Christchurch City Council

Cranford Basin

Geotechnical Investigation Report

September 2015

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1. Introduction

1.1 Background and Scope

The Christchurch City Council (CCC) is presently conducting a review of the District Plan. During this process some areas of the Cranford Basin have been considered for development as residential land use. Several investigations and reports in the area have been provided to the CCC by landowners (or their representatives) regarding the ground conditions at their property and the suitability of the land for residential land use.

GHD has been engaged by the CCC to undertake geotechnical investigations and reporting to outline the findings of the geotechnical investigations in relation to future residential development potential of the site to accompany the Section 32 report for rezoning of the area as part of Phase 3 of the District Plan Review. Specific comment was also requested regarding geotechnical implications of potential housing density for potential foundation types and relevant constraints to development of the area.

A previous desktop study produced by GHD (February 2015) identified the potential for significant organic materials (peat and organic silts) to be present across the majority of the area in question. Due to the potential settlement issues of organic material on building foundations further intrusive investigations have been undertaken to provide undisturbed samples of organic material. One-dimensional consolidation testing was undertaken on the undisturbed samples to provide estimations of potential settlement. Investigations were also undertaken in areas where previous investigations or information pertaining to ground conditions was not available.

1.2 Site Location

The proposed rezoning would involve the development of residential houses around some of the perimeter of the Cranford Basin, and a storm water detention area as illustrated by the Draft Papanui/Cranford Basin Planning Constraint Map provided in Appendix A.

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 2.5 km south of Styx River and 7 km west of the coast (Pegasus Bay).

2. Supplied Geotechnical Investigations

CCC supplied GHD with a number of geotechnical investigation reports provided to them by land owners regarding the zoning of the land.

- Geotechnical Report for Proposed Plan Change, 340 Cranford St and 60 Croziers Rd, St Albans, Christchurch, prepared by Eliot Sinclair 30 June 2015.
- Site Appraisal – Geotechnical Report, Cranford Street, Christchurch, prepared by Connell Wagner 18 February 2007.
- Proposed Subdivision Development, 340/341 Cranford Street. Preliminary Geotechnical Evaluation, prepared by Tonkin & Taylor Ltd April 2013.
- Desktop Geotechnical Review, Proposed Christchurch Replacement District Plan for the Case Family at 340 Cranford Street, Saint Albans, prepared by Eliot Sinclair 15 April 2015.

- Geotechnical Report, Proposed 12.5-hectare Residential Subdivision, Grants Road, Papanui, prepared by Bell Geoconsulting Ltd April 2013.

3. Published Information on Ground Conditions

3.1 Published Geology

As shown in Figure 1, 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.

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.

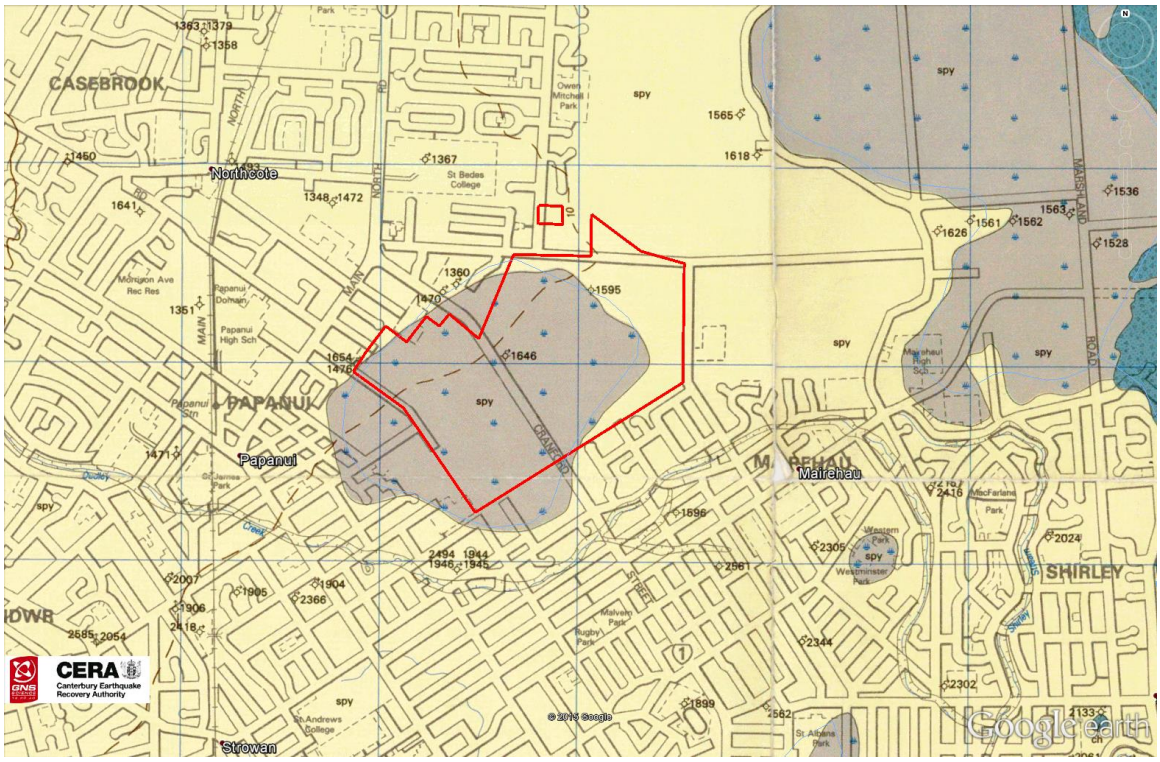

Figure 1 Geology Map Excerpt

3.2 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 B. Full logs are provided in Appendix B.

[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.

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 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

Bore Name	Log Depth	Groundwater	Location	Log Summary
				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 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.

3.3 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	11.15 m	0.0 – 3.0 m Sandy SILT (SPT-N 0-17)

Bore Name	Location	Depth	Log Summary
	corner		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) 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

3.3.1 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.

3.3.2 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.

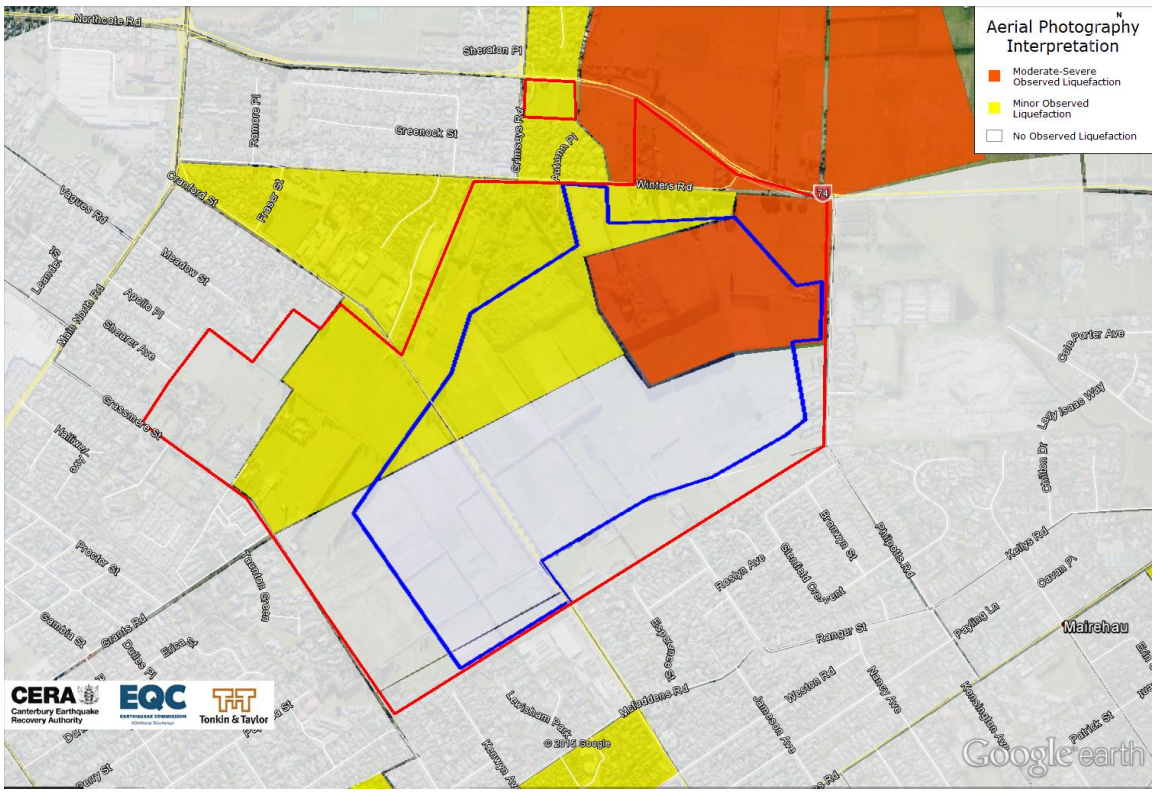

Figure 2 Aerial Photography Liquefaction Interpretation, 4 September 2010

3.3.3 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.

3.4 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.

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.

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

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

3.6 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..

4. Seismicity

4.1.1 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.

4.1.2 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] 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/

5. Further Geotechnical Investigations

A previous desktop study produced by GHD (February 2015) identified the potential for significant organic materials (peat and organic silts) to be present across the majority of the area to be investigated. Due to the potential settlement issues of organic material on building foundations investigations have been undertaken to provide undisturbed samples of organic material. Investigations were also undertaken in areas where previous investigations or information pertaining to ground conditions was not available.

Five sonic boreholes with standard penetration tests (SPT), collection of undisturbed samples, and five cone penetrometer tests were scheduled. One borehole and CPT were not undertaken as access to the property was not provided.

The ground conditions encountered in the GHD investigations are summarised in this section. Table 4 and Table 5 provide summaries of the ground materials encountered in the investigations. Detailed logs can be found in Appendix B.

5.1 Machine Drilled Boreholes Summary

The GHD machine drilled boreholes (BH101 to BH102) shows that the subsurface geology is relatively consistent across the area investigated (Table 4).

Table 4 Summary of Machine Drilled Boreholes

Soil Unit	BH101	BH102	BH103	BH104
Topsoil	0.0 – 0.3 m	0.0 – 0.8 m	0.0 – 0.5 m	0.0 – 0.6 m
Upper Alluvium	0.3 – 1.1 m	0.8 – 2.9 m	0.5 – 2.5 m	0.6 – 1.4 m
Swamp Deposits	1.1 – 2.0 m	2.9 – 3.8 m	2.5 - 4.3 m	1.4 – 2.9 m
Lower Alluvium	2.0 – 15.08 m	3.8 – 12.49 m	4.3 – 17.05 m	2.9 – 10.97 m

Groundwater was encountered between 0.83 m bgl and 0.85 m agl

The boreholes investigations were scheduled to a target depth of 20 m below ground level, however risk of significant artesian pressures meant holes were terminated before this depth.

5.2 CPT Investigations

The soil behaviour type encountered by the GHD CPT's investigations is summarised in Table 5. Groundwater depths were recorded at the completion of each from 0.5 to 1.3 m bgl.

Table 5 Summary of CPT-Inferred Lithology for CPT101 to CPT104

Soil Behaviour Type	CPT101	CPT102	CPT103	CPT104
Clays and sand mixtures	0.5 – 4.8 m	0.0 – 0.6 m	0.0 – 5.6 m	0.0 – 1.6 m
Organic	-	0.6 – 3.7 m	-	1.6 – 3.1 m
Sand mixtures	4.8 – 8.0 m	-	5.6 – 8.4 m	3.1 – 4.8 m
Sands	8.0 – 15.7 m	3.7 – 8.6 m	-	4.8 – 14.5 m
Clays and sand mixtures	15.7 – 17.4 m	8.6 – 10.0 m	-	14.5 – 16.7 m
Sands	17.4 – 17.78 m	10.0 – 16.1 m	8.4 – 14.3 m	16.7 – 17.02 m

Soil Behaviour Type	CPT101	CPT102	CPT103	CPT104
Clays and sand mixtures		16.1 – 17.2 m	14.3 – 16.3 m	
Sands		17.2 – 18.09 m	16.3 – 17.13 m	

6. Laboratory Testing

Undisturbed samples were recovered from each of the boreholes, the materials targeted for sampling were high in organic content as this is the most likely to cause the greatest consolidation. One-dimensional consolidation testing was undertaken on the undisturbed samples to provide estimations of potential settlement.

Four undisturbed samples were sent to the Geotechnics Auckland Laboratory to undertake one–dimensional consolidation test. The tests were undertaken in accordance with NZS 4402:1986 Test 7.1. This procedure involves the incremental loading of the sample and calculation of the void ratio (consolidation) of the sample at each incremental load. The sample is then unloaded and elastic rebound is then measured. Three of the samples were loaded up to 483 kPa, the remaining sample was loaded up to 241 kPa as this sample may have begun to plastically deform under the higher load.

A summary of the results is provided in Table 6, full test results are provided in Appendix C.

Table 6 One Dimensional Consolidation Test Summary

Specimen	Description	Maximum Pressure	Coefficient of Volume Compressibility Mv (m^2/MN)
BH101 2.5 – 2.55 m	Sandy SILT, trace clay	483 kPa	0.055 to 0.090
BH102 3.65 – 3.70 m	Organic SILT, minor clay	241 kPa	1.0 to 2.5
BH103 3.05 – 3.10 m	SILT, minor organics	483 kPa	0.35 to 1.4
BH104 3.10 – 3.15 m	SILT, minor clay	483 kPa	0.15 to 1.2

7. Summary of Ground Conditions

A location plan showing all the ground condition information considered in this report has been provided in Appendix D.

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, the CGD, and our further investigations the site has been determined to comprise alluvium, underlain by swamp derived deposits. This is further underlain by alluvium, underlain by the Riccarton Gravels.

7.1.1 Upper Alluvium

The upper alluvium is present to depths of 1.0 to 3.0 m bgl. It comprises sand, silty sands, sandy silts and silts. This material has low strengths of very loose to loose and very soft to firm.

7.1.2 Organic Deposits

Previous investigations and further investigations have shown organic deposits are present across the majority of the site, some areas have minimal organic material present. The layer of organic deposits varies in thickness across the site, typically it at least 1m thick. The material comprises silts, organic silts and peat with strengths varying from very soft to soft.

7.1.3 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 and a higher sand content in the form of sandy gravel and gravel layers. The gravel content is not present across the entire site. This layer has a higher density (up to dense) than the upper alluvium due its higher sand and gravel content.

7.1.4 Riccarton Gravels

The Riccarton Gravels are present below the lower alluvium and are encountered approximately 17 to 20 m bgl. This layer comprises dense to very dense sandy gravels.

7.1.5 Groundwater

Groundwater has been recorded in investigation logs between 0.85 m agl and 3.7 m bgl. Typically the upper alluvium and organic deposits act as a confining layer for the underlying sand and gravel lower alluvium.

8. Liquefaction Analysis

8.1 Methodology used for Analysis

Assumptions made for the analysis process are as follows:

- Importance Level 2, 50-year design life, giving peak ground accelerations (PGA's) of:
  - 0.35 g for Ultimate Limit State (ULS), and
  - 0.13 g for Serviceability Limit State (SLS);
- Earthquake Magnitude 7.5; and
- Groundwater levels at 2.0 m bgl.

Liquefaction assessment has been calculated using CLiq[7] (CPT Liquefaction Assessment Software) using the Boulanger and Idriss 2014 method.

The raw data for the CPT's has been obtained from the CGD, provided by landowners investigations or our own investigations, this data has been reanalysed.

8.2 Results of Liquefaction Analysis

8.2.1 Liquefiable Strata

The results of the liquefaction analysis using the CPT data under ULS conditions (Importance level 2, 0.35g) identified discrete layers of liquefiable material throughout the depth investigated. Further details can be found in the Liquefaction and Settlement Analysis Graphs in Appendix D.

[7] CLiq v.1.7.1.14 (2006), GeoLogismiki

8.2.2 Calculated Liquefaction-induced Settlements

Estimated ground settlements for ULS (L3), SLS, ULS index, and SLS index events are outlined in Table 7.

Index Values are calculated liquefaction-induced settlements for the top 10 m of subsoils (refer MBIE Guidelines[8]). These values are a key parameter used in the determining TC2 and TC3 ground performance. The ULS index value is calculated using a Importance Level 2 PGA of 0.35g.

[8] Ministry of Business, Innovation & Employment (2012): *Guidance: Repairing and rebuilding houses affected by the Canterbury earthquakes;* Version 3, Dec 2012. Ministry of Business, Innovation & Employment: Wellington, NZ.

Table 7 Liquefaction-induced Settlements Calculated from CPTs

Investigation Point	Depth Investigated	SLS Index Value (PGA: 0.13g)	ULS Index Value (PGA: 0.35)	Total SLS Settlement (PGA: 0.13g)	Total ULS Settlement Level 3 (PGA: 0.45g)
CPT101	17.78 m	60 mm	142 mm	93 mm	238 mm
CPT102	18.09 m	22 mm	48 mm	46 mm	138 mm
CPT103	17.13 m	59 mm	98 mm	87 mm	162 mm
CPT104	17.02 m	11 mm	72 mm	33 mm	140 mm
CPT17238	6.70 m	12 mm	31 mm	12 mm	31 mm
CPT23216	19.68 m	14 mm	37 mm	22 mm	108 mm
CPT32136	10.00 m	73 mm	118 mm	73 mm	118 mm
CPT32142	10.00 m	34 mm	92 mm	134 mm	92 mm
CPT32143	10.00 m	44 mm	75 mm	44 mm	75 mm
CPT32145	10.00 m	68 mm	120 mm	68 mm	120 mm
CPT55297	6.37 m	12 mm	32 mm	12 mm	32 mm
CPT55301	7.34 m	19 mm	30 mm	19 mm	30 mm
CPT7836	2.99 m	0 mm	0 mm	0 mm	0 mm
CPT7840	2.99 m	0 mm	1 mm	0 mm	1 mm
CPT9167	7.05 m	12 mm	46 mm	12 mm	46 mm
BGL001	5.61 m	10 mm	42 mm	10 mm	42 mm
BGL002	5.32 m	8 mm	24 mm	8 mm	24 mm
BGL003	5.33 m	5 mm	30 mm	5 mm	30 mm
BGL004	6.23 m	14 mm	28 mm	14 mm	28 mm
BGL005	5.01 m	2 mm	16 mm	2 mm	16 mm
BGL006	3.76 m	8 mm	14 mm	8 mm	14 mm
BGL007	5.33 m	18 mm	46 mm	18 mm	46 mm
BGL008	8.09 m	56 mm	83 mm	56 mm	83 mm
BGL009	4.37 m	9 mm	35 mm	9 mm	35 mm
BGL010	4.79 m	8 mm	21 mm	8 mm	21 mm
BGL011	6.08 m	3 mm	21 mm	3 mm	21 mm
BGL012	6.31 m	17 mm	48 mm	17 mm	48 mm
TC2		0-50 mm	0-100 mm		
TC3		> 50 mm	> 100 mm		

8.3 Interpretation of Liquefaction Assessment

Overall, the site is considered to be of low to moderate liquefaction susceptibility. This is based on:

- Limited observable liquefaction damage from the post-February earthquake aerial photograph;
- Estimated settlements being potentially significant for ULS index (0 to 142 mm) and SLS index (0 to 68 mm), ground performances indicated from CPT analysis range from TC2 to TC3.
- Shallow groundwater levels of approximately 2.0 m; and

The excess pore water pressures that must be developed to liquefy a soil increase with depth below the water table; this typically only occurs in a large-magnitude, long-duration earthquakes. Deeper layers (below 15 m) are not likely to develop this level of pressure. This means susceptible soils are unlikely to liquefy below 15 m depth. In addition, the effects of deeper strata liquefying are not as consequential at the surface.

9. Hydrogeological Assessment

The lithology of the shallow material within the Cranford Basin influences the hydraulic characteristics of the shallow groundwater system. The conceptual geological model for the site describes the presence of thin layer of alluvial material, overlying more dense silts and organic material (i.e. peat), which give way to sand and silt deposits with occasional gravel lenses. The presence of the shallow alluvial material is not consistent across the site, with numerous bore logs describing soils which give way to organic peat deposits. Brown and Weeber[1] (1992) describe the surficial geology as a drained swamp, with organic peats and silts near surface. Historically the Cranford Basin drained to the Avon River catchment to the South (PDP[9], (2013)). However, the installation of drainage networks by land owners has resulted in the majority of the Cranford basin being drained to the Styx River catchment via the Rhodes Main Drain sub-catchment. The southern part of the basin drains to the Dudley Creek catchment and to the Avon River.

The geological sequence of the deposits is approximated in Table 4, with a summary of Environment Canterbury well logs provided in Table 1. The Riccarton Gravel aquifer (referred to as the first confined aquifer) is located at or about 17-20 m bgl, and was not targeted for this investigation. However, for the purpose of this report it is considered to be hydraulically distinct from the overlying deposits of the Christchurch and Springton deposits. This is consistent with White *et al* (2007)[10], which characterised the extent of the Springston gravel lobes within the Christchurch deposits. The Cranford Basin is within an area classified by White *et al* (2007) as being associated with the Fendalton Gravel lobe. The water bearing units of the Springston and Riccarton gravels were considered to be disconnected based on the information presented in White *et al* (2007).

The variable thickness of the upper alluvium material across the site suggests that the water table aquifer is limited in vertical thickness and lateral extent, with the groundwater within the alluvial material likely to be perched on the underlying silts and organic peat deposits. Drainage of the water table aquifer is likely to occur towards the shallow drainage networks that are located across the site area. The hydraulic properties of the shallow alluvial material are not known. Recharge to the water table is likely to be from rainfall infiltration and possible groundwater seepage from the underlying Springston formation.

The silt and organic peats that are documented across the site at or about 1 m bgl to 4.5 m bgl is associated with the swamp deposits of the Christchurch Formation. The silt material is considered to be of low permeability, with hydraulic conductivity likely to be less than 1×10^{-8} m/s in the horizontal flow direction. However, specific tests on the silt layer were not undertaken in the field. The presence of organic peat material is likely to act as an area of weakness in the confining layer, which may enable groundwater in the lower alluvial deposits to upwell and discharge as spring flow. In addition, where the silt deposits are thin there is the potential for groundwater from the lower alluvial deposits to breach the confining layer and emerge as seepage or spring flow.

9 PDP, 2013: Cranford Basin spring identification. Report for Christchurch City Council. Report Reference: CO2771502, September 2013.
10 White, P.A., Weeber, J.H., Pamer. R., Minni, G. and Cave, S., 2007 Identification of Springston Formation Gravel Lobes in the Christchurch Formation, GNS Science Consultancy Report 2007/195, October 2007.

Below the silt and peat layer(s) are deposits of gravels and sands that are associated with former channels and flood deposits of the Waimakariri River (i.e. Springston gravel lobes). A review of bore logs and the interpretation of the drilling logs discussed in Section 7 indicate that the extent of these deposits varies in thickness and lateral extent. Groundwater contained in these deposits exhibits a positive vertical hydraulic gradient, with static water level measured above ground or just below ground level in the four monitoring wells screened in the lower alluvium. There were no monitoring wells installed as part of this investigation into the Riccarton Gravels. Therefore, no conclusions could be reached regarding the likely degree of hydraulic difference between the water bearing units in the Springston deposits versus the Riccarton Gravel aquifer.

The artesian pressures observed in the monitoring wells indicate a potential for groundwater to flow through zones of weakness in the overlying deposits (i.e. peat deposits and thin silt/sand deposits) to discharge as springs. PDP (2013)[9] mapped several springs in the basin area. Many of the springs mapped by PDP[9] (2013) were characterised as CCC drainage springs, with three springs specifically noted as permanent springs (and have an associated ECan spring identification number). Two new springs were identified post the Canterbury earthquakes to the north of Cranford Basin (Aqualinc, 2011) [11]. There are no further details of the characteristics of the new springs available. Thorley (2015) [12] presented the results of field investigations of the seepage and artesian springs in the Cranford Basin as part of the Notice of Requirement (NoR) for the Northern Arterial Extension hearing.

