

GEOTECHNICAL INVESTIGATION

FOSTER BLOCK, GOULDS ROAD

ROLLESTON

SUBMITTED TO:

R.D. HUGHES DEVELOPMENTS LTD
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21 December 2011

DISTRIBUTION

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1 Copy – Geoscience Consulting (NZ) Ltd

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1 INTRODUCTION

Geoscience Consulting (NZ) Ltd (Geoscience) was requested by Kelvin Back of R.D. Hughes Developments Ltd to undertake a preliminary geotechnical investigation of a proposed residential sub-division site on Goulds Road, Rolleston (herein referred to as 'the site') as outlined in our proposal (ref. P11382, dated 9th November 2011).

We understand the site has recently been rezoned from rural to residential and that this report was commissioned in order to provide sufficient information for Geoscience to comment on the likely 'Technical Category'¹ into which this land will fall. This report is not intended for 224c sub-division sign off or for building consent purposes. The Selwyn District Council guidelines indicate further geotechnical testing may be required for these consents. A final report will be provided following earthworks to confirm the site technical category. We assume this will be required as a condition of subdivision consent.

Our scope of works included the following:

- Desktop study of relevant publically available geotechnical and geological publications;
- Undertake a visual inspection of the site to identify land damage following the recent earthquakes;
- Organise and technical supervision approximately 12 test pits to depths of between 1 and 4 m.
- Arrange for a sub-contractor to complete approximately 80 Mechanical Scala Penetrometer tests across the site to a target depth of 1-2 m.
- Presentation of a report outlining our findings on the prevailing ground conditions and including our opinion as to the appropriate 'Technical Category' for the site. This will include a comment on the likely liquefaction potential at the site. We will also outline what further geotechnical work we consider will be required for sub-division consent.

2 SITE DESCRIPTION

The site is located on relatively flat ground approximately 2 km southeast of the centre of Rolleston. The site is bound by Dynes Road to the northwest, Goulds Road to the West, East Maddisons Road to the southwest and farmland to the southeast and northeast (Figure 1). The site is currently used for a mixture of grazing and cropping. There are no significant watercourses in the area.

The Department of Building and Housing (DBH) has recently divided the CERA 'Green Zone' into the following Technical Categories¹:

- TC1 ('Grey') where "future land damage from liquefaction is unlikely, and ground settlements are expected to be within normally accepted tolerances";
- TC2 ('Yellow') where "minor to moderate land damage from liquefaction is possible in future large earthquakes"; and
- TC3 ('Blue') where "moderate to significant land damage from liquefaction is possible in future significant earthquakes".

The site does not yet have a classification and it was the aim of this report to give an indication as to what category we consider the land will fall into.

Site photographs are presented in Appendix 1.

3 GEOLOGY

The site is mapped² as being underlain by brownish grey river alluvium.

4 GEOHAZARDS

4.1 Seismicity

Historically, Christchurch City has been considered to be in a region of low concentrations of active faults and seismicity. However, the Canterbury region has recently had three earthquakes with magnitude greater than 6. As a result, there is a heightened level of seismic risk stemming from the recently discovered Greendale, Lyttelton and Port Hills Faults. The recent seismic activity in the Canterbury region is currently considered to have increased the probability of another large (M6.0-6.9) earthquake to 21%³ between the time of writing and November 2012.

Preliminary mapping⁴ of the recent faulting in Canterbury illustrates the approximate locations of the Greendale Fault and sub-surface Lyttelton Fault rupture, the distribution of associated aftershocks since the 4th of September 2010 event, and known active faults in the Canterbury area. Large regional areas of faulting^{2,5} namely the Ashley Fault, Porters Pass-Amberley Fault Zone, and the Hope and Alpine Faults, are further afield but present a high seismic hazard risk to the Christchurch area due to the anticipated size of earthquakes generated. The largest of these faults is the Alpine Fault, which has a return period of 250-300 years and is expected to produce a M8 earthquake. The last rupture on the Alpine Fault is believed to have occurred in 1717⁶.

4.2 Liquefaction and Lateral Spreading

The site is located outside the “potentially liquefiable ground zone” and “lateral spread zone” identified by the Selwyn District Council⁷, and we consider the potential for liquefaction and lateral spreading to be very low owing to the nature of the subsurface materials¹ and depth to groundwater at the site.

Aerial photography⁸ taken in the days following the 22nd of February event shows no sign of any ejected sand and silt at the site and surrounding areas. We are unaware of any liquefaction or lateral spreading being observed within approximately 20 km of the site during the recent large earthquakes affecting the Canterbury region.

5 FIELD INVESTIGATIONS

5.1 Test Pits

Geoscience visited the site on the 30th of November 2011 and completed logging of materials from 12 machine excavated test pits. Our investigations found the geology to be consistent with published mapping, as summarised in Table 1.

Table 1: Summary of Typical Subsurface Conditions

Depth (m)	Material Description	Material Type	Density/Consistency
0.0 to 0.3	SILT with trace to minor sand, dark brown, dry.	TOPSOIL	Stiff
0.3 to 4.0	Sandy fine to coarse GRAVEL, brown, well graded, rounded, dry. Some SAND lenses (<0.2 m)	ALLUVIUM	Very Dense
>4.0	Inferred GRAVEL		Very Dense

Groundwater was not encountered in any of the test pits.

Full logs are presented in Appendix 2 and are written in accordance with the New Zealand Geotechnical Society 'Guideline for the Field Classification and Description of Soil and Rock for Engineering Purposes'⁹.

5.2 AutoScala (Penetrometer) Testing

The AutoScala is a small mechanical rig that pushes a Scala Penetrometer cone into the ground. A total of 91 tests were carried out approximately every 100 m across the site by Canterbury Geotest to a maximum depth of 1.2 m below ground level. The AutoScala tests were undertaken to assess the subsurface strength profile and to help determine if ground beneath the site meets the requirements of static "good ground", defined in NZS 3604:2011¹⁰ as follows:

"Where the number of blows per 100 mm depth of penetration below the underside of the proposed footing at each test site exceeds:

- *5 down to a depth equal to twice the width of the widest footing; and*
- *3 at greater depths.*

Furthermore, the definition of "good ground" also excludes organic topsoil, soft or very soft peat, soft or very soft clay and / or uncertified fill below the depth of footing at any test site. Sites prone to liquefaction also do not meet under the definition of "good ground".

"Good ground" under static conditions was typically encountered immediately beneath the topsoil layer (on average 0.3 m) and at a maximum depth of 0.45 m below ground level.

AutoScala results including a summary sheet are presented in Appendix 3.

5.3 Environment Canterbury (ECan) Borehole Logs

A review was conducted of deep ECan borehole logs in the general area. A total of four representative borelogs from holes located either on or immediately adjacent to the site were reviewed. The logs from these holes are presented in Appendix 4 and indicate the site is underlain by a mixture of claybound and sandy gravels to depths of at least 114 m below ground level. Some minor clay and peat layers are recorded below approximately 28 m depth in some of the boreholes. None of these materials are prone to liquefaction.

5.3.1 Groundwater

Groundwater is recorded on the ECan borehole logs at depths ranging from 9 to 11 m below ground level.

6 CONCLUSIONS

Based on our site investigation and assessment we conclude the following:

- Geotechnical materials underlying the site typically comprise of 0.3 m of topsoil underlain by very dense gravel to depths of at least several tens of metres and probably hundreds of metres depth.
- AutoScala testing indicates “good ground” can typically be found immediately below the topsoil layer and at a maximum depth of 0.45 m.
- ECan borehole logs in the area indicate groundwater can be found at between 9 and 11 m below ground level.
- There is no evidence of any liquefaction having occurred at or near the site during recent large earthquakes. We consider the likelihood of liquefaction or lateral spreading occurring at the site to be very low based on the depth to groundwater and the nature of the sub-surface materials (namely gravel).

7 RECOMMENDATIONS

Based on our findings we consider the site characteristics to be consistent with a Technical Category 1 (TC1) classification where:

“Future land damage from liquefaction is unlikely. You can use standard foundations for concrete slabs or timber floors. Foundation requirements changed in 2011 and information is available on the Department of Building and Housing’s website”¹:

It should be noted that while we consider the site suitable for residential sub-division, this report is not intended for 224c sub-division sign off or for building consent purposes. The Selwyn District Council guidelines indicate further geotechnical testing may be required for these consents. A final report will be provided following earthworks to confirm the site technical category. We assume this will be required as a condition of subdivision consent.

8 REFERENCES

- 1 The Department of Building and Housing, October 2011: Preview of the Update to: Guidance on House Repairs and Reconstruction following the Canterbury Earthquakes (<http://www.dbh.govt.nz/earthquake--reconstruction-guidance-preview>)
- 2 Brown, L.J., Weeber, J.H., 1992: Sheet 1 - Geology of the Christchurch Urban Area 1:25,000. Institute of Geological and Nuclear Sciences, Lower Hutt.
- 3 http://www.geonet.org.nz/var/storage/images/media/images/news/2011/chch_seismicity_04_09_11/58577-1-eng-GB/Chch_Seismicity_04_09_11.jpg
- 4 <http://www.geonet.org.nz/canterbury-quakes/aftershocks/>
- 5 Rattenbury, M.S.; Townsend, D.B.; Johnston, M.R., 2006: Sheet 13 - Geology of the Kaikoura Area 1:250,000. Institute of Geological and Nuclear Sciences, Lower Hutt.
- 6 Pettinga J.R., Yetton M.D., Van Dissen R.J., and Downes G., 2001: Earthquake Source Identification and Characterisation for the Canterbury Region, South Island, New Zealand, Bulletin of the New Zealand Society for Earthquake Engineering, Vol 34, No. 4, pp 282-317
- 7 Selwyn District Council 2011: 2010 Canterbury Earthquake Liquefaction Report, Issue 05.6; Prepared by Geotech Consulting Ltd.
- 8 <http://koordinates.com/#/layer/3185-christchurch-post-earthquake-aerial-photos-24-feb-2011/>

- 9 New Zealand Geotechnical Society, 2005: Guideline for the Field Classification and Description of Soil and Rock for Engineering Purposes.
- 10 Standards Association of New Zealand, 2011: Timber Framed Buildings – New Zealand, NZS 3604:2011. Standards New Zealand, Wellington.

We also acknowledge the New Zealand GeoNet project and its sponsors EQC, GNS Science and LINZ, for providing data used in this report.

9 LIMITATIONS

- (i) This report has been prepared for the use of our client, R.D. Hughes Developments Ltd, their professional advisers and the relevant Territorial Authorities in relation to the specified project brief described in this report. No liability is accepted for the use of any part of the report for any other purpose or by any other person or entity.
- (ii) Assessments made in this report are based on the ground conditions indicated from published sources, site inspections and subsurface investigations described in this report based on accepted normal methods of site investigations. Variations in ground conditions may exist between test locations and therefore have not been taken into account in the report.
- (iii) This Limitation should be read in conjunction with the IPENZ/ACENZ Standard Terms of Engagement.

We trust that this information meets your current requirements. Please do not hesitate to contact the undersigned on 03 328 9012 if you require any further information.

For and on behalf of Geoscience Consulting (NZ) Ltd,

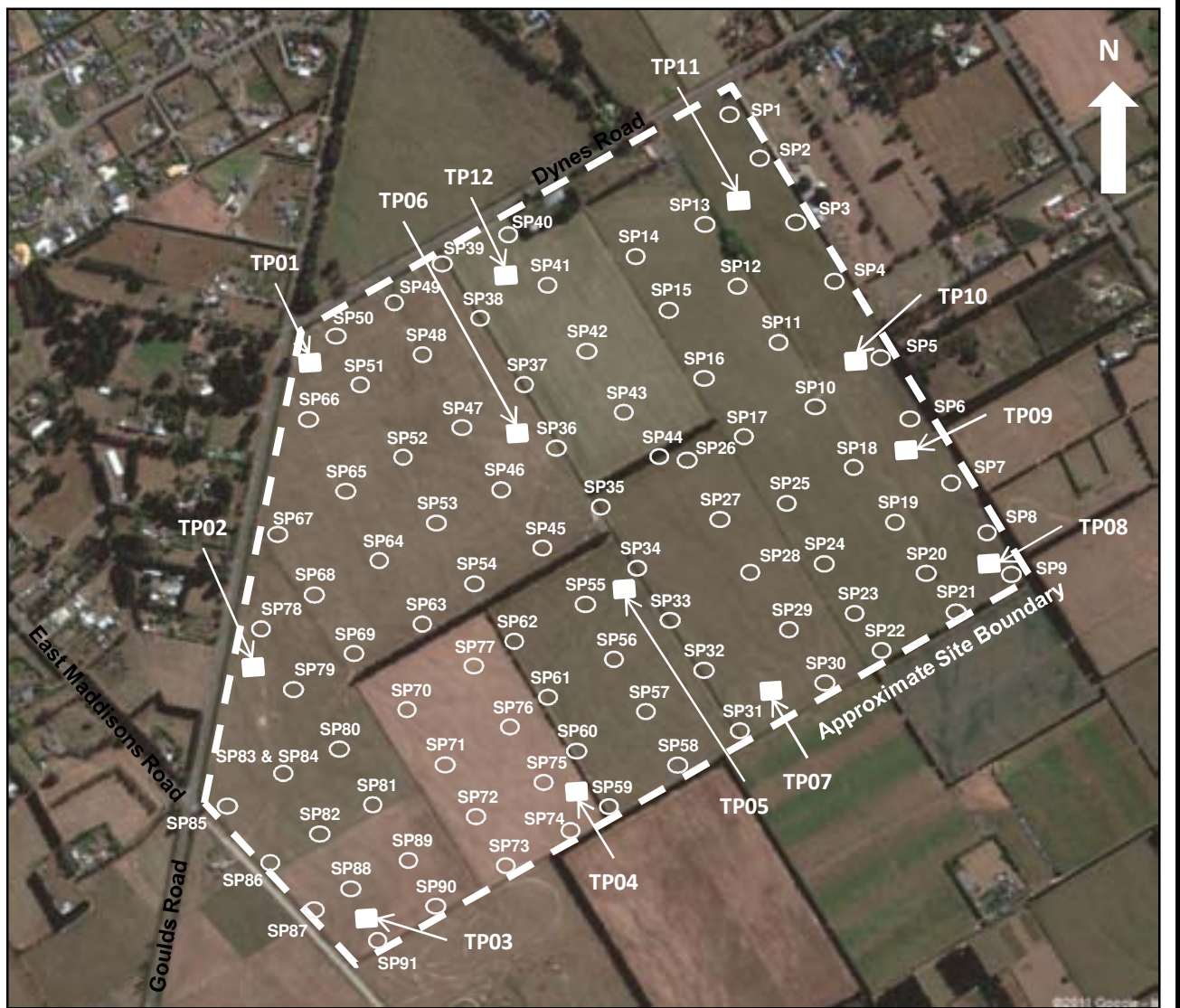
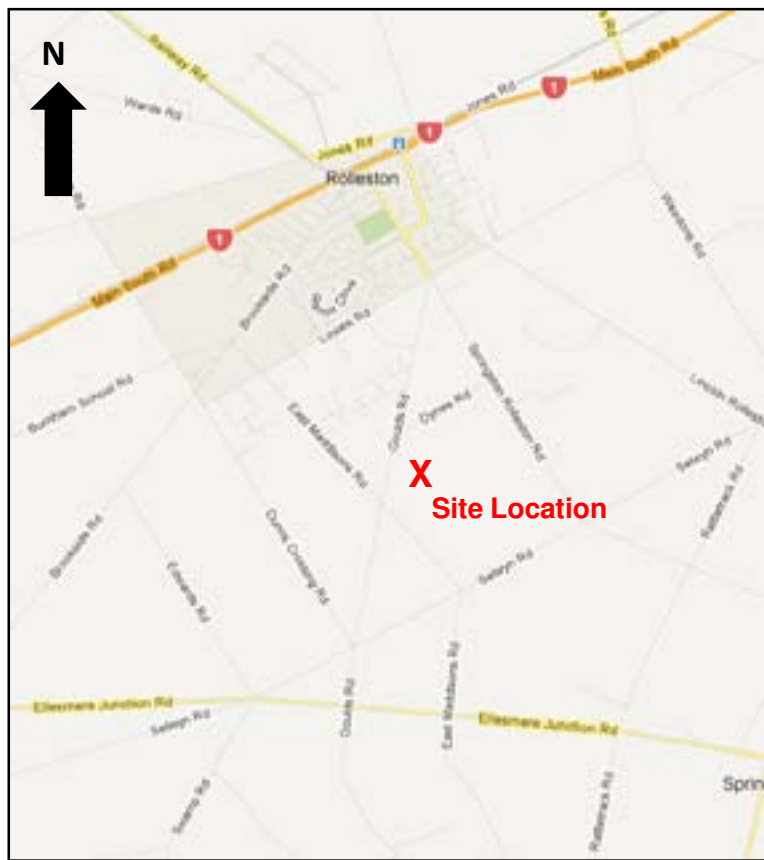


Greg Martin

Associate Engineering Geologist



FIGURES



- AutoScala Test Location
- = Test Pit Location

Note:
Map and aerial photograph courtesy of Google Maps



Date	Nov-11	Client	Hughes Construction Ltd		
Drawn by	CM	Project	Foster Block, Goulds Road, Rolleston		
Approved by	MW	Description	Site Location Plan		
Scale	NTS	Figure Number	1	Project Number	11283_1



APPENDIX 1

Site Photographs



Photo 1: View looking north east from centre of site.



Photo 2: View looking south.



Photo 3: View looking south east.



Photo 4: View looking west.



Photo 5: View of sub surface material in Test Pit 1.



Photo 6: Gravel removed from Test Pit.



