STAGE 3 - SECTION 32

CHAPTER 17

RURAL - CRANFORD BASIN

APPENDIX 1 - CRANFORD BASIN GEOTECHNICAL DESKTOP REPORT

Notified 25 July 2015

Christchurch City Council

Christchurch City Council

Cranford Basin

Geotechnical Desktop Report

February 2015

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1. Introduction

GHD has been engaged by the Christchurch City Council to undertake a desktop geotechnical study for proposed development of Cranford Basin. The proposed development involves the development of residential houses around some of the perimeter (red area) of the Cranford Basin, and a storm water detention area (blue area) as illustrated by Figure 1.

The site is situated 4 km north of the Christchurch Central Business District. It is relatively flat at approximately 5 m above sea level. It is approximately 2.5k m south of Styx River and 7 km west of the coast (Pegasus Bay).

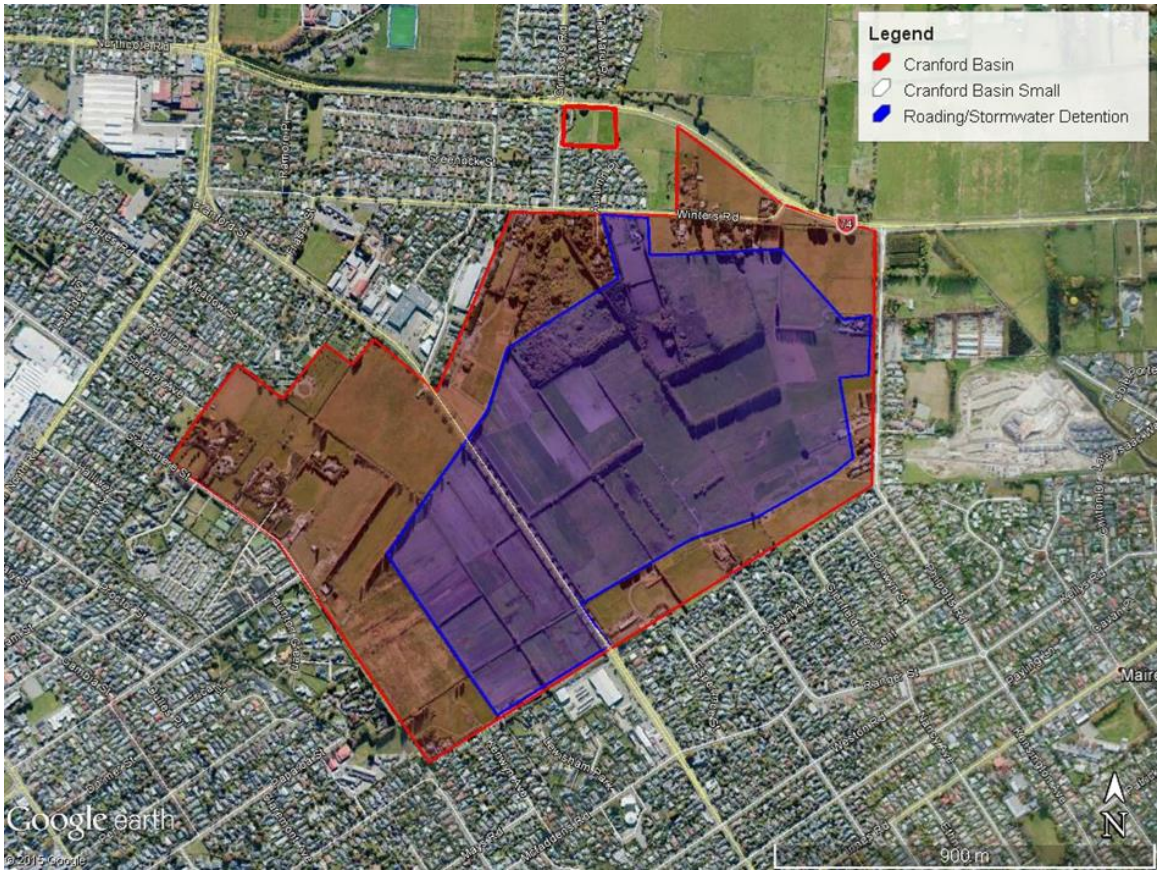


Figure 1 Site Location

2. Published Information on Ground Conditions

2.1 Published Geology

As shown in Figure 2, Brown & Weeber[1] (1992) indicates that the site geology comprises two different units. The majority of the site is overlying peat swamp, now drained. The north eastern end of the section is overlying dominantly alluvial sand and silt overbank deposits. Both units are alluvial soils of the Yaldhurst Member, sub-group of the Springston Formation, Holocene in age.

[1] Brown, L. J. & Weeber, J.H. (1992): Geology of the Christchurch Urban Area. Institute of Geological and Nuclear Sciences 1:25,000 Geological Map 1. IGNS Limited: Lower Hutt.

Brown and Webber (1992) also shows the Riccarton gravels are located approximately 10-15 m bgl and groundwater is likely within 1-2 m of ground level.

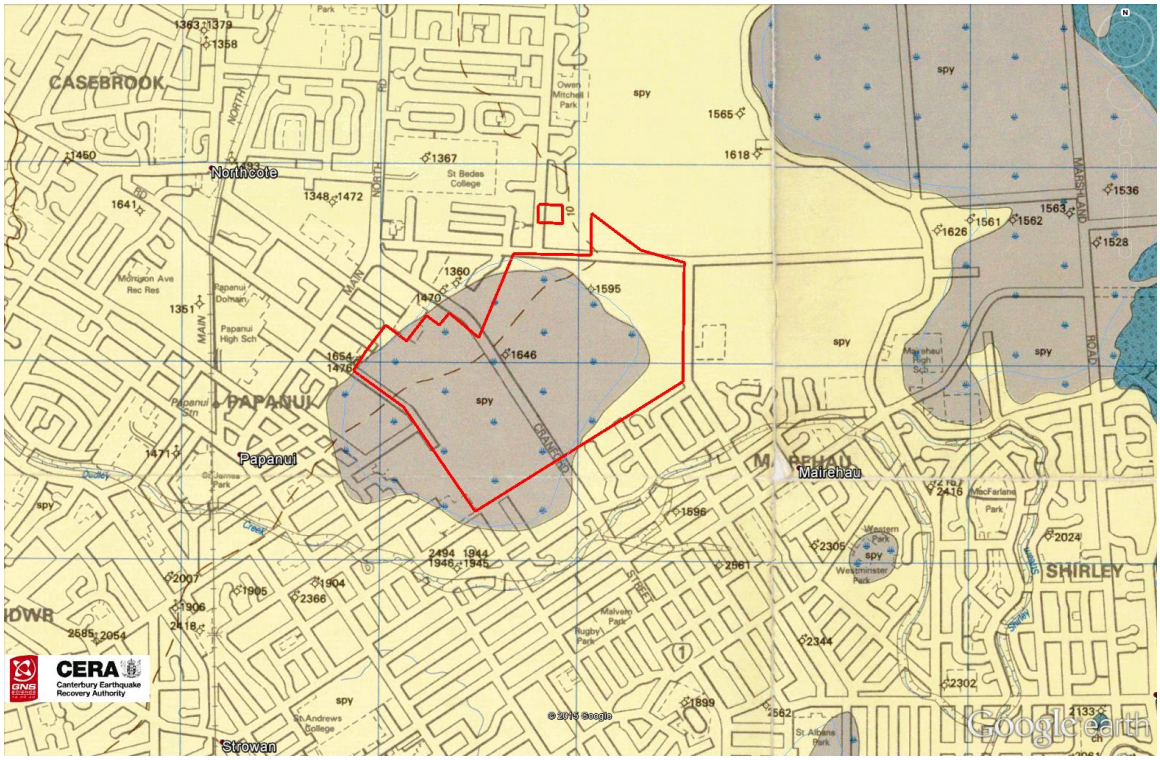


Figure 2 Geology Map Exert

2.2 Environment Canterbury Logs

A search of the Environment Canterbury (ECan) groundwater wells identified many wells with lithographic bore logs present in the proposed area. Several of the logs located around the site are summarised in Table 1. Location of investigations is provided in Appendix A. Full logs are provided in Appendix A.

Table 1 Ecan Well Logs

Bore Name	Log Depth	Groundwater	Location	Log Summary
M35/12374	3.2 m	0.5 m bgl	Southern corner	0.0 – 0.5 m Peat soil 0.5 – 3.2 m Peat
M35/15178	6.0 m	Not recorded	Southern edge	0.0 – 2.5 m Peat soil 2.5 – 6.0 m Grey silt
M35/15177	6.0 m	Not recorded	Southern edge	0.0 – 2.45 m Peat and silt 2.45 – 6.0 m Grey silt
M35/14948	3.0 m	Not recorded	Southern edge	0.0 – 0.8 m Topsoil and peat 0.8 – 3.0 m Silt
M35/14966	3.9 m	Not recorded	South-eastern corner	0.0 – 0.2 m Topsoil 0.2 – 2.4 m Sandy silt 2.4 – 3.2 m Peat

Bore Name	Log Depth	Groundwater	Location	Log Summary
				3.2 – 3.9 m Silt
M35/13183	3.09 m	Not recorded	Eastern edge	0.0 – 1.52 m Gravelly topsoil 1.52 – 2.99 m Peat 2.99 – 3.09 m Sandy Silt
M35/12573	1.2 m	0.55 m bgl	Eastern edge	0.0 – 0.3 m Topsoil some silt 0.3 – 0.8 m Clayey silt 0.8 – 1.2 m Peat
M35/18347	23.0 m	Not recorded	Northern edge	0.0 – 0.3 m Topsoil 0.3 – 3.2 m Silt 3.2 – 6.3 m Peat 6.3 – 19.1 m Sand 19.1 – 23.0 m Sandy gravel
M35/12643	15.2 m	Not recorded	Northern edge	0.0 – 0.76 m Topsoil, sand 0.76 – 1.37 m Peat 1.37 – 5.18 m Sandy silt and peat 5.18 – 15.2 m Sand some gravel
M35/10866	15.0 m	Not recorded	North western edge	0.0 – 0.7 m Topsoil 0.7 – 7.0 m Silt with organics 7.0 – 15.0 m Sand/sitly sand
M35/15699	5.2 m	0.7 m bgl	North western edge	0.0 – 0.4 m Topsoil 0.4 – 0.9 m Sand 0.9 – 1.6 m Peat 1.6 – 2.7 m Silt 2.7 – 3.4 m Peat 3.4 – 4.4 m Sandy silt 4.4 – 5.2 m Peat
M35/14022	12.2 m	Not recorded	Western corner	0.0 – 3.05 m Peat and clay 3.05 – 12.2 m Sand some silt
M35/14021	7.32 m	1.42 m bgl	Western edge	0.0 – 4.27 m Peat and clay 4.27 – 5.79 m Sand and silt 5.79 – 7.32 m Gravel
M35/14019	5.18 m	Not recorded	Western edge	0.0 – 3.05 m Peat and clay 3.05 – 4.88 m Sand

Bore Name	Log Depth	Groundwater	Location	Log Summary
				4.88 – 5.18 m Gravel
M35/1646	25.4 m	3.7 m	Centre	0.0 – 0.6 m Topsoil 0.6 – 6.3 m Peat 6.3 – 14.6 m Gravel 14.6 – 17.8 m Sand 17.8 – 18.3 m Peat 18.3 – 25.4 m Gravel

It should be noted that the logs have been written by the well driller and not a geotechnical professional or to a standard. In addition strength data is not recorded.

2.3 Canterbury Geotechnical Database Investigations

Multiple investigations are present on the Canterbury Geotechnical Database (CGD) around the proposed site. A summary of pertinent logs is provided in Table 2, full logs are provided in Appendix A.

Table 2 Canterbury Geotechnical Database Investigations

Bore Name	Location	Depth	Log Summary
BH_27476	Eastern edge	22.0 m	0.0 – 3.0 m Fill 3.0 – 5.5 m Organic SILT (SPT-N 0,1) 5.5 – 7.0 m Sandy SILT and SAND (SPT-N 14) 7.0 – 17.5 m SAND & GRAVEL (SPT-N 14-46) 17.5 – 18.0 m PEAT 18.0 – 22.0 m Sandy GRAVEL (SPT-N 50)
BH_23510	Southern corner	11.15 m	0.0 – 3.0 m Sandy SILT (SPT-N 0-17) 3.0 – 6.0 m SILT some organics (SPT-N 0-4) 6.0 – 11.15 m SAND & GRAVEL (SPT-N 14-36)
BH_20993	Southern edge	10.95 m	0.0 – 1.5 m SAND 1.5 – 5.7 m PEAT & Organic SILT (SPT-N 0 -7) 5.7 – 10.95 m SAND & GRAVEL (SPT-N 18-24)
BH_35483	Northern point	21.61 m	0.0 - 2.0 m PEAT & organic CLAY (SPT-N 0) 2.0 – 5.8 m CLAY & organic CLAY (SPT-N 0-4) 5.8 – 17.8 m SAND some silt (SPT-N 15-36) 17.8 – 18.2 m ORGANIC SILT 18.2 – 21.6 m SAND & GRAVEL (SPT-N 50-69)
BH_23908	North-eastern edge	18.5 m	0.0 – 1.3 m SAND 1.3 – 6.5 m SILT & PEAT (SPT-N 0-2)

Bore Name	Location	Depth	Log Summary
			6.5 – 8.5 m Silty SAND (SPT-N 9-18) 8.5 – 17.5 m SAND (SPT-N 12-41) 17.5 – 18.5 m PEAT & SAND with peat

2.3.1 Crack data

No cracks were recorded on the proposed site in the CGD post-earthquake crack data layer. Several <10 mm cracks have been identified 100 m south of the southern corner of the site.

2.3.2 Post Earthquake Land Observations

The aerial photography interpretation of observed liquefaction identifies the northern portion of the site as having experienced minor liquefaction with some moderate to serve liquefaction observed in the north-eastern corner of the site following the 4 September 2010 earthquake.

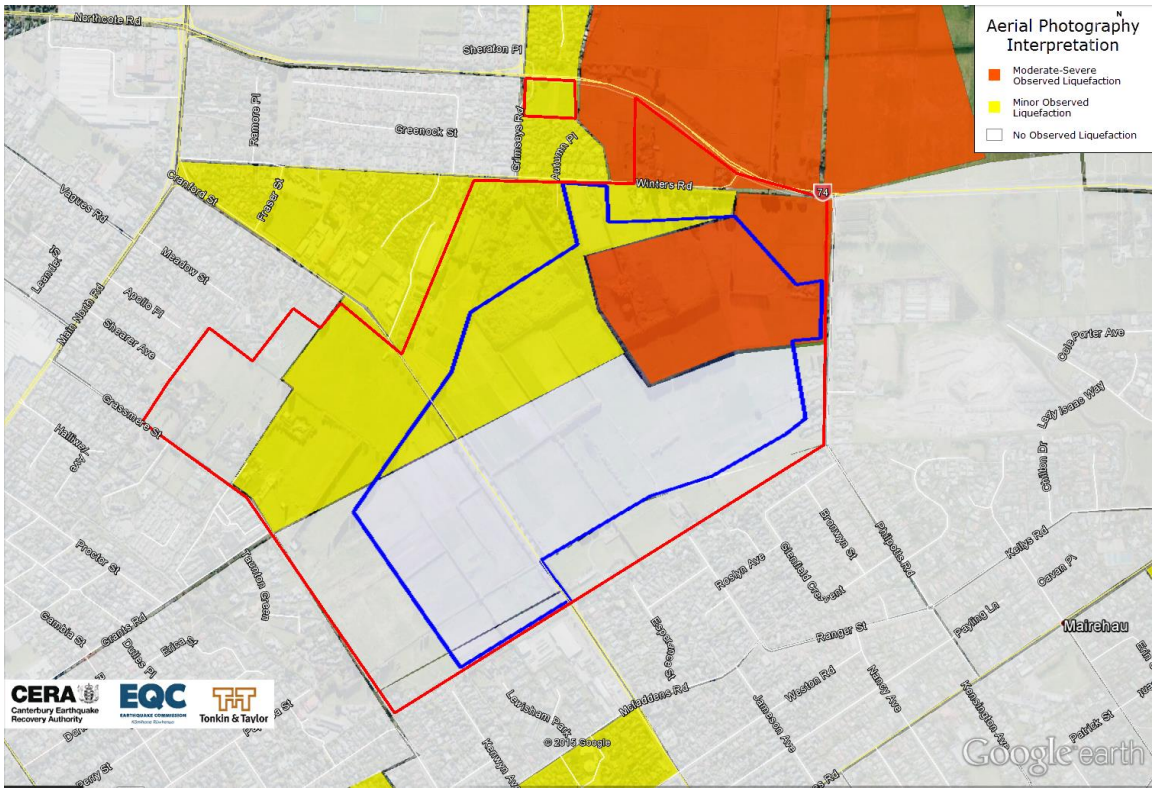


Figure 3 Aerial Photography Liquefaction Interpretation, 4 September 2010

2.3.3 Shallow Foundation Hazard Map, August 1990

The shallow foundation hazard map[2] provided in the CGD identifies the area as being a high risk area where investigation is essential due to peat areas and old swamps or lakes.

2.4 CERA Landing Zoning

Canterbury Earthquake Recovery Authority (CERA) has indicated the site is situated within the Green Zone, indicating that repair and rebuild may take place.

[2] Canterbury Geotechnical Database (2012) "Shallow Foundation Hazard Map - 1990", Map Layer CGD5132 - 20 Nov 2012, retrieved 11/02/2015 from https://canterburygeotechnicaldatabase.projectorbit.com/

Land in the CERA green zone has been divided into three technical categories. These categories describe how the land in expected to perform in future earthquakes.

The site has been categorised as "N/A" – Urban Non-residential". However, surrounding residential properties to the north, west and east have been categorised as TC2 (yellow), indicating minor to moderate land damage from liquefaction is possible in future significant earthquakes. Some neighbouring properties to the south have been categorised as TC3 (blue) zone[3]. This means that moderate to significant land damage from liquefaction is possible in future significant earthquakes.

2.5 Historic Aerials

Historic aerials available on the ECan GIS database show snapshots of the land use of the site from 1941 until present. The earliest aerial available (1941) shows the site being used for agricultural production of fruit and vegetables. The land use has not changed much from 1941 to the present, some roading has been added through the site and residential houses constructed around the perimeter.

2.6 Summary of Ground Conditions

The proposed site is an area that is well known to be underlain by swamp derived deposits comprising soft silts, organic silts and peat. From the investigations available from ECan well database and CGD the site has been determined to comprise alluvium, underlain by swamp derived deposits. This is further underlain by alluvium, underlain by the Riccarton Gravels.

2.6.1 Upper Alluvium

The upper alluvium is not present across the entire site and reaches depths of 1.0 to 3.0 m bgl. It comprises sand, sandy silt and silty sands with strengths varying from loose/very soft to medium dense/stiff.

2.6.2 Swamp Deposits

As shown in the ECan/CGD BH logs swamp deposits are present across the entire site. In most areas of the site they are underlying the upper alluvium, however some areas they are present from the ground surface. The layer of swamp deposits varies in thickness across the site from 1 to 5 m. The material comprises silts, organic silts and peat with strengths varying from very soft to soft. A thin (~0.5 m) swamp deposit is also present at the base of the lower alluvium, overlying the Riccarton Gravels, in some areas.

2.6.3 Lower Alluvium

The lower alluvium is encountered beneath the swamp deposits. It has a similar composition to the upper alluvium with the addition of gravel in sandy gravel and gravel layers. It therefore has a higher density of medium dense to dense.

2.6.4 Riccarton Gravels

The Riccarton Gravels are present below the lower alluvium and is encountered approximately 19 m bgl. It comprises dense to very dense sandy gravels.

[3] CERA Landcheck website, http://cera.govt.nz/my-property

2.6.5 Groundwater

Groundwater is has been recorded in investigation logs between 0.5 and 3.7 m bgl. Where shallow peat is present on site it is likely to be saturated, providing a higher the groundwater level.

3. Seismicity

3.1.1 Nearby Faults

There are many faults in the Canterbury region, however only those considered most likely to have an adverse effect on the site are detailed below.

Table 3 Summary of Known Active Faults[4,5]

Known Active Fault	Distance from Site	Direction from Site	Max Likely Magnitude	Avg Recurrence Interval
Alpine Fault	120 km	NW	~8.3	~300 years
Greendale Fault (2010)	22 km	W	7.1	~15,000 years
Hope Fault	105 km	N	7.2~7.5	120~200 years
Kelly Fault	105 km	NW	7.2	~150 years
Porters Pass Fault	60 km	NW	7.0	~1100 years
Port Hills Fault (2011)	10 km	N	6.3	Not Estimated

The recent earthquake sequence since 4 September 2010 has identified the presence of a previously unmapped active fault system underneath the Canterbury Plains. This includes the Greendale Fault and Port Hills Fault listed in Table 3 above. Research and published information on this system is in development and the average recurrence interval is yet to be established for the Port Hills Fault.

