REPORT

Tonkin+Taylor

Proposed Naval Point Development

Geotechnical Desktop Study

Prepared for
Christchurch City Council

Prepared by
Tonkin & Taylor Ltd

Date
July 2020

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Document Control

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July 2020	1	Client issue	S. Forster	M. Jacka	M. Jacka

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Christchurch City Council	1 PDF copy
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1 Introduction

Christchurch City Council (CCC) are considering a proposed development within the Naval Point area at the Port of Lyttelton. As part of the proposed development, we understand the following two proposed buildings are being considered:

- A one or two-storey building for the Naval Point Marine Rescue Trust (NPMRT), refer Site 1 on Figure 1 below.
- A small one-storey pavilion/sports changing room building, located near the southern end of the Lyttelton Recreation Grounds, refer Site 2 on Figure 1 below.

Figure 1: Approximate locations of the two sites considered in this report (map data: Google).

2 Scope of work

We have completed the following scope of work for this project:

- Review our T+T database and the NZ Geotechnical Database (NZGD) for relevant nearby geotechnical information.
- Review our T+T database for information about foundation types used for nearby projects on similar ground and the construction costs and observed performance of these.
- Interpret the nearby geotechnical information to develop a conceptual ground model for each site, and identify geotechnical constraints as relates to the conceptual ground model.
- Provide high-level foundation concept options for both sites, including concepts for both one and two-storey structures for the proposed NPMRT building.
- Provide a high-level qualitative cost comparison for the foundation concepts for the NPMRT building.
- Preparation and issue of this geotechnical desktop report summarising the above.

3 Expected site conditions

3.1 Inferred subsurface soil profile

The Naval Point area is generally understood to have been reclaimed in the 1920's by placing harbour-dredged marine deposits on top of in-situ marine deposits, behind a rock revetment/breakwater. Layers of silt, sand and Banks Peninsula loess are expected to underlie the in-situ marine deposits. Below the silt, sand and loess, bedrock comprising volcanic basalt is expected to dip steeply below Naval Point towards the harbour.

The soil profile beneath Site 1 and 2 is likely to be similar. Although due to the steeply dipping bedrock, potentially thicker deposits of reclamation fill and in-situ marine deposits may underlie Site 2. Based on our knowledge from previous work within the Naval Point area, and using currently available geotechnical information contained on the NZGD and ECan well database (refer Appendices A and B), we have inferred a single representative soil profile beneath both sites which is presented in Table 3.1 below.

Table 3.1: Inferred representative soil profile adopted for assessing concept options

Layer No.	Soil description	Inferred depth from existing ground surface to top of soil layer (mbgl)
1	Gravel veneer	0
2	Reclamation fill – Very soft to soft clayey silt	0 – 1
3	Marine sediment – Very soft to firm clayey silt	7 – 10
4	Pleistocene sediments – Loose sand/silty sand and firm silt layers, becoming dense/stiff with depth	20 – 30
5	Basalt bedrock	30+

NOTE: Should development proceed, site-specific geotechnical investigations will be required to confirm the soil profile and soil parameters for foundation design at each site.

3.2 Groundwater

Ground surface information[1] indicates Site 1 and 2 are located approximately 3 – 3.5 m above mean sea level. Due to the proximity of the sites to the coastline, the median groundwater level has been assumed to be close to or slightly above sea level. Tidal variation in the order of ±1 m about the median could be expected, and water levels may also vary in response to other factors such as seasonal effects and heavy rainfall events.

For the purposes of assessing concept options a median groundwater level of 3 mbgl has been assumed, noting that transient groundwater levels may rise to 2 mbgl.

[1] https://data.linz.govt.nz/layer/53587-canterbury-christchurch-and-selwyn-lidar-1m-dem-2015/

4 Geotechnical considerations

4.1 Seismic considerations

4.1.1 Site subsoil class

Due to the inferred soil profile presented in Table 3.1, both sites are expected to be characterised as either a Class D (deep or soft soil) or Class E (very soft soil) site from NZS 1170.5:2004. Differences between these site subsoil classes can significantly affect the site spectral responses, which subsequently affect both geotechnical and structural design.