Date taken	30/11/11	Client	R. D. Hughes Developments Ltd		
Taken by	RC	Project	Foster Block, Goulds Road, Rolleston		
Approved by	GM	Description	Site Photographs		
Scale	N/A	Photo No.	1 to 6	Project Number	11283_1



APPENDIX 2

Test Pit Logs

Engineering Log - Test Pit

Client: R. D. Hughes Developments Ltd
Principal: Kelvin Back
Project: Foster Block
Test Pit Location: Refer to Site Location Plan

Date Started: 30/11/2011
Date Completed: 30/11/2011
Logged By: JC/RC
Checked By: GM

Machine Type: 16 Tonne Digger
Excavation Dimensions: 2.00 by 3.00
Vane No.: N/A

Excavation Information				Material Substance						
Material	Water	Notes, samples, tests etc	Depth (m)	Graphic Log	Classification Symbol	Material	Moisture Condition	Consistency / Density Index	Shear Vane (Dial Readings kPa)	Scala (Blows/100mm)
						Soil - soil type, colour, structure, grading, bedding, plasticity, sensitivity; Secondary and minor components Rock - colour, fabric, rock type; discontinuities; additional information				2 4 6 8
TOPSOIL			0.2	TS	ML	SILT with minor sand; dark brown. Low plasticity. [TOPSOIL]	D	St		
			0.4	TS						
			0.6	[GRAVEL LOG]	GW	Sandy fine to coarse GRAVEL; brown, rounded, well graded. Sand is medium to coarse.	D	MD		
		0.8								
		1.0								
		1.2								
		1.4		[SAND LENSE LOG]	GW	Coarse SAND lense.	D-M	MD		
		1.6								
		1.8								
		2.0								
		2.2		[SAND LENSE LOG]	GW	Coarse SAND lense.				
		2.4								
		2.6								
		2.8								
		3.0		[SAND LENSE LOG]	GW					
		3.2								
		3.4								
		3.6								

EOH: 3.6 m
Termination: Target depth
Notes:
 Met target depth at 3.6 m. No groundwater encountered.

Sketch/Photo



Engineering Log - Test Pit

Client: R. D. Hughes Developments Ltd
Principal: Kelvin Back
Project: Foster Block
Test Pit Location: Refer to Site Location Plan

Date Started: 30/11/2011
Date Completed: 30/11/2011
Logged By: JC/RC
Checked By: GM

Machine Type: 16 Tonne Digger
Excavation Dimensions: 2.00 by 3.00
Vane No.: N/A

Excavation Information				Material Substance							
Material	Water	Notes, samples, tests etc	Depth (m)	Graphic Log	Classification Symbol	Material	Moisture Condition	Consistency / Density Index	Shear Vane (Dial Readings kPa)	Scala (Blows/100mm)	
						Soil - soil type, colour, structure, grading, bedding, plasticity, sensitivity; Secondary and minor components Rock - colour, fabric, rock type; discontinuities; additional information				2 4 6 8	
TOPSOIL			0.2	TS	ML	SILT with trace fine sand; dark brown, friable. Low plasticity. [TOPSOIL]	D	St			
ALLUVIUM			0.4	[Graphic Log: Sandy fine to coarse gravel]	GW	Sandy fine to coarse GRAVEL; brown, rounded, well graded. Sand is fine to coarse.	D	MD			
			0.6								
			0.8								
			1.0								
			1.2								
			1.4							D-M	D
			1.6								
			1.8								
			2.0								
			2.2							GW	
		2.4									
		2.6									
		2.8									
		3.0									

EOH: 3 m
Termination: Target depth
Notes: Met target depth at 3.0 m. No groundwater encountered.

Sketch/Photo



Engineering Log - Test Pit

Client: R. D. Hughes Developments Ltd
Principal: Kelvin Back
Project: Foster Block
Test Pit Location: Refer to Site Location Plan

Date Started: 30/11/2011
Date Completed: 30/11/2011
Logged By: JC/RC
Checked By: GM

Machine Type: 16 Tonne Digger
Excavation Dimensions: 2.00 by 3.00
Vane No.: N/A

Excavation Information				Material Substance						
Material	Water	Notes, samples, tests etc	Depth (m)	Graphic Log	Classification Symbol	Material	Moisture Condition	Consistency / Density Index	Shear Vane (Dial Readings kPa)	Scala (Blows/100mm)
						Soil - soil type, colour, structure, grading, bedding, plasticity, sensitivity; Secondary and minor components Rock - colour, fabric, rock type; discontinuities; additional information				2 4 6 8
TOPSOIL			0.2	TS	ML	SILT with trace fine sand; dark brown, friable. Low plasticity. [TOPSOIL]	D	St		
ALLUVIUM			0.4	[Graphic Log: Pattern of dots and dashes]	GW	Sandy fine to coarse GRAVEL; brown, well graded, rounded. Sand is fine to coarse.	D-M	MD		
			0.6							
			0.8							
			1.0							
			1.2							
			1.4							
			1.6							
			1.8							
			2.0							
			2.2							
			2.4							
			2.6							
			2.8							
			3.0							
			3.2							
			3.4							
			3.6							
		3.8								
		4.0								

EOH: 4 m
Termination: Target depth
Notes: Met target depth at 4.0 m. No groundwater encountered.

Sketch/Photo



Engineering Log - Test Pit

Client: R. D. Hughes Developments Ltd
Principal: Kelvin Back
Project: Foster Block
Test Pit Location: Refer to Site Location Plan

Date Started: 30/11/2011
Date Completed: 30/11/2011
Logged By: JC/RC
Checked By: GM

Machine Type: 16 Tonne Digger Excavation Dimensions: 2.00 by 3.00 Vane No.: N/A										
Excavation Information				Material Substance						
Material	Water	Notes, samples, tests etc	Depth (m)	Graphic Log	Classification Symbol	Material	Moisture Condition	Consistency / Density Index	Shear Vane (Dial Readings kPa)	Scala (Blows/100mm)
						Soil - soil type, colour, structure, grading, bedding, plasticity, sensitivity; Secondary and minor components Rock - colour, fabric, rock type; discontinuities; additional information				2 4 6 8
TOPSOIL			0.2	TS	ML	SILT with trace sand; dark brown, friable. Low plasticity. [TOPSOIL]	D	St		
ALLUVIUM			0.4	[Graphic Log: Pattern of dots and dashes]	GW	Sandy fine to coarse GRAVEL; brown, well graded, rounded. Sand is fine to coarse.	D	D		
		0.6								
		0.8								
		1.0								
		1.2								
	1.4									
	1.6									
	1.8									
	2.0				GW	Medium SAND lense	D-M	D		

EOH: 2 m
Termination: Target depth
Notes:
 Met target depth at 2.0 m. No groundwater encountered.

Sketch/Photo



Engineering Log - Test Pit

Client: R. D. Hughes Developments Ltd
Principal: Kelvin Back
Project: Foster Block
Test Pit Location: Refer to Site Location Plan

Date Started: 30/11/2011
Date Completed: 30/11/2011
Logged By: JC/RC
Checked By: GM

Machine Type: 16 Tonne Digger
Excavation Dimensions: 2.00 by 3.00
Vane No.: N/A

Excavation Information				Material Substance									
Material	Water	Notes, samples, tests etc	Depth (m)	Graphic Log	Classification Symbol	Material	Moisture Condition	Consistency / Density Index	Shear Vane (Dial Readings kPa)	Scala (Blows/100mm)			
						Soil - soil type, colour, structure, grading, bedding, plasticity, sensitivity; Secondary and minor components Rock - colour, fabric, rock type; discontinuities; additional information				2 4 6 8			
TOPSOIL			0.2	TS	ML	SILT with minor sand; dark brown, friable. Low plasticity. [TOPSOIL]	D	St					
			0.4		SP	Fine to medium SAND; brown, poorly graded.	D	L					
ALLUVIUM			0.6		GW	Sandy fine to coarse GRAVEL; brown, rounded, well graded. Sand is fine to coarse.	D-M	MD					
			0.8										
			1.0										
			1.2										
			1.4										
			1.6										
			1.8										
			2.0										
			2.2										
			2.4										
			2.6										
			2.8										
			3.0										

EOH: 3 m
Termination: Target depth
Notes: Met target depth at 3.0 m. No groundwater encountered.

Sketch/Photo


















Engineering Log - Test Pit

Client: R. D. Hughes Developments Ltd
Principal: Kelvin Back
Project: Foster Block
Test Pit Location: Refer to Site Location Plan

Date Started: 30/11/2011
Date Completed: 30/11/2011
Logged By: JC/RC
Checked By: GM

Machine Type: 16 Tonne Digger
Excavation Dimensions: 2.00 by 3.00
Vane No.: N/A

Excavation Information				Material Substance						
Material	Water	Notes, samples, tests etc	Depth (m)	Graphic Log	Classification Symbol	Material	Moisture Condition	Consistency / Density Index	Shear Vane (Dial Readings kPa)	Scala (Blows/100mm)
						Soil - soil type, colour, structure, grading, bedding, plasticity, sensitivity; Secondary and minor components Rock - colour, fabric, rock type; discontinuities; additional information				2 4 6 8
DPSG			0.2		ML	SILT with trace sand; dark brown. Low plasticity. [TOPSOIL]	D	St		
ALLUVIUM			0.4		GW	Sandy fine to coarse GRAVEL; brown, well graded, rounded. Sand is fine to coarse.	D	MD		
			0.6							
			0.8							
			1							
			1.2							
			1.4							
			1.6							
			1.8							
			2							
			2.2							
			2.4							
			2.6							
			2.8							
			3							

EOH: 3 m
Termination: Target depth
Notes: Met target depth at 3.0 m. No groundwater encountered.

Sketch/Photo



Engineering Log - Test Pit

Client: R. D. Hughes Developments Ltd
Principal: Kelvin Back
Project: Foster Block
Test Pit Location: Refer to Site Location Plan

Date Started: 30/11/2011
Date Completed: 30/11/2011
Logged By: JC/RC
Checked By: GM

Machine Type: 16 Tonne Digger Excavation Dimensions: 2.00 by 3.00 Vane No.: N/A													
Excavation Information				Material Substance									
Material	Water	Notes, samples, tests etc	Depth (m)	Graphic Log	Classification Symbol	Material	Moisture Condition	Consistency / Density Index	Shear Vane (Dial Readings kPa)	Scala (Blows/100mm)			
						Soil - soil type, colour, structure, grading, bedding, plasticity, sensitivity; Secondary and minor components Rock - colour, fabric, rock type; discontinuities; additional information				2 4 6 8			
TOPSOIL			0.2	TS	ML	SILT with minor sand; dark brown. Low plasticity. [TOPSOIL]	D	St					
ALLUVIUM			0.4		GW	Sandy fine to coarse GRAVEL; brown, rounded, well graded. Sand is medium to coarse.	D	MD					
			0.6										
			0.8										
			1.0										
			1.2										
			1.4										
			1.6										
			1.8										
			2.0										

EOH: 2 m
Termination: Target depth
Notes:
 Met target depth at 2.0 m. No groundwater encountered.

Sketch/Photo



Engineering Log - Test Pit

Client: R. D. Hughes Developments Ltd
Principal: Kelvin Back
Project: Foster Block
Test Pit Location: Refer to Site Location Plan

Date Started: 30/11/2011
Date Completed: 30/11/2011
Logged By: JC/RC
Checked By: GM

Machine Type: 16 Tonne Digger Excavation Dimensions: 2.00 by 3.00 Vane No.: N/A													
Excavation Information				Material Substance									
Material	Water	Notes, samples, tests etc	Depth (m)	Graphic Log	Classification Symbol	Material Soil - soil type, colour, structure, grading, bedding, plasticity, sensitivity; Secondary and minor components Rock - colour, fabric, rock type; discontinuities; additional information	Moisture Condition	Consistency / Density Index	Shear Vane (Dial Readings kPa)	Scala (Blows/100mm)			
										2 4 6 8			
TOPSOIL			0.2	TS	ML	SILT with minor sand; dark brown. Low plasticity. [TOPSOIL]	D	St					
			0.4		SM	Silty fine SAND; light brown. Well graded.	D	L					
ALLUVIUM			0.6		GW	Sandy fine to coarse GRAVEL; brown, rounded, well graded. Sand is fine to coarse.	D	L-MD					
			0.8										
			1.0										
			1.2										
			1.4										
			1.6										
			1.8										
			2.0										
			2.2										

EOH: 2.3 m
 Termination: Target depth
 Notes:
 Met target depth at 2.3 m. No groundwater encountered.











Sketch/Photo



Engineering Log - Test Pit

Client: R. D. Hughes Developments Ltd
Principal: Kelvin Back
Project: Foster Block
Test Pit Location: Refer to Site Location Plan

Date Started: 30/11/2011
Date Completed: 30/11/2011
Logged By: JC/RC
Checked By: GM

Machine Type: 16 Tonne Digger Excavation Dimensions: 2.00 by 3.00 Vane No.: N/A											
Excavation Information				Material Substance							
Material	Water	Notes, samples, tests etc	Depth (m)	Graphic Log	Classification Symbol	Material	Moisture Condition	Consistency / Density Index	Shear Vane (Dial Readings kPa)	Scala (Blows/100mm)	
						Soil - soil type, colour, structure, grading, bedding, plasticity, sensitivity; Secondary and minor components Rock - colour, fabric, rock type; discontinuities; additional information				2 4 6 8	
TS			0.2		ML	Silt with trace sand; dark brown. Low plasticity. [TOPSOIL]	D	St			
ALLUVIUM			0.4		GW	Sandy fine to coarse GRAVEL; brown, well graded, rounded. Sand is fine to coarse.	D	D			
			0.6								
			0.8								
			1.0								
			1.2								
			1.4								
			1.6								
			1.8								
			2.0								

EOH: 2 m
 Termination: Target depth
 Notes: Met target depth at 2.0 m. No groundwater encountered.











Sketch/Photo



Engineering Log - Test Pit

Client: R. D. Hughes Developments Ltd
Principal: Kelvin Back
Project: Foster Block
Test Pit Location: Refer to Site Location Plan

Date Started: 30/11/2011
Date Completed: 30/11/2011
Logged By: JC/RC
Checked By: GM

Machine Type: 16 Tonne Digger Excavation Dimensions: 2.00 by 3.00 Vane No.: N/A										
Excavation Information				Material Substance						
Material	Water	Notes, samples, tests etc	Depth (m)	Graphic Log	Classification Symbol	Material	Moisture Condition	Consistency / Density Index	Shear Vane (Dial Readings kPa)	Scala (Blows/100mm)
						Soil - soil type, colour, structure, grading, bedding, plasticity, sensitivity; Secondary and minor components Rock - colour, fabric, rock type; discontinuities; additional information				2 4 6 8
PS			0.2		ML	SILT with trace sand; dark brown. Low plasticity. [TOPSOIL]	D	St		
ALLUVIUM			0.4		GW	Sandy fine to coarse GRAVEL; brown, well graded, rounded. Sand is fine to medium.	D	L-MD		
			0.6							
			0.8							
			1.0							
			1.2							
			1.4							
			1.6							
			1.8							
			2.0		GW	Medium SAND lense.				

EOH: 2 m
 Termination: Target depth
 Notes:
 Met target depth at 2.0 m. No groundwater encountered.

Sketch/Photo


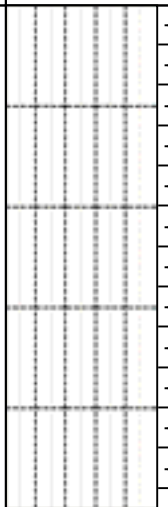


Engineering Log - Test Pit

Client: R. D. Hughes Developments Ltd
Principal: Kelvin Back
Project: Foster Block
Test Pit Location: Refer to Site Location Plan

Date Started: 30/11/2011
Date Completed: 30/11/2011
Logged By: JC/RC
Checked By: GM

Machine Type: 16 Tonne Digger
Excavation Dimensions: 2.00 by 3.00
Vane No.: N/A

Excavation Information				Material Substance						
Material	Water	Notes, samples, tests etc	Depth (m)	Graphic Log	Classification Symbol	Material	Moisture Condition	Consistency / Density Index	Shear Vane (Dial Readings kPa)	Scala (Blows/100mm)
						Soil - soil type, colour, structure, grading, bedding, plasticity, sensitivity; Secondary and minor components Rock - colour, fabric, rock type; discontinuities; additional information				2 4 6 8
PS			0.2		ML	SILT with trace sand; dark brown. Low plasticity. [TOPSOIL]	D	St		
			0.4		GW	Sandy fine to coarse GRAVEL; brown, rounded, well graded. Sand is fine to medium.	D	MD		
			0.6							
			0.8							
			1		GW	Medium SAND lense.		L		
			1.2							
			1.4							
			1.6							
			1.8		GW	Medium SAND lense.				
			2							
			2.2							
			2.4							

EOH: 2.5 m
Termination: Target depth
Notes:
 Met target depth at 2.5 m. No groundwater encountered.











Sketch/Photo



Engineering Log - Test Pit

Client: R. D. Hughes Developments Ltd
Principal: Kelvin Back
Project: Foster Block
Test Pit Location: Refer to Site Location Plan

Date Started: 30/11/2011
Date Completed: 30/11/2011
Logged By: JC/RC
Checked By: GM

Machine Type: 16 Tonne Digger Excavation Dimensions: 2.00 by 3.00 Vane No.: N/A										
Excavation Information				Material Substance						
Material	Water	Notes, samples, tests etc	Depth (m)	Graphic Log	Classification Symbol	Material	Moisture Condition	Consistency / Density Index	Shear Vane (Dial Readings kPa)	Scala (Blows/100mm)
						Soil - soil type, colour, structure, grading, bedding, plasticity, sensitivity; Secondary and minor components Rock - colour, fabric, rock type; discontinuities; additional information				2 4 6 8
DPSG			0.2		ML	SILT with trace sand; dark brown. Low plasticity. [TOPSOIL]	D	St		
			0.4		SW	Fine to medium SAND; light brown. Well graded.	D	MD		
ALLUVIUM			0.6		GW	Sandy fine to coarse GRAVEL; brown, well graded, rounded. Sand is fine to coarse.	D	D		
		0.8								
		1.0								
		1.2								
			1.4							
			1.6							
			1.8							
			2.0							

EOH: 2 m
 Termination: Target depth
 Notes: Met target depth at 2.0 m. No groundwater encountered.

