



Prestons Subdivision
GEOTECHNICAL REPORT FOR LOT 4000
CDL Land NZ Limited

26 August 2021
Revision: 1
Reference: 235361

*Bringing ideas
to life*

Document control record

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Report title		GEOTECHNICAL REPORT FOR LOT 4000				
Document ID		Project number		235361		
File path		P:\235361\069 Stage 2 Building Consent\Geotech\Building Consent Reports\Development Lots\Lot 4000\235361 Building Consent Report Lot 4000.docx				
Client		CDL Land NZ Limited				
Client contact		Jason Adams		Client reference		
Rev	Date	Revision details/status	Author	Reviewer	Verifier (if required)	Approver
0	20 October 2014	Draft for Review	J Muirson	J Muirson	J Kupec	T Browne
1	26 August 2021	Final for Issue	C Scott	J Muirson		J Kupec
Current revision		1				

Approval			
Author signature		Approver signature	
			
Name		Name	
Chris Scott		Dr Jan Kupec	
Title		Title	
Geotechnical Engineer		Technical Director	

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1 Executive Summary

CDL Land NZ Ltd has commissioned Aurecon New Zealand Ltd to undertake site specific geotechnical investigations and assessments for individual residential lots for building consent purposes for the Prestons South Subdivision Stage 2. This report documents the results of the geotechnical assessment and presents geotechnical comments together with foundation recommendations for the residential house on Lot 4000 at the Prestons South Subdivision.

As part of the subdivision development extensive geotechnical testing, including cone penetration tests (CPTs), were carried out to define the liquefaction potential at the overall subdivision and to monitor the site works that have occurred. **Based on our information the property is likely to perform to a level equivalent to Technical Category 1 (TC1 - Grey) set by the Ministry of Business, Innovation and Employment (MBIE) in their guidelines issued in December 2012.**

The site development has included extensive bulk earthworks. All earthworks and compliance testing have been undertaken in accordance with the earthworks specification. The engineering sign off and bulk earthworks are documented in the Geotechnical Completion Report. The earthfill at the subdivision construction stage was placed and signed off in accordance with NZS4431:1989. Based on review of the available geotechnical information, including bulk earthworks information and NZS4431 compliance records, we consider that a determination in accordance with NZS3604:2011 Section 3.1.3 is appropriate and the property meets the requirements for NZS3604 type foundations.

The geotechnical site specific assessment comprised a review of previous geotechnical investigations undertaken for the subdivision development and a site specific geotechnical investigation. Two hand auger boreholes were undertaken to assess the upper soil profile and groundwater level. Four dynamic cone penetrometers (DCPs) were carried out on the lot, two of the DCPs were located immediately adjacent to the hand auger boreholes with the other DCPs being located on the opposite side of the lot.

Based on our knowledge of the site setting and our past work we recommend that any residential structure that is to be developed on Lot 4000 be founded on standard NZS3604:2011 compliant foundations. These foundations require a minimum geotechnical ultimate bearing capacity of at least 300kPa, which for Lot 4000 is achieved at a minimum depth of 0.5m below ground level as this represents the current thickness of the topsoil and loose soil.

This report shall be read as a whole. Our limitations are presented in Section 7.

2 Introduction

CDL Land NZ Ltd is currently undertaking a large residential subdivision with associated commercial lots. Previously Aurecon New Zealand Ltd has undertaken detailed geotechnical investigations and assessments for the purpose of the plan change, subdivision resource consent application, liquefaction assessment, technical classification of the entire subdivision, and observation of bulk earthworks construction.

Aurecon New Zealand Ltd has since been commissioned to undertake site specific geotechnical investigations and assessment of individual lots for building consent application purposes. The site which this report is focused on comprises a single lot, designated Lot 4000 at the Prestons South Subdivision to the south of Prestons Road in Marshland, Christchurch. This report documents the results of the geotechnical assessment and presents geotechnical comments together with foundation recommendations for the proposed house on the lot. We note that at the time of writing this report the location and structural form of the dwelling were unknown, and it is inferred to comprise NZS3604:2011 type residential buildings only.

This report shall be read as a whole. Our limitations are presented in Section 7.

3 Site Conditions

3.1 Site Description

The Prestons Subdivision is located on the northern fringes of Christchurch City. The site is made up of a series of adjacent properties forming an irregular and elongated rectangle shape, orientated approximately north to south. The total area of the overall Prestons Subdivision site is approximately 190ha. The site can be separated into two distinct blocks, Prestons North which runs from the Lower Styx Road in the north through to Prestons Road in the south and the Prestons South development which continues from Prestons Road through to Mairehau Road to the south.

This building consent report is for Lot 4000 which is located in Stage 2 of the Prestons South Subdivision development (refer Figure 1 in Appendix A). The lot is bordered by residential lots to the north and south, an access road to the east and an open storm water channel to the west.

3.2 Surface Water

There are no natural sources of surface water on the subdivision. There is a storm water channel to the west of Lot 4000.

3.3 Regional Geology

The geology of the site is described in the 1:250,000 scale geological map – ‘*Geology of the Christchurch Area*’, published in 2008 by the Institute of Geological and Nuclear Sciences. Note this map has been referenced as it is at an appropriate scale and covers the entire site. The map indicates the underlying geology comprises ‘*Dominantly sand of fixed and semi-fixed dunes and beach deposits*’ and ‘*drained peat swamp*’. The subdivision geotechnical investigation identified that this area was predominantly underlain by aeolian (dune) and beach sand deposits.