Conservative estimates of the subsoil class may be assumed, or testing during site-specific investigations can be undertaken to inform the likely subsoil class at each site.

4.1.2 Liquefaction

We are not aware of observations of significant ground disruption at Naval Point due to liquefaction effects during the 2010/2011 Canterbury Earthquake Sequence, however significant displacement of wharves and reclamation edges was observed elsewhere across the port. Based on the cohesive nature of the soil descriptions within the upper 20 - 30 m of the sites (i.e. clayey silts), these soils are not considered susceptible to liquefaction. Deeper sand/silty sands may be susceptible to liquefaction but due to the depth of those soils, consequential ground surface damage is likely to be negligible if they were to liquefy.

Regardless, in the absence of site-specific investigations it should be assumed that discrete lenses/layers of potentially liquefiable may be present within the reclaimed fill and should be investigated and assessed as part of further development of the sites.

4.1.3 Cyclic softening

Even if liquefaction is not expected or has not been observed at the sites, the loosely placed soft reclamation fill could soften in future large design earthquakes. This could result in ground surface damage and foundation settlement and should be investigated and assessed as part of further development of the sites.

4.1.4 Lateral ground movement

Lateral spread of the ground surface can occur as blocks of land move laterally towards a free edge due to underlying liquefied material. Vertical ground displacement will also occur as the ground moves towards the free edge. More ground movement tends to occur closest to the free edge, and reduces with distance from the free edge.

If liquefaction susceptible soils are identified at the proposed sites then the effects of lateral spreading may extend landward by approximately 100 m from the free edge (i.e. the rock revetment/breakwater). Therefore, if lateral spreading were to occur it would unlikely affect the proposed Sports pavilion, but would affect the proposed NPMRT building (based on our current understanding of the proposed locations in Figure 1).

In the absence of liquefaction, some lateral ground movement may still occur during strong seismic shaking due to displacement and rearrangement of the rocks that form the revetment/breakwater at the edge of the reclaimed land. We are aware that this phenomenon occurred during the 2010/2011 Canterbury Earthquake Sequence in some parts of the port.

The implications of lateral ground movement, and associated vertical ground displacement, can be mitigated by robust foundation detailing and/or ground improvement. It should be noted that mitigating lateral ground movement though foundation detailing would be much easier for a single-storey structure than a two-storey structure, because the two-storey structure would be less tolerant of differential ground movement and therefore more susceptible to toppling/collapse.

4.2 Bearing capacity and settlement

Foundation bearing capacity is dependent on many inputs that are currently unknown for this project such as foundation dimensions and bearing depth, however the bearing capacity of the reclamation fill is expected to be very low. Therefore, as a minimum, some surface treatment such as an engineered gravel raft is recommended to improve foundation bearing capacity if shallow foundations are adopted.

Even if the bearing capacity for shallow foundations is sufficient following construction of a gravel raft, static settlement is still likely to occur due to compression of the soft reclamation fill under future building loads. Static settlement is considered a key geotechnical issue at these sites.

An example of static settlement within the Naval Point area are some of the nearby oil tanks that were founded on stone column ground improvement, which we understand have settled several hundreds of millimetres (in line with design expectations). Although the loads from the oil tanks are expected to be much larger than the proposed structures described in this report, oil tanks are generally more settlement-tolerant and it highlights the compressible nature of the soils underlying Naval Point.

5 Conceptual foundation options

5.1 General

The Ministry of Building, Innovation and Employment (MBIE) published a guidance document[2] following the 2010/2011 Canterbury Earthquakes which includes some design principles for rebuilding residential houses. Although the MBIE Guidance Document applies to residential houses and focuses primarily on addressing liquefaction induced damage, the overarching design principles of deformation tolerance and ease of repairability are considered useful for this site to address potential ground settlement. In summary, these principles are:

- Use lightweight materials, particularly for roof and wall cladding to reduce loads on foundations.
- Use stiffened and tied together foundations to improve resistance to ground deformation.
- Adopt regular building footprint shapes (e.g. rectangular) rather than complex plan shapes.
- Consider a suspended floor to facilitate simple relevelling repairs, if required.
- Avoid using mixed foundation systems across a single structure, to mitigate differential foundation performance.
- Adopt flexible service connections at the building boundary to allow for some movement and ease of repair.