Appendix 8 of Thorley (2015)[12] describes the nature of the springs and seeps mapped in the Cranford Basin. The majority of the springs were characterised as seepage in shallow depressions within the peat deposits. Some of the seeps are drained via channels which were installed by land owners.

The three permanent springs identified on the Environment Canterbury database had notable flow according to Thorley (2015)[12] (Table 8).

Table 8 - Springs in the Cranford Basin noted on ECan GIS

Spring No.	Type	Flow	Comments
M35/8136	Artesian	>20L/s	Large pool area with a depth of > 1 m bgl
M35/8128	Seepage	Variable	Depth of 0.7m enhanced with drainage
M35/8139	Artesian	Strong	Shallow depression with fast flowing discharge containing silt, gravels, and organic material. Drain is cut to take flow away. Comments from Thorley (2015) note that a hard ruler was inserted into the spring up to 1 m without refusal.

In addition to the mapped springs, there were examples of standpipes of unknown depth intercepting artesian groundwater conditions, which were either capped or partially capped.

In summary based on the geological conceptual model of the site, any excavation that extends into the peat and silts could result in the ingress of groundwater under artesian pressure, even if

11 Aqualinc Research Limited, 2011: Earthquake Related Springs February 2011. Prepared for The Earthquake Commission. Aqualinc Research Limited Report No. C110669

12 Thorley, M., 2015: Statement of evidence of Michael J Thorley for Christchurch City Council and New Zealand Transport Agency (8 April 2015). Notice of Requirement by CCC and NZTA for designations for Northern Arterial, Northern Arterial Extension and Cranford Street upgrade.

the silt layer has not been breached. It is likely that under such circumstances the inflow of groundwater to the excavation would be persistent unless it was capped. Piling through the peat and silt layer for foundations (as discussed in Section 10 below) will need to be mindful of creating a zone of weakness in the confining layer, resulting in new seepage or spring flows.

10. Geotechnical Assessment

The ground conditions show some natural variations 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. Therefore the shallow soils do not meet the classification of 'good ground' in accordance with NZS 3604 due to the presence of soft soils and potentially compressible organic material.

Liquefaction analysis of relevant CPTs has indicated liquefaction induced settlement for most of this area as equivalent to TC2 land, with some CPT's indicating TC2/TC3 and TC3 land. TC2 consistent ground conditions for this zone are considered appropriate as minimal liquefaction has been observed following the Canterbury earthquake sequence.

10.1 Organic Material Development Constraints

The organic material identified onsite (peat and organics silts) can cause a number of issues for building foundations. Consolidation of organic can be separated into several phases with different lifespans.

Initial consolidation begins as soon as the soil is loaded, by loading the soil the void spaces are reduced and water is expelled from the soil. Initial settlement occurs for a finite period of time until the load has been equalised, further load is required to compress more.

Long term consolidation from decomposition of the organic material has the potential to occur for the life of the structure. The organic materials mass is reduced as bacteria breakdown the material.

Water fluctuation consolidation typically occurs when water is removed from the organic material. Nearby excavations of foundations or infrastructure trenches that require dewatering are a common cause of ground water fluctuations that cause settlement.

10.1.1 Consolidation Analysis

Potential consolidation of shallow foundations was analysed from the one-dimensional consolidation testing of the undisturbed soil samples. Loads were assumed from a residential building with a TC2 type foundation (gravel raft and with concrete slab on grade) with lightweight roof and lightweight cladding. A conservative load of 12 kPa was assumed for the building type as described previously. A typical soil profile was prepared for the consolidation analysis where the thickness of the organic material was varied from 0.5 to 1.0m. Potential consolidation was analysed to be in the range of 15 to 45 mm. The majority of consolidation occurred in the organic SILT layer.

10.2 Potential Foundation Types

This area is well known to contain peat and organic layers. The previous desktop study identified the potential of these layers to be present in layers up to 5 m thick. Further investigation was undertaken to provide undisturbed samples for one-dimensional consolidation tests with resulting settlements of 15 to 45 mm. Therefore new foundations in this area will require site specific geotechnical investigations and specific engineering design

Foundations for new residential houses need to be designed to mitigate settlement and consolidation from both organic and liquefiable materials. To mitigate against settlement and consolidation it is recommended that residential building foundations are piled through the very soft soils and organic material. The required piling depth will vary, it is likely that the lower alluvium will provide a suitable strata for pile bearing and embedment, therefore piling depths could range from 5-7 m bgl.

The potential consolidation of the organic material under a shallow foundation is likely to be greater than 25 mm. A 25 mm limiting maximum settlement was suggested by Terzaghi and Peck[13] (1967) that most ordinary structures can withstand. Although shallow foundations can be designed to "float" above the peat this cannot mitigate the long term settlement (total or differential). Differential settlement can cause damage to foundations and service connections. Therefore we do not consider shallow foundation as an appropriate standard solution.

Shallow foundations maybe appropriate for small areas of the site that are identified with higher density intrusive investigations as having no or minimal organic material (combined less than ~300 mm thickness).

10.3 Housing Density

The chosen density of residential development will not influence piled foundation design. Should further investigations identify areas suitable for shallow foundations high density housing will cause increased consolidation effects on foundations.

10.4 Development Considerations and Risks

Services in this area will likely have to be constructed in ground with an allowable bearing capacity less than 50 kPa, therefore a 'soft ground' raft would be required.

Any trenching or excavations deeper than ~1 m bgl will most likely require dewatering. Dewatering of organic material can cause settlement and consolidation of adjacent land. Excavations requiring dewatering need an approved temporary earthworks plan and it is recommended a dilapidation survey is undertaken of any nearby structures prior to works beginning.

The area around 117 Philpotts Road is likely to have similar ground conditions to the remainder of the site however there is no nearby geotechnical investigation to confirm this. GHD was unable to obtain access to this site to undertake intrusive investigations.

[13] Terzahi, K. and Beck, R. B., 1967, Soil Mechanics in Engineering Practice, 2nd ed.; John Wiley, New York.

11. Summary

GHD has been engaged by the Christchurch City Council to undertake a geotechnical study for the proposed development of Cranford Basin. The development involves the potential rezoning 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. From the investigations available from ECan well database, the CGD, and our further investigations the site has been determined to comprise alluvium, underlain by swamp derived deposits. This is further underlain by alluvium, underlain by the Riccarton Gravels. The shallow soils do not meet the classification of 'good ground' in accordance with NZS 3604 due to the presence of soft soils and potentially compressible organic material.

Groundwater was encountered at shallow depths within the upper alluvium and silt and peat layers. The lower alluvial material is water bearing and contains gravel lenses which exhibit artesian pressures. Springs were identified across the site by PDP (2013) and Thorley (2015), many of which are characterised as shallow depression seeps within the peat/organic material. These seeps are drained to CCC drainage networks. Three artesian springs are shown on Environment Canterbury well database, which were noted as having strong and permanent flows. Excavations are likely to encounter groundwater, with deeper excavations at risk of breaching the confining material (silt) which separates the lower alluvial gravel from the surface. Piling through the confining material will need to account for potential for increasing discharge of groundwater from the lower alluvial Springston gravel as seeps/springs.

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 and consolidation from both swamp deposits and liquefiable materials. The greatest consolidation will result from settlement of the organic soils and there bio-gradation. Therefore design and construction of new foundations of this area will require site specific geotechnical investigations and specific engineering design.

To mitigate against settlement and consolidation it is recommended that residential building foundations are piled through the very soft soils and organic material. The required piling depth will vary, it is likely that the lower alluvium will provide a suitable strata for pile bearing and embedment, therefore piling depths could range from 5-7 m bgl.

The potential consolidation of the organic material under a shallow foundation is likely to be greater than 25 mm, therefore shallow foundations are not considered appropriate for this site. Shallow foundations maybe appropriate for small areas of the site that are identified with further investigation as having no or minimal organic material.

12. 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 section 1.1 of 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.

The opinions, conclusions and any recommendations in this report are based on assumptions made by GHD described in this report. GHD disclaims liability arising from any of the assumptions being incorrect.

The opinions, conclusions and any recommendations in this report are based on information obtained from, and testing undertaken at or in connection with, specific sample points. Site conditions at other parts of the site may be different from the site conditions found at the specific sample points.

Investigations undertaken in respect of this report are constrained by the particular site conditions, such as the location of buildings, services and vegetation. As a result, not all relevant site features and conditions may have been identified in this report.

Site conditions (including the presence of hazardous substances and/or site contamination) may change after the date of this report. GHD does not accept responsibility arising from, or in connection with, any change to the site conditions. GHD is also not responsible for updating this report if the site conditions change.

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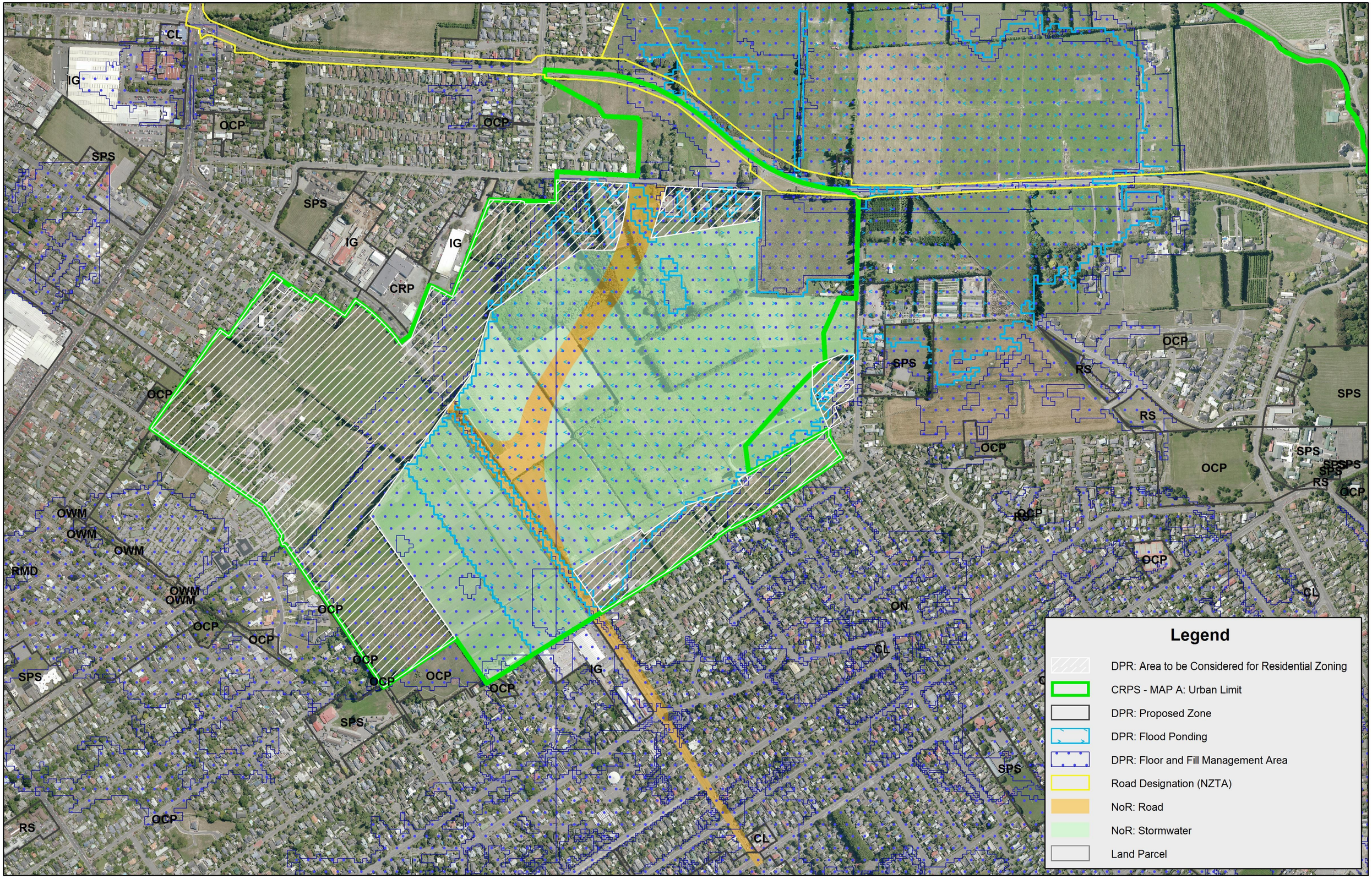
Appendices

Appendix A – (Location Plan)



Christchurch City Council

The proposed Christchurch Replacement District

Draft Papanui / Cranford Basin Planning Constraint Map

0 100 200 300 400
Metres

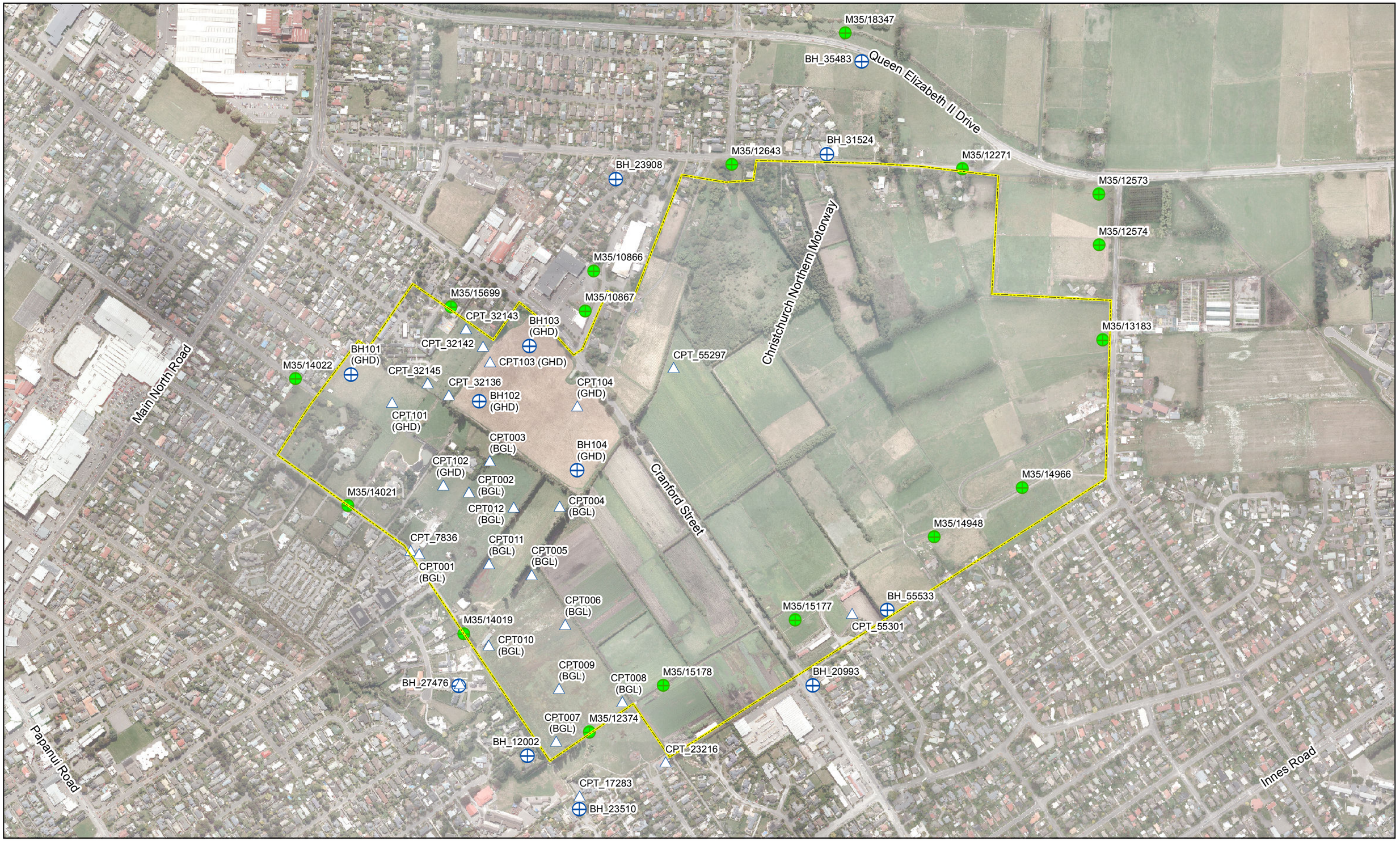
N

WorkSpace: 771745CranfordBasinConstraints_V2.gws
Layout: A3 Planning Constraint Map
Scale: 1:8,000 @ A3
Date: 14/01/2015

Appendix B – (Existing Investigation Logs)

Environment Canterbury Borehole Logs

Canterbury Geotechnical Database Investigation Logs



Scale: 1:7,000 (atPaper Size A3)

0 30 60 120 180 240

Metres

Map Projection: Transverse Mercator
Horizontal Datum: NZGD 2000
Grid: NZGD 2000 New Zealand Transverse Mercator

N

Borehole
Cranford Basin
CPT
Ecan

Christchurch City Council
Cranford Basin Geotechnical Investigation and Report

GeoTech Plan

Job Number	51-33038
Revision	A
Date	04 Sep 2015

N:\NZ\Christchurch\Projects\51\33038\GIS\Maps\Mxds\5133038_Z001_RevA_CranfordBasinGeoTechPlan_A3.mxd

Data source: Data Custodian, Data Set Name/Title, Version/Date. Created by:gpayne2

226 Antigua Street Christchurch 8011 New Zealand **T** 64 3 378 0900 **F** 64 3 377 8575 **E** chcmail@ghd.com **W** www.ghd.com

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:

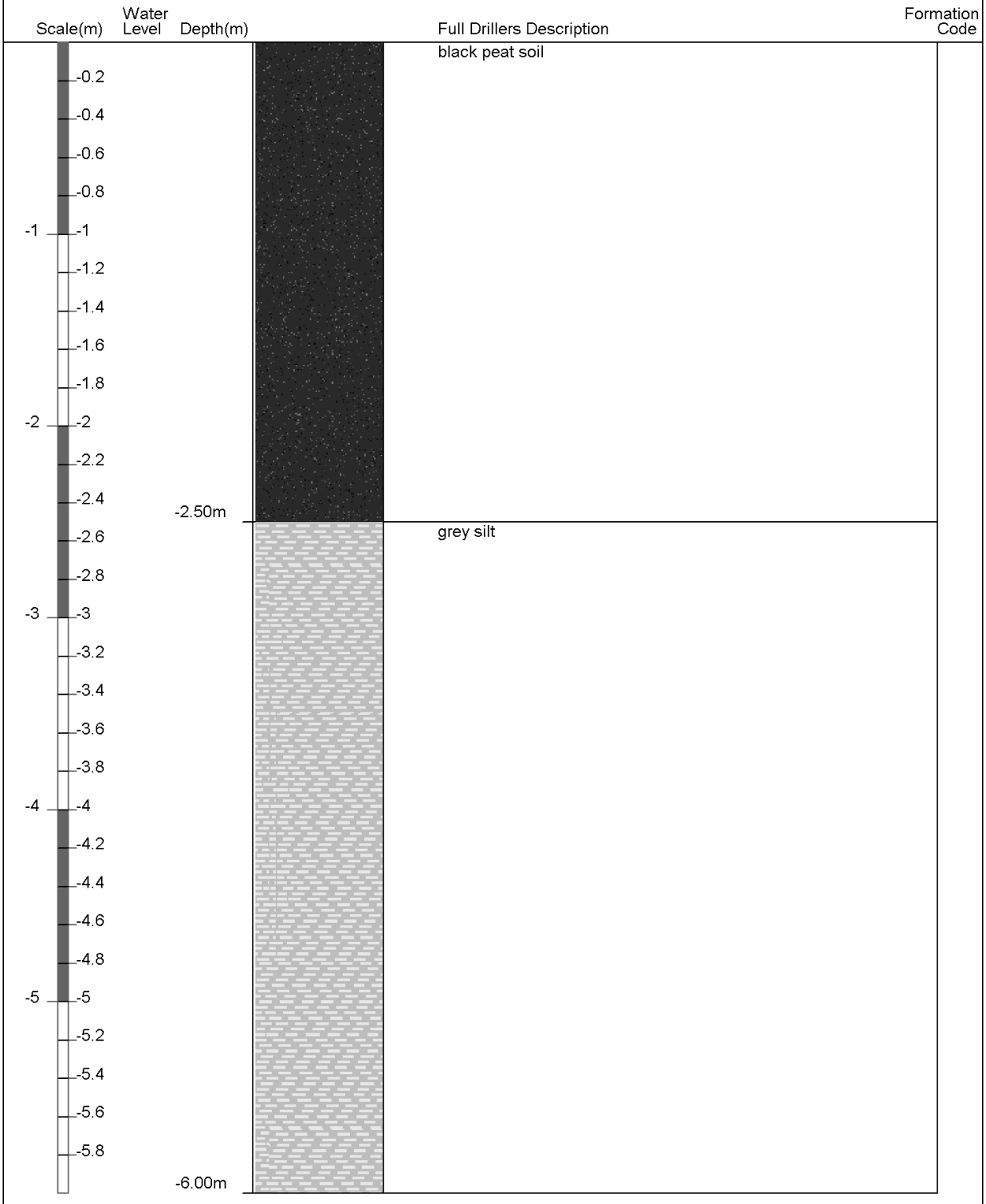
Step Test Date	Step	Yield (l/s)	Drawdown	Duration (mins)

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:

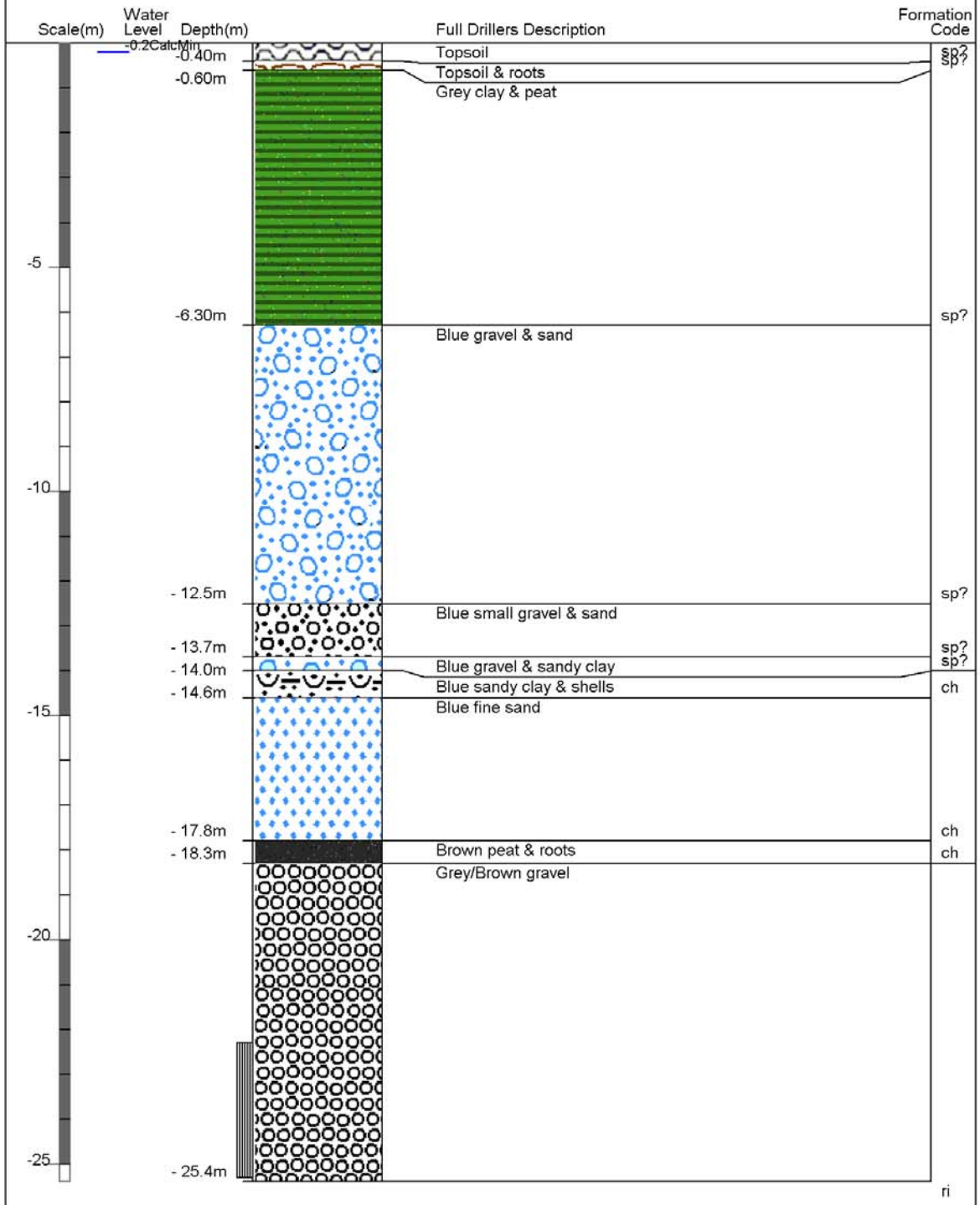
Step Test Date	Step	Yield (l/s)	Drawdown	Duration (mins)
28 Feb 1972	1	19	3	

