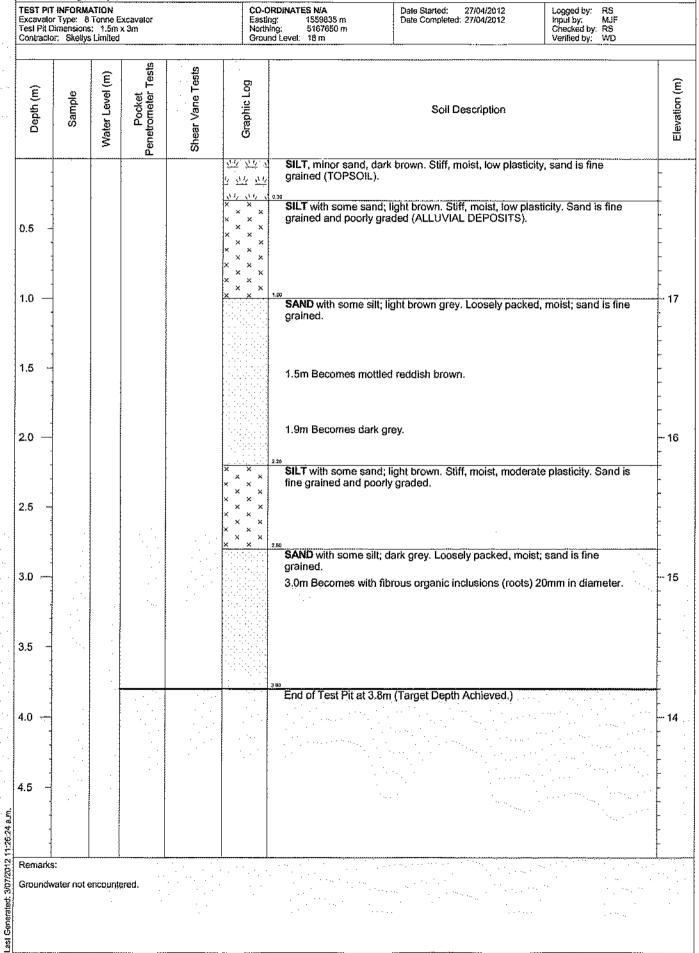
Database File: STAGE 7 TO 15 UPDATED TEST PIT LOGS GPJ. Library: AURECON CHRISTCHURCH GLB. Data template: CHCH DATA TEMPLATE NOV 2010.GDT

aurecon Client: TP03 Fulton Hogan Land Development Limited Aurocon (How Zonland) Limited Unit 5, 560 Covendish Fld PO BOX 1085 Project Name: Rosemerryn Farm Subdivision Location: Stage 7 to 15 см staturch 8140 New Zadand Telephata, +6+3 386 D82t www.au/acangray.com Poosinile: +0+3 3378 6855 Emsil: christihurch@gs.au/acongroup.com Project Reference: 224464 Sheet 1 of 1 CO-ORDINATES N/A Easting: 1559600 m Northing: 5167558 m Logged by: TEST PIT INFORMATION Date Started: 27/04/2012 RS Input by: MJF Checked by: RS Verified by: WD Excavator Type: 8 Tonne Excavator Test Pit Dimensions: 1.5m x 3m Date Completed: 27/04/2012 Contractor: Skellys Limited Ground Level: N/A Verified by: Tests Shear Vane Tests Water Level (m) Graphic Log Elevation (m) Depth (m) Sample Penetrometer Soil Description SILT, minor sand, dark brown. Stiff, moist, low plasticity, sand is fine grained (TOPSOIL). V V V 1, 34 34 34 34 SILT with some sand; light brown mottled orange brown. Stiff, moist, moderate plasticity; sand is fine to medium grained (ALLUVIAL DEPOSITS). x x 0.5 x x × × × × x × × x × × 1.0 1.0m Becomes sandy. × × × × × × 1.3m Becomes with trace sand; grey mottled light brown. × х 1.5 SAND with some silt; dark grey. Loosely packed moist; sand is fine to medium grained. ₹ 2.02.3m Becomes with fibrous organic inclusions (branches and roots up to 30mm in diameter). 2.5 SILT with minor sand; dark grey. Stiff, moist, moderate plasticity. × x x × × × x x x × x х 3.0 × × × × x x × x x x x × 3.4m Becomes with fibrous organic inclusions (up to 80mm in diameter). × × × 3.5 x × × × × × x х х x × x 4.0 End of Test Pit at 4m (Target Depth Achieved.) 4,5 11:26:23 a.m. 3/07/2012 Remarks: Groundwater at 2.0m Generated last

Data template: CHCH DATA TEMPLATE NOV 2010.GDT Database File: STAGE 7 TO 15 UPDATED TEST PIT LOGS GPJ, LIDRAY, AURECON CHRISTCHURCH, GLB. aurecon Aurecon (New Ze Unit 1, 150 Caver

PO BOX 1081 Christohuren 6140 New Zeeland +64 3 306 6021 +04 3 379 6955 w.szrazongra vali: chnobolur Factanika econgracia. h@ap.

### Client: Fulton Hogan Land Development Limited Project Name: Rosemerryn Farm Subdivision Location: Stage 7 to 15 Project Reference: 224464



Database file: STAGE 7 TO 15 UPDATED TEST PIT LOGS.GPJ. Ubrary. AURECON CHRISTCHURCH.GLB. Data tempate: CHCH DATA TEMPLATE NOV 2010.GDT

Sheet 1 of 1

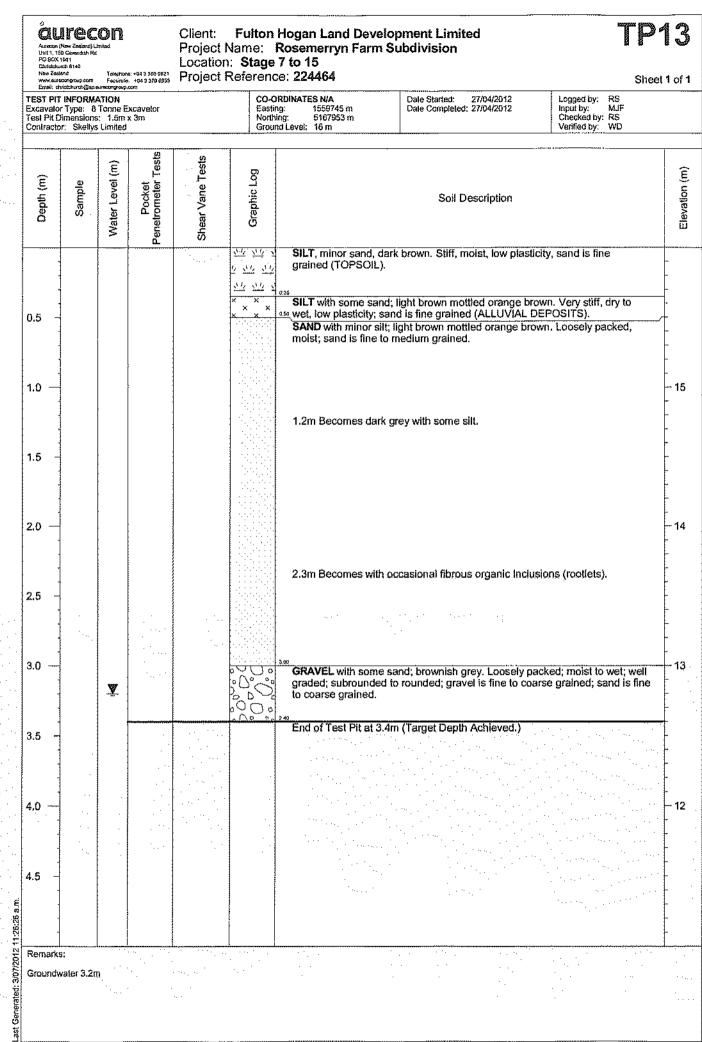
aurecon Client: Fulton Hogan Land Development Limited Project Name: Rosemerryn Farm Subdivision Autocon (Nov Unit 1, 150 C 20 ADX 100 w Zecia Location: Stage 7 to 15 Nii h-Bt40

New Zosland

Project Reference: 224464

+64 3 308 6024 +64 3 379 6955 Sheet 1 of 1 www.sulecongroup.com Emoil: christonurch@ap.e Foccimile: congroup.com CO-ORDINATES N/A Easting: 1559761 m Northing: 5167731 m Logged by: RS Input by: MJF Checked by: RS Verified by: WD TEST PIT INFORMATION Date Started: 27/04/2012 Date Completed: 27/04/2012 Excavator Type: 8 Tonne Excavator Test Pit Dimensions: 1.5m x 3m Contractor: Skellys Limited Ground Level: 16 m Pocket Penetrometer Tests Shear Vane Tests Water Level (m) Graphic Log Elevation (m) Depth (m) Sample Soll Description SILT, minor sand, dark brown. Stiff, moist, low plasticity, sand is fine grained (TOPSOIL). 14 24 2 26 11 <u>...</u> × <u>,14</u>, X SILT with some sand; light brown. Stiff, moist, low plasticity; sand is fine to medium grained (ALLUVIAL DEPOSITS). × x × 0.5 x × × x x х x x × x × х × × х 1.0 15 x x × × × 1.1m Becomes brownish grey mottled orange. × x × × × × x x × 1.5 x x x × SAND with minor silt; greyish brown mottled orange brown. Loosely packed, moist; sand is fine to medium grained. 2.0 14 2.0m Becomes dark grey. ¥ 2.1m Becomes with fibrous organic inclusions (up to 20mm in diameter). 2.5 3.0 13 3.5 End of Test Pit at 3.7m (Target Depth Achieved.) 4.0 -12 4.5 Lasl Generated: 3/07/2012 11:38:47 a.m. Remarks: Groundwater at 2.1m

Database File: STAGE 7 TO 15 UPDATED TEST PIT LOGS.GPU. Library: AURECON CHRISTCHURCH GLB. Data template: CHCH DATA TEMPLATE NOV 2010.GDT



Database File: STAGE 7 TO 15 UPDATED TEST PIT LOGS.GPJ. Ubray: AURECON CHRISTCHURCH.GLB. Data temptate: CHCH DATA TEMPLATE NOV 2010.GDT

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Enal: christehurch@uz

Depth (m)

0.5

1.0

1.5

2.0

2.5

3.0

3,5

4.0

4.5

Generaled:

Last

TEST PIT INFORMATION

Sample

### Client: Fulton Hogan Land Development Limited Project Name: Rosemerryn Farm Subdivision Location: Stage 7 to 15 Project Reference: 224464

CO-ORDINATES NZTM Easting: 1559655 m Northing: 5167974 m Ground Level; N/A Logged by: LFS Input by: LFS Checked by: JSM Verified by: JK Date Started: 6/09/2011 Date Completed: 6/09/2011 Excavator Type: 30t Excavalor Test Pil Dimensions: Contractor: Fulton Hogan Pocket Penetrometer Tests Shear Vane Tests Nater Level (m) Graphic Log Elevation (m) Soll Description 1.17 11 TOPSOIL SILT with trace sand and rootlets; Dark brown. Firm. Moist. Low plasticity. Sand fine grained. 24 30 ι, SAND; Brown, Medium dense, Moist, Fine grained. Shoar vane at tm: t01/24kPa SILT; Light brown. Soft. Moist. Low plasticity. × x х × × x × х x × x × SAND; Brown orange, Loose, Wet, Sand fine grained. SAND; Grey. Loose. Wet. Sand fine grained. Sandy SILT; Blue grey. Firm. Wet. Low plasticity. Sand is fine grained. × × × × × × x × × × × × × × × × × × × x × × x × × х Y End of Test Pit at 3.7m (GW Reached)

3/07/2012 11:25:32 a.m. Remarks: Tree roots @ 2.4m Groundwater reached 3.7m

Sheet 1 of 1

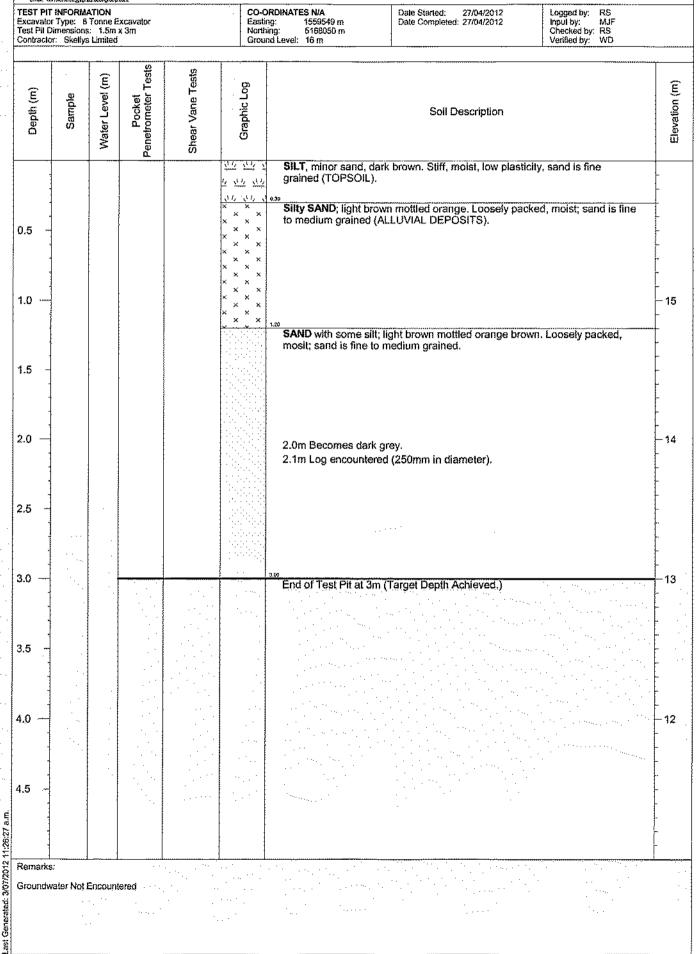
Client: Fult Aurora Mar Zadang Lumina Unit 1, 150 Casendah MA Ontochurn 840 New Zadang Telephone: -043 300 Bast Wer Zadang

## Client: Fulton Hogan Land Development Limited Project Name: Rosemerryn Farm Subdivision Location: Stage 7 to 15 Project Reference: 224464

Sheet 1 of 1

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TP



Database File: STAGE 7 TO 15 UPDATED TEST PT LOGS.GPJ, Lbrany: AURECON CHRISTCHURCH.GLB, Data template: CHCH DATA TEMPLATE NOV 2010.GDT

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TEST PIT INFORMATION

### Client: Fulton Hogan Land Development Limited Project Name: Rosemerryn Farm Subdivision Location: Stage 7 to 15 Project Reference: 224464

Logged by: RS Input by: MJF Checked by: RS CO-ORDINATES N/A Easting: 1559708 m Date Started: 27/04/2012 Date Completed: 27/04/2012 Excavator Type: 8 Tonne Excavator Test Pit Dimensions: 1.5m x 3m Contractor: Skellys Limited Easting: Northing 5168009 m Ground Level: 13 m Pocket Penetrometer Tests Shear Vane Tests Vater Level (m) Elevation (m) Graphic Log ŝ Sample Depth ( Soil Description 57 <u>...</u> SILT, minor sand, dark brown. Stiff, moist, low plasticity, sand is fine grained (TOPSOIL). ١, 14 14 44 24 × × Silty SAND; light brown mottled orange. Loosely packed, moist; sand is fine x × to medium grained (ALLUVIAL DEPOSITS). × 0.5 × × × × x × × × x × × × × 1.0 12 × × × × × x × × × x × × 1.4m Becomes with some slit, grey mottled orange brown. x 1.5 x x 1.5m Becomes with occasional fibrous organic inclusions (rootlets). × × × x × × × × X, × × × 2.0 × 11 2.0m Becomes dark grey. × × × ż × × × × х × × × 2.5 × × × × × ×. × x х x x V 50 GRAVEL with some sand; brownish grey. Loosely packed; saturated; well 3.0 10 graded; subrounded to rounded; gravel is fine to coarse grained; sand is fine to coarse grained. End of Test Pit at 3m (Too dense to excavate.) 3.5 4.0 -9 4.5 3/07/2012 11:26:28 a.m. Remarks: Groundwater at 2.9m Generated:

Database File: STAGE 7 TO 15 UPDATED TEST PIT LOGS.GPJ, LIbrary: AURECON CHRISTCHURCH.GI, B, Data template: CHCH DATA TEMPLATE NOV 2010.GDT

Sheet 1 of 1

Autocan (New Zealand) Emiled Unit 1, 150 Cavondish Rd PO 60X 1401

Contractures B140
 Divide studies B140
 New Zealand
 Telephone: +04.0.366.0821
 wew surrecongroup.com
 Facture1.a +84.6.376.6555
 Embil: relivide/sturctl@gp\_elidecorease.com

## Client: Fulton Hogan Land Development Limited Project Name: Rosemerryn Farm Subdivision Location: Stage 7 to 15 Project Reference: 224464

Sheet 1 of 1

**TP20** 

	TEST PIT Excavalor Tesl Pil D Contracio	r Type: 8 limensions	ATION Tonne E	Excevator x 3m	· · · . · .	East North	DRDINATES N/A ng: 1559485 m ing: 5188200 m nd Level: 18 m	Date Started: 27/04/2012 Date Completed: 27/04/2012	Logged by: RS Input by: MJF Checked by: RS Verified by: WD			
	Depth (m)	Sample	Water Level (m)	Pocket Penetrometer Tests	Shear Vane Tests	Graphic Log		Soil Description		Elevation (m)		
	0.5 -					<u>     10 10 10 10 10 10 10 10 10 10 10 10 </u>	grained (TOPSOIL).	brown. Stiff, moisf, low plastic brown mottled orange brown. I grained (ALLUVIAL DEPOSITS		rondonada <mark>y Boole II - E - E</mark>		
	1.0					<u>X X</u>	SAND with some silt; ig medium grained.	ght brown mottled orange brow	m; sand is fine to	- 17 		
	2.0					· · ·			grained.	sh grey. Loosely packed; mois I; gravel is fine to coarse grain	t to wet; well graded; ed; sand is fine to coarse	- 16
	3.5						J. 117	(Target Depth Achieved.)				
	4.0									- <b>14</b>		
Last Generated: 3/07/2012 11:26:29 a.m.	Remarks		encounte	ered,						I		

Database File: STAGE 7 TO 15 UPDATED TEST PIT LOGS, GPJ, LIbrary: AURECON CHRISTCHURCH.GLB, Data template: CHCH DATA TEMPLATE NOV 2010.GDT

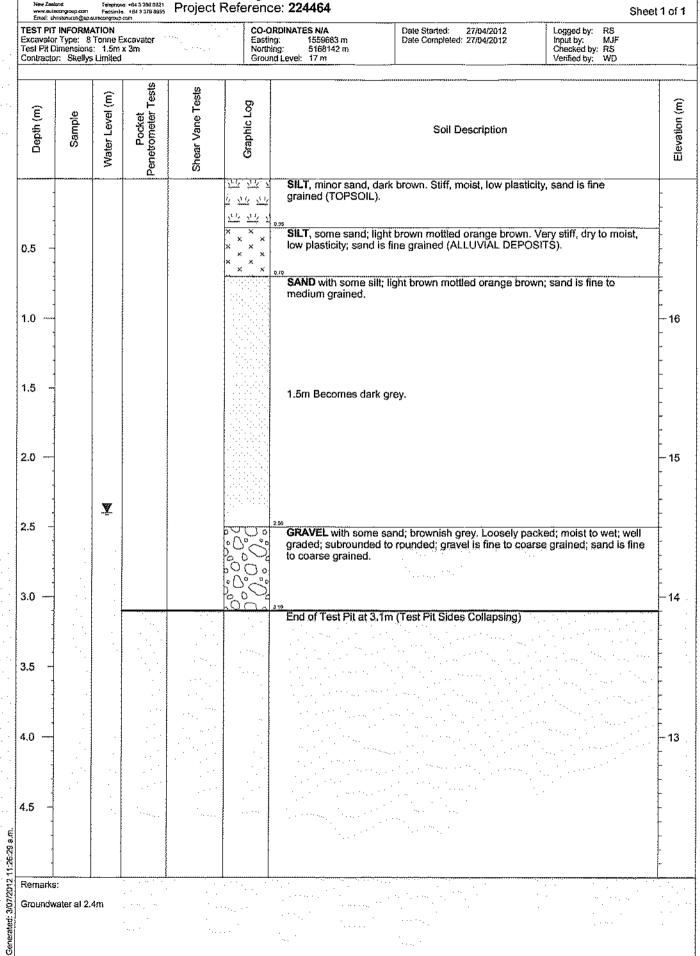
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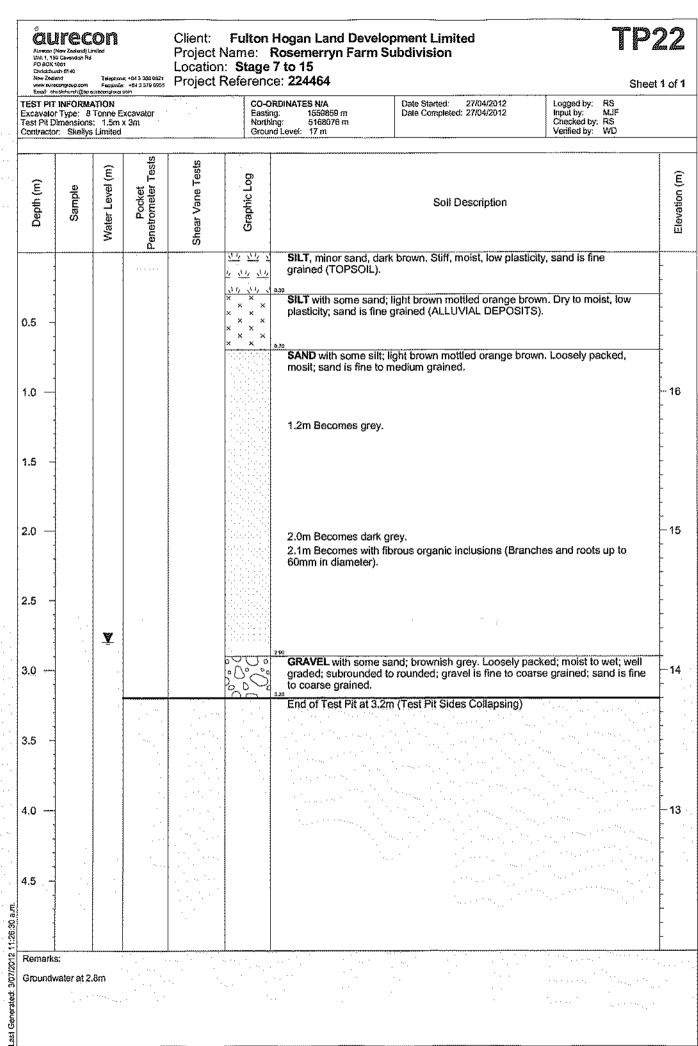
### Client: Fulton Hogan Land Development Limited Project Name: Rosemerryn Farm Subdivision Location: Stage 7 to 15 Project Reference: 224464

Sheet 1 of 1

TP21



Data template: CHCH DATA TEMPLATE NOV 2010.GDT Database File: STAGE 7 TO 15 UPDATED TEST PIT LOGS GPJ, LIbrary: AURECON CHRISTCHURCH.GLB,



Database File: STAGE 7 TO 15 UPDATED TEST PIT LOGS.GPJ. Library: AURECON CHRISTCHURCH GLB, Data lemplate: CHCH DATA TEMPLATE NOV 2010.GDT

e: STAGE 7 TO 15 UPDA

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### Client: Fulton Hogan Land Development Limited Project Name: Rosemerryn Farm Subdivision Location: Stage 7 to 15 Project Reference: 224464

Sheet 1 of 1

TP28

Now Zealand Telephone. +8+ 3 368 0821 www.autoccogooup.com Facelinite. +84 3 378 6855 Email: christichurch@ep.autocongroup.com Logged by: RS Inpul by: MJF Checked by: RS Checked by: WD Dale Started: 27/04/2012 Dale Completed: 27/04/2012 CO-ORDINATES N/A TEST PIT INFORMATION 1559471 m 5168269 m Excavator Type: 8 Tonne Excavator Test Pil Dimensions: 1.5m x 3m Easting: Northing: Contractor: Skellys Limited Ground Level: 14 m Pocket Penetrometer Tests Shear Vane Tests Water Level (m) Elevation (m) Graphic Log Depth (m) Sample Soil Description SILT, minor sand, dark brown. Stiff, moist, low plasticity, sand is fine 24 24 N grained (TOPSOIL). 4 24 24 14 14 Sandy SILT, light brown mottled orange brown. Very stiff, dry, low plasticity, sand is fine grained (ALLUVIAL DEPOSITS). Sandy GRAVEL; brownish grey. Loosely packed; moist to wet; well graded; subrounded to rounded; gravel is fine to coarse grained; sand is fine to coarse 600 0.5°0 ៓៰៰ D grained. n ò 1.0 · 13 Database File: STAGE 7 TO 15 UPDATED TEST PIT LOGS.GPJ. LIbrary: AURECON CHRISTCHURCH;GLB. Data temptate: CHCH DATA TEMPLATE NOV 2010.EDT 1.5 2.0 12 2.5 Pag. D 3.0 11 End of Test Pit at 3m (Target Depth Achieved.) 3.5 4.0 10 4.5 Last Generated: 3/07/2012 11:26:31 a.m. Remarks: Groundwater not encountered.

aurecon Client: Fulton Hogan Land Development Limited Project Name: Rosemerryn Farm Subdivision Unit 1, 160 ( Location: Stage 7 to 15 он ложи влан 3 70 New Zawland Теlephona, +64 3 356 6821 иминискиргаца.com Рассілійсь +64 3 376 6855 Елияі: christohurchigap.burecongroup.com Project Reference: 224464 Sheet 1 of 1 Logged by: RS Input by: MJF Checked by: RS Date Started: 27/04/2012 Date Completed: 27/04/2012 CO-ORDINATES N/A TEST PIT INFORMATION Excavator Type: 8 Tonne Excavator Test Pit Dimensions: 1.5m x 3m Contractor: Skellys Limited Easting: N/A Northing: N/A Ground Level: N/A Pocket Penetrometer Tests Shear Vane Tests Ê Graphic Log Jepth (m) Water Level ( Sample Soil Description <u> 84 84</u> SILT, minor sand, dark brown. Stiff, moist, low plasticity, sand is fine grained (TOPSOIL). 34 34 μ, di. SILT, some sand, light brown mottled orange brown. Very stiff. dry, low plasticity, Sand is fine grained (ALLUVIAL DEPOSITS). × × × 0.5 x × × x × × × × SAND with some silt; light brown mottled orange brown; sand is fine to medium grained. 1.0 1.2m Becomes dark grey. 1.5 1.6m Becomes fibrous organic inclusions (branches up to 100mm diameter). 2.0 2.0m Tree stump 0.5m diameter. 2.5 GRAVEL with some sand; brownish grey. Loosely packed; moist to wet; well graded; subrounded to rounded; gravel is fine to coarse grained; sand is fine , O to coarse grained. D 00 Y 3.0 End of Test Pit at 3m (Target Depth Achieved.) 3.5 4.0

4.5

Remarks:

Groundwater at 3.0m

Generaled: 3/07/2012 11:26:33 a.m.

