43 to 47 Allens Road, Allenton, Ashburton

Geotechnical Design Report

Prepared for Kāinga Ora
Prepared by Beca Limited

18 April 2023

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Contents

Appendices

Revision History

Revision Nº	Prepared By	Description	Date
01	Kiri Moonen David Dobson	For Building and Subdivision Consent.	18/04/2023

Document Acceptance

Action	Name	Signed	Date
Prepared by	Kiri Moonen David Dobson		18/04/2023
Reviewed by	Sam Glue		18/04/2023
Approved by	Paul Horrey		18/04/2023
on behalf of	Beca Limited		

Executive Summary

Ground Investigations Conducted	
Cone Penetrometer Tests (CPTs)	3
Hand Augers	6
Ground Conditions	
The soil profile consists of silty gravels in the upper 2m. This is expected to extend beyond 30m depth based on nearby investigations.	
Site Classification	
NZS1170.5 Site Subsoil class	Soil class D
Liquefaction Hazard	
The MBIE residential Foundation Technical Category at this site is:	TC1
Predicted maximum SLS free field settlements	0 mm
Predicted maximum ULS free field settlements	<5 mm
Lateral Movement Hazard	
Distance to the nearest free face/ watercourse	700 m
Height of the free face	1.5 – 2.0 m
Risk of lateral movement-induced ground damage	Low
Design Depths	
Measured depth to groundwater at time of investigation	Not encountered
Average depth to groundwater Canterbury Maps	4.1 – 5.0 m bgl
Topsoil thickness	0.3 m / 108.35 m RL
Max depth to achieve 200 kPa ultimate bearing capacity	0.3 m bgl / 108.35 m RL
Foundation Solution	
Controlling factor for foundation solution	Depth to good ground.
Recommended foundation type	TC1 stiffened waffle slab on 200 mm thick gravel raft, designed for 200kPa geotechnical ultimate bearing capacity.
Long term static settlement (50 years, excl. liquefaction settlement)	Negligible
Modulus of subgrade reaction for foundation	8 MPa
Driveway CBR	16 %
Soakage pit feasibility	Not feasible

Preliminary Foundation Depths (m RL)

House Typology / Position	Existing ground Level (m RL)	FFL (m RL*) (top of stiffened waffle slab)	Waffle slab thickness (mm)	Base of waffle slab (m RL*)	Base of gravel pad / excavation level (m RL*)	Thickness of gravel pad (mm)
House 1	108.56	108.85	400	108.45	108.25	200
Houses 2&3	108.68	108.96	400	108.56	108.36	200
Houses 4&5	108.67	108.95	400	108.55	108.35	200
Houses 6&7	108.73	109.06	400	108.66	108.46	200
Houses 8&9	108.78	109.13	400	108.73	108.53	200

*Based on preliminary slab finished floor level (m RL, LVD) as stated. If this changes during detailed design, the finished ground level and base of raft will need to be updated on final construction drawings.

1 Introduction

Kāinga Ora is redeveloping the site at 43 to 47 Allens Road in Allenton, Ashburton. Beca Limited (Beca) has been commissioned to undertake a geotechnical investigation and provide analysis and recommendations to support the development of the site. This report outlines the findings from the geotechnical investigations, desktop assessment, geotechnical design, and recommendations.

2 Site Description

The house development site is located in Allenton at 43 to 47 Allens Road in the north of Ashburton. The site is being uplifted from three houses to nine houses on a plot covering an area of 2170 m^2 and has predominantly flat topography. The site is 0.7 km from the nearest waterway Wakanui Creek to the northeast. The site location and basic details of the proposed development are presented in Figure 2-1.

Figure 2-1:Site Location Plan.

3 Geology

The published geology map (Cox and Barrell, 2007) shows the site to be underlain by Late Pleistocene (Q2a) aged river gravel, sand and silt forming a modern floodplain or low-level terrace.

The Mt Hutt-Mt Peel fault zone (also called the Canterbury Range Front Faults and Geraldine-Mt Hutt Fault System) is the nearest mapped active fault system located approximately 32 km northwest of the site. Active faults within this fault zone include the Peel Forest Fault and the Montalto Fault (GNS, 2020). A study of this fault system by Pettinga et al. (2001) indicates that the average earthquake recurrence interval on this fault system is approximately every 5,000 to 10,000 years. This fault system has the potential to produce earthquakes up to magnitude 7.3 Mw (Pettinga et al., 2001). No other active faults are known to exist within a 30 km radius from the site.

The Canterbury Plains typically have a shallow unconfined aquifer with a water table at less than 20 m deep below the ground surface. Deeper confined aquifers are generally found at 30 to 80 m and 130 to 160 m depth (Cox and Barrell, 2007).

The geological map of the site area is presented in Figure 3-1.

Figure 3-1: Geology at the site (GNS Science, 2022).

4 Desktop Information

A geotechnical desktop assessment was undertaken to understand the published information of the site. The following resources were reviewed:

- New Zealand Geotechnical Database (NZGD)
- Beca Reports Database
- Canterbury Maps
- Ashburton District Planning Maps
- Historical Black Maps detailing surface vegetation prior to development (source Canterbury Maps)
- Retrolens – historical aerial photographs

4.1 Desktop Review Summary

The findings of the assessment are as follows:

- There is existing geotechnical data within 100 m of the site. This information showed the site is likely underlain by interbedded loose to dense sand and soft to very stiff silt underlain by dense gravels from depths of approximately 0.8 m to 5.3 m bgl. This indicates that there is a risk of liquefaction in the area.
- There are no nearby previous project velocity developments in Ashburton.
- The desktop information indicates that the depth to ground water is approximately 4.1 to 5.0 m bgl. This is based on the local wells, sourced from the Environment Canterbury Well Database (2022). This could vary depending on seasonal fluctuations.
- The site is approximately 700 m from the nearest waterway, the Wakanui Creek to northeast with a free face height of approximately 1.5 to 2 m.
- Early geomorphic maps of the city ('Black Maps') show the site as grass and tussock land.
- A review of historic aerial imagery shows that the land was used a driveway for an old manor prior to being developed between 1940 and 1955.
- The site is not in a tsunami evacuation zone.
- The site is not in a flood management zone.
- The site subsoil class is likely to be classified as class D according to AS/NZS1170.5:2002.
- The site is classified as having very low liquefaction potential (Yetton & McCahon, 2002).
- MBIE Residential Foundation Technical Category (TC) system is not applicable for the Ashburton area, however it can be used to compare the equivalent risk and it is expected the liquefaction risk at this site would result in an equivalent TC1 or TC2.

Figure 4-1: Ground Investigation data within 600m of the site (New Zealand Geotechnical Database (NZGD), 2023).

5 Geotechnical Investigation

The geotechnical investigation commenced on 5 April 2023 and was completed on the same day. The investigation locations have been surveyed post construction in terms of New Zealand Transverse Mercator Projection (NZTM2000). Elevations have been surveyed in Lyttleton Vertical Datum 1937 (LVD1937). Locations are presented on a site plan in Appendix A. The site investigations were observed and logged full time by a Beca Engineering Geologist, and the logs have been verified by a Beca Senior Geotechnical Engineer.

5.1 Standards and Calibration

The investigation was undertaken in general accordance with the New Zealand Ground Investigation Specification (2017), and a list of standards used during the site investigation is shown in Table 5-1.

Table 5-1: Summary of Standards used in this Investigation

Field Procedure	Standard Used
Soil and Rock Logging	In general accordance with New Zealand Geotechnical Society Guidelines (NZGS, 2005).
Scala (Dynamic Cone) Penetrometer Testing	NZS 4402.6.5.2 (1988)
Cone Penetration Testing	ASTM D5778-20 (1)

Notes:

(1) Standard widely adopted by contractors in NZ with the requirement of a maximum of half the allowable zero drift limit

Up to date calibration certificates for the testing equipment used in the investigations are attached in Appendix B.

5.2 Hand Auger Hole

Hand augers were drilled and logged on site by Beca staff. The hand auger logs and photographs are shown in Appendix C. Hand auger test locations can be referred to within Appendix A and are summarised in Table 5-2.

In-situ testing comprised scala penetrometer testing undertaken between the ground surface and to 900 mm below the base of the hole, undertaken at 50 mm centres. The hole was augered between tests, with a maximum of one rod length per test.

Table 5-2: Hand Auger Summary

Hand Auger ID	Location	Easting	Northing	Ground Level (m RL)	Total Depth (m bgl)
AR112275-GE-HA-001	Front, 43 Allens Road	1498867.5	5139884.5	108.55	0.55
AR112275-GE-HA-002	Back, 43 Allens Road	1498843.6	5139899.6	108.69	0.40
AR112275-GE-HA-003	Front, 45 Allens Road	1498877.5	5139886.7	108.69	0.55
AR112275-GE-HA-004	Back, 45 Allens Road	1498859.5	5139903.0	108.72	0.45
AR112275-GE-HA-005	Front, 47 Allens Road	1498889.5	5139905.9	108.61	0.35
AR112275-GE-HA-006	Back, 47 Allens Road	1498875.3	5139921.7	108.74	0.25

Notes:

RL (Relative Level) (CDD)

Survey coordinates are given in NZTM2000

m bgl (metres below ground level)

5.3 Scala (Dynamic Cone) Penetrometer Testing

Scala penetrometer tests were carried out at the ground surface at six locations. Tests were carried out in general accordance with the methods described in NZS 4402 Test 6.5.2. Scala test locations are summarised in Table 5-3 and are presented in Appendix D.

Table 5-3: Scala Summary

Scala ID	Location	Easting	Northing	Ground Level (m RL)	Total Depth (m bgl)
AR112275-GE-DCP-001	Front, 43 Allens Road	1498866.9	5139876.4	108.60	0.65
AR112275-GE-DCP-002	Back, 43 Allens Road	1498855.6	5139898.4	108.70	0.40
AR112275-GE-DCP-003	Front, 45 Allens Road	1498881.9	5139894.2	108.68	1.00
AR112275-GE-DCP-004	Back, 45 Allens Road	1498858.3	5139918.1	108.72	0.55
AR112275-GE-DCP-005	Front, 47 Allens Road	1498885.3	5139900.8	108.55	0.40
AR112275-GE-DCP-006	Back, 47 Allens Road	1498864.8	5139921.6	108.80	0.50

Notes:
RL (Relative Level) (CDD)
Survey coordinates are given in NZTM2000
m bgl (metres below ground level)

5.4 Cone Penetration Testing (CPT)

Static CPTs were conducted by Geotechnics Ltd using a Ingenjörsfirman Geotech AB 220 CPT fitted with a 46 mm to measure cone resistance, sleeve friction and water pressure. CPT test locations are summarised in Table 5-4 and are presented in Appendix A.