The GNS Active Fault System database (GNS, 2012a) indicates that the site is located approximately:

- 27km north east of the eastern end of the Greendale Fault System. Movement on the Greendale Fault System was responsible for the Magnitude 7.1 Darfield (Canterbury) Earthquake on 4 September 2010.
- 14km north of the epicentre of the Magnitude 6.2 Christchurch Earthquake on 22 February 2011.
- 12km north west of the Magnitude 6.0 earthquake on 13 June 2011 (GNS, 2012b).
- 8km north west of the Magnitude 5.9 earthquake on 23 December 2012.

3.4 Site Earthworks

Site earthworks have been undertaken to prepare the site for residential building purposes. The subsurface profile was stripped and the site was built up with compacted engineered fill. During bulk earthworks shallow organic material, where encountered, was removed as part of the bulk earthworks.

All earthworks and compliance testing have been undertaken in accordance with the earthworks specification. Details of the site bulk earthworks are provided in the Aurecon report titled ‘*Prestons Park Subdivision – Stage U1 Geotechnical Completion Report*’ Rev 0, dated 9 October 2018. The Geotechnical Completion Report has been completed as part of the requirements of NZS4404:2010 ‘*Land development and subdivision infrastructure*’ and Christchurch City Council ‘*Infrastructure Design Standards - Part 4: Geotechnical Requirements*’. The compacted fill was placed and signed off in accordance with NZS4431:1989 ‘*Code of practice for earth fill for residential development*’.

3.5 Technical Classification

The landcheck maps historically provided on The Canterbury Earthquake Recovery Authority (CERA) website indicated the site is classified as rural and unmapped. The technical categories were developed by the Ministry for Business, Innovation and Employment (MBIE) with the support from the Engineering Advisory Group (EAG) in mid-2011 and hence prior to the start of the subdivision development. The site has since been modified by civil engineering and bulk earthworks.

As part of the subdivision consent geotechnical assessment, site specific liquefaction assessment was carried out over the wider subdivision area. This is detailed in the Aurecon reports titled '*Prestons Road Subdivision, Geotechnical Assessment Report for Resource Consent*', Revision 2 dated 5 March 2012, '*Prestons Road Subdivision, Detailed Geotechnical Design Report*', Revision 2 dated 12 July 2012 and '*Prestons South Subdivision Resource Consent Geotechnical Report*', Revision 1 dated 6 June 2013.

Based on the results from our liquefaction assessment and bulk earthworks undertaken on the wider subdivision, Lot 4000 is likely to perform to a level equivalent to Technical Category 1 (TC1 - Grey) in the MBIE Guidelines issued in December 2012.

4 Geotechnical Assessment

4.1 General

The geotechnical assessment comprised a review of relevant previous geotechnical investigations and construction data and an in-situ geotechnical investigation. The geotechnical investigation comprised hand held testing on the individual lot and a review of the previous geotechnical investigations undertaken for the subdivision within the vicinity of the lot. Two hand auger boreholes were undertaken to assess the upper soil profile and groundwater level. Four dynamic cone penetrometers (DCPs) were carried out on the lot. The hand held testing was undertaken on the lot following the site earthworks. The testing density is considered reasonable as the geotechnical project engineers were involved in the observation of the civil engineering works.

4.2 Previous Investigations

The previous geotechnical testing and investigations undertaken by Aurecon across the entire subdivision site comprised of a combination of cone penetrometer tests (CPT) and machine excavated test pits. Further details regarding these investigation locations are found in the Aurecon reports titled '*Prestons Road Subdivision, Geotechnical Assessment Report for Resource Consent*', Revision 2 dated 5 March 2012, '*Prestons Road Subdivision, Detailed Geotechnical Design Report*', Revision 2 dated 12 July 2012 and '*Prestons South Subdivision Resource Consent Geotechnical Report*', Revision 1 dated 6 June 2013. In addition, testing carried out as part of the subdivision development is presented in the Aurecon Geotechnical Completion Report.

4.3 Hand Held Testing

Two hand auger boreholes were undertaken on the lot as part of the geotechnical investigation to assess the upper soil profile and the groundwater level. The test location and the borehole log have been uploaded to the New Zealand Geotechnical Database (NZGD). The borehole log is attached in Appendix B. The hand held testing was undertaken at an earlier date, however it is still considered suitable for the purposes of building consent as no further earthworks or site modifications have been undertaken.

The hand auger borehole logs indicate the upper soil profile consists of topsoil underlain by sand to the termination depth. The hand auger boreholes were terminated when soil samples became saturated and the holes started to collapse.

The logging of the recovered hand auger samples was undertaken in accordance with the New Zealand Geotechnical Society's "*Guideline for the Field Classification and Description of Soil and Rock for Engineering Purposes: 2005*".

4.4 Dynamic Cone Penetrometers

Four DCPs were carried out with the locations and results uploaded to the NZGD. The DCP test results are attached in Appendix B. Two of the DCPs were located adjacent to the hand auger boreholes, with the other DCPs being located on the opposite half of the lot. The DCPs were undertaken at an earlier date, however they are still considered suitable for the purposes of building consent as no further earthworks or site modifications have been undertaken.