Sketch/Photo

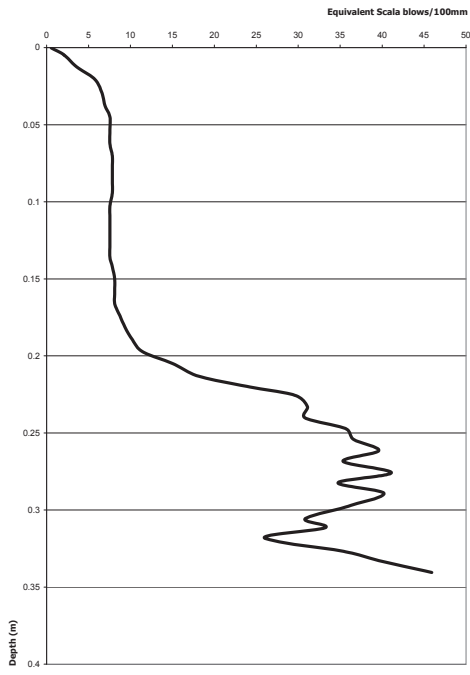




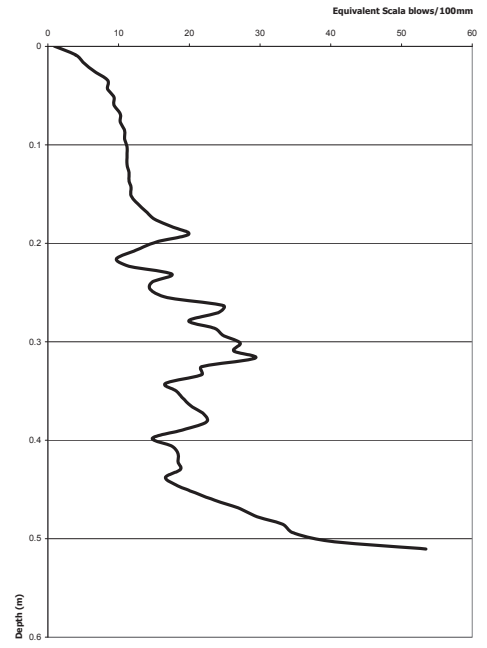
APPENDIX 3

AutoScala (Penetrometer) Logs

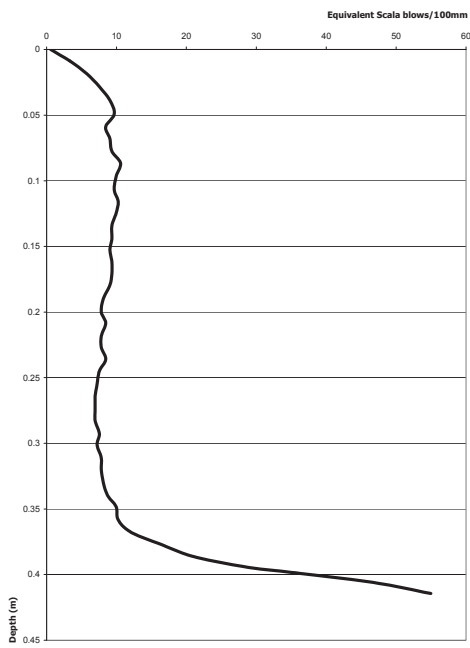
Foster Block Site1
Canterbury Geotest AutoScala Machine



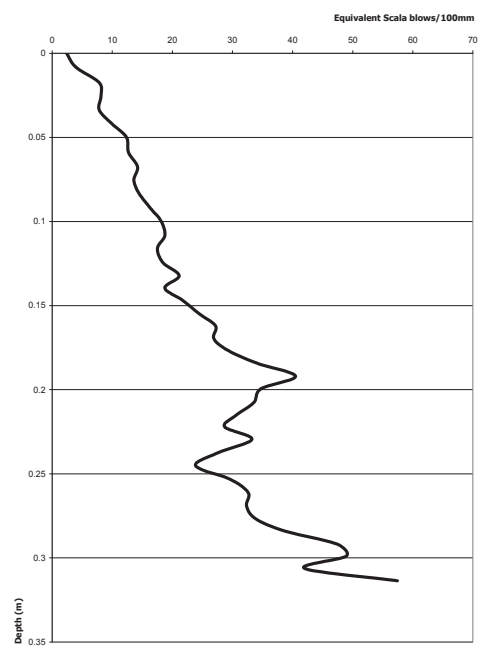
Foster Block Site 2
Canterbury Geotest AutoScala Machine



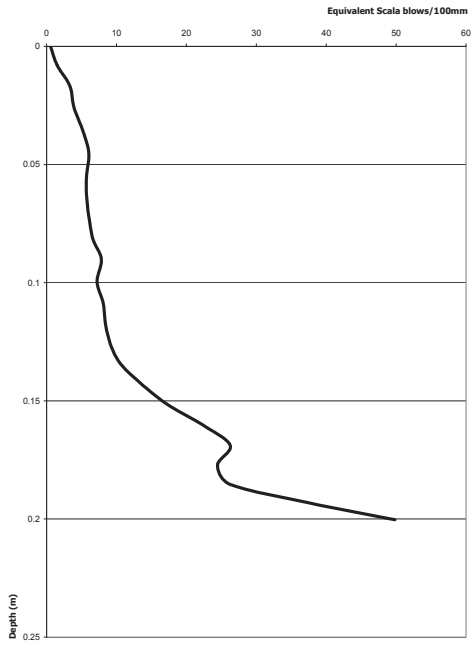
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Canterbury Geotest AutoScala Machine



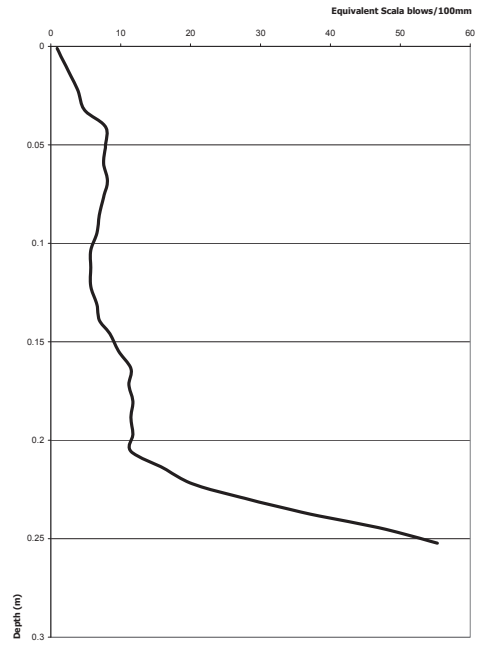
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Canterbury Geotest AutoScala Machine



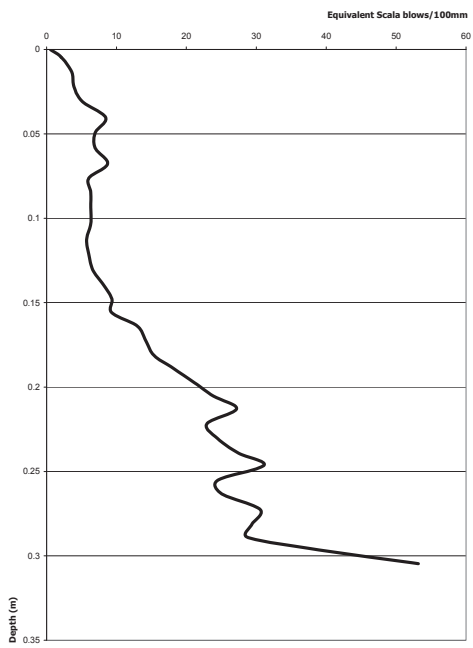
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Canterbury Geotest AutoScala Machine



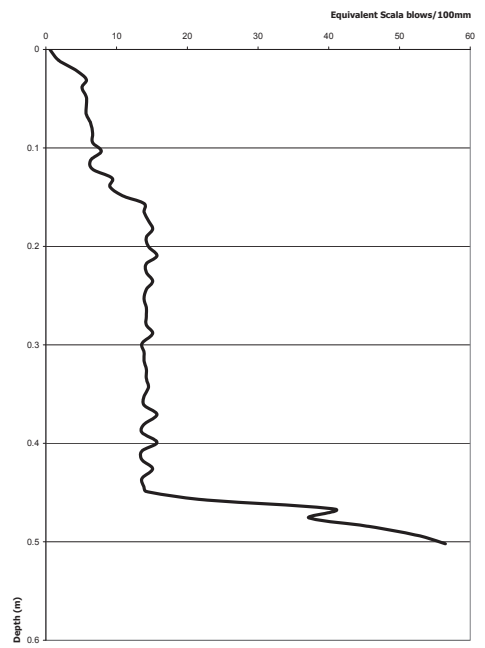
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Canterbury Geotest AutoScala Machine



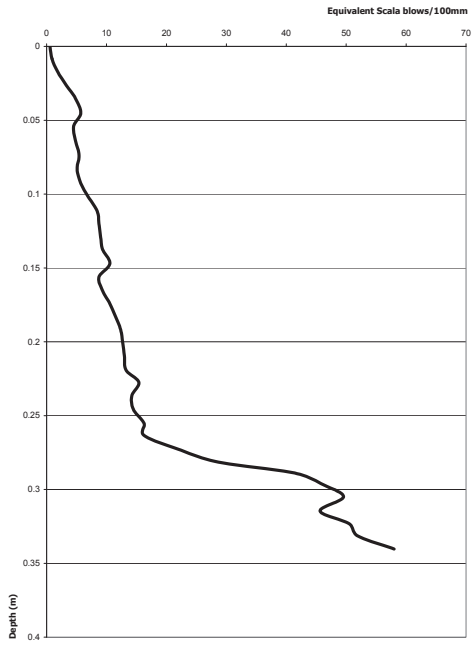
Foster Block Site 7
Canterbury Geotest AutoScala Machine



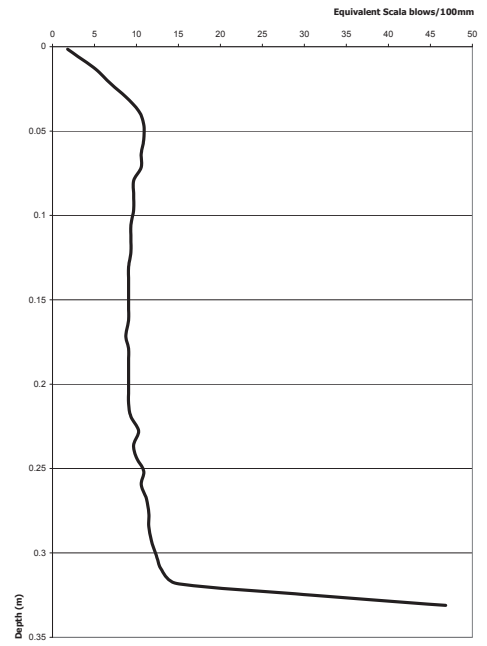
Foster Block Site 8
Canterbury Geotest AutoScala Machine



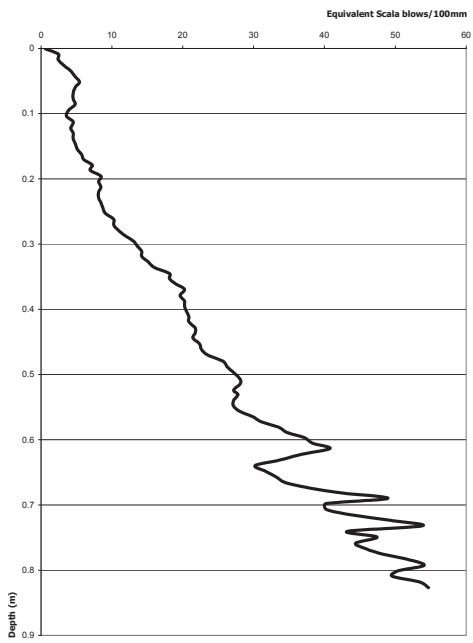
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Canterbury Geotest AutoScala Machine



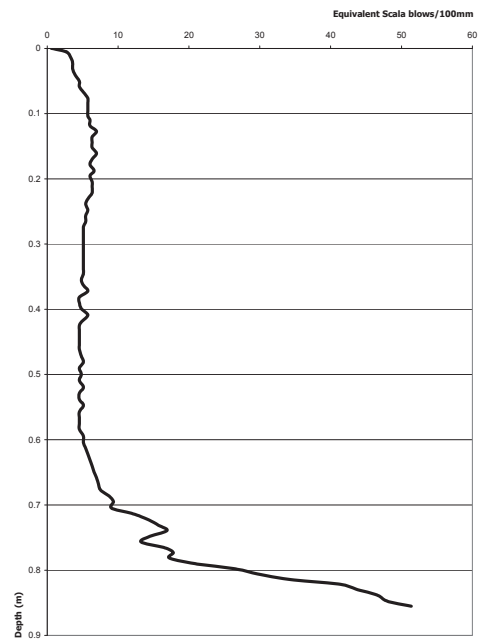
Foster Block Site 10
Canterbury Geotest AutoScala Machine 1/12/2011



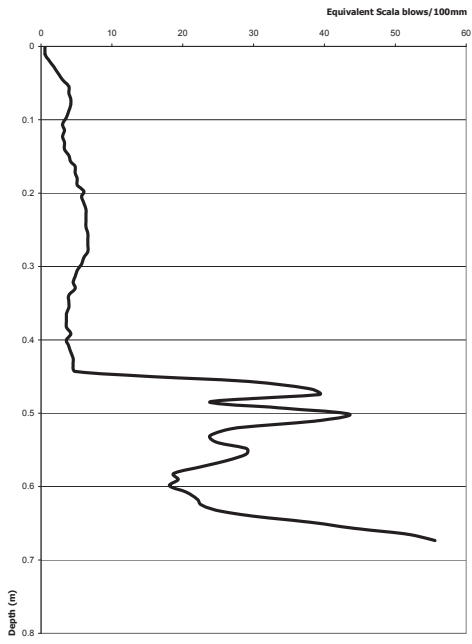
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Canterbury Geotest AutoScala Machine



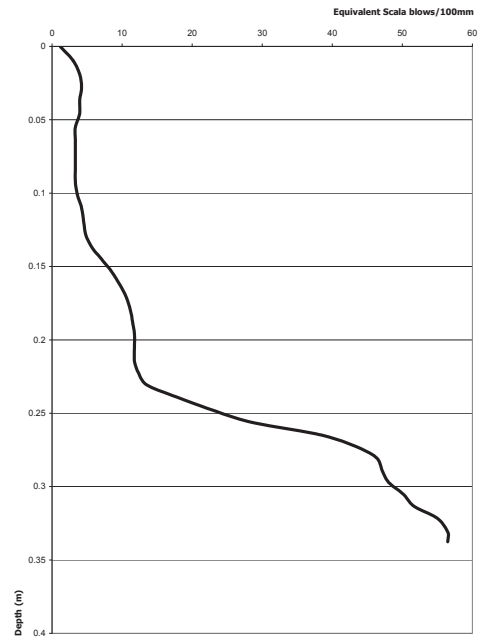
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Canterbury Geotest AutoScala Machine



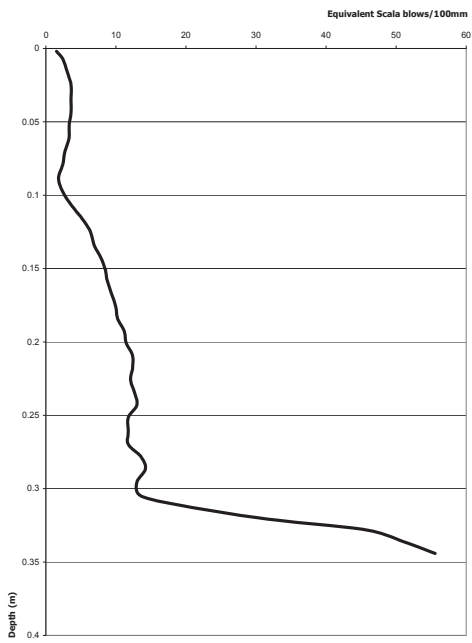
Foster Block Site 13
Canterbury Geotest AutoScala Machine



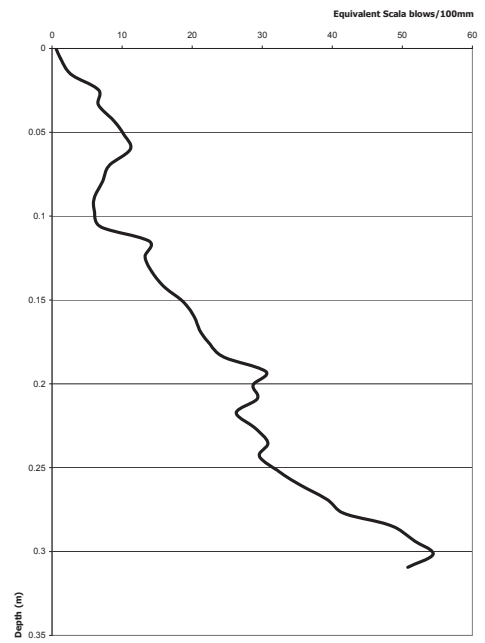
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Canterbury Geotest AutoScala Machine



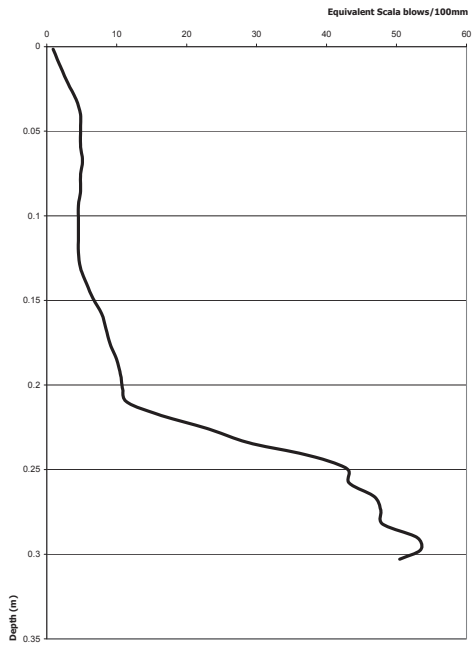
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Canterbury Geotest AutoScala Machine