Last

Elevation (m)

TP30 aurecon Client: Fulton Hogan Land Development Limited Aurenon (New Zen) Unit 1, 150 Cavend PO BOX 1001 Christoburch 8140 New Zeoland Project Name: Rosemerryn Farm Subdivision Location: Stage 7 to 15 . Telephone: +64.3 308 6821 Facontile: +64.3 379 5955 Project Reference: 224464 www.autocongroup.com Email: christohurch@ap.ac Sheet 1 of 1 conteroup.t CO-ORDINATES N/A Easting: 1559847 m Northing: 5168197 m Ground Level: 13 m Logged by: RS Input by: MJF Checked by: RS Verified by: WD Date Started: 27/04/2012 Date Completed: 27/04/2012 TEST PIT INFORMATION Excavator Type: 8 Tonne Excavator Test Pit Dimensions: 1.5m x 3m Contractor: Skellys Limited Tests Shear Vane Tests Water Level (m) Graphic Log Elevation (m) Penetrometer T Depth (m) Sample Soil Description 27.57 SILT, minor sand, dark brown. Stiff, moist, low plasticity, sand is fine grained (TOPSOIL). Ŀ. 14 14 дų, 11, SILT, with some sand; light brown mottled orange brown. Very stiff, dry. low plasticity; Sand is fine grained (ALLUVIAL DEPOSITS). × × × x × 0.5 x × × ¥ SAND with some silt; light brown mottled orange brown; sand is fine to medium grained. 1.0 12 1.2m Becomes dark grey. 1.5 1.6m Becomes with fibrous organic inclusions (branches up to 100mm diameter). 2.0 11 2.0m Tree stump 0.5m diameter. 2.5 Y 3.0 10 GRAVEL with some sand; brownish grey. Loosely packed; moist to wet; well graded; subrounded to rounded; gravel is fine to coarse grained; sand is fine to coarse grained. End of Test Pit at 3.2m (Target Depth Achieved.) 3.5 4.0 -9 4.5 3/07/2012 11:26:33 a.m. Remarks: Groundwater at 3.0m Last Generated:

Database File: STAGE 7 TO 15 UPDATED TEST PIT LOGS, GPJ, Ubrary: AURECON CHRISTCHURCH.GLB, Data template: CHCH DATA TEMPLATE NOV 2010.GDT

aurecon Client: **Fulton Hogan Land Development Limited** IP33 Project Name: Rosemerryn Farm Subdivision Location: Stage 7 to 15 hurch &14D New Zealand Telephone. +64 3 360 D821 www.puracowgroup.com Facsingle. +64 3 378 0055 Erval christetunet@sp.puracongroup.com Project Reference: 224464 Sheet 1 of 1 CO-ORDINATES N/A TEST PIT INFORMATION 27/04/2012 Logged by: RS Inpul by: MJF Checked by: RS RS MJF Date Started: Excavator Type: 8 Tonne Excavator Test Pit Dimensions: 1.5m x 3m Easting: Northing 1559526 m 5168388 m Dale Completed: 27/04/2012 Contractor: Skellys Limited Ground Level: 16 m Verified by: WD Pocket Penetrometer Tests Shear Vane Tests Water Level (m) Graphic Log Elevation (m) Depth (m) Sample Soil Description 14.14 SILT, minor sand, dark brown. Stiff, moist, low plasticity, sand is fine grained (TOPSOIL). 4 11/ 14 35 34 SILT with some sand; brown. Stiff, wet, low to moderate plasticity. Sand is fine to medium grained (ALLUVIAL DEPOSITS). × × x х × 0.5 × × x × x x x × x × × × 1.0 15 SAND with minor silt; light brown mottled orange brown. Loosely packed. moist; sand is fine to medium grained. 1.5 1.8m Becomes light grey mottled orange brown. 2.0 14 2.3m Becomes dark grey. 2.5 3.0 13 End of Test Pit at 3.1m (Target Depth Achieved.) 3,5 4.0 12 4.5 3/07/2012 11:26:34 a.m. Remarks: Groundwater not encountered. Last Generated:

Database File: STAGE 7 TO 15 UPDATED TEST PIT LOGS. GPJ, LIGRAY, AURECON CHRISTCHURCH. GLB, Data template: CHCH DATA TEMPLATE NOV 2010. GDT

durecon Client: Fulton Hogan Land Development Limited Aurocan (New Un4 1, 150 Ca PD BOX 1061 Project Name: Rosemerryn Farm Subdivision Location: Stage 7 to 15 Christehursh 8148 New Zeoland Teisplane. + 64 3 366 0821 Fact/mile: + 64 3 379 6955 Project Reference: 224464 Emsil, christehuschilliopau XIQYDUD.D TEST PIT INFORMATION CO-ORDINATES N/A Logged by: RS Input by: MJF Checked by: RS Date Started: 27/04/2012 Excavator Type: 8 Tonne Excavator Test Plt Dimensions: 1.5m x 3m Contractor: Skellys Limited 1559565 m 5168402 m Easting: Northing: Date Completed: 27/04/2012 Verified by: Ground Level: 11 m Pocket Penetrometer Tests Shear Vane Tests Water Level (m) Graphic Log Depth (m) Sample Soil Description SILT, minor sand, dark brown. Stiff, moist, low plasticity, sand is fine grained (TOPSOIL). 14.54 4 34 34 SILT, minor to some sand, brown. Stiff, moist, low to moderate plasticity, sand is fine to medium grained (ALLUVIAL DEPOSITS). × × × 0.5 × x x × × × × × x × x × 1.0

SAND with minor silt; brown and grey. Loosely packed; moist; poorly

2.5m Becomes with organic inclusions (branches and large roots).

GRAVEL with some sand; brownish grey. Loosely packed; moist to wet; well graded; subrounded to rounded; gravel is fine to coarse grained; sand is fine

to coarse grained. End of Test Pit at 3.7m (Target Depth Achieved.)

graded; sand is fine to medium grained.

2.0m Becomes with some silt.

2.3m Becomes dark grey.

× × × × ×

00

Database File: STAGE 7 TO 15 UPDATED TEST PIT LOGS.GPU, Library: AURECON CHRISTCHURCH.GLB. Data temptate: CHCH DATA TEMPLATE NOV 2010.GDT

Y Groundwater at 3.5m

1.5

2.0

2.5

3.0

3.5

4.0

4.5

Remarks:

Last Generated: 3/07/2012 11:26:36 a.m.

WD

Sheet 1 of 1

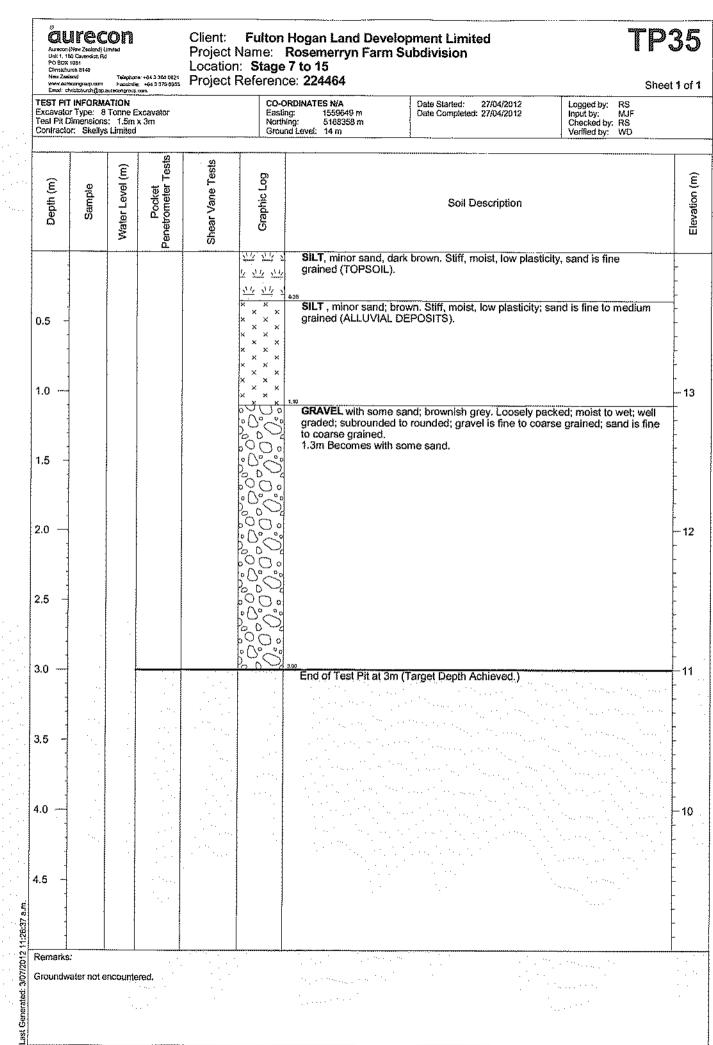
Elevation (m)

10

9

8

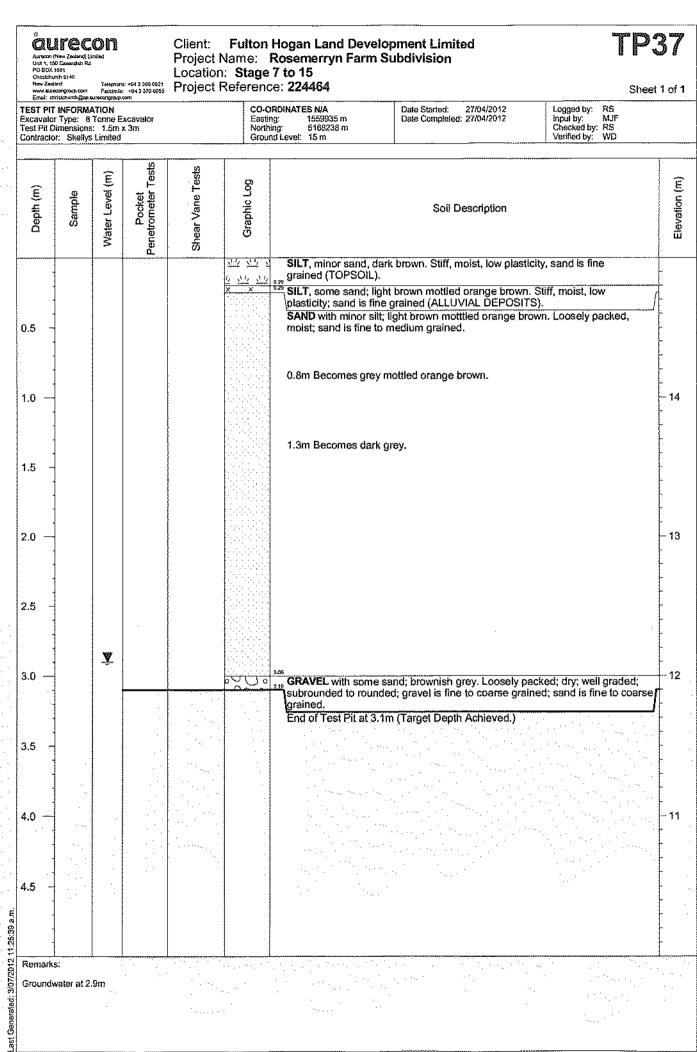
7



Dalabase File: STAGE 7 TO 15 UPDATED TEST PTI LOGS, GPJ. Library: AURECON CHRISTCHURCH, GLB, Data template: CHCH DATA TEMPLATE NOV 2010.GDT

aurecon TP36 Client: Fulton Hogan Land Development Limited Aureon (New Zeoland) Under Unit 5, 550 Caversish Rd PC 80X 1055 Cansidaurch 8149 New Zeoland Project Name: Rosemerryn Farm Subdivision Location: Stage 7 to 15 Telephone, +84 2 300 0825 Pacaimila: +84 3 376 6065 Project Reference: 224464 New zeola w www.collocongroup.com inaccipile: 46 Empil: christeliuxchi@ap.aurecongroup.com Sheel 1 of 1 CO-ORDINATES N/A Easting: 1559878 m Northing: 5168255 m Ground Level: 16 m TEST PIT INFORMATION Date Started: 27/04/2012 Logged by: RS MJF Excavalor Type: 8 Tonne Excavalor Tesl Pit Dimensions: 1.5m x 3m Contractor: Skellys Limited Date Completed: 27/04/2012 input by: MJI Checked by: RS Verified by WD Pocket Penetrometer Tests Shear Vane Tests Water Level (m) Graphic Log Elevation (m) Depth (m) Sample Soil Description SILT, minor sand, dark brown. Stiff, moist, low plasticity, sand is fine grained (TOPSOIL).  $\overline{M}, \overline{M}$ 1 4 34 34 SILT, some sand; light brown mottled orange brown. Very stiff, dry, low plasticily; sand is fine grained (ALLUVIAL DEPOSITS). v х × × x × 0.5 υ 10 GRAVEL with some sand; brownish grey. Loosely packed; dry; well graded; subrounded to rounded; gravel is fine to coarse grained; sand is fine to coarse grained. ٥  $\cap$ 1.0 15 1.5 1.5m Becomes sandy and moist. 2.0 14 2.5 D Ō  $\bigcirc$ ø 3.0 13 End of Test Pil al 3m (Targel Depth Achieved.) 3.5 4.0 12 4.5 Last Generated: 3/07/2012 11:26:38 a.m. Remarks: Groundwater not encountered.

Database File: STAGE 7 TO 15 UPDATED TEST PIT LOGS.GPJ. LIbrary: AURECON CHRISTCHURCH.GLB. Data template: CHCH DATA TEMPLATE NOV 2010. GDT



Database File: STAGE 7 TO 15 UPDATED TEST PIT LOGS (GPJ, Ubrary: AURECON CHRISTCHURCH GLB, Data tempiale: CHCH DATA TEMPLATE NOV 2010.GDT

aurecon Fulton Hogan Land Development Limited TP38 Client: Project Name: Rosemerryn Farm Subdivision Location: Stage 7 to 15 +84 3 368 D821 +64 3 379 0955 Project Reference: 224464 New Zeoland Telaphone: www.goracongroup.com Factimile. Email: contribuichigito.sunccongroup.com Sheet 1 of 1 Logged by: RS Input by: MJF Checked by: RS WD CO-ORDINATES N/A Easting: 1559993 m Northing: 5168257 m Ground Level: 16 m Date Started: 27/04/2012 Date Completed: 27/04/2012 TEST PIT INFORMATION Excavator Type: 8 Tonne Excavator Test Pit Dimensions: 1.5m x 3m Contractor: Skellys Limited Tests Shear Vane Tests Water Level (m) Elevation (m) Graphic Log Ξ Penetrometer 1 Sample Depth ( Soil Description SILT, minor sand, dark brown. Stiff, dry, low plasticity, sand is fine grained 22 22 (TOPSOIL). 34 14 SILT with some sand; light brown mottled orange brown. Very stiff, dry, low plasticity; Sand is fine grained (ALLUVIAL DEPOSITS). × x × SAND with minor to some silt; light brown mottled orange brown. Loosely 0.5 packed; sand is fine to medium grained. GRAVEL with some sand; brownish grey. Loosely packed; dry; well graded; n 1.0 15 subrounded to rounded; gravel is fine to coarse grained; sand is fine to coarse grained. £ 1.4m Becomes moist. 1.5 2.0 14 2m Becomes sandy. 2.5 Δ V End of Test Pit at 2.8m (Target Depth Achieved.) 13 3.0 3.5 12 4.0 4,5 3/07/2012 11:26:40 a.m. Remarks: Groundwater at 2.7m

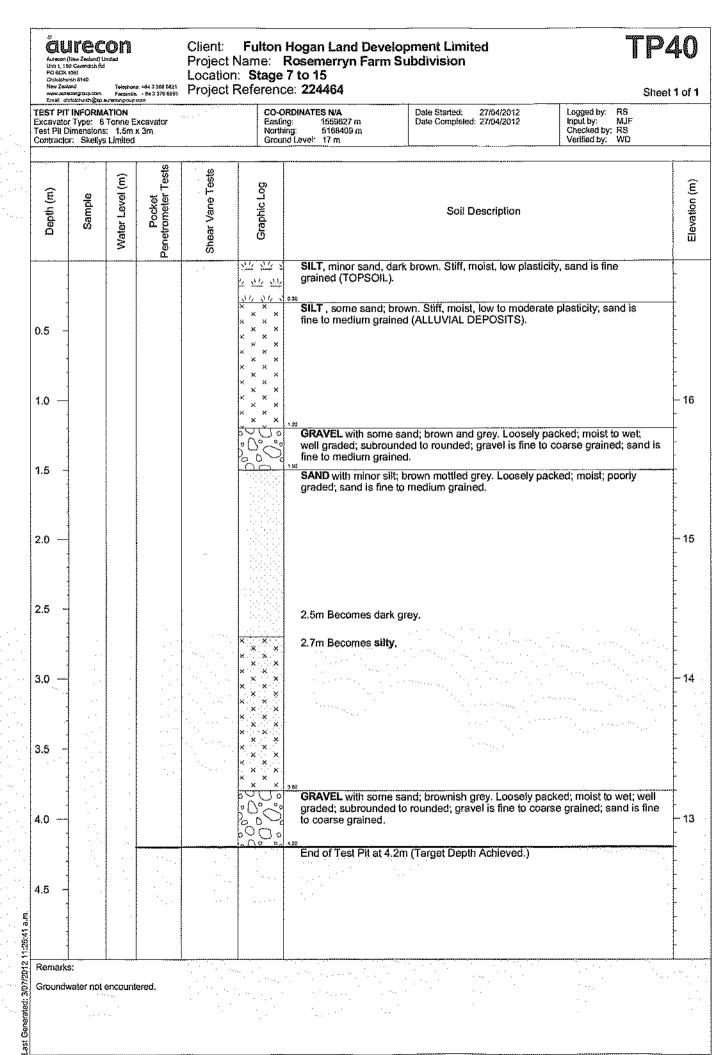
Last Generated:

Database File: STAGE 7 TO 15 UPDATED TEST PIT LOGS GPJ, LIDPAY: AURECON CHRISTCHURCH GLB. Data template: CHCH DATA TEMPLATE NOV 2010.GDT

Aurecon (N Unit 1, 150 PO BOX 10 Christoture New Zaslan Www.cuteco	b 8140	ritod Telophone Facernika	. 104 3 388 0821 184 3 379 0055 Xm					
TEST PIT INFORMATION Excavator Type: 8 Tonne Excavator Test Pit Dimensions: 1.5m x 3m Contractor: Skellys Limited				CO-ORDINATES N/A         Date Started:         27/04/2012         Logged by:           Easting:         1559837 m         Date Completed:         27/04/2012         Input by:           Northing:         5168324 m         Date Completed:         27/04/2012         Input by:           Ground Level:         16 m         Verified by:         Verified by:				
Depth (m)	Sample	Water Level (m)	Pocket Penetrometer Tests	Shear Vane Tests	Graphic Log	Soil Description		
0.5 -					10 11/ 11/ 1 1/ 11/ 11/ ×	SILT, minor sand, dark brown. Stiff, dry, low plasticity, sand is fine grain (TOPSOIL). SILT with some sand; light brown mottled orange brown. Very stiff, dry, plasticity; sand is fine grained (ALLUVIAL DEPOSITS).	F	
1.0						GRAVEL with some sand; brownish grey. Loosely packed; dry; well gran subrounded to rounded; gravel is fine to coarse grained; sand is fine to grained.	ded; coarse	
1.5						1.4m Becomes sandy.	- - - -	
2.0 -						1.9m Becomes moist.	• • • •	
2.5 -						End of Test Pit at 2.5m (Target Depth Achieved.)		
3.0								
3.5								
4.0								
4.5			· . · .					
Remarks: Groundwa		encounte	əred.	L				

Database File: STAGE 7 TO 15 UPDATED TEST PIT LOGS.GPU, Library: AURECON CHRISTCHURCH.GLB, Data template: CHCH DATA TEMPLATE NOV 2010.GDT

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Database File: STAGE 7 TO 15 UPDATED TEST PIT LOGS.GPJ. Library: AURECON CHRISTCHURCH.GLB. Data template: CHCH DATA TEMPLATE NOV 2010.GDT

Aurecon Unit 1, 1 PO 20X Cansicht New Zep Www.pur	urch 8140	.Insited: J Telepinan Faccionile	ne; +64 3 386 8821 a: +64 3 379 6055 .com	Client: Fulton Hogan Land Development Limited Project Name: Rosemerryn Farm Subdivision Location: Stage 7 to 15 Project Reference: 224464					
Excavalo Test Pit D	IEST PIT INFORMATION Excavator Type: 8 Tonne Excavator lest Pit Dimensions: 1.5m x 3m Contractor: Skellys Limited				CO-ORDINATES N/A         Date Started:         27/04/2012         Logged by:         RS           Easting:         1557263 m         Date Completed:         27/04/2012         Input by:         MJ           Northing:         5166808 m         Date Completed:         27/04/2012         Logged by:         RS           Ground Level:         18 m         Verified by:         WI				
Depth (m)	Sample	Water Level (m)	Pocket Penetrometer Tests	Shear Vane Tests	Graphic Log	Soil Description	Ī		
					<u> </u>		-		
0.5 -					× × × × × × × × × × × × × × × × × × ×	poorly graded (ALLUVIAL DEPOSITS).	1. 1		
1.0 —	-					0.95m Becomes brown mottled grey. 1.10 SAND with minor silt; brown mottled grey. Loosely packed, moist; sand is fine grained and poorly graded.	-1 1		
1.5	- - - - - - - - - - - - - - - - - - -						-		
2.0 —						2.0m Becomes dark grey mottled orange brown. 2.2m Becomes with some silt.	- - -		
2.5 -		Ţ	· · · · ·		× × × × × × × × × × × × × × × × × × ×	SILT with some sand; dark grey. Moist, moderate plasticity; sand is fine grained.			
3.0				· · · · · · · · · · · · · · · · · · ·			- 18		
3.5 -					* × × × × × × × × × × × × × × × × × × ×	360	* 		
4.0 —						End of Test Pit at 3.9m (Maximum Extention of Excavator.)	- 14 		
4.5				· · · ·			1		

# Last Generated: 3/07/2012 Remarks: Groundwater at 2.7m

Database File: STAGE 7 TO 15 UPDATED TEST PIT LOGS GPJ, LIbrary: AURECON CHRISTCHURCH GLB, Data template: CHCH DATA TEMPLATE NOV 2010.GDT

aurecon Client: Fulton Hogan Land Development Limited IP03Aurecon (New Zenland) Limited Unit 1, 150 Cavendish Fid PO BOX 1061 Project Name: Rosemerryn Farm Subdivision Location: Stage 7 to 15 Ġи itchurch 8140 New Zadand Telephata, +6+3 386 D82t www.au/acangray.com Poosinile: +0+3 3378 6855 Emsil: christchurch@gs.au/acongroup.com Project Reference: 224464 Sheet 1 of 1 Logged by: CO-ORDINATES N/A TEST PIT INFORMATION Date Started: 27/04/2012 RS 1559600 m 5167558 m Input by: MJF Checked by: RS Verified by: WD Excavator Type: 8 Tonne Excavator Test Pit Dimensions: 1.5m x 3m Easting: Northing: Date Completed: 27/04/2012 Contractor: Skellys Limited Ground Level: N/A Verified by: Tests Shear Vane Tests Water Level (m) Graphic Log Elevation (m) Depth (m) Sample Penetrometer Soil Description SILT, minor sand, dark brown. Stiff, moist, low plasticity, sand is fine grained (TOPSOIL). μ, 24 24 34 34 SILT with some sand; light brown mottled orange brown. Stiff, moist, moderate plasticity; sand is fine to medium grained (ALLUVIAL DEPOSITS). × × 0.5 x x × × × × x x × x × × 1.0 1.0m Becomes sandy. × × × × × × 1.3m Becomes with trace sand; grey mottled light brown. × × × 1.5 SAND with some silt; dark grey. Loosely packed moist; sand is fine to medium grained. ₹ 2.0 2.3m Becomes with fibrous organic inclusions (branches and roots up to 30mm in diameter). 2.5 SILT with minor sand; dark grey. Stiff, moist, moderate plasticity. × x x x × × x x × × x х 3.0 x × × × x x x x x x × х × 3.4m Becomes with fibrous organic inclusions (up to 80mm in diameter). × × 3.5 × × × x × × × х х x × x 4.0 End of Test Pit at 4m (Target Depth Achieved.) 4.5 11:26:23 a.m. 3/07/2012 Remarks: Groundwater at 2.0m Generated last

Data template: CHCH DATA TEMPLATE NOV 2010.GDT Database File: STAGE 7 TO 15 UPDATED TEST PIT LOGS.GPJ, LIBrary: AURECON CHRISTCHURCH.GLB,

aurecon Aurecon (New Unit 1, 150 Ca PO BOX 1081

Christohuren 6140 New Zeolonis +84 3 306 6821 +84 3 379 6855 w.szrazongra vali: chnobshur h@op

### Client: Fulton Hogan Land Development Limited Project Name: Rosemerryn Farm Subdivision Location: Stage 7 to 15 Project Reference: 224464

Date Started:

Date Completed: 27/04/2012

27/04/2012

CO-ORDINATES N/A Easting: 1559835 m Northing: 5167650 m

18 m

Ground Level:

Logged by: RS Input by: MJF Checked by: RS

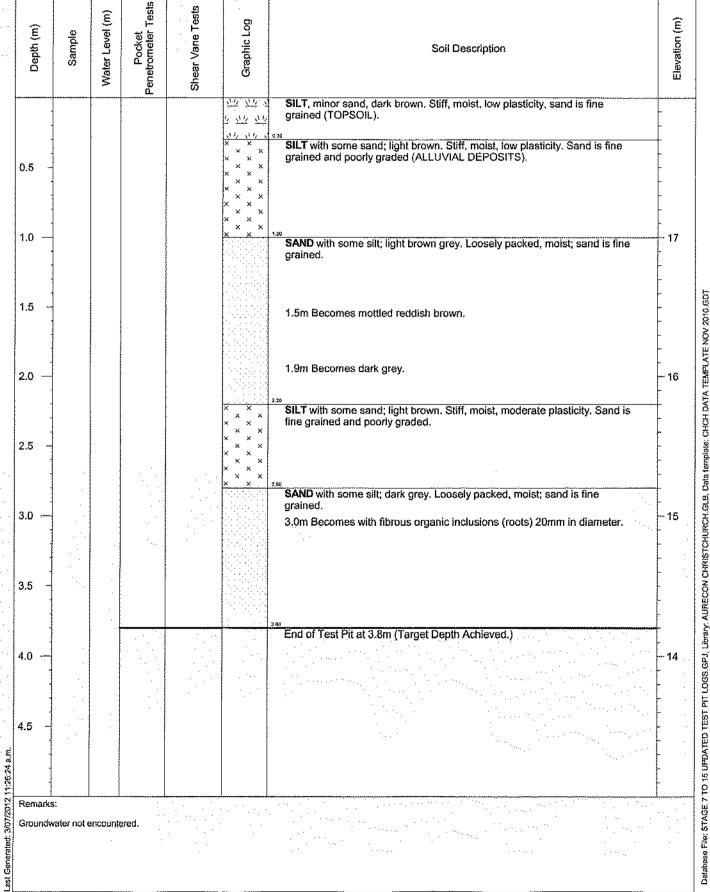
WD

Verified by:

TP06

TEST PIT INFORMATION Excavator Type: 8 Tonne Excavator Test Pit Dimensions: 1.5m x 3m Contractor: Skellys Limited

Finanziania scongrauța



aurecon	Client: Fulton Hogan Land Development Limited
Autocon (New Zeoland) Limited Unit 1, 150 Carendati Rei	Project Name: Rosemerryn Farm Subdivision
PO 80X 1001	Location: Stage 7 to 15
Christohurch 8140	Location. Stage / to 15
New Zosland Telephone, +64 3 308 C621	Decident Deferences 024404