DCP logs indicate 5 blows per 100mm penetration, which is equivalent to an ultimate bearing capacity of 300kPa, was consistently encountered from a shallow depth.

4.5 Groundwater Levels

Groundwater levels were measured within the hand auger borehole at the time of the investigation and correlated to our site specific knowledge. An indicative groundwater level was noted where holes collapsed due to saturated soil. Groundwater was encountered at approximately 1.8m to 1.9m depth below ground level. It should be noted that groundwater levels may vary seasonally.

A review of the NZGD indicates that regional groundwater levels are likely to be in the order of 1m to 2m below ground level. These groundwater levels are reasonably consistent with those measured during the investigation, when taking into account the subdivision earthworks filling and cutting.

4.6 Topsoil Depth

The depth of topsoil has been determined from the single hand auger and two DCPs undertaken on site. We note that the topsoil depths may vary by +/- 100mm between the testing locations and hence it is recommended that at least a 100mm tolerance should be allowed for building foundation excavations.

If greater certainty of topsoil depths across the whole site is required for construction costing then further testing would be necessary across the footprint of the proposed structure (unknown at the time of writing this report). **The responsibility and liability for any additional testing shall be met by the section purchaser.**

5 Foundation Recommendations

The site is expected to perform in line with TC1 requirements in future earthquakes. Due to the residential land use of the development, the presence of certified fill and the TC1 technical classification, future residential development will be able to adopt standard NZS3604 compliant foundations.

5.1 Foundation Types

It is recommended that residential structures that are built on Lot 4000 are founded on standard NZS3604:2011 compliant foundations. These foundations require a minimum geotechnical ultimate bearing capacity of at least 300kPa. The site investigation results indicate that approximately 300mm to 400mm of topsoil was present, which will need to be removed and the clean subgrade exposed for foundation construction.

Based on our understanding of the site works and the investigation results, we recommend that NZS3604:2011 compliant foundations are embedded a minimum depth of 0.5m below current ground level.

5.2 Foundation Construction Recommendations

Construction should proceed in accordance with the NZS3604:2011. Topsoil should be removed from beneath the floor slab and compacted hardfill placed under the floor slab to the required level. In addition, the following recommendations should be considered:

1. To ensure that excavated footings are adequately founded we recommend that excavations should be undertaken by a digger fitted with a smooth edge bucket. The base should be tidily trimmed by hand, lightly compacted with a plate compactor and immediately covered with a concrete tidy slab or 100mm of compacted granular hardfill. A suitable qualified engineer with foundation experience or territorial authority building inspector should be retained to verify the adequate founding has been achieved and all loose and soft or compressible material was removed.
2. If there are significant soft layers beneath a sub-excavation, the softer material will have to be excavated and backfilled with 10MPa concrete or compacted hardfill underneath all load bearing foundation elements. For the hardfill, the sub-excavation will have to have plan dimensions of $B+2D$ where B is the footing width and D is the depth of undercut. For 10MPa concrete the sub-excavation can have the same dimensions as the footing.
3. Depending on the soil encountered, the time of year, and fluctuations of the groundwater level, it is possible that excavations may encounter groundwater. The building contractor is to take appropriate measures to deal with any groundwater ingress to the foundation excavations and keep the excavations and backfill free of groundwater intrusions until the footings are cast.
4. The footing excavations are likely to expose layers of granular soils, which can be adversely affected by rainfall or stormwater. Foundation excavations should not be left open for more than three days. In addition, rainfall and stormwater should not be allowed to pond within the footing excavations as this may affect the bearing capacity of the subsoils.

6 References

Forsyth, Barrell & Jongers, (compilers), 2008. *Geology of the Christchurch Area*. Institute of Geological and Nuclear Sciences, 1:250,000 Geological Map 16.

New Zealand Geotechnical Database (2016). Retrieved 1 May 2017 from <https://www.nzgd.org.nz>

Christchurch City Council, 2010. *Infrastructure Design Standards - Part 4: Geotechnical Requirements*.

Geonet, 2012. <ftp://ftp.geonet.org.nz/strong/processed/Proc> (23/10/12)

GNS, 2012a. <http://maps.gns.cri.nz/website/af/viewer.htm> (23/10/12)

GNS, 2012b. <http://www.gns.cri.nz/Home/News-and-Events/Media-Releases/earthquake-part-of-aftershock-sequence> (23/10/12)

Ministry of Business Innovation and Employment (MBIE), 2012 '*Repairing and rebuilding houses affected by the Canterbury earthquakes*'.

NZGS, 2005. *Guidelines for the Classification and Field Description of Soils and Rocks in Engineering*. NZ Geotechnical Society Inc, Wellington, New Zealand.

NZS 3604:2011. *Timber Framed Buildings*. Standards New Zealand, Wellington, New Zealand.

NZS 4404:2010 *Land development and subdivision infrastructure*. Standards New Zealand, Wellington, New Zealand.

NZS 4431:1989 *Code of practice for earth fill for residential development*. Standards New Zealand, Wellington, New Zealand.