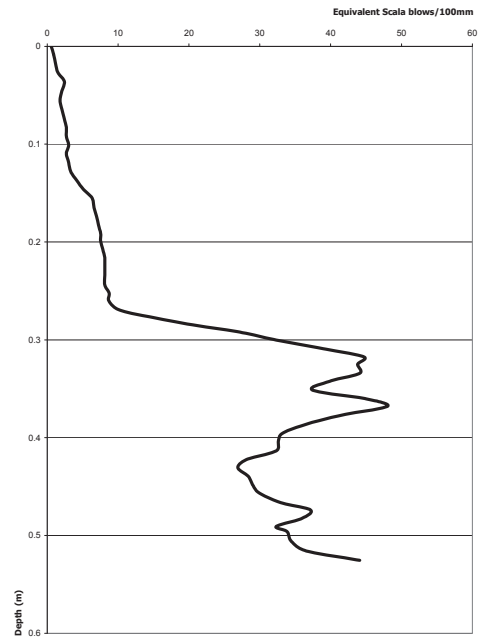
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Canterbury Geotest AutoScala Machine



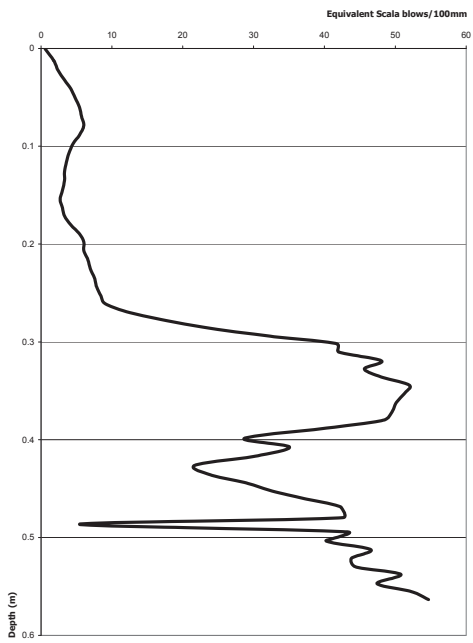
Foster Block Site 17
Canterbury Geotest AutoScala Machine



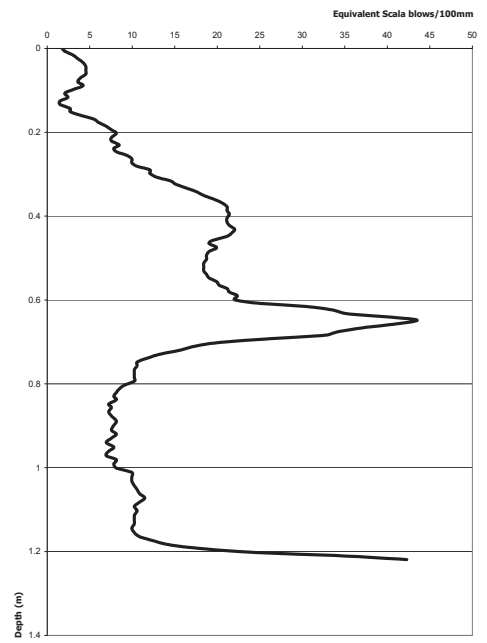
Foster Block Site 18
Canterbury Geotest AutoScala Machine



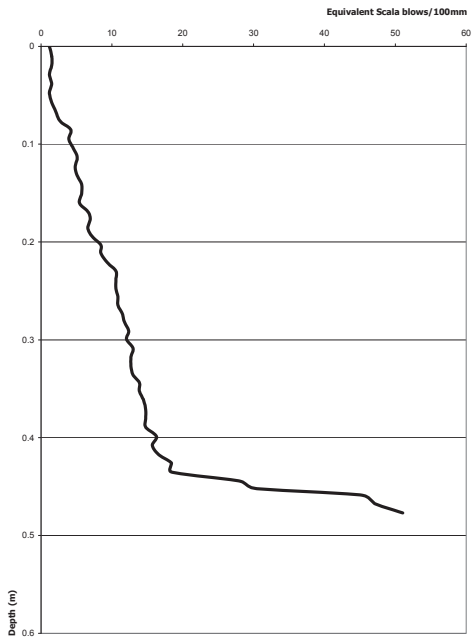
Foster Block Site 19
Canterbury Geotest AutoScala Machine



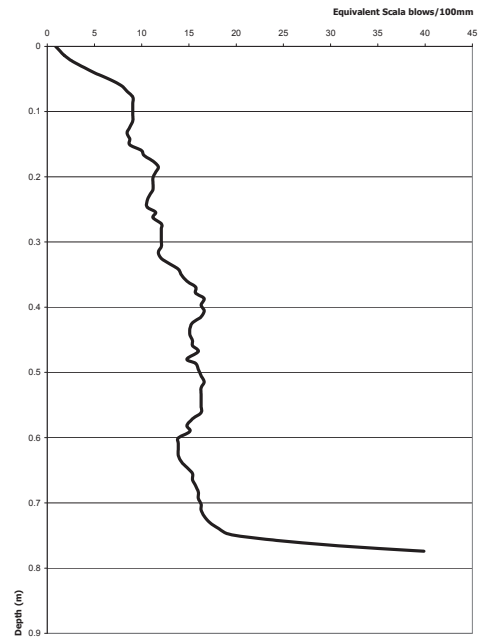
Foster Block Site 20
Canterbury Geotest AutoScala Machine



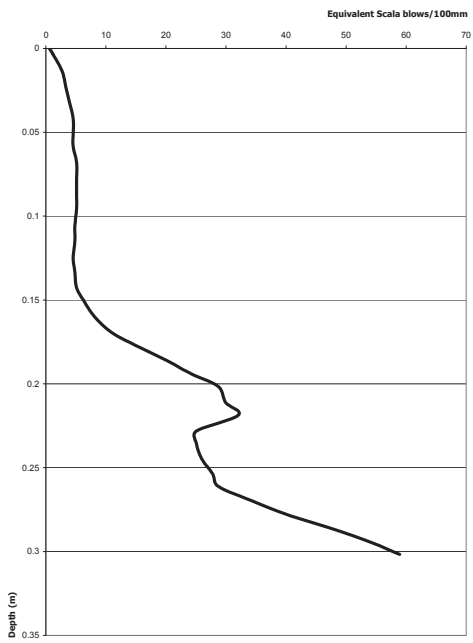
Foster Block Site 21
Canterbury Geotest AutoScala Machine



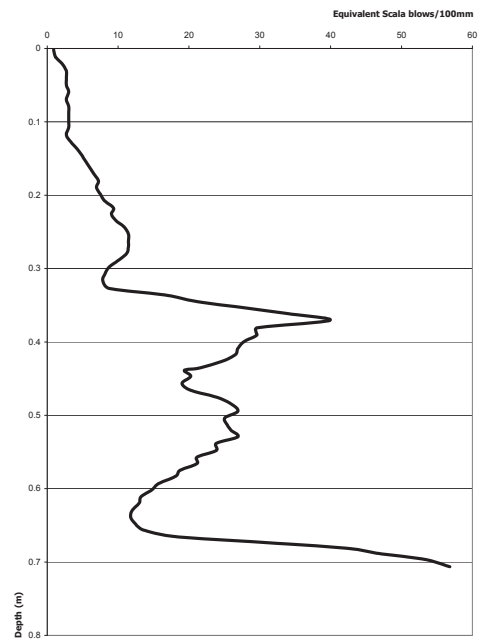
Foster Block Site 22
Canterbury Geotest AutoScala Machine



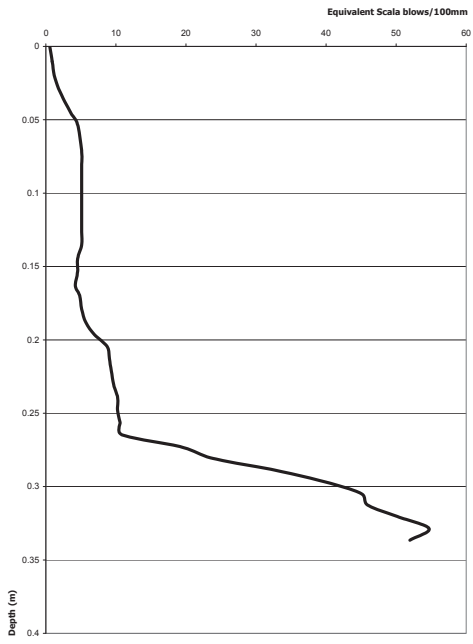
Foster Block Site 23
Canterbury Geotest AutoScala Machine



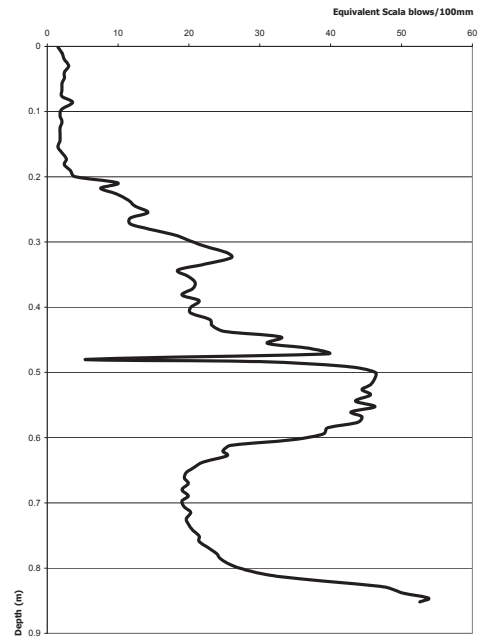
Foster Block Site 24
Canterbury Geotest AutoScala Machine



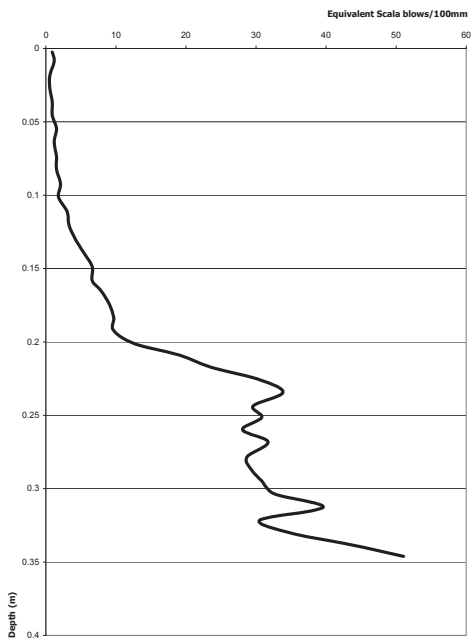
Foster Block Site 25
Canterbury Geotest AutoScala Machine



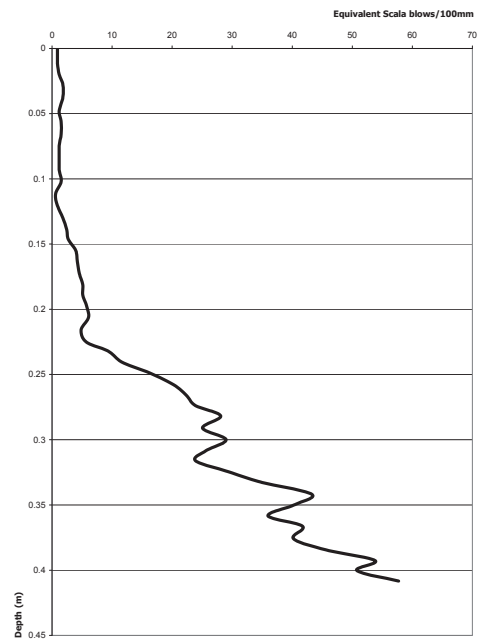
Foster Block Site 26
Canterbury Geotest AutoScala Machine



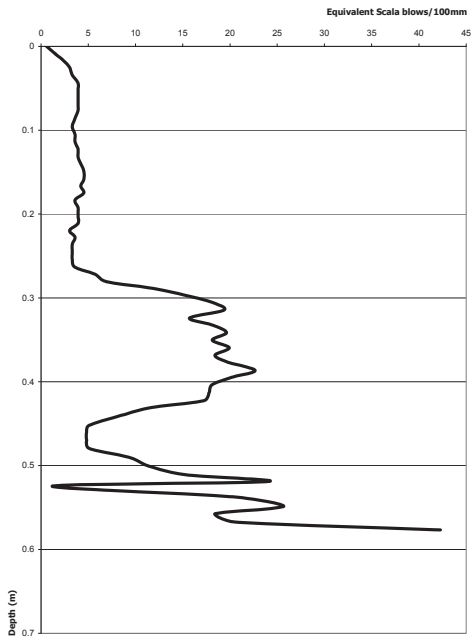
Foster Block Site 27
Canterbury Geotest AutoScala Machine



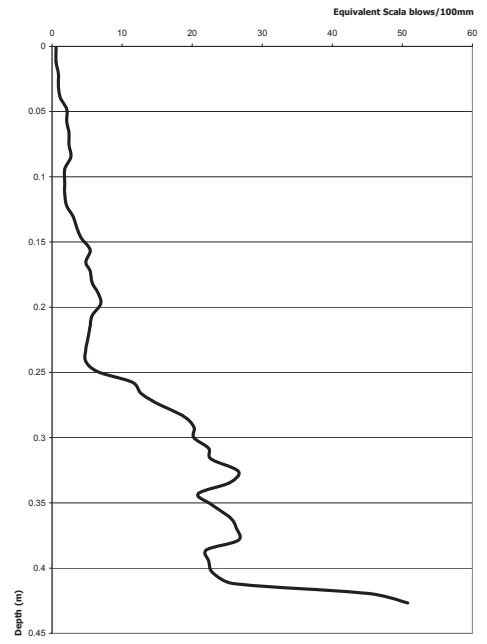
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Canterbury Geotest AutoScala Machine



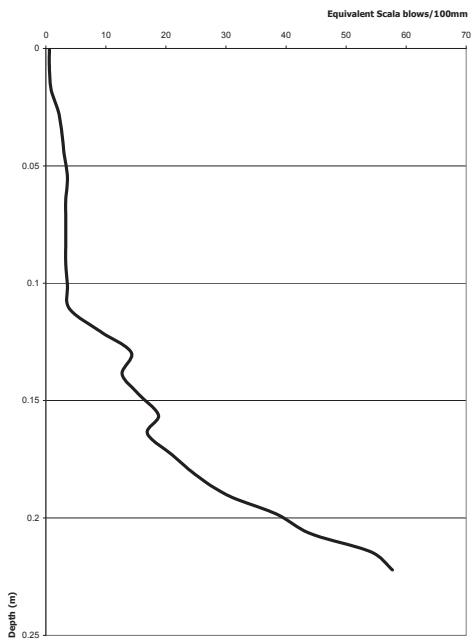
Foster Block Site 29
Canterbury Geotest AutoScala Machine



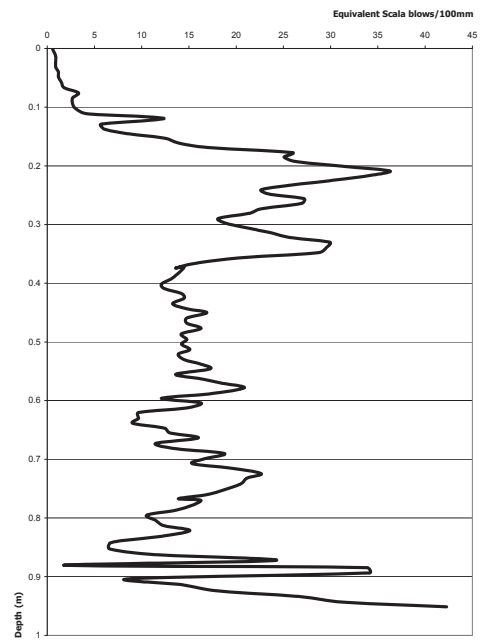
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Canterbury Geotest AutoScala Machine



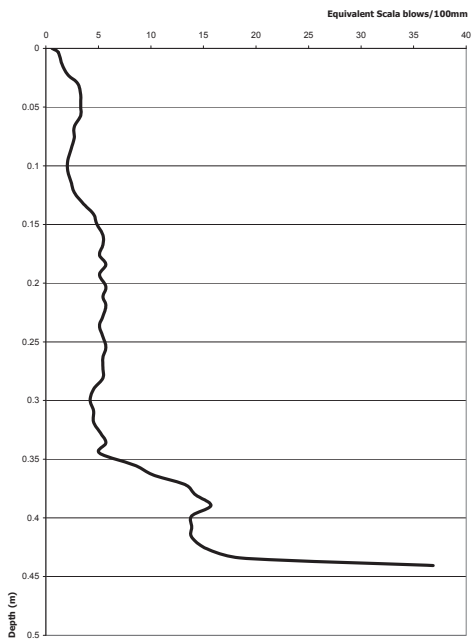
Foster Block Site 31
Canterbury Geotest AutoScala Machine



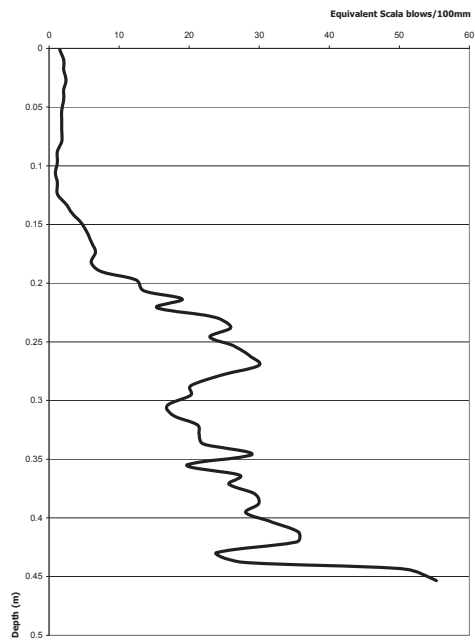
Foster Block Site 32
Canterbury Geotest AutoScala Machine