Test records for cone resistance, sleeve friction and friction ratio, zero drift and pore pressure are included in Appendix E.

Table 5-4: CPT Summary

CPT ID	Location	Easting	Northing	Ground Level (m RL)	Total Depth (m bgl)	Type of Test
AR112275-GE-CPT-001	Front, 43 Allens Road, north	1498866.6	5139881.8	108.56	2.02	Static
AR112275-GE-CPT-002	Back, 45 Allens Road, middle	1498860.1	5139906.4	108.71	0.50	Static
AR112275-GE-CPT-003	Front, 47 Allens Road, east	1498891.1	5139904.3	108.64	0.96	Static

Notes:
RL (Relative Level) (CDD)
Survey coordinates are given in NZTM2000
m bgl (metres below ground level)

5.5 Groundwater

Groundwater was not recorded in any in-situ testing at the time of the investigation.

6 Geotechnical Parameters

6.1 Generalised Soil Profile

The site investigations revealed a soil profile consisting of silty gravels in the upper 2 m. This is expected to extend beyond 30m. A generalised soil profile was generated from the ground investigations conducted in April 2023 and is summarised within Table 6-1.

Table 6-1: Generalised Soil Profile

Soil Unit	Description	Depth to Top of Layer (m bgl)	Layer Thickness (m)	Average Cone Resistance q_c (MPa)
1a	Firm, SILT, some organics *[Topsoil]*	0.0	0.2 – 0.3	-
2a	Firm, SILT, some to trace sand, trace clay/gravel *[Springston formation]*	0.2 – 0.3	0.1 – 0.3	2
2b	Firm, gravelly SILT, some sand *[Springston formation]**	0.4	0.7	20
2c	Dense, SAND/GRAVEL *[Springston formation]*	2.0	undefined	25

Notes:
m bgl (metres below ground level)
*Only encountered in ST-002 and the CPTs

Groundwater well bore logs, K37/0775 and K37/3129 (New Zealand Government, 2023) 500 to 600 m from site, indicates that gravel extends to at least 30 m depth. Borehole data from BH_133290 (New Zealand Geotechnical Database (NZGD), 2023), approximately 100 m from site, show sandy gravel extending to the base of the borehole, 1.4 m bgl, which is similar to what we found on site.

In contrast, borehole data from BH_133299 (New Zealand Geotechnical Database (NZGD), 2023), approximately 60 m from site, shows silts extending to 4.5 m depth. This was not encountered in our in investigations and is not representative of our ground profile.

6.2 Design Soil Parameters

The soil strength parameters adopted for the geotechnical assessment and design are set out in Table 6-2. Listed soil units correspond with those described in Table 6-1.

Table 6-2: Soil Strength Parameters

Soil Unit	Description	Unit Weight (kN/m^3)	Friction Angle, Φ (degree)	Effective Cohesion, c' (kPa)	Young's Modulus (MPa)
2a	Firm, SILT, some to trace sand, trace clay/gravel *[Springston formation]*	16	27	1	8
2b	Firm, gravelly SILT, some sand *[Springston formation]*	19	33	1	30
2d	Dense, SAND/GRAVEL *[Springston formation]*	22	35	0	50

7 Seismic Design Requirements

7.1 Design Life and Importance Level

The proposed structure is being designed as Importance Level of 2 (IL2) structure with a design life of 50 years, in accordance with AS/NZS 1170.0:2002 and as agreed upon with Kāinga Ora.

7.2 Site Subsoil Class

The site subsoil class in accordance with NZS 1170.5:2004 depends on the depth of the underlying soils or rock with each site being classified as either Site Class A, B, C, D or E. Class A refers to sites founded directly on very strong rock material, while Site Class B refers to slightly less competent rock. Class E refers to sites with more than 10 m of soils with SPT N values of less than 6 (i.e., soft soils). These classes are not applicable to the site as shown by the investigative data.

Class C refers to shallow soil sites, with a limit concerning the maximum depth of soils depending on the geology and density. The maximum depth of a Class C site, considering unit 4 (dense sand) is 55 m.

The geological map of the Christchurch Area (Forsyth, Barrell , & Jongens, 2008) indicates that alluvial materials are likely to continue to depth beyond 100 m depth. A review of Beca data and publicly available information also shows the alluvial deposits extending beyond 100 m. As such, a Site Subsoil Class of D (deep soil site) has been adopted for this assessment.

7.3 Seismic Loads

Seismic (earthquake) loads were computed for the site according to the methodology outlined within the MBIE Earthquake Geotechnical Engineering Practice (Module 1, Section 5.1) for the site location (Ashburton). This module states recommended values for earthquake peak ground acceleration (PGA) and effective magnitude (Mw) for the Ashburton region.

Two limit state load cases were analysed: Serviceability Limit State (SLS) and Ultimate Limit State (ULS) design earthquakes:

- For a SLS design earthquake: The structure is “intended to be used without the need for repair”.
- For a ULS design earthquake: The structure is required to maintain life safety of the building’s occupants and ensure the structural integrity of the building is not lost following the event.

Peak Ground Acceleration (amax) and Earthquake Magnitude (M) values recommended for Geotechnical Assessment were applied for the site as per Table A1 (MBIE, 2021) for Site Classes A, B, C, D and E, for level ground conditions. The recommended PGAs and Mw for liquefaction analyses are summarized in Table 7-1.

Table 7-1: Peak Ground Acceleration and Effective Magnitude for Liquefaction Analysis

Limit State Load	Annual Probability of Exceedance (yr)	Effective Magnitude (Mw)	Peak Ground Acceleration (PGA)
SLS1	1/50	6.10	0.06g
ULS	1/500	6.10	0.26g

8 Liquefaction Assessment

Liquefaction may occur in loosely consolidated and saturated deposits as earthquake-induced cyclic shearing causes pore-water pressures to increase and exceed the static confining pressures, resulting in significant loss of stiffness and strength. Surface effects of liquefaction typically include surface cracking and permanent ground deformations such as vertical settlements and lateral displacements.

Fine grained cohesive soils that have 'clay-like' behaviour may be susceptible to cyclic softening under intense earthquake shaking. Cyclic softening induces a loss in shear strength to its residual/remoulded capacity as a result of monotonic and cyclic loading.

An assessment of the likelihood of liquefaction is required for deposits identified as being potentially susceptible to liquefaction, as set out in Earthquake Geotechnical Engineering Practice Module 3 (NZGS, 2021). The likelihood of liquefaction at the site under the design earthquakes listed in Table 8-1 was assessed from the CPT data using the methodology outlined by Boulanger and Idriss (2014) and an assumed design groundwater depth of 0.5 m bgl. The adopted groundwater is conservative to see what is possible in the materials encountered. We are not expecting groundwater in the upper 2.0 m, as it was not encountered in the in-situ testing.

Results from the liquefaction assessment are summarised within Table 8-1, and full results are available within Appendix F.

Table 8-1: Liquefaction Triggering Potential Summary

CPT	Depth	Liquefaction Induced Free Field Settlement mm (Liquefaction Potential Index [LPI]) *'risk'*	
		SLS	ULS
AR112275-GE-CPT-001	2.02	0 [0] *'insignificant'*	<5 [0] *'mild'*
AR112275-GE-CPT-002	0.50	0 [0] *'insignificant'*	0 [0] *'insignificant'*
AR112275-GE-CPT-003	0.96	0 [0] *'insignificant'*	0 [0] *'insignificant'*

For determination of the MBIE technical category assignment to the site, the liquefaction induced free field settlement over the top 10 m is summarised below:

- SLS = 0 mm
- ULS = 5 mm

Based on the estimated free field settlement calculated above, the site is considered TC1 in line with the repairing and rebuilding houses affected by the Canterbury earthquakes guidance document (Ministry of Business, Innovation and Employment (MBIE), 2012). While the MBIE guidance is not applicable outside of the Christchurch area. The risk of liquefaction in the Ashburton area is similar to Christchurch, therefore we recommend that it is used for classification and foundation recommendation requirements at this site.

8.1.1 Estimated Differential Settlement

Literature indicates that differential settlements across a structure can be considered to be between 50% and 100% of the total estimated free-field settlements depending on lithology and length of the structure. CPTs were undertaken across the site and provide an indication of the anticipated differential settlements. We recommend that the full total estimated free field settlement be considered as differential settlement equating to 0 mm for SLS, and 3 mm across the raft for ULS events.

Note that in addition to free field settlement, settlement can potentially result from loss of soil associated with liquefaction ejecta or lateral ground movement.

8.1.2 Lateral Spreading

Lateral spreading occurs as liquefied soils lose shear strength and flows towards an unconfined free face exposure (i.e. towards a river bank) resulting in horizontal displacements of the ground surface. Surface effects typically include cracking and ejection of liquefied deposits.

Based on available information the site is considered to have a very low risk of lateral spreading due to the lack of topographic variability across the site and no nearby water courses.

9 Foundation Design Recommendations

9.1 Bearing Capacity

The ultimate bearing capacity was assessed from dynamic cone penetrometer (DCP) testing. Testing was conducted at the proposed house locations on site, and a depth to competent bearing was determined. Table 9-1 shows the depth to a competent bearing at each test location. Full bearing capacity results can be referred to in Appendix G.