7 Explanatory Statement

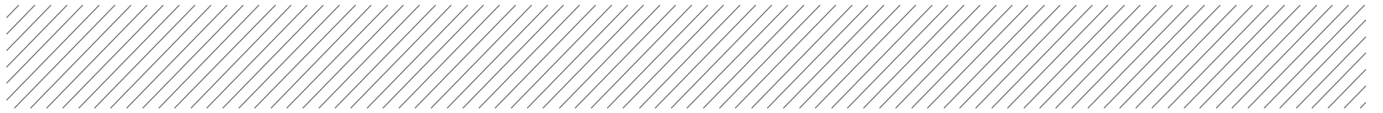
We have prepared this report in accordance with the brief as provided. The contents of the report are for the sole use of the Client for the purpose of building consent application only, and no responsibility or liability will be accepted to any other third party. Data or opinions contained within the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

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

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

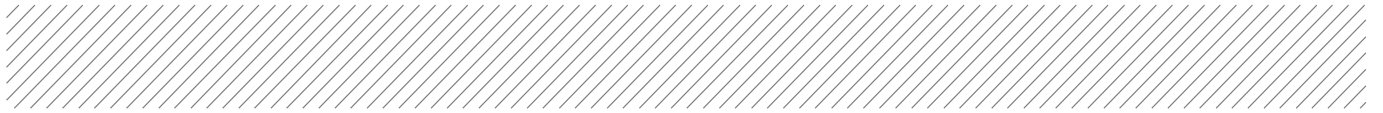
Subsurface conditions, such as groundwater levels, can change over time. This should be borne in mind, particularly if the report is used after a protracted delay.

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Appendix A

Figures



Appendix B

Test Results

HAND AUGER RECORD

HOLE NO. **Lot 4000 - HA1**

PROJECT NO. **235361**

PROJECT **Prestons Park Subdivision
Stage 2**

CLIENT **CDL Land NZ Ltd**

CO-ORDINATES (NZTM)

SHEET **1** of **1**

METHOD **HA**

E 1573378

DATE from **18/09/2018** to **18/09/2018**

N 5185704



MACHINE & NO. **NA**















ORIENTATION **VERTICAL**

GROUND-LEVEL **+13.27** m RL

STRATA DESCRIPTION

SUBORDINATE FRACTION, MAJOR FRACTION, MINOR FRACTION, COLOUR,
STRUCTURE, STRENGTH, MOISTURE CONDITION
GRADING, BEDDING, PLASTICITY, ETC...
(NZ GEOTECHNICAL SOCIETY - FIELD DESCRIPTION OF SOIL AND ROCK)

Water level	Tests	Samples Type Ref Depth	Reduced Level	Depth (m)	Legend	STRATA DESCRIPTION
		0.00		0.00		SILT with some sand; dark brown. Moist; sand, fine. (TOPSOIL)
			+12.97	0.30		Fine to coarse SAND; brownish grey. Moist.
						1.50m Becomes wet.
						1.80m Becomes saturated.
			+11.07	2.20		End of Hand Auger at 2.20m, on 18/09/2018 <i>Termination Reason: Hole collapsing.</i>

-  Small Disturbed Sample
-  Large Disturbed Sample
-  SPT Liner Sample
-  Thin Wall Undisturbed Sample
-  U100 Undisturbed Sample
-  Pocket Penetrometer Test
-  Piston Sample
-  Water Level
-  Impression Packer Test
-  Standard Penetration Test
-  Permeability Test
-  Piezometer / Standpipe Tip
-  Packer Test
-  In-situ Vane Shear Test

LOGGED C. WILSON

DATE 18/09/2018

CHECKED J. MARTIN

DATE 04/10/2018



REMARKS















Groundwater encountered at 1.8m bgl.

Co-ordinates and elevation from site survey.

Elevation based on Lyttelton Vertical Datum.

PROJECT	Prestons Park Subdivision Stage 2		
CLIENT	CDL Land NZ Ltd	CO-ORDINATES (NZTM)	SHEET 1 of 1
METHOD	HA	E 1573363 N 5185715	DATE from 18/09/2018 to 18/09/2018
MACHINE & NO.	NA	ORIENTATION VERTICAL	GROUND-LEVEL +13.33 m RL

Water level	Tests	Samples Type Ref Depth	Reduced Level	Depth (m)	Legend	STRATA DESCRIPTION
						SUBORDINATE FRACTION, MAJOR FRACTION, MINOR FRACTION, COLOUR, STRUCTURE, STRENGTH, MOISTURE CONDITION, GRADING, BEDDING, PLASTICITY, ETC... (NZ GEOTECHNICAL SOCIETY - FIELD DESCRIPTION OF SOIL AND ROCK)
		0.00		0.00		SILT with some sand; dark brown. Moist; sand, fine. (TOPSOIL)
			+12.93	0.40		Fine to coarse SAND; brownish grey. Moist.
						1.60m Becomes wet.
						1.90m Becomes saturated.
			+11.03	2.30		End of Hand Auger at 2.30m, on 18/09/2018 <i>Termination Reason: Hole collapsing.</i>