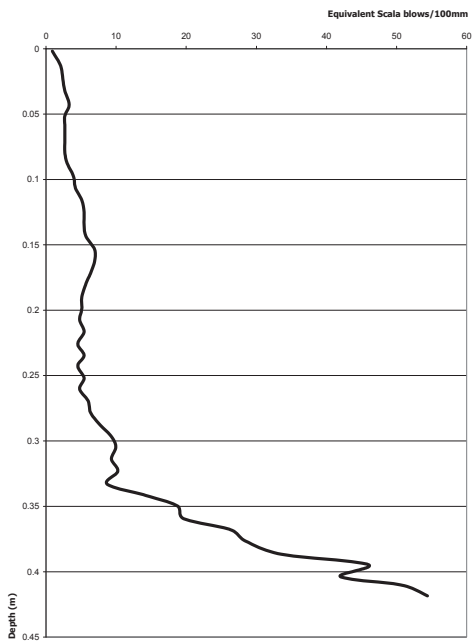
Foster Block Site 33
Canterbury Geotest AutoScala Machine



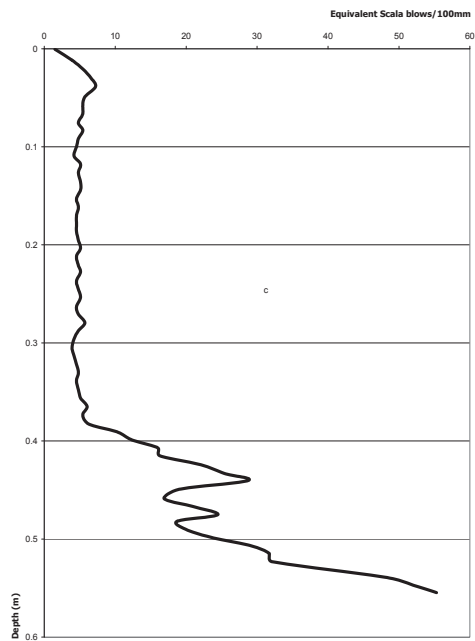
Foster Block Site 34
Canterbury Geotest AutoScala Machine



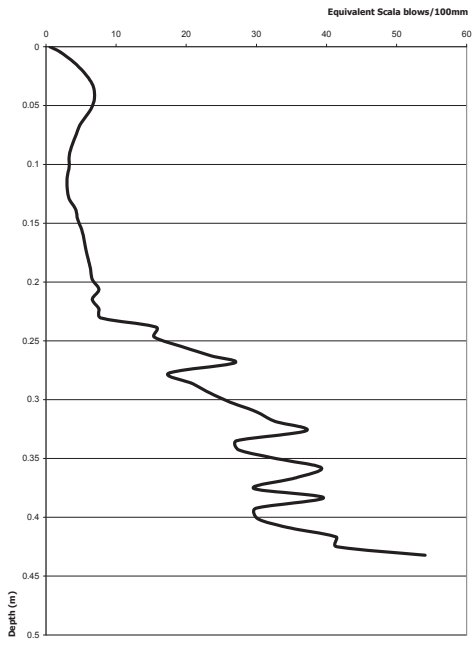
Foster Block Site 35
Canterbury Geotest AutoScala Machine



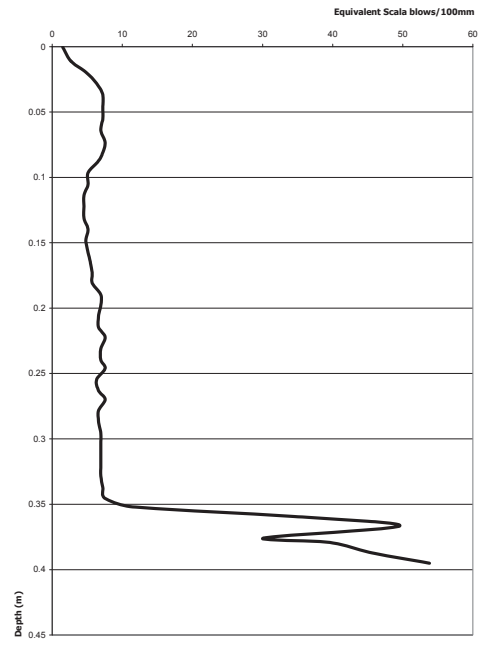
Foster Block Site 36
Canterbury Geotest AutoScala Machine



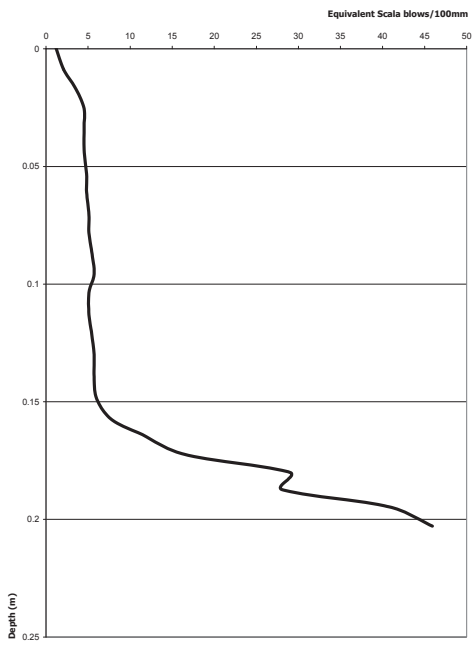
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Canterbury Geotest AutoScala Machine



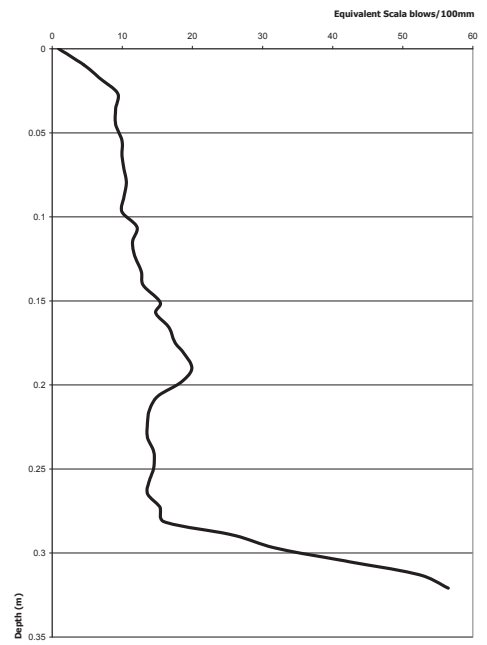
Foster Block Site 38
Canterbury Geotest AutoScala Machine



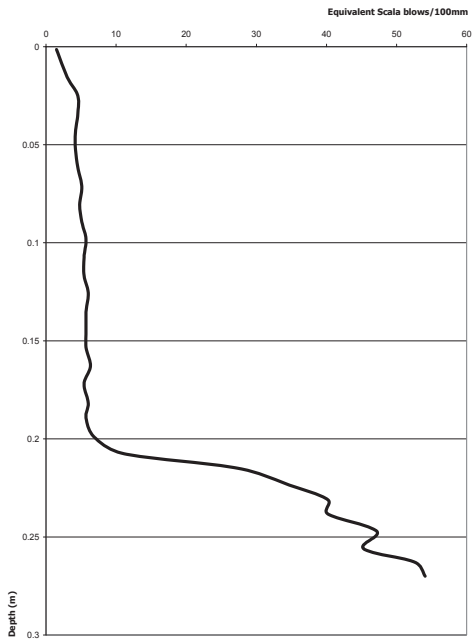
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Canterbury Geotest AutoScala Machine



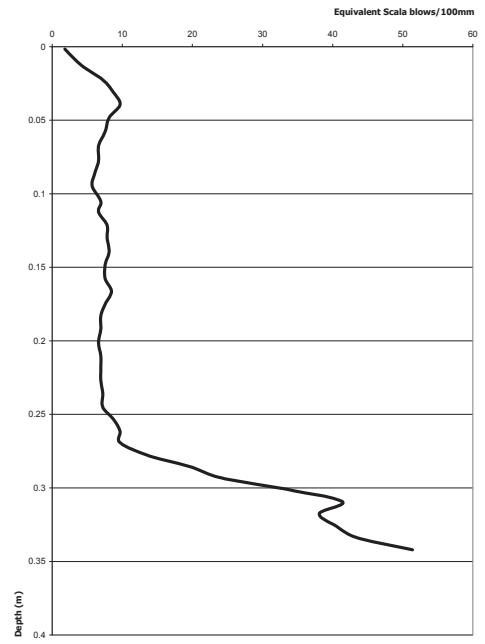
Foster Block Site 40
Canterbury Geotest AutoScala Machine



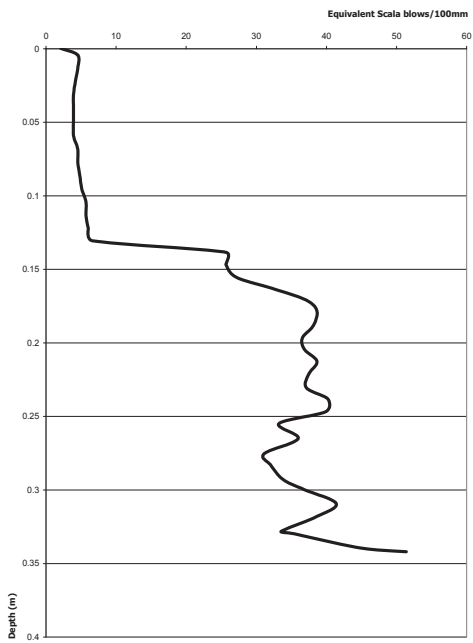
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Canterbury Geotest AutoScala Machine



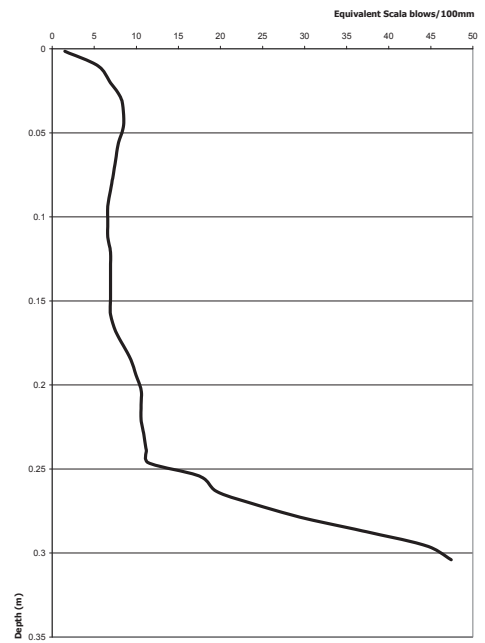
Foster Block Site 42
Canterbury Geotest AutoScala Machine



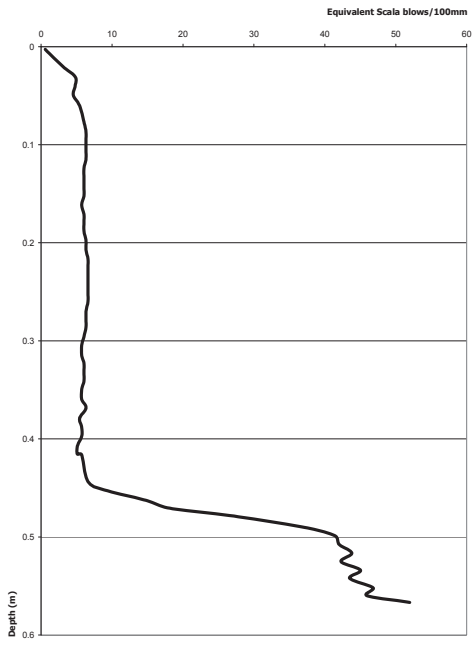
Foster Block Site 43
Canterbury Geotest AutoScala Machine



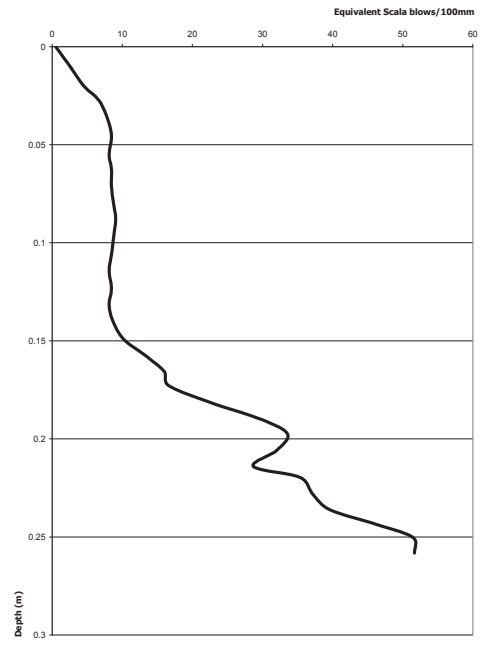
Foster Block Site 44
Canterbury Geotest AutoScala Machine



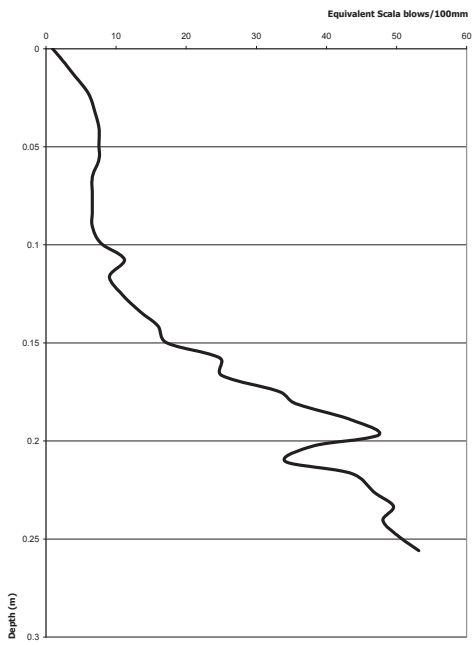
Foster Block Site 45
Canterbury Geotest AutoScala Machine



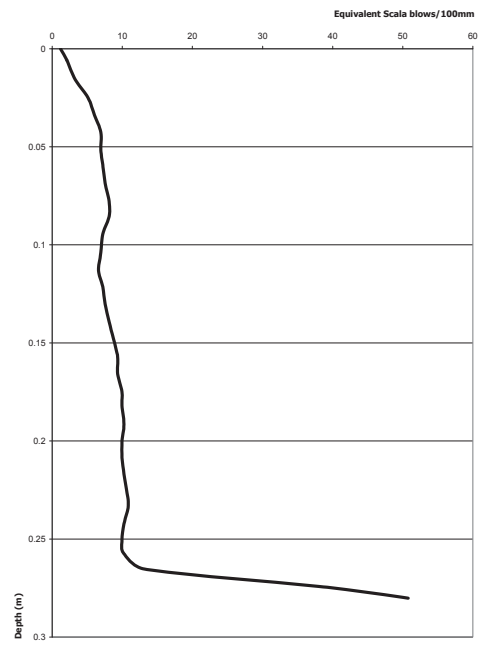
Foster Block Site 46
Canterbury Geotest AutoScala Machine



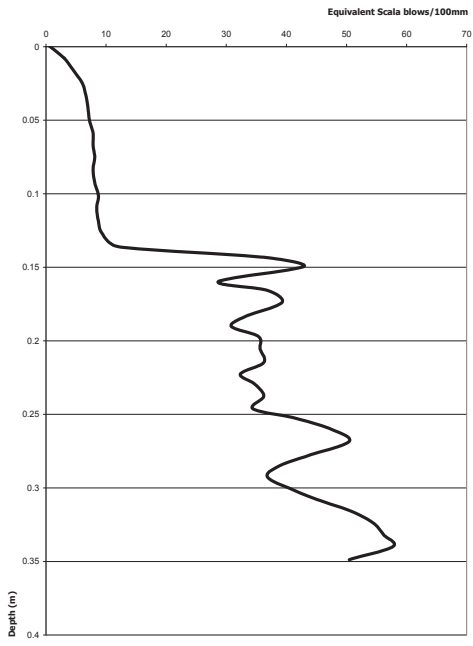
Foster Block Site 47
Canterbury Geotest AutoScala Machine



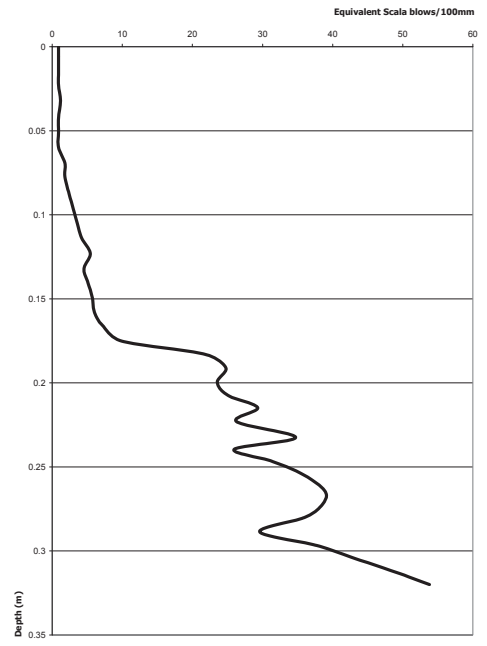
Foster Block Site 48
Canterbury Geotest AutoScala Machine



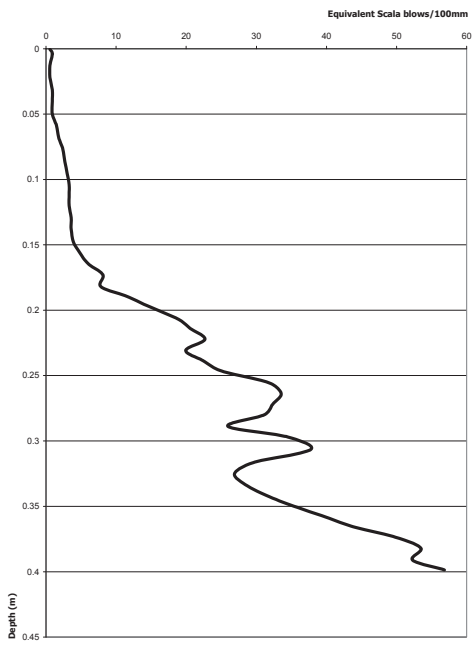
Foster Block Site 49
Canterbury Geotest AutoScala Machine