3.1.2 Ground Shaking Hazard

New Zealand Standard NZS 1170.5:2004 quantifies the Seismic Hazard factor for Christchurch as 0.30, being in a moderate to high earthquake zone. This value has been upgraded recently (from 0.22) to reflect the seismicity hazard observed in the earthquakes since 4 September 2010.

The recent seismic activity has produced earthquakes of Magnitude 6.3 with significant peak ground accelerations (PGA) across large parts of the city.

Conditional PGA's from the CGD[6] indicate the PGA to be 0.20 g during the 4 September 2010 earthquake, 0.26 g on 22 February 2011, and 0.15 g on 13 June 2011.

4. Liquefaction Potential

The site is considered to have a minor to moderate susceptibility to liquefaction, due to the following reasons:

- Neighbouring properties classified as TC2 or TC3
- Observations of liquation ejecta material in post-earthquake aerials;

[4] Stirling, M.W, McVerry, G.H, and Berryman K.R. (2002): "A New Seismic Hazard Model for New Zealand", Bulletin of the Seismological Society of America, Vol. 92 No. 5, June 2002, pp. 1878-1903.
5 GNS Active Faults Database, http://maps.gns.cri.nz/website/af/viewer
6 Canterbury Geotechnical Database (2012): "Conditional PGA for Liquefaction Assessment", Map Layer CGD5110 - 27 Sept 2012, retrieved 11/02/2015 from https://canterburygeotechnicaldatabase.projectorbit.com/

- Presence of saturated sands and silty sands beneath some areas of the site.

Further analysis could be undertaken to better determine and quantify the liquefaction hazard. This should involve a more comprehensive liquefaction analysis.

5. Listed Land Use Register

A brief search of the Environment Canterbury List Land Use Register (LLUR) identified several properties have HAIL (List of Hazardous Activities and Industries) activities including:

- A8 – Livestock dip or spray race operations
- A10 – Persistent pesticide bulk storage or use (multiple properties)
- A17 – Storage tanks or drums for fuel, chemicals or liquid waste.

If the land use is to be changed from its current land use to residential land use it is recommended a Preliminary Site Investigation and subsequent Detailed Site Investigation are undertaken in accordance with the National Environmental Standards..

6. Geotechnical Assessment

The ground conditions vary somewhat across the site. However, the determining factor for foundation design at the site is the presence of significant organic soils and peat that is encountered across the whole site.

Foundations for new residential houses need to be designed to mitigate settlement from both swamp deposits and liquefiable materials. The greatest settlement will result from settlement of the organic material, which will occur both immediately after the soil is loaded, and over many years as the organic soils biodegrade and compress.

To mitigate this settlement it is recommended that residential building foundations are piled. The required piling depth will vary across the site and will require further specific investigations and specific design. It is likely that the lower alluvium will provide a suitable strata for pile bearing and embedment, therefore piling depths could range from 5-10 m bgl.

7. Summary

GHD was engaged to undertake a desktop geotechnical study for proposed development of Cranford Basin involving the development of residential houses around some of the perimeter of the Cranford Basin.

The proposed site is an area that is well known to be underlain by swamp derived deposits comprising soft silts, organic silts and peat. Investigations available from the ECan well database and the CGD indicate the site is overlying: alluvium comprising sandy silt and silty sands; underlain by swamp derived deposits comprising silts, organic silts and peat; underlain by alluvium comprising sandy silt, silty sands, sand with some gravel; underlain by the Riccarton Gravels. Associated with this, the site is considered to have a minor to moderate susceptibility to liquefaction.

Groundwater has been recorded in investigation logs between 0.5 and 3.7 m bgl. Where peat is present on site it is likely to be saturated, providing a higher groundwater level.

A brief search of the Environment Canterbury List Land Use Register identified several properties have HAIL activities. If the land use is to be changed from its current land use to residential land use it is recommended a Preliminary Site Investigation and subsequent Detailed Site Investigation are undertaken.

Foundations for new residential houses need to be designed to mitigate settlement from both swamp deposits and liquefiable materials. The greatest settlement will result from settlement of the organic soils and there bio-gradation. To mitigate this settlement it is recommended that residential building foundations are piled. The required piling depth will vary across the site and will require further specific investigations and specific design. However it is likely that the lower alluvium will provide a suitable strata for pile bearing and embedment, therefore piling depths could range from 5-10 m bgl.

8. Scope and limitations

This report: has been prepared by GHD for Christchurch City Council and *may only be used and relied on by Christchurch City Council for the purpose agreed between GHD and the Christchurch City Council as set out in f this report.*

GHD otherwise disclaims responsibility to any person other than Christchurch City Council arising in connection with this report. GHD also excludes implied warranties and conditions, to the extent legally permissible.

The services undertaken by GHD in connection with preparing this report were limited to those specifically detailed in the report and are subject to the scope limitations set out in the report.

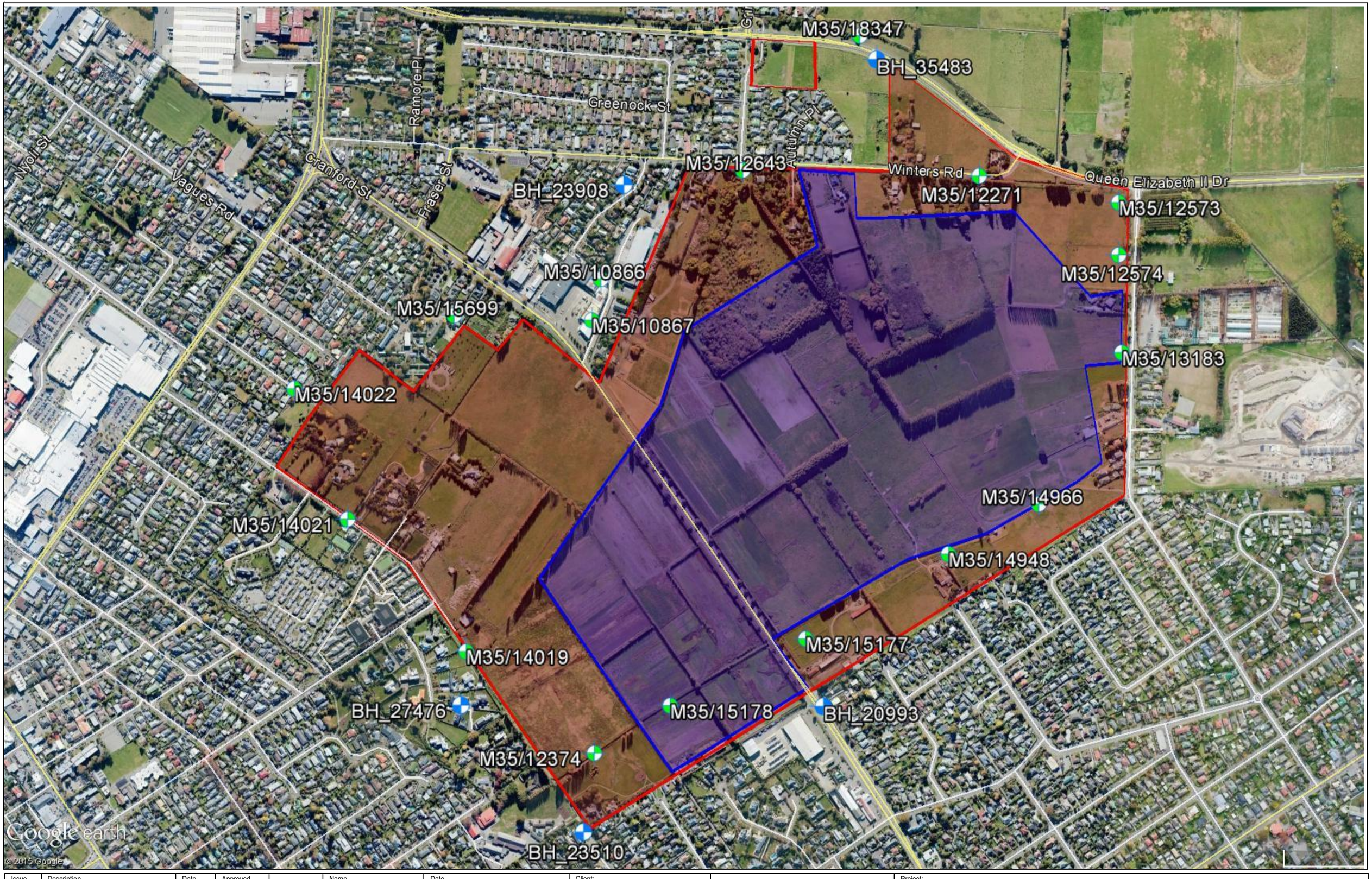
The opinions, conclusions and any recommendations in this report are based on conditions encountered and information reviewed at the date of preparation of the report. GHD has no responsibility or obligation to update this report to account for events or changes occurring subsequent to the date that the report was prepared.

Appendices

Appendix A - (Existing Investigation Logs)

Environment Canterbury Borehole Logs

Canterbury Geotechnical Database Investigation Logs



Issue	Description	Date	Approved		Name	Date
0	Cranford Basin			Designed	D. Wodos	13/02/2015
				Drawn	D. Woods	13/02/2015
				Checked		
				Approved		
				Scale @ NTS	Projection:	

This map should only be used for the purpose for which it was intended. GHD Limited accepts no responsibility for errors or omissions that may occur in data supplied from external sources.

Client:

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Level 3
27 Napier Street
Freemans Bay
Auckland 1011

Ph: (09) 370 8000
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Project:

Cranford Basin – Investigation Locations

Issued For:	Desktop Report	Project Number:	51-33038	Sheet Number:	GEO	Issue:	01

Unknown No: M35/15178
Well Name: CCC BorelogID 4314
Owner: CCC borelog

Environment Canterbury
Your regional council

Street of Well:	Dudley Creek	**File No:**	
Locality:		**Allocation Zone:**	Christchurch/West Melton
NZTM Grid Reference:	BX24:69647-83869 QAR 3	**CWMS Zone:**	Christchurch - West Melton
NZTM X-Y:	1569647 - 5183869		
Location Description:	Dudley Creek Diversion - 200m west of Cranford St	**Uses:**	Geotechnical / Geological Investigation
ECan Monitoring:			
Well Status:	Filled in		

Drill Date:		**Water Level Count:**	0
Well Depth:	6.00m -GL	**Strata Layers:**	2
Initial Water Depth:		**Aquifer Tests:**	0
Diameter:		**Yield/Drawdown Tests:**	0
Measuring Point Ait:	8.78m MSD QAR 4	**Highest GW Level:**	
GL Around Well:	0.00m -MP	**Lowest GW Level:**	
MP Description:		**First Reading:**	
		Last Reading:	
Driller:		**Calc. Min. (Below MP):**	
Drilling Method:		**Last Updated:**	27 Mar 2008
Casing Material:		**Last Field Check:**	
Pump Type:			
Yield:		**Aquifer Type:**	
Drawdown:		**Aquifer Name:**	
Specific Capacity:			

Screens:

Screen No.	Screen Type	Top (m)	Bottom (m)	Diameter (mm)	Leader Length (mm)	Slot Size (mm)	Slot Length (mm)

Step Tests:

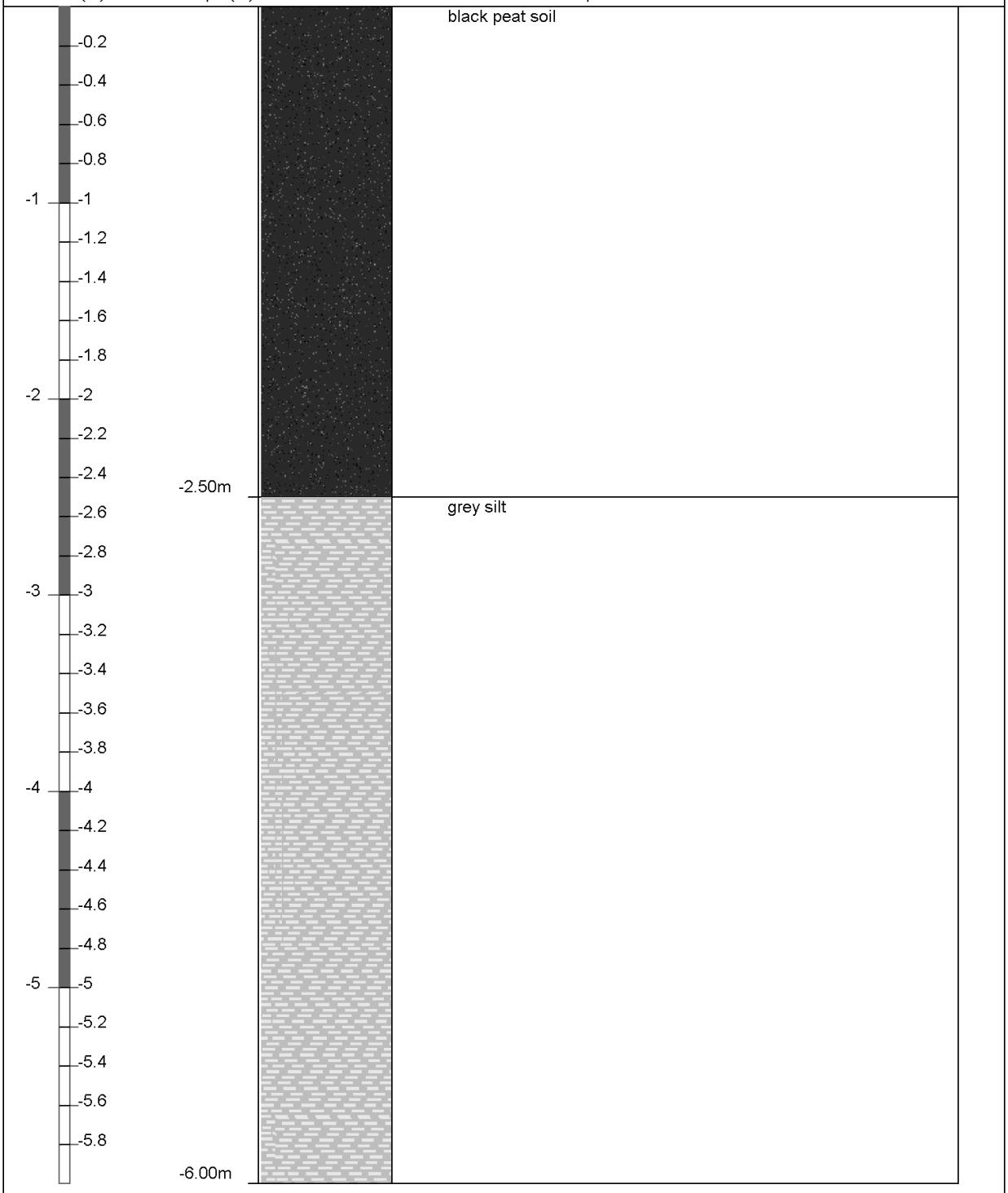
Step Test Date	Step	Yield (l/s)	Drawdown	Duration (mins)

Aquifer test date(s) where this is an observation bore

Borelog for well M35/15178

Gridref: M35:79648-45483 Accuracy : 3 (1=high, 5=low)
Ground Level Altitude : 8.78 +MSD
Well name : CCC BorelogID 4314
Drill Method : Not Recorded
Drill Depth : -6m Drill Date :

Environment Canterbury Regional Council



Bore or Well No: M35/1646
Well Name:
Owner: HARRISON, J.

Environment Canterbury
Your regional council

Street of Well: CRANFORD ST
File No:
Locality: PAPANUI
Allocation Zone: Christchurch/West Melton
NZTM Grid Reference: BX24:69699-84386 QAR 4
CWMS Zone: Christchurch - West Melton
NZTM X-Y: 1569699 - 5184386
Location Description:
Uses:
ECan Monitoring:
Well Status: Not Used

Drill Date: 28 Feb 1972
Water Level Count: 0
Well Depth: 25.40m -GL
Strata Layers: 10
Initial Water Depth: 3.70m -MP
Aquifer Tests: 0
Diameter: 152mm
Yield/Drawdown Tests: 1

Measuring Point Ait: 5.00m MSD QAR 3
Highest GW Level:
GL Around Well: 0.00m -MP
Lowest GW Level:
MP Description:
First Reading:
Last Reading:
Driller: A M Bisley & Co
Calc. Min. (Below MP): -0.20m -MP
Drilling Method: Cable Tool
Last Updated: 08 Nov 2013
Casing Material:
Last Field Check:
Pump Type: Unknown
Yield: 19 l/s
Aquifer Type: Flowing Artesian
Drawdown: 3 m
Aquifer Name: Riccarton Gravel
Specific Capacity: 6.33 l/s/m

Screens:

Screen No.	Screen Type	Top (m)	Bottom (m)	Diameter (mm)	Leader Length (mm)	Slot Size (mm)	Slot Length (mm)
1	Galvanised (Nold)	22.3	25.3				

Step Tests:

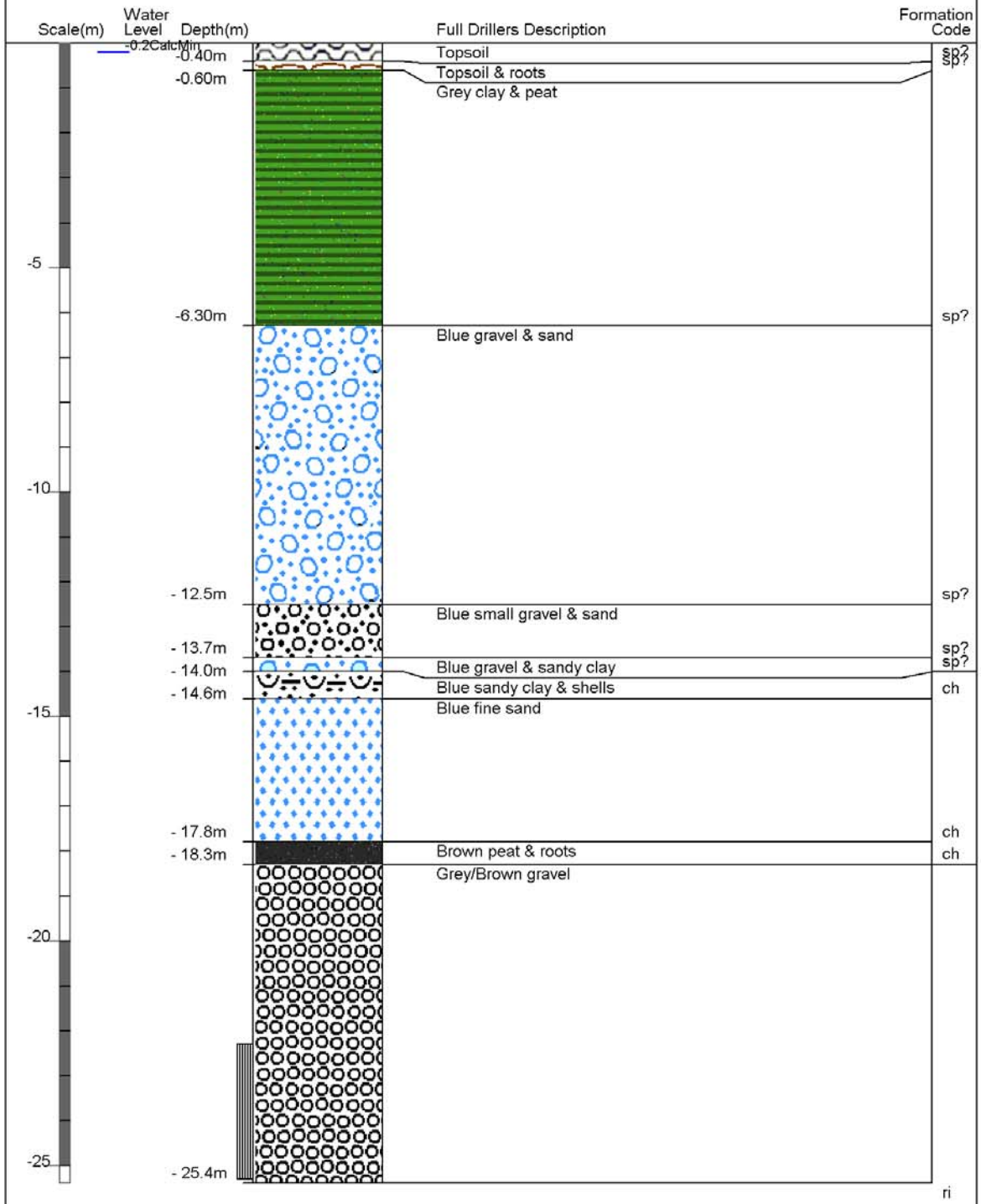
Step Test Date	Step	Yield (l/s)	Drawdown	Duration (mins)
28 Feb 1972	1	19	3	