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:

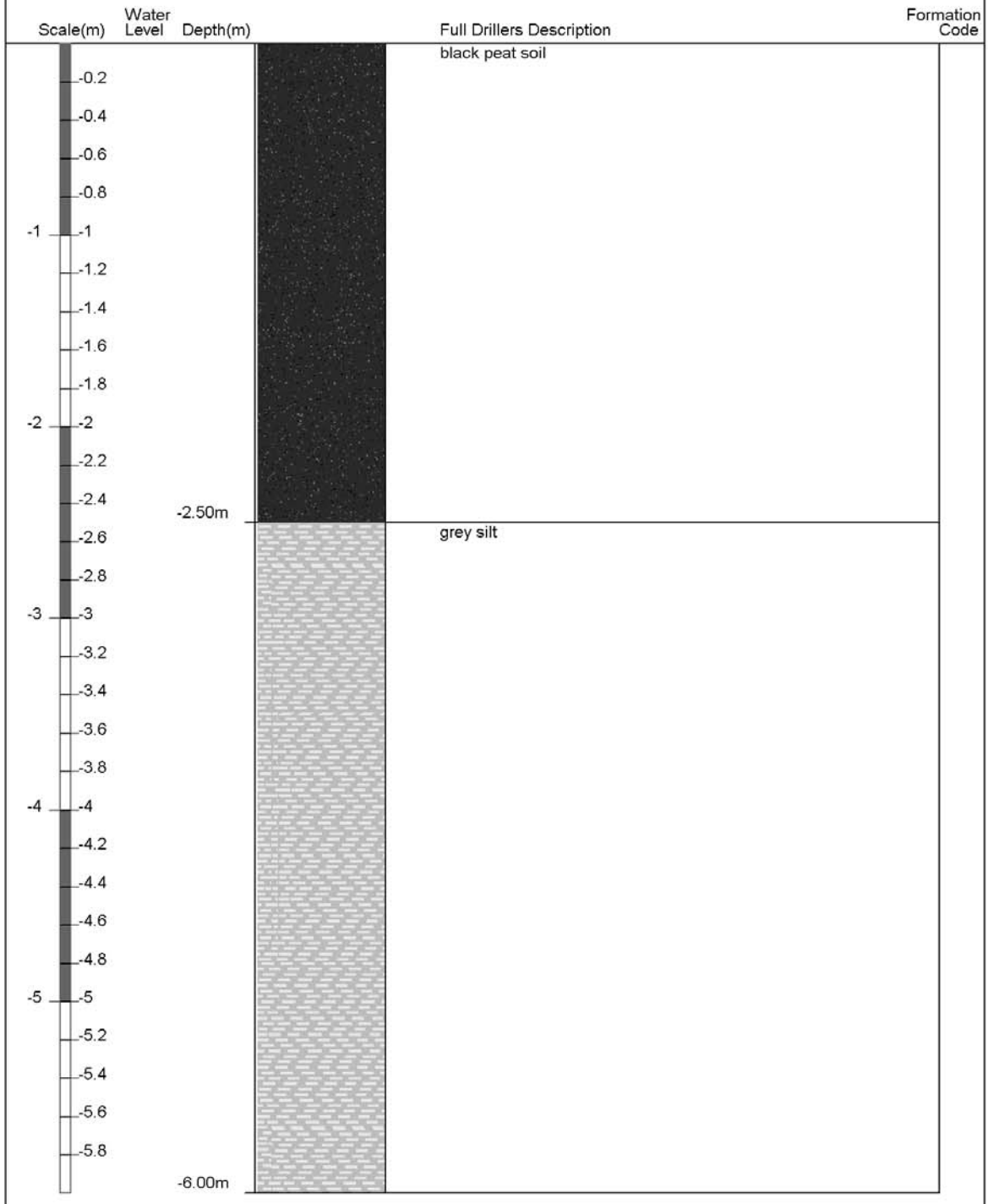
Step Test Date	Step	Yield (l/s)	Drawdown	Duration (mins)

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:

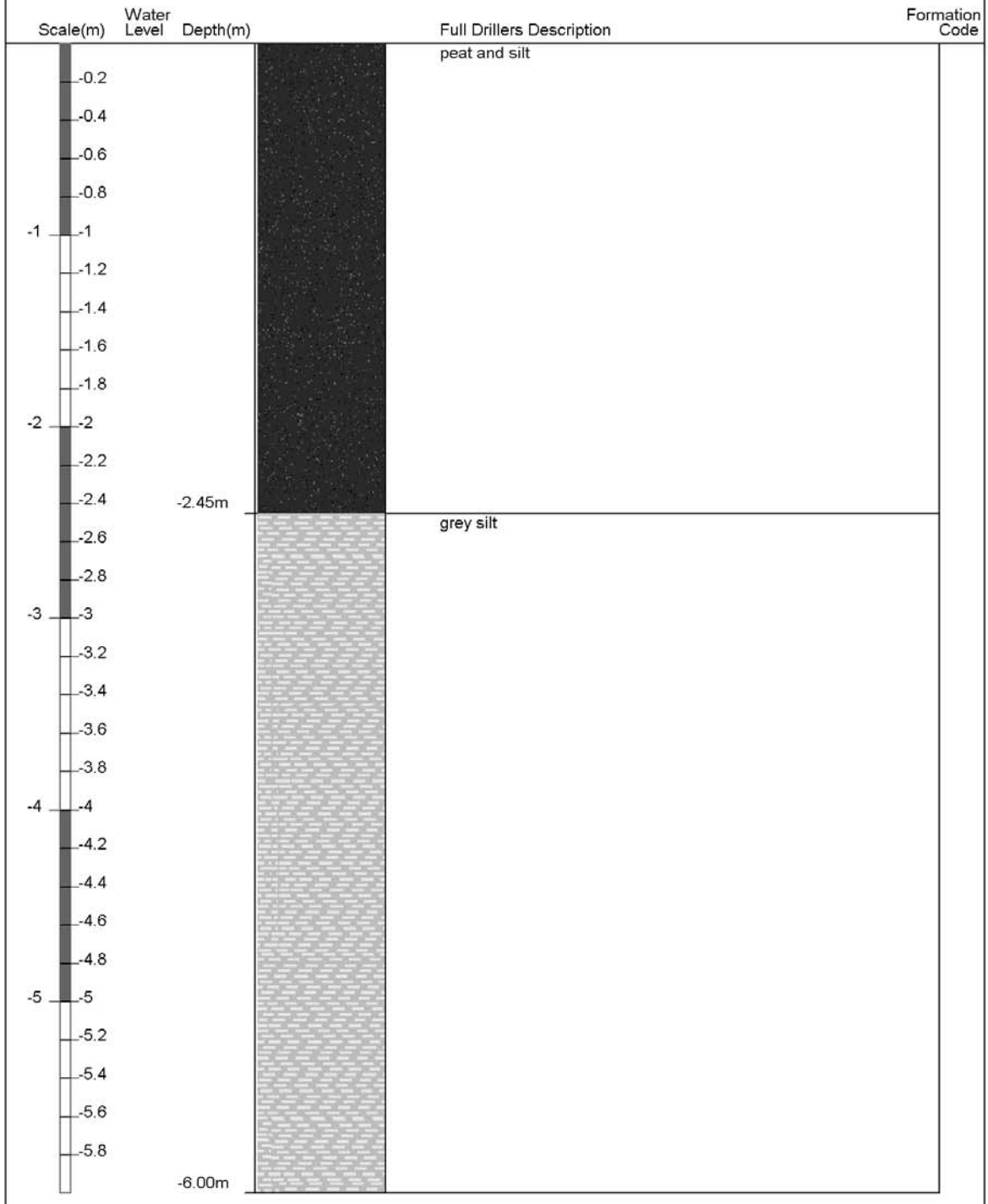
Step Test Date	Step	Yield (l/s)	Drawdown	Duration (mins)

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:

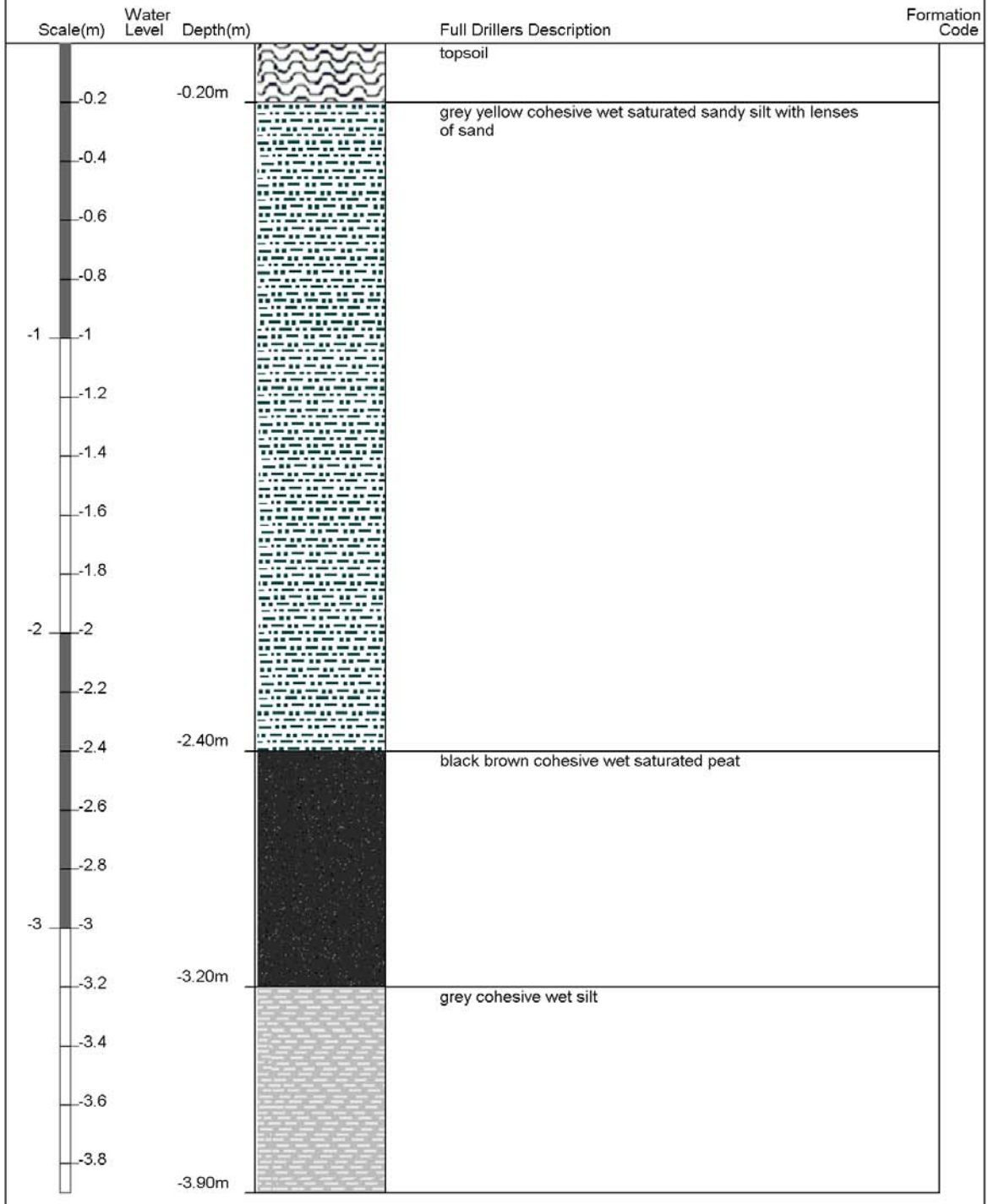
Step Test Date	Step	Yield (l/s)	Drawdown	Duration (mins)

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:

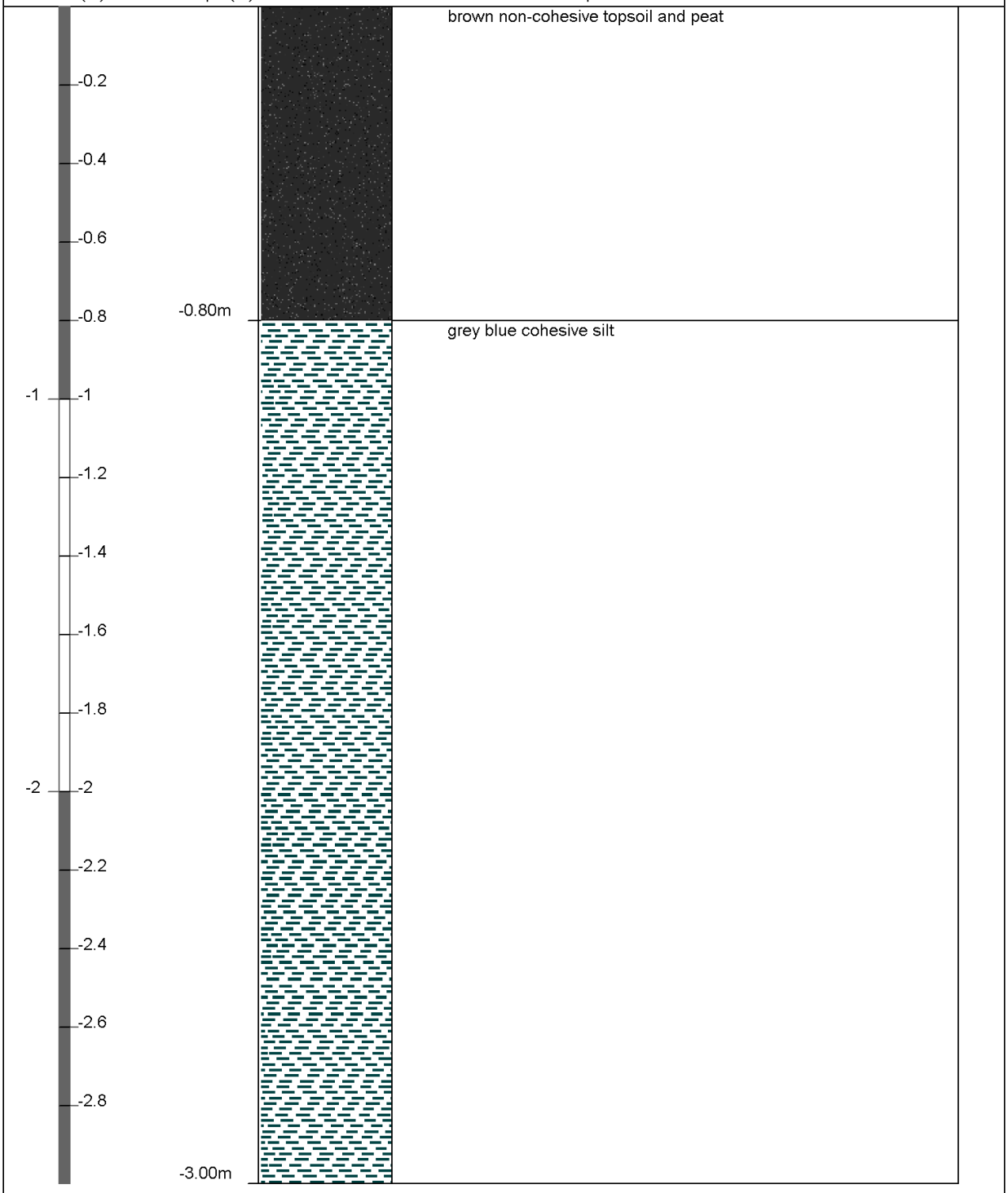
Step Test Date	Step	Yield (l/s)	Drawdown	Duration (mins)

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:

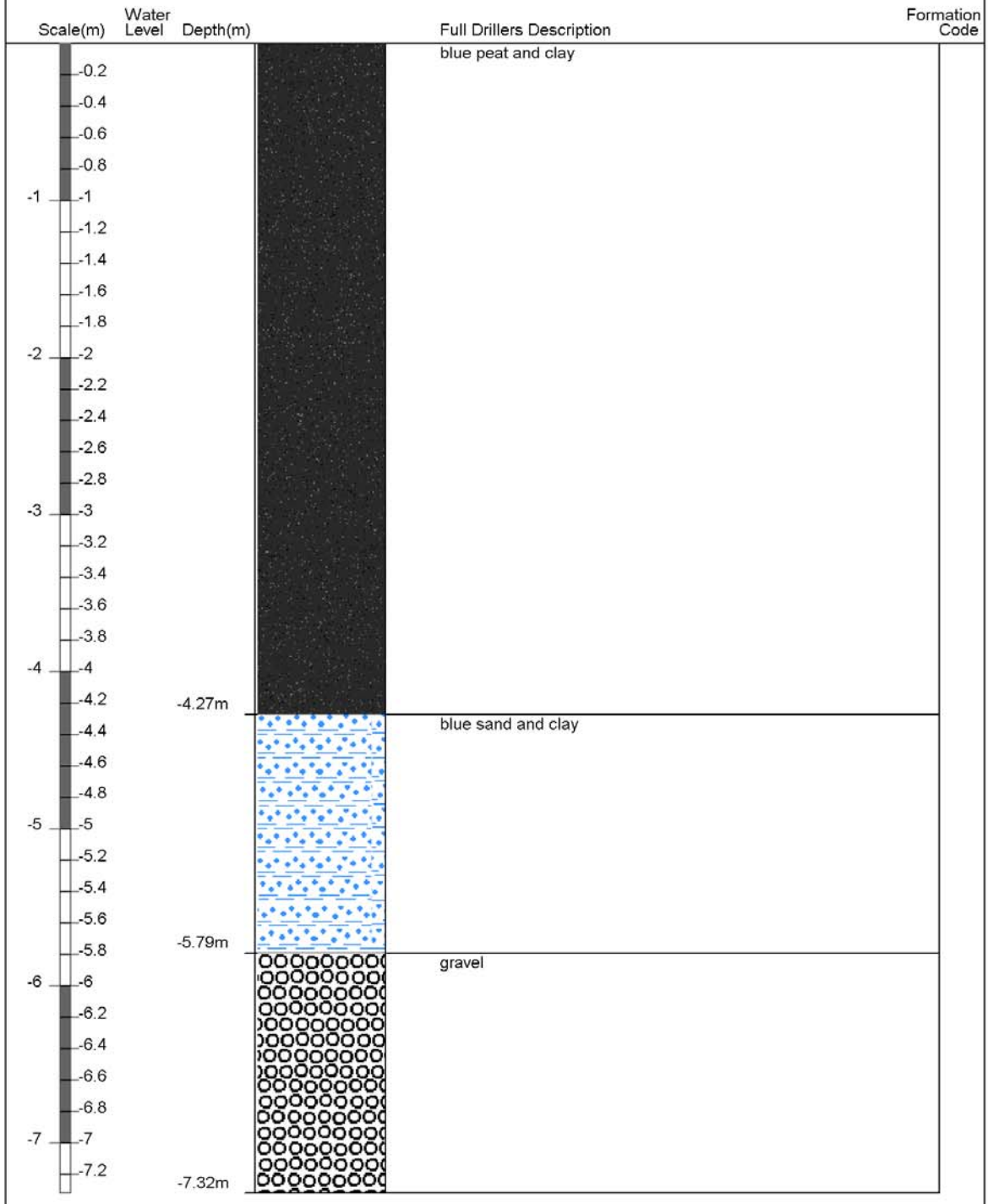
Step Test Date	Step	Yield (l/s)	Drawdown	Duration (mins)

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:

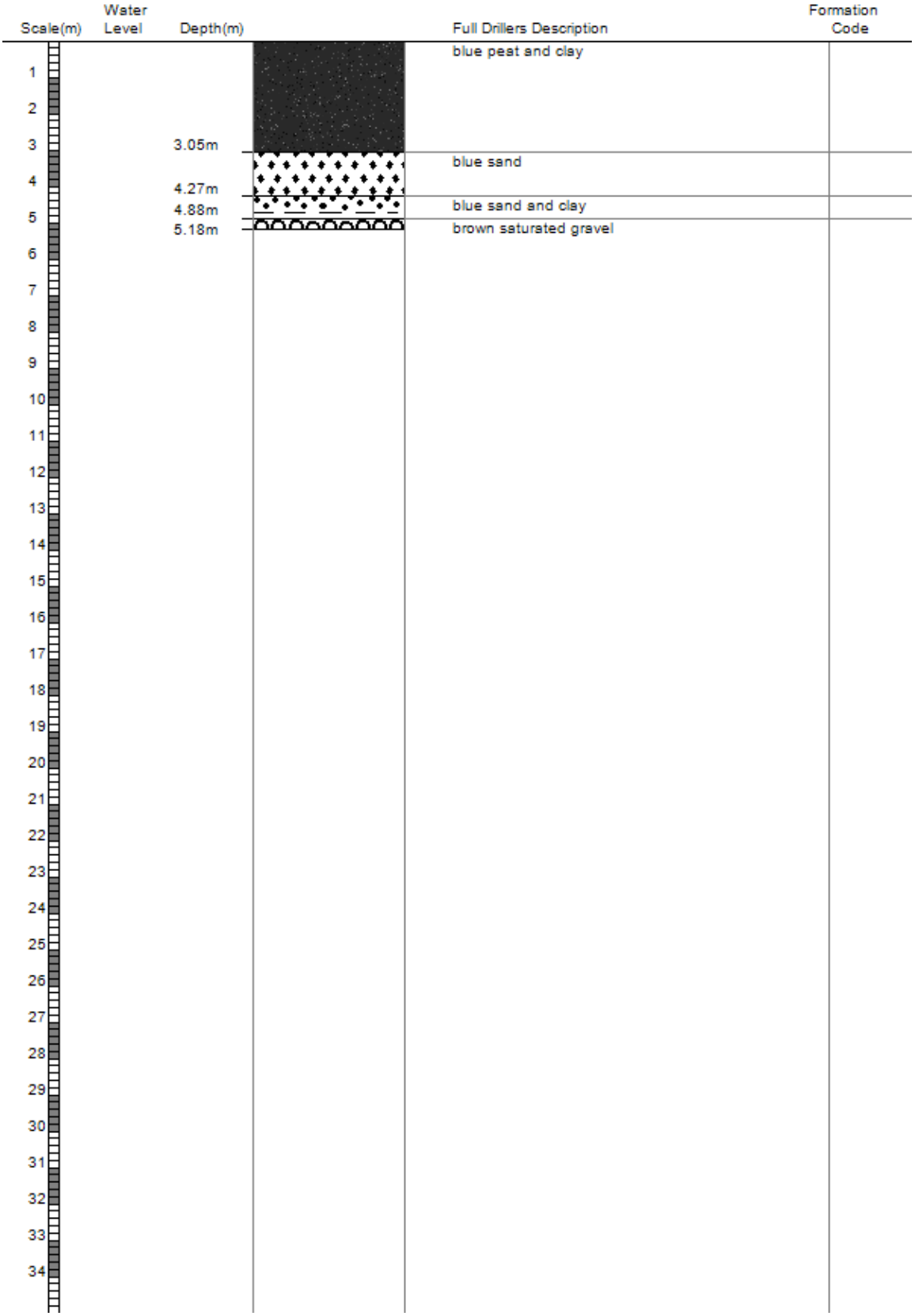
Step Test Date	Step	Yield (l/s)	Drawdown	Duration (mins)