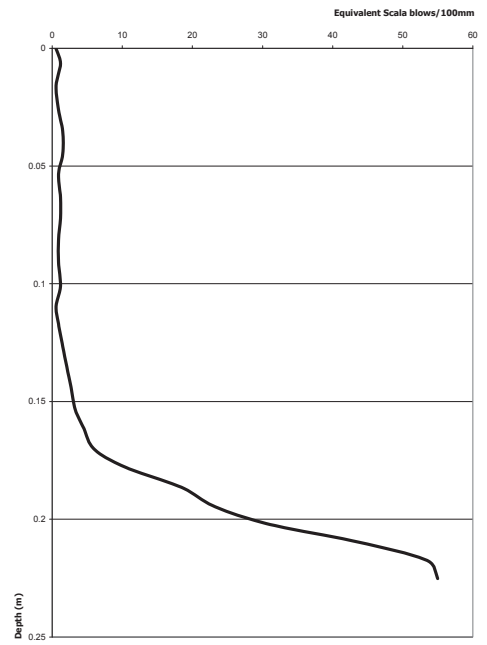
Foster Block Site 50
Canterbury Geotest AutoScala Machine



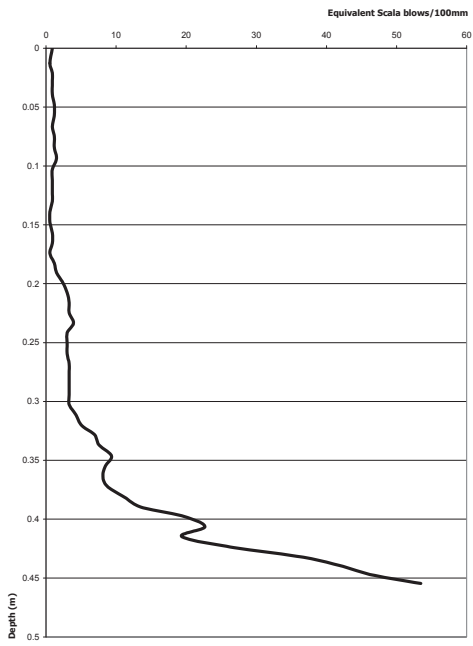
Foster Block Site 51
Canterbury Geotest AutoScala Machine



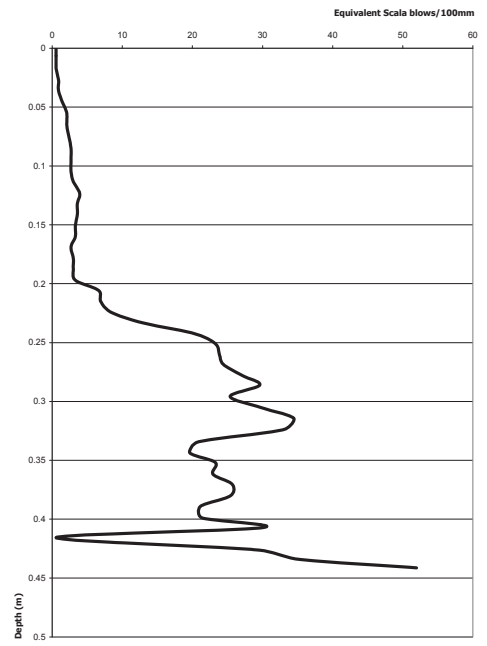
Foster Block Site 52
Canterbury Geotest AutoScala Machine



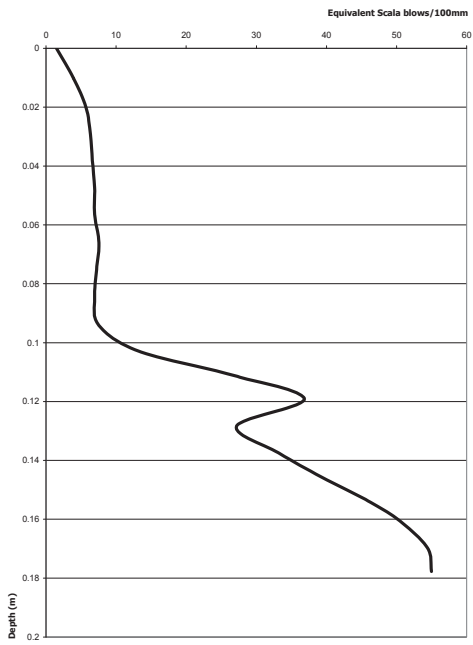
Foster Block Site 53
Canterbury Geotest AutoScala Machine



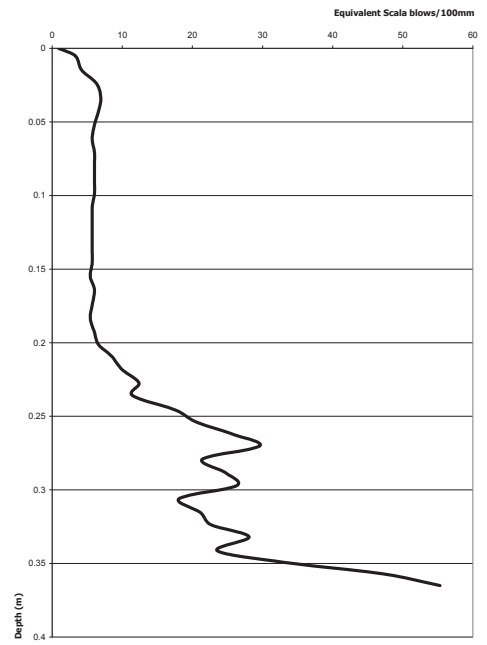
Foster Block Site 54
Canterbury Geotest AutoScala Machine



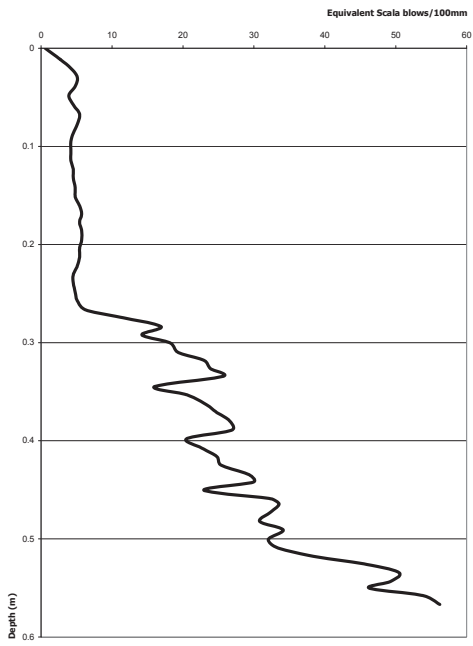
Foster Block Site 55
Canterbury Geotest AutoScala Machine



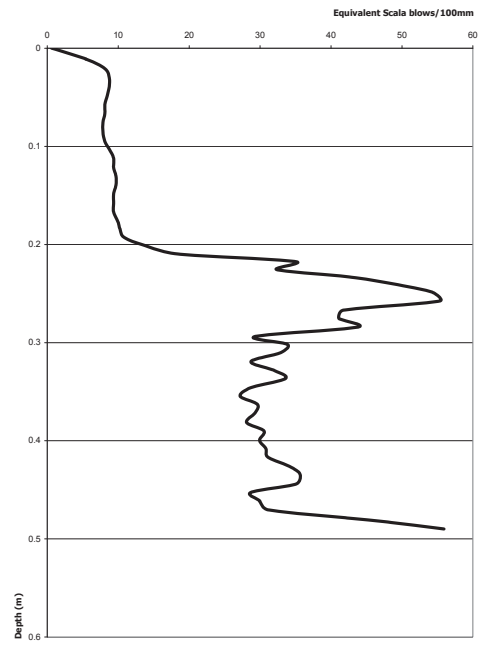
Foster Block Site 56
Canterbury Geotest AutoScala Machine



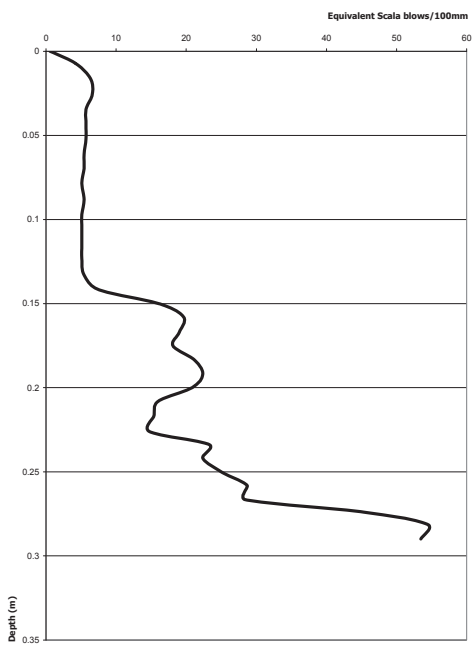
Foster Block Site 57
Canterbury Geotest AutoScala Machine



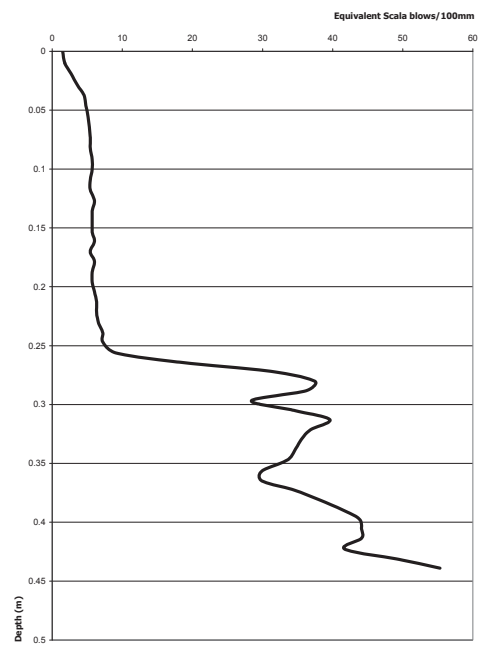
Foster Block Site 58
Canterbury Geotest AutoScala Machine



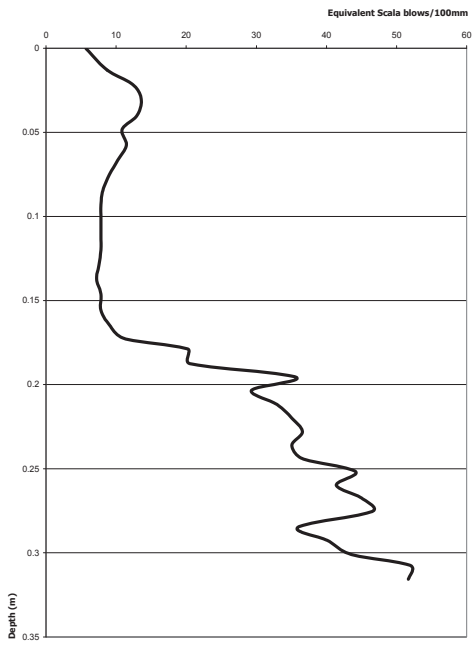
Foster Block Site 59
Canterbury Geotest AutoScala Machine



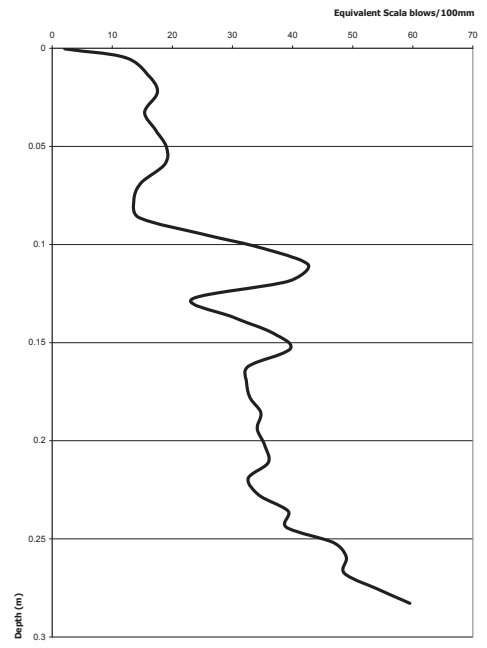
Foster Block Site 60
Canterbury Geotest AutoScala Machine



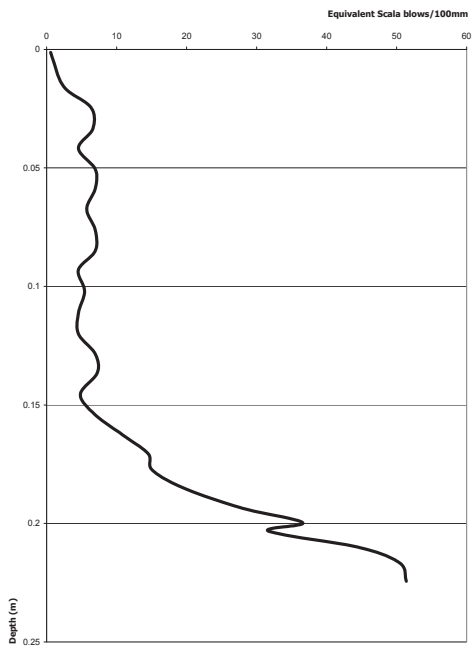
Foster Block Site 61
Canterbury Geotest AutoScala Machine



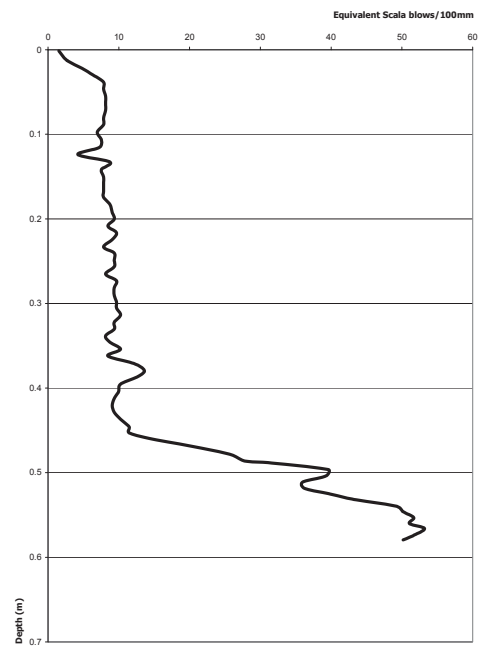
Foster Block Site 62
Canterbury Geotest AutoScala Machine



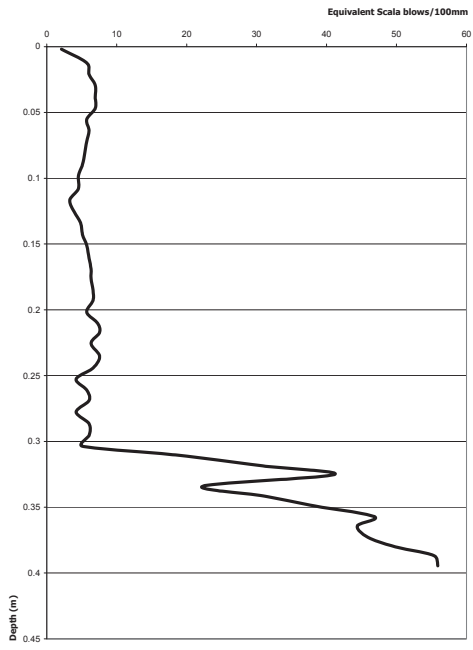
Foster Block Site 63
Canterbury Geotest AutoScala Machine



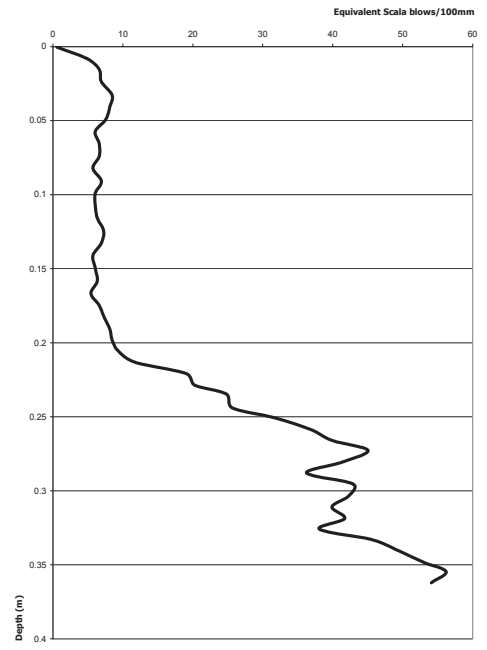
Foster Block Site 64
Canterbury Geotest AutoScala Machine



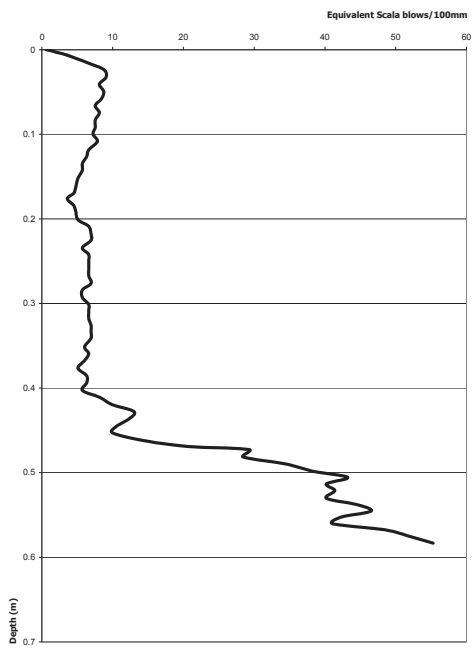
Foster Block Site 65
Canterbury Geotest AutoScala Machine



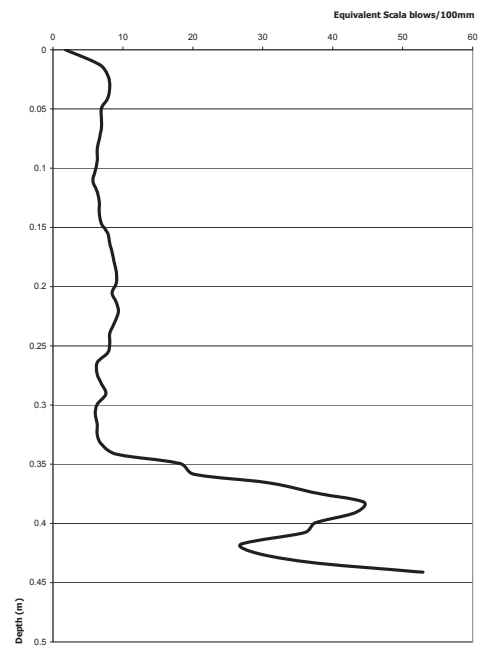
Foster Block Site 66
Canterbury Geotest AutoScala Machine