Table 9-1: Depth to variable bearing capacity layers

Test ID	Location	Depth to 200kPa Ultimate Bearing Capacity (Static)		Depth to 100kPa Ultimate Bearing Capacity (Static)	
		m bgl	(m RL)	m bgl	(m RL)
AR112275-GE-HA-001	Front, 43 Allens Road, north side	0.1	108.45	0.0	108.55
AR112275-GE-HA-002	Back, 43 Allens Road, west side	0.1	108.59	0.0	108.69
AR112275-GE-HA-003	Front, 45 Allens Road, south side	0.1	108.59	0.0	108.69
AR112275-GE-HA-004	Back, 45 Allens Road, south side	0.0	108.72	0.0	108.72
AR112275-GE-HA-005	Front, 47 Allens Road, north side	0.0	108.61	0.0	108.61
AR112275-GE-HA-006	Back, 47 Allens Road, east side	0.0	108.74	0.0	108.74
AR112275-GE-ST-001	Back, 43 Allens Road, middle	0.1	108.59	0.0	108.69
AR112275-GE-ST-002	Back, 45 Allens Road, middle	0.0	108.75	0.0	108.75
AR112275-GE-ST-003	Back. 47 Allens Road, middle	0.1	108.68	0.0	108.78
AR112275-GE-DCP-001	Front, 43 Allens Road, south side	0.0	108.60	0.0	108.60
AR112275-GE-DCP-002	Back, 43 Allens Road, east side	0.0	108.70	0.0	108.70
AR112275-GE-DCP-003	Front, 45 Allens Road, north side	0.1	108.58	0.0	108.68
AR112275-GE-DCP-004	Back, 45 Allens Road, north side	0.2	108.52	0.0	108.72
AR112275-GE-DCP-005	Front, 47 Allens Road, south side	0.0	108.55	0.0	108.55
AR112275-GE-DCP-006	Back, 47 Allens Road, west side	0.2	108.60	0.1	108.70

We recommend that a specific engineer designed shallow foundation solution is designed for 200 kPa geotechnical ultimate bearing capacity which is present from 0.2 m bgl.

9.2 Static Settlement

The site investigations show that the site is not underlain by organic soils and the risk of long-term static settlement is considered to be low. Static settlement was assessed based on the CPT results using the settlement analysis tool in CPeT-IT (version 3.0, published by GeoLogismiki). The assumed ultimate limit state (ULS) dead load for the structure is 730 kN (100% weatherboard cladding), for a plan area of 97 m^2 as provided by the structural engineer for a typical TC1 raft slab foundation. The raft foundation is assumed to act as a large rigid footing and the dead loads are assumed to be evenly spread over the foundation. Dead and live loads were factored by 1.2 and 1.5 respectively and converted to surcharge loads (approx. 15 kPa, considering plan area) for the purposes of the settlement assessment.

Settlements were estimated at this site are outlined below in Table 9-2.

Table 9-2: Static Settlement Analysis for 50 Year Design Life Results.

CPT Test	Settlement (mm) (12 months)	Settlement (mm) (50 years)
AR112275-GE-CPT-001	Negligible	Negligible
AR112275-GE-CPT-002	Negligible	Negligible
AR112275-GE-CPT-003	Negligible	Negligible

The settlement analysis results estimate that the construction loads proposed will likely result in negligible long-term static settlement over the 50-year design life of the structures.

9.3 Soil Modulus of Subgrade Reaction

Soil springs were determined on site based on an ultimate bearing capacity of 200 kPa for a maximum deformation of 25 mm based on recommendations in Foundation Analysis and Design, (Bowles, 1997). Due to the potential variation in soil stiffness under a slab we recommend a range of modulus of subgrade reaction is modelled from -50% to +200% of the estimated value. The estimated modulus of subgrade reaction is 8 MPa and the recommended range for design is 4 to 16 MPa.

9.4 Foundation Solution

No MBIE Residential Foundation Technical Category (TC) maps exist for the Ashburton area. However, foundation recommendations are provided in accordance with the 'repairing and rebuilding houses affected by the Canterbury earthquakes' guidance (2012) to account for the site specific risks which are similar to the conditions encountered in Christchurch.

Kainga Ora's preferred foundation system for this site is a TC1 stiffened waffle slab over a gravel pad in accordance with the "Repairing and rebuilding houses affected by the Canterbury earthquakes" guidance, 2012.

While the site is technically TC1, the ground does not meet the NZS3604 definition of "good ground" (including 300 kPa ultimate geotechnical bearing capacity) until approximately 0.4 m bgl. A TC1 stiffened raft suitable for 200 kPa is considered more economically feasible than an excavate and replace of the soft ground with compacted gravel hardfill to 0.4 m bgl (for a standard TC1 shallow foundation solution). Topsoil removal considers the elevation of base of topsoil encountered at site, being 108.35 m RL in HA-001.

Foundation levels are summarised within Table 9-3 and consider the advised preliminary finished floor level (FFL) requirement of 108.85 m RL, elevation of the base of topsoil and the thickness of the TC1 stiffened waffle (400 mm).

Note these levels are preliminary only and if amended during detailed design, final construction drawings will require updating.

Table 9-3: Summary of preliminary foundation levels

House Typology / Position	Existing Ground Level (m RL)	Finished Floor Level Requirement (m RL*) (top of stiffened waffle slab)	Base of stiffened waffle slab (m RL*)	Base of gravel pad / excavation level (m RL*)	Thickness of gravel pad (mm)
House 1	108.56	108.85	108.45	108.25	200
Houses 2 & 3	108.68	108.96	108.56	108.36	200
Houses 4 & 5	108.67	108.95	108.55	108.35	200
Houses 6 & 7	108.73	109.06	108.66	108.46	200
Houses 8 & 9	108.78	109.13	108.73	108.53	200

Notes:

*Based on preliminary slab finished floor level (m RL, CDD) as stated. If this changes during detailed design, the finished ground level and base of raft will need to be updated on final construction drawings.

The slab is to be constructed on a layer of non-woven geotextile at the bottom of the excavation and should be compacted in maximum 200 mm thick layers to 95% of maximum dry density. The waffle slab is to be constructed on top of the gravel raft. Please refer to the Beca Kainga Ora Project Velocity Specification for construction information, material details and testing requirements.

This design will limit the damage on the foundations from seismic induced ground movements and would be expected to be repairable if any damage does occur. However, the house may be out of level after a major seismic event.

The PS1 producer statement for the geotechnical foundation design is included in Appendix I.

An alternative solution for this site would be an NZS 3604 timber piled foundation supporting a raised floor level. Timber piles are to be founded at a minimum depth of 1.5 m bgl on the stiff sandy silt (2c). NZS 3604 ‘good ground’ criteria including an ultimate geotechnical bearing capacity of 300 kPa, is met from a depth of 1.5 m bgl as per section 9.1.

If this option is to be pursued, foundation (auger) diameter, concrete encasement, and timber pile dimensions are to be determined as per the requirements of NZS 3604 section 6.4.5, based on the span of bearers and joists as per Table 6.1. The piles shall be augered and concreted in place in accordance with the requirements of NZS 3604. Based on proposed finished floor levels, this option was not pursued further by Kainga Ora.

10 Pavement Design Recommendations

The California Bearing Ratio (CBR) for pavement design was assessed from the DCP testing conducted across the site, with an average penetration depth (mm) per blow (e) was derived from the results of each test. Values within the upper 300 mm soil deposits were disregarded as they are considered unreliable due to insufficient lateral resistance on the rod tip and will likely be removed during initial site stripping. CBR percentages are calculated in accordance with Austroads – Guide to Pavement Technology Part 2 and are listed in Table 10-1. The insitu CBR is determined from a weighted average of the CBR below the cut level (70% weighting in top 300mm and 30% weighting for 900mm below this level). A recommended CBR of up to 16 % is proposed for pavement design. The CBR results are included in Appendix H.

Table 10-1: CBR Summary

Test ID	DCP Depth Considered (m bgl)	Insitu CBR (%)[1]
AR112275-GE-HA-001	0.3 – 1.5	43
AR112275-GE-HA-002	0.3 – 1.5	37
AR112275-GE-HA-003	0.3 – 1.5	18
AR112275-GE-HA-004	0.3 – 1.5	16
AR112275-GE-HA-005	0.3 – 1.5	50
AR112275-GE-HA-006	0.3 – 1.5	50
AR112275-GE-ST-001	0.3 – 1.5	40
AR112275-GE-ST-002	0.3 – 1.5	25
AR112275-GE-ST-003	0.3 – 1.5	20
AR112275-GE-DCP-001	0.3 – 1.5	32
AR112275-GE-DCP-002	0.3 – 1.5	42
AR112275-GE-DCP-003	0.3 – 1.5	27
AR112275-GE-DCP-004	0.3 – 1.5	38
AR112275-GE-DCP-005	0.3 – 1.5	20
AR112275-GE-DCP-006	0.3 – 1.5	42

[1] Austroads – Guide to Pavement Technology Part 2: Pavement Structural Design, Section 5.2, Figure 5.3.

These CBR results are based on insitu testing representing the soil conditions and moisture content at the time of testing and may not reflect the worst case (e.g., saturated conditions).

11 Natural Hazard Assessment

The risk of natural hazards at the site has been assessed in accordance with section 106 of the Resource Management Act (RMA) and appropriate CCC and MBIE documents to support the subdivision consent application for the property. The statement of professional opinion for the development of the land is included in Appendix J. A summary of the section 106 hazards at the site is included in Table 11-1 below.

Table 11-1: RMA s106 Hazard Assessment Summary Table

Natural Hazard	Current Risk (as per s106(1)(a))	Effects from Development (as per s106(1)(a))
Flood Inundation	**Low Risk** the CCC District plan indicated it property not in a flood zone.	**Low Risk** Stormwater management is being designed in accordance with CCC standards.
Slips	**Low Risk** the property is not located near a slope or channel.	
Subsidence and Settlement (Static)	**Low Risk** CPTs and hand augers have indicated there are no peat or soft cohesive soils within the ground profile.	**Low Risk** Assessments have estimated loading of the site may induce negligible static consolidation settlement over the design life.
Subsidence and Settlement (Seismic)	**Low Risk** the land is currently unclassified. The site investigations have confirmed the site is considered TC1 and there is a risk of minor liquefaction induced settlements in ULS events. Foundations to be designed to allow for seismic induced liquefaction damage risk.	
Lateral Spreading	**Low Risk** the site is not situated near any free faces or watercourses that may cause lateral spreading in an earthquake.	
Erosion	**Low Risk** no surface water flow source of erosion has been identified near the site.	
Falling Debris	**Low Risk** no source of falling debris has been identified near the site.	

12 Geotechnical Risks

The investigation is based upon isolated investigation data over the site and there is a residual risk with geotechnical investigations and design that conditions may differ from those assumed or deteriorate on site during construction. A summary of the risks and proposed mitigation measures is included in Table 12-1 below.