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:

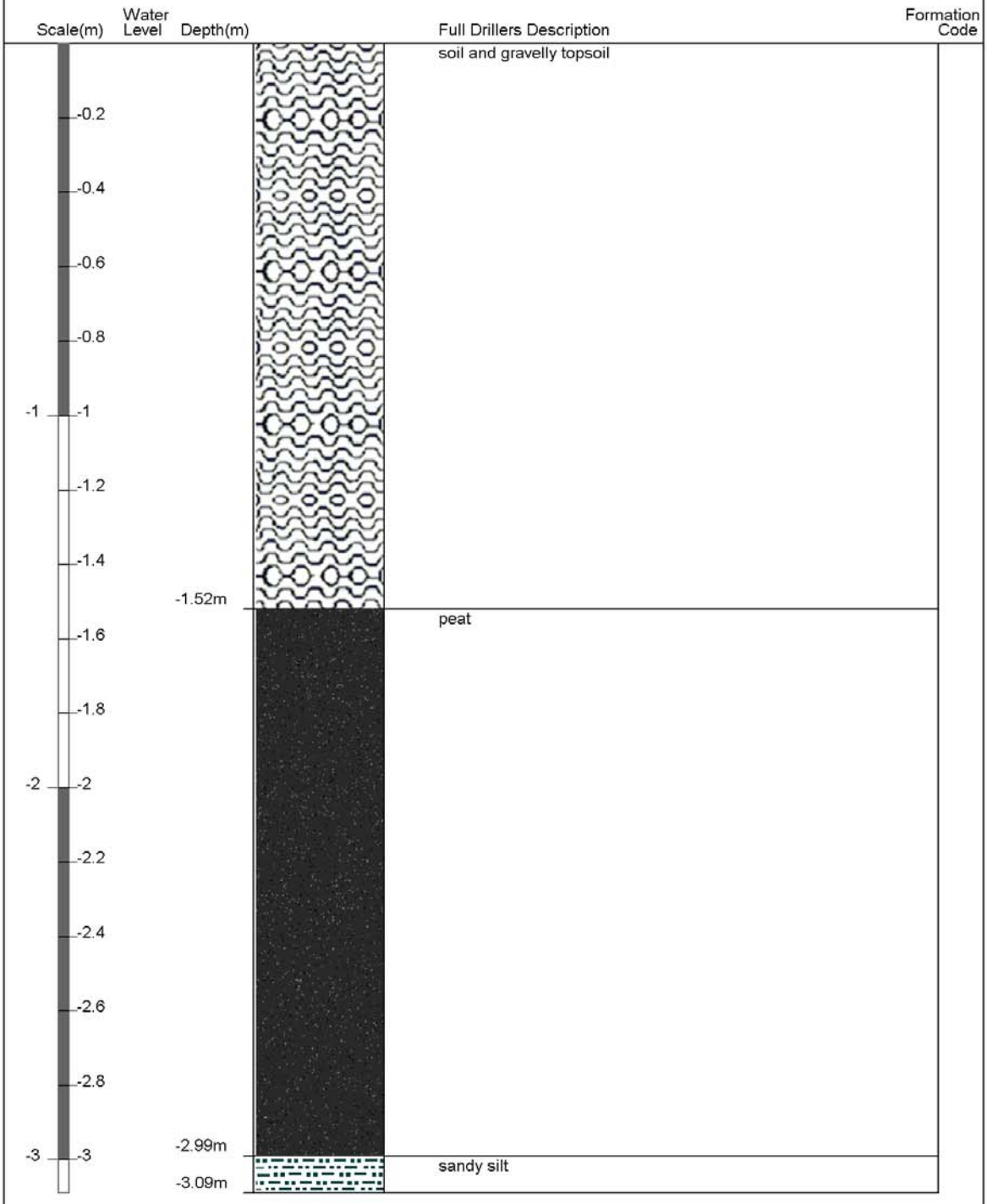
Step Test Date	Step	Yield (l/s)	Drawdown	Duration (mins)

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:

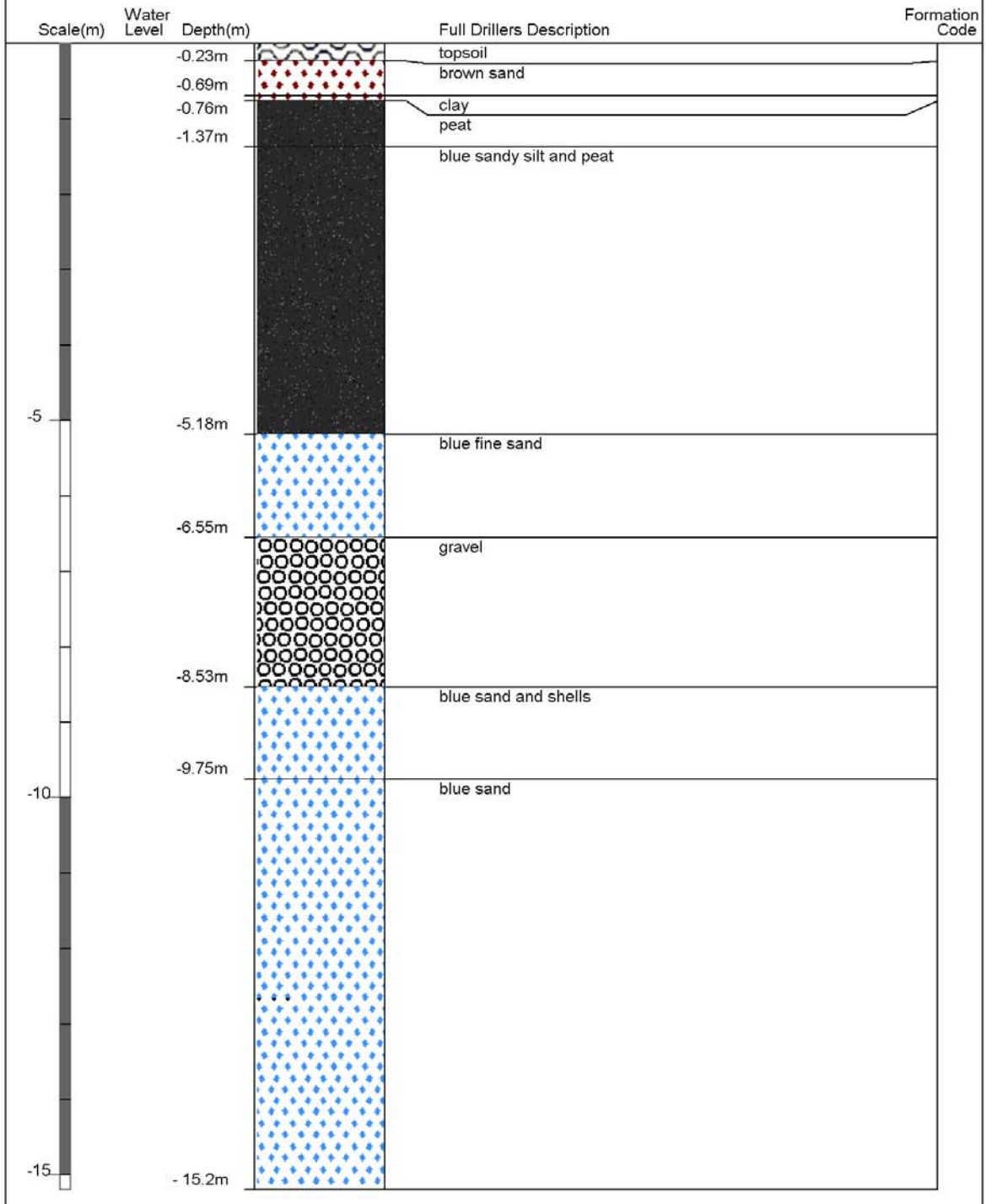
Step Test Date	Step	Yield (l/s)	Drawdown	Duration (mins)

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:

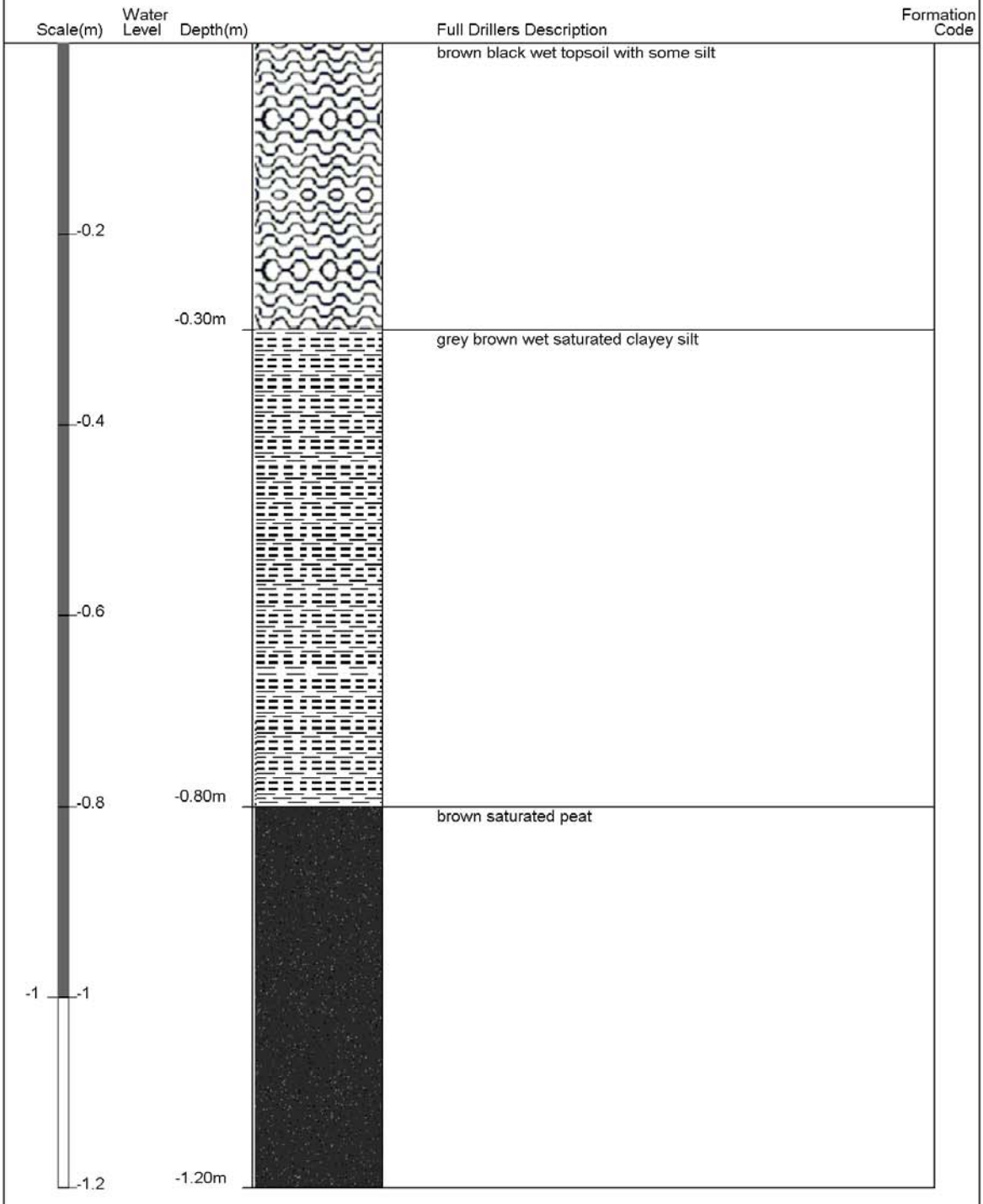
Step Test Date	Step	Yield (l/s)	Drawdown	Duration (mins)

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:

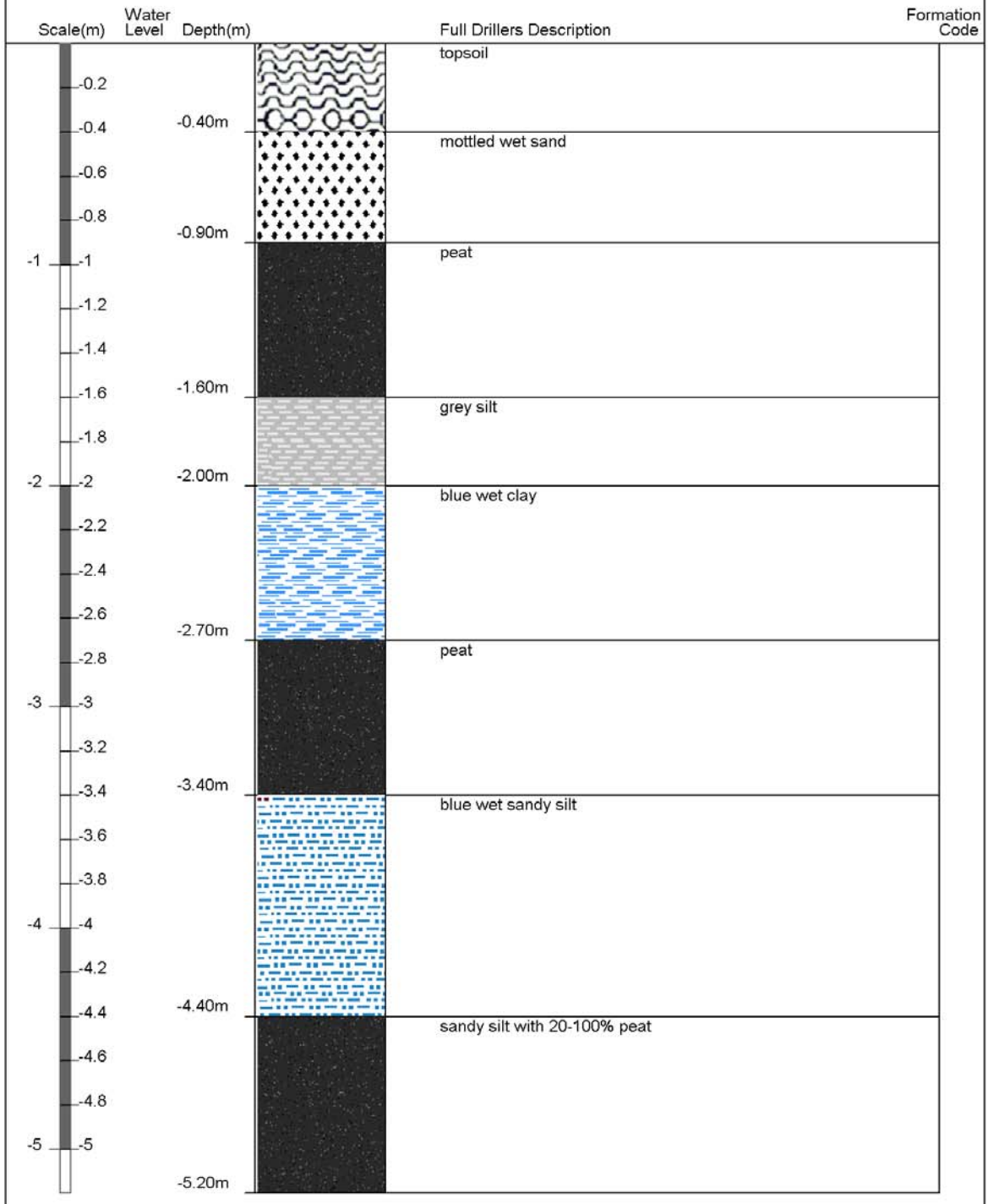
Step Test Date	Step	Yield (l/s)	Drawdown	Duration (mins)

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.			4	1/1// 1/1/1/1	100	SPT				5.96m, light water flow (artesian) 0.7m head		
	At 6.20m: fibrous organic inclusion. From 6.25m: with trace of silt.					97	Sonic						
	Fine to coarse SAND with trace of silt; grey. 'Very loose', well graded.	8											
	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						
Christchurch Formation	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.	13				101	Sonic						
				24	3/4// 3/5/7/9	128	SPT				1.0m heave PSD		
	At 14.17m: coarse shell fragment.	14											
	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											
				22	2/2// 4/4/6/8	133	SPT				3.0m heave		
		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											
Riccarton Gravel	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											
	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	Graphic Log	Water Level	Moisture Condition	Consistency / Density Index	TCR (%) 25 50 75	SPT N-Value 0 10 20 30 40 50	
0.0	TOPSOIL	ML	SILT with trace rootlets; dark brown. [TOPSOIL]							
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]							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								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								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								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								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										

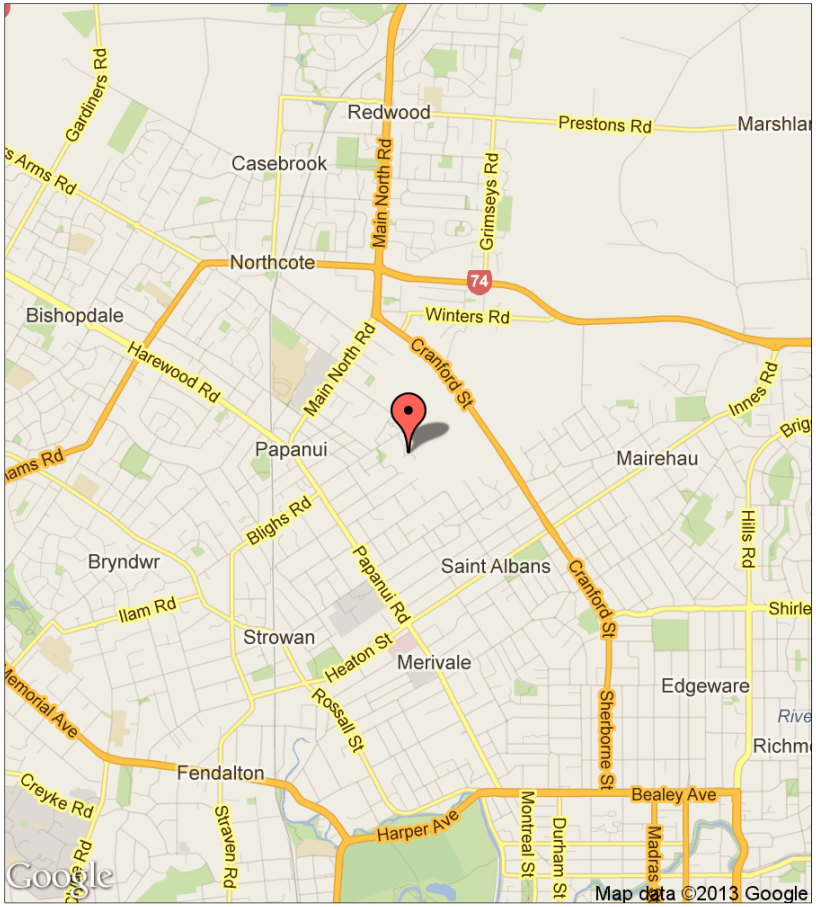
MACHINE BOREHOLE - MB01

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	TCR (%)	SPT N-Value
8.5	ALLUVIUM	SP	Minor silt encountered from 8.6 m to 8.8 m depth.	L-MD		
9.0						SPT: 9 m 2,2,3,3,4,5 N = 15 450 mm pen.
9.5						
10.0						SPT: 10 m 3,2,2,2,3,3 N = 10 450 mm pen.
10.5						
11.0						SPT: 11 m 3,3,4,5,4,4 N = 17 450 mm pen.
11.5						
12.0						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		SPT: 13 m 2,3,4,3,6,9 N = 22 450 mm pen.
13.5						
14.0						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.			SPT: 15 m 3,5,6,6,9,10 N = 31 450 mm pen.
15.5			EOH: 15.45 m			
16.0						
16.5						
17.0						

Termination: Target depth
Moisture condition not recorded.
T = TOPSOIL



⊕ = 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	ALLUVIUM/PEAT	PT	Fibrous PEAT; black.							
		ML	SILT with trace gravel; grey with orange mottles.							
2.0		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.
3.5										
4.0										SPT: 4 N = 0 450 mm pen.
4.5										
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						
19.0				N/R N/R						
19.5				N/R N/R						
20.0				N/R N/R						
20.5										
21.0										

Termination: Target Depth
Standing groundwater encountered at 0.4 m depth.
N/R = Not Recorded.
A/P = ALLUVIUM/PEAT

06-28-2012 Y:\Projects\11245 Southern Response - Arrow\D3504583 - 37 Wiremu Street, Redwood\Field Testing Results\D3504583_MB01.bor

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 unit	Core recovery (%)	Method	Tests	Samples	Depth (m)	Classification symbol	Moisture	Strength/density	Soil description
TOPSOIL	90	Hand Auger			0.0	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)					0.35	ML			Sandy SILT, brownish grey, moist, low plasticity. Sand is fine to medium.
					1.1		W		1.1m- wet, quick dilatancy.
					1.35				1.35 to 1.5m- no recovery.
	67	SPT	0/0//0/5/8/4 N=17		1.5			VSt	Sandy SILT, grey, very stiff, wet, low plasticity. Sand is fine to medium. 1.5 to 1.8m- sample not retained.
	0	SPT	0/0//0/0/0/0 N=0		1.8			VS	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]
	0	RM	*ATP@3.0m *FC@3.0m						
	100	SPT	0/0//0/0/0/0 N=0	B	3.0	MH			SILT with some organics and trace sand, brownish grey, very soft, wet, high plasticity. Organics are fibrous. Sand is fine to Medium.
	0	RM							
	100	SPT	0/0//0/0/0/0 N=0						
	0	RM							
	67	SPT	0/1//0/2/1/1 N=4		5.0			F	5.0m- trace rootlets, grey, firm. 5.3 to 5.45m- no recovery.
	0	RM	*FC@6.0m						
	67	SPT	1/2//4/3/3/4 N=14	B	6.0	SM		MD	Silty fine to medium SAND, grey, medium dense, wet, poorly graded.
					6.25	ML		St	Sandy SILT, grey, stiff, wet, low plasticity. Sand is fine to medium. 6.3 to 6.45m- no recovery.
	0	RM							
	78	SPT	1/1/2/2/2/2// 2/3/3/4/4/3/ 3/4/3/3/3/3 N=38		7.0	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.
	0	RM							
	100	SPT	2/1/2/3/2/2// 2/2/2/2/2/1/ 2/1/2/1/2/2 N=21		7.6	SP		MD	Fine to medium SAND with minor silt, grey, medium dense, wet, poorly graded.
					7.8	GW			Fine to coarse GRAVEL with trace sand and trace silt, grey, subangular to subrounded, medium dense, wet, well graded. Sand is fine to coarse.
	33	PQDT			8.25	SW			Fine to coarse SAND with minor silt, grey, medium dense, wet, well graded. 8.4 to 9.1m- no recovery.
	67	SPT	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.
	71	PQDT							

Groundwater level at approx. 1.1 m.