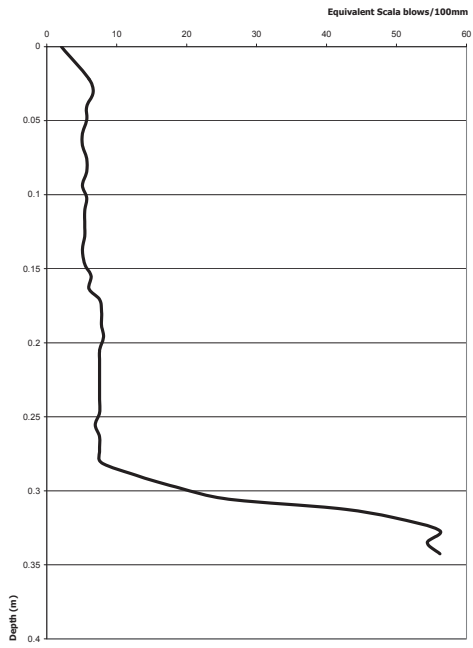
Foster Block Site 67
Canterbury Geotest AutoScala Machine



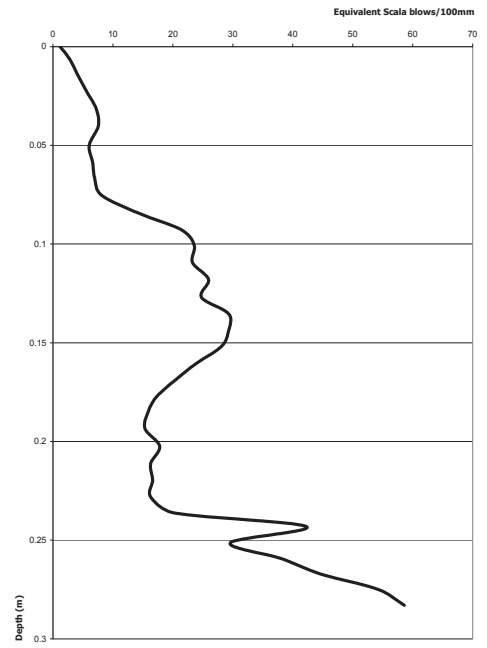
Foster Block Site 68
Canterbury Geotest AutoScala Machine



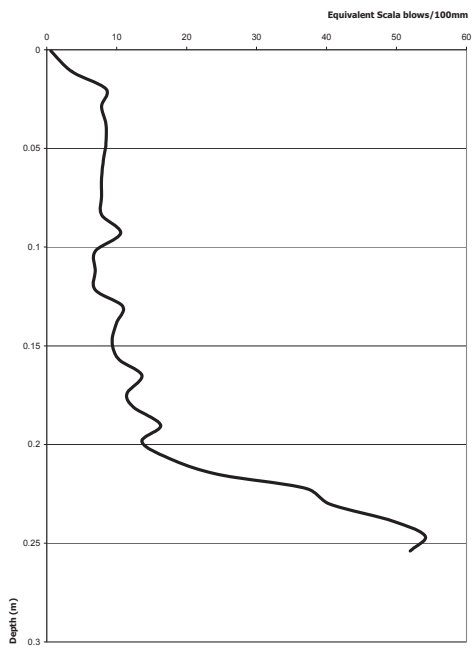
Foster Block Site 69
Canterbury Geotest AutoScala Machine



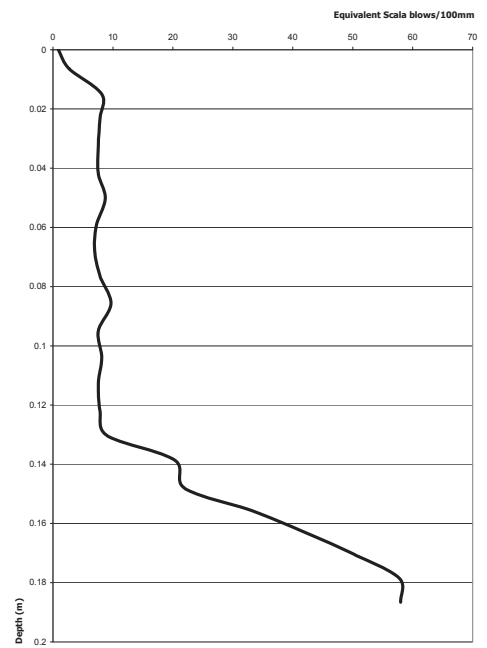
Foster Block Site 70
Canterbury Geotest AutoScala Machine



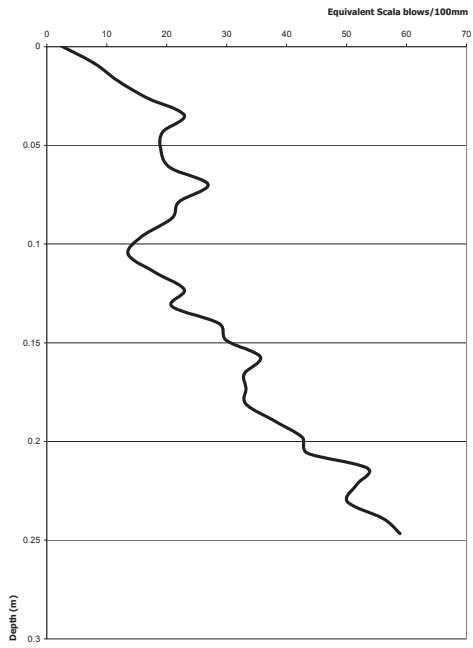
Foster Block Site 71
Canterbury Geotest AutoScala Machine



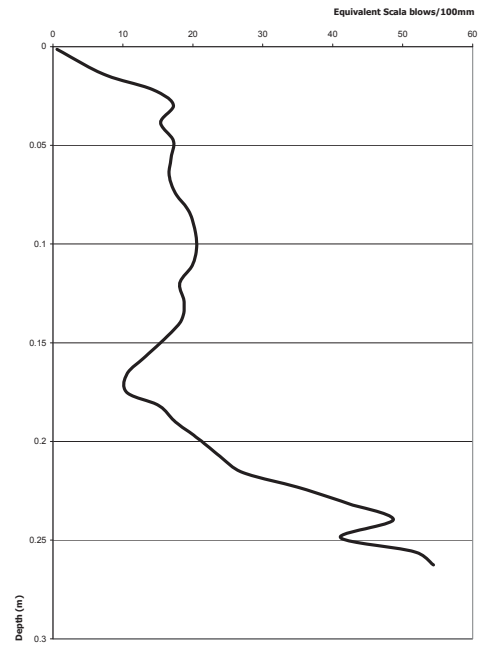
Foster Block Site 72
Canterbury Geotest AutoScala Machine



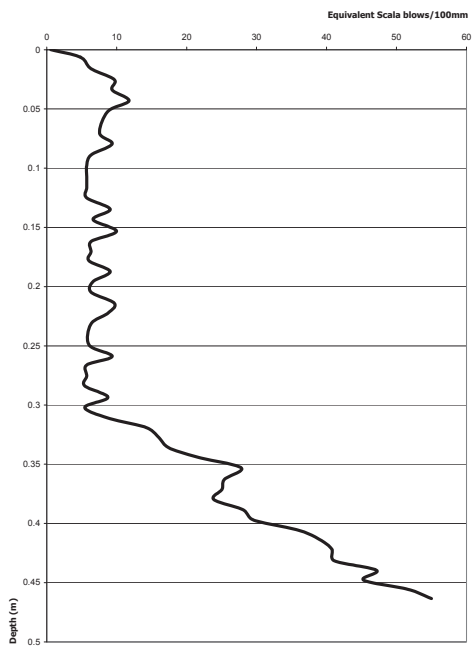
Foster Block Site 73
Canterbury Geotest AutoScala Machine



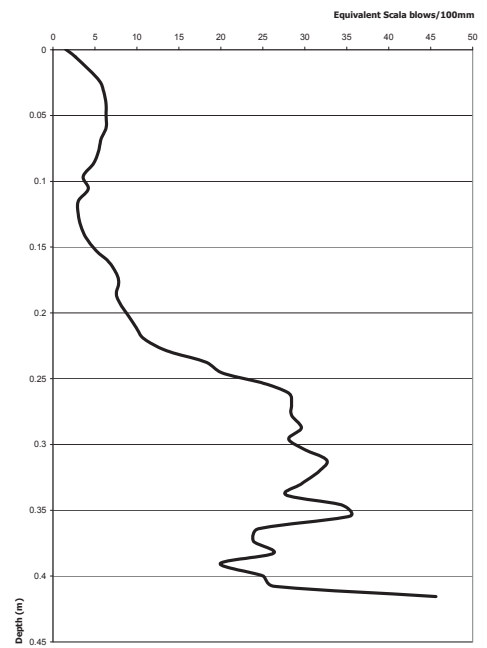
Foster Block Site 74
Canterbury Geotest AutoScala Machine



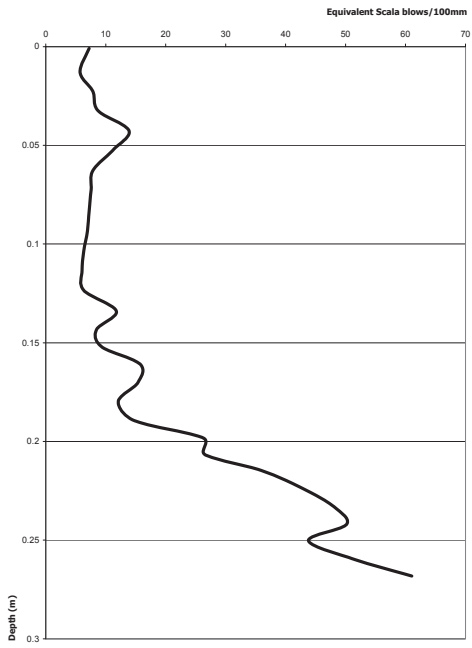
Foster Block Site 75
Canterbury Geotest AutoScala Machine



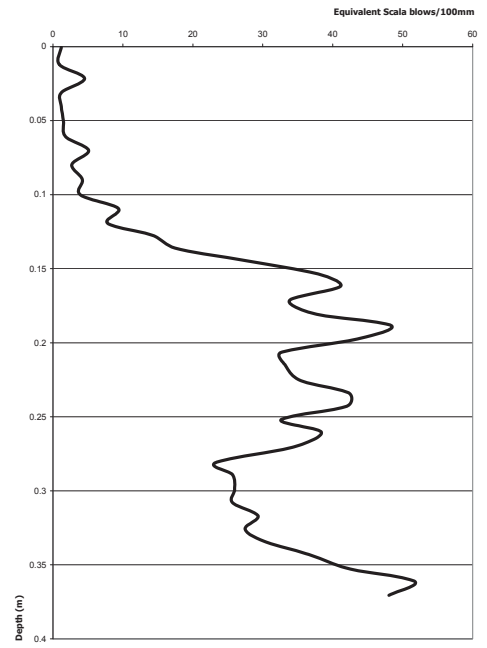
Foster Block Site 76
Canterbury Geotest AutoScala Machine



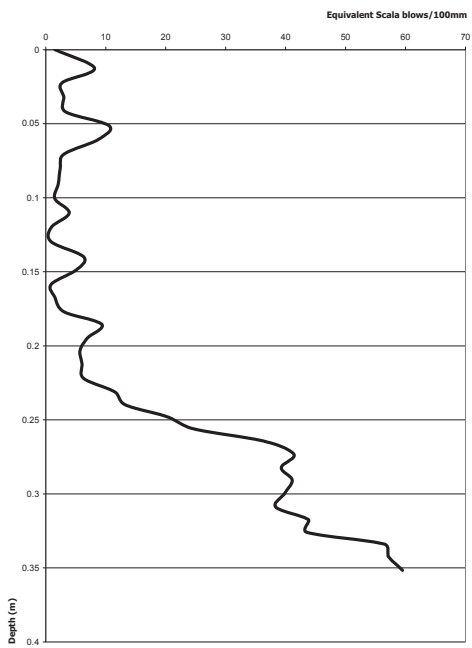
Foster Block Site 77
Canterbury Geotest AutoScala Machine



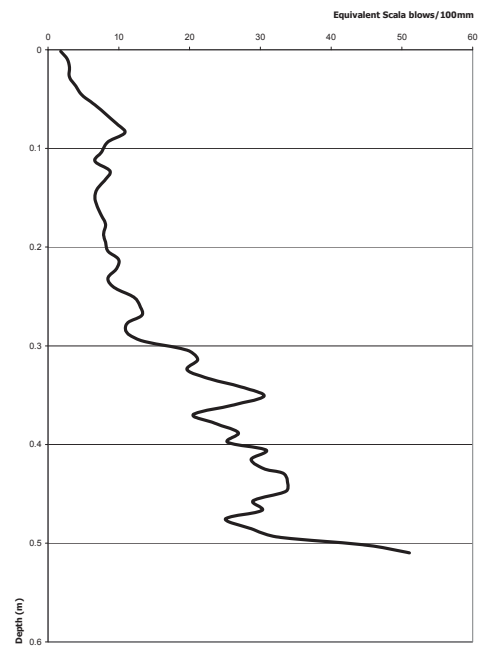
Foster Block Site 78
Canterbury Geotest AutoScala Machine



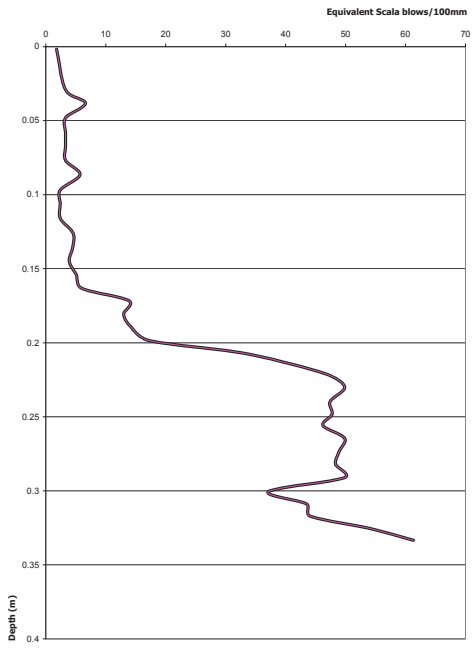
Foster Block Site 79
Canterbury Geotest AutoScala Machine



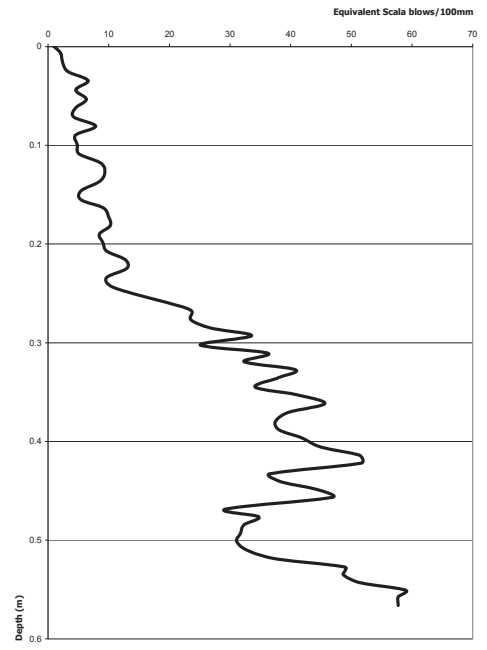
Foster Block Site 80
Canterbury Geotest AutoScala Machine



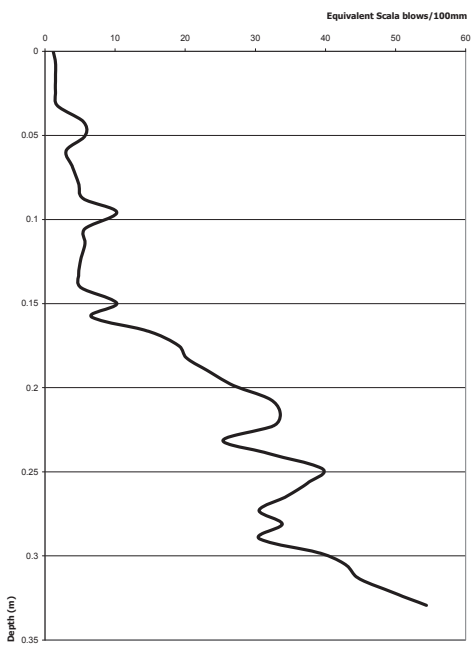
Foster Block Site 81
Canterbury Geotest AutoScala Machine



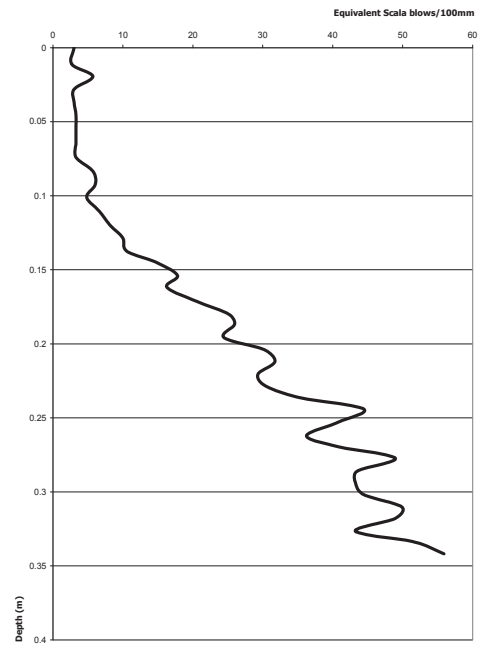
Foster Block Site 82
Canterbury Geotest AutoScala Machine