<ul style="list-style-type: none">  Small Disturbed Sample  Large Disturbed Sample  SPT Liner Sample  Thin Wall Undisturbed Sample  U100 Undisturbed Sample  Pocket Penetrometer Test  Piston Sample 	<ul style="list-style-type: none">  Water Level  Impression Packer Test  Standard Penetration Test  Permeability Test  Piezometer / Standpipe Tip  Packer Test  In-situ Vane Shear Test 	LOGGED <u>C. WILSON</u> DATE <u>18/09/2018</u> CHECKED <u>J. MARTIN</u> DATE <u>04/10/2018</u>	REMARKS Groundwater encountered at 1.9m bgl. Co-ordinates and elevation from site survey. Elevation based on Lyttelton Vertical Datum.
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PROJECT **Prestons Park Subdivision
Stage 2**

PROJECT NO. **235361**

CO-ORDINATES (NZTM)
**E 1573378
N 5185704**

GROUND LEVEL **+13.27 m RL**

TESTED / SUPERVISED BY **C. WILSON**

DATE **18/09/2018**

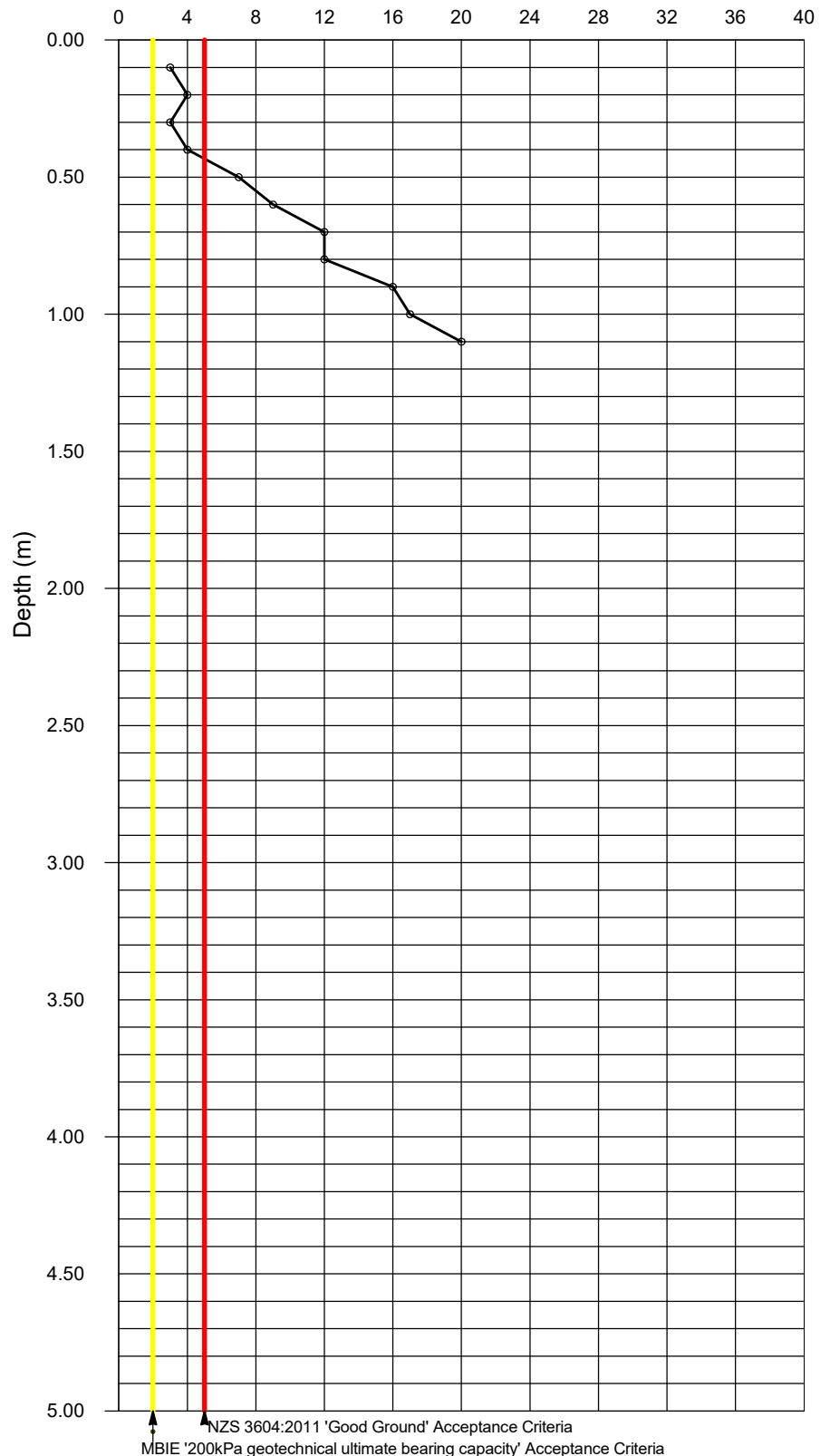
CHECKED BY **J. MARTIN**

DATE **04/10/2018**

Results

Depth (m)	Blows per 100 mm	Depth (m)	Blows per 100 mm
0.0	3	3.5	
0.1	4		
0.2	3		
0.3	4		
0.4	7	4.0	
0.5	9		
0.6	12		
0.7	12		
0.8	16		
0.9	17	4.5	
1.0	20		
1.1			
1.2			
1.3			
1.4		5.0	
1.5			
1.6			
1.7			
1.8			
1.9			
2.0			
2.1			
2.2			
2.3			
2.4			
2.5			
2.6			
2.7			
2.8			
2.9			
3.0			
3.1			
3.2			
3.3			
3.4			
3.5			