Log Scale 1:50

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 HOLE FINISHED: 28/5/13
R.L.:	8.39 m	DRILL METHOD: PQDT/RM/Auto SPT	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.	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: 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.
YALDHURST MEMBER OF THE SPRINGSTON FORMATION (ALLUVIAL)			71 56	PQDT SPT		1/1/2/2/2/2// 3/2/2/2/2/1/ 2/2/2/2/2/2 N=24		-2 11		GW	W	D MD				Sandy fine to coarse GRAVEL with trace silt, grey, subangular to subrounded, dense, wet, well graded. Sand is fine to coarse. 10.4 to 10.7m- no recovery. 10.7m- medium dense. 10.95 to 11.15m- no recovery.
								-3 12 -4 13 -5 14 -6 15 -7 16 -8 17 -9 18 -10 19 -11 20								End of borehole at 11.15mbgl (target depth)

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
	DRILL METHOD: PQDT/Auto SPT		HOLE FINISHED: 9/4/13
R.L.: 6.43 m			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.	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
FILL											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.
YALDHURST MEMBER OF THE SPRINGSTON FORMATION (ALLUVIAL)			33	Hand Auger				6			SP						Fine to medium SAND with minor rootlets and minor silt, light brown, moist, poorly graded. 0.5 to 1.5m- no recovery. 1.2m- wet.
			44	SPT		3/2//1/1/0/1 N=3		5	1		Pt	W	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. 1.7 to 1.95m- no recovery. 1.95m- trace fine to medium sand. 2.1m- some silt. 2.4 to 3.0m- no recovery.
			43	PQDT				4	2								
			33	SPT		0/0//0/0/0/0 N=0		3	3				VS				3.0m- very soft. 3.15 to 3.45m- no recovery.
						✱ATP@3.5m ✱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.
			100	PQDT				2	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				ML						SILT with minor organics and minor sand, grey, firm, wet, low plasticity. Organics are fibrous (wood) and amorphous. Sand is fine to medium. 5.15m- trace amorphous and fibrous organics. 5.5 to 5.7m- some fibrous organics (wood).
									6		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. 6.0m- medium dense.
			67	SPT		5/5//5/5/6/6 N=22		0					MD				
			100	PQDT					7		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.
			44	SPT		1/1/1/1/1/2// 2/2/2/1/1/2/ 2/2/2/1/2/2 N=21		-1									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		-2									
			100	PQDT					9								9.4 to 9.45m- no recovery.
								-3									
									10								

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	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.	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: 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.
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.
								11 / -5								End of borehole at 10.95mbgl (target depth)
								12 / -6								
								13 / -7								
								14 / -8								
								15 / -9								
								16 / -10								
								17 / -11								
								18 / -12								
								19 / -13								
								20								

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Email: christchurch@ap.aurecongroup.com

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				2.30		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)				
					5.20		PEAT; dark brown. Soft; wet. Peat is fibrous.									
	100				5.30		SILT with some peat; brownish grey. Soft; wet; moderate plasticity.									
					5.40		PEAT; dark brown. Soft; wet. Peat is fibrous.									
							SILT with some peat; brownish grey. Soft; wet; moderate plasticity.									
	20						3.45m Becomes very soft.					SPT at 6m N = 4 0/1, 3 450mm (SS)				
							3.9m Becomes soft.									
							SAND some silt; grey. Moderately packed; wet. Sand is fine to medium grained.									
	100				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.									
	35				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)				
	95				9.65		8.0m Becomes with no sand. Grey.									

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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Email: christchurch@ap.aurecongroup.com

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
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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

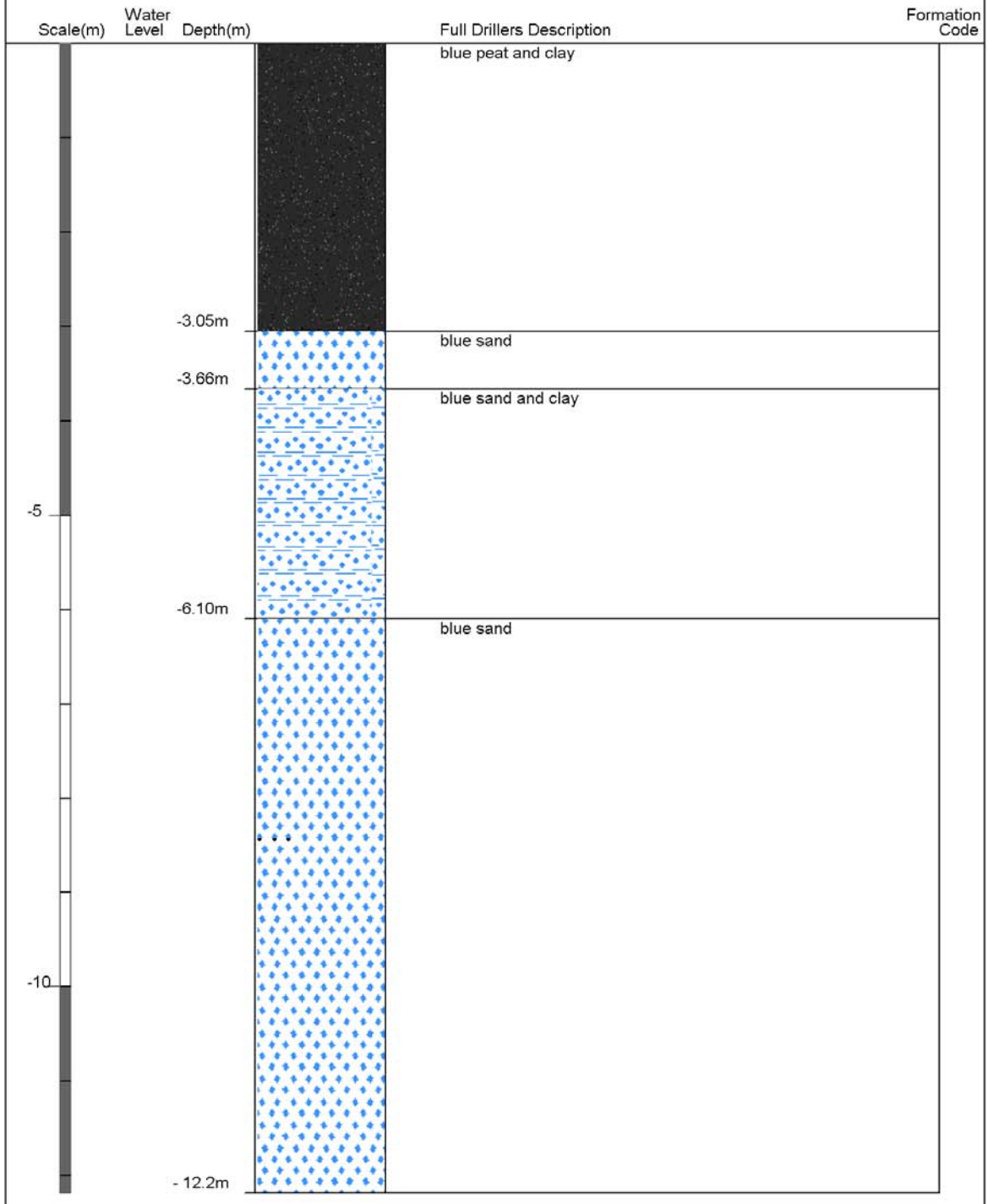
Last Generated: 22/08/2012 12:17:28 p.m.

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

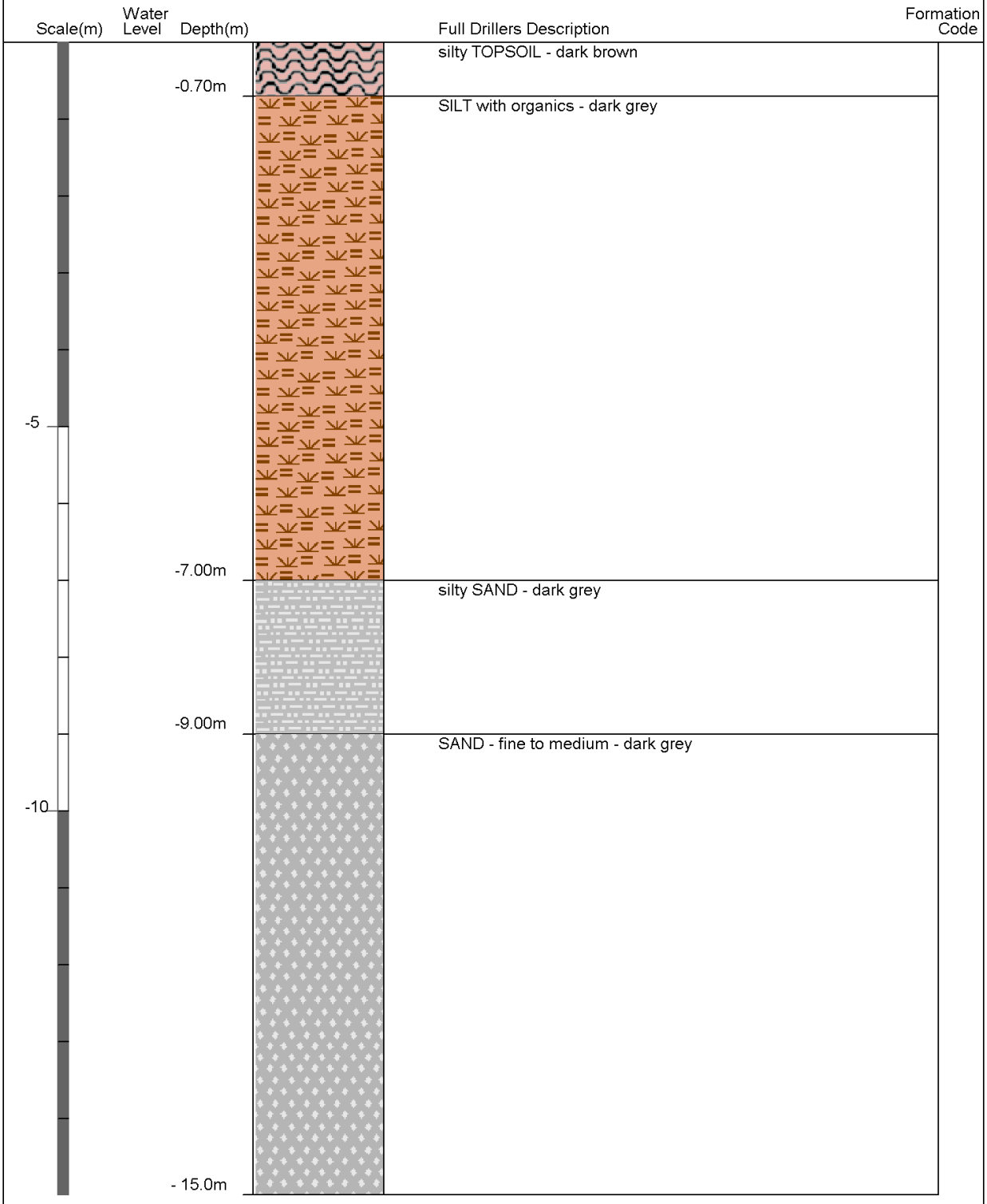
Environment Canterbury Regional Council



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



Appendix C – (Further Investigation Results)

Geotechnical Logs

CPT Plots

BOREHOLE with Piezo LOG

GHD Limited

PO Box 13468
Christchurch 8141

Site Identification: **BH101**

Sheet 1 of 4

Project: Cranford Basin Geotechnical Investigations
Client: Christchurch City Council
Site: Grassmere Street
Job No.: 5133038

Coordinates: **E** 1569019.807, **N** 5184497.777 **Datum:** NZTM
Total Depth: 15.5m
Commenced: 26-Jun-15
Completed: 29-Jun-15
Contractor: McMillan Drilling

Equipment: Track 8140 LS
Shear Vane:
Bore Diameter (mm): 96
Inclination: -90
Comments:

Logged:	DW
Processed:	DW
Checked:	JR

Depth (m)/ [Elev.]	Drilling Method	Core Run / Recovery (%)	Support / Casing (m)	Water	Geological Fm	Classification	Graphic Log	SOIL DESCRIPTION: (Soil Code), Soil Name [minor MAJOR], colour, structure [zoning, defects, cementing], plasticity or grain size, secondary components, structure. (Geological Formation) / ROCK DESCRIPTION: Weathering, colour, fabric, ROCK NAME (Formation Name)	Moisture Condition	Consistency/ Relative Density	Weathering	Estimated Rock Strength (EW VW W MS S VS ES)	RQD (%)	Defect Spacing (mm) (20 40 100 300 1000)	TESTS & SAMPLES / ROCK MASS DEFECTS: Depth, Type, Inclinations, Roughness, Texture, Aperture, Coating
0.3	HQ Coring	109	None			OL		TOPSOIL trace rootlets; dark brown. Moist; low plasticity.	M						
						ML		SILT; grey. Soft to firm; moist; low plasticity.	M	S					
0.6						SP		Fine SAND trace silt; grey. Loose; wet; poorly graded.	M	L					
0.9						ML		SILT some sand; grey. Soft to firm; moist; low plasticity; sand, fine.	M	S					
1															1
1.1						OL		Organic SILT; dark brown. Soft; moist; low plasticity.	M	S					
1.2						ML		SILT some sand; grey. Very soft; moist; low plasticity; sand, fine.	M	VS					
1.4	SPT	11	None					Coreloss							SPT 0,0, 0,0, 0,0, [0]
1.8						Pt		PEAT; amphorous; dark brown; soft; moist; H1.	M	S					
1.9	Push tube	100	None			Pt		Inferred PEAT; amphorous; dark brown; soft; moist; H1.	M	S					
2						ML		Inferred SILT; grey. Soft; moist; low plasticity.	M	S					2
2.7	HQ Coring	583	None			SM		Inferred Silty fine to medium SAND; grey. Wet; poorly graded.	W						
2.9	SPT	100	None			SM		Silty fine to medium SAND; grey. Medium dense; wet; poorly graded.	W	MD					SPT 3,3, 4,2, 3,3, [12]
3															3
3.5	HQ Coring	100	None			ML		SILT trace sand; grey. Very soft; wet; low plasticity; quick and dilatant behaviour; sand, fine.	W	VS					
4															4
	SPT	100	None												SPT 0,0, 0,0, 0,0, [0]
5															5

BOREHOLE LOG NZ ALT CRANFORD BASIN.GPJ NZ GINT DATA TEMPLATE VER 1.5.GDT 21/9/15

BOREHOLE with Piezo LOG

GHD Limited

PO Box 13468
Christchurch 8141

Site Identification: **BH101**

Project: Cranford Basin Geotechnical Investigations
Client: Christchurch City Council
Site: Grassmere Street
Job No.: 5133038

Coordinates: **E** 1569019.807, **N** 5184497.777 **Datum:** NZTM
Total Depth: 15.5m
Commenced: 26-Jun-15 **Contractor:** McMillan Drilling
Completed: 29-Jun-15

Equipment: Track 8140 LS **Inclination:** -90
Shear Vane:
Bore Diameter (mm): 96 **Comments:**

Logged:	DW
Processed:	DW
Checked:	JR

Depth (m)/ [Elev.]	Drilling Method	Core Run / Recovery (%)	Support / Casing (m)	Water	Geological Fm	Classification	Graphic Log	SOIL DESCRIPTION: (Soil Code), Soil Name [minor MAJOR], colour, structure [zoning, defects, cementing], plasticity or grain size, secondary components, structure. (Geological Formation) / ROCK DESCRIPTION: Weathering, colour, fabric, ROCK NAME (Formation Name)	Moisture Condition	Consistency/ Relative Density	Weathering	Estimated Rock Strength (EW VW W MS S VS ES)	RQD (%)	Defect Spacing (mm) (20 40 100 300 1000)	TESTS & SAMPLES / ROCK MASS DEFECTS: Depth, Type, Inclinations, Roughness, Texture, Aperture, Coating
5.2	HQ Coring		None			ML		SILT trace sand; grey. Very soft; wet; low plasticity; quick and dilatant behaviour; sand, fine.	W	VS					
						ML		SILT with some wood fragments; grey mottled black. Soft; wet; low plasticity.	W	S					
6															SPT 0,0, 0,0, 1,1, [2]
6.1	SPT		None			ML		SILT; grey. Soft; wet; low plasticity.	W	S					
6.2						SM		Sandy SILT; grey. Soft; wet; low plasticty; quick and dilatant behaviour; sand, fine to medium.	W	S					
7	HQ Coring		None												
	SPT		None												SPT 0,0, 0,2, 3,2, [7]
7.9						ML		SILT; grey. Soft; wet; low plasticity; quick and dilatant behaviour.	W	S					
8	HQ Coring		None												
9															
	SPT		None												SPT 0,0, 2,3, 4,3, [12]
9.2						SP		Fine to medium SAND some silt; grey. Medium dense; wet; poorly graded; quick and dilatant behaviour.	W	MD					
10	HQ Coring		None												

BOREHOLE LOG NZ ALT CRANFORD BASIN.GPJ NZ GINT DATA TEMPLATE VER 1.5.GDT 21/9/15

BOREHOLE with Piezo LOG

GHD Limited

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Completed: 29-Jun-15

Equipment: Track 8140 LS **Inclination:** -90
Shear Vane:
Bore Diameter (mm): 96 **Comments:**

Logged:	DW
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Checked:	JR

Depth (m)/ [Elev.]	Drilling Method	Core Run / Recovery (%)	Support / Casing (m)	Water	Geological Fm	Classification	Graphic Log	SOIL DESCRIPTION: (Soil Code), Soil Name [minor MAJOR], colour, structure [zoning, defects, cementing], plasticity or grain size, secondary components, structure. (Geological Formation) / ROCK DESCRIPTION: Weathering, colour, fabric, ROCK NAME (Formation Name)	Moisture Condition	Consistency/ Relative Density	Weathering	Estimated Rock Strength (EW VW W MS S VS ES)	RQD (%)	Defect Spacing (mm) (20 40 100 300 1000)	TESTS & SAMPLES / ROCK MASS DEFECTS: Depth, Type, Inclinations, Roughness, Texture, Aperture, Coating
11	HQ Coring		None			SP		Fine to medium SAND; grey. Loose; wet; poorly graded. 10.14 to 10.19m wood fragment	W	L					
	SPT		None												SPT 3,3, 1,1, 1,0, [3]
	HQ Coring		None												
12	SPT		None					@12.04m becomes dense		D					SPT 7,7, 7,7, 7,9, [30]
13	HQ Coring		None												
	SPT		None					@13.56m becomes very dense		VD					SPT 7,5, 6,6, 15,30, [57]
14	HQ Coring		None					14.4 to 14.55m wood fragment							
15															

BOREHOLE with Piezo LOG

GHD Limited

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Christchurch 8141

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Logged:	DW
Processed:	DW
Checked:	JR

Depth (m)/ [Elev.]	Drilling Method	Core Run / Recovery (%)	Support / Casing (m)	Water	Geological Fm	Classification	Graphic Log	SOIL DESCRIPTION: (Soil Code), Soil Name [minor MAJOR], colour, structure [zoning, defects, cementing], plasticity or grain size, secondary components, structure. (Geological Formation) / ROCK DESCRIPTION: Weathering, colour, fabric, ROCK NAME (Formation Name)	Moisture Condition	Consistency/ Relative Density	Weathering	Estimated Rock Strength (EW VW W MS S VS ES)	RQD (%)	Defect Spacing (mm) (20 40 100 300 1000)	TESTS & SAMPLES / ROCK MASS DEFECTS: Depth, Type, Inclinations, Roughness, Texture, Aperture, Coating
	SPT		None			SP		Fine to medium SAND; grey. Loose; wet; poorly graded. @15.08m becomes medium dense	W	L MD					SPT 6,7, 6,5, 5,5, [21]
15.5								Termination Depth = 15.5m, Target Depth							

BOREHOLE LOG NZ ALT CRANFORD BASIN.GPJ NZ GINT DATA TEMPLATE VER 1.5.GDT 21/9/15

BOREHOLE with Piezo LOG

GHD Limited

PO Box 13468
Christchurch 8141

Site Identification: **BH102**

Sheet 1 of 3

Project: Cranford Basin Geotechnical Investigations
Client: Christchurch City Council
Site: Cranford Street
Job No.: 5133038

Coordinates: **E** 1569278.232, **N** 5184443.543 **Datum:** NZTM
Total Depth: 12.5m
Commenced: 24-Jun-15
Completed: 24-Jun-15
Contractor: McMillan Drilling

Equipment: Track 8140 LS
Shear Vane:
Bore Diameter (mm): 96
Inclination: -90
Comments:

Logged:	DW
Processed:	DW
Checked:	JR

Depth (m)/ [Elev.]	Drilling Method	Core Run / Recovery (%)	Support / Casing (m)	Water	Geological Fm	Classification	Graphic Log	SOIL DESCRIPTION: (Soil Code), Soil Name [minor MAJOR], colour, structure [zoning, defects, cementing], plasticity or grain size, secondary components, structure. (Geological Formation) / ROCK DESCRIPTION: Weathering, colour, fabric, ROCK NAME (Formation Name)	Moisture Condition	Consistency/ Relative Density	Weathering	Estimated Rock Strength (EW VW W MS S VS ES)	RQD (%)	Defect Spacing (mm) (20 40 100 300 1000)	TESTS & SAMPLES / ROCK MASS DEFECTS: Depth, Type, Inclinations, Roughness, Texture, Aperture, Coating
0.3	HQ Coring	68	None		Christchurch Formation	OL		TOPSOIL trace rootlets; dark brown. Moist; low plasticity.	M						
								Coreloss inferred TOPSOIL							
0.8						SP		Fine SAND trace silt; grey. 'Loose'; wet; poorly graded; quick and dilatant behaviour.	W	'L'					
1															1
1.4	SPT	100	None			ML		SILT; grey. Very soft; moist; low plasticity.	M	VS					SPT 1,0, 0,0, 0,0, [0]
2	HQ Coring	112	None												2
2.9						ML		SILT with organics; brown. Very soft; moderately plastic.	M	VS					
3	Push tube	54	None												3
3.8						SP		Fine to medium SAND trace silt; grey. Loose; wet; poorly graded.	W	L					
4	HQ Coring	211	None												4
	SPT	78	None												SPT 0,0, 0,0, 2,2, [4]
5		142													5

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BOREHOLE with Piezo LOG

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Christchurch 8141

Site Identification: **BH102**

Project: Cranford Basin Geotechnical Investigations
Client: Christchurch City Council
Site: Cranford Street
Job No.: 5133038

Coordinates: **E** 1569278.232, **N** 5184443.543 **Datum:** NZTM
Total Depth: 12.5m
Commenced: 24-Jun-15 **Contractor:** McMillan Drilling
Completed: 24-Jun-15

Equipment: Track 8140 LS **Inclination:** -90
Shear Vane:
Bore Diameter (mm): 96 **Comments:**

Logged:	DW
Processed:	DW
Checked:	JR

Depth (m)/ [Elev.]	Drilling Method	Core Run / Recovery (%)	Support / Casing (m)	Water	Geological Fm	Classification	Graphic Log	SOIL DESCRIPTION: (Soil Code), Soil Name [minor MAJOR], colour, structure [zoning, defects, cementing], plasticity or grain size, secondary components, structure. (Geological Formation) / ROCK DESCRIPTION: Weathering, colour, fabric, ROCK NAME (Formation Name)	Moisture Condition	Consistency/ Relative Density	Weathering	Estimated Rock Strength (EW VW W MS S VS ES)	RQD (%)	Defect Spacing (mm) (20 40 100 300 1000)	TESTS & SAMPLES / ROCK MASS DEFECTS: Depth, Type, Inclinations, Roughness, Texture, Aperture, Coating
5.0	HQ Coring	142			Christchurch Formation	SP		Gravelly fine to coarse SAND; grey. Wet; well graded; gravel, fine to medium, subangular to subrounded, greywacke.	W						
5.2						SP		Fine to medium SAND; grey. Wet; poorly graded.	W						
5.7						GW		Sandy fine to coarse GRAVEL; grey. Medium dense; well graded; subangular to subrounded; greywacke; sand, fine to coarse.	W	MD					
6	SPT	100	None												SPT 1,3, 3,4, 3,3, [13]
6.7	HQ Coring	100	None			SP		Fine to medium SAND; grey. Loose; wet; poorly graded.	W	L					
7															7
	SPT	100	None												SPT 1,1, 1,1, 2,5, [9]
8	HQ Coring	100	None												8
8.1						GW		Sandy fine to coarse GRAVEL; grey. Dense; well graded; subangular to subrounded; greywacke; sand, fine to coarse.	W	D					
9	SPT	100	None												SPT 8,10, 13,12, 12,10, [47]
	HQ Coring	100	None												9
10															10

BOREHOLE with Piezo LOG

GHD Limited

PO Box 13468
Christchurch 8141

Site Identification: **BH102**

Sheet 3 of 3

Project: Cranford Basin Geotechnical Investigations
Client: Christchurch City Council
Site: Cranford Street
Job No.: 5133038