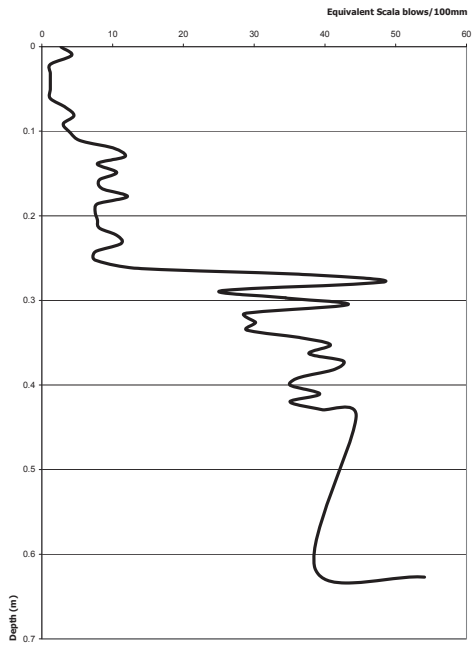
Foster Block Site 83
Canterbury Geotest AutoScala Machine



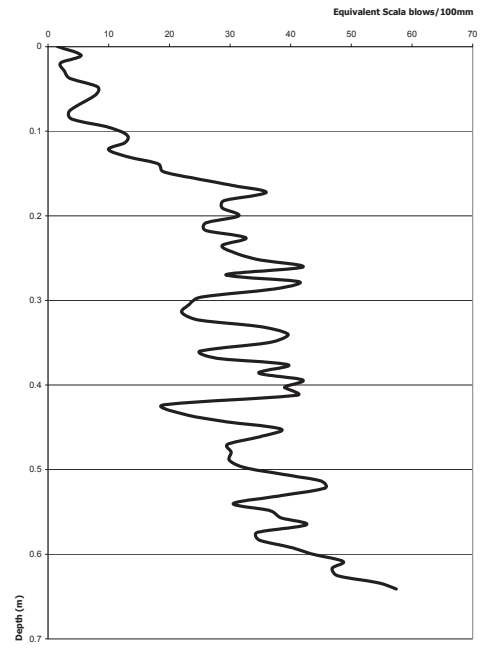
Foster Block Site 84
Canterbury Geotest AutoScala Machine



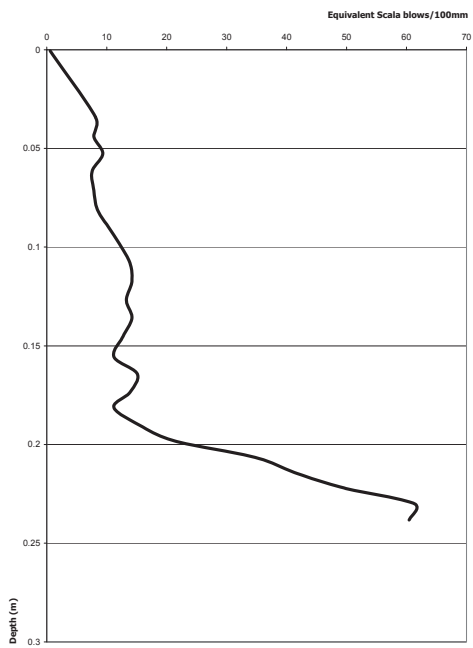
Foster Block Site 85
Canterbury Geotest AutoScala Machine



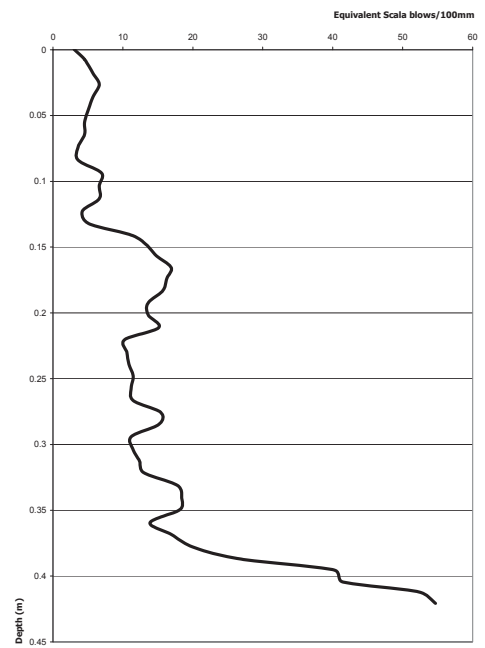
Foster Block Site 86
Canterbury Geotest AutoScala Machine



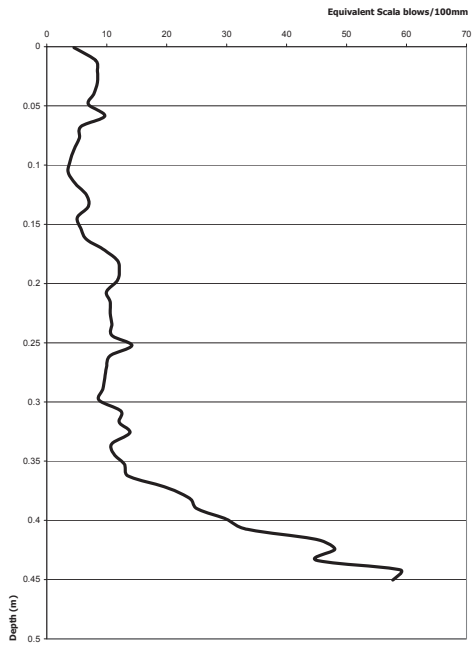
Foster Block Site 87
Canterbury Geotest AutoScala Machine



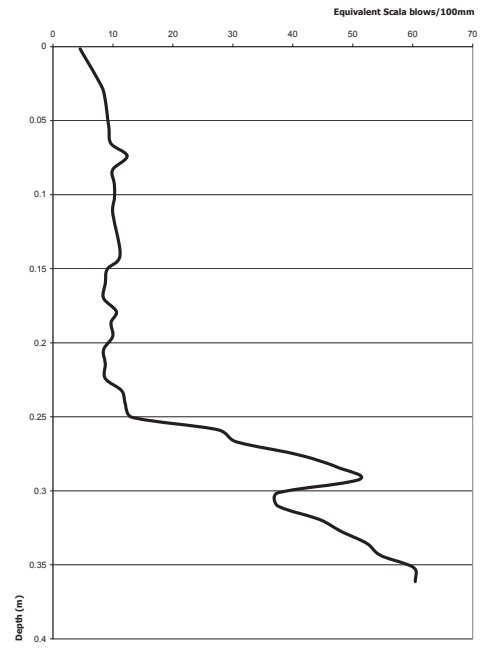
Foster Block Site 88
Canterbury Geotest AutoScala Machine



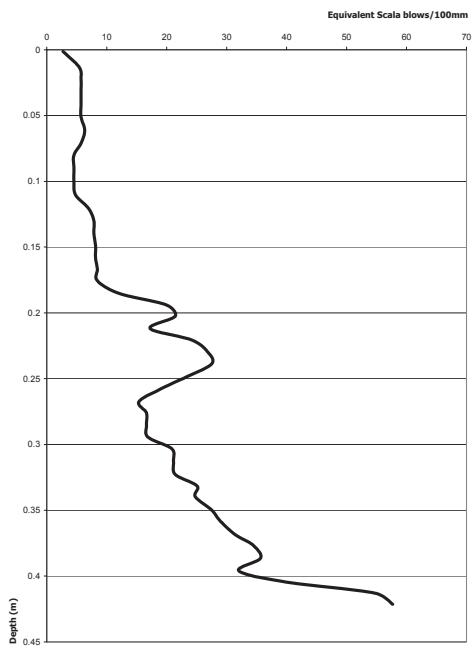
Foster Block Site 89
Canterbury Geotest AutoScala Machine



Foster Block Site 90
Canterbury Geotest AutoScala Machine



Foster Block Site 91
Canterbury Geotest AutoScala Machine



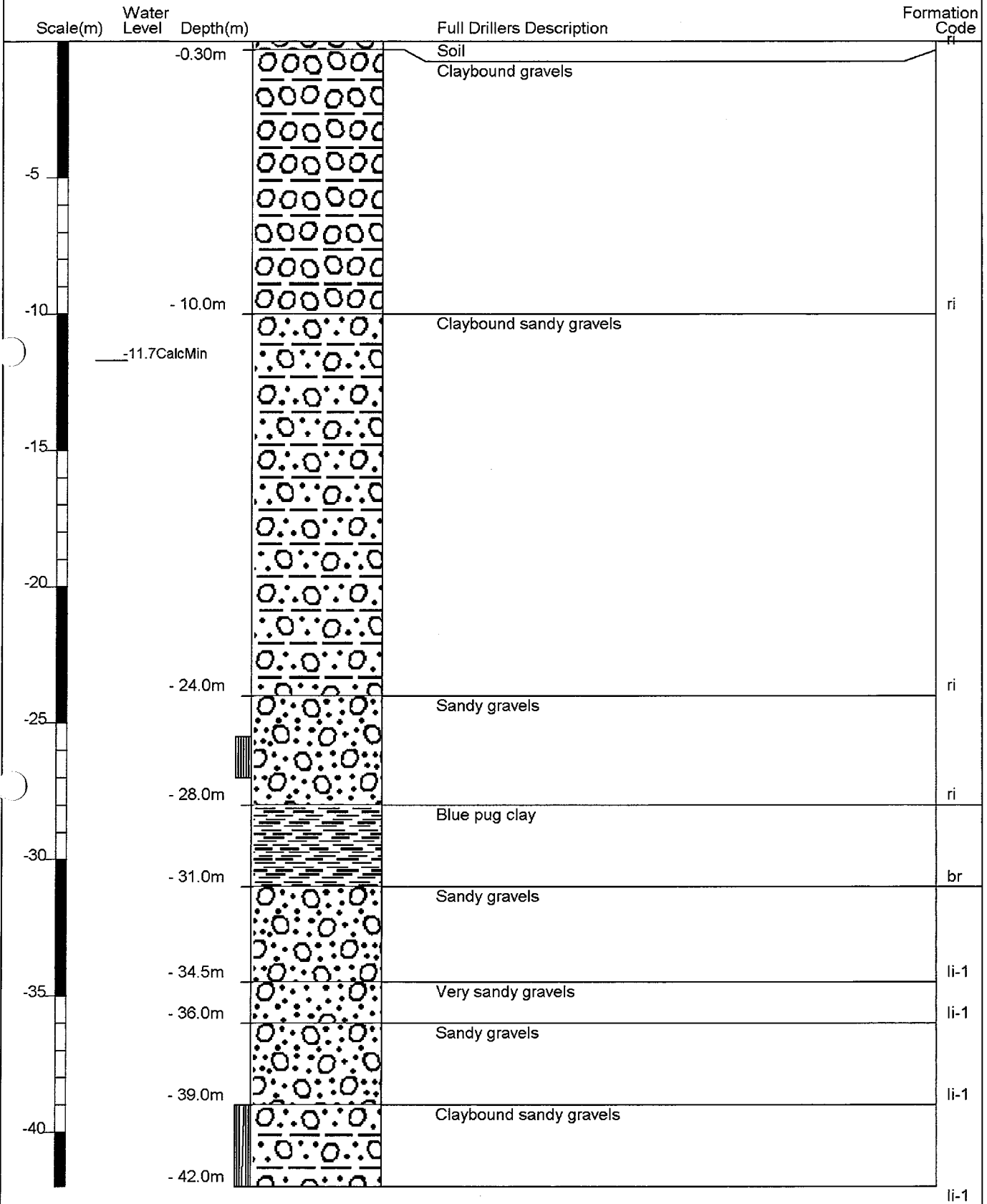


APPENDIX 4

ECan Borehole Logs

Borelog for well M36/6902

Gridref: M36:6126-3161 Accuracy : 3 (1=best, 4=worst)
 Ground Level Altitude : 35 +MSD
 Driller : Smiths Welldrilling
 Drill Method : Rotary Rig
 Drill Depth : -42m Drill Date : 29/08/2001



Borelog for well M36/0204

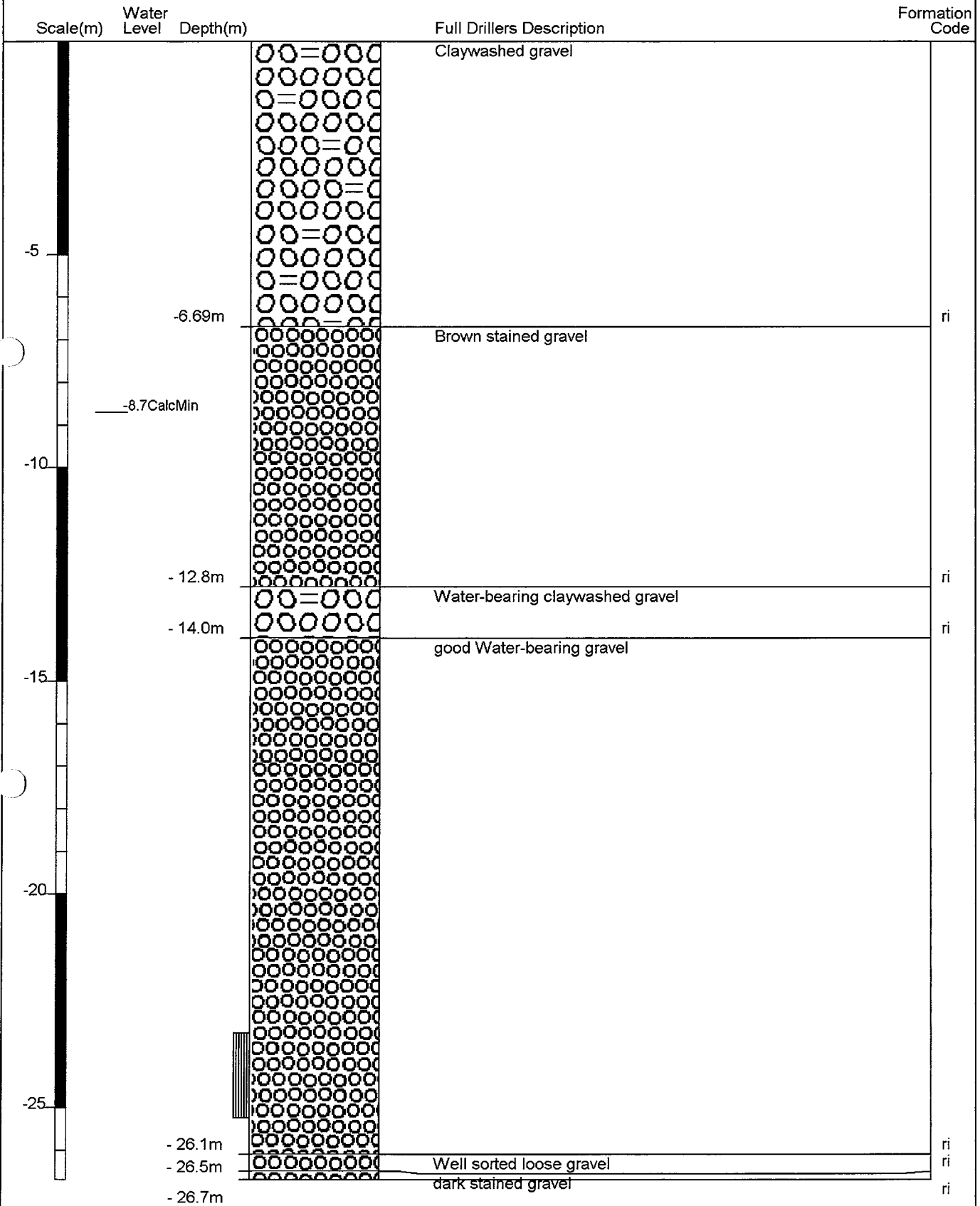
Gridref: M36:614-326 Accuracy : 4 (1=best, 4=worst)
 Ground Level Altitude : 39.42 +MSD
 Driller : J W Horne (& Co)
 Drill Method : Unknown
 Drill Depth : -27.4m Drill Date : 1/04/1975



Scale(m)	Water Level	Depth(m)	Full Drillers Description	Formation Code
		-0.30m	Topsoil Good clean Grey gravel	sp
-5				
		-9.10m	Tight claybound Brown gravel	sp-ri
-10				
	-11.3CalcMin	-11.9m		ri
		-12.5m	Loose Brown gravel	ri
		-14.3m	Hard compact big Brown gravel	ri
-15				
		-15.5m	Loose small gravel	ri
		-17.1m	Hard clean gravel	ri
		-17.1m	Big rough hard Brown gravel	ri
-20				
		-20.1m	Loose Yellow claywash gravel	ri
		-25.6m		ri
		-26.2m	Big stones	br?
		-27.4m	Loose claywash gravel	br?

Borelog for well M36/4891

Gridref: M36:6011-3161 Accuracy : 4 (1=best, 4=worst)
 Ground Level Altitude : 39.15 +MSD
 Driller : Clemence Drilling Contractors
 Drill Method : Unknown
 Drill Depth : -26.7m Drill Date : 5/05/1995



Borelog for well M36/7204

Gridref: M36:6177-3216 Accuracy : 4 (1=best, 4=worst)
 Ground Level Altitude : 36 +MSD
 Driller : Smiths Welldrilling
 Drill Method : 1st Rotary 2nd Cable
 Drill Depth : -114m Drill Date : 23/08/2000



Scale(m)	Water Level	Depth(m)	Full Drillers Description	Formation Code
		-0.20m	Soil	
			Claybound gravels	
		-9.00m		ri
	-11.1 Calm	-12.0m	Sandy gravels	ri
			Claybound sandy gravels	
		-20.0m		ri
			Sandy gravels	
		-35.0m		ri-br
		-36.0m	Peat	br
		-40.0m	Sandy gravels	li
			Claybound sandy gravels	
		-45.0m		li
		-48.0m	Sandy free gravels	li
			Claybound gravels with clay	
		-57.0m		li
		-60.0m	Sand	li-2
		-62.5m	Claybound gravels	li
		-66.0m	Claybound sandy gravels	li
			Sandy gravels	
		-88.0m		li-bu
			Free sandy gravels	
		-93.5m		wa?
			Very sandy gravels	
		-102.0m		wa
			Sandy gravels	
		-114.0m		wa