Number of blows per 100mm



PROJECT **Prestons Park Subdivision
Stage 2**

PROJECT NO. **235361**

CO-ORDINATES (NZTM)
**E 1573363
N 5185715**

GROUND LEVEL **+13.33 m RL**

TESTED / SUPERVISED BY **C. WILSON**

DATE **18/09/2018**

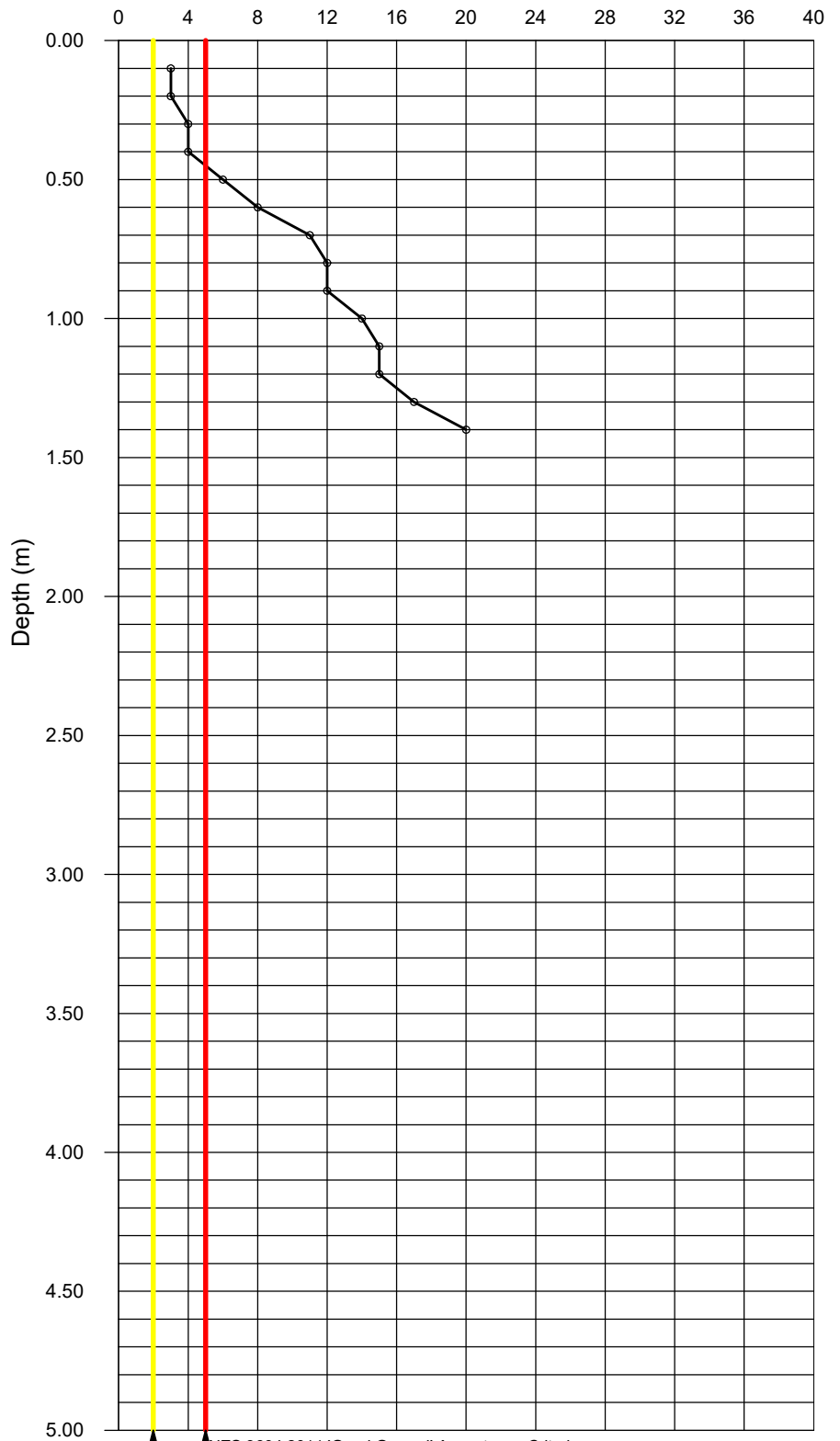
CHECKED BY **J. MARTIN**

DATE **04/10/2018**

Results

Depth (m)	Blows per 100 mm	Depth (m)	Blows per 100 mm
0.0	3	3.5	
0.1	3		
0.2	4		
0.3	4		
0.4	6		
0.5	8		
0.6	11		
0.7	12		
0.8	12		
0.9	14		
1.0	15		
1.1	15		
1.2	17		
1.3	20		
1.4			
1.5			
2.0			
2.5			
3.0			
3.5			

Number of blows per 100mm



Remarks:

20 blows for 100mm in the last increment.
Co-ordinates and elevation data from site survey.
Elevation based on Lyttelton Vertical Datum.
Effective refusal, 20+ blows per 100mm penetration.