Aquifer test date(s) where this is an observation bore

Borelog for well M35/1646

Gridref: M35:797-460 Accuracy : 4 (1=high, 5=low)
Ground Level Altitude : 5 +MSD
Driller : A M Bisley & Co
Drill Method : Cable Tool
Drill Depth : -25.4m Drill Date : 28/02/1972

Environment Canterbury Regional Council



Unknown No: M35/15178
Well Name: CCC BorelogID 4314
Owner: CCC borelog

Environment Canterbury
Your regional council

Street of Well:	Dudley Creek	**File No:**	
Locality:		**Allocation Zone:**	Christchurch/West Melton
NZTM Grid Reference:	BX24:69647-83869 QAR 3	**CWMS Zone:**	Christchurch - West Melton
NZTM X-Y:	1569647 - 5183869		
Location Description:	Dudley Creek Diversion - 200m west of Cranford St	**Uses:**	Geotechnical / Geological Investigation
ECan Monitoring:			
Well Status:	Filled in		

Drill Date:		**Water Level Count:**	0
Well Depth:	6.00m -GL	**Strata Layers:**	2
Initial Water Depth:		**Aquifer Tests:**	0
Diameter:		**Yield/Drawdown Tests:**	0
Measuring Point Ait:	8.78m MSD QAR 4	**Highest GW Level:**	
GL Around Well:	0.00m -MP	**Lowest GW Level:**	
MP Description:		**First Reading:**	
		Last Reading:	
Driller:		**Calc. Min. (Below MP):**	
Drilling Method:		**Last Updated:**	27 Mar 2008
Casing Material:		**Last Field Check:**	
Pump Type:			
Yield:		**Aquifer Type:**	
Drawdown:		**Aquifer Name:**	
Specific Capacity:			

Screens:

Screen No.	Screen Type	Top (m)	Bottom (m)	Diameter (mm)	Leader Length (mm)	Slot Size (mm)	Slot Length (mm)

Step Tests:

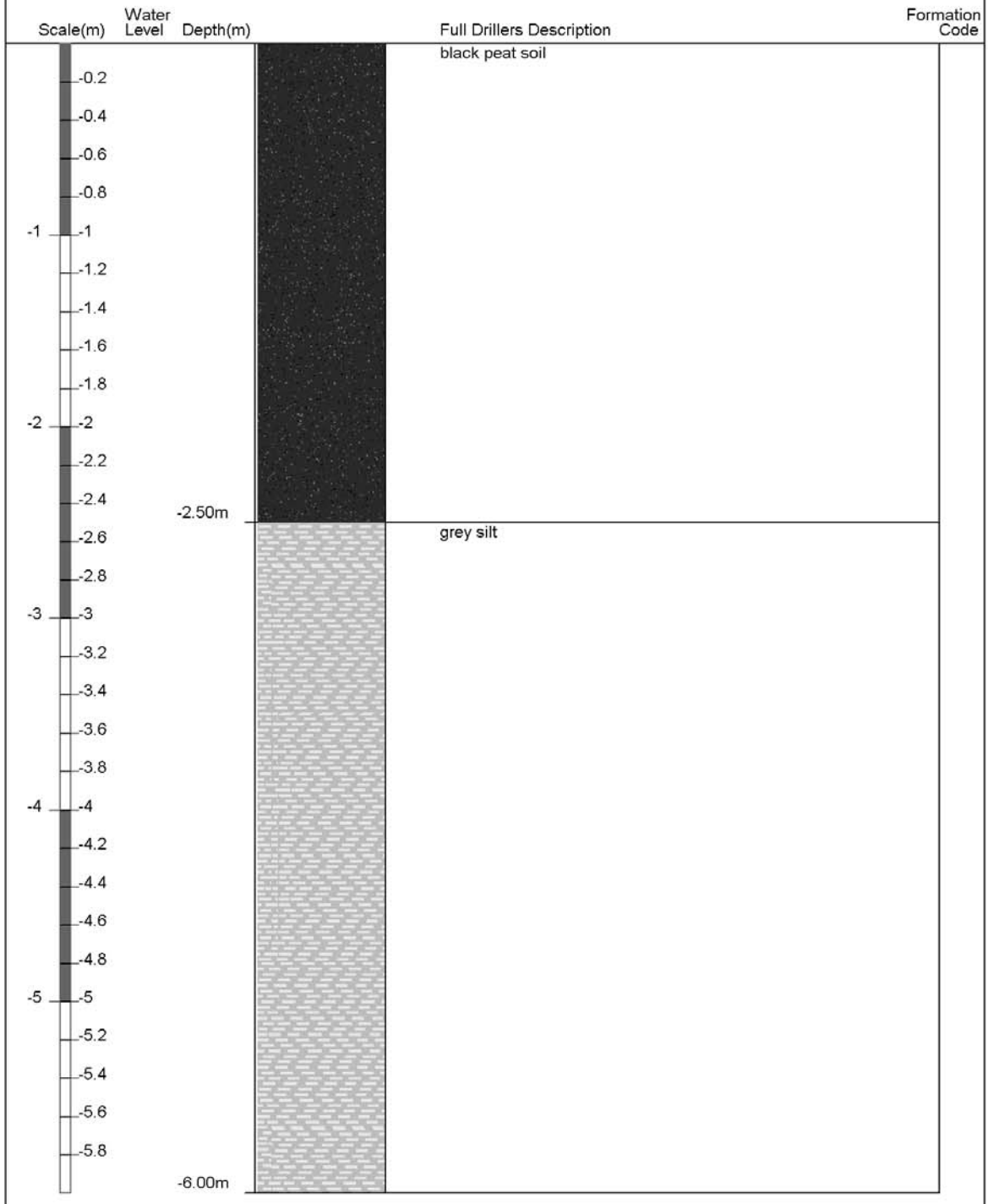
Step Test Date	Step	Yield (l/s)	Drawdown	Duration (mins)

Aquifer test date(s) where this is an observation bore

Borelog for well M35/15178

Gridref: M35:79648-45483 Accuracy : 3 (1=high, 5=low)
Ground Level Altitude : 8.78 +MSD
Well name : CCC BorelogID 4314
Drill Method : Not Recorded
Drill Depth : -6m Drill Date :

Environment Canterbury Regional Council



Unknown No: M35/15177
Well Name: CCC BorelogID 4313
Owner: CCC borelog

Environment Canterbury
Your regional council

Street of Well:	Dudley Creek	**File No:**	
Locality:		**Allocation Zone:**	Christchurch/West Melton
NZTM Grid Reference:	BX24:69914-84004 QAR 3	**CWMS Zone:**	Christchurch - West Melton
NZTM X-Y:	1569914 - 5184004		
Location Description:	Dudley Creek Diversion - 100m east of Cranford St	**Uses:**	Geotechnical / Geological Investigation
ECan Monitoring:			
Well Status:	Filled in		

Drill Date:		**Water Level Count:**	0
Well Depth:	6.00m -GL	**Strata Layers:**	2
Initial Water Depth:		**Aquifer Tests:**	0
Diameter:		**Yield/Drawdown Tests:**	0
Measuring Point Ait:	8.63m MSD QAR 4	**Highest GW Level:**	
GL Around Well:	0.00m -MP	**Lowest GW Level:**	
MP Description:		**First Reading:**	
		Last Reading:	
Driller:		**Calc. Min. (Below MP):**	
Drilling Method:		**Last Updated:**	27 Mar 2008
Casing Material:		**Last Field Check:**	
Pump Type:			
Yield:		**Aquifer Type:**	
Drawdown:		**Aquifer Name:**	
Specific Capacity:			

Screens:

Screen No.	Screen Type	Top (m)	Bottom (m)	Diameter (mm)	Leader Length (mm)	Slot Size (mm)	Slot Length (mm)

Step Tests:

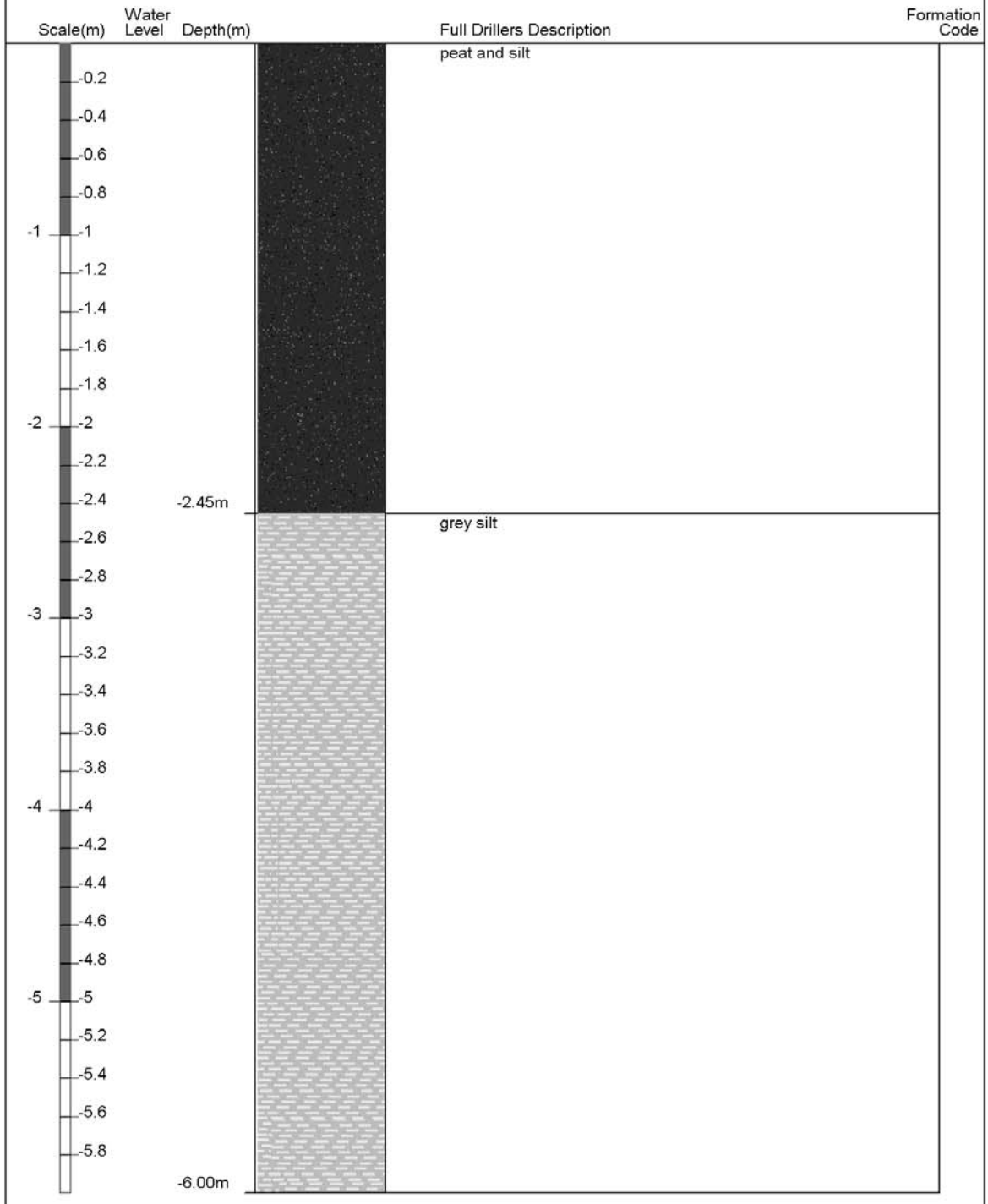
Step Test Date	Step	Yield (l/s)	Drawdown	Duration (mins)

Aquifer test date(s) where this is an observation bore

Borelog for well M35/15177

Gridref: M35:79915-45618 Accuracy : 3 (1=high, 5=low)
Ground Level Altitude : 8.63 +MSD
Well name : CCC BorelogID 4313
Drill Method : Not Recorded
Drill Depth : -6m Drill Date :

Environment Canterbury Regional Council



Unknown No: M35/14966
Well Name: CCC BorelogID 3961
Owner: CCC borelog

Environment Canterbury
Your regional council

Street of Well:	Philpotts Rd	**File No:**	
Locality:		**Allocation Zone:**	Christchurch/West Melton
NZTM Grid Reference:	BX24:70375-84268 QAR 3	**CWMS Zone:**	Christchurch - West Melton
NZTM X-Y:	1570375 - 5184268		
Location Description:	Philpotts Rd - in paddock west of road about 200m west of road bend ag	**Uses:**	Geotechnical / Geological Investigation
ECan Monitoring:			
Well Status:	Filled in		

Drill Date:		**Water Level Count:**	0
Well Depth:	3.90m -GL	**Strata Layers:**	4
Initial Water Depth:		**Aquifer Tests:**	0
Diameter:		**Yield/Drawdown Tests:**	0
Measuring Point Ait:	8.42m MSD QAR 4	**Highest GW Level:**	
GL Around Well:	0.00m -MP	**Lowest GW Level:**	
MP Description:		**First Reading:**	
		Last Reading:	
Driller:		**Calc. Min. (Below MP):**	
Drilling Method:		**Last Updated:**	27 Mar 2008
Casing Material:		**Last Field Check:**	
Pump Type:			
Yield:		**Aquifer Type:**	
Drawdown:		**Aquifer Name:**	
Specific Capacity:			

Screens:

Screen No.	Screen Type	Top (m)	Bottom (m)	Diameter (mm)	Leader Length (mm)	Slot Size (mm)	Slot Length (mm)

Step Tests:

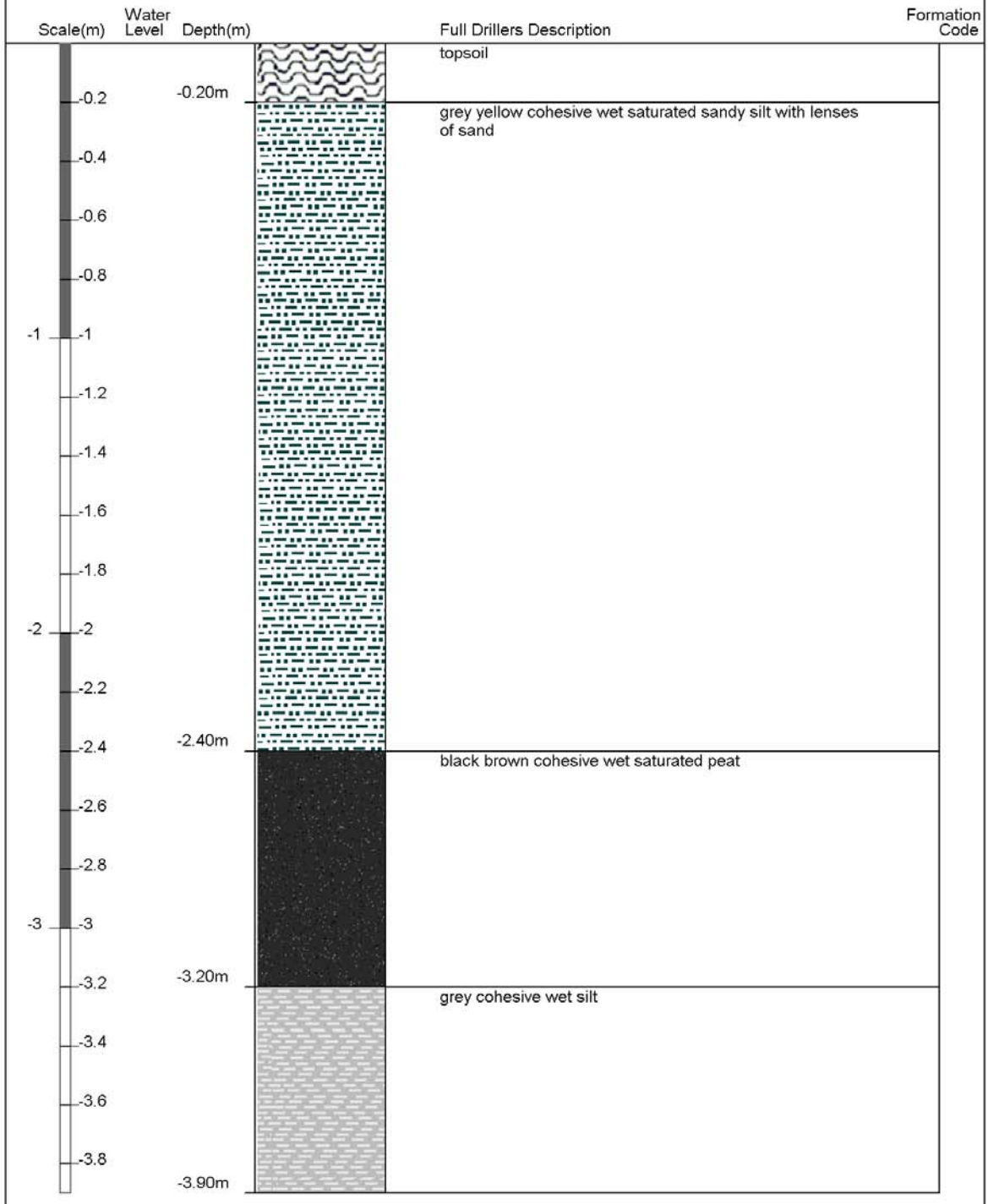
Step Test Date	Step	Yield (l/s)	Drawdown	Duration (mins)

Aquifer test date(s) where this is an observation bore

Borelog for well M35/14966

Gridref: M35:80376-45882 Accuracy : 3 (1=high, 5=low)
Ground Level Altitude : 8.42 +MSD
Well name : CCC BorelogID 3961
Drill Method : Not Recorded
Drill Depth : -3.9m Drill Date :

Environment Canterbury Regional Council



Unknown No: M35/14948
Well Name: CCC BorelogID 3943
Owner: CCC borelog

Environment Canterbury
Your regional council

Street of Well:	Croziers Rd -	**File No:**	
Locality:		**Allocation Zone:**	Christchurch/West Melton
NZTM Grid Reference:	BX24:70187-84160 QAR 3	**CWMS Zone:**	Christchurch - West Melton
NZTM X-Y:	1570187 - 5184160		
Location Description:	Croziers Rd - in MWD/Crozier Property 420m northwest of Croziers Rd an	**Uses:**	Geotechnical / Geological Investigation
ECan Monitoring:			
Well Status:	Filled in		

Drill Date:	05 Jul 1987	**Water Level Count:**	0
Well Depth:	3.00m -GL	**Strata Layers:**	2
Initial Water Depth:		**Aquifer Tests:**	0
Diameter:		**Yield/Drawdown Tests:**	0
Measuring Point Ait:	8.47m MSD QAR 4	**Highest GW Level:**	
GL Around Well:	0.00m -MP	**Lowest GW Level:**	
MP Description:		**First Reading:**	
		Last Reading:	
Driller:		**Calc. Min. (Below MP):**	
Drilling Method:		**Last Updated:**	27 Mar 2008
Casing Material:		**Last Field Check:**	
Pump Type:			
Yield:		**Aquifer Type:**	
Drawdown:		**Aquifer Name:**	
Specific Capacity:			

Screens:

Screen No.	Screen Type	Top (m)	Bottom (m)	Diameter (mm)	Leader Length (mm)	Slot Size (mm)	Slot Length (mm)

Step Tests:

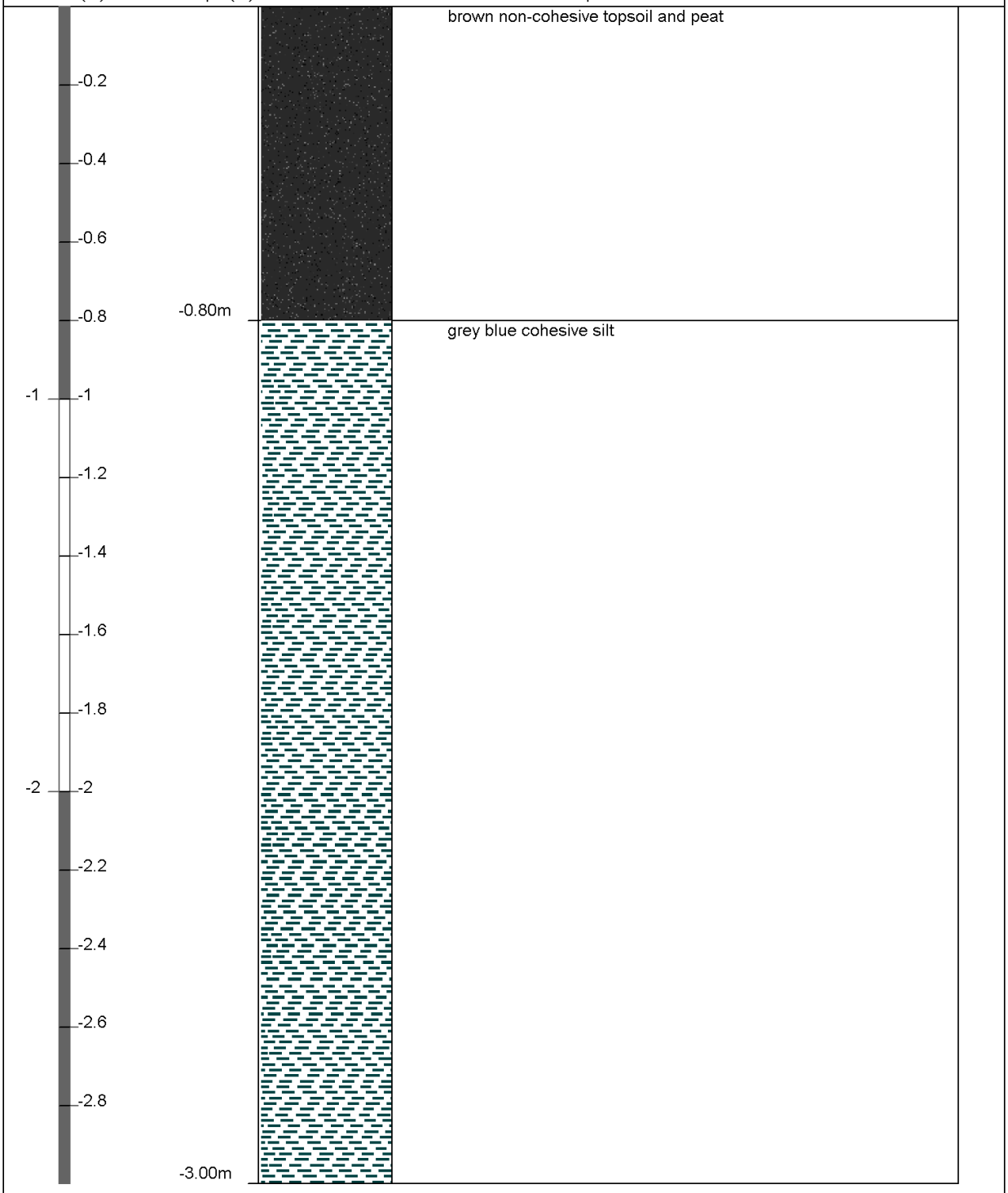
Step Test Date	Step	Yield (l/s)	Drawdown	Duration (mins)

Aquifer test date(s) where this is an observation bore

Borelog for well M35/14948

Gridref: M35:80188-45774 Accuracy : 3 (1=high, 5=low)
Ground Level Altitude : 8.47 +MSD
Well name : CCC BorelogID 3943
Drill Method : Not Recorded
Drill Depth : -3m Drill Date : 5/07/1987

Environment Canterbury Regional Council



Unknown No: M35/14021
Well Name: CCC BorelogID 2525
Owner: CCC borelog

Environment Canterbury
Your regional council

Street of Well:	Grassmere St	**File No:**	
Locality:		**Allocation Zone:**	Christchurch/West Melton
NZTM Grid Reference:	BX24:69013-84235 QAR 3	**CWMS Zone:**	Christchurch - West Melton
NZTM X-Y:	1569013 - 5184235		
Location Description:	Grassmere St - 320m northwest of angle	**Uses:**	Geotechnical / Geological Investigation
ECan Monitoring:			
Well Status:	Filled in		

Drill Date:	01 Jan 1959	**Water Level Count:**	0
Well Depth:	7.32m -GL	**Strata Layers:**	3
Initial Water Depth:	-1.42m -MP	**Aquifer Tests:**	0
Diameter:		**Yield/Drawdown Tests:**	0
Measuring Point Ait:	10.28m MSD QAR 4	**Highest GW Level:**	
GL Around Well:	0.00m -MP	**Lowest GW Level:**	
MP Description:		**First Reading:**	
		Last Reading:	
Driller:		**Calc. Min. (Below MP):**	
Drilling Method:		**Last Updated:**	27 Mar 2008
Casing Material:		**Last Field Check:**	
Pump Type:			
Yield:		**Aquifer Type:**	
Drawdown:		**Aquifer Name:**	
Specific Capacity:			

Screens:

Screen No.	Screen Type	Top (m)	Bottom (m)	Diameter (mm)	Leader Length (mm)	Slot Size (mm)	Slot Length (mm)

Step Tests:

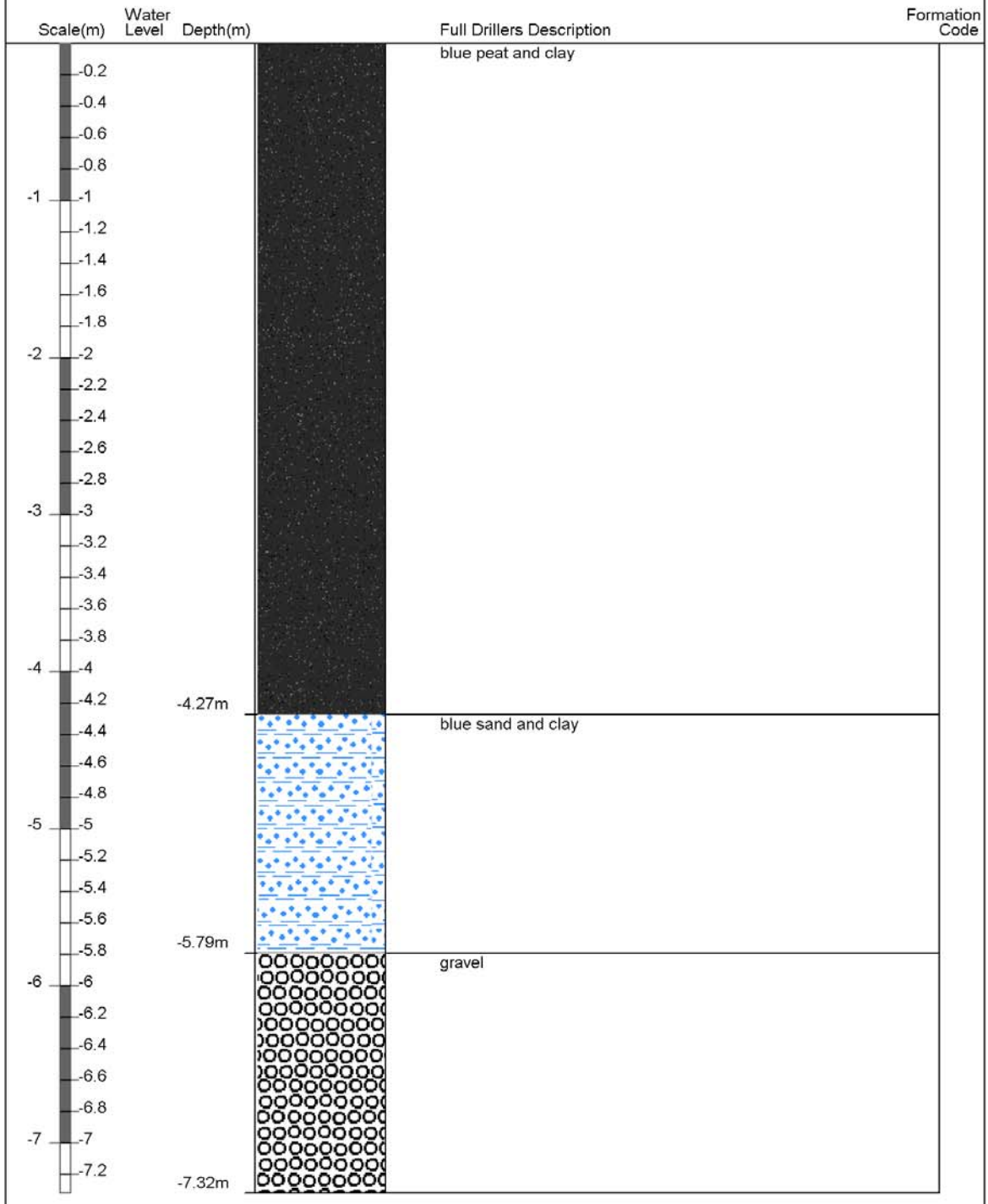
Step Test Date	Step	Yield (l/s)	Drawdown	Duration (mins)

Aquifer test date(s) where this is an observation bore

Borelog for well M35/14021

Gridref: M35:79013-45849 Accuracy : 3 (1=high, 5=low)
Ground Level Altitude : 10.28 +MSD
Well name : CCC BorelogID 2525
Drill Method : Not Recorded
Drill Depth : -7.32m Drill Date : 1/01/1959

Environment Canterbury Regional Council



Unknown No: M35/14019
Well Name: CCC BorelogID 2523
Owner: CCC borelog

Environment Canterbury
Your regional council

Street of Well:	Grassmere St	**File No:**	
Locality:		**Allocation Zone:**	Christchurch/West Melton
NZTM Grid Reference:	BX24:69246-83977 QAR 3	**CWMS Zone:**	Christchurch - West Melton
NZTM X-Y:	1569246 - 5183977		
Location Description:	Grassmere St - 140m southeast of Grants Rd	**Uses:**	Geotechnical / Geological Investigation
ECan Monitoring:			
Well Status:	Filled in		

Drill Date:	01 Jan 1959	**Water Level Count:**	0
Well Depth:	5.18m -GL	**Strata Layers:**	4
Initial Water Depth:		**Aquifer Tests:**	0
Diameter:		**Yield/Drawdown Tests:**	0
Measuring Point Ait:	9.29m MSD QAR 4	**Highest GW Level:**	
GL Around Well:	0.00m -MP	**Lowest GW Level:**	
MP Description:		**First Reading:**	
		Last Reading:	
Driller:		**Calc. Min. (Below MP):**	
Drilling Method:		**Last Updated:**	27 Mar 2008
Casing Material:		**Last Field Check:**	
Pump Type:			
Yield:		**Aquifer Type:**	
Drawdown:		**Aquifer Name:**	
Specific Capacity:			

Screens:

Screen No.	Screen Type	Top (m)	Bottom (m)	Diameter (mm)	Leader Length (mm)	Slot Size (mm)	Slot Length (mm)

Step Tests:

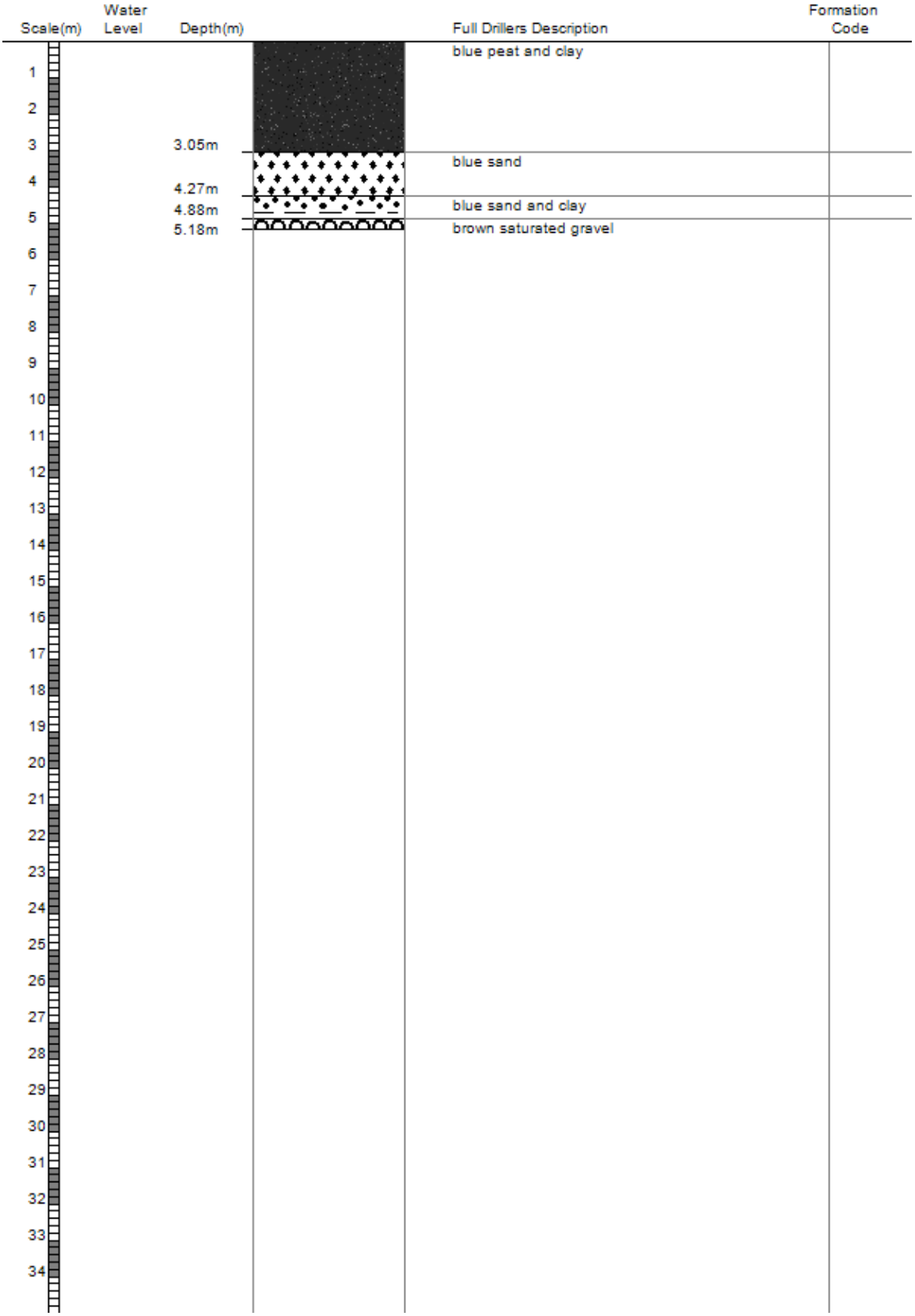
Step Test Date	Step	Yield (l/s)	Drawdown	Duration (mins)

Aquifer test date(s) where this is an observation bore

Borelog for well M35/14019

Map Reference (NZMG): 2479246 mN, 5745591 mE
QAR Accuracy: 3
Ground Level Altitude: 9.3 +MSD
Driller:
Drill Method:
Well Depth: 5.17999982833862m Drill Date: 01/01/1959

Environment Canterbury Regional Council
Kaunihera Taiao ki Waitaha



Unknown No: M35/13183
Well Name: CCC BorelogID 1450
Owner: CCC borelog

Environment Canterbury
Your regional council

Street of Well:	Philpotts Rd	**File No:**	
Locality:		**Allocation Zone:**	Christchurch/West Melton
NZTM Grid Reference:	BX24:70553-84565 QAR 3	**CWMS Zone:**	Christchurch - West Melton
NZTM X-Y:	1570553 - 5184565		
Location Description:	Philpotts Rd - 300m north of angle - at M.H	**Uses:**	Geotechnical / Geological Investigation
ECan Monitoring:			
Well Status:	Filled in		

Drill Date:	01 Jan 1956	**Water Level Count:**	0
Well Depth:	2.99m -GL	**Strata Layers:**	3
Initial Water Depth:		**Aquifer Tests:**	0
Diameter:		**Yield/Drawdown Tests:**	0
Measuring Point Ait:	8.53m MSD QAR 4	**Highest GW Level:**	
GL Around Well:	0.00m -MP	**Lowest GW Level:**	
MP Description:		**First Reading:**	
		Last Reading:	
Driller:		**Calc. Min. (Below MP):**	
Drilling Method:		**Last Updated:**	27 Mar 2008
Casing Material:		**Last Field Check:**	
Pump Type:			
Yield:		**Aquifer Type:**	
Drawdown:		**Aquifer Name:**	
Specific Capacity:			

Screens:

Screen No.	Screen Type	Top (m)	Bottom (m)	Diameter (mm)	Leader Length (mm)	Slot Size (mm)	Slot Length (mm)

Step Tests:

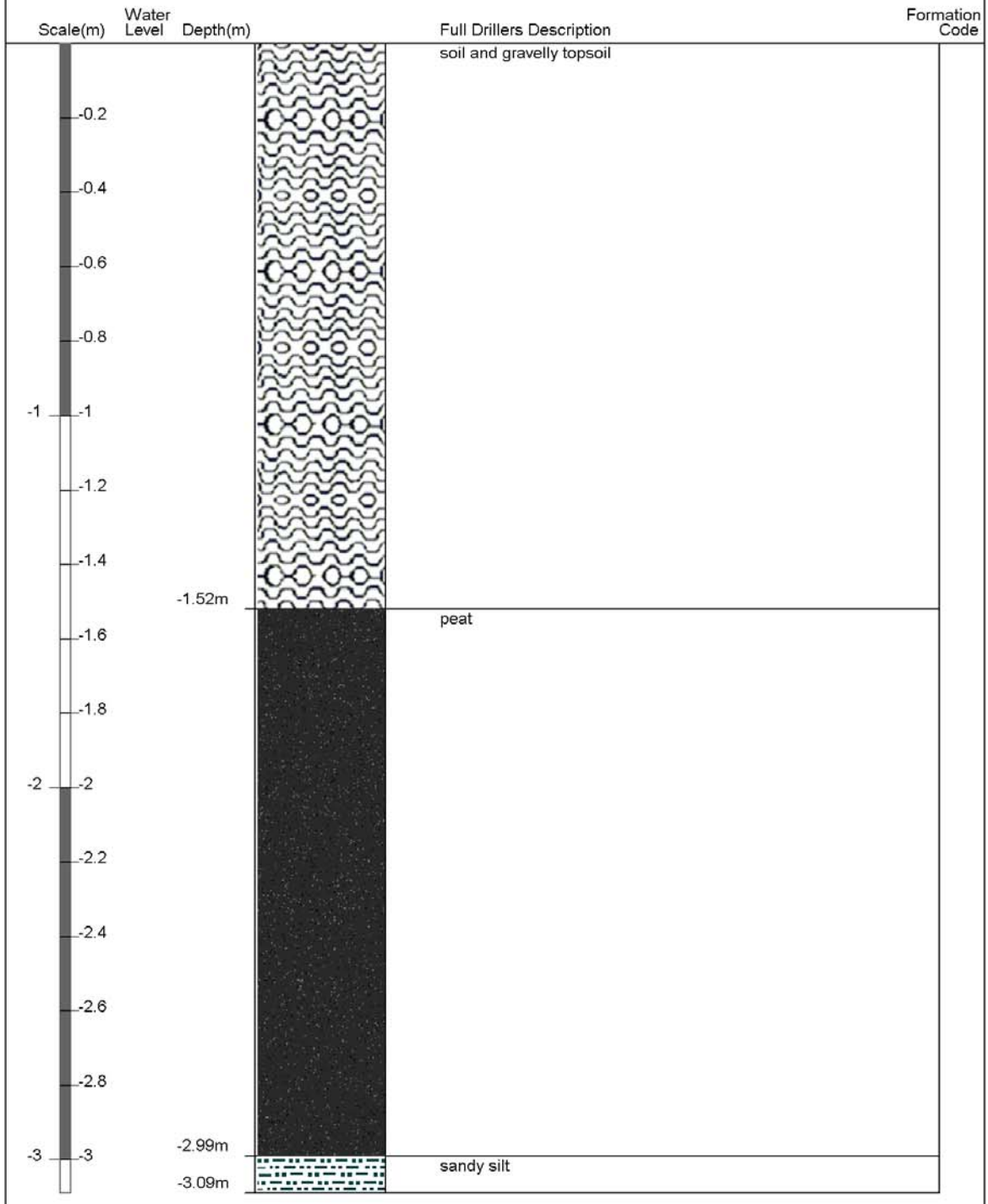
Step Test Date	Step	Yield (l/s)	Drawdown	Duration (mins)

Aquifer test date(s) where this is an observation bore

Borelog for well M35/13183

Gridref: M35:80554-46179 Accuracy : 3 (1=high, 5=low)
Ground Level Altitude : 8.53 +MSD
Well name : CCC BorelogID 1450
Drill Method : Not Recorded
Drill Depth : -3.09m Drill Date : 1/01/1956