Table 12-1: Development risks and recommended mitigation measures

Risk	Likelihood	Effects on development	Proposed mitigation measures
Isolated soft zones in subgrade cut (<200kPa ultimate bearing capacity)	Possible	Additional over-excavation required, minor delays	Test subgrade cut surface during construction and recommend additional excavation and replacement with AP65 in affected areas
Heavy rain during subgrade cut or backfilling works	Likely	Foundation softens and requires additional over excavation. Fill becomes contaminated with fines and cannot be compacted to target density, fill removed and replaced, significant delays	Aim to complete foundation excavation works only during fine weather. Install geotextile between cut subgrade and fill to reduce risk of fines migration into fill during rain events. Backfill the excavation promptly. Adjust the compaction methodology to match the subgrade and aggregate moisture content.
Encountering groundwater during foundation excavations	Rare	Dewatering may be required for foundation excavations.	Plan for dewatering if deep foundation excavations below groundwater level are required.

13 Applicability Statement

This report has been prepared by Beca Ltd (Beca) on the specific instructions of Kāinga Ora (Client). It is solely for our Client's use for the purpose for which it is intended in accordance with the agreed scope of work. Any use or reliance by any person contrary to the above, to which Beca has not given its prior written consent, is at that person's own risk.

Should you be in any doubt as to the applicability of this report and/or its recommendations for the proposed development as described herein, and/or encounter materials on site that differ from those described herein, it is essential that you discuss these issues with the authors before proceeding with any work based on this document.

In preparing this report Beca has relied on key information including the following:

- *Site survey information supplied by Kāinga Ora Project Velocity Survey on 06/04/2023.*
- *Site investigation data (boreholes, CPTs, etc) and CES data from the New Zealand Geotechnical Database, accessed 03/04/2023.*
- *Site investigation CPTs supplied by Geotechnics Ltd on 06/04/2023.*
- *Preliminary foundation floor levels supplied by Kāinga Ora Project Velocity Civil Engineer on 12/04/2023.*

Unless specifically stated otherwise in this report, Beca has relied on the accuracy, completeness, currency and sufficiency of all information provided to it by, or on behalf of, the Client, including the information listed above, and has not sought independently to verify the information provided.

This report should be read in full, having regard to all stated assumptions, limitations and disclaimers. No part of this report shall be taken out of context and, to the maximum extent permitted by law, no responsibility is accepted by Beca for the use of any part of this report in any context, or for any purpose, other than that stated herein.

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A

Appendix A – Site Investigation Plan

www.beca.com

www.beca.com

No.	Revision	By	Chk	Appd	Date

Drawing Originator: Beca

Original Scale (A1)
Reduced Scale (A3)

Design	
Drawn	
Dsg Verifier	
Dwg Check	

* Refer to Revision 1 for Original Signature

Client: Kāinga Ora Homes and Communities

Project: PROJECT VELOCITY

Title: GROUND INVESTIGATION PLAN
43 - 47 Allens Road

Discipline: GEOTECHNICAL

Drawing No.

Rev.

DO NOT SCALE

IF IN DOUBT ASK

SUE2854M

B

Appendix B – Calibration Certificates

Göteborg:2022-03-01

CALIBRATION CERTIFICATE FOR CPT PROBE 4593

Probe No	4593
Date of Calibration	2022-03-01
Calibrated by	Alexander Dahlin
Run No	1927
Test Class:	ISO 1

Point Resistance	**Tip Area 10cm²**	
Maximum Load	100	MPa
Range	100	MPa
Scaling Factor	**842**	
Resolution	0,9061	kPa
Area factor (a)	0,856	

ERRORS
Max. Temperature effect when not loaded 30,789 kPa
Temperature range 5 –40 deg. Celsius.

Local Friction	**Sleeve Area 150cm²**	
Maximum Load	0,5	MPa
Range	0,5	MPa
Scaling Factor	**3664**	
Resolution	0,0104	kPa
Area factor (b)	0	

ERRORS
Max. Temperature effect when not loaded 0,52 kPa
Temperature range 5 –40 deg. Celsius.

Pore Pressure		
Maximum Load	2	MPa
Range	2	MPa
Scaling Factor	**3947**	
Resolution	0,0193	kPa

ERRORS
Max. Temperature effect when not loaded 1,738 kPa
Temperature range 5 –40 deg. Celsius.

Tilt Angle.	**Scaling Factor: 0,94**	
Range	0 - 40	Deg.

Backup memory
Conductivity probe

Cptlog Cone data base information

Göteborg: 2022-03-01

Cone name
4593

Serial number
4593

Date of purchase
User.

Ranges

Point resistance
100 (Mpa)

Local friction
0,5 (Mpa)

Pore pressure
2 (Mpa)

Tilt sensor
40 (Deg)

temperature
(C)

Elect. Conductivity
(mS/m)

Geometric parameters

Area factor a
0,856

Area factor b
0

Tip area
10 (cm^2)

Sleeve area
150 (cm^2)

Scaling factors

Point resistance
842

Local friction
3664

Pore pressure
3947

Tilt sensor
0,94

temperature
1

Elect. Conductivity A

Elect. Conductivity B

Type
Nova cone

Memory option
With memory

C

Appendix C – Hand Auger Logs and Photographs

Geotechnical Log Key Sheet

SOIL AND ROCK DESCRIPTIONS

Soil and Rock Descriptions are in general accordance with the NZ Geotechnical Society (NZGS), 2005.
Hand-held Vane Shear Strength measurements are in general accordance with the NZGS, 2001.

METHODS

BH	Machine Borehole
CPT	Cone Penetration Test
DCP	Dynamic Cone Penetration
HA	Hand Auger
SPT	Standard Penetration Test
IVAN	In-situ Vane Test
MA	Machine Auger
OB	Open Barrel
SNC	Sonic Core Drilling
TP	Test Pit/Trench
TT	Triple Tube
PT	Thin-walled Open Drive Tube
VE	Vacuum Excavation
W	Wash Boring

WEATHERING

CW	Completely Weathered
HW	Highly Weathered
MW	Moderately Weathered
SW	Slightly Weathered
UW	Unweathered

SAMPLES

B	Bulk Disturbed Sample
C	Core Sample
D	Small Disturbed Sample
PT	Thin-wall Open Drive (Push) Tube Sample

WATER

Groundwater Level (GWL)

IN-SITU TESTS

Shear Vane

Su	In-situ peak undrained shear strength and remoulded undrained shear strength
UTP	Unable to Penetrate
CB	Pilcon-type vane tested in Core Barrel
DH	Pilcon-type vane tested in-situ (downhole)
GV	Geonor vane, tested in-situ
IcV	Icone vane, tested in-situ

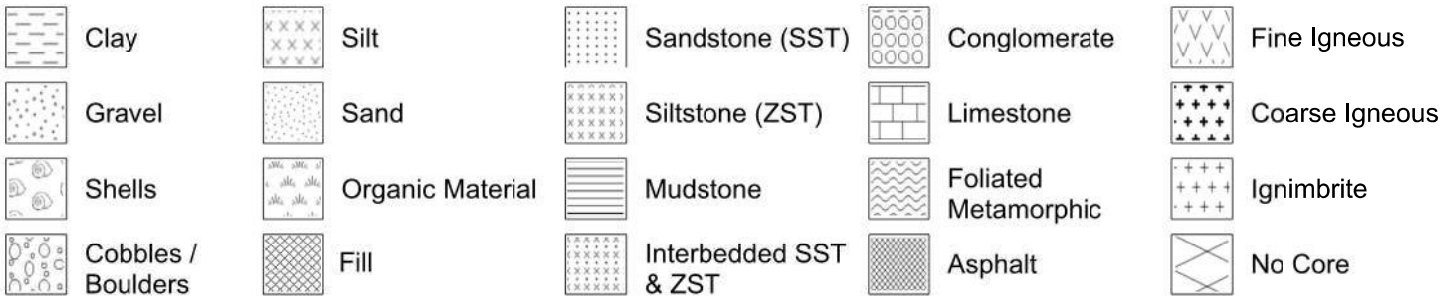
Standard Penetration Test (SPT)

N	SPTn Sampler (Split-spoon)
Nc	SPTn Solid Cone
HB	SPT Hammer Bouncing

TERMINOLOGY

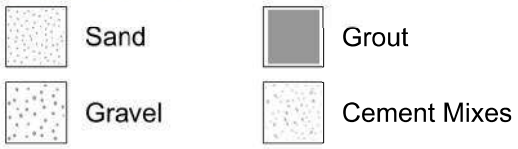
RL	Relative Ground Level
RQD	Rock Quality Designation

GRAPHIC LOG (1 or a combination of the following)

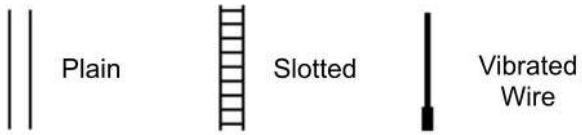


MONITORING INSTALLATION

Backfill Material



Standpipe



ORGANIC SOILS

Von Post Degree of Humidification

H1	Completely unconverted and mud-free peat, when pressed gives clear water and plant structure is visible.
H2	Partially unconverted and mud-free peat, when pressed gives almost clear water and plant structure is visible.
H3	Very slightly decomposed or very slightly muddy peat, when pressed gives marked muddy water, no peat substance passes through the fingers and plant structure is less visible.
H4	Slightly decomposed or slightly muddy peat, when pressed gives muddy water and plant structure is less visible.
H5	Moderately decomposed or very muddy peat with growth structure evident but slightly obliterated.
H6	Moderately decomposed or very muddy peat with indistinct growth structure.
H7	Fairly well decomposed or very muddy peat but the growth structure can just be seen.
H8	Well decomposed or very muddy peat with very indistinct growth structure.
H9	Practically decomposed or mud-like peat in which almost no growth structure is evident.
H10	Completely decomposed or mud peat where no growth structure can be seen, entire substance passes through the fingers when pressed.