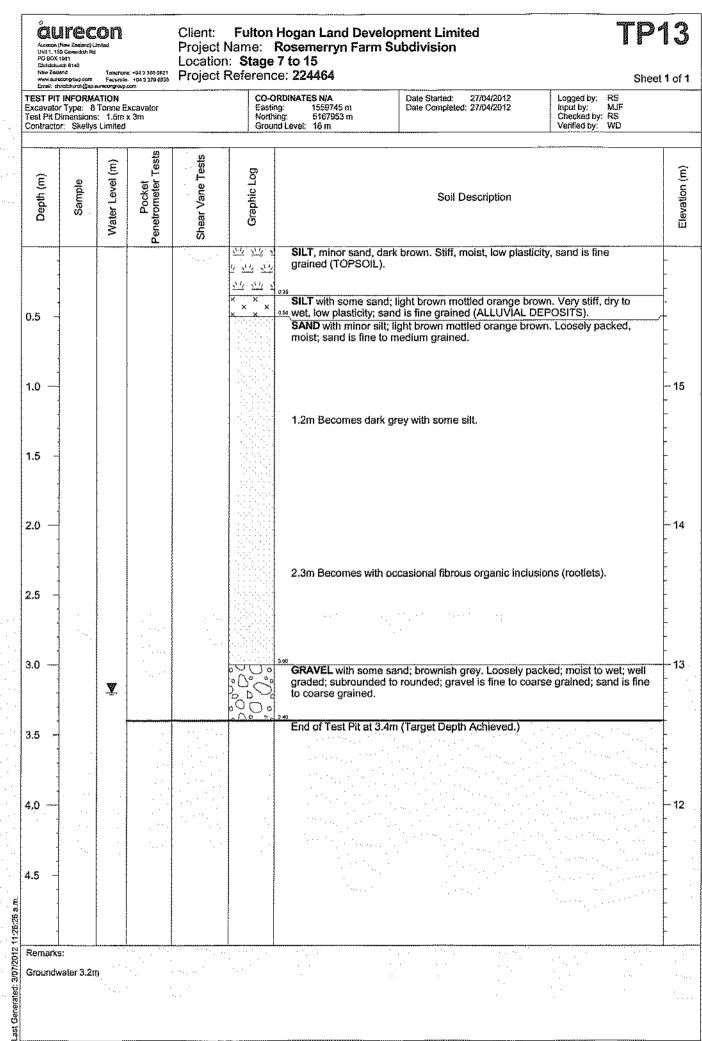
+64 3 308 6021 +64 3 379 6955 Project Reference: 224464

www.sullecongroup.com Email: christchurch@ap. congroup.ed CO-ORDINATES N/A Easting: 1559761 m Northing: 5167731 m Logged by: RS Input by: MJF Checked by: RS Verified by: WD TEST PIT INFORMATION Date Started: 27/04/2012 Date Completed: 27/04/2012 Excavator Type: 8 Tonne Excavator Test Pit Dimensions: 1.5m x 3m Contractor: Skellys Limited Ground Level: 16 m Pocket Penetrometer Tests Shear Vane Tests Water Level (m) Graphic Log Elevation (m) Depth (m) Sample Soil Description SILT, minor sand, dark brown. Stiff, moist, low plasticity, sand is fine grained (TOPSOIL). 14 24 4 26 11 <u>,14</u>. X 11/2 × SILT with some sand; light brown. Stiff, moist, low plasticity; sand is fine to medium grained (ALLUVIAL DEPOSITS). × х × 0.5 x × x × x х × x × × × x × x × 1.0 15 x × × × × 1.1m Becomes brownish grey mottled orange. x x × × × × × x × 1.5 × x x × SAND with minor silt; greyish brown mottled orange brown. Loosely packed, moist; sand is fine to medium grained. 2.0 14 2.0m Becomes dark grey. Y 2.1m Becomes with fibrous organic inclusions (up to 20mm in diameter). 2.5 3.0 13 3.5 End of Test Pit at 3.7m (Target Depth Achieved.) 4.0 12 4.5 Last Generated: 3/07/2012 11:38:47 a.m. Remarks: Groundwater at 2.1m

Database File: STAGE 7 TO 15 UPDATED TEST PIT LOGS.GPU, LIbrary: AURECON CHRISTCHURCH GLB, Data template: CHCH DATA TEMPLATE NOV 2010.GDT

Sheet 1 of 1

TP08



# Dalabase File: STAGE 7 TO 15 UPDATED TEST PIT LOGS.GPJ, Ubray: AURECON CHRISTCHURCH.GLB, Dala template: CHCH DATA TEMPLATE NOV 2010.GDT

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aurecon +64 3 366 0821 +64 3 370 6955

Telephus. Facsimila: scongroup co

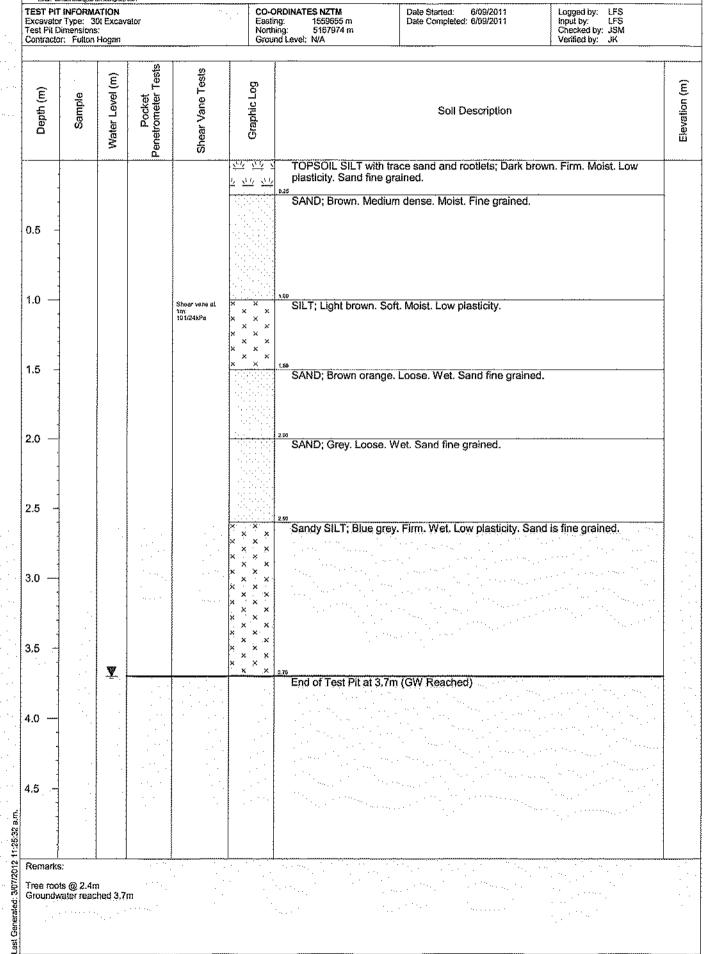
### Client: Fulton Hogan Land Development Limited Project Name: Rosemerryn Farm Subdivision Location: Stage 7 to 15 Project Reference: 224464

Date Started: 6/09/2011 Date Completed: 6/09/2011

TP14

TEST PIT INFORMATION Excavator Type: 301 Excavator Test Pit Dimensions: Contractor: Futton Hogan

Email: christchurch@caa



Database File: TEST PIT DATA FROM PREVIOUS INVESTIGATIONS (SPJ, LIbrary: AURECON CHRISTCHURCH, GLR, Data template: CHCH DATA TEMPLATE NOV 2010. GDT

aurecon Client: (New ISD Ca PO BOX 100 +04 3 368 0821 +04 3 376 0855 Project Reference: 224464 New Zealand Telephote www.sulecologio.p.com Factingle Empit: doi/stchurch/@rg.surecongroup.c

# Fulton Hogan Land Development Limited Project Name: Rosemerryn Farm Subdivision Location: Stage 7 to 15

6

TP

CO-ORDINATES N/A Easting: 1559549 m Northing: 5168050 m Ground Level: 16 m Date Started: 27/04/2012 Date Completed: 27/04/2012 RS MJF RS WD TEST PIT INFORMATION Logged by: Excavator Type: 8 Tonne Excavator Test Pit Dimensions: 1.5m x 3m Contractor: Skelfys Limited Inpul by: Checked by: Verified by: Pocket Penetrometer Tests Shear Vane Tests Water Level (m) Elevation (m) Graphic Log Ê Sample Depth ( Soil Description 24 24 3 SILT, minor sand, dark brown. Stiff, moist, low plasticity, sand is fine grained (TOPSOIL). 4 24 24 32 34 Silty SAND; light brown mottled orange. Loosely packed, moist; sand is fine to medium grained (ALLUVIAL DEPOSITS). × × × 0.5 x x × ж x × × x x × × × × × × 1.0 15 × × × x × SAND with some silt; light brown mottled orange brown. Loosely packed, mosit; sand is fine to medium grained. 1.5 2.0 14 2.0m Becomes dark grey. 2.1m Log encountered (250mm in diameter). 2,5 3.0 13 End of Test Pit at 3m (Target Depth Achieved.) 3.5 4,0 12 4.5 Last Generated: 3/07/2012 11:26:27 a.m. Remarks: Groundwater Not Encountered

aurecon

X 16 matchurch I twy Zasies Telephone: +64 3 366 0822 Fecsimile: +64 3 370 8955

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Franii christchurchailya

### Client: Fulton Hogan Land Development Limited Project Name: Rosemerryn Farm Subdivision Location: Stage 7 to 15 Project Reference: 224464

Logged by: RS Input by: MJF Checked by: RS CO-ORDINATES N/A Easting: 1559708 m Date Started: 27/04/2012 Date Completed: 27/04/2012 TEST PIT INFORMATION Excavator Type: 8 Tonne Excavator Test Pit Dimensions: 1.5m x 3m Contractor: Skellys Limited Easting: Northing 5168009 m Ground Level: 13 m Pocket Penetrometer Tests Shear Vane Tests Vater Level (m) Elevation (m) Graphic Log ŝ Sample Depth ( Soil Description 57 <u>...</u> SILT, minor sand, dark brown. Stiff, moist, low plasticity, sand is fine grained (TOPSOIL). ١, 14 14 4 2.9 × Silty SAND; light brown mottled orange. Loosely packed, moist; sand is fine × × to medium grained (ALLUVIAL DEPOSITS). × 0.5 × × × × x × × × × × × × × 1.0 12 × × × × × x × × x × × × 1.4m Becomes with some silt, grey mottled orange brown. х 1.5 × × 1.5m Becomes with occasional fibrous organic inclusions (rootlets). × × × × × × × × x × × × 2.0 × 11 2.0m Becomes dark grey. × × × ż × × × × x × × × 2.5 × × × × ż ×. × × х x × V To GRAVEL with some sand; brownish grey. Loosely packed; saturated; well 3.0 10 graded; subrounded to rounded; gravel is fine to coarse grained; sand is fine to coarse grained. End of Test Pit at 3m (Too dense to excavate.) 3.5 4.0 -9 4.5 3/07/2012 11:26:28 a.m. Remarks: Groundwater at 2.9m Generated: SE

Database File: STAGE 7 TO 15 UPDATED TEST PIT LOGS.GPJ, LIbrary: AURECON CHRISTCHURCH.GLB, Data template: CHCH DATA TEMPLATE NOV 2010.GDT

Sheet 1 of 1

aurecon Unit 1, 150 Ca PO BOX 10

Christelunch New Zealand

### Client: Fulton Hogan Land Development Limited Project Name: Rosemerryn Farm Subdivision Location: Stage 7 to 15 Project Reference: 224464

Database File: STAGE 7 TO 15 UPDATED TEST PIT LOGS, GPJ, Library: AURECON CHIRISTCHURCH, GLB, Data template: CHCH DATA TEMPLATE NOV 2010, GDT

Logged by: RS Input by: MJF Checked by: RS Hed by: WD CO-ORDINATES N/A Easting: 1659485 m Northing: 5168200 m Ground Level: 18 m Date Started: 27/04/2012 Date Completed: 27/04/2012 TEST PIT INFORMATION Excavator Type: 8 Tonne Excavator Test Pit Dimensions: 1.5m x 3m Contractor: Skeliys Limited Tests Shear Vane Tests Water Level (m) Elevation (m) Graphic Log Ξ Penetrometer 7 Sample Depth ( Soil Description <u> 10</u> 10 SILT, minor sand, dark brown. Stiff, moist, low plasticity, sand is fine grained (TOPSOIL). i, 29 22 <u>.</u> 24 SILT, some sand, light brown mottled orange brown. Very stiff, dry, low plasticity, Sand is fine grained (ALLUVIAL DEPOSITS). х x × × 0.5 × х x × x × × × х × x × 1.0 17 SAND with some silt; light brown mottled orange brown; sand is fine to medium grained. 1.5 2.0 16 Sandy GRAVEL brownish grey. Loosely packed; moist to wet; well graded; subrounded to rounded; gravel is fine to coarse grained; sand is fine to coarse grained. ₽  $\cap$ 25D 0  $\Box$ Ç 3.0 15 . Ω End of Test Pit at 3.1m (Target Depth Achieved.) 3.5 4.0 14 4.5 3/07/2012 11:26:29 a.m. Remarks: Groundwater not encountered. Generated: ast

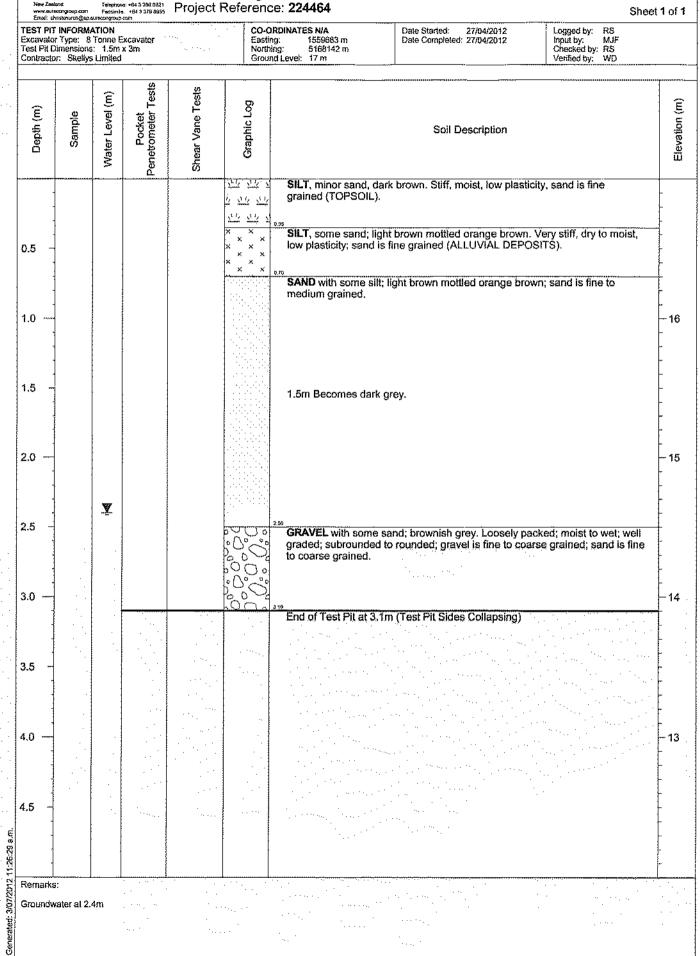
aurecon Unit 1, 150 Ca , O fil X 108

Last

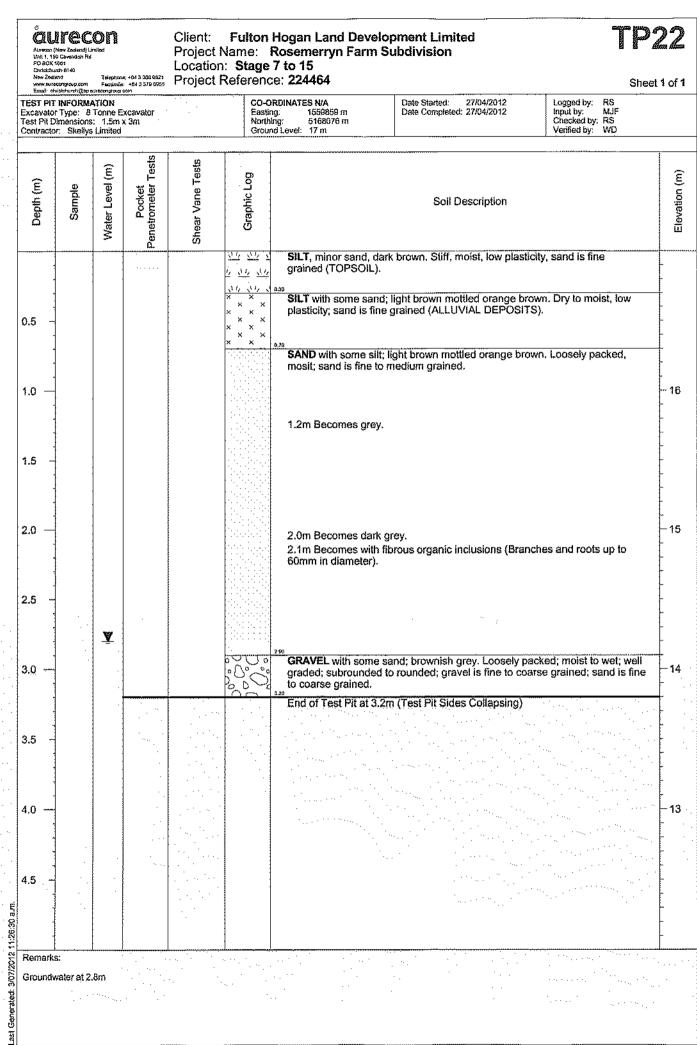
### Client: Fulton Hogan Land Development Limited Project Name: Rosemerryn Farm Subdivision Location: Stage 7 to 15 Project Reference: 224464

Sheet 1 of 1

TP21



Data template: CHCH DATA TEMPLATE NOV 2010.GDT Database File: STAGE 7 TO 15 UPDATED TEST PIT LOGS GPJ, LIbrary: AURECON CHRISTCHURCH.GLB,



# Database File: STAGE 7 TO 15 UPDATED TEST PIT LOGS.GPJ. Library: AURECON CHRISTCHURCH GLB, Data lemplate: CHCH DATA TEMPLATE NOV 2010.GDT

aurecon

Autocon (New Zes Unit 1, 150 Covers PC BOX 1081 rch 8140

### Client: Fulton Hogan Land Development Limited Project Name: Rosemerryn Farm Subdivision Location: Stage 7 to 15 Project Reference: 224464

Sheet 1 of 1

TP28

Now Zealand Telephone. +8+ 3 368 0821 www.autoscopacup.com Facstrike. +84 3 378 6955 Email: stratchursh@ap.sutocongroup.com Logged by: RS Input by: MJF Checked by: RS Checked by: WD CO-ORDINATES N/A TEST PIT INFORMATION 27/04/2012 Date Started: 1559471 m 5168269 m Excavator Type: 8 Tonne Excavator Test Pit Dimensions: 1.5m x 3m Easting: Northing: Date Completed: 27/04/2012 Contractor: Skellys Limited Ground Level: 14 m Pocket Penetrometer Tests Shear Vane Tests Water Level (m) Elevation (m) Graphic Log Depth (m) Sample Soil Description 54 54 SILT, minor sand, dark brown. Stiff, moist, low plasticity, sand is fine 1 grained (TOPSOIL). 4 24 24 507 3.4 Sandy SILT, light brown mottled orange brown. Very stiff, dry, low plasticity, sand is fine grained (ALLUVIAL DEPOSITS). Sandy GRAVEL; brownish grey. Loosely packed; moist to wet; well graded; subrounded to rounded; gravel is fine to coarse grained; sand is fine to coarse 60°-0.5D grained.  $\cap$ ò 1.0 13 1.5 2.0 12 2.5 Pag. D 3.0 11 End of Test Pit at 3m (Target Depth Achieved.) 3.5 4.0 10 4.5 3/07/2012 11:26:31 a.m. Remarks: Groundwater not encountered. Last Generated:

Database File: STAGE 7 TO 15 UPDATED TEST PIT LOGS.GPJ, LIbrary: AURECON CHRISTCHURCH;GLB, Data temptate: CHCH DATA TEMPLATE NOV 2010.EDT

aurecon Client: Fulton Hogan Land Development Limited Project Name: Rosemerryn Farm Subdivision Unit 1, 160 ( Location: Stage 7 to 15 Teleptona +84.3 338 8821 www.aurecomproto.com Factorials: +84.3 376 8955 Entel: christaturchigae.aurecomprote.com Project Reference: 224464 Sheet 1 of 1 Logged by: RS Input by: MJF Checked by: RS Date Started: 27/04/2012 Date Completed: 27/04/2012 CO-ORDINATES N/A TEST PIT INFORMATION Excavator Type: 8 Tonne Excavator Test Pit Dimensions: 1.5m x 3m Contractor: Skellys Limited Easting: N/A Northing: N/A Ground Level: N/A Pocket Penetrometer Tests Shear Vane Tests € Elevation (m) Graphic Log Jepth (m) Water Level ( Sample Soil Description SILT, minor sand, dark brown. Stiff, moist, low plasticity, sand is fine grained (TOPSOIL). 54 54 μ, 4. SILT, some sand, light brown mottled orange brown. Very stiff, dry, low plasticity, Sand is fine grained (ALLUVIAL DEPOSITS). × × × 0.5 × × × x × × × × SAND with some silt; light brown mottled orange brown; sand is fine to medium grained. 1.0 1.2m Becomes dark grey. 1.5 1.6m Becomes fibrous organic inclusions (branches up to 100mm diameter). 2.0 2.0m Tree stump 0.5m diameter. 2.5 GRAVEL with some sand; brownish grey. Loosely packed; moist to wet; well graded; subrounded to rounded; gravel is fine to coarse grained; sand is fine 00 to coarse grained. D 00 Y 3.0 End of Test Pit at 3m (Target Depth Achieved.) 3.5 4.0 4.5 Generated: 3/07/2012 11:26:33 a.m. Remarks: Groundwater at 3.0m

Last

Database File: STAGE 7 TO 15 UPDATED TEST PTT LOGS.CPJ, Library: AURECON CHRISTCHURCH GLB, Data temptate: CHCH DATA TEMPLATE NOV 2010.GDT

.

aurecon TP30 Client: Fulton Hogan Land Development Limited Aurenan (New Zen) Unit 1, 150 Gavend PO BOX 1001 Christoburch 8140 New Zeoland Project Name: Rosemerryn Farm Subdivision Location: Stage 7 to 15 . Telephone: +84 3 388 6821 Facontile: +64 3 378 6855 Project Reference: 224464 www.butecongroup.com mail: enristchurch@pp.ce Sheet 1 of 1 conteroup.t CO-ORDINATES N/A Easting: 1559847 m Northing: 5168197 m Ground Level: 13 m Logged by: RS Input by: MJF Checked by: RS Verified by: WD Date Started: 27/04/2012 Date Completed: 27/04/2012 TEST PIT INFORMATION Excavator Type: 8 Tonne Excavator Test Pit Dimensions: 1.5m x 3m Contractor: Skellys Limited Tests Shear Vane Tests Water Level (m) Graphic Log Elevation (m) Penetrometer T Depth (m) Sample Soil Description NY 84 SILT, minor sand, dark brown. Stiff, moist, low plasticity, sand is fine grained (TOPSOIL). Ŀ. дų, 34 SILT, with some sand; light brown mottled orange brown. Very stiff, dry. low plasticity; Sand is fine grained (ALLUVIAL DEPOSITS). × × × x × 0.5 x × × ¥ SAND with some silt; light brown mottled orange brown; sand is fine to medium grained. 1.0 12 1.2m Becomes dark grey. 1.5 1.6m Becomes with fibrous organic inclusions (branches up to 100mm diameter). 2.011 2.0m Tree stump 0.5m diameter. 2.5 Y 3.0 10 GRAVEL with some sand; brownish grey. Loosely packed; moist to wet; well graded; subrounded to rounded; gravel is fine to coarse grained; sand is fine to coarse grained. End of Test Pit at 3.2m (Target Depth Achieved.) 3.5 4.0 -9 4.5 3/07/2012 11:26:33 a.m. Remarks: Groundwater at 3.0m Last Generated:

Database File: STAGE 7 TO 15 UPDATED TEST PIT LOGS, GPJ, Ubrary: AURECON CHRISTCHURCH.GLB, Data template: CHCH DATA TEMPLATE NOV 2010.GDT

aurecon Client: **Fulton Hogan Land Development Limited** IP33 Project Name: Rosemerryn Farm Subdivision 1 10 Location: Stage 7 to 15 hurch &14D New Zealand Telephone. +64 3 360 D821 www.puracongroup.com Facsingle. +64 3 378 0055 Erval christetunet@sp.puracongroup.com Project Reference: 224464 Sheet 1 of 1 TEST PIT INFORMATION CO-ORDINATES N/A Logged by: RS Input by: MJF Checked by: RS RS MJF 27/04/2012 Date Started: Excavator Type: 8 Tonne Excavator Test Pit Dimensions: 1.5m x 3m Easting: Northing 1559526 m 5168388 m Date Completed: 27/04/2012 Contractor: Skellys Limited Ground Level: 16 m Verified by: WD Tests Shear Vane Tests Water Level (m) Graphic Log Elevation (m) Depth (m) Penetrometer 7 Sample Soil Description 24.22 SILT, minor sand, dark brown. Stiff, moist, low plasticity, sand is fine grained (TOPSOIL). 4 34 24 11 <u>.</u> × SILT with some sand; brown. Stiff, wet, low to moderate plasticity. Sand is fine to medium grained (ALLUVIAL DEPOSITS). × × x х × 0.5 × × x × x x x × x × × × 1.0 15 SAND with minor silt; light brown mottled orange brown. Loosely packed. moist; sand is fine to medium grained. 1.5 1.8m Becomes light grey mottled orange brown. 2.0 14 2.3m Becomes dark grey. 2.5 3.0 13 End of Test Pit at 3.1m (Target Depth Achieved.) 3,5 4.0 12 4.5 3/07/2012 11:26:34 a.m. Remarks: Groundwater not encountered. Last Generated:

Database File: STAGE 7 TO 15 UPDATED TEST PIT LOGS. GPJ, LIGRAY, AURECON CHRISTCHURCH. GLB, Data temptate: CHCH DATA TEMPLATE NOV 2010. GDT

aurecon Client: Fulton Hogan Land Development Limited Aurocan (New Un4 1, 150 Ca PD BOX 1061 Project Name: Rosemerryn Farm Subdivision Location: Stage 7 to 15 Christenarch 8140 New Zeoland Teisplane, +64 3 388 0821 Facsimila: +64 3 379 6955 Project Reference: 224464 Sheet 1 of 1 Email. christehusch@op.a XIQYDUD.D Logged by: RS Input by: MJF Checked by: RS Verified by: WD TEST PIT INFORMATION CO-ORDINATES N/A Date Started: 27/04/2012 Excavator Type: 8 Tonne Excavator Test Plt Dimensions: 1.5m x 3m Contractor: Skellys Limited 1559565 m 5168402 m Easting: Northing: Date Completed: 27/04/2012 Ground Level: 11 m Pocket Penetrometer Tests Shear Vane Tests Water Level (m) Graphic Log Depth (m) Sample Soil Description SILT, minor sand, dark brown. Stiff, moist, low plasticity, sand is fine grained (TOPSOIL). 24.54 4 14 14 SILT, minor to some sand, brown. Stiff, moist, low to moderate plasticity, sand is fine to medium grained (ALLUVIAL DEPOSITS). × × x 0.5 × × x × × × × × × × x × 1.0 × × × x × SAND with minor silt; brown and grey. Loosely packed; moist; poorly graded; sand is fine to medium grained. 1.5 2.0 2.0m Becomes with some silt. 2.3m Becomes dark grey. 2.5 2.5m Becomes with organic inclusions (branches and large roots). 3.0

Last Generated: 3/07/2012 11:26:36 a.m.

3.5

4.0

4.5

Remarks:

Groundwater at 3.5m

Y

End of Test Pit at 3.7m (Target Depth Achieved.)

GRAVEL with some sand; brownish grey. Loosely packed; moist to wet; well graded; subrounded to rounded; gravel is fine to coarse grained; sand is fine

to coarse grained.