5.2 Proposed sports pavilion

We understand the proposed sports pavilion will be a relatively small single-storey structure located at the south side of the Lyttelton Recreation Grounds (refer Figure 1 - Site 2). Based on currently available information we expect shallow foundations constructed on a geogrid-reinforced gravel raft would likely be a suitable option to consider for this structure. The gravel raft would typically extend 1.5 - 2 m below the underside of the foundations, and extend 1.5 - 2 m beyond the building

[2] Ministry of Business, Innovation and Employment (December 2012) *Repairing and rebuilding houses affected by the Canterbury earthquakes*, Third edition.

footprint. We also recommend the design principles outlined in Section 5.1 are adopted, particularly the use of lightweight construction materials to reduce the loads on the foundations and detailing of service connections.

We note that the proposed location of the sports pavilion is near a row of large trees. If the trees are to be removed and the pavilion is constructed over this area, then additional foundation settlement can occur if significant organic material (such as tree stumps and large roots) is not removed, because this material can decay over time.

5.3 Proposed NPMRT building

5.3.1 Conceptual foundation options

Because the project is only conceptual at this stage, details of the proposed NPMRT building are not available. However, we understand consideration is being given to either a one or two-storey structure. By their nature, two-storey structures are heavier than one-storey structures for the same building footprint size and a heavier structure will settle more than lighter one. Also, any differential settlement/tilt across the first floor will be visually magnified on higher floors, therefore a two-storey option will require more robust ground support than a one-storey structure.

A number of ground support options are considered potentially feasible for this site, including:

- Geogrid reinforced gravel raft (likely suitable for one-storey structure only)
- Preloading with wick drains
- Stone columns
- Deep piles

Comments and additional recommendations for each option are presented in Table 5.1 below.

Table 5.1: Summary of potentially feasible ground support options

Ground support option	Comments and recommendations
Geogrid reinforced raft	• Similar option to the proposed sports pavilion described in Section 5.2. • Likely only suitable for a one-storey structure. • We recommend the design principles outlined in Section 5.1 are adopted, particularly the use of lightweight construction materials to reduce the loads on the foundations and adopting stiff, tied together shallow foundations on top of the gravel raft.
Preloading with wick drains	• This method involves temporarily loading the ground with soil (usually gravel) embankments to consolidate the ground prior to constructing buildings. • A large volume of imported fill would be required, even more so for a two-storey structure. • Pre-loading can take a long time for the soils to consolidate, but providing drainage by installing wick-drains can speed up this process. • After the preload has been removed, robust shallow foundations could be constructed on a shallow gravel raft to support a one or two-storey building, although we recommend the design principles outlined in Section 5.1 are adopted.
Stone columns	• This method involves inserting a vibratory probe into the ground, gravel is fed through the probe as it is extracted forming a stone column within the ground. • Stone columns are typically installed in a grid pattern across a building footprint, and extending approximately 3 – 5 m beyond the footprint. • Stone columns have been used successfully beneath some oil tanks within the broader Naval Point area to improve bearing capacity and manage foundation settlement. • Following installation of stone columns, robust shallow foundations could be constructed on a shallow gravel raft to support a one or two-storey building.
Deep piles	• Driven steel piles extending to depths greater than approximately 25 m to stiff soils or bedrock may be adopted for this site. • The piles could support a reinforced concrete slab for one or two-storey buildings. • The rock revetment/breakwater at the seaward edge of the reclaimed land is expected to extend at a downward angle beneath the reclamation fill. The rock revetment/breakwater is not considered a suitable pile founding layer, and this should be considered during investigation and design if the proposed building is to be located close to the coastline.

5.3.2 Qualitative cost comparison of foundation concepts

We have completed a high-level qualitative relative cost comparison of the foundation concepts described in the previous section, considering one and two-storey buildings and based on previous experience with similar work (refer Table 5.2). The intention is to provide an indication of relative costs for the four options presented, suitable to inform optioneering discussions. This qualitative assessment could be further refined if desired, by selecting specific foundation options and building footprint and weight details for further consideration.