NZS 3604:2011 'Good Ground' Acceptance Criteria
MBIE '200kPa geotechnical ultimate bearing capacity' Acceptance Criteria

PROJECT **Prestons Park Subdivision
Stage 2**

PROJECT NO. **235361**

CO-ORDINATES (NZTM)
**E 1573363
N 5185706**

GROUND LEVEL **+13.34 m RL**

TESTED / SUPERVISED BY **C. WILSON**

DATE **18/09/2018**

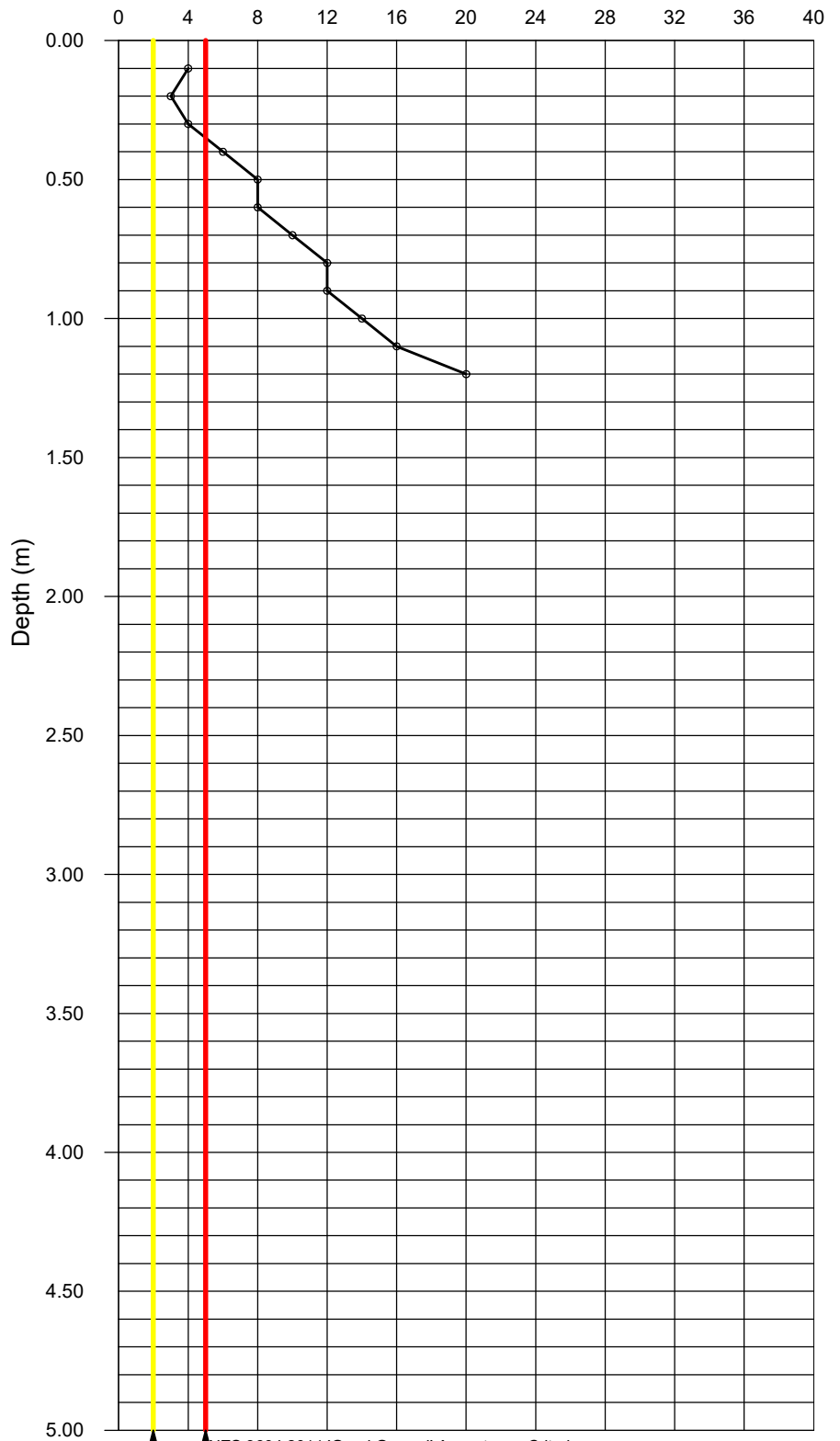
CHECKED BY **J. MARTIN**

DATE **04/10/2018**

Results

Depth (m)	Blows per 100 mm	Depth (m)	Blows per 100 mm
0.0	4	3.5	
0.1	3		
0.2	4		
0.3	6		
0.4	8		
0.5	8	4.0	
0.6	10		
0.7	12		
0.8	12		
0.9	14	4.5	
1.0	16		
1.1	20		
1.2		5.0	
1.3			
1.4			
1.5			
1.6			
1.7			
1.8			
1.9			
2.0			
2.1			
2.2			
2.3			
2.4			
2.5			
2.6			
2.7			
2.8			
2.9			
3.0			
3.1			
3.2			
3.3			
3.4			
3.5			

Number of blows per 100mm



Remarks:

20 blows for 100mm in the last increment.
Co-ordinates and elevation data from site survey.
Elevation based on Lyttelton Vertical Datum.
Effective refusal, 20+ blows per 100mm penetration.