Coordinates: **E** 1569278.232, **N** 5184443.543 **Datum:** NZTM
Total Depth: 12.5m
Commenced: 24-Jun-15
Completed: 24-Jun-15
Contractor: McMillan Drilling

Equipment: Track 8140 LS
Shear Vane:
Bore Diameter (mm): 96

Inclination: -90
Comments:

Logged:	DW
Processed:	DW
Checked:	JR

Depth (m)/ [Elev.]	Drilling Method	Core Run / Recovery (%)	Support / Casing (m)	Water	Geological Fm	Classification	Graphic Log	SOIL DESCRIPTION: (Soil Code), Soil Name [minor MAJOR], colour, structure [zoning, defects, cementing], plasticity or grain size, secondary components, structure. (Geological Formation) / ROCK DESCRIPTION: Weathering, colour, fabric, ROCK NAME (Formation Name)	Moisture Condition	Consistency/ Relative Density	Weathering	Estimated Rock Strength (EW VW W MS S VS ES)	RQD (%)	Defect Spacing (mm) (20 40 100 300 1000)	TESTS & SAMPLES / ROCK MASS DEFECTS: Depth, Type, Inclinations, Roughness, Texture, Aperture, Coating
	HQ Coring	100	None		Christchurch Formation	GW		Sandy fine to coarse GRAVEL; grey. Dense; well graded; subangular to subrounded; greywacke; sand, fine to coarse.	W	D					
10.5	SPT	110	None			SP		Fine to medium SAND; grey. Very dense; wet; poorly graded.	W	VD					SPT 10,13, 16,16, 20,8, [60+]
11	HQ Coring	96	None None			GW		Sandy fine to coarse GRAVEL; grey. 'Dense'; well graded; subangular to subrounded; greywacke; sand, fine to coarse.	W	'D'					
11.9						SM		Silty fine SAND; grey. Dense; wet; poorly graded.	W	D					
12	SPT	100													SPT 8,8, 12,13, 12,12, [49]
12.5								Termination Depth = 12.49m, Target Depth							
13															
14															
15															

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BOREHOLE with Piezo LOG

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PO Box 13468
Christchurch 8141

Site Identification: **BH103**

Sheet 1 of 4

Project: Cranford Basin Geotechnical Investigations
Client: Christchurch City Council
Site: Cranford Street
Job No.: 5133038

Coordinates: **E** 1569379.036, **N** 5184555.284 **Datum:** NZTM
Total Depth: 17.1m

Commenced: 23-Jun-15
Completed: 24-Jun-15

Contractor: McMillan Drilling

Equipment: Track 8140 LS
Shear Vane:
Bore Diameter (mm): 96

Inclination: -90
Comments:

Logged:	DW
Processed:	DW
Checked:	JR

Depth (m)/ [Elev.]	Drilling Method	Core Run / Recovery (%)	Support / Casing (m)	Water	Geological Fm	Classification	Graphic Log	SOIL DESCRIPTION: (Soil Code), Soil Name [minor MAJOR], colour, structure [zoning, defects, cementing], plasticity or grain size, secondary components, structure. (Geological Formation) / ROCK DESCRIPTION: Weathering, colour, fabric, ROCK NAME (Formation Name)	Moisture Condition	Consistency/ Relative Density	Weathering	Estimated Rock Strength (EW VW W MS S VS ES)	RQD (%)	Defect Spacing (mm) (20 40 100 300 1000)	TESTS & SAMPLES / ROCK MASS DEFECTS: Depth, Type, Inclinations, Roughness, Texture, Aperture, Coating
0.0	HQ Coring	100	None		Christchurch Formation	OL		TOPSOIL trace rootlets; dark brown. Moist; low plasticity.	M						
0.5	HQ Coring	109	None			ML		SILT; grey. Firm; moist; low plasticity.	M	F					
1.0	HQ Coring	213	None			SP		Fine to medium SAND trace silt; grey. Very loose; moist; poorly graded.	M	VL					
1	SPT	100	None												SPT 2,1, 1,0, 1,1, [3]
1.8	HQ Coring	100	None			ML		SILT; grey. Firm; moist; low plasticity.	M	F					
2.5	Push Tube	71	None					Push Tube, no sample to log							
3.5	HQ Coring	100	None			OL		SILT with organics; grey mottled dark brown. Very soft; slightly plastic; organics, wood and roolets.	M	VS					
3.7						ML		SILT; grey. Firm; moist; low plasticity.	M	F					
4.1						ML		SILT trace organics; brown. Soft; moist; moderately plastic.	M	F					
4.3						ML		SILT; grey. Firm; wet; low plasticity; quick and dilatant behaviour.	W	F					
5	SPT	100	None												SPT 0,0, 0,0, 2,1, [3]
		100													

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BOREHOLE with Piezo LOG

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PO Box 13468
Christchurch 8141

Site Identification: **BH103**

Project: Cranford Basin Geotechnical Investigations
Client: Christchurch City Council
Site: Cranford Street
Job No.: 5133038

Coordinates: **E** 1569379.036, **N** 5184555.284 **Datum:** NZTM
Total Depth: 17.1m
Commenced: 23-Jun-15 **Contractor:** McMillan Drilling
Completed: 24-Jun-15

Equipment: Track 8140 LS **Inclination:** -90
Shear Vane:
Bore Diameter (mm): 96 **Comments:**

Logged:	DW
Processed:	DW
Checked:	JR

Depth (m)/ [Elev.]	Drilling Method	Core Run / Recovery (%)	Support / Casing (m)	Water	Geological Fm	Classification	Graphic Log	SOIL DESCRIPTION: (Soil Code), Soil Name [minor MAJOR], colour, structure [zoning, defects, cementing], plasticity or grain size, secondary components, structure. (Geological Formation) / ROCK DESCRIPTION: Weathering, colour, fabric, ROCK NAME (Formation Name)	Moisture Condition	Consistency/ Relative Density	Weathering	Estimated Rock Strength (EW VW W MS S VS ES)	RQD (%)	Defect Spacing (mm) (20 40 100 300 1000)	TESTS & SAMPLES / ROCK MASS DEFECTS: Depth, Type, Inclinations, Roughness, Texture, Aperture, Coating
5.3	HQ Coring	100	None		Christchurch Formation	ML		SILT; grey. Firm; wet; low plasticity; quick and dilatant behaviour.	W	F					
						SM		Silty fine SAND; grey. Wet; poorly graded.	W						
5.7						ML		SILT; grey. Soft; wet; low plasticity; quick and dilatant behaviour.	W						
6															6
6.6	HQ Coring	122	None			SM		Silty fine SAND; grey. Wet; poorly graded; quick and dilatant behaviour.	W						
6.8						ML		SILT; grey. Soft; wet; low plasticity; quick and dilatant behaviour.	W						
7															7
7.0						SM		Silty fine SAND; grey. Wet; poorly graded; quick and dilatant behaviour.	W						
7.5	SPT	100	None			SP		Fine to medium SAND trace silt; grey. Loose; wet; poorly graded.	W	L					SPT 0,0, 0,0, 1,3, [4]
8	HQ Coring	100	None												8
9	SPT	100	None												SPT 1,0, 1,0, 3,4, [8] 9
	HQ Coring	100	None												
10															10

BOREHOLE with Piezo LOG

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PO Box 13468
Christchurch 8141

Site Identification: **BH103**

Project: Cranford Basin Geotechnical Investigations
Client: Christchurch City Council
Site: Cranford Street
Job No.: 5133038

Coordinates: **E** 1569379.036, **N** 5184555.284 **Datum:** NZTM
Total Depth: 17.1m
Commenced: 23-Jun-15 **Contractor:** McMillan Drilling
Completed: 24-Jun-15

Equipment: Track 8140 LS
Shear Vane:
Bore Diameter (mm): 96

Inclination: -90
Comments:

Logged:	DW
Processed:	DW
Checked:	JR

Depth (m)/ [Elev.]	Drilling Method	Core Run / Recovery (%)	Support / Casing (m)	Water	Geological Fm	Classification	Graphic Log	SOIL DESCRIPTION: (Soil Code), Soil Name [minor MAJOR], colour, structure [zoning, defects, cementing], plasticity or grain size, secondary components, structure. (Geological Formation) / ROCK DESCRIPTION: Weathering, colour, fabric, ROCK NAME (Formation Name)	Moisture Condition	Consistency/ Relative Density	Weathering	Estimated Rock Strength (EW VW W MS S VS ES)	RQD (%)	Defect Spacing (mm) (20 40 100 300 1000)	TESTS & SAMPLES / ROCK MASS DEFECTS: Depth, Type, Inclinations, Roughness, Texture, Aperture, Coating
11	HQ Coring	100	None		Christchurch Formation	SP		Fine to medium SAND trace silt; grey. Loose; wet; poorly graded.	W	L					SPT 1,3, 2,0, 1,0, [3]
	SPT	100	None												
	HQ Coring	100	None												
12	SPT	100	None					@12.16 - 12.31m with trace shell fragments							SPT 3,2, 2,3, 4,5, [14]
	HQ Coring	100	None												
13	SPT	100	None												SPT 1,1, 1,1, 1,2, [5]
14	HQ Coring	100	None												
15															

BOREHOLE with Piezo LOG

GHD Limited

PO Box 13468
Christchurch 8141

Site Identification: **BH103**

Project: Cranford Basin Geotechnical Investigations
Client: Christchurch City Council
Site: Cranford Street
Job No.: 5133038

Coordinates: **E** 1569379.036, **N** 5184555.284 **Datum:** NZTM
Total Depth: 17.1m
Commenced: 23-Jun-15 **Contractor:** McMillan Drilling
Completed: 24-Jun-15

Equipment: Track 8140 LS
Shear Vane:
Bore Diameter (mm): 96

Inclination: -90
Comments:

Logged:	DW
Processed:	DW
Checked:	JR

Depth (m)/ [Elev.]	Drilling Method	Core Run / Recovery (%)	Support / Casing (m)	Water	Geological Fm	Classification	Graphic Log	SOIL DESCRIPTION: (Soil Code), Soil Name [minor MAJOR], colour, structure [zoning, defects, cementing], plasticity or grain size, secondary components, structure. (Geological Formation) / ROCK DESCRIPTION: Weathering, colour, fabric, ROCK NAME (Formation Name)	Moisture Condition	Consistency/ Relative Density	Weathering	Estimated Rock Strength (EW VW W MS S VS ES)	RQD (%)	Defect Spacing (mm) (20 40 100 300 1000)	TESTS & SAMPLES / ROCK MASS DEFECTS: Depth, Type, Inclinations, Roughness, Texture, Aperture, Coating
		100													
15.1	SPT	100	None		Christchurch Formation	SP		Organic fine SAND trace wood fragments; dark brown. Medium dense; moist; poorly graded.	M	MD					SPT 2,1, 3,2, 3,4, [12]
15.8	HQ Coring	100	None			SP		Fine to medium SAND; grey. Medium dense; wet; poorly graded.	W	MD					
16															16
	SPT	100	None												SPT 4,3, 4,4, 4,9, [21]
17															17
17.1								Termination Depth = 17.05m, Target Depth							
18															18
19															19
20															20

BOREHOLE LOG NZ ALT CRANFORD BASIN.GPJ NZ GINT DATA TEMPLATE VER 1.5.GDT 21/9/15

BOREHOLE with Piezo LOG

GHD Limited

PO Box 13468
Christchurch 8141

Site Identification: **BH104**

Sheet 1 of 3

Project: Cranford Basin Geotechnical Investigations
Client: Christchurch City Council
Site: Cranford Street
Job No.: 5133038

Coordinates: **E** 1569475.26, **N** 5184305.058 **Datum:** NZTM
Total Depth: 11.0m
Commenced: 25-Jun-15 **Contractor:** McMillan Drilling
Completed: 25-Jun-15

Equipment: Track 8140 LS
Shear Vane:
Bore Diameter (mm): 96

Inclination: -90
Comments:

Logged:	DW
Processed:	DW
Checked:	JR

Depth (m)/ [Elev.]	Drilling Method	Core Run / Recovery (%)	Support / Casing (m)	Water	Geological Fm	Classification	Graphic Log	SOIL DESCRIPTION: (Soil Code), Soil Name [minor MAJOR], colour, structure [zoning, defects, cementing], plasticity or grain size, secondary components, structure. (Geological Formation) / ROCK DESCRIPTION: Weathering, colour, fabric, ROCK NAME (Formation Name)	Moisture Condition	Consistency/ Relative Density	Weathering	Estimated Rock Strength (EW VW W MS S VS ES)	RQD (%)	Defect Spacing (mm) (20 40 100 300 1000)	TESTS & SAMPLES / ROCK MASS DEFECTS: Depth, Type, Inclinations, Roughness, Texture, Aperture, Coating
0.6	HQ Coring	100	None		Christchurch Formation	OL		TOPSOIL trace rootlets; dark brown. Moist; low plasticity.	M						
						ML		SILT; grey. Soft to firm; moist; low plasticity.	M	S					
1.4	SPT	100	None			OL		Organic SILT with wood fragments; dark brown. Very soft; moist; low plasticity.	M	VS					SPT 0,0, 0,0, 0,0, [0]
	Push Tube	100	None												
2.9	HQ Coring	100	None												
	HQ Coring	100	None			SM		Silty fine SAND; grey. Wet; poorly graded; quick and dilatant behaviour.	W						
3.8						SP		Fine to medium SAND trace silt; grey. Medium dense; wet; poorly graded.	W	MD					
	SPT	100	None												SPT 1,0, 2,3, 4,6, [15]
		100													

BOREHOLE with Piezo LOG

GHD Limited

PO Box 13468
Christchurch 8141

Site Identification: **BH104**

Project: Cranford Basin Geotechnical Investigations
Client: Christchurch City Council
Site: Cranford Street
Job No.: 5133038

Coordinates: **E** 1569475.26, **N** 5184305.058 **Datum:** NZTM
Total Depth: 11.0m
Commenced: 25-Jun-15 **Contractor:** McMillan Drilling
Completed: 25-Jun-15

Equipment: Track 8140 LS
Shear Vane:
Bore Diameter (mm): 96

Inclination: -90
Comments:

Logged:	DW
Processed:	DW
Checked:	JR

Depth (m)/ [Elev.]	Drilling Method	Core Run / Recovery (%)	Support / Casing (m)	Water	Geological Fm	Classification	Graphic Log	SOIL DESCRIPTION: (Soil Code), Soil Name [minor MAJOR], colour, structure [zoning, defects, cementing], plasticity or grain size, secondary components, structure. (Geological Formation) / ROCK DESCRIPTION: Weathering, colour, fabric, ROCK NAME (Formation Name)	Moisture Condition	Consistency/ Relative Density	Weathering	Estimated Rock Strength (EW VW W MS S VS ES)	RQD (%)	Defect Spacing (mm) (20 40 100 300 1000)	TESTS & SAMPLES / ROCK MASS DEFECTS: Depth, Type, Inclinations, Roughness, Texture, Aperture, Coating
5.1	HQ Coring	100	None		Christchurch Formation	SP			W	MD					
						GW		Sandy fine to coarse GRAVEL; grey. Medium dense; wet; subangular to subrounded, greywacke; well graded; sand, fine to coarse.	W	MD					
6															SPT 6 4,5, 4,6, 5,5, [20]
6.2	SPT	100	None			SP		Fine to medium SAND; grey. Medium dense; wet; poorly graded.	W	MD					
	HQ Coring	100	None												
6.9						GW		Sandy fine to coarse GRAVEL; grey. Dense; wet; subangular to subrounded, greywacke; well graded; sand, fine to coarse.	W	D					
7															7
	SPT	100	None												SPT 4,7, 8,7, 9,8, [32]
8.0	HQ Coring	100	None			SP		Fine to medium SAND; grey. Dense; wet; poorly graded.	W	D					
8															8
9															SPT 9 8,8, 8,10, 10,12, [40]
	SPT	100	None												
	HQ Coring	100	None												
10															10

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BOREHOLE with Piezo LOG

GHD Limited

PO Box 13468
Christchurch 8141

Site Identification: **BH104**

Project: Cranford Basin Geotechnical Investigations
Client: Christchurch City Council
Site: Cranford Street
Job No.: 5133038

Coordinates: **E** 1569475.26, **N** 5184305.058 **Datum:** NZTM
Total Depth: 11.0m
Commenced: 25-Jun-15 **Contractor:** McMillan Drilling
Completed: 25-Jun-15

Equipment: Track 8140 LS
Shear Vane:
Bore Diameter (mm): 96

Inclination: -90
Comments:

Logged:	DW
Processed:	DW
Checked:	JR

Depth (m)/ [Elev.]	Drilling Method	Core Run / Recovery (%)	Support / Casing (m)	Water	Geological Fm	Classification	Graphic Log	SOIL DESCRIPTION: (Soil Code), Soil Name [minor MAJOR], colour, structure [zoning, defects, cementing], plasticity or grain size, secondary components, structure. (Geological Formation) / ROCK DESCRIPTION: Weathering, colour, fabric, ROCK NAME (Formation Name)	Moisture Condition	Consistency/ Relative Density	Weathering	Estimated Rock Strength (EW VW W MS S VS ES)	RQD (%)	Defect Spacing (mm) (20 40 100 300 1000)	TESTS & SAMPLES / ROCK MASS DEFECTS: Depth, Type, Inclinations, Roughness, Texture, Aperture, Coating
11 11.0	HQ Coring	100	None		Christchurch Formation	SP		Fine to medium SAND; grey. Dense; wet; poorly graded.	W	D					
	SPT	100	None												SPT 1,0, 3,4, 5,8, [20]
								Termination Depth = 10.97m, Target Depth							
12															
13															
14															
15															

BOREHOLE LOG NZ ALT CRANFORD BASIN.GPJ NZ GINT DATA TEMPLATE VER 1.5.GDT 21/9/15

CONE PENETRATION TEST (CPT) REPORT

Client: GHD NZ Ltd

Location: Grassmere Street, Cranford Street
Christchurch

Printed: 26/06/2015

McMILLAN Drilling GROUP

CONE PENETRATION TEST

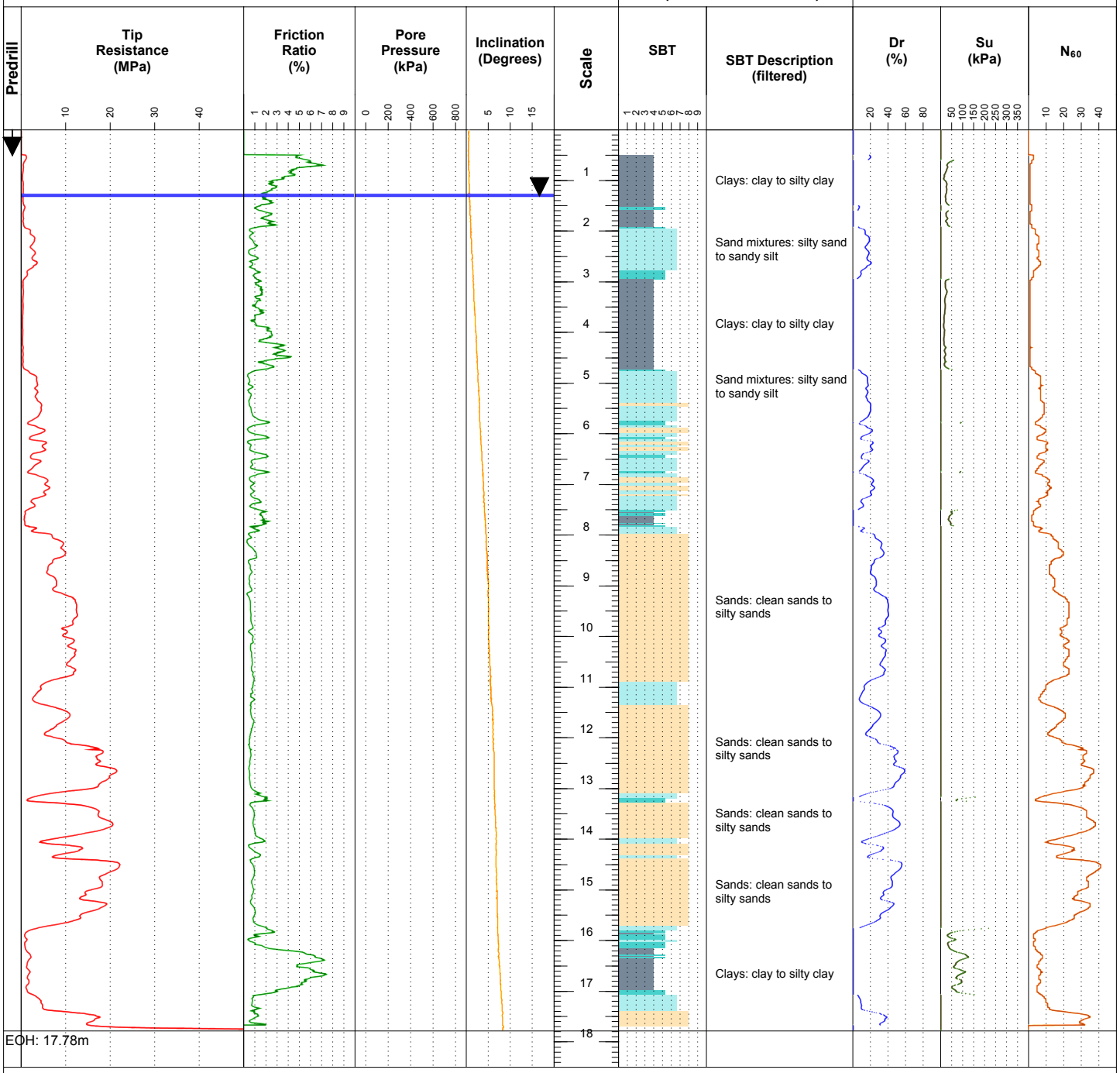
Job:	14784
CPT No.:	CPT101

Name: Cranford Basin
Client: GHD NZ Ltd
Location: 37 Grassmere Street, Christchurch

Grid: NZTM
Datum: Ground
Termination: -

North (m): 5184441.09
East (m): 1569102.68
Elevation (m): -
Hole Depth (m): 17.78

RAW DATA | **SOIL BEHAVIOUR TYPE (NON-NORMALISED)** | **ESTIMATED PARAMETERS**



Operator: P. Buunk
Rig: 14t truck mounted rig
Cone Reference: 080238T
Cone Area Ratio: 0.75
Cone Type: I-CFXY-10
Tip Resistance (MPa) Initial: -4.1778
Local Friction (MPa) Initial: -0.0362
Pore Pressure (KPa) Initial: -

Date: 16/06/2015
Predrill: 0.50
Water Level: 1.30
Collapse:
Final: -4.1051
Final: -0.0364
Final: -

Effective Refusal
Tip: ✓
Gauge:
Inclinometer:
Other:
Target Depth:

Soil Behaviour Type (SBT) - Robertson et al. 1986

0	Undefined	5	Sand mixtures: silty sand to sandy silt
1	Sensitive fine-grained	6	Sands: clean sands to silty sands
2	Clay - organic soil	7	Dense sand to gravelly sand
3	Clays: clay to silty clay	8	Stiff sand to clayey sand
4	Silt mixtures: clayey silt & silty clay	9	Stiff fine-grained

Notes & Limitations

Data shown on this report has been assessed to provide a basic interpretation in terms of Soil Behaviour Type (SBT) and various geotechnical soil and design parameters using methods published in P. K. Robertson and K.L. Cabal (2010), Guide to Cone Penetration Testing for Geotechnical Engineering, 4th Edition. The interpretations are presented only as a guide for geotechnical use, and should be carefully reviewed by the user. Both McMillan Drilling Ltd & Geroc Solutions Ltd do not warranty the correctness or the applicability of any of the geotechnical soil and design parameters shown and does not assume any liability for any use of the results in any design or review. The user should be fully aware of the techniques and limitations of any method used to derive data shown in this report.