00

Database File: STAGE 7 TO 15 UPDATED TEST PIT LOGS.GPU, Library: AURECON CHRISTCHURCH.GLB, Data temptate: CHCH DATA TEMPLATE NOV 2010.GDT

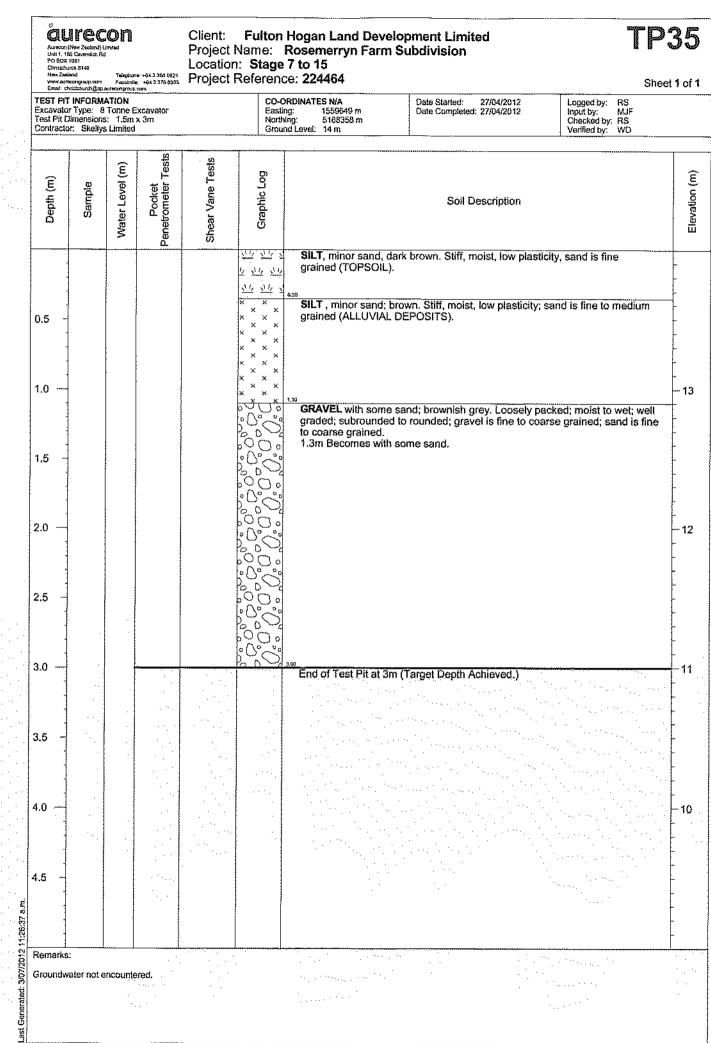
Elevation (m)

10

9

8

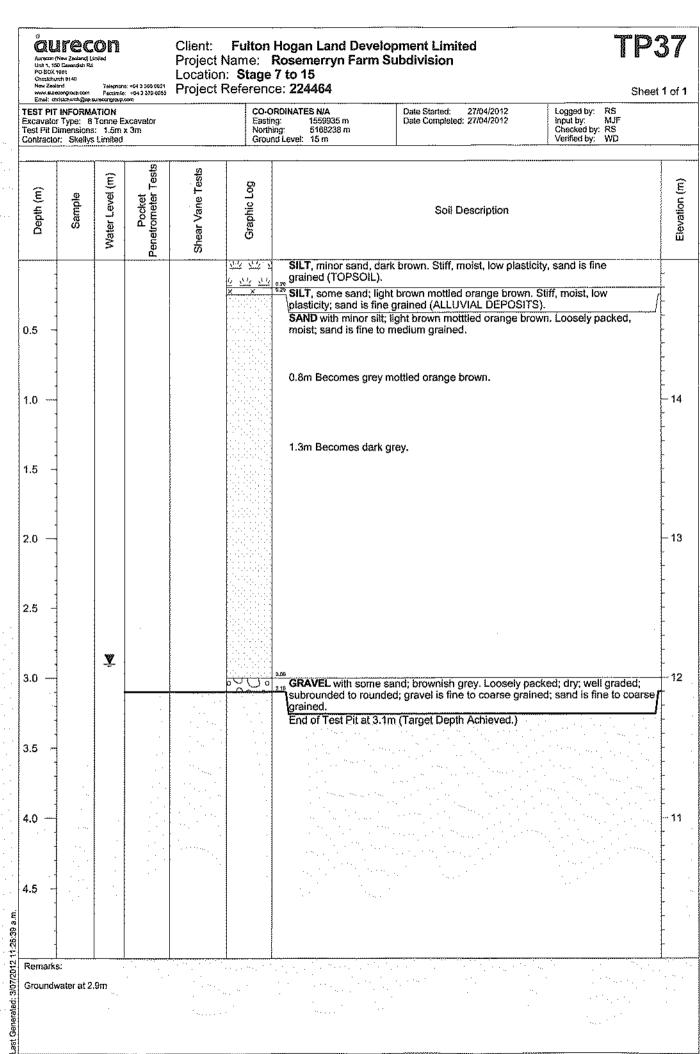
7



Database File: STAGE 7 TO 15 UPDATED TEST PTI LOGS.CPJ, Library: AURECON CHRISTCHURCH.GLB, Data tempate: CHCH DATA TEMPLATE NOV 2010.EDT

durecon TP36 Client: Fulton Hogan Land Development Limited Aureon (New Zeoland) Under Unit 1, 150 Caversish Rd PC 80X 1051 Cansidaurch 8149 New Zeoland Project Name: Rosemerryn Farm Subdivision Location: Stage 7 to 15 Telephone, +84 3 380 0821 Pacatipile: +84 3 376 6065 Project Reference: 224464 New zeola w Www.colfocongroup.com Practipula: +6 Empil: christeliuxch@sp.surecongroup.com Sheet 1 of 1 CO-ORDINATES N/A Easting: 1559878 m Northing: 5168255 m Ground Level: 16 m TEST PIT INFORMATION Date Started: 27/04/2012 Logged by: RS MJF Excavalor Type: 8 Tonne Excavator Test Pit Dimensions: 1.5m x 3m Contractor: Skellys Limited Date Completed: 27/04/2012 input by: MJI Checked by: RS Verified by: WD Penetrometer Tests Shear Vane Tests Water Level (m) Graphic Log Elevation (m) Depth (m) Sample Soil Description SILT, minor sand, dark brown. Stiff, moist, low plasticity, sand is fine grained (TOPSOIL).  $\overline{M}, \overline{M}$ ``\ 4 24 24 v SILT, some sand; light brown mottled orange brown. Very stiff, dry, low х x plasticity; sand is fine grained (ALLUVIAL DEPOSITS). × x × 0.5 J 10 GRAVEL with some sand; brownish grey. Loosely packed; dry; well graded; subrounded to rounded; gravel is fine to coarse grained; sand is fine to coarse grained. ٥  $\square$ 1.0 15 1.5 1.5m Becomes sandy and moist. 2.0 14 2.5 D Ō  $\bigcirc$ ø 3.0 13 End of Test Pit at 3m (Target Depth Achieved.) 3.5 4.0 12 4.5 Last Generated: 3/07/2012 11:26:38 a.m. Remarks: Groundwater not encountered.

Database File: STAGE 7 TO 15 UPDATED TEST PIT LOGS.GPJ, LIbrary: AURECON CHRISTCHURCH.GLB, Data template: CHCH DATA TEMPLATE NOV 2010. GDT



Database File: STAGE 7 TO 15 UPDATED TEST PIT LOGS (5PJ, Ubrary: AURECON CHRISTCHURCH GLB, Data template: CHCH DATA TEMPLATE NOV 2010.6DT

aurecon TP38 Client: Fulton Hogan Land Development Limited Project Name: Rosemerryn Farm Subdivision 3 160 Ca ND B Location: Stage 7 to 15 Christenne New Zeak +84 3 368 0821 +64 3 379 0955 Project Reference: 224464 New Zeoland Telaphone: www.goracongroup.com Factimile. Email: contribuichigito.sunccongroup.com Sheet 1 of 1 Logged by: RS Input by: MJF Checked by: RS WD CO-ORDINATES N/A Easting: 1659993 m Northing: 5168257 m Ground Level: 16 m Date Started: 27/04/2012 Date Completed: 27/04/2012 TEST PIT INFORMATION Excavator Type: 8 Tonne Excavator Test Pit Dimensions: 1.5m x 3m Contractor: Skellys Limited Tests Shear Vane Tests Water Level (m) Graphic Log Ξ Penetrometer 1 Sample Depth ( Soil Description 2.2 14 SILT, minor sand, dark brown. Stiff, dry, low plasticity, sand is fine grained (TOPSOIL). <u>...</u>  $\overline{M}$ SILT with some sand; light brown mottled orange brown. Very stiff, dry, low plasticity; Sand is fine grained (ALLUVIAL DEPOSITS). x × × × SAND with minor to some silt; light brown mottled orange brown. Loosely 0.5 packed; sand is fine to medium grained. GRAVEL with some sand; brownish grey. Loosely packed; dry; well graded; n 1.0 subrounded to rounded; gravel is fine to coarse grained; sand is fine to coarse grained. £ 1.4m Becomes moist. 1.5 2.0 2m Becomes sandy. 2.5 V Δ

3.0

3.5

4.0

4,5

Remarks:

Groundwater at 2.7m

3/07/2012 11:26:40 a.m.

Last Generated:

End of Test Pit at 2.8m (Target Depth Achieved.)

Database File: STAGE 7 TO 15 UPDATED TEST PIT LOGS.GPJ, IJDPay: AURECON CHRISTCHURCH.GLB, Data template: CHCH DATA TEMPLATE NOV 2010.GDT

Elevation (m)

15

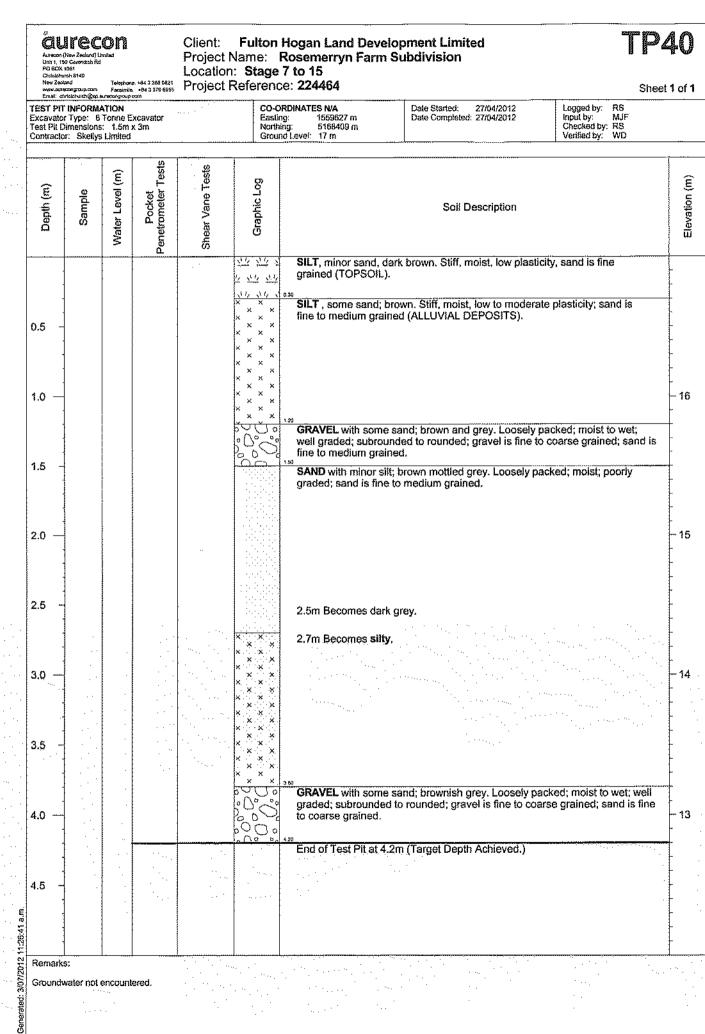
14

13

12

Aurecon (N Unit 1, 150 PO BOX 10 Christolwro New Zaalas Www.autec	b 814D	ritod Telophone Facetniki	. +04 3 358 0821 +04 3 375 0055 Xm	Location	lame: : <b>Stage</b>	Hogan Land Development Limited TPC Rosemerryn Farm Subdivision 7 to 15 se: 224464 Sheet	-					
TEST PIT Excavator Test Pit Di Contractor	Type: 8 mensions	Tonne Ex : 1.5m x	xcavator x 3m	CO-ORDINATES N/A     Date Started: 27/04/2012     Logged by: RS       Easting:     1559837 m     Date Completed: 27/04/2012     Input by: MJF       Northing:     5169324 m     Checked by: RS       Ground Level:     16 m     Verified by: WD								
Depth (m)	Sample	Water Level (m)	Pocket Penetrometer Tests	Shear Vane Tests	Graphic Log	Soil Description						
0.5 -					* * * * * * * * * * * * * * * * * * *	SILT, minor sand, dark brown. Stiff, dry, low plasticity, sand is fine grained (TOPSOIL). SILT with some sand; light brown mottled orange brown. Very stiff, dry, low plasticity; sand is fine grained (ALLUVIAL DEPOSITS).	- - -					
1.0						<b>GRAVEL</b> with some sand; brownish grey. Loosely packed; dry; well graded; subrounded to rounded; gravel is fine to coarse grained; sand is fine to coarse grained.	, , , , , , , , , , , , , , , , , , ,					
1.5 -						1.4m Becomes sandy.						
2.0						1.9m Becomes moist.	- - - -					
2.5 -						End of Test Pit at 2,5m (Target Depth Achieved.)						
3.0												
3.5												
4.0					n an an Anna an Anna an		<b>I</b> . <b>I</b> I I I.					
4.5 -							1.1.1.1					
Remarks Groundw		l encounte	ared.		• • • • • • • • • • • • •							

Database File: STAGE 7 TO 15 UPDATED TEST PIT LOGS.GPJ, Library: AURECON CHRISTCHURCH.GLB, Data template: CHCH DATA TEMPLATE NOV 2010.GDT



Last

Database File: STAGE 7 TO 15 UPDATED TEST PIT LOGS.GPJ, Library: AURECON CHRISTCHURCH.GLB, Data template: CHCH DATA TEMPLATE NOV 2010.GDT

## FIELD DESCRIPTION OF SOIL

SOIL

CLASSIFICATION

han 0.06mm raction finer MATERIAL

SIGULUDERS

POBBILES

GRAVEL

SAND

SIL

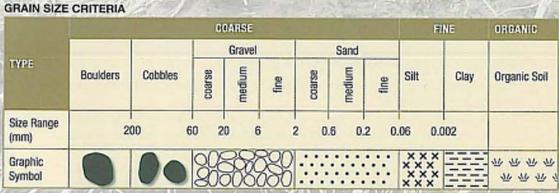
Particle size composition

ick/dilatan behaviour

uoiverla Plastic

BUARSE

SEQUENCE OF TERMS - fraction - colour - structure - strength - moisture - bedding - plasticity - sensitivity - additional



## PROPORTIONAL TERMS DEFINITION (COARSE SOILS)

Fraction	Term	% of Soll Mass	Example
Major	() [UPPER CASE]	≥ 50 [major constituent]	GRAVEL
Subordinate	() y [lower case]	20 - 50	Sandy
Minor	with some with minor	12-20 5-12	with some sand with minor sand
	with trace of (or slightly)	< 5	with trace of sand (slightly sandy)

## DENSITY INDEX (RELATIVE DENSITY) TERMS

Descriptive Term	Density Index (R <sub>D</sub> )	SPT "N" value (blows / 300 mm)	Dynamic Gone (blows / 100 mm)
Very dense	> 85	> 50	> 17
Dense	65 - 85	30 - 50	7 - 17
Medium dense	35 - 65	10-30	3-7
Loose	15 - 35	4-10	1-3
Very loose	< 15	<4	0-2

Note: 
 No correlation is implied between Standard Penetration Test (SPT) and Dynamic Cone Test values.
 SPT "N" values are uncorrected.
 Dynamic Cone Penetrometer (Scala)

## **ORGANIC SOILS/ DESCRIPTORS**

Term	Description
Topsoil	Surficial organic soil layer that may contain living matter. However topsoil may occur at greater depth, having been buried by geological processes or man- made fill, and should then be termed a buried topsoil
Organic clay, silt or sand	Contains finely divided organic matter; may have distinctive smell; may stain; may oxidise rapidly. Describe as for inorganic soils.
Peat	Consists predominantly of plant remains. <i>Firm:</i> Fibres already compressed together <i>Spongy:</i> Very compressible and open stucture <i>Plastic</i> : Can be moulded in hand and smears in fingers <i>Fibrous:</i> Plant remains recognisable and retain some strength <i>Amorphous:</i> No recognisable plant remains
Roolets	Fine, partly decomposed roots, normally found in the upper part of a soil profile or in a redeposited soil (e.g. colluvium or fill)
Carbonaceous	Discrete particles of hardened (carbonised) plant material.

Term	Description
High plasticity	Can be moulded or deformed over a wide range of moisture contents without cracking or showing any tendency to volume change
Low plasticity	When moulded can be crumbled in the fingers; may show quick or dilatant behaviour

å	CONSISTEN	ICY TERMS FOR	COHESIVE SOILS
	Descriptive Term	Undrained Shear Strength (kPa)	Diagnostic Features
	Very soft	< 12	Easily exudes between fingers when squeezed
	Soft	12 - 25	Easily indented by fingers
	Firm	25 - 50	Indented by strong finger pressure and can be indented by thumb pressure
	Stiff	50 - 100	Cannot be indented by thumb pressure
	Very stiff	100 - 200	Can be indented by thumb nail
	Hard	200 - 500	Difficult to indent by thumb nail

## MOISTURE CONDITION

Condition	Description	Granular Soils	<b>Cohesive Soils</b>
Dry	Looks and feels dry	Run freely through hands	Hard, powdery or friable
Moist	Feels cool, darkened in colour	Tend to cohere	Weakened by moisture, but no free water on hands when remoulding
Wet			Weakened by moisture, free water forms on hands when handling
Saturated	Feels cool, darkened in	n colour and free wa	ater is present on the sample

## **GRADING (GRAVELS & SANDS)**

Term	Description										
Well graded	Good representation	Good representation of all particle sizes from largest to smallest									
Poorly graded	Limited representation of grain sizes - further divided into:										
	Uniformly graded	Most particles about the same size									
-	Gap graded	Absence of one or more intermediate sizes									

## NZ GEOTECHNICAL SOCIETY INC

This field sheet has been taken from and should be used and read with reference to the document FIELD DESCRIPTION OF SOIL AND ROCK. Guideline For the Field Classification and Description of Soil and Rock for Engineering Purposes. NZ Geotechnical Society Inc, December 2005, www.nzgeotechsoc.org.nz

# Appendix G Borehole Logs

	Avvecor Upl 1, 1 PO BOJ Christol New Za	hunch all	indensi) i Indiah Ra 10	indjud nd Tuk	iqtifutymi.		Loca	ct Name: tion: SEE	TON HOGAN ROSEMEI PLAN Ince: 224464	RRYN FARI					N					
BO Dril	REH REH	OLE ( Aetho	NFOF d: Ci	MAT 31	10N 2 Tra	m		CO-ORDINA Easting:	N/A		Dete		plated	1: 19	109/1	2011		Logged by: Input by:	JSM JSM	UI &
	nere tract	r Can or:			n Dri	lìng	-	Northing: Ground Leve	NVA H: N/A			nation rtatio		90				Checked b Verified by	y: JSM JK	
Method/Casing	Core Recovery (%)	Water Lizes (%)	Groundwater Level (m)	R.l. (m)	Depth (m)	Graphic Log		Ma	terial Descriptio	n		USC Description	Consistency/Density	Moisture	Semple	kn-Siltu Testing	Laboratory Testing	Notes	Backfill	Geological Unit
		1	}				rootlets;		trace sand and Firm, Moist, L			œ							1	\$
							SAND; ( Loose.	Srey brown	with orange bro	wn mottles.	/	SP							3 (C)	
			Ţ		2	***		rk blue gre	y. Low plasticity	, Stiff. Moist.		Mł.			B					
WaSH						000.0	mottling. coarse g grained.	Dense. We rained and	rk grey with ora t to saturated. rounded. Sand	Gravel fine to	n In Silv	GW				SPT at 3m N = 35 6 499, 9, 9, 8 480mm (BC)	NO LABORATORY TESTING			
CC OB SSA HRAS HRAS HRAS HRAS HRAS HRAS HRAS	COR	arele on bar d ster ow sta bh dhill Triple Triple Triple LC Tr sct Pu st Tub sing	rê	ger		Inorga Inorga Inorga Claye Silky G Pouth Wall C Inorga ORGA ORGA PEAT Clayer Silky S	ant-calacter nite CLAYS Nigh pin nite CLAYS Nigh pin nite CLAYS Nigh pin Ac CLAYS Nigh pin (CLAYS Night) (CLAY Night) nite SIT high pines nite SIT high pines nite SIT how pines nite SI	sficity phosicity slicity slicy ity ity ity solue solue	VS very soft S soft E fign	B buik U undisturbed D disturbed Weter 2 at end of excavation 2 at time of 2 at time of	PP pe VS vs SPT st SS sc SC sc NE he SH sk Moistu D dry W wat	n per ne sh d, per lit spo lit spo lit co intra nits ur nits ur	estram ear Liest son ne riboun der ov Baci	cing vn we		Tos a	13. Provide Straugh Sa Provide Type Strategy Type Strategy Type Strategy Type Strategy Type Strategy Type Strategy Sa	ac 1 pipe		

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	AUG 0 2 3	nicon ( 141, 15 SCO electro el	New Z G-Ceve tob1 coh B1- and wompto	iculturid) midiuh R 40	and Te	lephone celebile	+013	Locat	ct Name ion: SEI	: FULTON HOGAN LAND DEVELOPMENT ct Name: ROSEMERRYN FARM SUBDIVISION ion: SEE PLAN ct Reference: 224464										<b>-10</b>	
1	<b>SORI</b> Xillin Xami	EHO 19 Ma eter	LE I etho Con	NFO d: C s: 10	AT 3	10N 12 Tr	sick F	llg	CO-ORDIN/ Easting: Northing:	N/A N/A	<u> </u>	Date	netion	i <b>płete</b> c K		109/	2011 2011	l Ir	Logged by: JSM Input by: JSM Checked by: JSM		
ľ	Contra	acto	r.	M	сМЯН				Ground Lev	el: N/A		Orie	ntatio	n:				Verffed by: JK			
	Method/Casing	Core Recovery (%)	Weter Loss (%)	Groundwater Lavel (m)	R.L. (m)	Capth (m)	Graphic Log			iterial Descript		USC Description	Consistency/Density	Molsture	Sampla	In-Situ Testing	Laboratory Tasting	Notes	Backfill	Geotogical Unit	
						- 12		mottling. coarse g grained.	Dense. We rained and (Layer Con	rounded. San	. Graval fine to d fine to medius evious page)	רא	GW				(BST at 16m N = 60 5, 77(2, 14, 13, 11 14 460mm (BC)	ORY TESTING			
		ondrin Didlor Vash	ete.c	pre al auge Tube Tube Tube (70m	f Jor	200,038	Class Trange Range Bilty G Poorty West G	DOTEMONE siffcation inc CLAYS high phase inc CLAYS high phase inc CLAYS low plast inc CL		Consistency VS very soft S soft F firm VS very soft F firm VS very soft H hard	Soit Samples B buik	VS Var SPT std SS spi SC sol	n pen ne sha 1. pen. It spoi lid con	- etrome	tu		SALT				
に見たい		ici T IMLC Xrect Xual 1 Xual 1		Tube Na Tu n (70n	bs im)		PEAT Clayey Silby S Roorly	NC SILT Ings ballot NIC CLAY madum 1 NIC SILT iow plastic mot highly argente a SAND SAND graded SAND graded SAND	y o hàgh pleudicity ty Xia	Density VI. very loose L loose MD medium dense D dense VD very dense	excavation	Molstur Molstur Odry Mimcis Wiwet Sisatus	ve it	Back		ß	Connent Sangt 1 1	21 20 20 20 20 20 20 20 20 20 20 20 20 20	1 bo		

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BO	Aureat Unit 1, PO 800 Christe New 20 Write Email	christen OLE	inde f	Linded Iced F	nersten TION		Local	ct Name tion: SE ct Refer	EIICE: 224464	RRYN FAF	M SI	OPI UBC	DIVI	ISIC	<b>)N</b> 5/09/	2011			HO	_	
Dia	ling l mete ntrac	ar Cor	e: 1i	DOmin	12 T/ n lan Di	ack R rilling	lg 	Easting: Northing: Ground Lev	N/A N/A /el: N/A		Incli	e Corr ination	3:	9 sd: 1	5/09/: C	2011	Input by: JSM Checked by: JSM Vertiled by: JK				
Method/Casing	Core Recovery (%)	Water Loss (%)	Groundwater Level (m)	R.L. (m)	Depth (m)	Graphic Log			Material Description				Consistency/Density	Moisture	Sampie	ht-Situ Testing	Leboratory Testing	Notes	Backfill	Geological Unit	
						¥4	rootlets;	L SILT with Dark brow e grained.	n trace sand and n. Firm. Moist. L	f occaisional ow plasticity.		OL.		l	<b>†</b>				88	\$	
			Y		- - - - -	^ × × × ×	SILT with	n minor sa	nd; Yellow brown ine to medium g	n. Low plastic rained.	ity.	ML									
					3	X * * X * X * X * X * X * X * X	Moist to 1	wet. Sand	ue grey. Loose fine to medlum (	grained.		SM				SPT at Sm N = 12 2, 20, 3, 3, 3 450mm (SC)			and a subsection of the subsec		
WASH					8	* * * * * * * * * * * * *	SILT: Dar Molst.	k blue gre	y. Low plasticity	Firm to stiff,		ML					NO LABORATORY TESTING		anokokokokokokokoko antokokokokokokoko		
					- 7	<u>Ďo°Ďo°Ďo°Ďo°Ďo°</u>	mottiling. [	Dense. We	rk grey with ora to saturated. rounded. Sand i	Gravel fine to	מי	ow	1						alananananananananananananananananan alamanananananananananananananananan	<b>94</b>	
Antho XC XB XSA XASH YASH YASH YA		crete n bari d stein aw ste h drill Triple Triple C Triple LC Tri ct Pus i Tube ing	nai In auge In auge	97 981 991 901 901	Could Be State Broom	Inorger Inorger Longer Clayey Sity Gi Poorty Well G Monger Inorger ORGAI ORGAI ORGAI ORGAI ORGAI ORGAI Slavey	Hillcatton is CLAYS high plass is CLAYS medium is CLAYS investion is CLAYS investion GRAVEL SAVEL SAVEL SAVEL SAVEL SAVEL SAVE IS CLAY medium IS CLAY medium IS CLAY medium IS CLAY medium IS CLAY medium IS CLAY medium IS CLAY medium IS CLAY medium IS CLAY MO IND Intel SAND medium SAND	ticity plasticity catly ty y high pissticity Ry high	Consistency VS very soft S soft F firm S soft VS very stiff H hard Density VI. very loase HD medium dense D dense D dense VD very datse	Solt Samples B busk U undisturbed D disturbed Water V at end of excavation I at time of excavation I at time of excavation I at time of closure	VS VS SPT sh SS sp SC so	in pen ine shi d. pen, lit spo- lid cor immer his un his un	etrom ear teat on te bourn der ov	cing wa we		Bity SAND	Silough Bandi pipe grana 1 grana Pipe grana Pipe	1  2: 1	<u>, ar 164</u>		

Database File: TEST PITS.GPU, LEvrary: COPY OF CHCH LIBRARY MARCH 2011,CLB, Data template: CHCH DATA TEMPLATE NOV 2010,CDT, Last Generated; 19/10/2011.