Hand Auger Log

Hand Auger ID: AR112275-GE-HA-001

Sheet 1 of 1

Project:	Project Velocity - 43-47 Allens Rd (Ashburton)	**Project Number:**	3160491/AR112275
Site Location:	43-47 Allens Rd, Allenton, Ashburton	**Client:**	Kainga Ora
Location:	Front yard, south eastern corner.	**Coordinate System:**	NZTM2000
		Northing:	5139884.5
		Easting:	1498867.5
		Vertical Datum:	LVD
		Ground level (mRL):	108.55
		Location Method:	Survey

Groundwater (m)	In Situ Tests: Su (kPa)	In Situ Tests: Scala blows/50mm	Samples	Depth (m)	RL (m)	Graphic Log	Soil/ Rock Description	Geological Unit
		1 0 1 1 1 1 8 9 9 12 16		0.0 0.5 1.0 1.5 2.0 2.5 3.0 3.5 4.0 4.5	108.5 108.0 107.5 107.0 106.5 106.0 105.5 105.0 104.5 104.0		Firm, SILT, trace fine sand, trace clay, some organics; dark brown; moist, low plasticity, insensitive. Organics: rootlets. [TOPSOIL]	
							Firm, SILT, trace fine sand, trace fine gravel, trace clay; brown; moist, low plasticity, insensitive. Gravels: subrounded to angular, unweathered, greywacke.	Springston Formation
							0.55m - End of hand auger	

Date Started:	05/04/2023	**Vane ID:**	N/A	**Comments:**	
Logged By:	KB	**Vane Width:**	N/A	Terminated on contact with gravel unit. Groundwater not encountered.	
Diameter:	50mm	**Vane Type:**	N/A		

For Explanation of Symbols and Abbreviations See Key Sheet

Photo Log

Location ID: AR112275-GE-HA-001

Project:	Project Velocity - 43-47 Allens Rd (Ashburton)	**Project number:**	3160491/AR112275
Site location:	43-47 Allens Rd, Allenton, Ashburton	**Client Name:**	Kainga Ora
Location:	Front yard, south eastern corner.	**Coordinate system:**	NZTM2000
		Northing:	5139884.5
		Easting:	1498867.5
		Vertical datum:	LVD
		Ground level (mRL):	108.55
		Location method:	Survey

Box 1 - 0.00mbgl to 0.40mbgl

Hand Auger Log

Hand Auger ID: AR112275-GE-HA-002

Sheet 1 of 1

Project:	Project Velocity - 43-47 Allens Rd (Ashburton)	**Project Number:**	3160491/AR112275
Site Location:	43-47 Allens Rd, Allenton, Ashburton	**Client:**	Kainga Ora
Location:	Back yard, north western corner	**Coordinate System:**	NZTM2000
		Northing:	5139899.6
		Easting:	1498843.6
		Vertical Datum:	LVD
		Ground level (mRL):	108.69
		Location Method:	Survey

Groundwater (m)	In Situ Tests: Su (kPa)	In Situ Tests: Scala blows/50mm	Samples	Depth (m)	RL (m)	Graphic Log	Soil/ Rock Description	Geological Unit
		1 0 1 2 2 2 4 5 8 14		0.5 1.0 1.5 2.0 2.5 3.0 3.5 4.0 4.5	108.5 108.0 107.5 107.0 106.5 106.0 105.5 105.0 104.5 104.0		Firm, SILT, minor fine sand, trace clay, trace organics; dark brown; moist, low plasticity, insensitive. Organics: rootlets. [TOPSOIL] Firm, SILT, trace fine sand, trace fine gravel, brown; moist, non plastic, insensitive. Gravel: sub-rounded to angular, unweathered, greywacke. [SPRINGSTON FORMATION] 0.40m - End of hand auger	

Date Started:	05/04/2023	**Vane ID:**	N/A	**Comments:**	
Logged By:	KB	**Vane Width:**	N/A	Terminated on contact with gravel unit. Groundwater not encountered.	
Diameter:	50mm	**Vane Type:**	N/A		

For Explanation of Symbols and Abbreviations See Key Sheet

Photo Log

Location ID: AR112275-GE-HA-002

Project:	Project Velocity - 43-47 Allens Rd (Ashburton)	**Project number:**	3160491/AR112275
Site location:	43-47 Allens Rd, Allenton, Ashburton	**Client Name:**	Kainga Ora
Location:	Back yard, north western corner	**Coordinate system:**	NZTM2000
		Northing:	5139899.6
		Easting:	1498843.6
		Vertical datum:	LVD
		Ground level (mRL):	108.69
		Location method:	Survey

Box 1 - 0.00mbgl to 0.40mbgl

Hand Auger Log

Hand Auger ID: AR112275-GE-HA-003

Sheet 1 of 1

Project:	Project Velocity - 43-47 Allens Rd (Ashburton)	**Project Number:**	3160491/AR112275
Site Location:	43-47 Allens Rd, Allenton, Ashburton	**Client:**	Kainga Ora
Location:	Front yard, south eastern side.	**Coordinate System:**	NZTM2000
		Northing:	5139886.7
		Easting:	1498877.5
		Vertical Datum:	LVD
		Ground level (mRL):	108.69
		Location Method:	Survey

Groundwater (m)	In Situ Tests: Su (kPa)	In Situ Tests: Scala blows/50mm	Samples	Depth (m)	RL (m)	Graphic Log	Soil/ Rock Description	Geological Unit
		0 1 1 1 0 2 2 1 1 2 4 4 5 11 10 7 15		0.5 1.0 1.5 2.0 2.5 3.0 3.5 4.0 4.5	108.5 108.0 107.5 107.0 106.5 106.0 105.5 105.0 104.5 104.0		Firm, SILT, minor fine sand, trace clay, trace organics; dark brown; moist, low plasticity, insensitive. Organics: rootlets. [TOPSOIL]	
							Firm, SILT, trace fine sand, trace clay, trace fine to coarse gravel; brown; moist, low plasticity, insensitive. Gravel: sub-rounded to angular, unweathered, greywacke.	Springston Formation
							0.55m - End of hand auger	

Date Started:	05/04/2023	**Vane ID:**	N/A	**Comments:**	
Logged By:	JB	**Vane Width:**	N/A	Terminated on contact with gravel unit. Groundwater not encountered.	
Diameter:	50mm	**Vane Type:**	N/A		

For Explanation of Symbols and Abbreviations See Key Sheet

Photo Log

Location ID: AR112275-GE-HA-003

Project:	Project Velocity - 43-47 Allens Rd (Ashburton)	**Project number:**	3160491/AR112275
Site location:	43-47 Allens Rd, Allenton, Ashburton	**Client Name:**	Kainga Ora
Location:	Front yard, south eastern side.	**Coordinate system:**	NZTM2000
		Northing:	5139886.7
		Easting:	1498877.5
		Vertical datum:	LVD
		Ground level (mRL):	108.69
		Location method:	Survey

Box 1 - 0.00mbgl to 0.55mbgl

Hand Auger Log

Hand Auger ID: AR112275-GE-HA-004

Sheet 1 of 1

Project:	Project Velocity - 43-47 Allens Rd (Ashburton)	**Project Number:**	3160491/AR112275
Site Location:	43-47 Allens Rd, Allenton, Ashburton	**Client:**	Kainga Ora
Location:	Back yard, western side.	**Coordinate System:**	NZTM2000
		Northing:	5139903.0
		Easting:	1498889.5
		Vertical Datum:	LVD
		Ground level (mRL):	108.72
		Location Method:	Survey

Groundwater (m)	In Situ Tests: Su (kPa)	In Situ Tests: Scala blows/50mm	Samples	Depth (m)	RL (m)	Graphic Log	Soil/ Rock Description	Geological Unit
		1 2 2 3 3 1 3 3 10		0.0	108.5		Medium dense, fine sandy SILT, some organics; dark brown; dry, non plastic, insensitive. Organics: roots and rootlets. [TOPSOIL]	
				0.5	108.0		Medium dense, SILT, some fine sand; greyish brown; dry, non plastic, insensitive. [SPRINGSTON FORMATION]	
				1.0	107.5		0.45m - End of hand auger	
				1.5	107.0			
				2.0	106.5			
				2.5	106.0			
				3.0	105.5			
				3.5	105.0			
				4.0	104.5			
				4.5	104.0			

Date Started:	05/04/2023	**Vane ID:**	N/A	**Comments:**
Logged By:	JB	**Vane Width:**	N/A	Terminated on contact with inferred gravel unit. Groundwater not encountered.
Diameter:	50mm	**Vane Type:**	N/A	

For Explanation of Symbols and Abbreviations See Key Sheet

Photo Log

Location ID: AR112275-GE-HA-004

Project:	Project Velocity - 43-47 Allens Rd (Ashburton)	**Project number:**	3160491/AR112275
Site location:	43-47 Allens Rd, Allenton, Ashburton	**Client Name:**	Kainga Ora
Location:	Back yard, western side.	**Coordinate system:**	NZTM2000
		Northing:	5139903.0
		Easting:	1498889.5
		Vertical datum:	LVD
		Ground level (mRL):	108.72
		Location method:	Survey

Box 1 - 0.00mbgl to 0.45mbgl

Hand Auger Log

Hand Auger ID: AR112275-GE-HA-005

Sheet 1 of 1

Project:	Project Velocity - 43-47 Allens Rd (Ashburton)	**Project Number:**	3160491/AR112275
Site Location:	43-47 Allens Rd, Allenton, Ashburton	**Client:**	Kainga Ora
Location:	Front yard, south eastern side.	**Coordinate System:**	NZTM2000
		Northing:	5139905.9
		Easting:	1498889.5
		Vertical Datum:	LVD
		Ground level (mRL):	108.61
		Location Method:	Survey

Groundwater (m)	In Situ Tests: Su (kPa)	In Situ Tests: Scala blows/50mm	Samples	Depth (m)	RL (m)	Graphic Log	Soil/ Rock Description	Geological Unit
		1 3 3 4 3 6 4 17		0.0	108.5		Loose, fine sandy SILT, some organics, trace fine gravel; brown; dry, non plastic, insensitive. Organics: roots and rootlets. Gravel: subrounded to subangular, unweathered, greywacke. [TOPSOIL]	
							Dense, SILT, some fine sand, trace fine gravel; light brown; dry, non plastic, insensitive. Gravel: subrounded, unweathered, greywacke. [SPRINGSTON FORMATION]	
				0.5	108.0		0.35m - End of hand auger	
				1.0	107.5			
				1.5	107.0			
				2.0	106.5			
				2.5	106.0			
				3.0	105.5			
				3.5	105.0			
				4.0	104.5			
				4.5	104.0			

Date Started:	05/04/2023	**Vane ID:**	N/A	**Comments:**
Logged By:	JB	**Vane Width:**	N/A	Terminated on contact with gravel unit. Groundwater not encountered.
Diameter:	50mm	**Vane Type:**	N/A	