If detailed cost estimates are required, then we recommend that advice is sought from a specialist quantity surveyor with contractor input.

Table 5.2: Summary of high-level cost comparison

Ground support/foundation option	One-storey building	Two-storey building
Geogrid reinforced raft – with robust shallow foundations	$	Unlikely to be suitable
Preloading with wick drains – with robust shallow foundations on a shallow gravel raft	$$	$$$
Stone columns – with robust shallow foundations on a shallow gravel raft	$$$$	$$$$ to $$$$$
Deep piles – with reinforced concrete slab	$$$$	$$$$ to $$$$$

6 Further work

If the development progresses for either site described in this report, then site-specific geotechnical investigations and testing will need to be completed to develop the preferred concept to a design stage.

The potential for contaminated land and implications on development at both sites has not been addressed in this report. T+T can provide this additional service if required by the project.

7 Applicability

This report has been prepared for the exclusive use of our client Christchurch City Council, with respect to the particular brief given to us and it may not be relied upon in other contexts or for any other purpose, or by any person other than our client, without our prior written agreement.

The recommendations and opinions in this report are based on limited geotechnical investigation data located near the proposed development sites. The nature and continuity of subsurface conditions away from the investigation locations is inferred, and it must be appreciated that the actual conditions may vary from the assumed model.

Tonkin & Taylor Ltd

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Appendix A: NZGD investigations

Deep geotechnical investigations located near the proposed development sites (BH_13845 circled in red is attached).

SOURCE: NZGD

AECOM

LOG OF DRILLHOLE

HOLE IDENTIFICATION BH01

Client: Fishing Support Limited
Project: 13 Mariners Way PGAR
Project number: 60263482

Co-ordinates: 637727mE 5170094mN
Orientation: -90° Elevation: 8m (Approx)
Location: 13 Mariners Way
Feature: Western side of site

GEOLOGICAL DESCRIPTION	Test Records (Shear Vane residual - peak 0 - 200 kPa; N Values 0 - 50)	Drilling Method	Depth	MATERIAL DESCRIPTION
FILL		HQ3	0	Medium GRAVEL with some coarse sand; orange to orange grey. Moist; sub-rounded to sub-angular; slightly weathered greywacke and volcanics.
	ss 2,2,1,1,1,2 N=5	SPT	1	Very clayey SILT; brown grey. Soft; moist; high plasticity.
		HQ3		
FILL grading to MARINE DEPOSITS - boundary is not clear	ss 0,0,0,0,0,1 N=1	SPT	2	Silty fine SAND; orange grey. Very loose to loose; moist. Orange mottled bands, <8mm thick.
				Clayey SILT; black grey. Very soft to soft; moist; high plasticity. 2.2m: Increasing organic content; dark grey. 2.7 to 3m: Sandy SILT. Sand is fine.
		HQ3		
	ss 0,0,0,0,0,1 N=1	SPT	3	
		HQ3		
	ss 0,0,0,0,0,0 N=0 SUOW	SPT	4	
		HQ3		
	ss 0,0,0,0,0,0 N=0 SUOW	SPT	5	
		HQ3	6	
	ss 0,0,0,0,0,0 N=0 SUOW	SPT		
		HQ3	7	
	sc 0,0,0,0,0,0 N=0 SUOW	SPT	8	
		HQ3	9	
	ss 0,0,0,0,0,0 N=0 SUOW	SPT		

Core Loss/Lift: 0 - 100%
Instrumentation: 1

GROUNDWATER OBSERVATIONS

Depth	Piezometer	Reading	Date
1.9m		1	15/05/2012

Date logged: 16/05/2012
Logged: JWW
Checked: MPN

Casing Details
Depth Diameter

Remarks
1. Coordinates in NZMG are approximate. Elevations are approximate.
2. Driller recorded water level at beginning of dat.