	Client:         FULTON HOGAN LAND DEVELOPMENT           Auston (New 2-Hand) Limited         Project Name:         ROSEMERRYN FARM SUBDIVISION           Unter 1 192 Central Intel         Diddo Name         ROSEMERRYN FARM SUBDIVISION           Cristoburge 11 August         Telephone: -44 3 305 0571         Project Reference: 224464           Term Amburge 11 August 11 August         Project Reference: 224464         Project Reference: 224464														BH04 Sheet 2 of 2							
<b>BO</b> Drif Dis		bLE f Aetho r Con	NFOI d: C e: 10	MAT	ION 12 Trz	m ack R	·····	CO-ORDINA Easting: Northing: Ground Leve	it <b>es n/a</b> N/a N/a	<b>.</b>	Date	e Start Com nation ntation	pletec :		/09/2			Logged by: JSM input by: JSM Checked by: JSM Verified by: JK				
Method/Casing	Core Recovery (%)	Water Losa (%)	Groundwater Level (m)	R.L. (m)	Depth (m)	Graphic Log		Ма	terial Descriptio	on		USC Description	Consistency/Density	Moisture	Semple	In-Silu Testing	Leboratory Testing	Notes	Backfill	Geological Unit		
WASH					- 17 - 17 - 18		mottling. coarse g grained.	Donse. Wa rained and (Layer Con	d at 15m (Targa	Gravel fine to I fine to mediu <i>vious pagė)</i>	, m	GW				SPT at 10m N = 49 3, 8/10, 18, 9, 1 460mm (SC)	NO LABORATORY TESTING					
Meth CC SSA MAS HQ3 HQ3 HQ3 HQ3 HQ3 HQ3 HQ3 HQ3 HQ3 HQ3		icrete an bau ic ster sh drif Sh drif Triple Triple Triple C Triple Strip Stri	n aug em al Tuba Tuba Tuba tub tiple T	inpe '	2255990000	Inorga Inorga Claya Silty C Poorth Well is Inorga ORG/ ORG/	atfication artic CLAYS high pla mic CLAYS madium mic CLAYS madium mic CLAYS madium gRAVEL gradad GRAVEL and GRAVEL wic SK. Top plastic wic SK. Tow plastic wic SK. Tow plastic wic SK. Tow plastic and highly organic of State SAND State SAND	sticity pissiloity slotty slotty sty ity ity ity softs softs	Consistency VS very soft 5 goft 9 firm VS very stiff H hard Density VL very focse L loose UD medium dense D dense D dense	Soli Samples B bulk U undisturbed D disturbed Water V at end of excavation at time of excavation at time of excavation	VS vi SPT si SS si SC si	en pen ans sh id. pen pilt spo pilt spo	etrom ear test top ne r bout	cing Mi we			Sicush Bas Sicush Bas Sicush Sicush Bas	MDL: 1 1 pipes 2 r pape	.E			

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									<b>Bore Log</b>
McMILL	A	Ν		ient:		Aureo	con NZ Ltd		Bore No.: BH001
DRILLING SERV			Pro	oject:	E	dward S	Street, Lincol	n	Job No.: 9402
Grid Reference: Refer Rig Operator: P. Sm	to Aure iith	and TP econ NZ ack, 10	site p				С ,	Date Commenc Date Complet Conse Datu	ed: 19/09/2011 ent:
		5	>		bo	ed)		Installa	ation & Resources
Description	Method	Drivability	<b>Kecovery</b> 25 50 75	Depth	Graphic Log	000000 SPT N-Value	SPT Data (uncorrecte		h Toby PVC End Cap
TOPSOIL.				0				Concre (1 bag	
Yellow brown plastic SILT.				- 1 -				(1 big Benton (0.25 bag	ite — <b>Z</b>
Blue grey SILT, some grey sand.			100%	- 2 -				Collapse / Arisin	gs Blank (3.40m)
				- 3 -	x x x x x x x x x x x x x x x x x x x		N = 5 (C) 3.0m 1,1/1,1,1,2 450 mm	Walton Pa (2 baç	rk
E.O.H 4.4m <b>Remarks:</b> Installation of Ground water monitor	oring we	ell BH001						Additional F Plastic Liner	Resources: m
SPT @ 3.0m								Flush Mounted	l Toby Box - Standard ea X
SPT: "Doughnut" trip SPT Hammer #	001 use	ed (energ	y ratio	52.0%)				Above Crewed	- Environmental ea
		1 2 3 4 5	Very Hai	sh - No Han ly Easy Pus I Push - Coi sh - Full Ha rd Push - V	ery Slow, F	ull Hamme	on elatively Fast edium ow er \ Very Slow	Geotextile Soc Handclear Loca Decontaminat	ation ea 🗌 e Equipment ea 🗌
120 High Street, Southb	ridge 76	02, Cante	rbury, N	lew Zeal	and   p	h: (03) 3	24 2571 fax: +(	64 3 324 2431 we	eb: www.drilling.co.nz

									Bore Log
McMILL	Δ	Ν		ient:		Aureo	con NZ Ltd		Bore No.: BH002
DRILLING SERV			Pr	oject:	Ed	dward	Street, Lincol	n	Job No.: <b>9402</b>
Grid Reference: Refer	to Aure	1 and TF econ NZ :		lan			C	Date Commence Date Complet	ed: 19/09/2011
Rig Operator: P. Sm Rig Model and Mounting: CAT 3		ack, 100	mm (J	AFR)			1	Conse Datu	
			_		bo	e (p		Installa	ation & Resources
Description	Method	Drivability	Recovery	Depth	Graphic Log	(nncorrected)			
Description	Met	Driva	Reco	De	raph	PT N ncor	SPT Data (uncorrecte		h Toby PVC End Cap
			25 50 75	0	о О	<b>S</b> <u></u> 10203040			
. TOPSOIL. . Blue SILT some GRAVEL with depth.					× ×			Concre (1 bag Benton	us)
				- 1 -	× × × ×			(1 bag	
-					× × × ×				
-				- 2 -					SWL 1.80 m
-					× × ×				
-				- 3 -	× ^ × , × × ×		∏ N = 35 (C) 3.0m		
Fine to coarse Sandy fine to coarse GRAVEL, minor to some silt.					0.00	•	N = 35 (C) 3.0m 6, 9 / 9, 9, 9, 8 450 mm		gs - C - C Blank (13.30m)
-				- 4 -	.0 0 0				
-					0000				
-				- 5 -	0000 0000				
-					0.00				
-				- 6 -	0 0 0				
-				-	0,00			Collapse / Arisin	gs - 60 - 60 - Blank
-			100%	- 7 -					60 60
-					0.00				
-				- 8 -	0.000				
-					0.00				
-				- 9 -	.0 0 0				
				10	000				
-				- 10 -	000		N = 50 (C) 10.0m 5, 7 / 12, 14, 13, 1 450 mm	1	
-				- 11 -	0.00				
-					0000				
- -				- 12 -	0 <u>0</u> 0 0				
- - -				Ē	0000				
-				- 13 -	0.00				20 20 12.8m
r - -					0.000			Walton Pa	
- -				- 14 -	0.00			(2 bag	JS)
E.O.H 14.3m Remarks:					0 0			Additional F	Resources:
Installation of Ground water monito	oring we	ell BH002.						Plastic Liner Flush Mountee	m 🔄
SPT @ 3.0m and 10.0m	001	d (creation		F3 00()					- Standard ea 🗴
SPT: "Doughnut" trip SPT Hammer #	UUT USE							Above Ground	- Environmental ea
		Di 1 1	rivabil Easy Pus Relative	l <b>ity</b> sh - No Han ly Easy Pue	nmer \ Fast h - Light H-	t Penetrati	ion elatively Fast edium	Geotextile Soc Handclear Loca	
		3 I 4 I 5 V	Medium Hard Put Very Hai	n Push - Coi sh - Full Ha rd Push - V	nsistent Ha mmer \ So ery Slow, F	mmer \ M mewhat Sl ull Hamme	ledium low er \ Very Slow	Decontaminat	
120 High Street, Southb	ridge 76							64 3 324 2431 we	eb: www.drilling.co.nz

<sup>120</sup> High Street, Southbridge 7602, Canterbury, New Zealand | ph: (03) 324 2571 fax: +64 3 324 2431 web: www.drilling.co.nz Report Created: 28/09/2011 4:16:02 p.m.

									Bore Log
McMILL	A	Ν	Clie			Aureo	con NZ Ltd		Bore No.: BH003
DRILLING SERV			Pro	oject:	Ec	dward S	Street, Lincolr	ו	Job No.: <b>9402</b>
		Γ20 and T econ NZ s		an			D	ate Commenc Date Complet	
Rig Operator: P. Sm Rig Model and Mounting: CAT 3		ack, 100r	nm (A	AFR)				Conse Datu	
					b	el)		Installa	ation & Resources
Description	Method	Drivability	Recovery	Depth	Graphic Log	(nncorrected)		mstand	ation & Resources
Description	Met	Driva	Reco	Del	raph	PT N ncori	SPT Data (uncorrecte		h Toby PVC End Cap
		_	5 50 75	0	G	<b>I</b> 10203040			
TOPSOIL. Grey Sandy SILT.			100%	- 1 -			N = 7 (C) 1.5m 1, 1 / 1, 1, 2, 3 450 mm	Concre (1 bag Benton (0.25 bag Collapse / Arisin Walton Pa (1 bag	ark →
E.O.H 2.9m <b>Remarks:</b> Installation of Ground water monitor	ring				<u>.</u>			Additional F	
Installation of Ground water monito SPT Testing @ 1.5m	ning we	כטטרום זו.						Flush Mounted	-
SPT: "Doughnut" trip SPT Hammer #	4001 use	ed (energy	ratio !	52.0%)					- Standard ea X - Environmental ea
		1 E 2 R 3 N	ivabilit asy Push elatively Aedium I lard Push 'ery Harc	n - No Han / Easy Pus Push - Cor	nmer \ Fast h - Light Ha nsistent Hau mmer \ Sor ery Slow, Fu	Penetrati mmer \ Re mmer \ M newhat SI ull Hamme	on elatively Fast edium ow er \ Very Slow	Above Ground Geotextile Soc Handclear Loca Decontaminat	ation ea 🗌
120 High Street, Southb	ridge 76							64 3 324 2431 we	eb: www.drilling.co.nz

									<b>Bore Log</b>
McMILL	Δ	Ν		ent:		Aureo	con NZ Ltd		Bore No.: BH004
DRILLING SERV			Pro	oject:	Ed	dward S	Street, Lincolr	ı	Job No.: 9402
Grid Reference: Refer Rig Operator: P. Smi	to Aure ith	F22 and Fecon NZ rack, 100	site pl				D	ate Commenc Date Complet Conse Datu	ted: 15/09/2011 ent:
					g	el d)		Installa	ation & Resources
Description	Method	Drivability	Recovery	Depth	Graphic Log	(nncorrected)			
Description	Met	Driva	Reco	De	raph	PT N ncor	SPT Data (uncorrecte		h Toby PVC End Ca
		1234	25 50 75	0	G	<b>S</b> <u></u> 10203040			
TOPSOIL. Yellow brown plastic SILT.					× ×			Concre (1 bag	
- Yellow brown plastic SIL1.							N = 12 (C) 3.0m 2.2/3,3,3,3 450 mm	Bentoni (1 bag	ss)
GRAVEL, minor to some silt.			100%	- 7 - 8 - 9 - 10 - 11 - 12 - 13 - 13 - 13 - 13 - 13 - 13			N = 49 (C) 10.0m 3.6 / 10, 15, 9, 15 450 mm	Collapse / Arising Walton Pa (2 bag	ark
E.O.H 14.2m Remarks:				- 14 ·	0.7 0	::::		Additional R	Resources:
Installation of Ground water monito	ring we	II BH004.						Plastic Liner Flush Mounted	m 📃 d Toby Box
SPT @ 3.0m and 10.0m SPT: "Doughnut" trip SPT Hammer #	001	d (energy	/ ratio	52 <b>በ%</b> ነ					- Standard ea X - Environmental ea
120 High Street, Southbr		D 1 2 3 4 5	rivabili Easy Push Relatively Medium Hard Pus Very Hard	<b>ty</b> h - No Har y Easy Pus Push - Co h - Full Ha d Push - V			on elatively Fast edium ow er \ Very Slow 24 2571 fax: +6	Geotextile Soci Handclear Loca Decontaminato	l Protective Surround ea k m ation ea e Equipment ea

120 High Street, Southbridge 7602, Canterbury, New Zealand | ph: (03) 324 2571 fax: +64 3 324 2431 web: www.drilling.co.nz Report Created: 28/09/2011 4:16:02 p.m.

aurecon

**BOREHOLE RECORD** 

HOLE NO.

BH101

METHOD DF MACHINE & NG FLUSHING ME SSELIG UIST B	io. <b>VTR</b> Edium		D Truc		Tests	C	E N	155938 516808			SILT with low plastic	ROUND-L S DRDINATE FRAC STRUCT GR Z GEOTECHINICA minor sand	TRATA DES TION, MAJOR FRAC TURE, STRENGTH, M ADING, BEDDING, PI L SOCIETY - FIELD D	TION, MING IOISTURE ( LASTICITY, DESCRIPTIC	ION DR FRACTION, COLOUR,
MACHINE & NG FLUSHING ME Casing febth/size sta sta sta sta sta sta sta sta sta sta	io. <b>VTR</b> Edium	Total core Recovery % Solid core	er		(2, 1, 2, 1,	Sar	E N DRIENT mples	155938 516808 FATION	3 9 1 VER1 4 0.00 0.00	regend to the second se	SILT with low plastic	ATE from ROUND-L S ORDINATE FRAC GRU Z GEOTECHNICA minor sand	21/01/2015 EVEL + TRATA DES TRATA DES TION, MAJOR FRAC TION, MAJOR FRAC TION, BEDDING, PI L SOCIETY - FIELD D d and trace ro	to 10.00 CRIPT TION, MING IOISTURE 4. ASTICITY ESCRIPTIC DOTIETS;	22/01/2015 m RL ION DR FRACTION, COLOUR, CONDITION ETC N OF SOIL AND ROCK)
Progress Progress depth/size e at st st st st st st st st st st st st st	EDIUM	Total core Recovery % Solid core	er		(2, 1, 2, 1,	Sar	N DRIENT mples	516808 FATION peonpoor Peon Poon Poor Peon Poor Poor Poor Poor Poor Poor Poor Po	9 VER1	x x x x x x x x x x	SILT with low plastic	ROUND-L S DRDINATE FRAC STRUCT GR Z GEOTECHINICA minor sand	EVEL + TRATA DESI TION, MAJOR FRAC UTION, MAJOR FRAC UTION, MAJOR FRAC UTION, MAJOR FRAC COLORNAL AND AND AND ADING, BEDDING, PI L SOCIETY - FIELD D d and trace ro	10.00 CRIPT TION, MING OISTURE ( ASTICITY, ESCRIPTIC	m RL ION DR FRACTION, COLOUR, CONDITION ETC IN OF SOIL AND ROCK)
Progress Progress and depth/size		Total core Recovery % Solid core		Fracture Index	(2, 1, 2, 1,	Sar		FATION eqn Fennen Lenen	(U) <b>VER1</b>	x x x x x x x x x x	SUBC (NZ SILT with low plastic	S DRDINATE FRAC STRUCT gr z GEOTECHINICA minor sand	TRATA DES TION, MAJOR FRAC FURE, STRENGTH, M ADING, BEDDING, PL L SOCIETY - FIELD D d and trace re	CRIPT TION, MINO IOISTURE ASTICITY, ESCRIPTIC	ION DR FRACTION, COLOUR, CONDITION ETC IN OF SOIL AND ROCK)
Drilling Progress stating depth/size e	Vater (m) shift taart/ endd X Keconet/		Recovery % R.Q.D.	Fracture	(2, 1, 2, 1,	Туре	Ref Depth	+9.50	0.00	$\frac{x^{1}l_{x}}{l_{x}} \frac{x^{1}l_{x}}{x^{1}}$	<sub>(NZ</sub> SILT with low plastic	DRDINATE FRAC STRUCT GR/ Z GEOTECHNICA minor sand	TION, MAJOR FRAC FURE, STRENGTH, M ADING, BEDDING, PL L SOCIETY - FIELD D	TION, MING IOISTURE ( LASTICITY, DESCRIPTIC	DR FRACTION, COLOUR, CONDITION ETC N OF SOIL AND ROCK)
Drilling Progress stating depth/size e	el (m) shift tart/ end Keater Keater Keater		R.Q.D.	Fracture Index	(2, 1, 2, 1,	Туре	Ref Depth	+9.50	0.00	$\frac{x^{1}l_{x}}{l_{x}} \frac{x^{1}l_{x}}{x^{1}}$	<sub>(NZ</sub> SILT with low plastic	DRDINATE FRAC STRUCT GR/ Z GEOTECHNICA minor sand	TION, MAJOR FRAC FURE, STRENGTH, M ADING, BEDDING, PL L SOCIETY - FIELD D	TION, MING IOISTURE ( LASTICITY, DESCRIPTIC	DR FRACTION, COLOUR, CONDITION ETC N OF SOIL AND ROCK)
//01/2015					(2, 1, 2, 1,	DT	- 0.00		F	<u>1/ 11/</u> × ×	low plastic				dark brown. Dry
	¥				(2, 1, 2, 1,	DT			F	×	OII - ···				
	¥	100 miles			(2, 1, 2, 1,					lv ^ v	SILT with , low plastic	minor sand	d; light brown	mottle	ed orange. Dry,
	¥	20			(2, 1, 2, 1,			+8.90	- 1:10 1:20		Fine SANI	D with som	ne silt; light bi	rown. E	Dry. with some silt.
	¥	85			(2, 1, 2, 1,		4.50		F	× × × ×	1.10m bec	comes silty	fine SAND.		
	¥	85			2, 2)		- 1.52	+8.40 +8.35	<u>- 1.60</u> -		Moist, low	plasticity.	, , ,		n mottled orange.
	¥				↓ N = 7			+8.00 +7.80 +7.75	<u>2.00</u> 2.20	× ×			AND with mir AND; browni		reddish brown. y. Moist.
	¥	85				р <u>т</u>		+7.60	- <u>2.20</u> - <u>2.25</u> - <u>2.40</u> -	× ×	SILT with	some sand		rganics	s; dark grey. Mois
	¥	85							F	· · · ·	Medium to	coarse S	AND; grey. N	loist.	le stisit.
	¥				(1, 3, 2, 1,	+	- 3.04	+6.96	<u> </u>	× × × ×	\Fine to coa	arse SANI	d; grey. Mois D with minor :	silt; gre	y. Moist.
	¥	1///			1, 5) N = 9			+6.45	- - 3.55	× × ×	-		ry, low plastic		
	1					DT		+6.30	<u> </u>	× 0 - 0	Sandy fine	e to coarse		rownisl	h grey. Dry, low
									F	0000	plasticity,	rounded to	subangular;	sand,	fine to coarse.
					(12, 16, 18, 20, 19,	-	- 4.56	+5.44	4.56	000				. Dr	hounded
					3) N = 60/240			+5.25 +5.05	- 4.75 - 4.95		Coarse SA	AND; dark	RAVEL; grey greyish brow	n. Mois	st.
					mm	рт рт				°0 °0 0 0 0 0 0 0	Fine to co brownish ( to coarse.	grey. Dry, s			d and minor silt; ingular; sand, fine
		70			(5, 8, 7, 8, 9, 9) N = 33		- 6.08		- - - - - -		6.08m - 6.	.30m coars	se GRAVEL v	with no	sand or silt. Grey
		\$5			(3, 4, 4, 3,		- 7.60	+2.40	- - - - - - - - - - - - - - - - - - -		7.60m bec	comes Sar	ndy fine to co	arse G	RAVEL with mind
					3, 5) ↓ N = 15	DT		+2.00	- <u>8.00</u>		and some		to coarse G	RAVEL	. with some sand
		40			(6, 7, 10, 9, 11, 10) ↓ N = 40		- 9.12	+0.88 +0.65	- <u>9.12</u> - <u>9.35</u> -		Gravelly m Dry; grave Fine to co	el, fine to co arse GRA	oarse.		greyish brown. d; grey. Dry; sanc
Small Disturbed	•	Ţ	Water I		acker Test		LOGGI	ED T.I	PLUNK	ET	REMARKS				
SPT Liner Sample	ble	Ţ	Standa	rd Pen	etration Test		DATE		01/201		Coorindate likely accu	es and grou rate to +/- 5	nd level base m.	d on ha	nd held GPS,
Thin Wall Undistu U100 Undisturbe			Permea Piezon		Test Standpipe Tip								orded at 3.8m	).	
Pocket Penetrom	•		Packer	Test	Shear Test		DATE		<u>SUCKL</u> 02/2015		of i namm	er energy r	auu 19%.		

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			'ec			1		DU	KE	пО		(EC	ORE			004404
	WHW.		group.com		ivici	on								PROJECT NO.		224464
PRO	JECT	Lincol	-	JUDU	1112											
MET	HOD	DP						(		DINAT 155938	ES (NZ	TM)		SHEET 2	of	2
MAC	HINE 8	NO. N	VTR 970	0-D	Truc	:k				516808				DATE from 21/01/2015	to	22/01/2015
FLUS	SHING	MEDIU	IM W	ater				(	ORIEN	ΤΑΤΙΟΙ	VER	TICAL		GROUND-LEVEL +	10.00	m RL
Progress	Casing depth/size	Water level (m) shift start/ end	Water Recovery % Total core Recoverv %	Solid core Recoverv %	R.Q.D.	Fracture Index	Tests		Ref Depti	Reduced Level	(m) (m) 10.00	Legend		STRATA DES SUBORDINATE FRACTION, MAJOR FRAC STRUCTURE, STRENGTH, M GRADING, BEDDING, PL (NZ GEOTECHNICAL SOCIETY - FIELD D	TION, MINO	OR FRACTION, COLOUR, CONDITION , ETC
			40 225	_			(0, 1, 0, 1 0, 0) ↓ N = 1	DT	— 10.64				10.64m to subr	n becomes medium to coa ounded.	rse GR	AVEL. Rounded
			60	_			(3, 4, 4, 6 9, 13) N = 32	, <b>4</b>	- 12.16	-3.16	- - - - - - - - - - - - - - - - - - -	0000 0000 0000 0000 0000				
				_			(10, 16,   19, 12, 13   13) ♥ N = 57	3, <b>1</b>	— 13.68	\$			grey. D 13.68m brownis	fine to coarse GRAVEL wi ry, rounded to subangular n - 14.00m sandy fine to m sh grey.	; sand,	fine to coarse.
2/01/2015 Sm Lar SP1 Thi							(14, 25, 20, 21, 24 N = ↓ 65/225 mm			-5.20			E	nd of Dynamic probe sam 22/01/201 Termination Reason: Targ	5	
Sm Lar SP1		bed Samp bed Samp ample		In		sion P	acker Test	st					REMAF Coorinc likely ac	RKS lates and ground level base ccurate to +/- 5m.	d on ha	nd held GPS,
Thi	n Wall Un	ndisturbed urbed Sar		-		ability	Test Standpipe T	in	DATE	<u>29</u> KED_ <b>B.</b>	/01/201			water level recorded at 3.8m nmer energy ratio 79%.	ı.	

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NUMBER         PROJECT NO.         224464           PROJECT         Resemention         Second         S	Ċ	lui	re				1		BC	RE	HO	LEF	REC	OR	D	HOLE NO.		BH102
METHOD       DP       CO-ORDINATES (NZTM) E 1560211 N 5183161       SHEET       1       of       2         MACHINE & NO. VTR 9700-D Truck       In 5183161       DATE from 2201/2015       Io       2201/201         FLUSHING MEDIUM       Water       ORIENTATION VERTCAL       GROUND-LEVEL       +9.00       m R.L         Image: State of the state of		w.aureco	ngrou	p.cor	n											PROJECT NO.		224464
MACHINE & NO. VTR 9700-D Truck     E 1560211 N 568161     DATE from 22012015 to 2201201     2201201       FLUSHING MEDIUM Water     ORIENTATION VERTICAL     GROUND-LEVEL     +9.00 m RL       Image: State of the stat	PROJECT			yn S	Subd	ivisi	on											
MACHINE & NO. VTR 9700-D Truck       NS188161       DATE from       Z201/2015       to       Z201/2015       Co       Z201/2015	METHOD	DP								CO-OR	DINATI	ES (NZ	ΓM)		S	HEET 1	of	2
FLUSHING MEDIUM     Water     ORIENTATION     VERTICAL     GROUND-LEVEL     4-9.00     m.L.       Image: Stand	MACHINE	& NO.	VTR	970	0-D	Truc	:k								D	ATE from 22/01/2015	to	22/01/2015
grad bit with starty in the coarse of RAVEL with some sind of the coarse of RAVEL with some sind fine to	FLUSHIN	G MEDI	JM	w	ater								ICAL		G	ROUND-LEVEL +	9.00	m RL
amount       20       amount	Drulling Progress Casing denth/size	Water level (m shift start/ end	Water Recovery %	Total core Recoverv %	Solid core Recovery %	R.Q.D.	Fracture Index	Tests		·			Legend			ORDINATE FRACTION, MAJOR FRACT STRUCTURE, STRENGTH, MC GRADING, BEDDING, PL/	ION, MIN DISTURE ASTICITY	DR FRACTION, COLOUR CONDITION ETC
Image: Sinul Disturbed Sample     Image: S				20	-			1 24, 23, 15	DT	- 0.00	+7.48			rootle angula	s; g ar; s	reyish brown. Dry to moi and, fine to coarse. (Log e to coarse GRAVEL; bro	ist, su gged f	brounded to rom sample bag h grey. Dry,
Image: Strain Disturbed Sample       Image: Strain Distrain Distremain Distremain Dister       Image: Strain Di					-			N = 69/262 mm		— 3.04		L		(Logg	ed fi	rom sample bag)		
Small Disturbed Sample       Vater Level         Small Disturbed Sample       Small Disturbed Sample       Small Disturbed Sample								6, 6)			+5.25	- - - 3.75 - - -	0000 0000 0000 0000	gravel 3.24m	, fin beo	e to medium, rounded to comes sandy fine to med	suba dium (	ngular. GRAVEL.
Small Disturbed Sample       Vater Level         Impression Packer Test       LOGGED       T. PLUNKET				15				(1, 1, 1, 1 2, 2) N = 6		— 4.56	11.11			SAND	; bro	own. Wet. (Logged from	samp	le bag)
Small Disturbed Sample       Vater Level         Impression Packer Test       Impression Packer Test         SPT Liner Sample       Vater Level				90				4, 7)		- 6.08	+2.92 +2.80	- 6.08 - 6.20 	0000 000 000 000 000	suban 6.20m	gula bec	ar; sand, fine to coarse. comes fine to coarse GR	AVEL	
Small Disturbed Sample       Vater Level         Impression Packer Test       LOGGED         SPT Liner Sample       Standard Penetration Test				0				(4, 7, 7, 5 5, 4) N = 21		— 7.60		F		_ round Silty fi	ed to ne to	o subangular; sand, fine o coarse GRAVEL with s	to co some	arse. sand; greyish
Large Disturbed Sample     Impression Packer Test     LOGGED     T. PLUNKET     Coorindates and ground level based on hand held GPS, likely accurate to +/- 5m.				100				12, 12)		- 9.12	-0.12	9.12		reddis	h gr	arse GRAVEL with minc rey. Dry, rounded to ang	or san ular; s	d; grey and and, medium to
SPT Liner Sample Standard Penetration Test GPS,			•	<u></u>				Packer Teet	I	LOGGI	ED <b>T</b> .	PLUNK	ET					
Thin Wall Undisturbed Sample Fermeability Test	SPT Liner	Sample		nle	ļ si	anda	rd Per	netration Tes	st	DATE				likely a	iccu	rate to +/- 5m.	on ha	nd held GPS,
Permeability fest       Groundwater level not recorded.         U100 Undisturbed Sample	U100 Und			·	<u> </u>		-		ïp	CHEC	KED <b>B.</b>	SUCKL	ING					