Remarks
Effective Refusal

Hole Depth (m): 17.78

McMILLAN Drilling GROUP

CONE PENETRATION TEST

Job: 14784

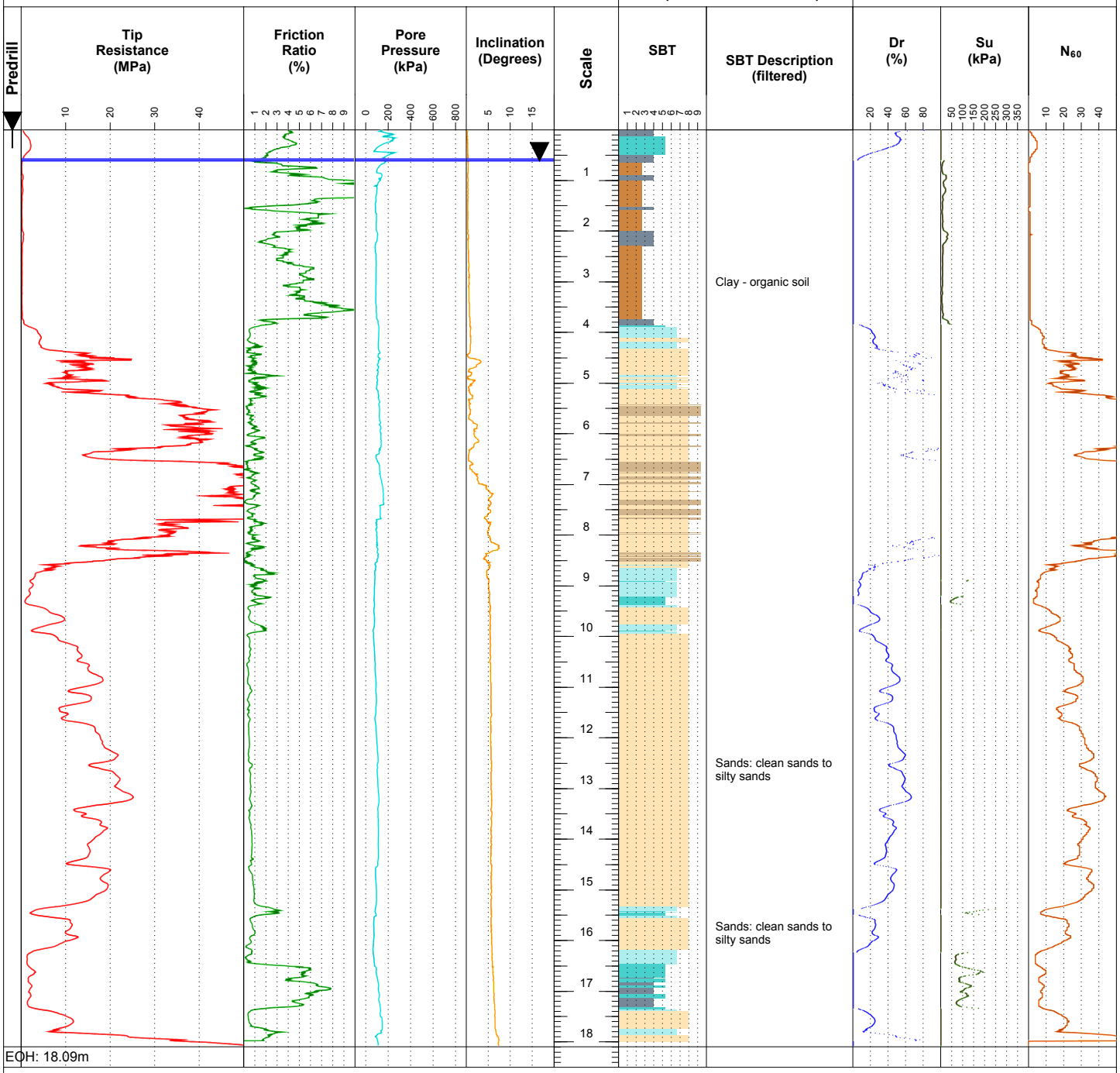
CPT No.: CPTu102

Name: Cranford Basin
Client: GHD NZ Ltd
Location: 45 Grassmere Street, Christchurch

Grid: NZTM
Datum: Ground
Termination: -

North (m): 5184275.13
East (m): 1569205.79
Elevation (m): -
Hole Depth (m): 18.09

RAW DATA | **SOIL BEHAVIOUR TYPE (NON-NORMALISED)** | **ESTIMATED PARAMETERS**



Operator: S. Cardona
Rig: 14t truck mounted rig
Cone Reference: 100992T
Cone Area Ratio: 0.75
Cone Type: I-CFXYP20-10
Tip Resistance (MPa) Initial: -4.6763
Local Friction (MPa) Initial: -0.0604
Pore Pressure (KPa) Initial: -269.189

Date: 26/06/2015
Predrill: 0.00
Water Level: 0.60
Collapse: 4.50
Final: -4.4542
Final: -0.0627
Final: -230.069

Effective Refusal
Tip: ✓
Gauge:
Inclinometer:
Other:
Target Depth:

Soil Behaviour Type (SBT) - Robertson et al. 1986

0	Undefined	5	Sand mixtures: silty sand to sandy silt
1	Sensitive fine-grained	6	Sands: clean sands to silty sands
2	Clay - organic soil	7	Dense sand to gravelly sand
3	Clays: clay to silty clay	8	Stiff sand to clayey sand
4	Silt mixtures: clayey silt & silty clay	9	Stiff fine-grained

Notes & Limitations

Data shown on this report has been assessed to provide a basic interpretation in terms of Soil Behaviour Type (SBT) and various geotechnical soil and design parameters using methods published in P. K. Robertson and K.L. Cabal (2010), Guide to Cone Penetration Testing for Geotechnical Engineering, 4th Edition. The interpretations are presented only as a guide for geotechnical use, and should be carefully reviewed by the user. Both McMillan Drilling Ltd & Geroc Solutions Ltd do not warranty the correctness or the applicability of any of the geotechnical soil and design parameters shown and does not assume any liability for any use of the results in any design or review. The user should be fully aware of the techniques and limitations of any method used to derive data shown in this report.

Remarks
Effective Refusal

Hole Depth (m): 18.09

McMILLAN Drilling GROUP

CONE PENETRATION TEST

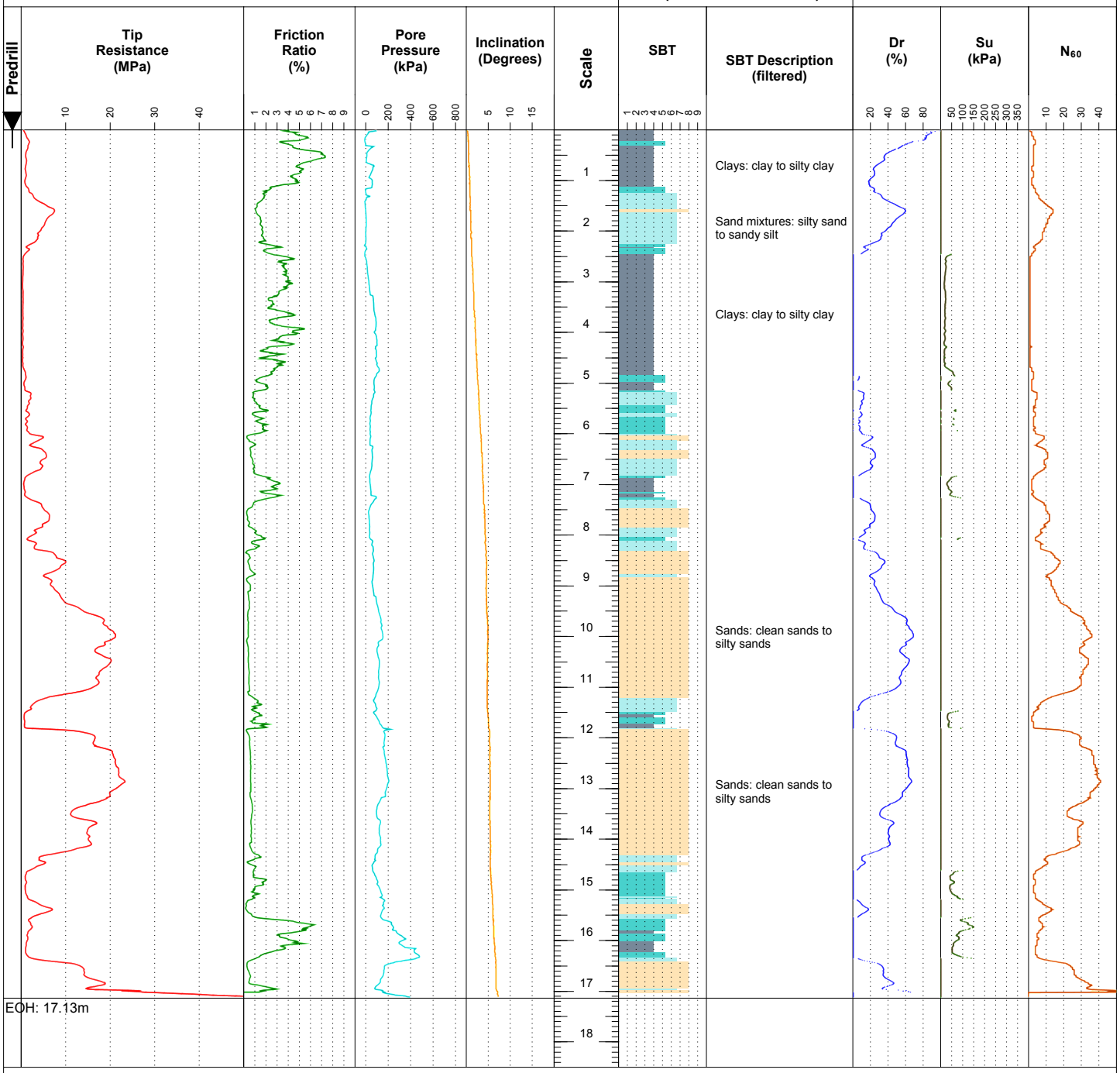
Job:	14784
CPT No.:	CPTu103

Name: Cranford Basin
Client: GHD NZ Ltd
Location: 503 Cranford Street, Christchurch

Grid: NZTM
Datum: Ground
Termination: -

North (m): 5184523.00
East (m): 1569299.52
Elevation (m): -
Hole Depth (m): 17.13

RAW DATA | **SOIL BEHAVIOUR TYPE (NON-NORMALISED)** | **ESTIMATED PARAMETERS**



Operator: S. Cardona
Rig: 14t truck mounted rig
Cone Reference: 100992T
Cone Area Ratio: 0.75
Cone Type: I-CFXYP20-10
Tip Resistance (MPa) Initial: -4.9018
Local Friction (MPa) Initial: -0.0565
Pore Pressure (KPa) Initial: -251.949

Date: 25/06/2015
Predrill: 0.00
Water Level: -
Collapse: 3.60
Final: -4.7023
Final: -0.0624
Final: -232.375

Effective Refusal
Tip: ✓
Gauge:
Inclinometer:
Other:
Target Depth:

Soil Behaviour Type (SBT) - Robertson et al. 1986

0	Undefined	5	Sand mixtures: silty sand to sandy silt
1	Sensitive fine-grained	6	Sands: clean sands to silty sands
2	Clay - organic soil	7	Dense sand to gravelly sand
3	Clays: clay to silty clay	8	Stiff sand to clayey sand
4	Silt mixtures: clayey silt & silty clay	9	Stiff fine-grained

Notes & Limitations

Data shown on this report has been assessed to provide a basic interpretation in terms of Soil Behaviour Type (SBT) and various geotechnical soil and design parameters using methods published in P. K. Robertson and K.L. Cabal (2010), Guide to Cone Penetration Testing for Geotechnical Engineering, 4th Edition. The interpretations are presented only as a guide for geotechnical use, and should be carefully reviewed by the user. Both McMillan Drilling Ltd & Geroc Solutions Ltd do not warranty the correctness or the applicability of any of the geotechnical soil and design parameters shown and does not assume any liability for any use of the results in any design or review. The user should be fully aware of the techniques and limitations of any method used to derive data shown in this report.

Remarks
Effective Refusal

Hole Depth (m): 17.13

McMILLAN Drilling GROUP

CONE PENETRATION TEST

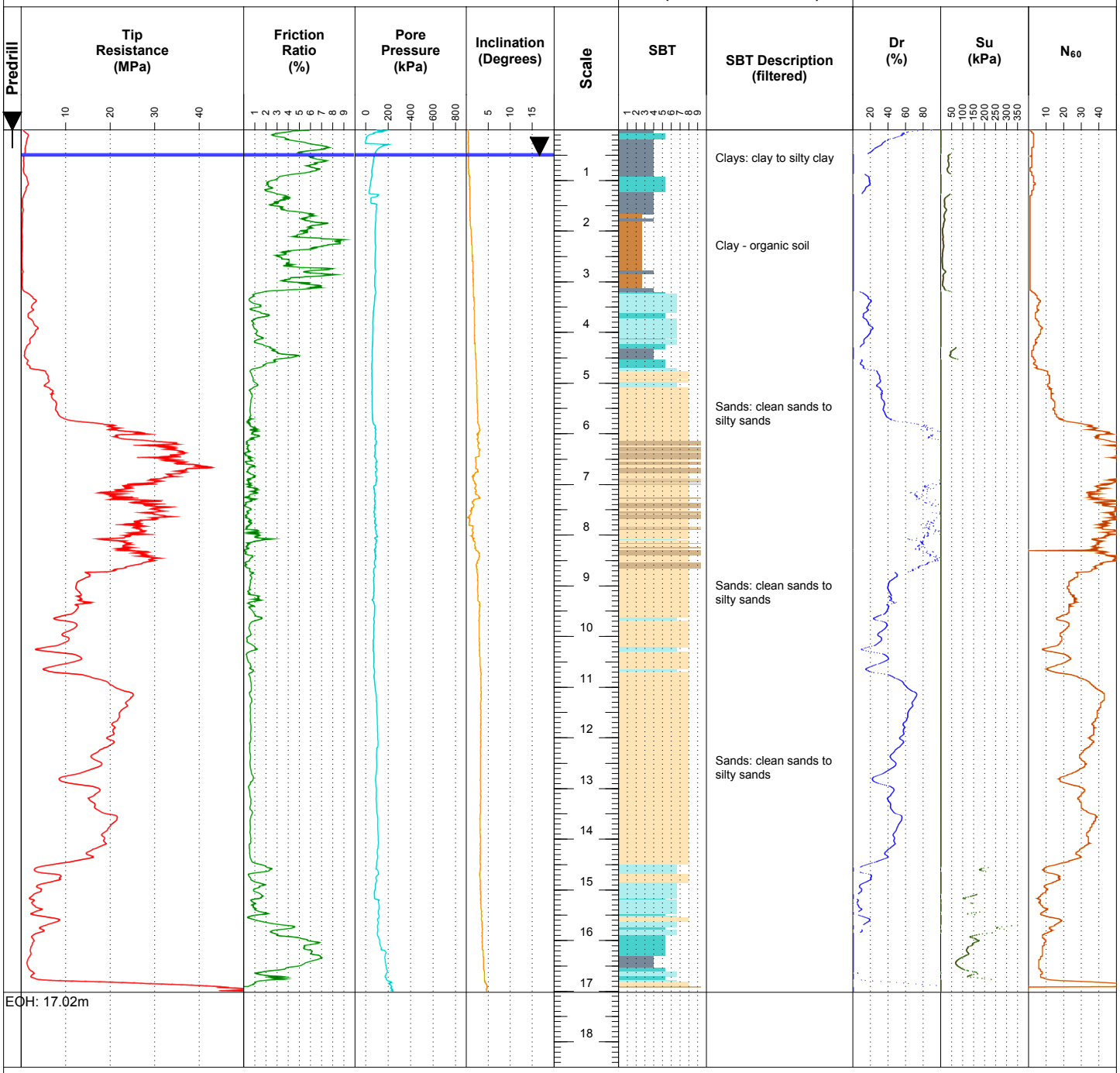
Job:	14784
CPT No.:	CPTu104

Name: Cranford Basin
Client: GHD NZ Ltd
Location: 471 Cranford Street, Christchurch

Grid: NZTM
Datum: Ground
Termination: -

North (m): 5184434.20
East (m): 1569474.94
Elevation (m): -
Hole Depth (m): 17.02

RAW DATA | **SOIL BEHAVIOUR TYPE (NON-NORMALISED)** | **ESTIMATED PARAMETERS**



Operator: S. Cardona
Rig: 14t truck mounted rig
Cone Reference: 100992T
Cone Area Ratio: 0.75
Cone Type: I-CFXYP20-10
Tip Resistance (MPa) Initial: -4.8535
Local Friction (MPa) Initial: -0.0542
Pore Pressure (KPa) Initial: -253.544

Date: 25/06/2015
Predrill: 0.00
Water Level: 0.50
Collapse: 2.40
Final: -4.7471
Final: -0.0628
Final: -219.617

Effective Refusal
Tip: ✓
Gauge:
Inclinometer:
Other:
Target Depth:

Soil Behaviour Type (SBT) - Robertson et al. 1986

0	Undefined	5	Sand mixtures: silty sand to sandy silt
1	Sensitive fine-grained	6	Sands: clean sands to silty sands
2	Clay - organic soil	7	Dense sand to gravelly sand
3	Clays: clay to silty clay	8	Stiff sand to clayey sand
4	Silt mixtures: clayey silt & silty clay	9	Stiff fine-grained

Notes & Limitations

Data shown on this report has been assessed to provide a basic interpretation in terms of Soil Behaviour Type (SBT) and various geotechnical soil and design parameters using methods published in P. K. Robertson and K.L. Cabal (2010), Guide to Cone Penetration Testing for Geotechnical Engineering, 4th Edition. The interpretations are presented only as a guide for geotechnical use, and should be carefully reviewed by the user. Both McMillan Drilling Ltd & Geroc Solutions Ltd do not warranty the correctness or the applicability of any of the geotechnical soil and design parameters shown and does not assume any liability for any use of the results in any design or review. The user should be fully aware of the techniques and limitations of any method used to derive data shown in this report.

Remarks
Effective Refusal

Hole Depth (m): 17.02

TEST DETAIL

PointID: CPT101

Sounding: 101

Operator:	P. Buunk	**Date:**	16/06/2015	**Effective Refusal**	
Cone Reference:	080238T	**Predrill:**	0.50	**Tip:**	✓
Cone Area Ratio:	0.75	**Water Level:**	1.30	**Gauge:**	
Cone Type:	I-CFXY-10	**Collapse:**		**Inclinometer:**	
				Other:	
Tip Resistance (MPa) Initial:	-4.1778	**Final:**	-4.1051		
Local Friction (MPa) Initial:	-0.0362	**Final:**	-0.0364		
Pore Pressure (kPa) Initial:	-	**Final:**	-	**Target Depth:**	

PointID: CPTu102

Sounding: 102

Operator:	S. Cardona	**Date:**	26/06/2015	**Effective Refusal**	
Cone Reference:	100992T	**Predrill:**	0.00	**Tip:**	✓
Cone Area Ratio:	0.75	**Water Level:**	0.60	**Gauge:**	
Cone Type:	I-CFXYP20-10	**Collapse:**	4.50	**Inclinometer:**	
				Other:	
Tip Resistance (MPa) Initial:	-4.6763	**Final:**	-4.4542		
Local Friction (MPa) Initial:	-0.0604	**Final:**	-0.0627		
Pore Pressure (kPa) Initial:	-269.189	**Final:**	-230.069	**Target Depth:**	

PointID: CPTu103

Sounding: 103

Operator:	S. Cardona	**Date:**	25/06/2015	**Effective Refusal**	
Cone Reference:	100992T	**Predrill:**	0.00	**Tip:**	✓
Cone Area Ratio:	0.75	**Water Level:**	-	**Gauge:**	
Cone Type:	I-CFXYP20-10	**Collapse:**	3.60	**Inclinometer:**	
				Other:	
Tip Resistance (MPa) Initial:	-4.9018	**Final:**	-4.7023		
Local Friction (MPa) Initial:	-0.0565	**Final:**	-0.0624		
Pore Pressure (kPa) Initial:	-251.949	**Final:**	-232.375	**Target Depth:**	

PointID: CPTu104

Sounding: 104

Operator:	S. Cardona	**Date:**	25/06/2015	**Effective Refusal**	
Cone Reference:	100992T	**Predrill:**	0.00	**Tip:**	✓
Cone Area Ratio:	0.75	**Water Level:**	0.50	**Gauge:**	
Cone Type:	I-CFXYP20-10	**Collapse:**	2.40	**Inclinometer:**	
				Other:	
Tip Resistance (MPa) Initial:	-4.8535	**Final:**	-4.7471		
Local Friction (MPa) Initial:	-0.0542	**Final:**	-0.0628		
Pore Pressure (kPa) Initial:	-253.544	**Final:**	-219.617	**Target Depth:**	

CPT CALIBRATION AND TECHNICAL NOTES

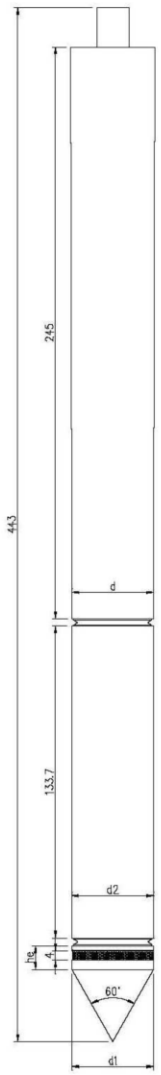
These notes describe the technical specifications and associated calibration references pertaining to the following cone types:

- ELCI-10CFXY measuring cone resistance, sleeve friction and inclination (standard cone);
- ELCI-CFXYP20-10 measuring cone resistance, sleeve friction, inclination and pore pressure (piezocone).

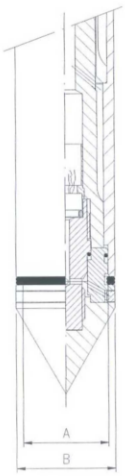
Dimensions

Dimensional specifications for both cone types are detailed below. All tolerances are routinely checked prior to testing and measurements taken are manually recorded on CPT field sheets. All field sheets are kept on file and available on request.

A.P. van den Berg Machinefabriek tel.: +31 (0)513-631355 info@apvandenberg.com	**DEVIATION of Straightness + MINIMUM Dimensions tip, friction jacket, cone adapter**	Standards: EN ISO 22476-1 APB-standard
Type of cone:	Icone 10 cm^2	
ALLOWABLE SIZE VARIATION		
Diameter of tip:	$35,3 \leq d1 \leq 36,0$	
Diameter of centering ring CFP	$35,3 \leq d1 \leq 36,0$	
Diameter of friction jacket:	$d_1 \leq d_2 < d_1 + 0,35$	
Height dimension of tip edge:	$7 \leq h_e \leq 10$	
PRODUCTION DIMENSIONS		
Tip:	$d_1 = 35,7\ ^{+0,2}_{0}$	
Jacket (C-cone):	$d_2 = 35,7\ ^{+0,2}_{0}$	
Friction jacket (CF-cone):	$d_2 = 35,9\ ^{+0,1}_{0}$	
Tip for used cone:	$d_1 = 35,5\ ^{+0,1}_{0}$	
MINIMUM DIMENSIONS		
Minimum diameter jacket (C-cone):	$d_2 = 35,2$ (APB standard)	
Minimum diameter friction jacket (CF-cone):	$d_2 = 35,3$	
Use "used cone"-tip when friction jacket diameter:	$d_2 \leq 35,65$	
Minimum diameter of cone adaptor:	d = 35,3	
Maximum deviation of straightness:	1 mm on a length of 1000 mm (max. oscillation 1,0 mm.)	



Cone surface ratio



A=0,25x3,14x30,9x30,9=750 MM²
B=0,25x3,14x35,7x35,7=1000 MM²

α = A/B β = 1 - A/B

α = 750/1000 = 0,75

β = 1 - 0,75 = 0,25

CPT CALIBRATION AND TECHNICAL NOTES (cont.)

Calibration

Each cone has a unique identification number that is electronically recorded and reported for each CPT test. The identification number enables the operator to compare 'zero-load offsets' to manufacturer calibrated zero-load offsets.

The recommended maximum zero-load offset for each sensor is determined as ± 5% of the nominal measuring range.