Hand held Shear Vane

vane shear strength per NZGS guideline

Driller: McNeill Drilling
Started: 15/05/2012
Drill Rig: UDR600
Finished: 16/05/2012
Core Boxes: 9

Date Printed: 1/06/2012

AECOM

LOG OF DRILLHOLE

HOLE IDENTIFICATION BH01

Client	Fishing Support Limited
Project	13 Mariners Way PGAR
Project number	60263482

Co-ordinates 637727mE 5170094mN
Orientation -90° Elevation 8m (Approx)
Location 13 Mariners Way
Feature Western side of site

GEOLOGICAL DESCRIPTION	Test Records (Shear Vane residual - peak 0 - 200 kPa; N Values 0 - 50)	Drilling Method (Casing remarks)	Core Loss/Lift (0 - 100%)	Depth	Graphic Log	MATERIAL DESCRIPTION (Subordinate MAJOR minor; colour; structure. Strength; moisture condition; grading; bedding; plasticity; sensitivity; major fraction description; subordinate fraction description; minor fraction description etc)	Instrumentation
FILL grading to MARINE DEPOSITS - boundary is not clear		HQ3				Clayey SILT; black grey. Very soft to soft; moist; high plasticity.	
						10.7 to 10.8m: Shell fragments, <50mm in size.	
	ss 1,0,1,0,1,0 N=2	SPT		11			
		HQ3		12		11.55 to 11.65m: Shell fragments, <10mm in size.	
						12.2 to 21.4m: Shell fragments, typically <20mm in size, some up to 60mm in size.	
	ss 0,0,0,0,0,0 N=0 SUOW	SPT					
		HQ3		13			
	ss 0,0,0,0,0,0 N=0 SUOW	SPT		14			
		HQ3		15			
	ss 0,0,0,0,0,1 N=1	SPT					
		HQ3		16			
	ss 1,0,1,0,1,0 N=2	SPT		17			
		HQ3		18			
	ss 0,0,0,0,0,0 N=0 SUOW	SPT					
				19		19m: Volcanic clast; red brown. Moderately weathered; sub rounded.	

GROUNDWATER OBSERVATIONS
Depth Piezometer Reading Date

Date logged 16/05/2012
Logged JWW
Checked MPN

Casing Details
Depth Diameter

Remarks
1. Coordinates in NZMG are approximate. Elevations are approximate.
2. Driller recorded water level at beginning of dat.

Hand held Shear Vane

vane shear strength per NZGS guideline

Driller: McNeill Drilling
Started: 15/05/2012
Drill Rig: UDR600
Finished: 16/05/2012
Core Boxes: 9

DRILLHOLE LOG SOIL 13 MARINERS WAY.GPJ BASE.GDT 01/06/12

Date Printed: 1/06/2012

AECOM

LOG OF DRILLHOLE

HOLE IDENTIFICATION: BH01

Client	Fishing Support Limited
Project	13 Mariners Way PGAR
Project number	60263482

Co-ordinates	637727mE		5170094mN
Orientation	-90°	Elevation	8m (Approx)
Location	13 Mariners Way		
Feature	Western side of site		

GEOLOGICAL DESCRIPTION	Test Records (Shear Vane residual - peak 0 - 200 kPa; N Values 0 - 50)	Drilling Method (Casing remarks)	Depth	MATERIAL DESCRIPTION (Subordinate MAJOR minor; colour; structure. Strength; moisture condition; grading; bedding; plasticity; sensitivity; major fraction description; subordinate fraction description; minor fraction description etc)
		HQ3	21	12.2 to 21.4m: Shell fragments, typically <20mm in size, some up to 60mm in size.
MARINE DEPOSITS - Sand and shell fragments	ss 1,1,3,1,2,3 N=9	SPT	22	Shelly medium SAND; black grey. Loose; moist. Shell fragments are coarse sand to fine gravel sized.
		HQ3		
	ss 2,1,2,2,6,6 N=16	SPT	23	23m: Becoming medium dense.
COLLUVIUM - Loess and volcanic materials		HQ3	24	Clayey SILT with some gravel; yellow brown. Soft; moist. Gravel is sub-angular; slightly weathered; basalt and rhyolite.
	ss 6,7,8,8,9,8 N=33	SPT	25	25m: Becoming dense.
			26–29	BH01 terminated at 25m Target Depth

Core Loss/Lift: 0 - 100%. Graphic Log. Instrumentation.