 Piston Sample
 In-situ Vane Shear Test
 DAIE
 UG/U2/2013

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		u	<b>'</b> e		10		1		BC	DRE	HO	LE F	REC	ORI	D	HOLE	NO.			BH102
	_	aurecon	group	p.con	n											PROJI	ECT NO.			224464
PR	OJECT	Rosen Lincol	-	/n S	ubdi	ivisi	on													
ME	THOD	DP								CO-OR			ΓM)		S⊦	IEET	2		of	2
MA	CHINE 8	NO. V	VTR	970	0-D 1	Truc	:k				156021 516816				DA	TE from	22/01/2	015	to	22/01/2015
FLU	JSHING	MEDIU	M	W	ater					ORIEN	ΓΑΤΙΟΝ	VER1	ICAL		GF	ROUND-I	_EVEL	+9	.00	m RL
Drilling Progress	Casing depth/size	Water level (m) shift start/ end	Water Recovery %		Solid core Recovery %	R.Q.D.	Fracture Index	Tests	s Sa	amples	Reduced Level	Depth (m) 10.00	Legend			RDINATE FRA STRUC GI	CTURE, STREN RADING, BEDE	R FRACTIO IGTH, MOIS DING, PLAS	N, MINO STURE C	R FRACTION, COLOUR,
				X88					 то 	-			°0 °0 0 0 0 0 0 °0							
								(3, 3, 6 4, 4) N = 19	, 5,		-1.64			REMA	Ter	mination	22/01	1/2015	•	10.64m, on h reached.
• Si Li Li Si	mall Distur arge Distur PT Liner Sa	bed Samp		1	Im	•	sion P	Packer Tes		LOGG				Coorin	dates		und level 5m.	based c	on har	nd held GPS,
	hin Wall Ur 100 Undist	urbed Sar	nple	ple _			ability leter /	Test Standpipe	еТір	CHECI		<u>01/2018</u> SUCKL					ot recorde ratio 79%			
PI PI PI PI	ocket Pene iston Samp		Test			acker -situ		Shear Tes	t	DATE		02/201								

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**BH103** HOLE NO. **BOREHOLE RECORD** urecon www.aurecongroup.com 224464 PROJECT NO **Rosemerryn Subdivision** PROJECT Lincoln METHOD DP CO-ORDINATES (NZTM) SHEET 1 of 2 E 1560056 MACHINE & NO. VTR 9700-D Truck DATE from 28/01/2015 to 28/01/2015 N 5167722 FLUSHING MEDIUM Water ORIENTATION VERTICAL **GROUND-LEVEL** +9.00 m RL Water STRATA DESCRIPTION % % % Reduced Level Casing depth/size Total core Recovery % Solid core Recovery % evel (m Water Recovery Drilling Progress SUBORDINATE FRACTION, MAJOR FRACTION, MINOR FRACTION, COLOUR, STRUCTURE, STRENGTH, MOISTURE CONDITION GRADING, BEDDING, PLASTICITY, ETC.... (NZ GEOTECHNICAL SOCIETY - FIELD DESCRIPTION OF SOIL AND ROCK) Fracture Index (m) (m) shift R.Q.D. Tests Samples Legend start/ end 0.00 Ref Depti 115 Mix of SILT with minor sand and trace rootlets; dark × brown. Dry, low plasticity; sand, fine to medium. × × (TOPSOIL) and; × SILT with some sand: light brown mottled orange. Drv. x ъ × low plasticity; sand, fine to medium. × (Logged from sample bag) × × × × +7.48 $\frac{1.52}{1.60}$ 1.5 (1, 1, 2, 2, 1, 2) N = 7 Sandy SILT; greyish brown. Stiff, wet, low plasticity; sand, 90 fine to medium. × 1.60m becomes silty fine to medium SAND; grey. Wet. Ŧ PEAT; dark brown. Fibrous, saturated. ĎТ × Peaty SILT; greyish brown. Firm, saturated, low plasticity; × × peat, fibrous. +6.30 2.70 SILT with some sand and trace organics; grey. Firm to stiff, wet, low plasticity; organics are fibrous. +5.96 - 3.04 3.04 (4, 8, 7, 7, 6, 6) N = 26 0 Silty fine to medium SAND; brown. Wet. +5.75 3.25 0000 Gravelly fine to coarse SAND; greyish brown. Wet; gravel, fine to coarse, subrounded to subangular. 0000 3.25m becomes Sandy fine to coarse GRAVEL. דת 0000 AGS4 BOREHOLE RECORD || Project: 224464 ROSEMERRYN 2015 BHS.GPJ || Library: AGS 4 0.GLB || Date: 9 February 2015 +4.44 4.56 Fine to coarse SAND with minor gravel; brown. Wet; (4, 7, 12, 11, 9, 8) N = 40 +4.20 gravel, fine to medium, subrounded to angular. 0000 Sandy fine to coarse GRAVEL; greyish brown. Wet, subrounded to angular; sand, fine to coarse. 0000 ъ 4.95m - 5.15m reddish brown. 000 0000 +2.92 6.08 6.08 (8, 13, 10, 7, 6, 5) N = 28 Fine to coarse SAND; brown. Wet. +2.75 - 6.25 +2.60 6.40 Sandy fine to medium GRAVEL; greyish brown. Wet, 0 +2.45- 6.55 subrounded to angular; sand, fine to coarse 0.00 Fine to coarse GRAVEL; grey. Wet, rounded to DT subangular. 0000 Sandy fine to coarse GRAVEL; greyish brown. Wet, 000 subrounded to angular; sand, fine to coarse. 0 000 +1.407.60 7 60 199 Fine to coarse SAND; brown. Wet. (8, 12, 13, 12, 12, 14) +1.10 7.90 N = 51 7.90m becomes gravelly fine to coarse SAND. Gravel, \fine to medium, rounded to subangular. 0 +0.90 - 8.10 +0.70 8.30 00 DΤ Fine to coarse GRAVEL with minor sand; grey. Wet, +0.50 8.50 subrounded to subangular, sand, fine to coarse. 000 No sample recieved. Sandy fine to coarse GRAVEL; greyish brown. Wet, 0000 subrounded to angular; sand, fine to coarse. 9.12 0000 (3, 11, 13, 13, 12, 10) N = 48 ĎТ 9.50m - 9.55m white. °0 ÷ 0 REMARKS ▼ Water Level • Small Disturbed Sample LOGGED T. PLUNKET Large Disturbed Sample Impression Packer Test Coorindates and ground level based on hand held GPS, likely accurate to +/- 5m. 0 SPT Liner Sample Standard Penetration Test DATE 29/01/2015 Thin Wall Undisturbed Sample Permeability Test Groundwater level recorded at 2.0m. U100 Undisturbed Sample Piezometer / Standpipe Tip 1 Å

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DATE

Packer Test

In-situ Vane Shear Test

Report ID:

P/S

Pocket Penetrometer Test

Piston Sample

CHECKED B. SUCKLING

05/02/2015

SPT hammer energy ratio 79%.

	a	u	'e			)	1		BC	DRE	HO	LE F	REC	ORI	D	HOLE NO.			BH103
	_	aurecon	group	o.con	n											PROJECT NO	D.		224464
PRO	DJECT	Rosen Lincol	-	/n S	ubd	IVISI	ion												
ME	THOD	DP								CO-OR			TM)		SH	IEET	2	of	2
MAG	CHINE 8	NO. V	VTR	9700	0-D <sup>-</sup>	Truc	:k				156005 516772	-			DA	ATE from 28/01	/2015	to	28/01/2015
FLU	SHING	MEDIU	M	Wa	ater					ORIEN	TATION	VER1	<b>FICAL</b>		GF	ROUND-LEVEL	+	9.00	m RL
Drilling Progress	Casing depth/size	Water level (m) shift start/ end	Water Recover	Grant Core Secovery %	Solid core Recovery %	R.Q.D.	Fracture Index	Tests		amples Ref Depth	Reduced Level	tid D 10.00	Coo Coo Coo Coo Coo Coo			STRAT. RDINATE FRACTION, MA STRUCTURE, STI GRADING, BI GEOTECHNICAL SOCIET	JOR FRACT RENGTH, MC EDDING, PL/	TON, MINO DISTURE ( ASTICITY,	DR FRACTION, COLOUR, CONDITION ETC
	5							(9, 12, 11, 10, 10, 11, 10, 10, 11, 10, 10, 11, 10, 10	 (6)	- 10.64	-1.64					of Dynamic prot 28, rmination Reaso	01/201	5	
Įį La	nall Distur Irge Distur PT Liner Sa	bed Samp		1	Im	•	sion F	Packer Tes netration T		LOGG					ndate	s and ground lev ate to +/- 5m.	el based	I on ha	nd held GPS,
3 <mark>Б</mark> SI	nin Wall Un	disturbed		_	Pe	ermea	ability	Test		DATE	_29	/01/2015	5	likely a	accur				
	100 Undist ocket Pene ston Samp	trometer		<b>1</b>	Pa	acker	Test	Standpipe Shear Test		CHEC		SUCKL		SPT ha	amme	er energy ratio 79	9%.		

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								Bore Log	`
	Client:		A	urecon N	IZ Ltd		Bore No.:	BH101	
McMILLAN Drilling	Project:		Rosemerr	yn Farm	developme	ent	Job No.:	14216	
Site Location: Ellesmere F Grid Reference: 1559383.26 Rig Operator: C. Nee Rig Model & Mounting: VTR 9700-I	omE, 5168089.1			opment)		te Complete Conse	ed: 21/01/2015 ed: 22/01/2015 nt: - m: Ground		
Description	Method	Drivability Recovery	Depth Graphic Log	SPT N-value (Uncorrected)	In-Situ Tests (Uncorrected)		Samples	Installat & Resourc	
TOPSOIL.  Fine SAND: light brown.  Silty fine SAND; light brown.  Medium SAND; grey. Trace of silt.  Trace of gravel Sandy fine to coarse GRAVEL; light brown.  Fine to coarse GRAVEL with minor silt and sand; brown.	Dual tube	55%     80%     25%     35%     55%     90%     25			V = 7 (S) 1.52; $V = 7 (S) 1.52;$ $V = 12, 1/2, 1, 2, 3;$ $V = 12, 1/2, 1, 2, 3;$ $V = 12, 1/2, 1, 2, 3;$ $V = 12, 1/2, 1, 3, 3;$ $V = 12, 1/2, 1, 1, 3/2, 1, 1, 3/2, 1, 1, 3/2, 1, 1, 3/2, 1, 1, 3/2, 1, 1, 3/2, 1, 1, 3/2, 1, 1, 3/2, 1, 1, 3/2, 1, 1, 3/2, 1, 1, 3/2, 1, 1, 3/2, 1, 1, 3/2, 1, 1, 3/2, 1, 1, 3/2, 1, 1, 3/2, 1, 1, 3/2, 1, 1, 3/2, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1,$	2 4m 5 56m 0, 19, 3 1ve 30m 5 12m 1, 10 64m 13 .68m	3.00 - 3.32m, 2, SPTLS –		
H: 15.2m			<u>F</u> foc	I	N = 60+ (C) 1 14, 25 / 20, 2 375mm Effec Refusal	1, 24		03339 15.2m	
emarks otechnical Investigation Borehole BH101 with SPT utic Water Levels: Bm @ Casing depth of 13.5m; 22/1/2015 D Liters Water Added fety Auto Trip Hammer #398 used (energy ratio 799		2 Relative 3 Medium	<b>bility</b> Jsh - No Hammer Aly Easy Push - Lit I Push - Consister Jsh - Full Hammer	ght Hammer \ It Hammer \ M	Relatively Fast ledium	Plastic Lin Flush Mou - Sta - En	inted Toby Bo andard vironmental ound Protecti Sock	х	m 1 ea ea ea m ea
20 High Street, Southbridge 7602, Ca	nterbury, New 2	5 Very Ha	ard Push - Full Ha	mmer \ Very S	ilow		inate Equipm	Hole Depth	

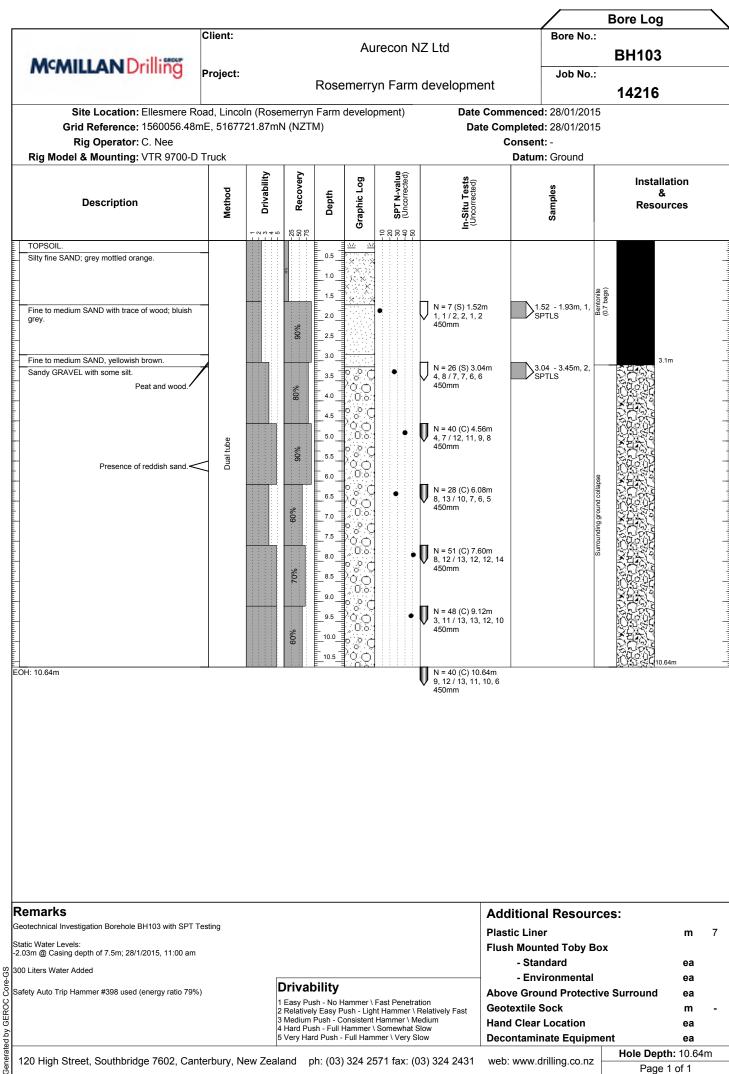
Created: 2/02/2015 3:06:47 p.m.

erated by GEROC Core-GS

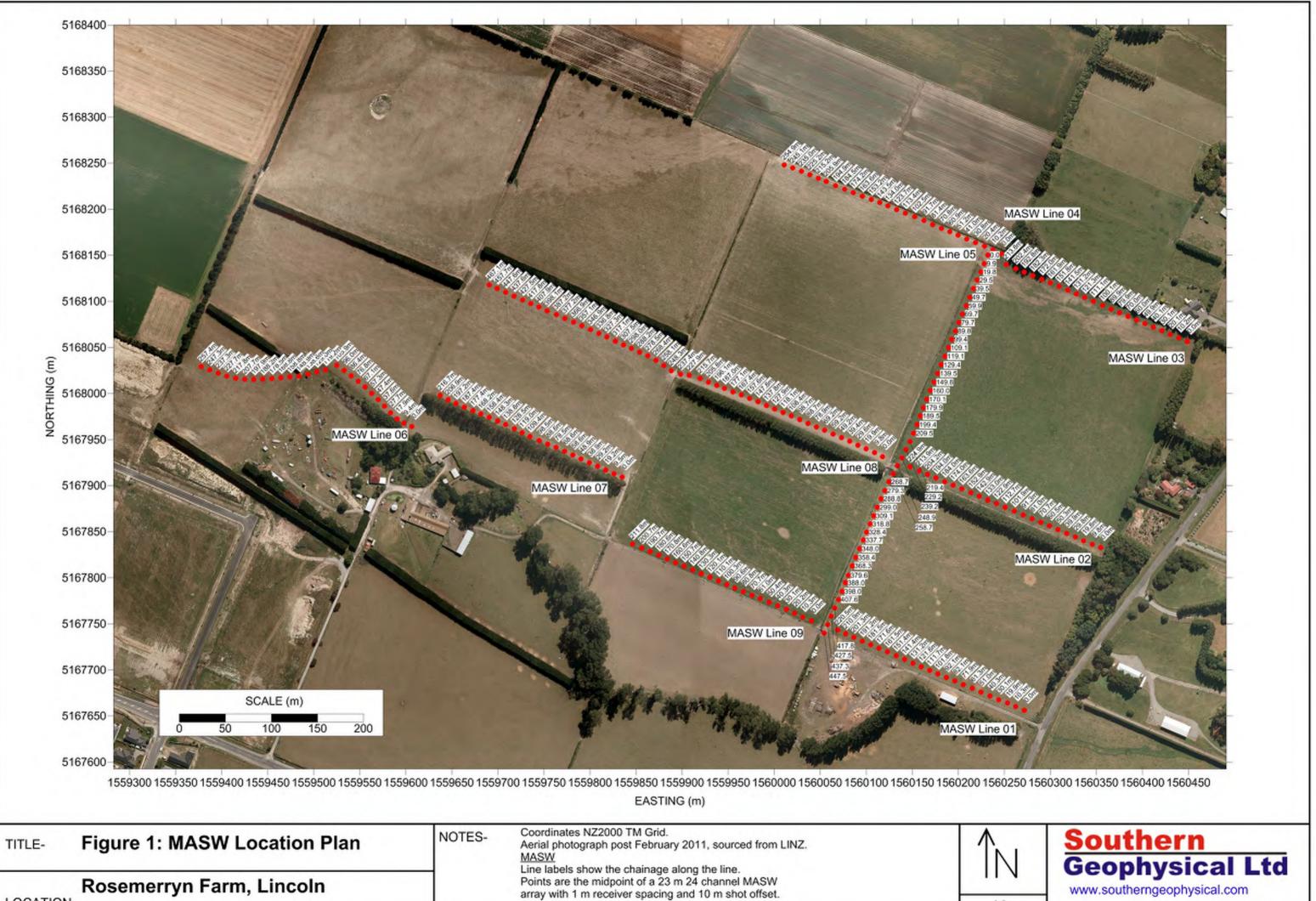
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									Bore Log		$\overline{}$
Mc MILLAN Drilling	Client:			Au	Irecon N	IZ Ltd		Bore No.:	BH102		
	Project:		Roser	merry	yn Farm	developm	ent	Job No.:	14216		
Site Location: Ellesmere I Grid Reference: 1560211.03 Rig Operator: C. Nee Rig Model & Mounting: VTR 9700-	7mE, 5168161.3			evelo	pment)		te Complete Conser	d: 22/01/2015 d: 22/01/2015 nt: - m: Ground			
Description	2	Drivability Recovery	Depth	Graphic Log	SPT N-value (Uncorrected)	In-Situ Tests (Uncorrected)		Samples	Installa & Resour		
TOPSOIL. Sandy coarse GRAVEL; brown. Hard; dry.			10000000000000000000000000000000000000		-01 -02 -03 -03 -03 -03 -03 -03 -03 -03 -03 -03	N = 60+ (C) 1 26, 25 / 24, 2 412mm Effec Refusal N = 22 (C) 3. 3, 5 / 5, 5, 6, 450mm	3, 15, 7 tive 04m	Bentonite		1	
Fine to medium gravelly SAND; brown. Fine to medium (rarely coarse) GRAVEL with minor silt and sand; brown.	Dual tube		4.5		•	V = 6 (C) 4.5(1) + 1.1 (C) + 1.1 (	2 )8m	round collarse			
		35%	10.0			450mm N = 21 (C) 7. 4, 7 / 7, 5, 5, 450mm N = 39 (C) 9. 5, 8 / 8, 7, 12 450mm	4 12m	Surrounding			
DH: 10.64m						V = 19 (C) 10 3, 3 / 6, 5, 4, - 450mm					
Cemarks Potechnical Investigation Borehole BH102 with SPT In Static Water Levels recorded O Liters Water Added Ifety Auto Trip Hammer #398 used (energy ratio 79		2 Relative 3 Medium 4 Hard Pu	ush - No Ha Iy Easy Pu Push - Coi Ish - Full Ha	sh - Ligl nsistent ammer \	Hammer \ M	Relatively Fast edium Slow	Plastic Lin Flush Mou - Sta - En Above Gro Geotextile Hand Clea	nted Toby Bo andard vironmental ound Protectiv Sock r Location	ox ve Surround	m ea ea m ea	6
20 High Street, Southbridge 7602, Ca					mer \ Very S	)3) 324 2431		inate Equipm drilling.co.nz	Hole Depth	ea 10.64	łm

Created: 2/02/2015 3:06:47 p.m.



# Appendix H MASW Soundings

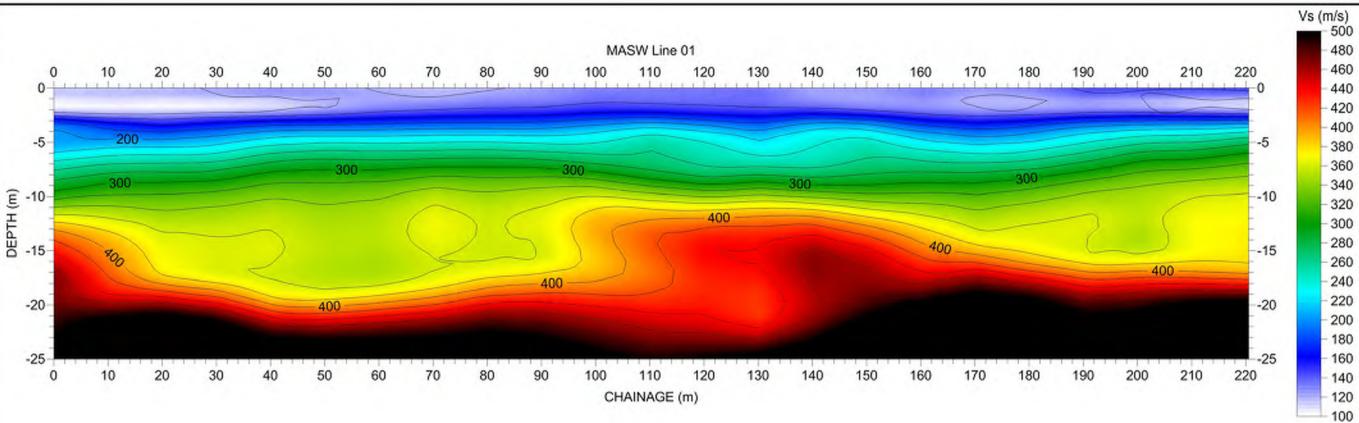


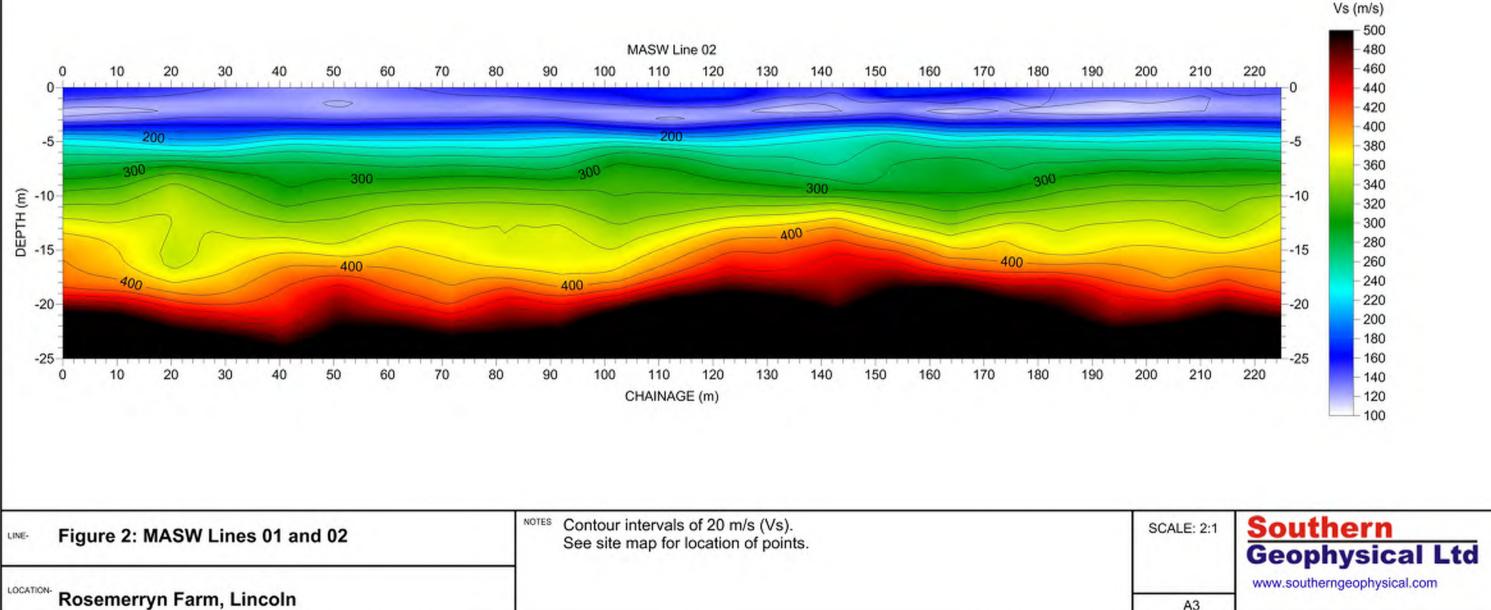
LOCATION-

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A3

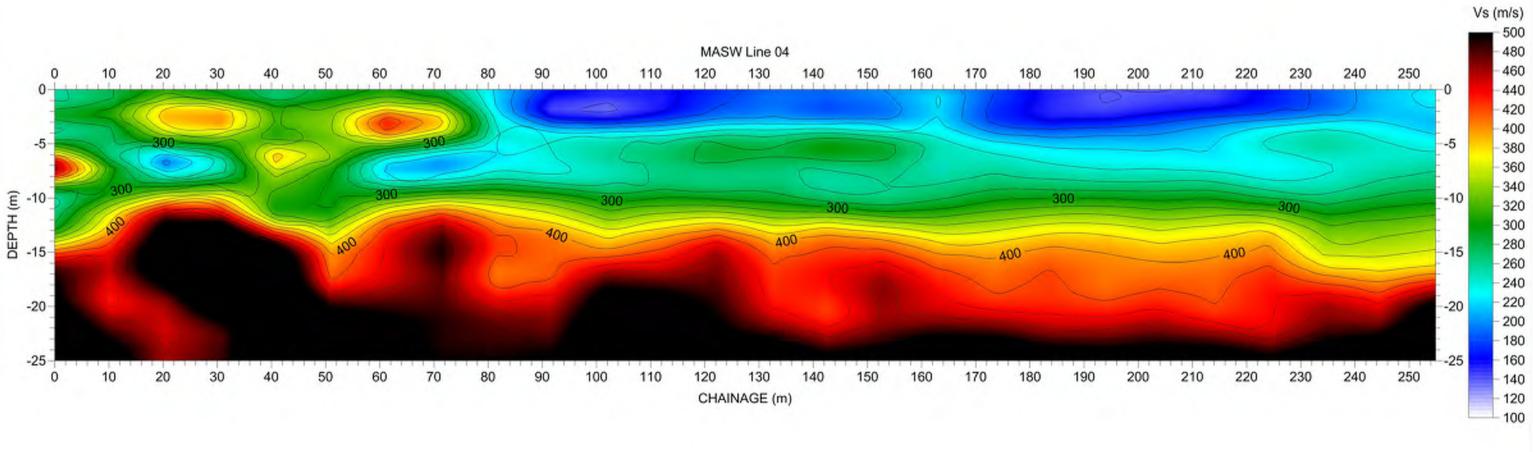
## MASW Line 01

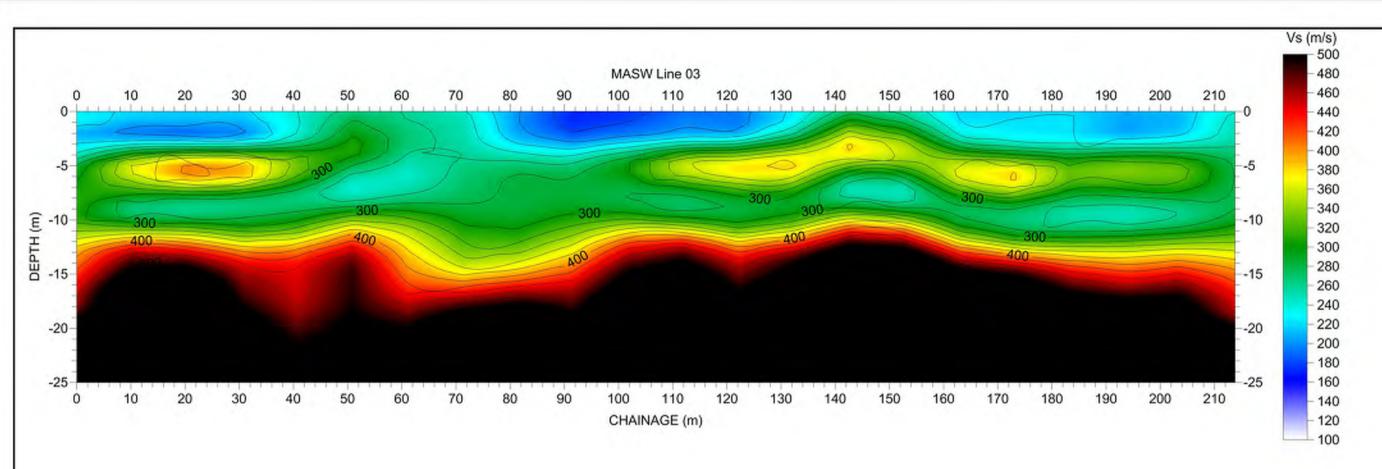




A3

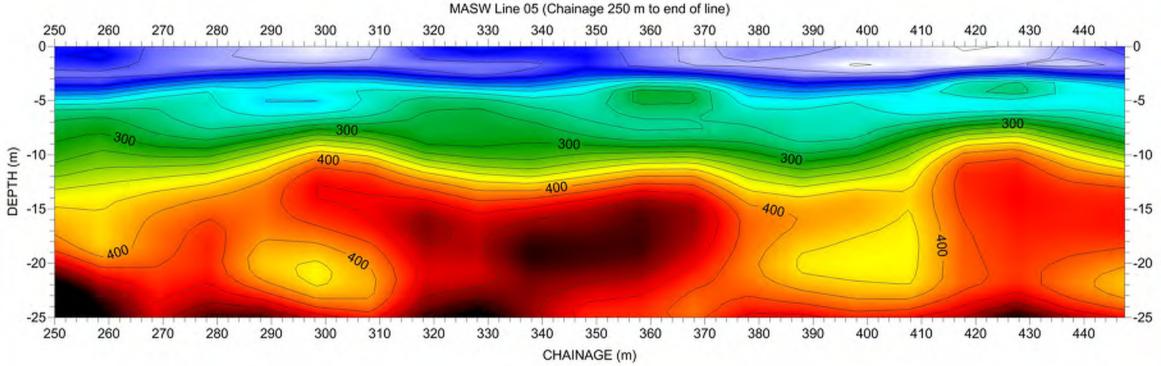
LINE- Figure 3: MASW Lines 03 and 04	NOTES Contour intervals of 20 m/s (Vs). See site map for location of points.	SCALE
LOCATION- Rosemerryn Farm, Lincoln		