For Explanation of Symbols and Abbreviations See Key Sheet

Photo Log

Location ID: AR112275-GE-HA-005

Project:	Project Velocity - 43-47 Allens Rd (Ashburton)	**Project number:**	3160491/AR112275
Site location:	43-47 Allens Rd, Allenton, Ashburton	**Client Name:**	Kainga Ora
Location:	Front yard, south eastern side.	**Coordinate system:**	NZTM2000
		Northing:	5139905.9
		Easting:	1498889.5
		Vertical datum:	LVD
		Ground level (mRL):	108.61
		Location method:	Survey

Box 1 - 0.00mbgl to 0.35mbgl

Hand Auger Log

Hand Auger ID: AR112275-GE-HA-006

Sheet 1 of 1

Project:	Project Velocity - 43-47 Allens Rd (Ashburton)	**Project Number:**	3160491/AR112275
Site Location:	43-47 Allens Rd, Allenton, Ashburton	**Client:**	Kainga Ora
Location:	Back yard, northern corner.	**Coordinate System:**	NZTM2000
		Northing:	5139921.7
		Easting:	1498875.3
		Vertical Datum:	LVD
		Ground level (mRL):	108.74
		Location Method:	Survey

Groundwater (m)	In Situ Tests: Su (kPa)	In Situ Tests: Scala blows/50mm	Samples	Depth (m)	RL (m)	Graphic Log	Soil/ Rock Description	Geological Unit
		1 1 2 2 2 2 21		0 0.5 1.0 1.5 2.0 2.5 3.0 3.5 4.0 4.5	108.5 108.0 107.5 107.0 106.5 106.0 105.5 105.0 104.5 104.0		Loose, SILT, some fine sand, trace fine gravel, some organics; dark brown; dry, non plastic, insensitive. Gravel: subrounded to subangular, unweathered, greywacke. Organics: roots and rootlets. [TOPSOIL] Medium dense, SILT, some fine to medium gravel, some fine sand; dark brown; moist, non plastic, insensitive. Gravel: subrounded to subangular, unweathered, greywacke. [SPRINGSTON FORMATION] 0.25m - End of hand auger	

Date Started:	05/04/2023	**Vane ID:**	N/A	**Comments:**	
Logged By:	JB	**Vane Width:**	N/A	Terminated on contact with gravel unit. Groundwater not encountered.	
Diameter:	50mm	**Vane Type:**	N/A		

For Explanation of Symbols and Abbreviations See Key Sheet

Photo Log

Location ID: AR112275-GE-HA-006

Project:	Project Velocity - 43-47 Allens Rd (Ashburton)	**Project number:**	3160491/AR112275
Site location:	43-47 Allens Rd, Allenton, Ashburton	**Client Name:**	Kainga Ora
Location:	Back yard, northern corner.	**Coordinate system:**	NZTM2000
		Northing:	5139921.7
		Easting:	1498875.3
		Vertical datum:	LVD
		Ground level (mRL):	108.74
		Location method:	Survey

Box 1 - 0.00mbgl to 0.25mbgl

D

Appendix D – Scala Results

Geotechnical Log Key Sheet

SOIL AND ROCK DESCRIPTIONS

Soil and Rock Descriptions are in general accordance with the NZ Geotechnical Society (NZGS), 2005.
Hand-held Vane Shear Strength measurements are in general accordance with the NZGS, 2001.

METHODS

BH	Machine Borehole
CPT	Cone Penetration Test
DCP	Dynamic Cone Penetration
HA	Hand Auger
SPT	Standard Penetration Test
IVAN	In-situ Vane Test
MA	Machine Auger
OB	Open Barrel
SNC	Sonic Core Drilling
TP	Test Pit/Trench
TT	Triple Tube
PT	Thin-walled Open Drive Tube
VE	Vacuum Excavation
W	Wash Boring

WEATHERING

CW	Completely Weathered
HW	Highly Weathered
MW	Moderately Weathered
SW	Slightly Weathered
UW	Unweathered

SAMPLES

B	Bulk Disturbed Sample
C	Core Sample
D	Small Disturbed Sample
PT	Thin-wall Open Drive (Push) Tube Sample

WATER

Groundwater Level (GWL)

IN-SITU TESTS

Shear Vane

Su	In-situ peak undrained shear strength and remoulded undrained shear strength
UTP	Unable to Penetrate
CB	Pilcon-type vane tested in Core Barrel
DH	Pilcon-type vane tested in-situ (downhole)
GV	Geonor vane, tested in-situ
IcV	Icone vane, tested in-situ

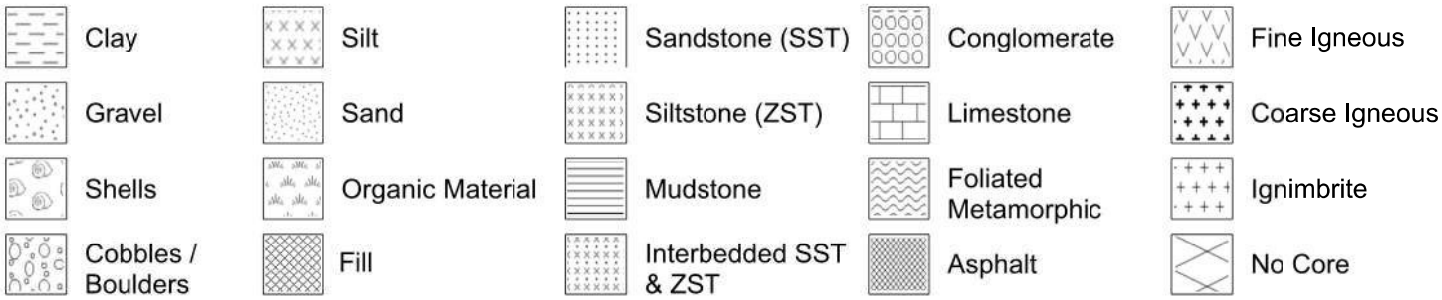
Standard Penetration Test (SPT)

N	SPTn Sampler (Split-spoon)
Nc	SPTn Solid Cone
HB	SPT Hammer Bouncing

TERMINOLOGY

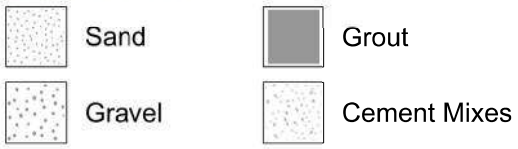
RL	Relative Ground Level
RQD	Rock Quality Designation

GRAPHIC LOG (1 or a combination of the following)

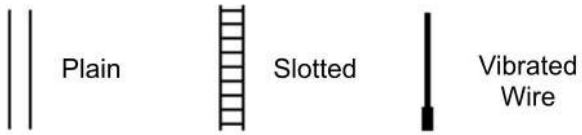


MONITORING INSTALLATION

Backfill Material



Standpipe



ORGANIC SOILS

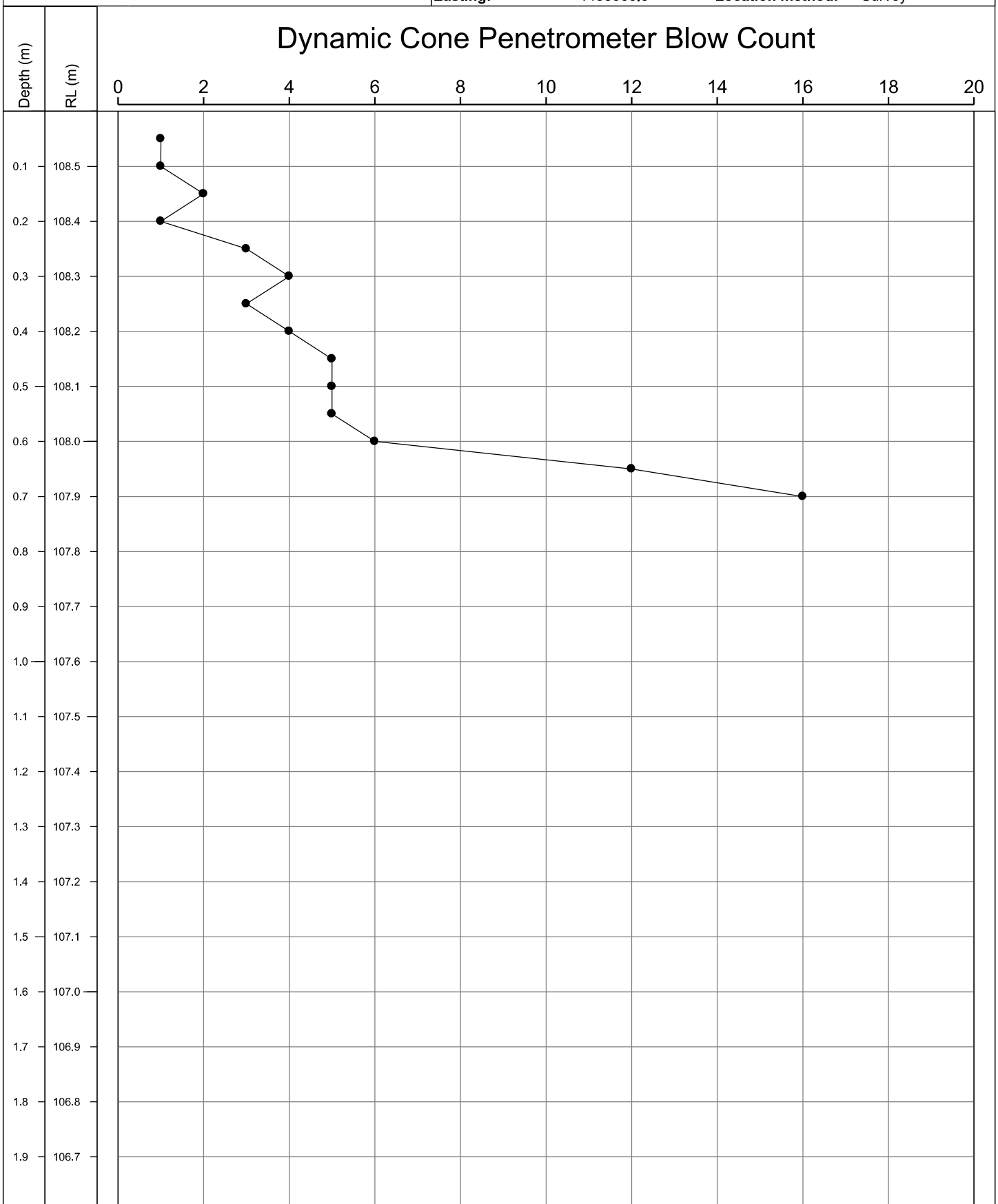
Von Post Degree of Humidification

H1	Completely unconverted and mud-free peat, when pressed gives clear water and plant structure is visible.
H2	Partially unconverted and mud-free peat, when pressed gives almost clear water and plant structure is visible.
H3	Very slightly decomposed or very slightly muddy peat, when pressed gives marked muddy water, no peat substance passes through the fingers and plant structure is less visible.
H4	Slightly decomposed or slightly muddy peat, when pressed gives muddy water and plant structure is less visible.
H5	Moderately decomposed or very muddy peat with growth structure evident but slightly obliterated.
H6	Moderately decomposed or very muddy peat with indistinct growth structure.
H7	Fairly well decomposed or very muddy peat but the growth structure can just be seen.
H8	Well decomposed or very muddy peat with very indistinct growth structure.
H9	Practically decomposed or mud-like peat in which almost no growth structure is evident.
H10	Completely decomposed or mud peat where no growth structure can be seen, entire substance passes through the fingers when pressed.