GROUNDWATER OBSERVATIONS
Depth Piezometer Reading Date

Date logged	16/05/2012
Logged	JWW
Checked	MPN

Casing Details
Depth Diameter

Remarks
1. Coordinates in NZMG are approximate. Elevations are approximate.
2. Driller recorded water level at beginning of dat.

Hand held Shear Vane

vane shear strength per NZGS guideline

Driller: McNeill Drilling	Started: 15/05/2012
Drill Rig: UDR600	Finished: 16/05/2012
Core Boxes	9

DRILLHOLE LOG SOIL 13 MARINERS WAY.GPJ BASE.GDT 01/06/12

Date Printed: 1/06/2012

Appendix B: ECan well logs

Well locations near the proposed development sites (wells are circled in red and attached). Image source: Canterbury Map

Borelog for well BX24/1298

Grid Reference (NZTM): 1576331 mE, 5171223 mN
Location Accuracy: 50 - 300m
Ground Level Altitude: m +MSD Accuracy:
Driller: McMillan Drilling Ltd
Drill Method: Machine Dug
Borelog Depth: 3.3 m Drill Date: 20-Oct-2015

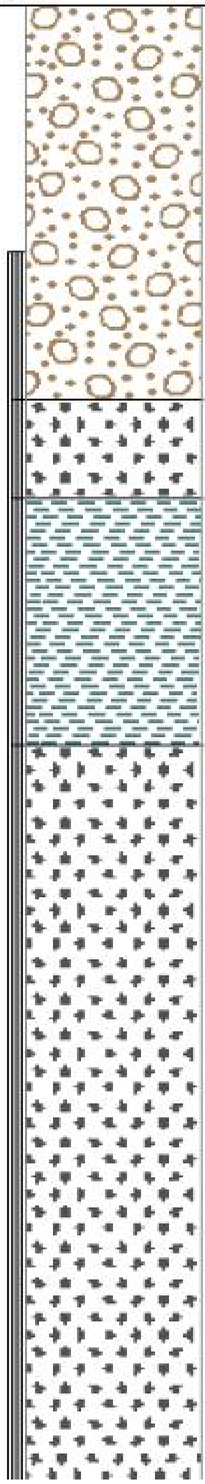
Environment Canterbury Regional Council
Kaunihera Taiao ki Waitaha

Scale(m)	Water Level	Depth(m)	Full Drillers Description	Formation Code
		0.70m	Brown sandy GRAVEL (2 - 60 MM). Not Recorded.	
1				
2		2.60m	Light brown silty SAND (0.06 - 2 MM). Not Recorded.	
3		3.30m	Brown SILT. Not Recorded.	

Borelog for well BX24/1299

Grid Reference (NZTM): 1576505 mE, 5171302 mN
Location Accuracy: 50 - 300m
Ground Level Altitude: m +MSD Accuracy:
Driller: McMillan Drilling Ltd
Drill Method: Machine Dug
Borelog Depth: 3.0 m Drill Date: 20-Oct-2015

Environment Canterbury Regional Council
Kaunihera Taiao ki Waitaha



Scale(m)	Water Level	Depth(m)	Full Drillers Description	Formation Code
			Brown sandy GRAVEL (2 - 60 MM). Not Recorded.	
		0.80m	Dark grey SAND (0.06 - 2 MM). Not Recorded.	
1		1.00m	Dark grey SILT. Not Recorded.	
		1.50m	Dark grey SAND (0.06 - 2 MM). Not Recorded.	
2				
		3.00m		

Borelog for well BX24/1300

Grid Reference (NZTM): 1576549 mE, 5171394 mN
Location Accuracy: 50 - 300m
Ground Level Altitude: m +MSD Accuracy:
Driller: McMillan Drilling Ltd
Drill Method: Machine Dug
Borelog Depth: 3.0 m Drill Date: 20-Oct-2015

Environment Canterbury Regional Council
Kaunihera Taiao ki Waitaha

Scale(m)	Water Level	Depth(m)	Full Drillers Description	Formation Code
			Light brown SILT. Not Recorded.	
1				
		1.90m	Dark grey CLAY. Not Recorded.	
2				
		2.80m	Dark grey SAND (0.06 - 2 MM). Not Recorded.	
		3.00m		