Environment Canterbury Regional Council



Unknown No: M35/12643
Well Name: CCC BorelogID 769
Owner: CCC borelog

Environment Canterbury
Your regional council

Street of Well:	Winters Rd /	**File No:**	
Locality:		**Allocation Zone:**	Christchurch/West Melton
NZTM Grid Reference:	BX24:69785-84919 QAR 3	**CWMS Zone:**	Christchurch - West Melton
NZTM X-Y:	1569785 - 5184919		
Location Description:	Winters Rd / Grimseys Rd - at P.S 53 site	**Uses:**	Geotechnical / Geological Investigation
ECan Monitoring:			
Well Status:	Filled in		

Drill Date:	08 Jan 1962	**Water Level Count:**	0
Well Depth:	15.20m -GL	**Strata Layers:**	9
Initial Water Depth:		**Aquifer Tests:**	0
Diameter:		**Yield/Drawdown Tests:**	0
Measuring Point Ait:	10.72m MSD QAR 4	**Highest GW Level:**	
GL Around Well:	0.00m -MP	**Lowest GW Level:**	
MP Description:		**First Reading:**	
		Last Reading:	
Driller:		**Calc. Min. (Below MP):**	
Drilling Method:		**Last Updated:**	27 Mar 2008
Casing Material:		**Last Field Check:**	
Pump Type:			
Yield:		**Aquifer Type:**	
Drawdown:		**Aquifer Name:**	
Specific Capacity:			

Screens:

Screen No.	Screen Type	Top (m)	Bottom (m)	Diameter (mm)	Leader Length (mm)	Slot Size (mm)	Slot Length (mm)

Step Tests:

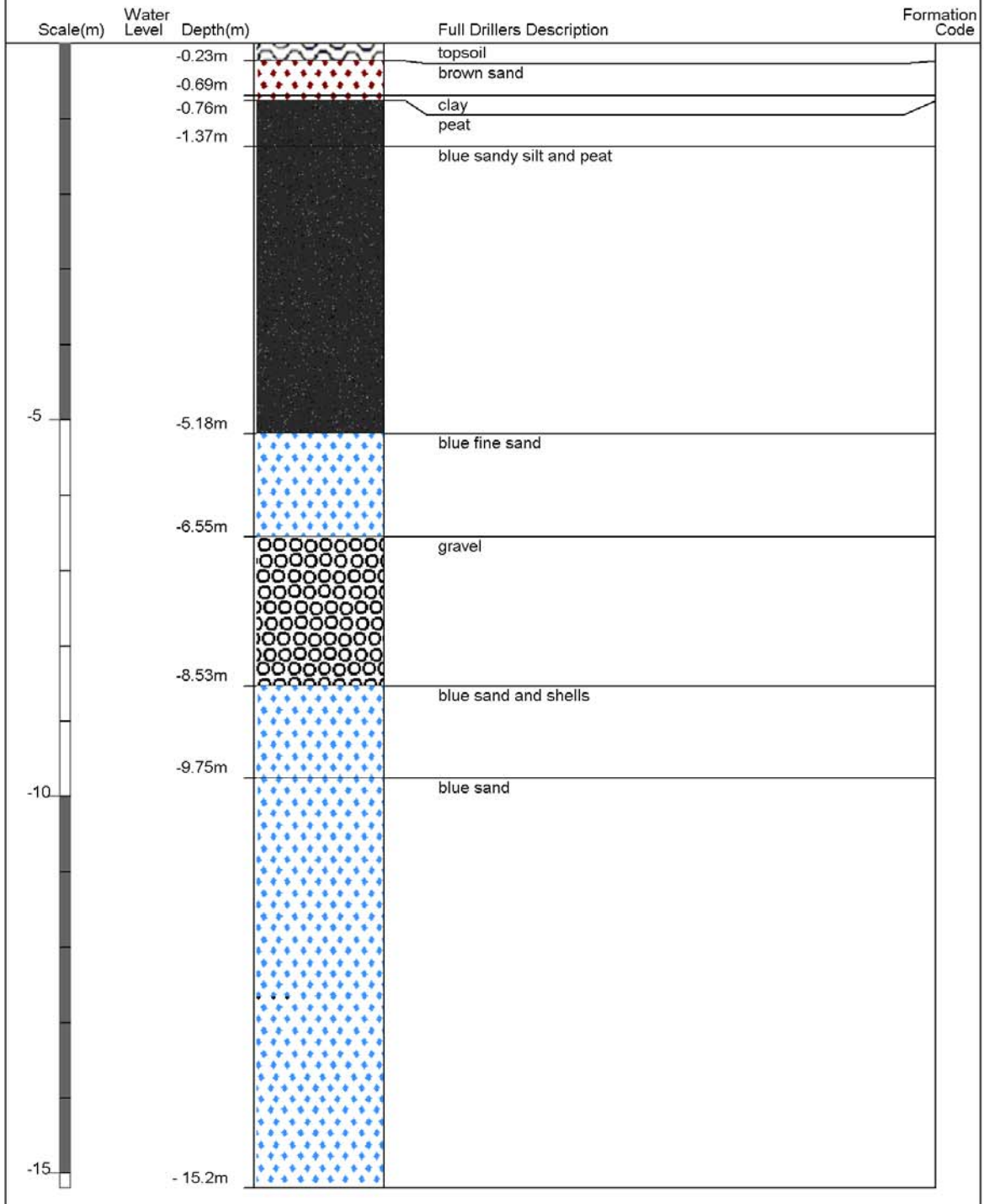
Step Test Date	Step	Yield (l/s)	Drawdown	Duration (mins)

Aquifer test date(s) where this is an observation bore

Borelog for well M35/12643

Gridref: M35:79786-46533 Accuracy : 3 (1=high, 5=low)
Ground Level Altitude : 10.72 +MSD
Well name : CCC BorelogID 769
Drill Method : Not Recorded
Drill Depth : -15.2m Drill Date : 8/01/1962

Environment Canterbury Regional Council



Unknown No: M35/12573
Well Name: CCC BorelogID 676
Owner: CCC borelog

Environment Canterbury
Your regional council

Street of Well:	Winters Rd /	**File No:**	
Locality:		**Allocation Zone:**	Christchurch/West Melton
NZTM Grid Reference:	BX24:70525-84845 QAR 3	**CWMS Zone:**	Christchurch - West Melton
NZTM X-Y:	1570525 - 5184845		
Location Description:	Winters Rd / Philpotts Rd - B.H 6 see plan for retention basin	**Uses:**	Geotechnical / Geological Investigation
ECan Monitoring:			
Well Status:	Filled in		

Drill Date:	09 Apr 1979	**Water Level Count:**	0
Well Depth:	1.20m -GL	**Strata Layers:**	3
Initial Water Depth:	-0.55m -MP	**Aquifer Tests:**	0
Diameter:		**Yield/Drawdown Tests:**	0
Measuring Point Ait:	8.68m MSD QAR 4	**Highest GW Level:**	
GL Around Well:	0.00m -MP	**Lowest GW Level:**	
MP Description:		**First Reading:**	
		Last Reading:	
Driller:		**Calc. Min. (Below MP):**	
Drilling Method:		**Last Updated:**	27 Mar 2008
Casing Material:		**Last Field Check:**	
Pump Type:			
Yield:		**Aquifer Type:**	
Drawdown:		**Aquifer Name:**	
Specific Capacity:			

Screens:

Screen No.	Screen Type	Top (m)	Bottom (m)	Diameter (mm)	Leader Length (mm)	Slot Size (mm)	Slot Length (mm)

Step Tests:

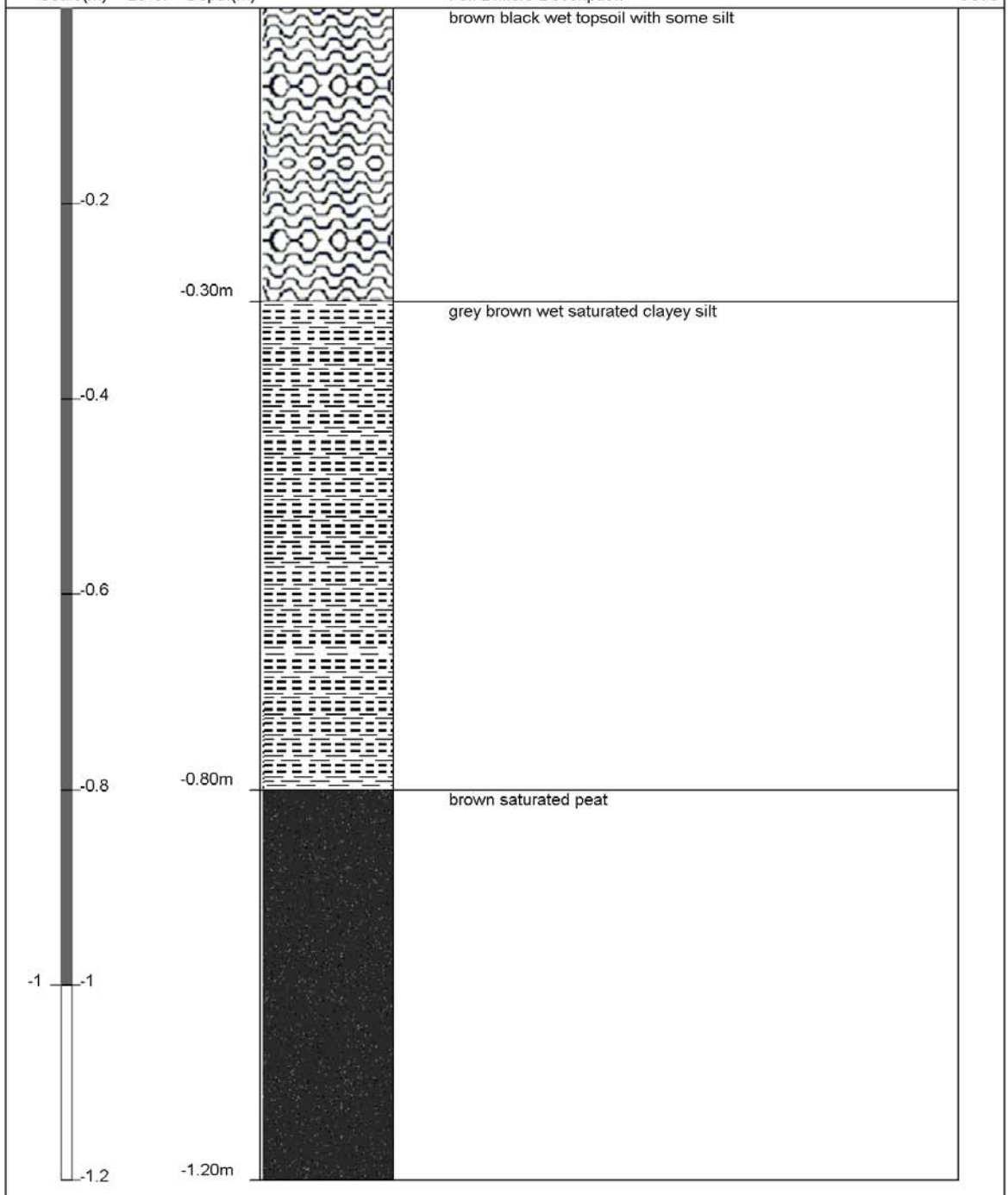
Step Test Date	Step	Yield (l/s)	Drawdown	Duration (mins)

Aquifer test date(s) where this is an observation bore

Borelog for well M35/12573

Gridref: M35:80526-46459 Accuracy : 3 (1=high, 5=low)
Ground Level Altitude : 8.68 +MSD
Well name : CCC BorelogID 676
Drill Method : Not Recorded
Drill Depth : -1.2m Drill Date : 9/04/1979

Environment Canterbury Regional Council



Bore or Well No: M35/10866
Well Name:
Owner: CRANFORD DEVELOPMENTS LIMITED

Environment Canterbury
Your regional council

Street of Well: 472 CRANFORD STREET
File No: CO6C/23738
Locality: PAPANUI
Allocation Zone: Christchurch/West Melton
NZTM Grid Reference: BX24:69509-84706 QAR 4
CWMS Zone: Christchurch - West Melton
NZTM X-Y: 1569509 - 5184706
Location Description:
Uses: Geotechnical / Geological Investigation
ECan Monitoring:
Well Status: Active (exist, present)

Drill Date: 02 Aug 2005
Water Level Count: 0
Well Depth: 15.00m -GL
Strata Layers: 4
Initial Water Depth:
Aquifer Tests: 0
Diameter: 125mm
Yield/Drawdown Tests: 0

Measuring Point Ait: 10.86m MSD QAR 4
Highest GW Level:
GL Around Well: 0.00m -MP
Lowest GW Level:
MP Description:
First Reading:
Last Reading:
Driller: CWDrill
Calc. Min. (Below MP):
Drilling Method: Concentrics
Last Updated: 08 Apr 2008
Casing Material:
Last Field Check:
Pump Type:
Yield:
Aquifer Type:
Drawdown:
Aquifer Name:
Specific Capacity:

Screens:

Screen No.	Screen Type	Top (m)	Bottom (m)	Diameter (mm)	Leader Length (mm)	Slot Size (mm)	Slot Length (mm)

Step Tests:

Step Test Date	Step	Yield (l/s)	Drawdown	Duration (mins)

Date	Comments
26 Jul 2005	Proposed LP location M35:7951-4632

Aquifer test date(s) where this is the pump bore

Aquifer test date(s) where this is an observation bore

Unknown No: M35/15699
Well Name: CCC BorelogID 5002
Owner: CCC borelog

Environment Canterbury
Your regional council

Street of Well:		**File No:**	
Locality:		**Allocation Zone:**	Christchurch/West Melton
NZTM Grid Reference:	BX24:69221-84636 QAR 3	**CWMS Zone:**	Christchurch - West Melton
NZTM X-Y:	1569221 - 5184636		
Location Description:		**Uses:**	Geotechnical / Geological Investigation
ECan Monitoring:			
Well Status:	Filled in		

Drill Date:	15 Feb 2005	**Water Level Count:**	0
Well Depth:	5.20m -GL	**Strata Layers:**	8
Initial Water Depth:	-0.70m -MP	**Aquifer Tests:**	0
Diameter:		**Yield/Drawdown Tests:**	0
Measuring Point Ait:	11.53m MSD QAR 4	**Highest GW Level:**	
GL Around Well:	0.00m -MP	**Lowest GW Level:**	
MP Description:		**First Reading:**	
		Last Reading:	
Driller:		**Calc. Min. (Below MP):**	
Drilling Method:		**Last Updated:**	27 Mar 2008
Casing Material:		**Last Field Check:**	
Pump Type:			
Yield:		**Aquifer Type:**	
Drawdown:		**Aquifer Name:**	
Specific Capacity:			

Screens:

Screen No.	Screen Type	Top (m)	Bottom (m)	Diameter (mm)	Leader Length (mm)	Slot Size (mm)	Slot Length (mm)

Step Tests:

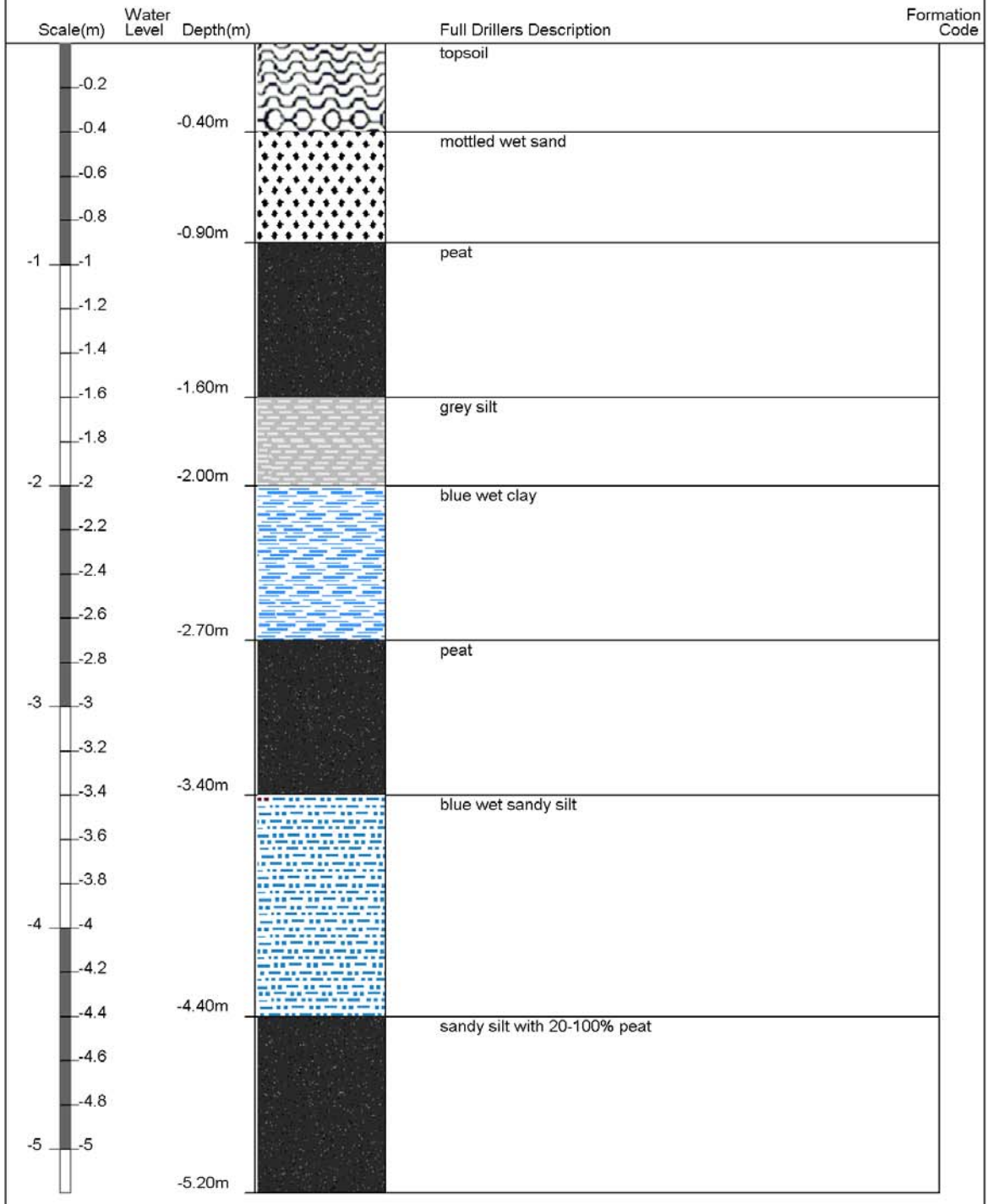
Step Test Date	Step	Yield (l/s)	Drawdown	Duration (mins)

Aquifer test date(s) where this is an observation bore

Borelog for well M35/15699

Gridref: M35:79221-46250 Accuracy : 3 (1=high, 5=low)
Ground Level Altitude : 11.53 +MSD
Well name : CCC BorelogID 5002
Drill Method : Not Recorded
Drill Depth : -5.2m Drill Date : 15/02/2005

Environment Canterbury Regional Council



Unknown No: M35/14022
Well Name: CCC BorelogID 2526
Owner: CCC borelog

Environment Canterbury
Your regional council

Street of Well:	Shearer Ave -	**File No:**	
Locality:		**Allocation Zone:**	Christchurch/West Melton
NZTM Grid Reference:	BX24:68906-84489 QAR 3	**CWMS Zone:**	Christchurch - West Melton
NZTM X-Y:	1568906 - 5184489		
Location Description:	Shearer Ave - 255m southeast of Main North Rd - at boundary	**Uses:**	Geotechnical / Geological Investigation
ECan Monitoring:			
Well Status:	Filled in		

Drill Date:	01 Jan 1959	**Water Level Count:**	0
Well Depth:	12.19m -GL	**Strata Layers:**	4
Initial Water Depth:		**Aquifer Tests:**	0
Diameter:		**Yield/Drawdown Tests:**	0
Measuring Point Ait:	11.59m MSD QAR 4	**Highest GW Level:**	
GL Around Well:	0.00m -MP	**Lowest GW Level:**	
MP Description:		**First Reading:**	
		Last Reading:	
Driller:		**Calc. Min. (Below MP):**	
Drilling Method:		**Last Updated:**	27 Mar 2008
Casing Material:		**Last Field Check:**	
Pump Type:			
Yield:		**Aquifer Type:**	
Drawdown:		**Aquifer Name:**	
Specific Capacity:			

Screens:

Screen No.	Screen Type	Top (m)	Bottom (m)	Diameter (mm)	Leader Length (mm)	Slot Size (mm)	Slot Length (mm)

Step Tests:

Step Test Date	Step	Yield (l/s)	Drawdown	Duration (mins)

Aquifer test date(s) where this is an observation bore

Borehole No: BH315

OPUS GEOTECHNICAL

PROJECT	CO-ORD.	R.L.	SHEET
Northern Arterial Specimen Design	E392125 N811604	14.63 m	1 of 3
LOCATION	**REF. GRID**	**DATUM**	**DEPTH**
Queen Elizabeth II Drive, South Abutment	Mount Pleasant 2000	SCIRT_CCC	21.61 m