DCP Report

Borehole ID: AR112275-GE-DCP-001

Project:	Project Velocity - 43-47 Allens Rd (Ashburton)	**Project number:**	3160491/AR112275
Site location:	43-47 Allens Rd, Allenton, Ashburton	**Client name:**	Kainga Ora
Location:	Front yard, south west corner.	**Coordinate system:**	NZTM2000
		Northing:	5139876.4
		Easting:	1498866.9
		Vertical datum:	LVD
		Ground level (mRL):	108.60
		Location method:	Survey



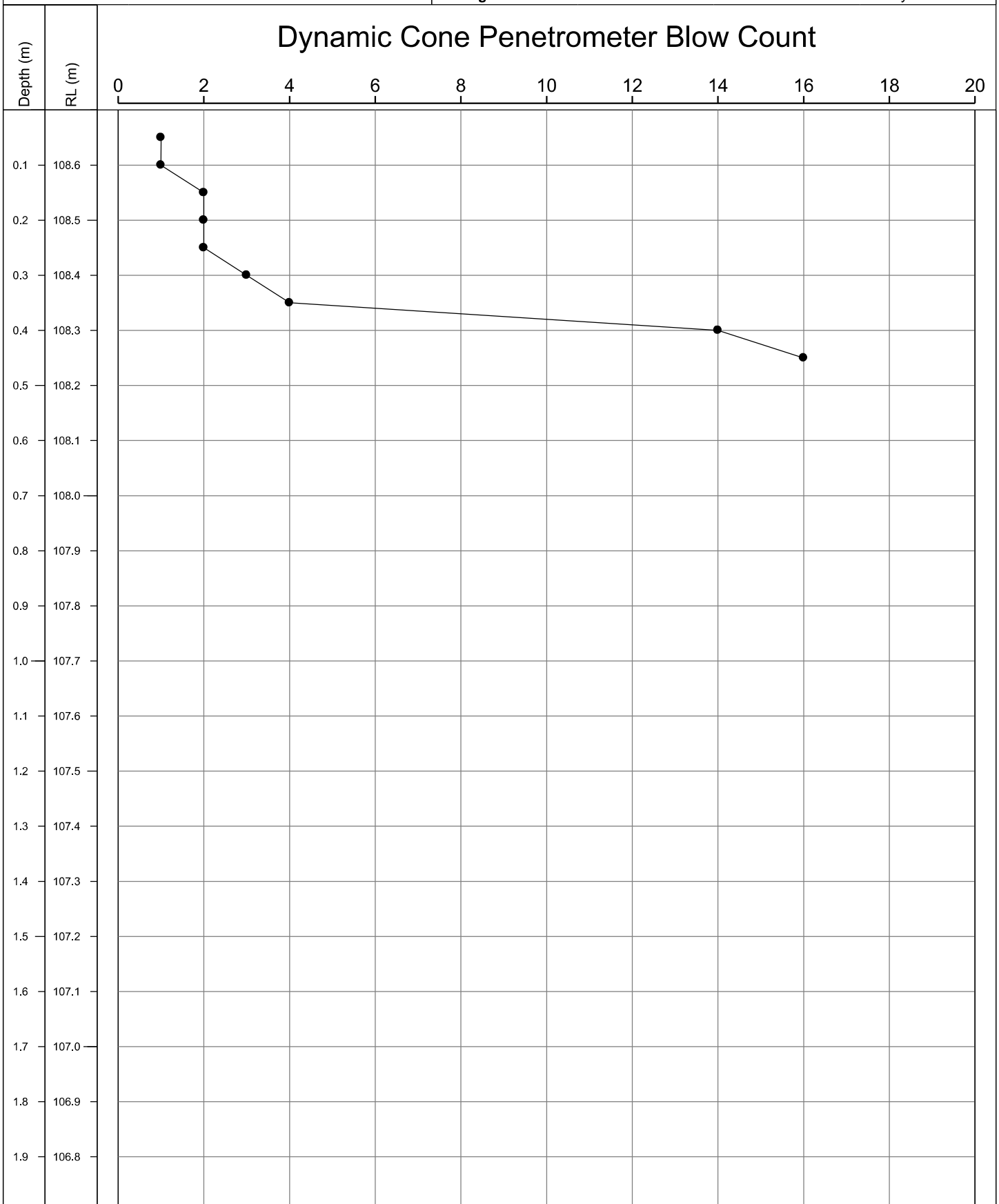
Date started:	05/04/2023	**Date end:**	05/04/2023	**Comments:**
Logged by:	KB	**Tested by:**	Beca Limited	Terminated on contact with inferred gravel unit.
Equipment:	9Kg DCP	**Method:**	NZS 4402.6.5.2:1988	

For Explanation of Symbols and Abbreviations See Key Sheet

DCP Report

Borehole ID: AR112275-GE-DCP-002

Project:	Project Velocity - 43-47 Allens Rd (Ashburton)	**Project number:**	3160491/AR112275
Site location:	43-47 Allens Rd, Allenton, Ashburton	**Client name:**	Kainga Ora
Location:	Centre of back yard.	**Coordinate system:**	NZTM2000
		Northing:	5139898.4
		Easting:	1498855.6
		Vertical datum:	LVD
		Ground level (mRL):	108.70
		Location method:	Survey



Date started:	05/04/2023	**Date end:**	05/04/2023
Logged by:	KB	**Tested by:**	Beca Limited
Equipment:	9Kg DCP	**Method:**	NZS 4402.6.5.2:1988

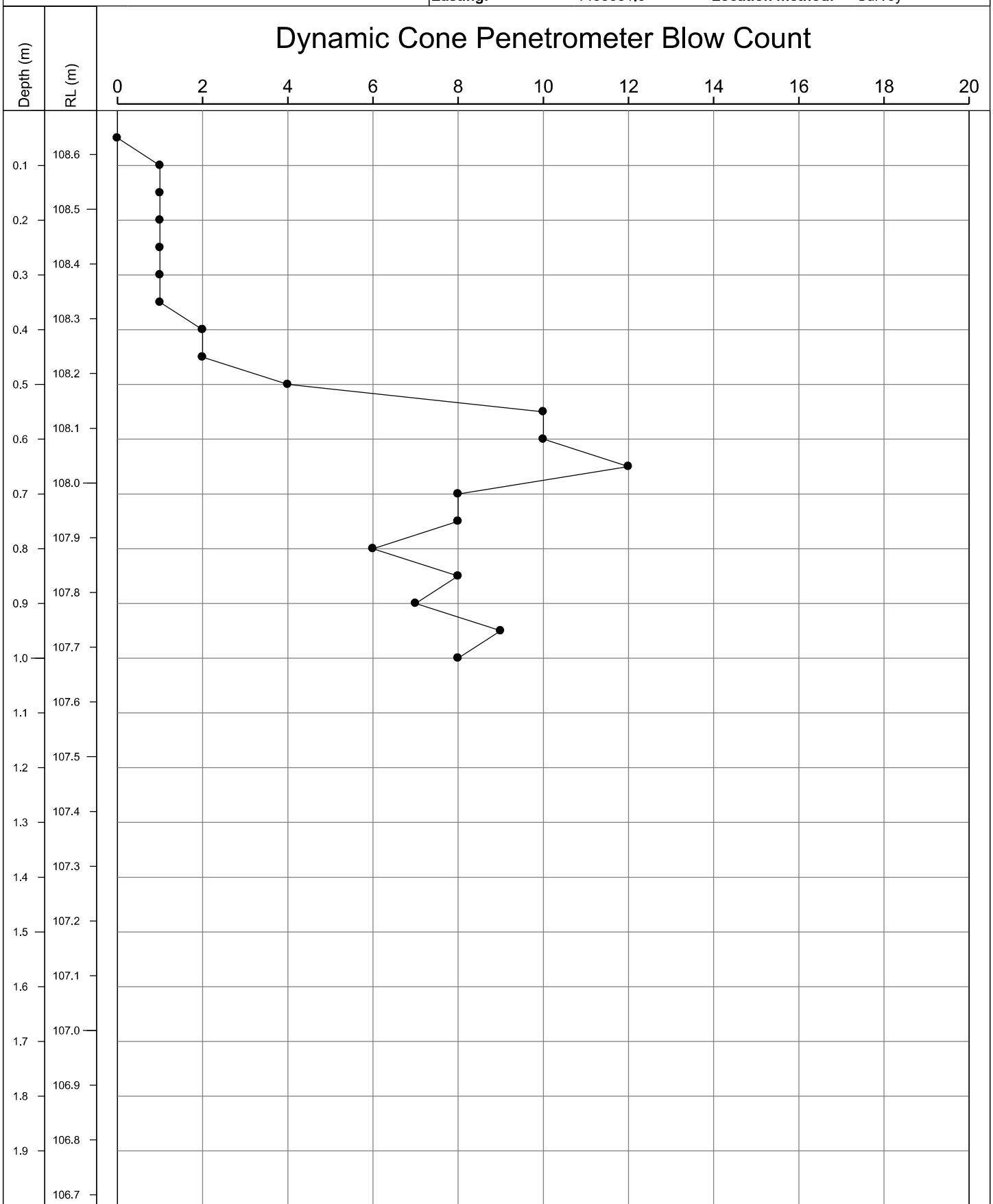
Comments:
Terminated on contact with inferred gravel unit.