NZS 3604:2011 'Good Ground' Acceptance Criteria
MBIE '200kPa geotechnical ultimate bearing capacity' Acceptance Criteria

PROJECT **Prestons Park Subdivision
Stage 2**

PROJECT NO. **235361**

CO-ORDINATES (NZTM)
**E 1573376
N 5185715**

GROUND LEVEL **+13.25 m RL**

TESTED / SUPERVISED BY **C. WILSON**

DATE **18/09/2018**

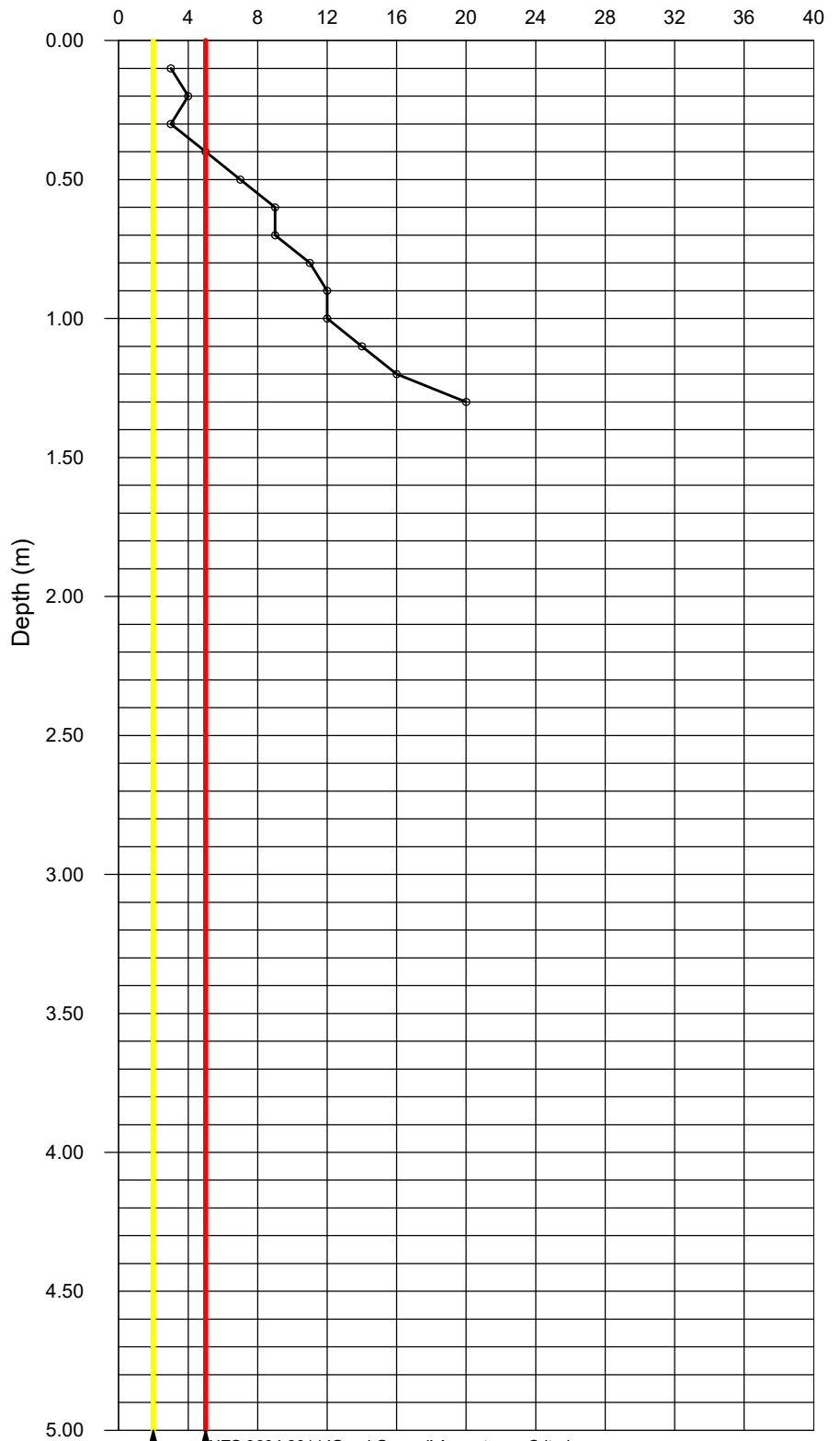
CHECKED BY **J. MARTIN**

DATE **04/10/2018**

Results

Depth (m)	Blows per 100 mm	Depth (m)	Blows per 100 mm
0.0	3	3.5	
0.1	4		
0.2	3		
0.3	5		
0.4	7		
0.5	9	4.0	
0.6	9		
0.7	11		
0.8	12		
0.9	12	4.5	
1.0	14		
1.1	16		
1.2	20		
1.3			
1.4			
1.5		5.0	
1.6			
1.7			
1.8			
1.9			
2.0			
2.1			
2.2			
2.3			
2.4			
2.5			
2.6			
2.7			
2.8			
2.9			
3.0			
3.1			
3.2			
3.3			
3.4			
3.5			

Number of blows per 100mm



Remarks:

20 blows for 100mm in the last increment.
Co-ordinates and elevation data from site survey.
Elevation based on Lyttelton Vertical Datum.
Effective refusal, 20+ blows per 100mm penetration.

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*Bringing ideas
to life*

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