GEOLOGY/UNIT	MAIN DESCRIPTION	R.L. (m) / DEPTH (m)	GRAPHIC LOG	TESTS: SPT 'N' VALUE	TESTS: SPT BLOW COUNTS OR SHEAR VALUE	CORE: TOTAL CORE RECOVERY (%)	CORE: SAMPLE TYPE	DRILLING: DRILLING METHOD	DRILLING: CASING	DRILLING: BASE OF HOLE & WATER LEVEL	ADDITIONAL NOTES	PIEZOMETER DETAILS	OTHER INSTRUMENTATION
Springston Formation	SILT with some clay and trace of sand; light brown. Soft, moderate plasticity. Trace of fibrous organic material. Interbedded with: Fibrous PEAT; black. Spongy.	14				42	HA	Rotary Sonic Drilling with SPTs		a.m. 0.0m 18/06		Bentonite	
	Fibrous PEAT; black. Soft, spongy.												
	Organic CLAY; light grey. Soft, high plasticity. Trace of fibrous organic material.									1310 1.03m 14/06			
	Fibrous PEAT; brownish black. Soft, spongy.			0	0/0// 0/0/0/0, own weight.	0	SPT						
	Organic CLAY; brownish grey. Very soft, moderate plasticity. Abundant fibrous organic material.					93	Sonic						
	CLAY; grey. Very soft, high plasticity. Abundant fibrous organic material.	12											
	From 3.40 to 3.55m Fibrous PEAT; dark brown. Very soft, plastic.			0	0/0// 0/0/0/0, own weight.	89	SPT						
	From 3.97 to 4.01m: brown fibrous organic layer, very soft.					100	Sonic						
	Organic CLAY; brownish grey. Very soft, high plasticity.	10		0	0/0// 0/0/0/0, own weight.	111	SPT				LL 78, PL 41, PI 37, WC 280, Org 3		
	CLAY; grey. Soft, high plasticity. Some fibrous organic material.					73	Sonic						
	Fine to medium SAND with minor silt; grey. Loose, uniformly graded. At 6.20m: fibrous organic inclusion. From 6.25m: with trace of silt.			4	1/1// 1/1/1/1	100	SPT				5.96m, light water flow (artesian) 0.7m head		
	Fine to coarse SAND with trace of silt; grey. 'Very loose', well graded.	8				97	Sonic						
Christchurch Formation	At 7.48m: becomes medium dense with trace of shell fragments.			20	2/3// 4/5/5/6	100	SPT				1.2m heave		
	Fine to medium SAND with minor silt; grey. 'Medium dense', well graded. Trace of fibrous organic material.	6				73	Sonic						
	Fine to coarse SAND with trace of silt; grey. 'Medium dense', well graded. Trace of shell fragments.			18	2/3// 4/4/6/4	100	SPT				SWL 1.03m, casing depth 9.00m 3.1m heave		
	From 9.85 to 9.90m: SILT; grey, mottled brown. Firm, low plasticity.					93	Sonic						

NOTES

Refer to Site Plans for Location.
Safety auto trip hammer #397 used (energy ratio 102%).

STARTED	14/06/2013	FINISHED	18/06/2013
INCLINATION/ AZIMUTH	Vertical; n/a	DRILLING Co.	McMillan Drilling
LOGGED	F Neeson / S Cooke	DRILLING RIG	Geoprobe 8140LC
CHECKED	S Cooke	DRILLER	D Berger
CLIENT	NZ Transport Agency	PROJECT No.	6-DC716.52

LOGGED IN ACCORDANCE WITH NZ GEOTECHNICAL SOCIETY GUIDELINES (2005) SEE ATTACHED KEY SHEET FOR EXPLANATION OF SYMBOLS

A3 BOREHOLE SOIL NART_SD_GINT_2013_MASTER_FILE.GPJ COMBO_TEM_MAR13.GDT 13/9/13

Scale 1:33.33 @ A3, 1:50 @ A4

Borehole No: BH315

OPUS GEOTECHNICAL

PROJECT	CO-ORD.	R.L.	SHEET
Northern Arterial Specimen Design	E392125 N811604	14.63 m	2 of 3
LOCATION	**REF. GRID**	**DATUM**	**DEPTH**
Queen Elizabeth II Drive, South Abutment	Mount Pleasant 2000	SCIRT_CCC	21.61 m

GEOLOGY/UNIT	MAIN DESCRIPTION	R.L. (m) / DEPTH (m)	GRAPHIC LOG	TESTS: SPT 'N' VALUE	TESTS: SPT BLOW COUNTS OR SHEAR VALUE	CORE: TOTAL CORE RECOVERY (%)	CORE: SAMPLE TYPE	DRILLING: DRILLING METHOD	DRILLING: CASING	DRILLING: BASE OF HOLE & WATER LEVEL	ADDITIONAL NOTES	PIEZOMETER DETAILS	OTHER INSTRUMENTATION
Christchurch Formation	From 9.90m: with minor silt. Fine to coarse SAND with trace of silt; grey. 'Medium dense', well graded. Trace of shell fragments.*(continued)*	10				93	Sonic	Rotary Sonic Drilling with SPTs			SWL 1.03m, casing depth 9.00m 3.1m heave	Bentonite	
	From 10.52m: with trace of silt and trace of shell fragments.	4									2.7m heave		
	From 10.75m: with some shell fragments.			**17**	2/3// 3/5/5/4	100	SPT						
	From 11.15m: with minor shell fragments.	11				110	Sonic						
	From 11.35m: with some shell fragments.												
	Fine to medium SAND with minor silt; grey. 'Medium dense to dense', poorly graded. Trace of shell fragments.												
		12		**36**	4/5// 6/9/10/11	100	SPT				4.0m heave		
	Fine SAND with trace of silt; grey. Medium dense, saturated, uniformly graded. Slightly dilatant.	2											
	From 12.89 to 12.91m: silty fine SAND, 'loose', dilatant.					101	Sonic						
		13											
				24	3/4// 3/5/7/9	128	SPT				1.0m heave PSD		
		14											
	At 14.17m: coarse shell fragment.												
	From 14.50m: with minor silt.	0				101	Sonic						
		15											
				15	2/2// 3/3/4/5	89	SPT				SWL 0.00m, casing depth 15.08m 1.0m heave		
	From 15.50m: with trace of silt.												
	From 16.00m: with minor silt.	16				113	Sonic						
	From 16.50m: with trace of silt.	-2									3.0m heave		
				22	2/2// 4/4/6/8	133	SPT						
		17											
						90	Sonic						
	From 17.70m: with minor silt and trace of fine to medium shell fragments. From 17.74m: with trace of silt. From 17.80m: with minor fine gravel, subangular to subrounded.												
	Organic SILT; brown. Firm wet, low plasticity. Slightly dilatant.	18											
	Fine to medium SAND with minor silt; brown. Very dense, saturated, uniformly graded. Dilatant.			**60**	3/4// 10/15/15/20	122	SPT				18.12m slow artesian flow, 3.4m head. 0.8m heave		
	From 18.50 to 18.55m: with some fine to coarse gravel, subangular to subrounded.	-4											
Riccarton Gravel	Gravelly fine to coarse SAND with minor silt; brown. 'Dense', saturated, well graded. Gravel, fine to medium, subangular to subrounded.	19				107	Sonic						
	Fine to medium SAND, greenish brown. Very dense, poorly graded.			**69**	21/21// 20/16/16/17	SC	SPT				0.6m heave		

NOTES

Refer to Site Plans for Location.
Safety auto trip hammer #397 used (energy ratio 102%).

STARTED	14/06/2013	FINISHED	18/06/2013
INCLINATION/ AZIMUTH	Vertical; n/a	DRILLING Co.	McMillan Drilling
LOGGED	F Neeson / S Cooke	DRILLING RIG	Geoprobe 8140LC
CHECKED	S Cooke	DRILLER	D Berger
CLIENT	NZ Transport Agency	PROJECT No.	6-DC716.52

LOGGED IN ACCORDANCE WITH NZ GEOTECHNICAL SOCIETY GUIDELINES (2005) *SEE ATTACHED KEY SHEET FOR EXPLANATION OF SYMBOLS*

A3 BOREHOLE SOIL NART_SD_GINT_2013_MASTER_FILE.GPJ COMBO_TEM_MAR13.GDT 13/9/13

Scale 1:33.33 @ A3, 1:50 @ A4

OPUS GEOTECHNICAL

Borehole No: BH315

PROJECT	CO-ORD.	R.L.	SHEET
Northern Arterial Specimen Design	E392125 N811604	14.63 m	3 of 3
LOCATION	**REF. GRID**	**DATUM**	**DEPTH**
Queen Elizabeth II Drive, South Abutment	Mount Pleasant 2000	SCIRT_CCC	21.61 m

GEOLOGY/UNIT	MAIN DESCRIPTION	R.L. (m) / DEPTH (m)	GRAPHIC LOG	TESTS: SPT 'N' VALUE	TESTS: SPT BLOW COUNTS OR SHEAR VALUE	CORE: TOTAL CORE RECOVERY (%)	CORE: SAMPLE TYPE	DRILLING: DRILLING METHOD	DRILLING: CASING	DRILLING: BASE OF HOLE & WATER LEVEL	ADDITIONAL NOTES	PIEZOMETER DETAILS	OTHER INSTRUMENTATION
Riccarton Gravel	Gravelly fine to coarse SAND with minor silt; brown. 'Dense', saturated, well graded. Gravel, fine to medium, subangular to subrounded.	20					SPT	Rotary Sonic Drilling with SPTs				Bentonite	
	Sandy fine to coarse GRAVEL with minor silt, greenish brown. Very dense, saturated, well graded. Gravel, fine to coarse, subrounded to rounded.	-6				97	Sonic						
		21		50	7/10// 12/12/12/14	SC	SPT				SWL +4.23m, casing depth 21.16m 21.35m fast artesian ground water encountered. 4.23m head.		
	Target depth not reached - borehole terminated at 21.61m. Artesian ground water prevents further progress: 4.23m head. Sealed and backfilled with bentonite. END OF BOREHOLE	22											
		-8											
		23											
		24											
		-10											
		25											
		26											
		-12											
		27											
		28											
		-14											
		29											

NOTES

Refer to Site Plans for Location.
Safety auto trip hammer #397 used (energy ratio 102%).

STARTED	14/06/2013	FINISHED	18/06/2013
INCLINATION/ AZIMUTH	Vertical; n/a	DRILLING Co.	McMillan Drilling
LOGGED	F Neeson / S Cooke	DRILLING RIG	Geoprobe 8140LC
CHECKED	S Cooke	DRILLER	D Berger
CLIENT	NZ Transport Agency	PROJECT No.	6-DC716.52

LOGGED IN ACCORDANCE WITH NZ GEOTECHNICAL SOCIETY GUIDELINES (2005) *SEE ATTACHED KEY SHEET FOR EXPLANATION OF SYMBOLS*

A3 BOREHOLE SOIL NART_SD_GINT_2013_MASTER_FILE.GPJ COMBO_TEM_MAR13.GDT 13/9/13

Scale 1:33.33 @ A3, 1:50 @ A4

MACHINE BOREHOLE - MB01

135 Winters Road
Mariehau
D3483807

Client	: Arrow International	**Date**	: 02/11/12
Project	: Southern Response	**Contractor**	: Pro-drill
Geoscience Ref.	: 9653.000.000	**Hole Depth**	: 15.45
Drilling Method	: Rotary Core	**Logged By**	: RB/CB
Core Diameter	: 63 mm	**Reviewed By**	: DB

Depth (m)	Material	USCS Symbol	DESCRIPTION	Consistency / Density Index	SPT N-Value
0.0	FILL	ML	SILT with trace rootlets; dark brown. [TOPSOIL]	N/A	
0.5	FILL	ML	SILT with trace gravel, cobbles and sand; brown. [FILL] Sand becomes minor. Sand, fine, poorly graded.	N/A	
1.0	FILL	ML	SILT with minor gravel, trace clay and organics; grey. Gravel, fine to coarse, subrounded, well graded. [FILL]	N/A	SPT: 1 m 0,0,0,0,0,0 N = 0 450 mm pen.
1.5	ALLUVIUM	ML	SILT with minor organics and trace clay; brown.	VS	
2.0	ALLUVIUM	ML		VS	SPT: 2 m 0,0,0,0,1,0 N = 1 450 mm pen.
2.5	PEAT	PT	Fibrous PEAT; blackish brown. Minor silt encountered from 2.8 m depth.	N/A	
3.0	PEAT	PT		N/A	SPT: 3 m 0,0,0,0,0,0 N = 0 450 mm pen.
3.5	ALLUVIUM	ML	SILT with minor organics and trace clay; grey	S	
4.0	ALLUVIUM	ML		S	SPT: 4 m 0,0,0,1,1,1 N = 3 450 mm pen.
4.5	ALLUVIUM	SP	SAND with trace organics and silt; grey. Sand, fine, poorly graded.	VL	
5.0	ALLUVIUM	SP		VL	SPT: 5 m 1,0,1,0,1,1 N = 3 450 mm pen.
5.5	ALLUVIUM	SM	Silty SAND; grey. Sand, fine, poorly graded.	VL	
6.0	ALLUVIUM	SP	SAND; grey. Sand, fine to medium, poorly graded.		SPT: 6 m 0,1,1,2,2,2 N = 7 450 mm pen.
6.5	ALLUVIUM	SP	Trace gravel encountered from 6.6 m depth.		
7.0	ALLUVIUM	SP			SPT: 7 m 1,2,3,2,2,3 N = 10 450 mm pen.
7.5	ALLUVIUM	SP	Trace shell encountered from 7.5 m depth. Minor peat encountered from 7.6 m to 7.8 m depth.		
8.0	ALLUVIUM	SP			SPT: 8 m 2,2,2,3,3,3 N = 11 450 mm pen.
8.5					

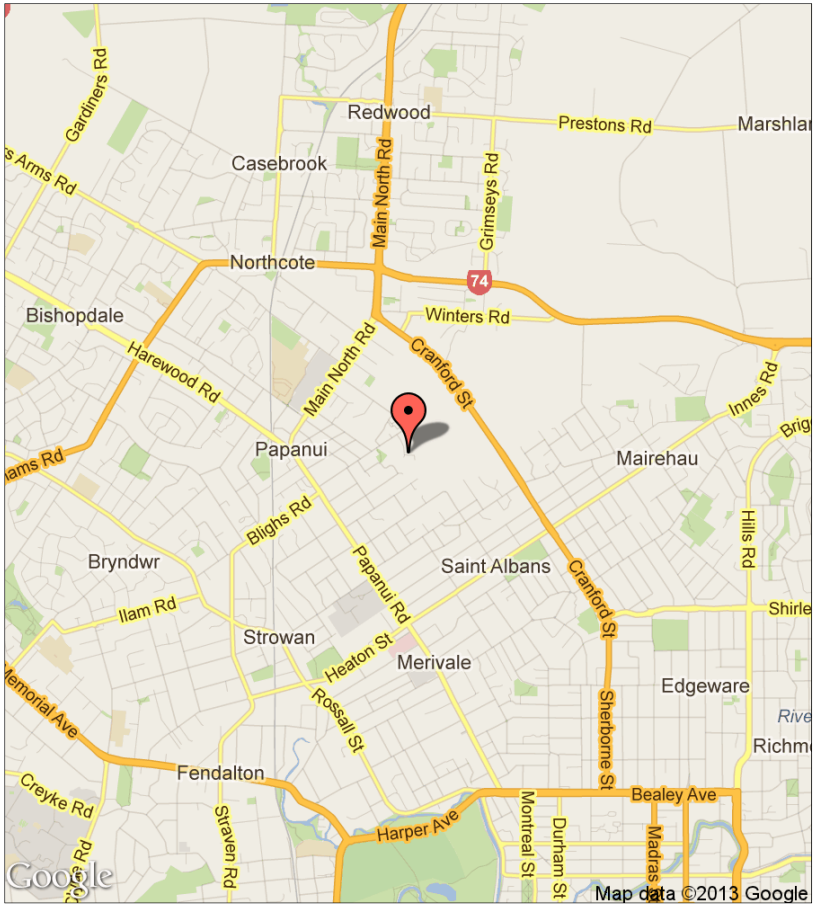
TCR (%): 25 50 75
SPT N-Value: 0 10 20 30 40 50

MACHINE BOREHOLE - MB01

135 Winters Road
Mariehau
D3483807

Client	: Arrow International	**Date**	: 02/11/12
Project	: Southern Response	**Contractor**	: Pro-drill
Geoscience Ref.	: 9653.000.000	**Hole Depth**	: 15.45
Drilling Method	: Rotary Core	**Logged By**	: RB/CB
Core Diameter	: 63 mm	**Reviewed By**	: DB

Depth (m)	Material	USCS Symbol	DESCRIPTION	Graphic Log	Water Level	Moisture Condition	Consistency / Density Index	TCR (%) 25 50 75	SPT N-Value 0 10 20 30 40 50	
8.5	ALLUVIUM	SP	Minor silt encountered from 8.6 m to 8.8 m depth.				L-MD			
9.0									o	SPT: 9 m 2,2,3,3,4,5 N = 15 450 mm pen.
9.5										
10.0									o	SPT: 10 m 3,2,2,2,3,3 N = 10 450 mm pen.
10.5										
11.0									o	SPT: 11 m 3,3,4,5,4,4 N = 17 450 mm pen.
11.5										
12.0									o	SPT: 12 m 3,3,3,4,4,4 N = 15 450 mm pen.
12.5		SM	Silty SAND with trace shell; grey. Sand, fine to medium, poorly graded.				MD			
13.0		SP	SAND with trace shell; grey. Sand, fine to medium, poorly graded.				MD-D		o	SPT: 13 m 2,3,4,3,6,9 N = 22 450 mm pen.
13.5										
14.0									o	SPT: 14 m 3,4,4,6,7,7 N = 24 450 mm pen.
14.5			Becomes dark yellowish brown at 14.8 m depth.							
15.0			Trace silt encountered from 15.0 m depth.						o	SPT: 15 m 3,5,6,6,9,10 N = 31 450 mm pen.
15.5			EOH: 15.45 m							
16.0										
16.5			Termination: Target depth Moisture condition not recorded. T = TOPSOIL							
17.0										



⊕ = Test Location

Note: All images sourced from Google Maps

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Date	Apr-13	**Client**	**Medical Assurance Society**		
Drawn by	DR	**Project**	**EQ Claims**		
Approved by	LF	**Description**	**Site Location Plan**		
Scale	NTS	**Geoscience Ref.**	9560	**Client Ref.**	Phase 730

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MACHINE BOREHOLE - MB01

11 Taunton Green
Papanui
Phase 730

Client	: Medical Assurance Society	**Date**	: 18/03/13
Project	: EQ Claims	**Contractor**	: Pro-Drill
Geoscience Ref.	: 9650.100.046	**Hole Depth**	: 22.0 m
Drilling Method	: Sonic	**Logged By**	: JC/DG
Core Diameter	: 83 mm	**Reviewed By**	: LF

Depth (m)	Material	USCS Symbol	DESCRIPTION	Graphic Log	Water Level	Moisture Condition	Consistency / Density Index	TCR (%) 25 50 75	SPT N-Value 0 10 20 30 40 50	
0.0	FILL	GM	Sandy fine to coarse GRAVEL with trace silt; greyish brown. Well graded, subrounded to subangular. Sand, fine to coarse, well graded [FILL].							
0.5		SM	Sandy SILT with minor gravel, trace brick, glass, porcelain and organics; grey. Sand, fine, poorly graded. Gravel fine to coarse, well graded, subrounded to subangular [FILL].							
1.0										
1.5		ML	SILT with some gravel, minor sand, trace charcoal, brick and organics; grey. Gravel, fine to coarse, well graded, subrounded to subangular [FILL].				N/A		o	SPT: 1.5 m 4,3,2,1,2,2 N = 7 450 mm pen.
2.0			Becomes dark greyish brown from 2.4 m depth.							
2.5			Minor wood and brick encountered from 2.7 m depth.							
3.0	PEAT SWAMP DEPOSITS	OL	Organic SILT with trace peat; dark brownish grey.						o	SPT: 3 m 1,0,1,0,0,0 N = 1 450 mm pen.
3.5										
4.0							N/A			
4.5									o	SPT: 4.5 m 0,0,0,0,0,0 N = 0 450 mm pen.
5.0			Wood encountered from 4.8 m depth.							
5.5	ALLUVIUM	SM	Sandy SILT; grey. Sand, fine, poorly graded.				VL			
6.0		SP	Fine to medium SAND with trace silt and gravel; greyish brown. Poorly graded.				MD		o	SPT: 6 m 4,5,3,3,4,4 N = 14 450 mm pen.
6.5										
7.0		GM	Sandy fine to coarse GRAVEL; brownish grey. Well graded, subrounded to subangular. Sand, fine to medium, poorly graded.				D			
7.5									o	SPT: 7.5 m 7,9,10,9,8,10 N = 37 450 mm pen.
8.0										
8.5										