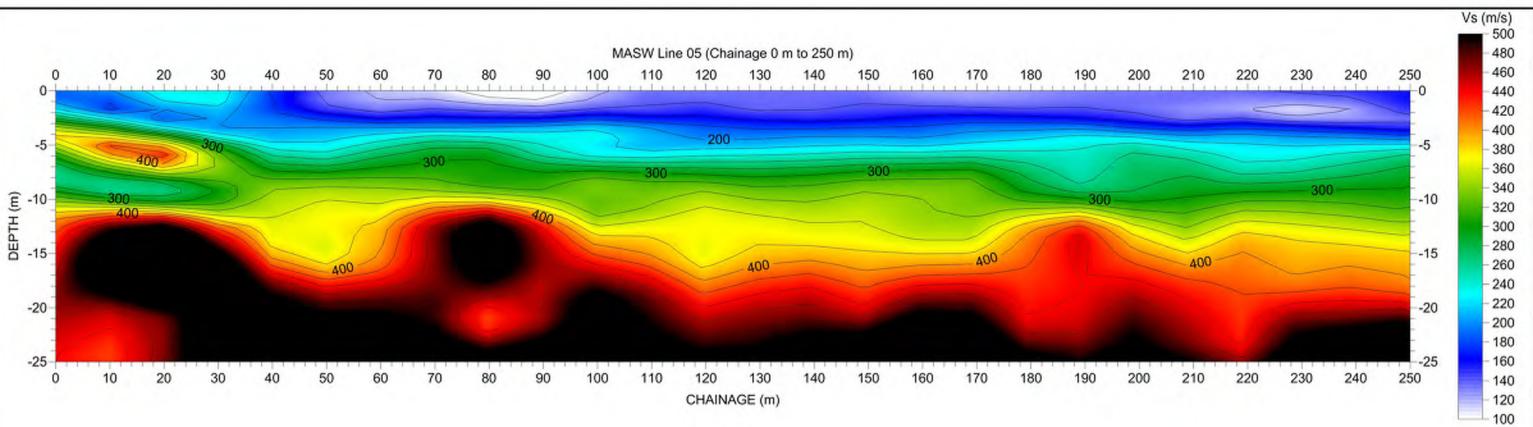




LINE- Figure 4: MASW Line 05	NOTES Contour intervals of 20 m/s (Vs). See site map for location of points.	SCAL
LOCATION- Rosemerryn Farm, Lincoln		

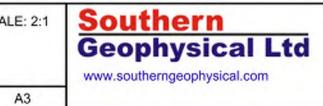


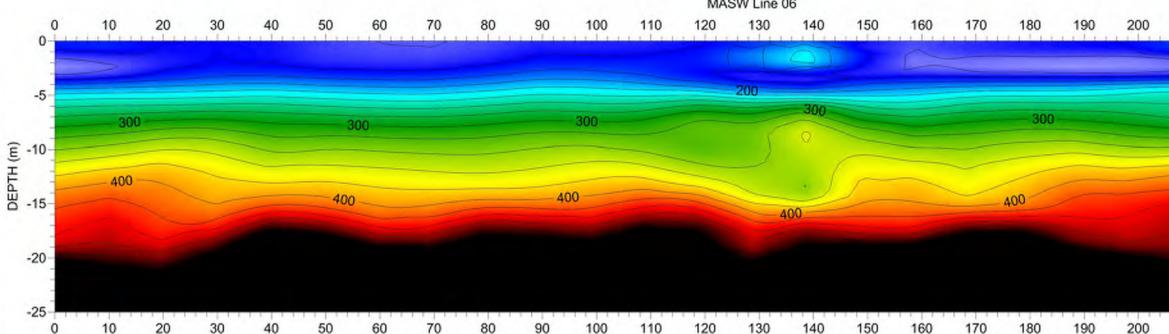
CHAINAGE (m)

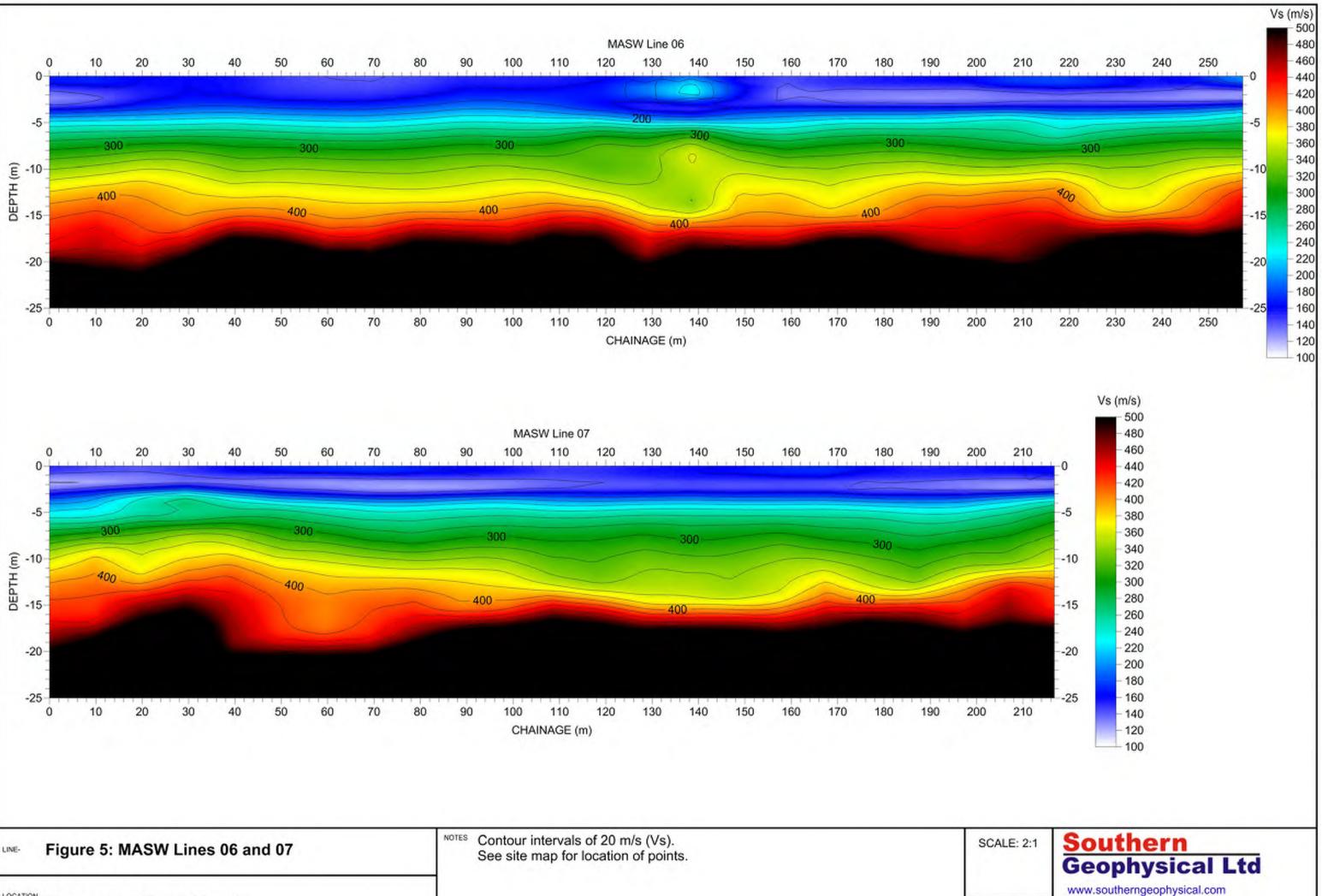


## Vs (m/s)

_	- 500	
	-480	
	-460	
	-440	
	-420	
	-400	
	- 380	
	- 360	
	- 340	
	- 320	
	- 300	
	-280	
ļ	-260	
ł	-240	
	-220	
ł	- 200	
	- 180	
	- 160	
	- 140	
	- 120	
	- 100	

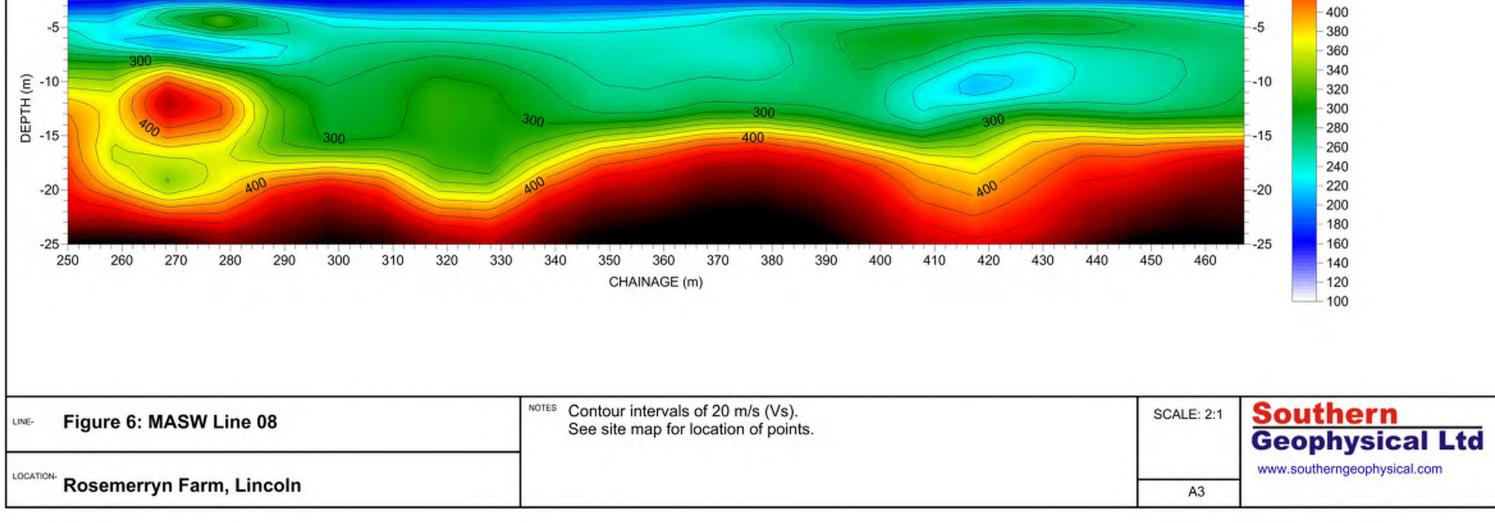






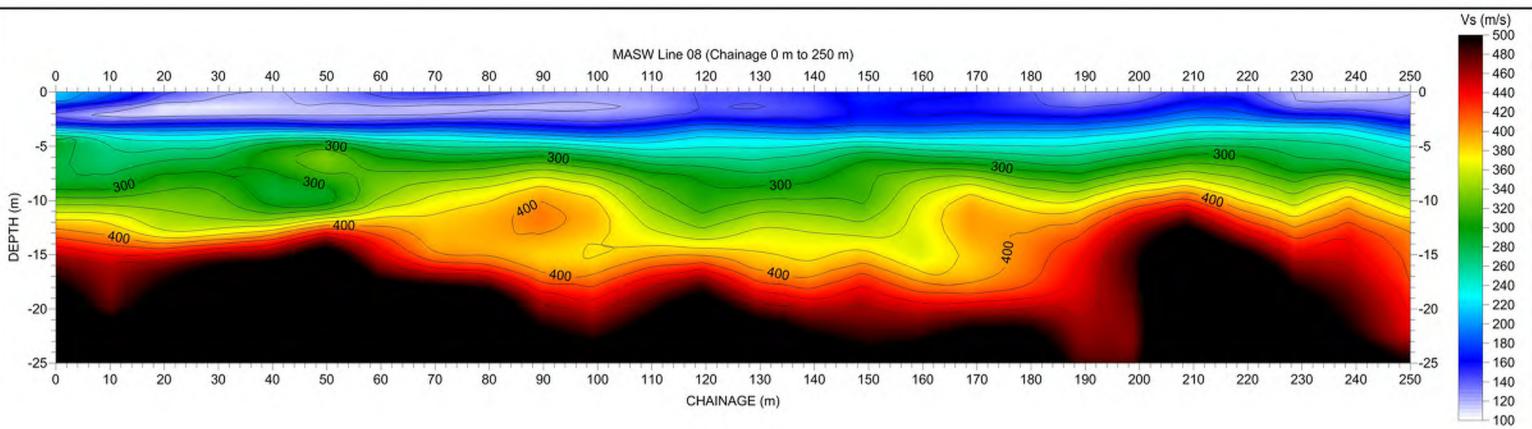
LOCATION-Rosemerryn Farm, Lincoln

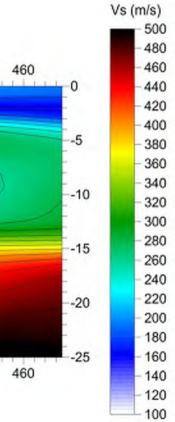
A3

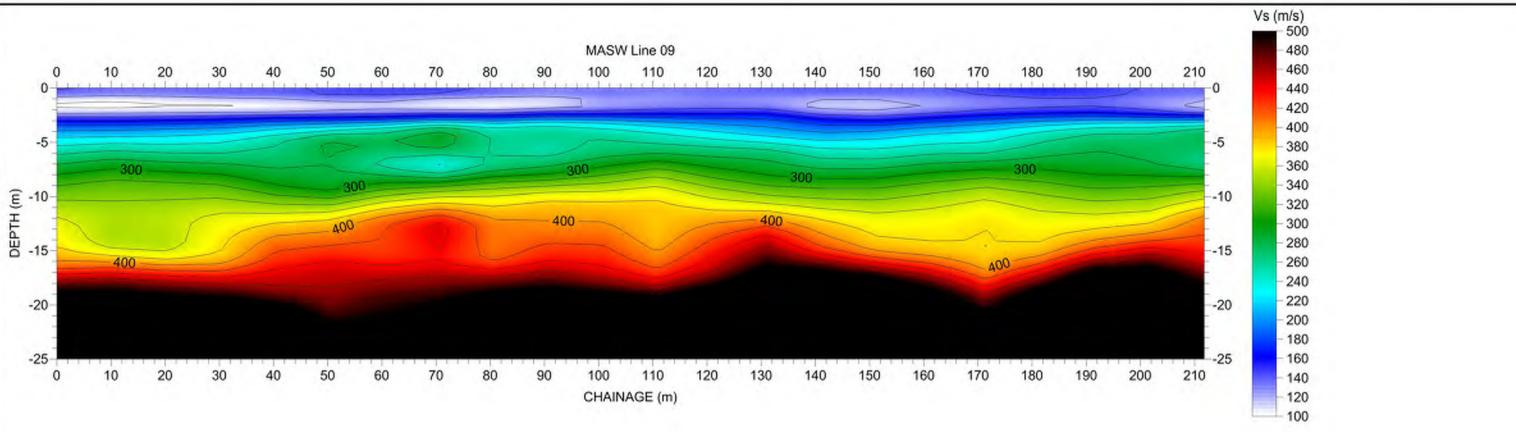


CHAINAGE (m)

MASW Line 08 (Chainage 250 m to end of line)

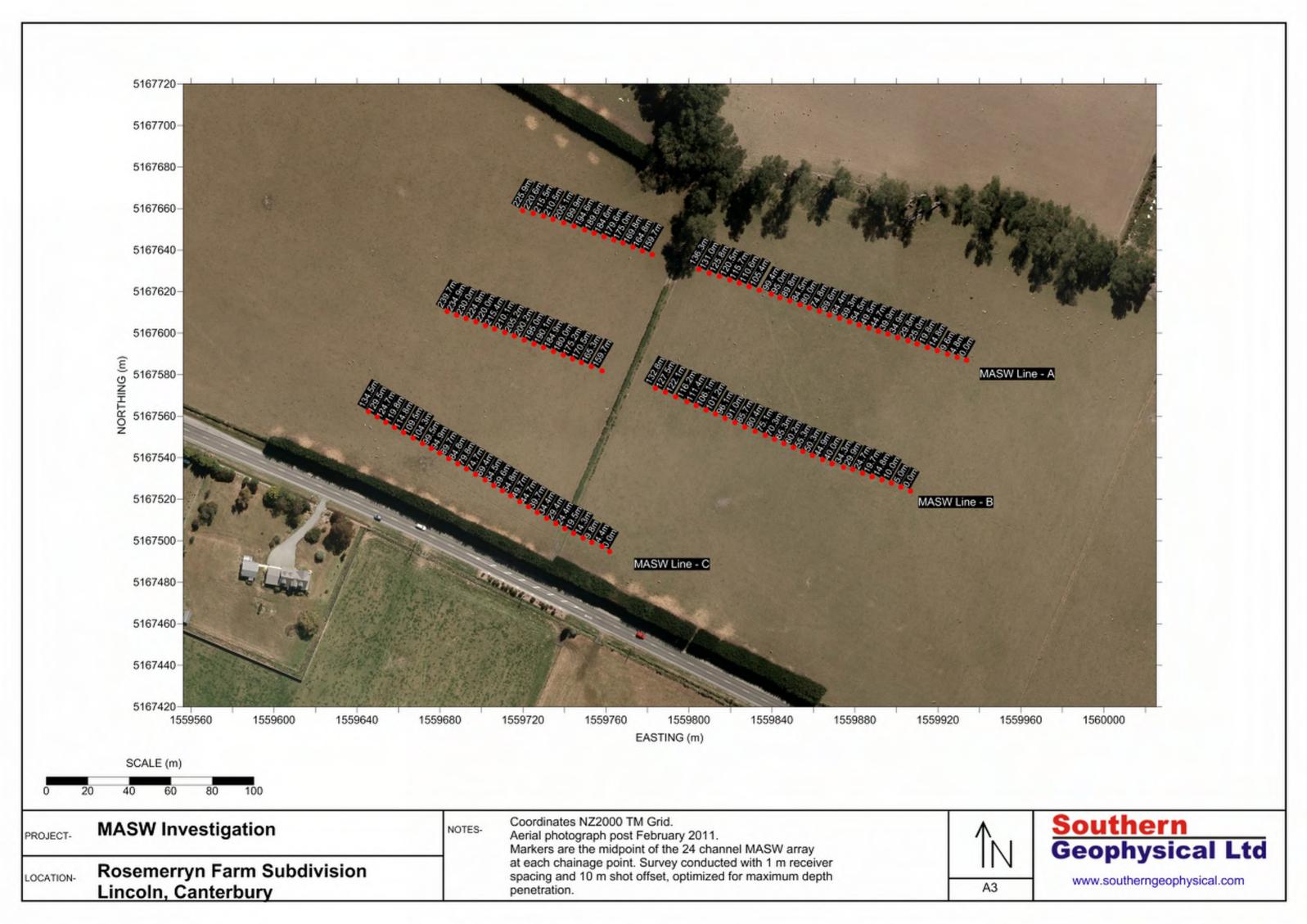


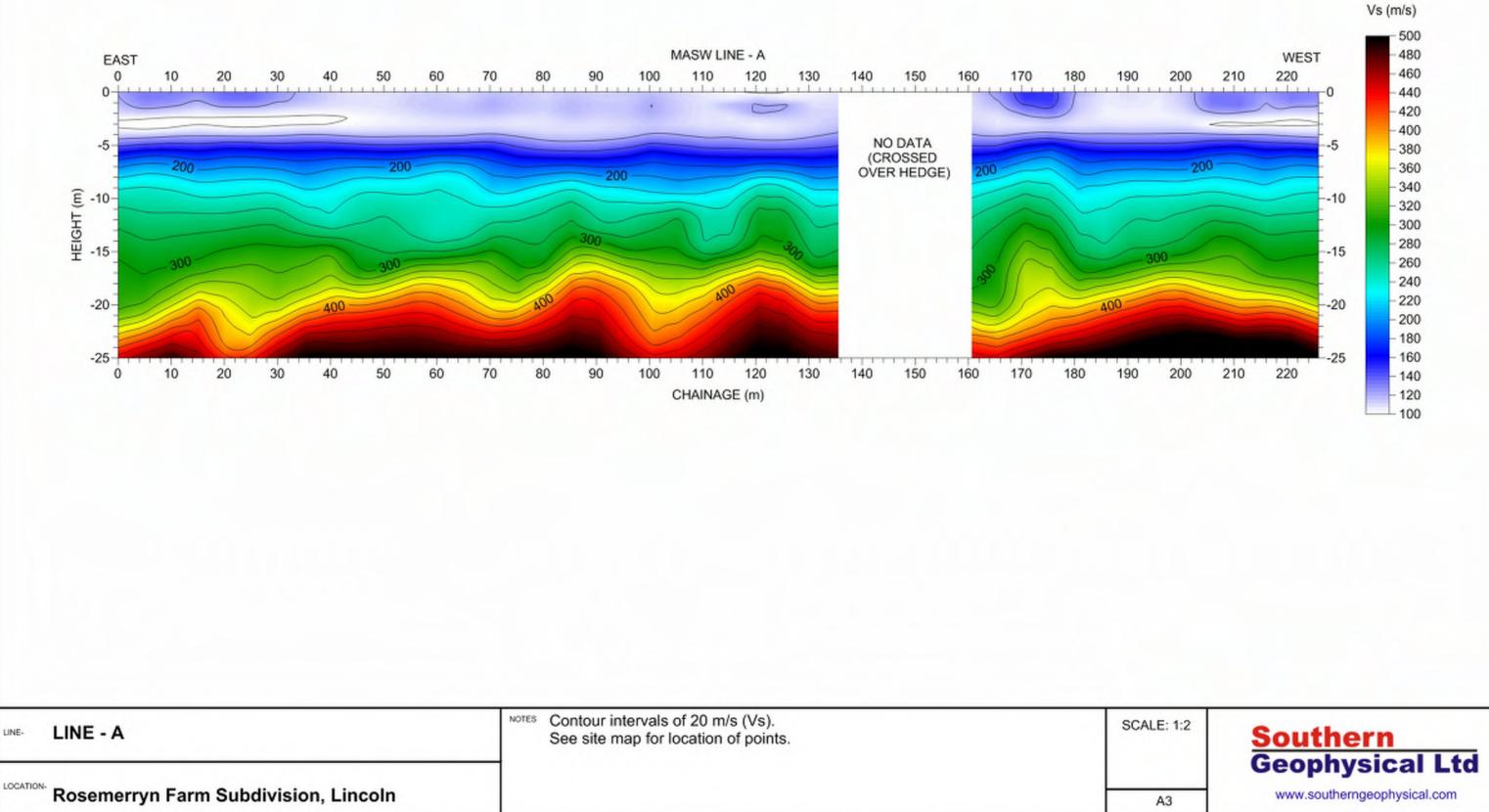




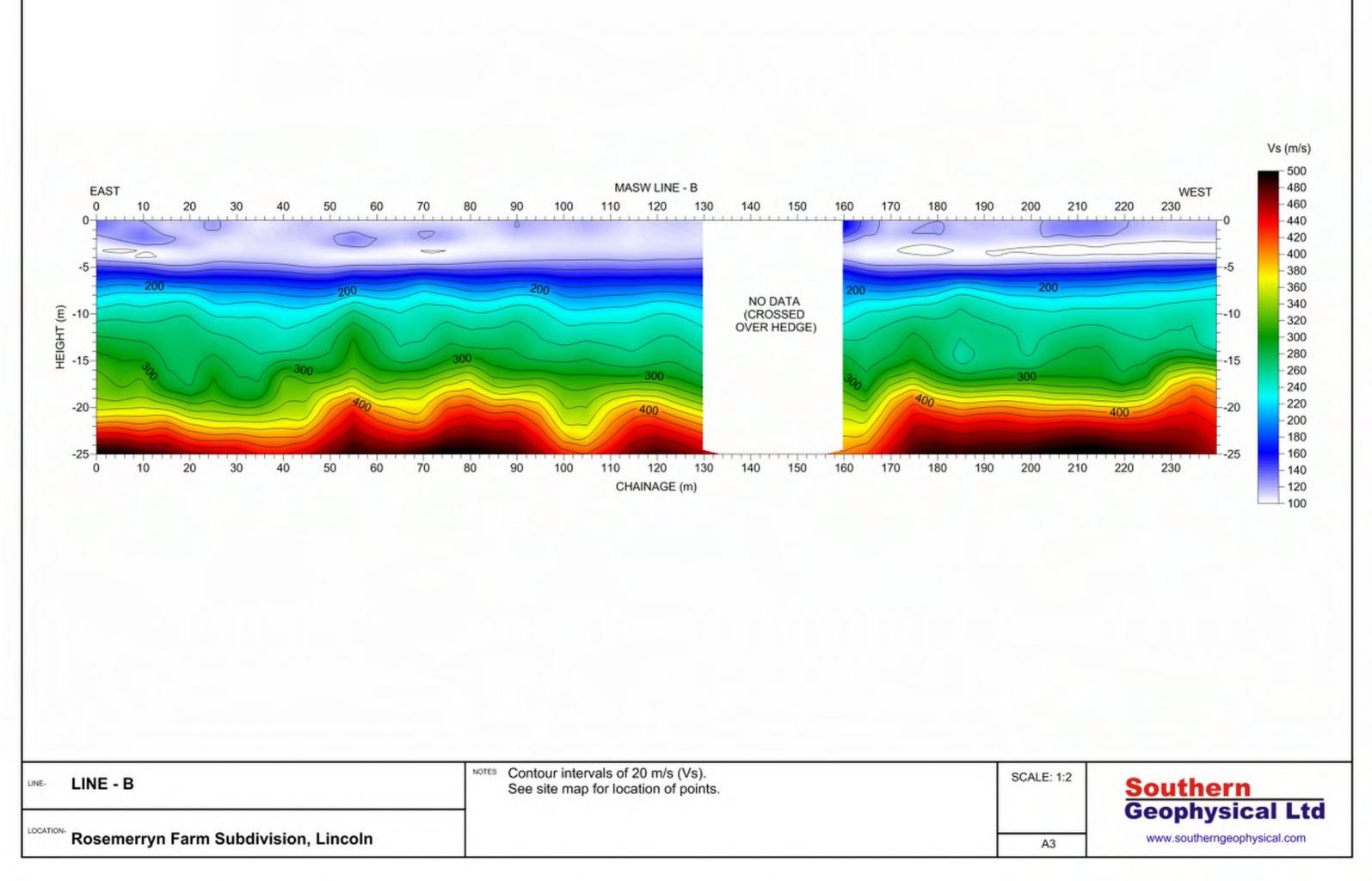
LINE- Figure 7: MASW Line 09	NOTES Contour intervals of 20 m/s (Vs). See site map for location of points.	SCAL
LOCATION- Rosemerryn Farm, Lincoln		