In addition to maximum zero-load offsets, McMillan Drilling also limits the difference in zero load offset before and after the test as ± 2% of the maximum measuring range. See table below:

	Tip (MPa)	Friction (MPa)	Pore Pressure (MPa)
Maximum Measuring Range:	150	1.50	3.00
Nominal Measuring Range:	75	1.00	2.00
Max. 'zero-load offset':	7.5	0.10	0.20
Max 'before and after test':	3	0.03	0.06

Note: The zero offsets are electronically recorded and reported for each test in the same units as that of each sensor.

TEST CERTIFICATE
Icone (all versions)

Supplier:	A.P. van den Berg Machinefabriek, Heerenveen The Netherlands
Production-order:	65193
Client:	MC Milan
Cone-type:	I-CFXY-10
Cone-number:	080238

To test / To check item	**Required value**	**Checked value**
Check Quad-ring groove behind friction sleeve with check ring ; Place ring behind friction sleeve without O-rings and Q-rings mounted Place friction sleeve, prepressure ring, centering ring and tighten tip	Sleeve fixed	✓
Isolation-resistance	>0.5 GΩ	✓ GΩ
Straightness total Icone (10 cm2). (Base part Icone: S <= 0,2 mm) **For dimensions 15cm Icones: see standard/table.**	S<= 2,2 mm	✓ mm
All Measurements: Test with both GOnsite! v2.xx and v3.12.		
Check alarm-settings Icone. Alarm values are set. (Kill Shutdown)	O.K.	✓
Software version? Check at opening screen. **NOTE DOWN version nr.:**	Version:	1.08
Calibration date of Icone; check cone data [F1]..[F1]	O.K.	✓
Zero-Value Tip	Good	-4,317 MPa
Zero-Value Local Friction	Good	-0,0428 MPa
Zero-Value Pore Pressure	Good	— kPa
Zero-Value Inclination X Zero-Value Inclination Y	-2°< X <+2° -2° < Y <+2°	-1,4 ° 0,5 °
Measurements Tip resistance OK?	Yes	✓
Influence of Tip on Local Friction? Tip: **Max Load**; Mantle free? 10cm²: **150 kN.** // 15 cm²: **150 kN.**	150 MPa	✓
Measurements Local Friction OK?	Yes	✓
Local Friction: **Max Load**	O.K.	✓
Measurements Pore Pressure OK?	Yes	—
Measure Pore Pressure to **150%**	O.K.	—
Measurements Inclination OK?	Yes	✓
Cone recognition on disconnecting and connecting Icone again?	Yes	✓

Remarks:

Calibrated by:	C.J. Ouwejan	Date: 28.08.14	Sign.:
Final check:	E.v.d. Dam	Date: 29.08.14	Sign.:

Work instructions: H:\Electro\Productie\Icone\beschrijving beproeving Icones.doc.

R:\E&D\Beproevingsprotocollen\Beproevingsprotocol Icone English.doc

TEST CERTIFICATE
Icone (all versions)

Supplier:	A.P. van den Berg Machinefabriek, Heerenveen The Netherlands
Production-order:	65193
Client:	MC. Milan
Cone-type:	I-CFXYP 20-10
Cone-number:	100992

To test / To check item	Required value	Checked value
Check Quad-ring groove behind friction sleeve with check ring ; Place ring behind friction sleeve without O-rings and Q-rings mounted Place friction sleeve, prepressure ring, centering ring and tighten tip	Sleeve fixed	
Isolation-resistance	>0.5 GΩ	GΩ
Straightness total Icone (10 cm2). (Base part Icone: S <= 0,2 mm) **For dimensions 15cm Icones: see standard/table.**	S<= 2,2 mm	mm
All Measurements: Test with both GOnsite! v2.xx and v3.12.		
Check alarm-settings Icone. Alarm values are set. (Kill Shutdown)	O.K.	
Software version? Check at opening screen. **NOTE DOWN version nr.:**	Version:	1.8
Calibration date of Icone; check cone data [F1]..[F1]	O.K.	
Zero-Value Tip	Good	-5,266 MPa
Zero-Value Local Friction	Good	-0,1003 MPa
Zero-Value Pore Pressure	Good	-257 kPa
Zero-Value Inclination X Zero-Value Inclination Y	-2°< X <+2° -2° < Y <+2°	0,0 ° -0,1 °
Measurements Tip resistance OK?	Yes	
Influence of Tip on Local Friction? Tip: **Max Load**; Mantle free? 10cm²: **150 kN.** // 15 cm²: **150 kN.**	150 MPa	
Measurements Local Friction OK?	Yes	
Local Friction: **Max Load**	O.K.	
Measurements Pore Pressure OK?	Yes	
Measure Pore Pressure to **150%**	O.K.	
Measurements Inclination OK?	Yes	
Cone recognition on disconnecting and connecting Icone again?	Yes	
Remarks:		

Calibrated by:	C.J. Ouwejan	Date:	20-08-14	Sign.:
Final check:	Erwin van Dam	Date:	29.08.14	Sign.:

Work instructions: H:\Electro\Productie\Icone\beschrijving beproeving Icones.doc.

McMILLAN Drilling GROUP

Appendix D – (Laboratory Results)

GHD
PO Box 13 468
Christchurch
Auckland

Attention: Mr Darren Woods

Dear Darren

LABORATORY TEST REPORT
Cranford Street, Christchurch

Sampling Procedure

Samples have been tested as received from the customer.

Sample/Test Location Plan

None.

Samples

Four push tube samples were delivered to our laboratory.

Date of Sample Receipt

09 July 2015.

Customer's Instructions

Testing instructions provided by Darren Woods of GHD.

Test Method

NZS 4402:1986 Test 7.1 One-dimensional consolidation.

Test Results

See pages 3 to 6.

Test Remarks

See pages 3 to 6.

Sample Descriptions

See pages 3 to 6.

General Remarks

Samples were destroyed during testing.

Descriptions are enclosed for your information, but are not covered under our scope of IANZ accreditation.

Please reproduce the report in full when transmitting to others or including in internal reports.

If we can be of any further assistance, feel free to call us on phone.

GEOTECHNICS LTD

Report prepared by:

.....
Sim Tirunahari
Soils Laboratory Manager

Authorised for Geotechnics by:

.....
Steven Anderson
PROJECT DIRECTOR
Approved Signatory

Report checked by:

.....
Steven Anderson
Regional Manager
Approved Signatory

27-Jul-15
p:\616674\workingmaterial\20150727.st.cranford st.rep1.docx

GEOTECHNICS
23 Morgan Street, Newmarket
Auckland 1023, New Zealand
p. +64 9 356 3510
w. www.geotechnics.co.nz

File:P:\616674.000\Working Material\BH101_2.50-2.55m_Consol.xlsx

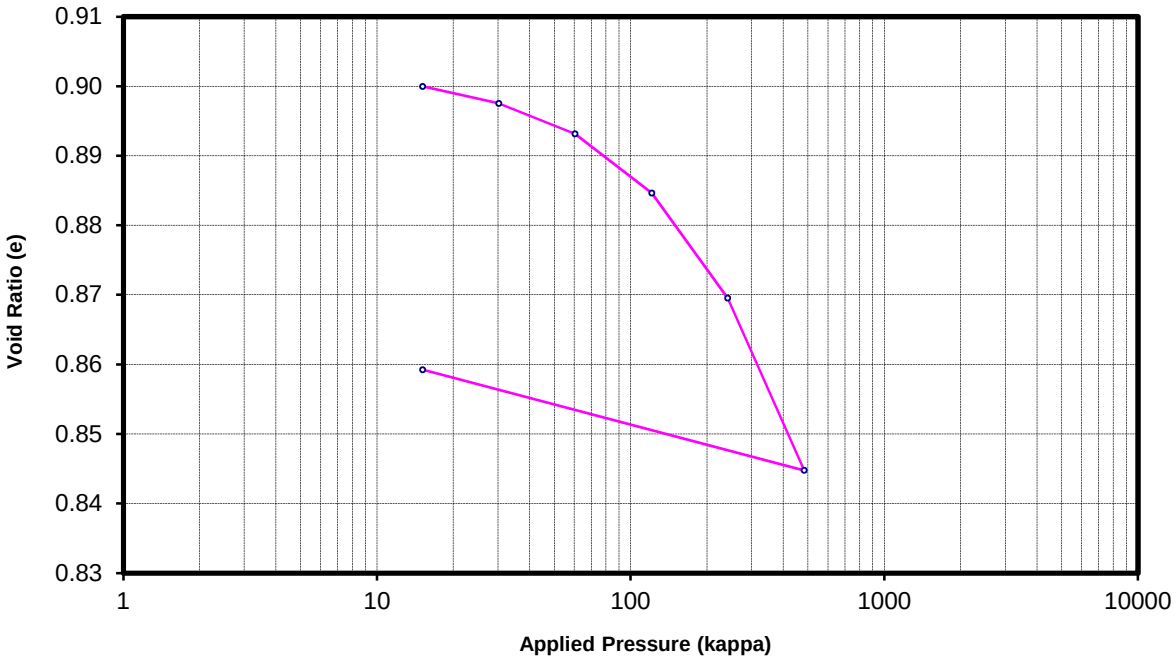
Your Project ID.: **5133038**

Site: **Cranford Street, Christchurch** Our Job No.: **616674.000**

BH No.: **101** Sample No.: **---** Depth: **2.50-2.55 (m)**

Test Method Used: NZS 4402:1986 Test 7.1 One-Dimensional Consolidation

ONE-DIMENSIONAL CONSOLIDATION TEST



Pressure (kPa)		Void Ratio (e)	Pressure Increment (kPa)	Coefficient of Consolidation Cv (m^2/yr)	Coefficient of Volume Compressibility Mv (m^2/MN)
As received	0	0.903			
Preload	15.1	0.900	0 to 15.1	NA	0.090
	30.2	0.898	15.1 to 30.2	38	0.085
	60.3	0.893	30.2 to 60.3	32	0.077
	121	0.885	60.3 to 121	16	0.074
	241	0.870	121 to 241	14	0.067
	483	0.845	241 to 483	12	0.055
Unload	15.1	0.859	483 to 15.1	NA	NA

Sample History: Undisturbed core trimmed at NWC. SQR of time fitting method used.

Description: sandy SILT with trace of clay, firm, light greenish grey.

Initial Dry Density (t/m³): 1.41 Initial Water Content: 32.6%

Solid Density (t/m³): 2.68 (Assumed) Initial Saturation: 97%

Temperature During Testing: Max = 16 ^{0}C Min = 15 ^{0}C

Remarks: The calculations of void ratio are affected by the solid density value. We have assumed a value of 2.68 t/m³.

Sample description is not IANZ accredited.

Entered by: ST Date: 24.07.2015 Checked by: MP Date: 24.07.2015

GEOTECHNICS
23 Morgan Street, Newmarket
Auckland 1023, New Zealand
p. +64 9 356 3510
w. www.geotechnics.co.nz

File:P:\616674.000\Working Material\BH102_3.65-3.70m_Consol.xlsx

Your Project ID.: **5133038**

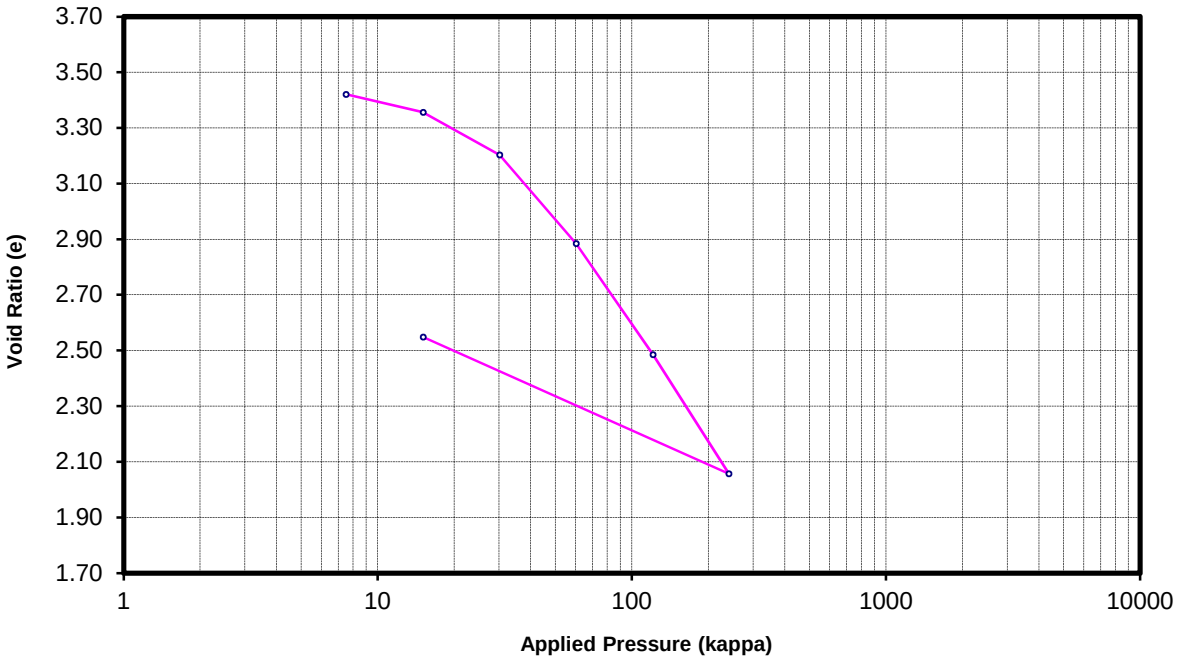
Site: **Cranford Street, Christchurch**

Our Job No.: **616674.000**

BH No.: **102** Sample No.: **---** Depth: **3.65-3.70 (m)**

Test Method Used: NZS 4402:1986 Test 7.1 One-Dimensional Consolidation

ONE-DIMENSIONAL CONSOLIDATION TEST



Pressure (kPa)		Void Ratio (e)	Pressure Increment (kPa)	Coefficient of Consolidation Cv (m^2/yr)	Coefficient of Volume Compressibility Mv (m^2/MN)
As received	0	3.492			
Preload	7.5	3.421	0 to 7.5	NA	2.1
	15.1	3.356	7.5 to 15.1	2.6	1.9
	30.2	3.203	15.1 to 30.2	2.0	2.3
	60.3	2.884	30.2 to 60.3	1.3	2.5
	121	2.485	60.3 to 121	1.0	1.7
	241	2.057	121 to 241	0.74	1.0
Unload	15.1	2.549	241 to 15.1	NA	NA

Sample History: Undisturbed core trimmed at NWC. SQR of time fitting method used.

Description: Organic SILT with trace to minor clay and trace of sand, few rootlets, soft, dark brown-black mixed with light greenish grey.

Initial Dry Density (t/m³): 0.53 Initial Water Content: 141%

Solid Density (t/m³): 2.40 (Assumed) Initial Saturation: 97%

Temperature During Testing: Max = 16 ^{0}C Min = 15 ^{0}C

Remarks: The calculations of void ratio are affected by the solid density value. We have assumed a value of 2.40 t/m³.

Sample description is not IANZ accredited.

Entered by: ST Date: 24.07.2015 Checked by: MP Date: 24.07.2015

GEOTECHNICS
23 Morgan Street, Newmarket
Auckland 1023, New Zealand
p. +64 9 356 3510
w. www.geotechnics.co.nz

File:P:\616674.000\Working Material\BH103_3.05-3.10m_Consol.xlsx

Your Project ID.: **5133038**

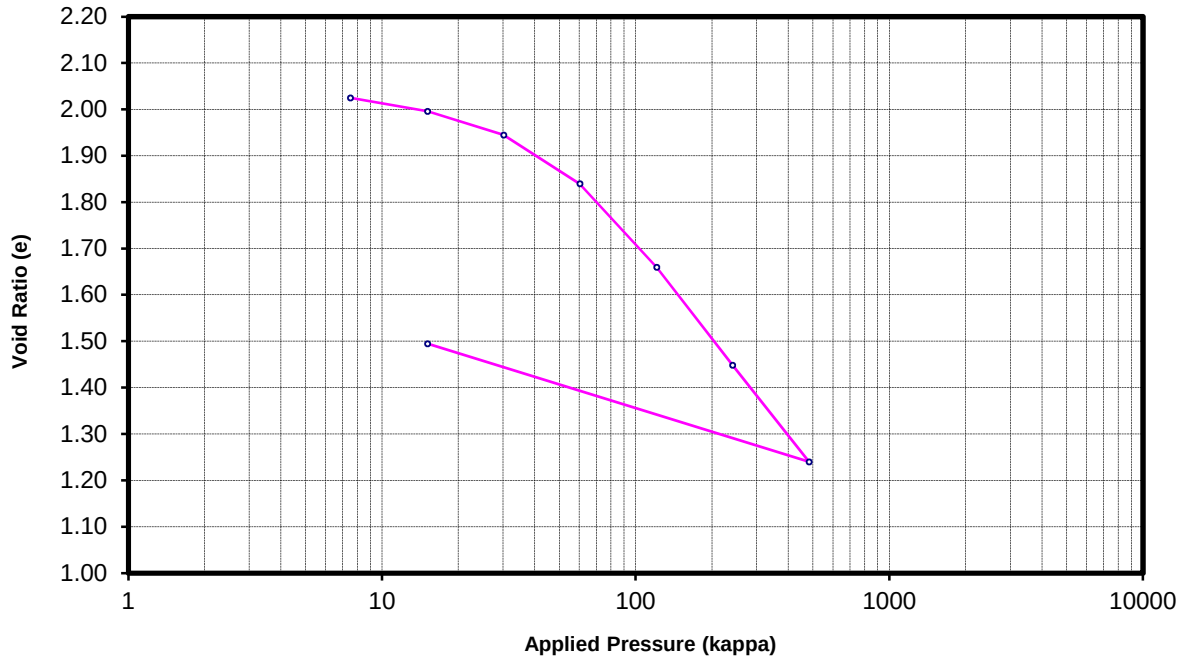
Site: **Cranford Street, Christchurch**

Our Job No.: **616674.000**

BH No.: **103** Sample No.: **---** Depth: **3.05-3.10 (m)**

Test Method Used: NZS 4402:1986 Test 7.1 One-Dimensional Consolidation

ONE-DIMENSIONAL CONSOLIDATION TEST



Pressure (kPa)		Void Ratio (e)	Pressure Increment (kPa)	Coefficient of Consolidation Cv (m^2/yr)	Coefficient of Volume Compressibility Mv (m^2/MN)
As received	0	2.057			
Preload	7.5	2.025	0 to 7.5	NA	1.4
	15.1	1.996	7.5 to 15.1	3.7	1.3
	30.2	1.945	15.1 to 30.2	3.2	1.1
	60.3	1.839	30.2 to 60.3	2.6	1.2
	121	1.660	60.3 to 121	2.2	1.0
	241	1.449	121 to 241	1.9	0.66
	483	1.240	241 to 483	1.8	0.35
Unload	15.1	1.495	483 to 15.1	NA	NA

Sample History: Undisturbed core trimmed at NWC. SQR of time fitting method used.

Description: SILT with minor to some organics and trace to minor clay, trace of sand, few rootlets, soft, dark brown-black mixed with light greenish grey.

Initial Dry Density (t/m^3): 0.82 Initial Water Content: 79.0%

Solid Density (t/m^3): 2.50 (Assumed) Initial Saturation: 96%

Temperature During Testing: Max = 16 ^{0}C Min = 15 ^{0}C

Remarks: The calculations of void ratio are affected by the solid density value. We have assumed a value of 2.50 t/m^3.

Sample description is not IANZ accredited.

Entered by: ST Date: 24.07.2015 Checked by: MP Date: 24.07.2015

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File:P:\616674.000\Working Material\BH104_3.10-3.15m_Consol.xlsx

Your Project ID.: **5133038**

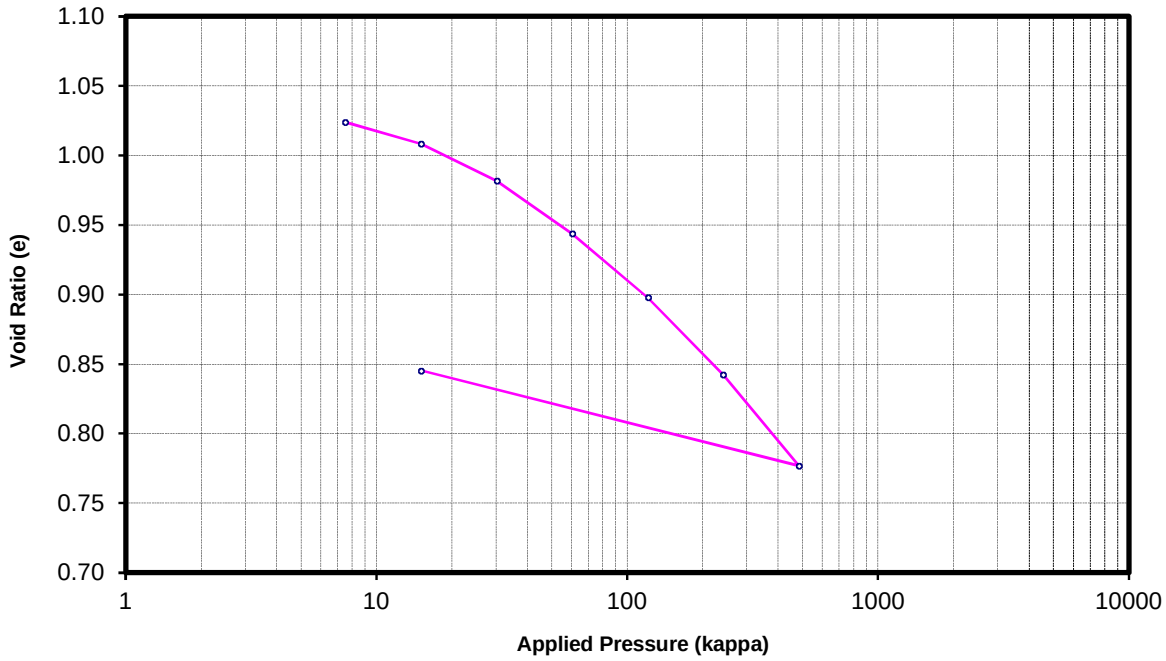
Site: **Cranford Street, Christchurch**

Our Job No.: **616674.000**

BH No.: **104** Sample No.: **---** Depth: **3.10-3.15 (m)**

Test Method Used: NZS 4402:1986 Test 7.1 One-Dimensional Consolidation

ONE-DIMENSIONAL CONSOLIDATION TEST



Pressure (kPa)		Void Ratio (e)	Pressure Increment (kPa)	Coefficient of Consolidation Cv (m^2/yr)	Coefficient of Volume Compressibility Mv (m^2/MN)
As received	0	1.042			
Preload	7.5	1.024	0 to 7.5	NA	1.2
	15.1	1.008	7.5 to 15.1	2.8	1.0
	30.2	0.982	15.1 to 30.2	4.1	0.88
	60.3	0.944	30.2 to 60.3	5.8	0.64
	121	0.898	60.3 to 121	7.9	0.39
	241	0.842	121 to 241	11	0.24
	483	0.777	241 to 483	14	0.15
Unload	15.1	0.845	483 to 15.1	NA	NA

Sample History: Undisturbed core trimmed at NWC. SQR of time fitting method used.

Description: SILT with trace to minor clay and trace of sand, few rootlets, soft, light greenish grey, mottled dark brown.

Initial Dry Density (t/m³): 1.31 Initial Water Content: 37.8%

Solid Density (t/m³): 2.68 (Assumed) Initial Saturation: 97%

Temperature During Testing: Max = 16 ^{0}C Min = 15 ^{0}C

Remarks: The calculations of void ratio are affected by the solid density value. We have assumed a value of 2.68 t/m³.

Sample description is not IANZ accredited.

Entered by: ST Date: 24.07.2015 Checked by: MP Date: 24.07.2015

Appendix E - (Liquefaction Analysis)

Provided as separate appendix document

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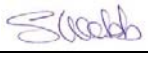
Document Status

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

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