GEOSCIENCE
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MACHINE BOREHOLE - MB01

11 Taunton Green
Papanui
Phase 730

Client	: Medical Assurance Society	**Date**	: 18/03/13
Project	: EQ Claims	**Contractor**	: Pro-Drill
Geoscience Ref.	: 9650.100.046	**Hole Depth**	: 22.0 m
Drilling Method	: Sonic	**Logged By**	: JC/DG
Core Diameter	: 83 mm	**Reviewed By**	: LF

Depth (m)	Material	USCS Symbol	DESCRIPTION	Graphic Log	Water Level	Moisture Condition	Consistency / Density Index	TCR (%) 25 50 75	SPT N-Value 0 10 20 30 40 50	
8.5	ALLUVIUM	GM	Cont. Sandy fine to coarse GRAVEL; brownish grey. Well graded, subrounded to subangular. Sand, fine to medium, poorly graded.				MD			
9.0									o	SPT: 9 m 12,11,8,6,5,4 N = 23 450 mm pen.
9.5										
10.0										
10.5									o	SPT: 10.5 m 4,6,6,7,6,6 N = 25 450 mm pen.
11.0										
11.5										
12.0									o	SPT: 12 m 3,4,2,2,6,5 N = 15 450 mm pen.
12.5		SP	Fine to medium SAND; greyish brown. Poorly graded.				D			
13.0										
13.5									o	SPT: 13.5 m 2,5,7,9,12,15 N = 43 450 mm pen.
14.0										
14.5			Becomes grey at 14.7 m depth.							
15.0		SM	Silty fine to medium SAND; grey. Poorly graded.				D		o	SPT: 15 m 3,8,10,12,10,14 N = 46 450 mm pen.
15.5		SP	Fine to medium SAND; grey. Poorly graded.				MD			
16.0										
16.5									o	SPT: 16.5 m 3,3,4,5,8,8 N = 25 450 mm pen.
17.0										

MACHINE BOREHOLE - MB01

11 Taunton Green
Papanui
Phase 730

Client	: Medical Assurance Society	**Date**	: 18/03/13
Project	: EQ Claims	**Contractor**	: Pro-Drill
Geoscience Ref.	: 9650.100.046	**Hole Depth**	: 22.0 m
Drilling Method	: Sonic	**Logged By**	: JC/DG
Core Diameter	: 83 mm	**Reviewed By**	: LF

Depth (m)	Material	USCS Symbol	DESCRIPTION	Graphic Log	Water Level	Moisture Condition	Consistency / Density Index	TCR (%) 25 50 75	SPT N-Value 0 10 20 30 40 50	
17.0	A	SP	Cont. Fine to medium SAND; grey. Poorly graded. Minor silt and shells encountered from 17.2 m depth. Shells encountered from 17.2 to 17.4 m depth.				MD			
17.5	PSD	Pt	Trace organics encountered from 17.5 m depth. Amorphous PEAT; black.				N/A			
18.0	ALLUVIUM	GM	Minor silt and trace clay encountered from 17.9 m depth. Sandy fine to coarse GRAVEL; grey. Well graded, subrounded to subangular. Sand, fine to coarse, well graded.				MD-D			SPT: 18 m 1,1,3,5,9,11 N = 28 450 mm pen.
18.5										
19.0			Becomes brownish grey from 19.1 m depth.							
19.5										SPT: 19.5 m 7,11,14,18,18 N = 50 365 mm pen.
20.0										
20.5										
21.0										SPT: 21 m 4,12,12,14,18,6 N = 50 400 mm pen.
21.5										
22.0			EOH: 22 m							
22.5										
23.0										
23.5										
24.0										
24.5										
25.0										
25.5										

Termination: Target depth
Machine borehole met target depth at 22.0 m depth.
Moisture condition not recorded.
A = ALLUVIUM
PSD = PEAT SWAMP DEPOSITS

GEOSCIENCE consulting (NZ) LIMITED

MACHINE BOREHOLE - MB01

37 Wiremu Street
Redwood
D3504583

Client	: Arrow International	**Date**	: 25/05/12
Project	: Southern Response	**Contractor**	: Pro-Drill (NZ) Ltd
Geoscience Ref.	: 11245	**Hole Depth**	: 18.5 m
Drilling Method	: Rotary Cored	**Logged By**	: LF/JR
Hole Diameter	: 63 mm	**Reviewed By**	: RC

Depth (m)	Material	USCS Symbol	DESCRIPTION	Graphic Log	Water Level	Moisture Condition	Consistency / Density	TCR (%) 25 50 75	SPT N-Value 0 10 20 30 40 50	
0.0	ALLUVIUM	SP	Fine to medium SAND; yellowish brown. Poorly graded.		▼	M-W	N/R			
1.0		ML	SILT; bluish grey.							SPT: 1 N = 2 450 mm pen.
1.5		PT	Fibrous PEAT; black.							
		ML	SILT with trace gravel; grey with orange mottles.							
2.0	ALLUVIUM/PEAT	PT	Fibrous PEAT; black.							SPT: 2 N = 0 450 mm pen.
2.5		ML	SILT with trace peat; dark grey.							
		PT	Fibrous PEAT; black.							
3.0		ML	SILT with minor peat; grey.				VS-S			SPT: 3 N = 0 450 mm pen.
4.0										SPT: 4 N = 0 450 mm pen.
5.0						S				SPT: 5 N = 0 450 mm pen.
5.5		PT	Silty PEAT; grey. Fibrous.							
6.0										SPT: 6 N = 2 450 mm pen.
6.5	ALLUVIUM	SP	Silty SAND; grey. Sand, fine, poorly graded.				VL			
7.0		OL	Peaty SILT with trace medium gravel; grey.				N/A			SPT: 7 N = 9 450 mm pen.
7.5		SM	Silty SAND; grey. Sand, fine, poorly graded. Peat interbed from 7.5 to 7.7 m depth.				L-D			
8.0										SPT: 8 N = 18 450 mm pen.
8.5		SP	Fine to medium SAND; grey. Poorly graded.							
9.0										SPT: 9 N = 20 450 mm pen.
9.5			Fine to medium SAND; grey. Poorly graded.							
10.0		SW	Fine to coarse SAND; grey. Well graded.							SPT: 10 N = 41 450 mm pen.
10.5										

GEOSCIENCE consulting (NZ) LIMITED

MACHINE BOREHOLE - MB01

37 Wiremu Street
Redwood
D3504583

Client	: Arrow International	**Date**	: 25/05/12
Project	: Southern Response	**Contractor**	: Pro-Drill (NZ) Ltd
Geoscience Ref.	: 11245	**Hole Depth**	: 18.5 m
Drilling Method	: Rotary Cored	**Logged By**	: LF/JR
Hole Diameter	: 63 mm	**Reviewed By**	: RC

Depth (m)	Material	USCS Symbol	DESCRIPTION	Graphic Log	Water Level	Moisture Condition	Consistency / Density	TCR (%) 25 50 75	SPT N-Value 0 10 20 30 40 50	
10.5	ALLUVIUM	SW	Fine to coarse SAND; grey. Well graded.			S	L-D			
11.0									o	SPT: 11 N = 20 450 mm pen.
11.5										
12.0		SP	Fine SAND with minor silt and shells; grey. Poorly graded.						o	SPT: 12 N = 5 450 mm pen.
12.5										
13.0									o	SPT: 13 N = 20 450 mm pen.
13.5										
14.0									o	SPT: 14 N = 28 450 mm pen.
14.5										
15.0									o	SPT: 15 N = 24 450 mm pen.
15.5										
16.0									o	SPT: 16 N = 28 450 mm pen.
16.5										
17.0		ML	SILT; grey.				St		o	SPT: 17 N = 12 450 mm pen.
17.5	A/P	PT	Fibrous PEAT; black.							
18.0		SP	Fine SAND with minor silt and peat; dark grey. Poorly graded.				MD		o	SPT: 18 N = 17 450 mm pen.
18.5			EOH: 18.5 m	N/R N/R N/R N/R N/R N/R N/R N/R N/R N/R N/R N/R						
19.0										
19.5										
20.0			Termination: Target Depth Standing groundwater encountered at 0.4 m depth. N/R = Not Recorded. A/P = ALLUVIUM/PEAT							
20.5										
21.0										

TONKIN & TAYLOR LTD

BOREHOLE LOG

BH No: PAP-POD07-BHCPT017
Hole Location: 218 Rutland Street

PROJECT: CHCH TC3 GEOTECHNICAL INVESTIGATIONS		LOCATION: PAPANUI	JOB No: 52003.000
CO-ORDINATES:	5745236.84 mN 2479479.12 mE	DRILL TYPE: Roto-Sonic Mud	HOLE STARTED: 28/5/13
		DRILL METHOD: PQDT/RM/Auto SPT	HOLE FINISHED: 28/5/13
R.L.:	8.39 m		DRILLED BY: Pro-Drill
DATUM:	NZMG, MSL (CCC 20/01/12 Datum -9.043m)	DRILL FLUID: LP2000	LOGGED BY: T&T-DG CHECKED: DAA

GEOLOGICAL | ENGINEERING DESCRIPTION

GEOLOGICAL UNIT, GENERIC NAME, ORIGIN, MINERAL COMPOSITION.	TESTS	DEPTH (m)	R.L. (m)	SAMPLES	GRAPHIC LOG	CLASSIFICATION SYMBOL	MOISTURE CONDITION / WEATHERING	STRENGTH/DENSITY CLASSIFICATION	SOIL DESCRIPTION / ROCK DESCRIPTION
TOPSOIL			8			OL	M		Organic SILT with trace rootlets and trace sand, dark brown, soft, moist, low plasticity. Organics are amorphous. Sand is fine to medium.
YALDHURST MEMBER OF THE SPRINGSTON FORMATION (ALLUVIAL)	0/0//0/5/8/4 N=17	1	7			ML	W	VSt	Sandy SILT, brownish grey, moist, low plasticity. Sand is fine to medium. 1.1m- wet, quick dilatancy. 1.35 to 1.5m- no recovery.
	0/0//0/0/0/0 N=0	2	6					VS	Sandy SILT, grey, very stiff, wet, low plasticity. Sand is fine to medium. 1.5 to 1.8m- sample not retained. 1.8 to 1.95m- no recovery. 1.95 to 2.0m- RM drill method. 2.0 to 2.45m- no recovery. 2.0m- very soft. [Obstruction at 1.65m, hole redrilled 2.0m away]
	ATP@3.0m FC@3.0m 0/0//0/0/0/0 N=0	3	5	B		MH			SILT with some organics and trace sand, brownish grey, very soft, wet, high plasticity. Organics are fibrous. Sand is fine to Medium.
	0/0//0/0/0/0 N=0	4	4						
	0/1//0/2/1/1 N=4	5	3					F	5.0m- trace rootlets, grey, firm. 5.3 to 5.45m- no recovery.
	FC@6.0m 1/2//4/3/3/4 N=14	6	2	B		SM ML		MD St	Silty fine to medium SAND, grey, medium dense, wet, poorly graded. Sandy SILT, grey, stiff, wet, low plasticity. Sand is fine to medium. 6.3 to 6.45m- no recovery.
	1/1/2/2/2/2// 2/3/3/4/4/3/ 3/4/3/3/3/3 N=38	7	1			GW		D	Sandy fine to coarse GRAVEL with trace silt, grey, subangular to subrounded, dense, wet, well graded. Sand is fine to coarse. 7.35 to 7.45m- no recovery.
	2/1/2/3/2/2// 2/2/2/2/2/1/ 2/1/2/1/2/2 N=21	8	0			SP GW SW		MD	Fine to medium SAND with minor silt, grey, medium dense, wet, poorly graded. Fine to coarse GRAVEL with trace sand and trace silt, grey, subangular to subrounded, medium dense, wet, well graded. Sand is fine to coarse. Fine to coarse SAND with minor silt, grey, medium dense, wet, well graded. 8.4 to 9.1m- no recovery.
	4/5/3/4/3/3// 4/4/3/4/3/3/ 3/2/3/3/2/2 N=36	9	-1			GW		D	Sandy fine to coarse GRAVEL with trace silt, grey, subangular to subrounded, dense, wet, well graded. Sand is fine to coarse. 9.4 to 9.55m- no recovery.
		10							

CORE RECOVERY (%): 90, 0, 0, 100, 0, 67, 0, 78, 0, 100, 33, 67, 71
METHOD: Hand Auger, SPT, SPT, RM, SPT, RM, SPT, RM, SPT, RM, SPT, PQDT, SPT, PQDT
CASING
FLUID LOSS
WATER

SHEAR STRENGTH (kPa): 10, 25, 50, 100, 200
COMPRESSIVE STRENGTH (MPa): 1, 5, 10, 20, 50, 100, 200
DEFECT SPACING (mm): 50, 100, 200, 500, 1000, 2000

SOIL DESCRIPTION
Soil type, minor components, plasticity or particle size, colour.
ROCK DESCRIPTION
Substance: Rock type, particle size, colour, minor components.
Defects: Type, inclination, thickness, roughness, filling.

TONKIN & TAYLOR LTD

BOREHOLE LOG

BH No: PAP-POD07-BHCPT017
Hole Location: 218 Rutland Street

PROJECT: CHCH TC3 GEOTECHNICAL INVESTIGATIONS | LOCATION: PAPANUI | JOB No: 52003.000

CO-ORDINATES: 5745236.84 mN, 2479479.12 mE
R.L.: 8.39 m
DATUM: NZMG, MSL (CCC 20/01/12 Datum -9.043m)

DRILL TYPE: Roto-Sonic Mud
DRILL METHOD: PQDT/RM/Auto SPT
DRILL FLUID: LP2000

HOLE STARTED: 28/5/13
HOLE FINISHED: 28/5/13
DRILLED BY: Pro-Drill
LOGGED BY: T&T-DG CHECKED: DAA

GEOLOGICAL | ENGINEERING DESCRIPTION

GEOLOGICAL UNIT, GENERIC NAME, ORIGIN, MINERAL COMPOSITION.	FLUID LOSS	WATER	CORE RECOVERY (%)	METHOD	CASING	TESTS	SAMPLES	R.L. (m)	DEPTH (m)	GRAPHIC LOG	CLASSIFICATION SYMBOL	MOISTURE CONDITION / WEATHERING	STRENGTH/DENSITY CLASSIFICATION	SHEAR STRENGTH (kPa)	COMPRESSIVE STRENGTH (MPa)	DEFECT SPACING (mm)	SOIL DESCRIPTION / ROCK DESCRIPTION
YALDHURST MEMBER OF THE SPRINGSTON FORMATION (ALLUVIAL)			71	PQDT				-2	11		GW	W	D				Sandy fine to coarse GRAVEL with trace silt, grey, subangular to subrounded, dense, wet, well graded. Sand is fine to coarse.
			56	SPT		1/1/2/2/2/2// 3/2/2/2/2/1/ 2/2/2/2/2/2 N=24							MD				10.4 to 10.7m- no recovery. 10.7m- medium dense. 10.95 to 11.15m- no recovery.
								-3	12								End of borehole at 11.15mbgl (target depth)
								-4	13								
								-5	14								
								-6	15								
								-7	16								
								-8	17								
								-9	18								
								-10	19								
								-11	20								

SOIL DESCRIPTION: Soil type, minor components, plasticity or particle size, colour.
ROCK DESCRIPTION: Substance: Rock type, particle size, colour, minor components. Defects: Type, inclination, thickness, roughness, filling.

T+T DATATEMPLATE-SPT.GDT rcb

Log Scale 1:50

TONKIN & TAYLOR LTD

BOREHOLE LOG

BH No: STA-TC201-BH001
Hole Location: 332 Cranford Street

PROJECT: CHCH GEOTECHNICAL INVESTIGATIONS		LOCATION: ST ALBANS	JOB No: 52003.000
CO-ORDINATES:	5745485.06 mN 2479949.49 mE	DRILL TYPE: Roto-Sonic	HOLE STARTED: 9/4/13 HOLE FINISHED: 9/4/13
R.L.:	6.43 m	DRILL METHOD: PQDT/Auto SPT	DRILLED BY: Pro-Drill
DATUM:	NZMG, MSL (CCC 20/01/12 Datum -9.043m)	DRILL FLUID: LP2000	LOGGED BY: MWH-RM CHECKED: DAA

GEOLOGICAL | ENGINEERING DESCRIPTION

GEOLOGICAL UNIT, GENERIC NAME, ORIGIN, MINERAL COMPOSITION.

FILL

YALDHURST MEMBER OF THE SPRINGSTON FORMATION (ALLUVIAL)

FLUID LOSS	WATER	CORE RECOVERY (%)	METHOD	CASING	TESTS	SAMPLES	R.L. (m)	DEPTH (m)	GRAPHIC LOG	CLASSIFICATION SYMBOL	MOISTURE CONDITION / WEATHERING	STRENGTH/DENSITY CLASSIFICATION	SHEAR STRENGTH (kPa)	COMPRESSIVE STRENGTH (MPa)	DEFECT SPACING (mm)	ENGINEERING DESCRIPTION
		33	Hand Auger				6	0		SM	M					Silty fine to coarse SAND with minor gravel and trace rootlets, dark brown, moist, well graded. Gravel is fine to coarse, angular to subangular.
										SP						Fine to medium SAND with minor rootlets and minor silt, light brown, moist, poorly graded.
							5	1								0.5 to 1.5m- no recovery. 1
											W					1.2m- wet.
		44	SPT		3/2//1/1/0/1 N=3		4	2		Pt		S				PEAT with trace silt and trace gravel, dark brown, fibrous to amorphous, soft, wet, high plasticity. Gravel is fine to medium, subangular to subrounded. 2
		43	PQDT													1.7 to 1.95m- no recovery.
							3	3								1.95m- trace fine to medium sand.
																2.1m- some silt.
																2.4 to 3.0m- no recovery.
		33	SPT		0/0//0/0/0/0 N=0		2	4				VS				3.0m- very soft. 3
					✱ATP@3.5m											3.15 to 3.45m- no recovery.
		100	PQDT		✱FC@3.5m	B				OH						Organic SILT with some sand, brownish grey, very soft, wet, high plasticity. Organics are fibrous and amorphous. Sand is fine to medium. 4
		22	SPT		2/2//1/2/1/3 N=7		1	5				F				4.5m- firm.
																4.6 to 4.95m- no recovery.
		100	PQDT		✱FC@5.4m	B	0	6		ML						SILT with minor organics and minor sand, grey, firm, wet, low plasticity. Organics are fibrous (wood) and amorphous. Sand is fine to medium. 5
																5.15m- trace amorphous and fibrous organics.
																5.5 to 5.7m- some fibrous organics (wood).
		67	SPT		5/5//5/5/6/6 N=22		-1	7		SP		L				Fine to medium SAND with trace gravel, trace organics, and trace silt, light grey, loose, wet, poorly graded. Gravel is medium to coarse, subrounded. Organics are fibrous. 6
												MD				6.0m- medium dense.
		100	PQDT				-2	8		GW	S					Sandy fine to coarse GRAVEL with trace silt, grey, subangular to subrounded, medium dense, saturated, well graded. Sand is fine to coarse.
																6.3 to 6.45m- no recovery. 7
		44	SPT		1/1/1/1/1/2// 2/2/2/1/1/2/ 2/2/2/1/2/2 N=21		-3	9								7.7 to 7.95m- no recovery.
		100	PQDT													8
		89	SPT		1/1/2/2/2/2// 3/2/2/2/2/2/ 2/2/2/1/2/2 N=24			10								9
		100	PQDT													9.4 to 9.45m- no recovery.

SOIL DESCRIPTION
Soil type, minor components, plasticity or particle size, colour.
ROCK DESCRIPTION
Substance: Rock type, particle size, colour, minor components.
Defects: Type, inclination, thickness, roughness, filling.