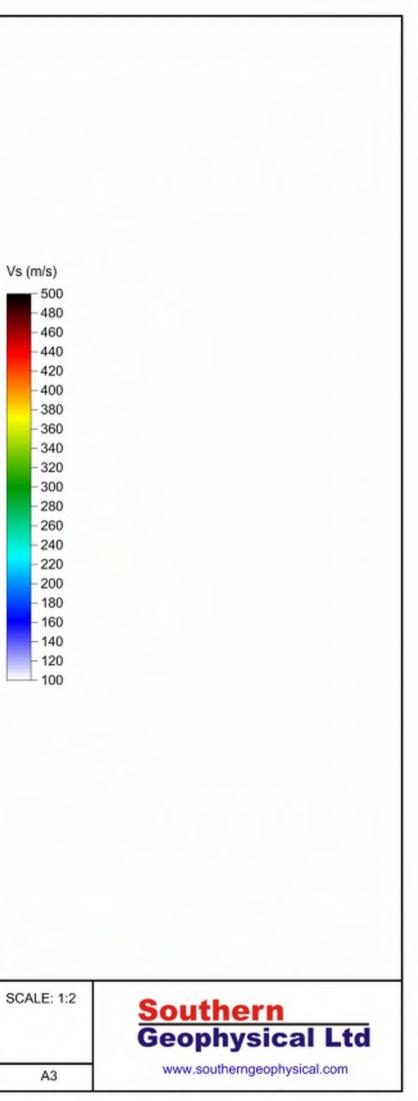


LINE-



MASW LINE - C WEST EAST 0 10 20 30 50 60 70 80 90 100 110 120 130 40 1111 1.1.1 1.1.1 ----0 0+ 1111 -5--5 200 200 (L) -10-LHOIEN -15--10 300 -15 400 400 400 -20--20 -25--25 70 20 30 50 80 60 90 110 Ó 10 40 100 120 130 CHAINAGE (m) NOTES Contour intervals of 20 m/s (Vs). LINE - C LINE-See site map for location of points.

LOCATION-Rosemerryn Farm Subdivision, Lincoln



# Appendix I Summary of Liquefaction Results

## Client: Fulton Hogan Land Development Project: Rosemerryn Subdivsion Subject: Boulanger and Idriss (2014) assessment

## Date: Feb 2014 Job Number: 224464 By: T. Plunket

### Southern Section

Year	CPT	Depth (m)				SLS-a (0.13g, Mw7.5)							g, Mw6.0)			ULS (0.35g, Mw7.5)								pt 2010 (0.3	4g, Mw7.1)				Se	pt 2010 (0.2	0g, Mw7.1)		
			(m bgl)	Total Settlement	Index Settlement					Total Settlement	Index Settlement					Total Settlement	Index Settlement					Total Settlement	Index Settlement					Total Settlement	Index Settlement				
2011	14	6.6	1	(mm) 105	(mm) N/A	41	Liquefiab 1.9	ole Layers 6.5	Ishihara Yes	(mm) 125	(mm) N/A	<b>LSN</b> 40	Liquefial 1.6	ble Layers 6.5	Ishihara Yes	(mm) 145	(mm) N/A	LSN 56	Liquefiab 1	le Layers 6.5	Ishihara Yes	(mm) 145	(mm) N/A	LSN 56	Liquefiable 1	Layers 6.5	Ishihara Yes	(mm) 130	(mm) N/A	LSN 50	Liquefiable 1.1	e Layers 6.5	Ishihara Yes
2011	18	6.2	1	40	N/A	15	2.1 3.5	2.3 5.4	No	65	N/A	13	1.9 3.5	2.8 5.4	Yes	85	N/A	35	1 3.5	2.8 5.4	Yes	85	N/A	34	1 3.5	2.8 5.4	Yes	70	N/A	25	1.9 3.5	2.8 5.4	Yes
2011	29	6.5	1	30	N/A	10	4.3 5.3	4.6 6.4	No	40	N/A	9	1.9 4.3	2.4 4.6	No	60	N/A	26	1 4.3	2.4 4.6	Yes	60	N/A	25	1 4.3	2.4 4.6	Yes	50	N/A	16	1.4 4.3	2.4 4.6	No
2012	1	5.9	1	20	N/A	11	3.1	3.6	No	35	N/A	11	5.3 3.1	6.4 3.6	No	45	N/A	22	5.3	6.4 1.4	No	45	N/A	22	5.3	6.4 1.4	No	40	N/A	16	5.3	6.4 3.6	No
	·						4.4	4.7 5.2					4.4	4.7 5.2					1.8 3.1	2 3.6					1.8 3.1	2 3.6					4.4	4.7 5.2	
							5	0.2					5	5.2					4.4	4.7 5.2					4.4	4.7 5.2					5	5.2	
2012	2	7.5	1	45	N/A	29	2.8 5.9	5.5	No	85	N/A	27	1.6 5.9	5.5 6.4	Yes	105	N/A	43	1	6.5	Yes	105	N/A	43	1	6.5	Yes	95	N/A	36	1.6 5.9	5.5	Yes
2012	3	8.4	1	55	N/A	22	3.2	6.4 3.9		85	N/A	20	1.5	5	Yes	105	N/A	37	1.2	6.5	Yes	105	N/A	36	1.2	6.5	Yes	95	N/A	33	1.5	6.4 5	Yes
							4.4 5.9	5 6.5					5.9 7.5	6.5 8					7.5	8.2					7.5	8.2					5.9 7.5	6.5 8	
2012	5	4.9	1	15	N/A	8	7.5 3.1	7.9 3.9	No	30	N/A	7	1.6	1.9	No	45	N/A	23	1.1	1.9	Yes	45	N/A	23	1.1	1.9	Yes	35	N/A	17	1.6	1.9	No
2012	6	10.2	1	70	70	25	3.2	3.7	No	95	95	23	3.1 1.6	3.9 2.4	Yes	135	135	43	3.1	3.9 2.4	Yes	130	130	42	3.1	3.9 2.4	Yes	115	115	35	3.1 1.3	3.9 2.4	No
							4.2 6.1	5.4 7.8					3.2 4.2	3.7 5.4					3.2 4.2	3.7 5.4					3.2 4.2	3.7 5.4					3.2 4.2	3.7 5.4	
2012	8	6.6	1	25	N/A	17	3.5	3.9	No	55	N/A	15	6.1 1.5	8.5 2.2	No	85	N/A	40	6.1 1	10 3.9	Yes	85	N/A	39	6.1 1	10 3.9	Yes	70	N/A	33	6 1.3	8.5 3.9	Yes
							4.4	5					2.6 4.4	3.8 5.1					4.4 5.8	5.1 6					4.4 5.8	5.1 6					4.4 5.8	5.1 6	
2012	9	4.2	1	10	N/A	9	Lin	nited	No	25	N/A	7	1.7 3.2	2.1 3.7	No	45	N/A	26	1 2.8	2.1 3.7	Yes	45	N/A	25	1 2.8	2.1 3.7	Yes	30	N/A	18	1.5 2.8	2.1 3.7	No
2012	10	4.1	1	0	N/A	2	Lin	nited	No	10	N/A	2	2.5	2.9	No	40	N/A	21	1.1 3.7	3 3.9	Yes	40	N/A	21	1.1 3.7	3 3.9	Yes	15	N/A	8	1.7	2.9	No
2012 2012	11 27	4.1 4.3	1	10 10	N/A N/A	15 12	Lin 2.9	nited 3.1	No No	30 30	N/A N/A	14 10	1.5 1.5	3	No No	50 55	N/A N/A	33 35	1	3.4 3.1	Yes Yes	50 55	N/A N/A	33 35	1	3.4 3.1	Yes Yes	40 45	N/A N/A	29 31	1.1 1.1	3.4 3.1	Yes Yes
2013	1	6.5	1	45	N/A	23	2.8	5.2	No	75	N/A	22	2.3 1.5	3.1 2.1	No	85	N/A	36	1	2.1	Yes	85	N/A	36	1	2.1	Yes	80	N/A	32	1.4	2.1	Yes
2013	2	6.9	1	45	N/A	22	3.4	4	No	70	N/A	20	2.8 1.7	5.2 2.4	No	85	N/A	35	2.8	5.2 2.4	Yes	85	N/A	35	2.8	5.2 2.4	Yes	75	N/A	33	2.8 1.3	5.2 2.4	No
							4.4 5.8	5 6.6	_				3.1 4.4	4 5					3.1 5.8	5 6.6					3.1 5.8	5 6.6					3.1 5.8	5 6.6	
2013	3	6.8	1	45	N/A	21	3.4	4.1	No	75	N/A	18	5.8 1.8	6.6 2.4	No	100	N/A	40	1	5.2	Yes	100	N/A	40	1	5.2	Yes	85	N/A	34	1.2	2.4	Yes
2010	0	0.0		10			4.4	5.2 6.8				10	3.2	5.2 6.8		100		10	5.8	6.8	100			10	5.8	6.8	100	00		0.	3.2	5.2 6.8	100
2013	4	6.6	1	35	N/A	20	3.4 5.6	4 6.2	No	60	N/A	19	1.6 3.4	2.7	No	80	N/A	38	1 3.4	2.7 4	Yes	80	N/A	38	1 3.4	2.7 4	Yes	70	N/A	31	1.4 3.4	2.7 4	No
2013	5	5.8	1	20	N/A	9	4.4	4.8	No	30	N/A	8	5.6 1.9	6.2 2.4	No	55	N/A	30	5.6	6.3 2.4	Yes	55	N/A	29	5.6	6.3 2.4	Yes	40	N/A	17	5.6	6.2 2.4	No
	6												4.4	4.8					4.4	4.8					4.4	4.8					4.4	4.8	
2013	0	6.3	1	25	N/A	16		nited	No	40	N/A	15	1.6	2.5	No	55	N/A	29	5.5	2.5 6.1	Yes	55	N/A	29	5.5	2.5 6.1	Yes	45	N/A	23	1.3 5.5	2.5 6	No
2013	/	7.6	1	15	N/A	8	5.3	5.8	No	25	N/A	/	5.3	5.9	No	45	N/A	23	1 5.3	2.4 6	Yes	45	N/A	22	1 5.3	2.4 6	Yes	35	N/A	16	1.7 5.3	2.4 5.9	No
2013	8	6.3	1	10	N/A	10		nited	No	20	N/A	9	1.6	2.4	No	35	N/A	21	1.1 5.4	2.4 6.1	Yes	35	N/A	21	1.1 5.4	2.4 6.1	Yes	25	N/A	18	1.1	2.4	Yes
2013	9	7.4	1	25	N/A	10	6.5	6.9	No	35	N/A	9	1.8 6.4	2.2 6.9	No	55	N/A	24	1 4.9	2.2 5.7	Yes	55	N/A	23	1 4.9	2.2 5.7	Yes	45	N/A	18	1.6 6.4	2.2 7.2	No
2013	10	7.5	1	75	N/A	29	3.4	4	No	90	N/A	27	1.7	2.6	No	110	N/A	43	6.3 1	7.3 2.9	Yes	110	N/A	43	6.3 1	7.3 2.9	Yes	100	N/A	37	1.7	2.6	No
							4.4 5.8	5.3 7					3.4 4.4	4 5.3					3.4 4.4	4 5.3					3.4 4.4	4 5.3					3.4 4.4	4 5.3	
2013	11	6.1	1	45	N/A	23	3.4	4	No	65	N/A	22	5.8 1.7	7 2.3	No	80	N/A	33	5.8 1	7.3 2.3	Yes	80	N/A	33	5.8 1	7.3 2.3	Yes	70	N/A	29	5.8 1.5	7.1 2.3	Yes
							4.3 5.6	5.2 5.9					3.1 5.6	5.2 5.9					3.1 5.6	5.2 6					3.1 5.6	5.2 6					3.1 5.6	5.2 6	
2013	12	7.3	1	65	N/A	27	2.9	7.2	No	95	N/A	26	1.6 2.9	2.2 7.2	No	105	N/A	37	1.2 2.9	2.2 7.2	Yes	105	N/A	37	1.2 2.9	2.2 7.2	Yes	100	N/A	35	1.6 2.9	2.2 7.2	Yes
2013	13	6.8	1	40	N/A	18	3.1 4.4	4 5.6	No	65	N/A	17	1.8 3.3	2.4 4	No	90	N/A	35	1 3.1	2.4 6.2	Yes	90	N/A	35	1 3.1	2.4 6.2	Yes	80	N/A	29	1.4 3.1	2.4 6.2	No
2013	14	6.5	1	50	N/A	27	3.2	4.1	No	75	N/A	26	4.4 1.8	6.2 2.9	No	90	N/A	37	1	6.3	Yes	90	N/A	37	1	6.3	Yes	80	N/A	33	1.7	6.1	Yes
							4.2 5.6	5.2 6.2					4.2 4.4	4.1 5.2																			
2013	15	7.7	1	50	N/A	21	3.5	3.9	No	65	N/A	19	5.6 1.7	6.2 2.7	No	85	N/A	36	1	2.7	Yes	85	N/A	36	1	2.7	Yes	75	N/A	31	1.7	2.7	No
							4.2 6.3	4.9 7.4					3.5 4.2	3.9 4.9					3.5 4.2	3.9 4.9					3.5 4.2	3.9 4.9					3.5 4.2	3.9 4.9	
2013	16	6	1	20	N/A	11	5.2	5.6	No	30	N/A	10	6.3 1.8	7.4	No	50	N/A	28	6	7.5	No	50	N/A	28	6	7.5	No	40	N/A	22	6.3	7.4	No
2013	17	7.1	1	55	N/A	17	5.1	6.8	No	65	N/A	17	5.2 1.8	5.7	No	80	N/A	28	4.9	5.8	Yes	80	N/A	28	4.9	5.8 2.3	Yes	70	N/A	23	4.9	5.7 2.3	No
2013	18	7.6	1	30	N/A	16	6.4	6.8	No	45	N/A	15	5.1	6.9 2.8	No	65	N/A	32	5.1 1	6.9 2.8	Yes	65	N/A	32	5.1	6.9 2.8	Yes	55	N/A	28	5.1	6.9 2.8	Yes
2013	19	7.1	1	40	N/A	20	2.2	2.9	No	55	N/A	19	6.4 1.9	6.8 2.9	No	65	N/A	28	6.4 1.3	6.8 2.9	Yes	65	N/A	28	6.4 1.3	6.8 2.9	Yes	60	N/A	25	6.4	6.8 2.9	Yes
2013	13			-70	11/17	20	3.5	2.9 3.8 6.5	140	00	11/17	10	3.5	2.9 3.8 6.5		00	17/77	20	3.5	2.9 3.8 6.5	100		11/73	20	3.5	2.9 3.8 6.5	100	00	19/73	20	3.5	2.9 3.8 6.5	100
2013 2013	20 21	7.3 7.5	1	60 55	N/A N/A	25 22	3.4 3.6	7.1 6.4	No No	85 85	N/A N/A	24 19	2.1	7.2 2.8	Yes	105 115	N/A N/A	40 44	1.2 1	7.2 6.4	Yes	105 115	N/A N/A	40 44	1.2 1	7.2 6.4	Yes Yes	95 100	N/A N/A	35 34	1.2	7.2 6.4	Yes Yes
2013			1		N/A N/A			4			N/A N/A		3.2	6.4	No No	115	N/A		1	9.1	Yes		N/A	44	1	9.1	Yes				1.9		
2013	22	9.3		75	IN/A	29	3.3 4.5 6	4 5.6 6.9	No	105	IN/A	26	1.5 3 4.5	2.3 4 5.6	NU	150	11/74	50		3.1	Yes	145	IN/A	40	1	J. I	162	130	N/A	45	8.2	6.9 9.1	Yes
							6 8.3	6.9 9.1					4.5 6 8.3	5.6 6.9																			
		I	I	I	L	I	1		I		I	I	8.3	9.1			I	I	I		1	l	l	L	l			<u> </u>	I	1			

### Client: Fulton Hogan Land Development Project: Rosemerryn Subdivsion Subject: Boulanger and Idriss (2014) assessment

### **Date:** Feb 2014 **Job Number:** 224464 **By:** T. Plunket

Northern Section

Year	CPT	Depth (m)	GWL			SLS-a (0.13	3a, Mw7.5)			5	SLS-b (0.19	a. Mw6.0)		ULS (0.35g, Mw7.5)						Se	pt 2010 (0.3	4a. Mw7.1)		Sept 2010 (0.20g, Mw7.1)					
			(m bgl)	Total				1	Total Index					Total Index						Index	1	.9,		Total Index					
			,	Settlement	Settlement				Settlement	Settlement				Settlement	Settlement				Settlement	Settlement				Settlement	Settlement			/	
				(mm)	(mm)	LSN	Liquefiable Lavers	Ishihara	(mm)	(mm)	LSN	Liquefiable Lavers	Ishihara	(mm)	(mm)	LSN	Liquefiable Lavers	Ishihara	(mm)	(mm)	LSN	Liquefiable Lavers	Ishihara	(mm)	(mm)	LSN	Liquefiable Lavers	Ishihara	
2011	6	3.1	2	0	N/A	1	Limited	No	5	N/A	1	Limited	No	15	N/A	6	2.4 3.1	Yes	15	N/A	6	2.4 3.1	Yes	10	N/A	4	2.6 3	No	
2011	7	1.4	2	0	N/A	0	Limited	No	0	N/A	0	Limited	No	0	N/A	0	Limited	No	0	N/A	0	Limited	No	0	N/A	0	Limited	No	
2011	9	3.7	2	5	N/A	5	Limited	No	15	N/A	4	2.4 2.7	No	35	N/A	16	2 3.7	Yes	35	N/A	16	2 3.7	Yes	30	N/A	13	2 3.7	No	
												2.9 3.4															i '		
2011	12	3.8	2	0	N/A	1	Limited	No	0	N/A	1	Limited	No	15	N/A	8	2 2.7	No	15	N/A	8	2 2.7	No	5	N/A	5	2.1 2.5	No	
2011	13	0.7	2	0	N/A	0	Limited	No	0	N/A	0	Limited	No	0	N/A	0	Limited	No	0	N/A	0	Limited	No	0	N/A	0	Limited	No	
2011	15	4.2	2	5	N/A	3	Limited	No	15	N/A	3	3 3.7	No	45	N/A	16	2 4.1	Yes	40	N/A	16	2 4.1	Yes	30	N/A	14	2 3.8	No	
2011	16	2.7	2	0	N/A	2	Limited	No	4	N/A	1	Limited	No	15	N/A	7	2 2.7	No	15	N/A	7	2 2.7	No	10	N/A	6	2.4 2.7	No	
2011	17	3.4	2	0	N/A	1	Limited	No	5	N/A	1	Limited	No	15	N/A	8	2.1 2.7	No	15	N/A	8	2.1 2.7	No	6	N/A	5	2.1 2.5	No	
2011	19	3.5	2	0	N/A	3	Limited	No	10	N/A	2	Limited	No	30	N/A	14	2 3.4	Yes	30	N/A	14	2 3.4	Yes	20	N/A	11	2 3.4	No	
2011	20	4.2	2	5	N/A	5	Limited	No	15	N/A	4	3.1 3.6	No	35	N/A	15	2 3.7	Yes	35	N/A	15	2 3.7	Yes	30	N/A	14	2 3.7	No	
2011	21	3.2	2	0	N/A	0	Limited	No	5	N/A	0	Limited	No	25	N/A	10	2 3	Yes	25	N/A	10	2 3	Yes	15	N/A	4	2.3 2.9	No	
2011	28	2.1	2	0	N/A	0	Limited	No	0	N/A	0	Limited	No	0	N/A	0	Limited	No	0	N/A	0	Limited	No	0	N/A	0	Limited	No	
2011	29	6.5	2	15	N/A	6	4.3 4.6	No	30	N/A	5	4.3 4.6	No	40	N/A	12	2 2.4	No	40	N/A	12	2 2.4	No	35	N/A	9	4.3 4.6	No	
							5.7 6.4					5.3 6.4					4.3 4.6					4.3 4.6					5.3 6.4		
																	5.3 6.4					5.3 6.4					ļ		
2011	33	2.6	2	0	N/A	0	Limited	No	0	N/A	0	Limited	No	10	N/A	4	2 2.5	No	10	N/A	4	2 2.5	No	0	N/A	2	Limited	No	
2011	34	3.6	2	0	N/A	1	Limited	No	5	N/A	1	Limited	No	15	N/A	7	2.2 2.7	No	15	N/A	7	2.2 2.7	No	10	N/A	6	2.2 2.6	No	
2012	12	3.3	2	0	N/A	1	Limited	No	5	N/A	1	Limited	No	20	N/A	10	2 2.9	Yes	20	N/A	9	2 2.9	Yes	5	N/A	5	Limited	No	
2012	13	4	2	0	N/A	1	Limited	No	5	N/A	0	Limited	No	25	N/A	11	2 3.5	Yes	25	N/A	10	2 3.5	Yes	10	N/A	4	Limited	No	
2012	14	3.9	2	0	N/A	3	Limited	No	10	N/A	3	2.9 3.2	No	25	N/A	12	2 3.3	Yes	25	N/A	12	2 3.3	Yes	20	N/A	9	2 3.2	No	
2012	15	5.9	2	5	N/A	6	Limited	No	25	N/A	5	3.5 4.7	No	50	N/A	16	3 4.7	Yes	50	N/A	16	3 4.7	Yes	35	N/A	13	3 4.7	No	
2012	16	3.4	2	0	N/A	1	Limited	No	5	N/A	1	Limited	No	25	N/A	10	2 3	Yes	25	N/A	10	2 3	Yes	10	N/A	5	2.3 2.9	No	
2012	17	2.7	2	0	N/A	1	Limited	No	0	N/A	1	Limited	No	10	N/A	6	2 2.4	No	10	N/A	6	2 2.4	No	5	N/A	5	2 2.3	No	
2012	18	3.5	2	0	N/A	1	Limited	No	5	N/A	1	Limited	No	20	N/A	10	2.1 2.9	No	20	N/A	10	2.1 2.9	No	15	N/A	7	2.1 2.9	No	
2012	19	4.4	2	0	N/A	1	Limited	No	5	N/A	1	Limited	No	20	N/A	10	2 3.2	Yes	20	N/A	9	2 3.2	Yes	7	N/A	4	Limited	No	
2012	20	3.7	2	0	N/A	0	Limited	No	0	N/A	0	Limited	No	5	N/A	3	2 2.3	No	5	N/A	3	2 2.3	No	1	N/A	0	Limited	No	
2012	21	2.7	2	0	N/A	0	Limited	No	0	N/A	0	Limited	No	5	N/A	2	Limited	No	5	N/A	1	Limited	No	0	N/A	0	Limited	No	
2012	22	4.6	2	5	N/A	3	Limited	No	15	N/A	5	2.3 3	No	35	N/A	15	2 3.2	No	35	N/A	15	2 3.2	No	25	N/A	13	2 3.1	No	
2012	23	2.1	2	0	N/A	0	Limited	No	0	N/A	0	Limited	No	0	N/A	0	Limited	No	0	N/A	0	Limited	No	0	N/A	0	Limited	No	
2012	24	0.8	2	0	N/A	0	Limited	No	0	N/A	0	Limited	No	0	N/A	0	Limited	No	0	N/A	0	Limited	No	0	N/A	0	Limited	No	
2012	25	3.7	2	0	N/A	0	Limited	No	0	N/A	0	Limited	No	15	N/A	7	2 3	Yes	15	N/A	7	2 3	Yes	5	N/A	2	Limited	No	
2015	101	2.1	2	0	N/A	0	Limited	No	0	N/A	0	Limited	No	0	N/A	0	Limited	No	0	N/A	0	Limited	No	0	N/A	0	Limited	No	
2015	102	4.4	2	0	N/A	1	Limited	No	5	N/A	1	Limited	No	25	N/A	10	2 3	Yes	25	N/A	10	2 3	Yes	10	N/A	5	2.2 2.7	No	
2015	103	4	2	5	N/A	5	Limited	No	15	N/A	5	2.4 3.1	No	20	N/A	10	2 3.1	Yes	20	N/A	10	2 3.1	Yes	20	N/A	9	2.1 3.1	No	
2015	104	6.3	2	0	N/A	3	Limited	No	10	N/A	2	Limited	No	35	N/A	14	2 4 4.4 4.9	Yes	35	N/A	13	2 4 4.4 4.9	Yes	15	N/A	1	2.4 3	No	
2015	105	3	2	0	N/A	1	Limited	No	3	N/A	0	Limited	No	20	N/A	9	2 2.9	Yes	20	N/A	8	2 2.9	Yes	10	N/A	5	2 2.7	No	

## aurecon

## **Aurecon New Zealand Limited**

Unit 1, 150 Cavendish Road Casebrook Christchurch 8051 PO Box 1061 Christchurch 8140 New Zealand

T +64 3 366 0821 F +64 3 379 6955 E christchurch@aurecongroup.com W aurecongroup.com

### Aurecon offices are located in: Angola, Australia, Botswana, Chile, China, Ethiopia, Ghana, Hong Kong, Indonesia, Lesotho, Libya, Malawi, Mozambique, Namibia, New Zealand, Nigeria, Philippines, Qatar, Singapore, South Africa, Swaziland, Tanzania, Thailand, Uganda, United Arab Emirates, Vietnam.