Borelog for well BX24/1301

Grid Reference (NZTM): 1576422 mE, 5171384 mN
Location Accuracy: 50 - 300m
Ground Level Altitude: m +MSD Accuracy:
Driller: McMillan Drilling Ltd
Drill Method: Machine Dug
Borelog Depth: 3.0 m Drill Date: 20-Oct-2015

Environment Canterbury Regional Council
Kaunihera Taiao ki Waitaha

Scale(m)	Water Level	Depth(m)	Full Drillers Description	Formation Code
		1.60m	Light brown SILT. Unsaturated (dry or moist).	
1				
2		3.00m	Grey silty CLAY. Unsaturated (dry or moist).	

Borelog for well BX24/1303

Grid Reference (NZTM): 1576331 mE, 5171298 mN
Location Accuracy: 50 - 300m
Ground Level Altitude: m +MSD Accuracy:
Driller: McMillan Drilling Ltd
Drill Method: Machine Dug
Borelog Depth: 3.3 m Drill Date: 20-Oct-2015

Environment Canterbury Regional Council
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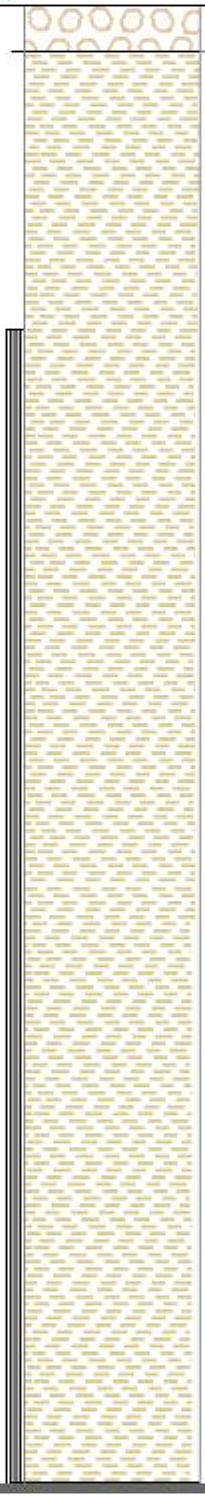
Scale(m)	Water Level	Depth(m)	Full Drillers Description	Formation Code
		0.20m	Light brown GRAVEL (2 - 60 MM). Unsaturated (dry or moist).	
1		1.60m	Dark grey SILT. Unsaturated (dry or moist).	
2, 3		3.30m	Grey CLAY. Unsaturated (dry or moist).	

Borelog for well BX24/1304

Grid Reference (NZTM): 1576236 mE, 5171370 mN
Location Accuracy: 50 - 300m
Ground Level Altitude: m +MSD Accuracy:
Driller: McMillan Drilling Ltd
Drill Method: Machine Dug
Borelog Depth: 3.2 m Drill Date: 20-Oct-2015

Environment Canterbury Regional Council
Kaunihera Taiao ki Waitaha



Scale(m)	Water Level	Depth(m)	Full Drillers Description	Formation Code
		0.10m	Light brown GRAVEL (2 - 60 MM). Unsaturated (dry or moist).	
1			Yellowish brown SILT. Unsaturated (dry or moist).	
2				
3		3.20m		

Borelog for well BX24/1305

Grid Reference (NZTM): 1576287 mE, 5171403 mN
Location Accuracy: 50 - 300m
Ground Level Altitude: m +MSD Accuracy:
Driller: McMillan Drilling Ltd
Drill Method: Machine Dug
Borelog Depth: 3.1 m   Drill Date: 22-Oct-2015

Environment Canterbury Regional Council
Kaunihera Taiao ki Waitaha

Scale(m)	Water Level	Depth(m)	Full Drillers Description	Formation Code
			Brown GRAVEL (2 - 60 MM). Unsaturated (dry or moist).	
1		1.20m	Dark grey GRAVEL (2 - 60 MM). Unsaturated (dry or moist).	
		1.30m	Grey SILT. Unsaturated (dry or moist).	
2				
3		3.10m		

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