T+T DATATEMPLATE-SPT.GDT rcb

TONKIN & TAYLOR LTD

BOREHOLE LOG

BH No: STA-TC201-BH001
Hole Location: 332 Cranford Street

PROJECT: CHCH GEOTECHNICAL INVESTIGATIONS | LOCATION: ST ALBANS | JOB No: 52003.000

CO-ORDINATES: 5745485.06 mN, 2479949.49 mE
R.L.: 6.43 m
DATUM: NZMG, MSL (CCC 20/01/12 Datum -9.043m)

DRILL TYPE: Roto-Sonic
DRILL METHOD: PQDT/Auto SPT
DRILL FLUID: LP2000

HOLE STARTED: 9/4/13
HOLE FINISHED: 9/4/13
DRILLED BY: Pro-Drill
LOGGED BY: MWH-RM CHECKED: DAA

GEOLOGICAL | ENGINEERING DESCRIPTION

GEOLOGICAL UNIT, GENERIC NAME, ORIGIN, MINERAL COMPOSITION.	FLUID LOSS	WATER	CORE RECOVERY (%)	METHOD	CASING	TESTS	SAMPLES	R.L. (m)	DEPTH (m)	GRAPHIC LOG	CLASSIFICATION SYMBOL	MOISTURE CONDITION / WEATHERING	STRENGTH/DENSITY CLASSIFICATION	SHEAR STRENGTH (kPa)	COMPRESSIVE STRENGTH (MPa)	DEFECT SPACING (mm)	SOIL DESCRIPTION / ROCK DESCRIPTION
YALDHURST MEMBER OF THE SPRINGSTON FORMATION (ALLUVIAL)			100 44	PQDT SPT		3/3/3/3/2/2// 2/1/2/1/0/1/ 1/2/1/2/2/3 N=18		-4			GW	S	MD				Sandy fine to coarse GRAVEL with trace silt, grey, subangular to subrounded, medium dense, saturated, well graded. Sand is fine to coarse. 10.7 to 10.95m- no recovery.
								-5	11								End of borehole at 10.95mbgl (target depth)
								-6	12								
								-7	13								
								-8	14								
								-9	15								
								-10	16								
								-11	17								
								-12	18								
								-13	19								
									20								

SOIL DESCRIPTION: Soil type, minor components, plasticity or particle size, colour.
ROCK DESCRIPTION: Substance: Rock type, particle size, colour, minor components. Defects: Type, inclination, thickness, roughness, filling.

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Client: **IAG/ Hawkins Construction Ltd**
Project Name: **133 Paparoa Street**
Location: **Papanui**
Project Reference: **229170**

BH1

BOREHOLE INFORMATION	**CO-ORDINATES N/A**		
Drilling Method: Sonic Drilling	Easting: N/A	Date Started: 5/05/2012	Logged by: TJP
Diameter Core: 100mm	Northing: N/A	Date Completed: 5/05/2012	Input by: TJP
Contractor: DCN Drilling Ltd	Ground Level: N/A	Inclination:	Checked by: RS
		Orientation:	Verified by: RS

Method/Casing	Core Recovery (%)	Water Loss (%)	Groundwater Level (m)	R.L. (m)	Depth (m)	Graphic Log	Material Description	USC Description	Consistency/Density	Moisture	Sample	In-Situ Testing	Laboratory Testing	Notes	Backfill	Geological Unit
Roto Sonic VB	100		NOT RECORDED		0.10		SILT with trace rootlets; brown. Stiff to very stiff; dry; low plasticity; friable (TOPSOIL).						NO LABORATORY TESTING			
					0.90		SILT with some gravel and minor sand; brown. Stiff; moist; low plasticity. Gravel is medium to coarse grained and rounded to subrounded. Sand is fine to medium grained.									
					1.00		0.4m Becomes with no gravel; greyish brown with orange brown and dark brown mottling. Dry.									
	45				1.30		0.5m Becomes with trace of gravel. Gravel is medium to coarse grained and rounded to subrounded.					SPT at 1.5m N = 1 1/0, 1 450mm (SS)				
					1.95		0.7 Becomes greyish brown with reddish brown mottling.									
	100				2.10		0.9 Becomes with no gravel; grey. Soft.									
					2.40		SAND with some silt and minor gravel; grey. Loosely packed; moist. Sand is fine to coarse grained and well graded. Gravel is fine to medium grained and rounded to subrounded.									
	10				2.85		PEAT with some silt and minor sand; dark brown. Soft; moist. Peat is fibrous.					SPT at 3m N = 0 0/0, 0 450mm (SS)				
	100						SILT; grey. Firm; moist; moderate plasticity.									
							PEAT; dark brown. Soft; moist. Peat is fibrous.									
							SILT with some peat; grey. Very soft; wet; moderate plasticity. Peat is fibrous.									
							2.0m Becomes greyish brown.									
	20						PEAT; dark brown. Soft; wet. Peat is fibrous.									
					4.95		SILT with some peat; brownish grey. Soft; wet; moderate plasticity.					SPT at 4.5m N = 0 0/0, 0 450mm (SS)				
	100				5.20		PEAT; dark brown. Soft; wet. Peat is fibrous.									
					5.30		SILT with some peat; brownish grey. Soft; wet; moderate plasticity.									
					5.40		PEAT; dark brown. Soft; wet. Peat is fibrous.									
	20						SILT with some peat; brownish grey. Soft; wet; moderate plasticity.					SPT at 6m N = 4 0/1, 3 450mm (SS)				
							3.45m Becomes very soft.									
	100						3.9m Becomes soft.									
							SAND some silt; grey. Moderately packed; wet. Sand is fine to medium grained.									
					7.00		Sandy SILT; grey. Firm; wet; low plasticity. Sand is fine to medium grained.									
					7.20		SILT with some sand; grey. Firm; saturated; low plasticity.									
	35						SAND with some silt; light brown. Loosely packed; saturated. Sand is fine to coarse grained and well graded.					SPT at 7.5m N = 37 3/15, 22 450mm (SS)				
							5.6m Becomes with minor silt.									
	30						6.0m Becomes with no silt.									
							Sandy GRAVEL; greyish brown. Loosely packed; saturated. Gravel is fine to medium grained, well graded and rounded to subrounded.									
					9.00		GRAVEL with some sand and cobble inclusions; brownish grey. Loosely packed; saturated. Gravel is fine to coarse grained, well graded and rounded to subrounded. Sand is fine to coarse grained and well graded.					SPT at 9m N = 47 10/23, 24 450mm (SS)				
	35				9.65		8.0m Becomes with no sand. Grey.									
	95															

Method
CC concrete core
OB open barrel
SSA solid stem auger
HSA hollow stem auger
WASH wash drill
PQ3 PQ Triple Tube
HQ3 HQ Triple Tube
NQ3 NQ Triple Tube
NMLC NMLC Triple Tube
DP Direct Push
DT Dual Tube (70mm)
Casing

USC Classification
CH Inorganic CLAYS high plasticity
CI Inorganic CLAYS medium plasticity
CL Inorganic CLAYS low plasticity
GC Clayey GRAVEL
GM Silty GRAVEL
GP Poorly Graded GRAVEL
GW Well Graded GRAVEL
MH Inorganic SILT high plasticity
ML Inorganic SILT low plasticity
OH ORGANIC CLAY medium to high plasticity
OL ORGANIC SILT low plasticity
PT PEAT and highly organic soils
SC Clayey SAND
SM Silty SAND
SP Poorly graded SAND
SW Well graded SAND

Consistency
VS very soft
S soft
F firm
S stiff
VS very stiff
H hard

Density
VL very loose
L loose
MD medium dense
D dense
VD very dense

Soil Samples
B bulk
U undisturbed
D disturbed

Water
at end of excavation
at time of excavation
at time of closure

In Situ Testing
PP pen penetrometer
VS vane shear
SPT std. pen. test
SS split spoon
SC solid cone
HB hammer bouncing
SH sinks under own weight

Moisture
D dry
M moist
W wet
S saturated

Backfill

Graphic Log
Topsoil
SILT
SAND
Peat
Sandy SILT
Sandy GRAVEL
GRAVEL

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Client: **IAG/ Hawkins Construction Ltd**
Project Name: **133 Paparoa Street**
Location: **Papanui**
Project Reference: **229170**

BH1

BOREHOLE INFORMATION	**CO-ORDINATES N/A**		
Drilling Method: Sonic Drilling	Easting: N/A	Date Started: 5/05/2012	Logged by: TJP
Diameter Core: 100mm	Northing: N/A	Date Completed: 5/05/2012	Input by: TJP
Contractor: DCN Drilling Ltd	Ground Level: N/A	Inclination:	Checked by: RS
		Orientation:	Verified by: RS

Method/Casing	Core Recovery (%)	Water Loss (%)	Groundwater Level (m)	R.L. (m)	Depth (m)	Graphic Log	Material Description	USC Description	Consistency/Density	Moisture	Sample	In-Situ Testing	Laboratory Testing	Notes	Backfill	Geological Unit
Roto Sonic VB	95		NOT RECORDED		10		SAND with minor; brown. Loosely packed; saturated. Sand is fine to medium grained.									
	35						10.50 GRAVEL with some sand; greyish brown. Loosely packed; saturated. Gravel is fine to coarse grained, well graded and rounded to subangular. Sand is fine to coarse grained and well graded. *(Layer Continued from previous page)*					SPT at 10.5m N = 50+ 15/27, 23 440mm (SS)				
	100				11		10.25m Becomes with minor sand. Gravel is medium to coarse grained, poorly graded and rounded to subrounded.									
							11.70 10.35m Becomes with some sand. Gravel is fine to coarse grained, well graded and rounded to subangular.									
	20				12		12.00 SAND; greyish brown. Loosely packed; saturated. Sand is medium to coarse grained and poorly graded.					SPT at 12m N = 29 12/14, 15 450mm (SS)				
	100				13		10.95m Becomes with some silt; orangish brown. Sand is fine to coarse grained. 11.1m Becomes no silt; greyish brown. Sand is medium to coarse grained. 11.3m Becomes with some gravel. Gravel is fine to medium grained, poorly graded and rounded to subangular.									
	35											SPT at 13.5m N = 25 11/11, 14 450mm (SS)				
	100				14		14.20 14.35 Sandy GRAVEL; brownish grey. Loosely packed; saturated; gravel is fine to coarse, well graded and rounded to subrouned. Sand is fine to coarse grained and poorly graded.						NO LABORATORY TESTING			
					15		15.00 SAND with minor gravel; greyish brown. Loosely packed; saturated. Sand is medium to coarse grained and poorly graded. Gravel is fine to medium grained, rounded to subangular. 12.7m Becomes with no gravel; brown. Sand is fine to coarse grained and well graded. 13.1m Becomes minor silt. 13.3m Becomes some silt; greyish brown. 13.95m Becomes with no silt; grey. Sand is medium to coarse grained and poorly graded.									
					16		SILT with some sand; grey. Stiff; saturated; low plasticity.									
					17		SAND with some silt; grey. Loosely packed; saturated. Sand is fine to coarse grained and well graded. 14.6m Becomes with no silt. Sand is medium to coarse grained.									
							Borehole Terminated at 15m (Required Depth)									
					18											
					19											

Method
CC concrete core
OB open barrel
SSA solid stem auger
HSA hollow stem auger
WASH wash drill
PQ3 PQ Triple Tube
HQ3 HQ Triple Tube
NQ3 NQ Triple Tube
NMLC NMLC Triple Tube
DP Direct Push
DT Dual Tube (70mm)
Casing

USC Classification
CH Inorganic CLAYS high plasticity
CI Inorganic CLAYS medium plasticity
CL Inorganic CLAYS low plasticity
GC Clayey GRAVEL
GM Silty GRAVEL
GP Poorly Graded GRAVEL
GW Well Graded GRAVEL
MH Inorganic SILT high plasticity
ML Inorganic SILT low plasticity
OH ORGANIC CLAY medium to high plasticity
OL ORGANIC SILT low plasticity
PT PEAT and highly organic soils
SC Clayey SAND
SM Silty SAND
SP Poorly graded SAND
SW Well graded SAND

Consistency
VS very soft
S soft
F firm
S stiff
VS very stiff
H hard

Density
VL very loose
L loose
MD medium dense
D dense
VD very dense

Soil Samples
B bulk
U undisturbed
D disturbed

Water
at end of excavation
at time of excavation
at time of closure

In Situ Testing
PP pen penetrometer
VS vane shear
SPT std. pen. test
SS split spoon
SC solid cone
HB hammer bouncing
SH sinks under own weight

Moisture
D dry
M moist
W wet
S saturated

Backfill

Graphic Log
Topsoil, SILT, SAND, Peat, Sandy SILT, Sandy GRAVEL, GRAVEL

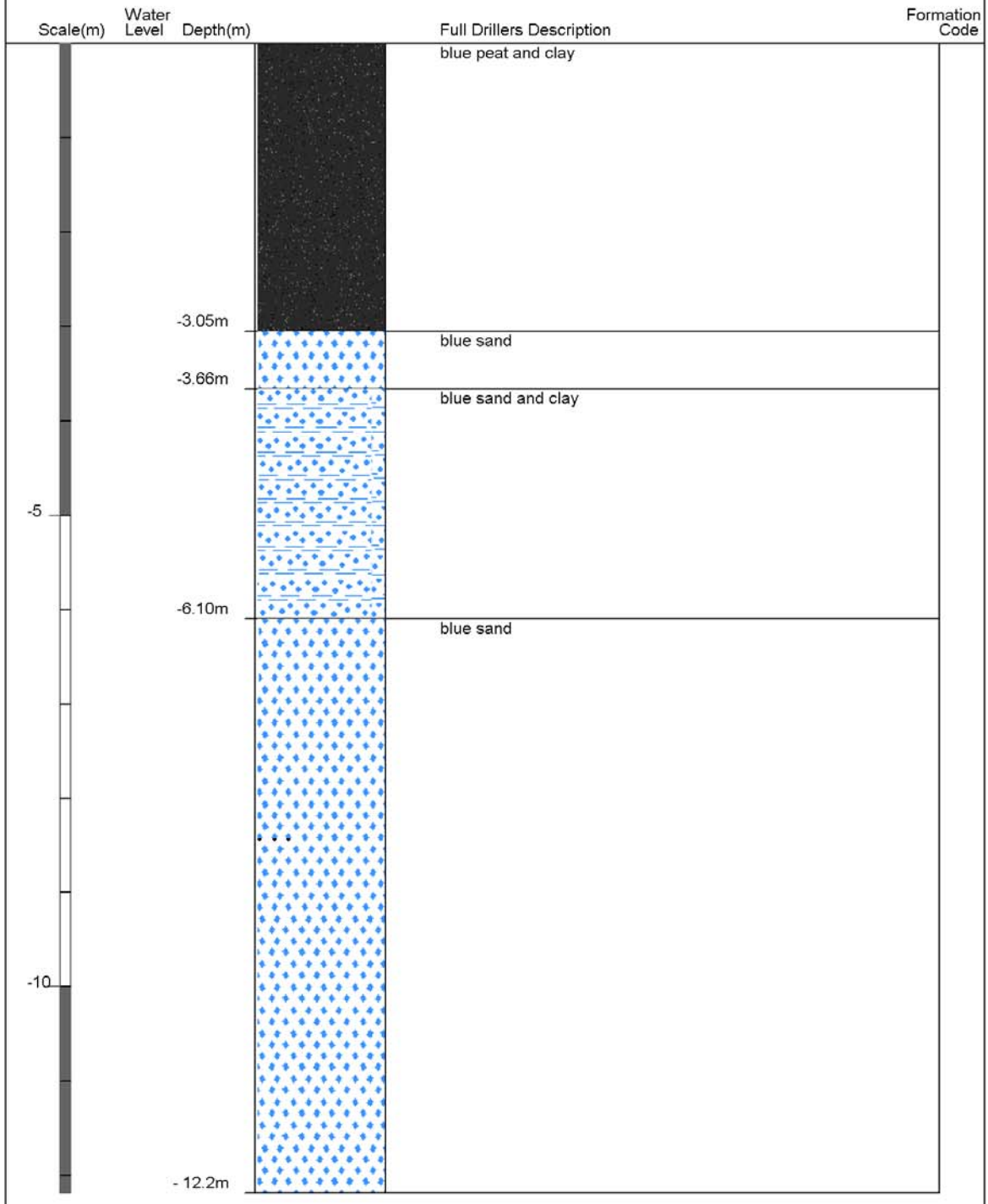
Last Generated: 22/08/2012 12:17:28 p.m.

Database File: 133 PAPAROA ST.GPJ, Library: AURECON CHRISTCHURCH.GLB, Data template: CHCH DATA TEMPLATE NOV 2010.GDT

Borelog for well M35/14022

Gridref: M35:78906-46103 Accuracy : 3 (1=high, 5=low)
Ground Level Altitude : 11.59 +MSD
Well name : CCC BorelogID 2526
Drill Method : Not Recorded
Drill Depth : -12.19m Drill Date : 1/01/1959

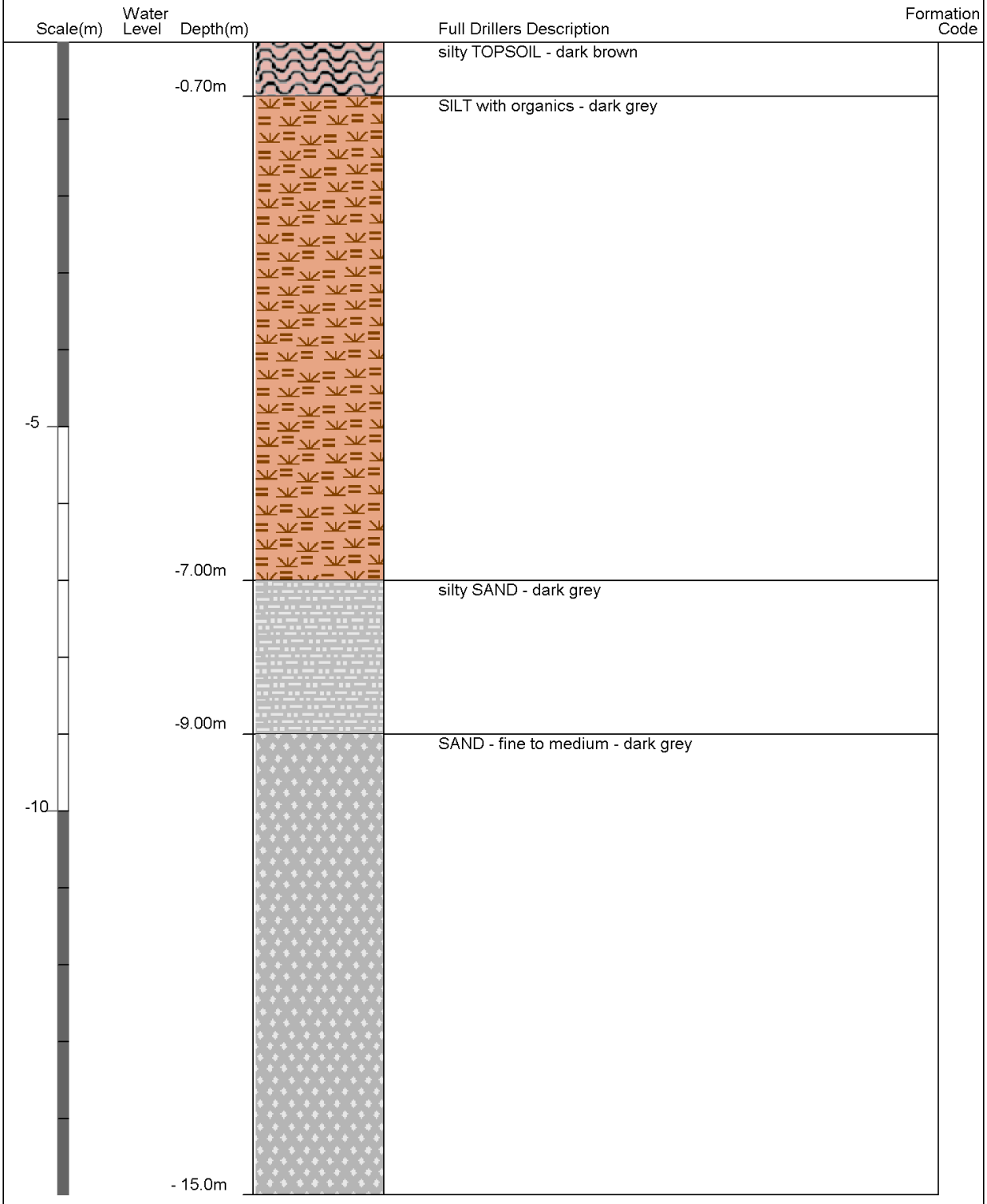
Environment Canterbury Regional Council



Borelog for well M35/10866

Gridref: M35:7951-4632 Accuracy : 4 (1=high, 5=low)
Ground Level Altitude : 10.86 +MSD
Driller : C W Drilling and Investigations Ltd
Drill Method : Concentrics
Drill Depth : -15m Drill Date : 2/08/2005

Environment Canterbury Regional Council



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Document Status

Rev No.	Author	Reviewer		Approved for Issue		
		Name	Signature	Name	Signature	Date
0	D. Woods	J. Riding		S. Webb		February 2015

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