For Explanation of Symbols and Abbreviations See Key Sheet

DCP Report

Borehole ID: AR112275-GE-DCP-003

Project:	Project Velocity - 43-47 Allens Rd (Ashburton)	**Project number:**	3160491/AR112275
Site location:	43-47 Allens Rd, Allenton, Ashburton	**Client name:**	Kainga Ora
Location:	Front yard, southern side.	**Coordinate system:**	NZTM2000
		Northing:	5139894.2
		Easting:	1498881.9
		Vertical datum:	LVD
		Ground level (mRL):	108.68
		Location method:	Survey



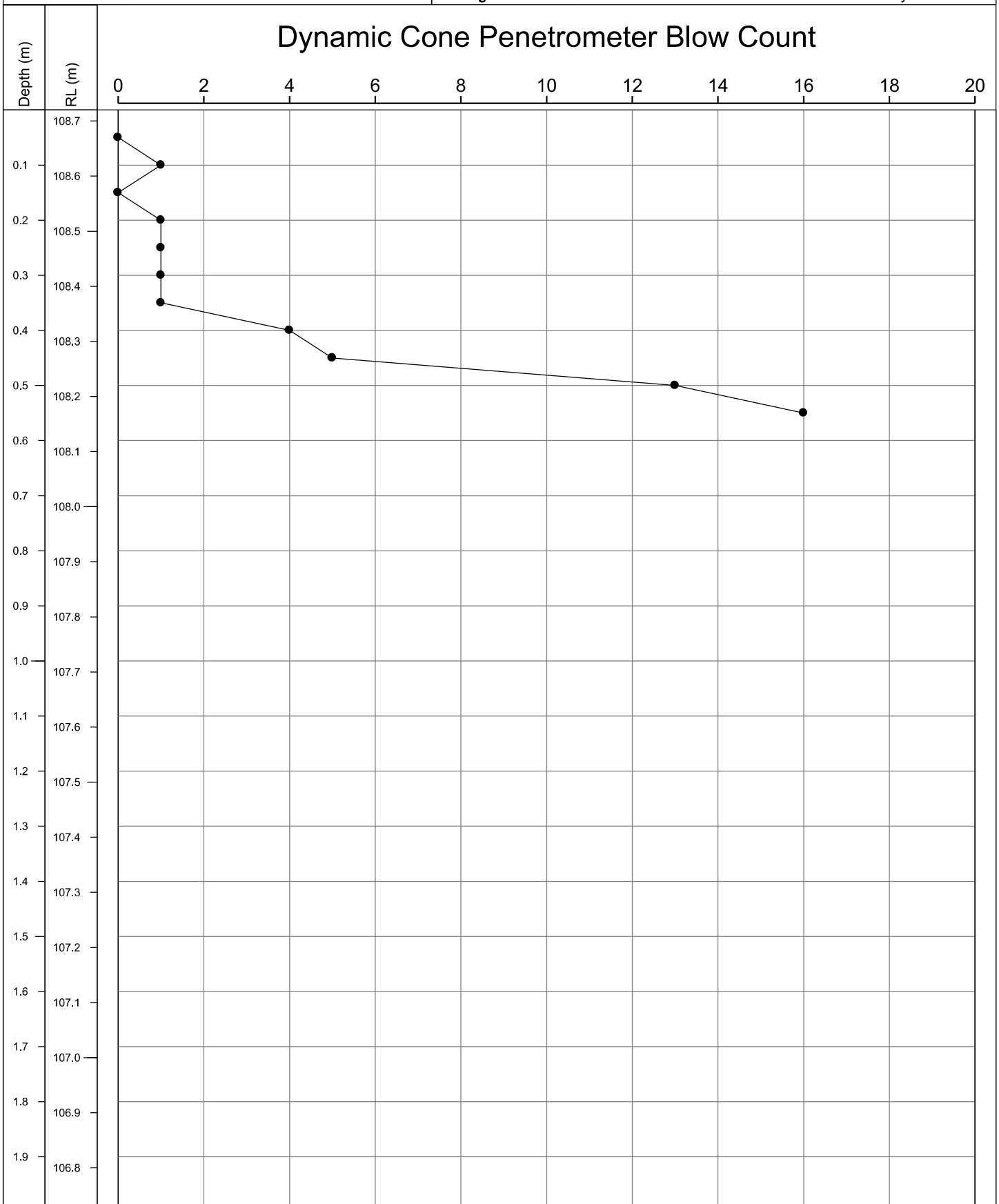
Date started:	05/04/2023	**Date end:**	05/04/2023	**Comments:**
Logged by:	JB	**Tested by:**	Beca Limited	Terminated due to effective refusal.
Equipment:	9Kg DCP	**Method:**	NZS 4402.6.5.2:1988	

For Explanation of Symbols and Abbreviations See Key Sheet

DCP Report

Borehole ID: AR112275-GE-DCP-004

Project:	Project Velocity - 43-47 Allens Rd (Ashburton)	**Project number:**	3160491/AR112275
Site location:	43-47 Allens Rd, Allenton, Ashburton	**Client name:**	Kainga Ora
Location:	Back yard, northern side.	**Coordinate system:**	NZTM2000
		Northing:	5139918.1
		Easting:	1498858.3
		Vertical datum:	LVD
		Ground level (mRL):	108.72
		Location method:	Survey



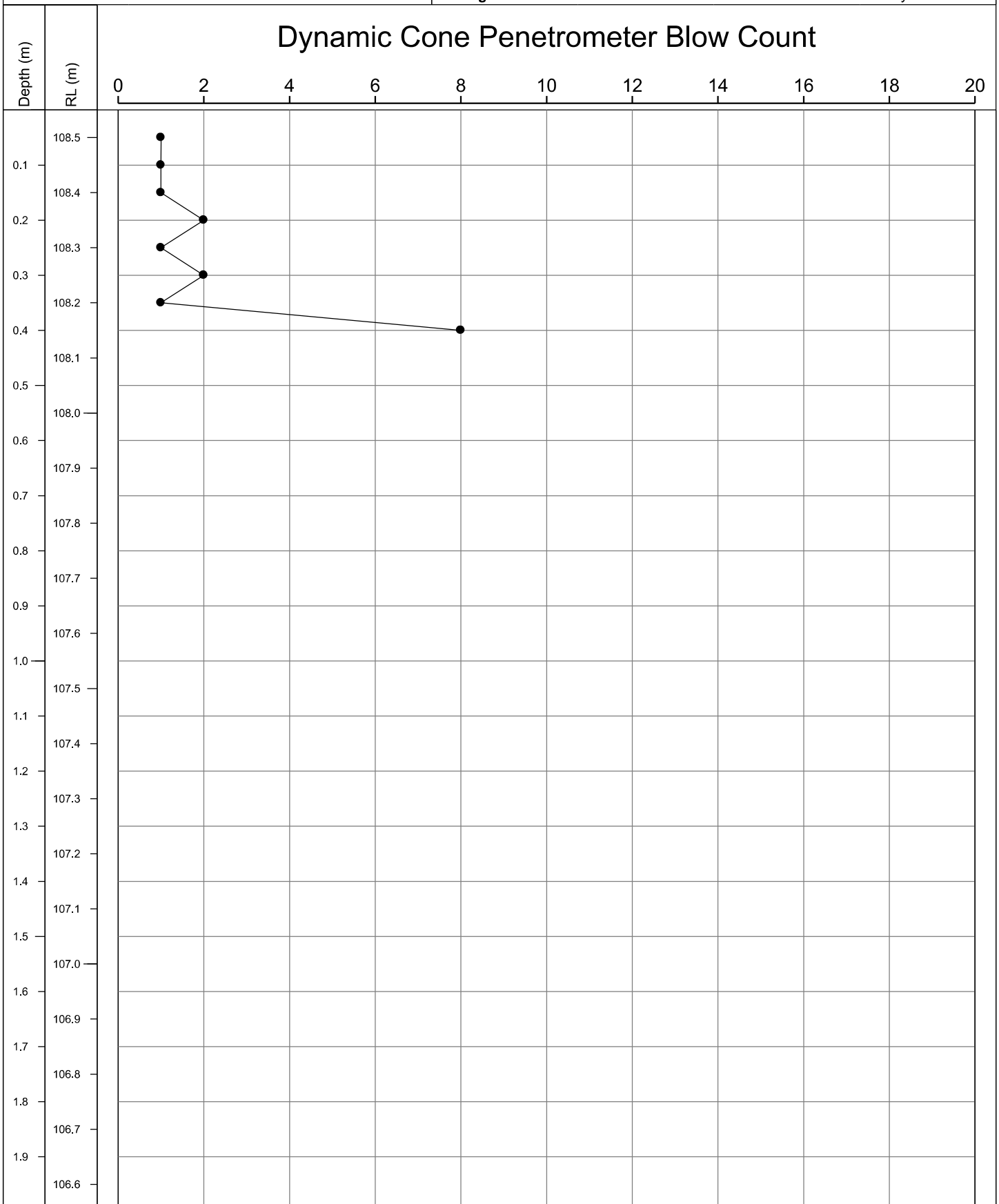
Date started:	05/04/2023	**Date end:**	05/04/2023	**Comments:**
Logged by:	JB	**Tested by:**	Beca Limited	Terminated on contact with gravel unit.
Equipment:	9Kg DCP	**Method:**	NZS 4402.6.5.2:1988	

For Explanation of Symbols and Abbreviations See Key Sheet

DCP Report

Borehole ID: AR112275-GE-DCP-005

Project:	Project Velocity - 43-47 Allens Rd (Ashburton)	**Project number:**	3160491/AR112275
Site location:	43-47 Allens Rd, Allenton, Ashburton	**Client name:**	Kainga Ora
Location:	Front yard, south west corner.	**Coordinate system:**	NZTM2000
		Northing:	5139900.8
		Easting:	1498885.3
		Vertical datum:	LVD
		Ground level (mRL):	108.55
		Location method:	Survey



Date started:	05/04/2023	**Date end:**	05/04/2023	**Comments:**
Logged by:	JB	**Tested by:**	Beca Limited	Terminated on contact with inferred gravel unit.
Equipment:	9Kg DCP	**Method:**	NZS 4402.6.5.2:1988	

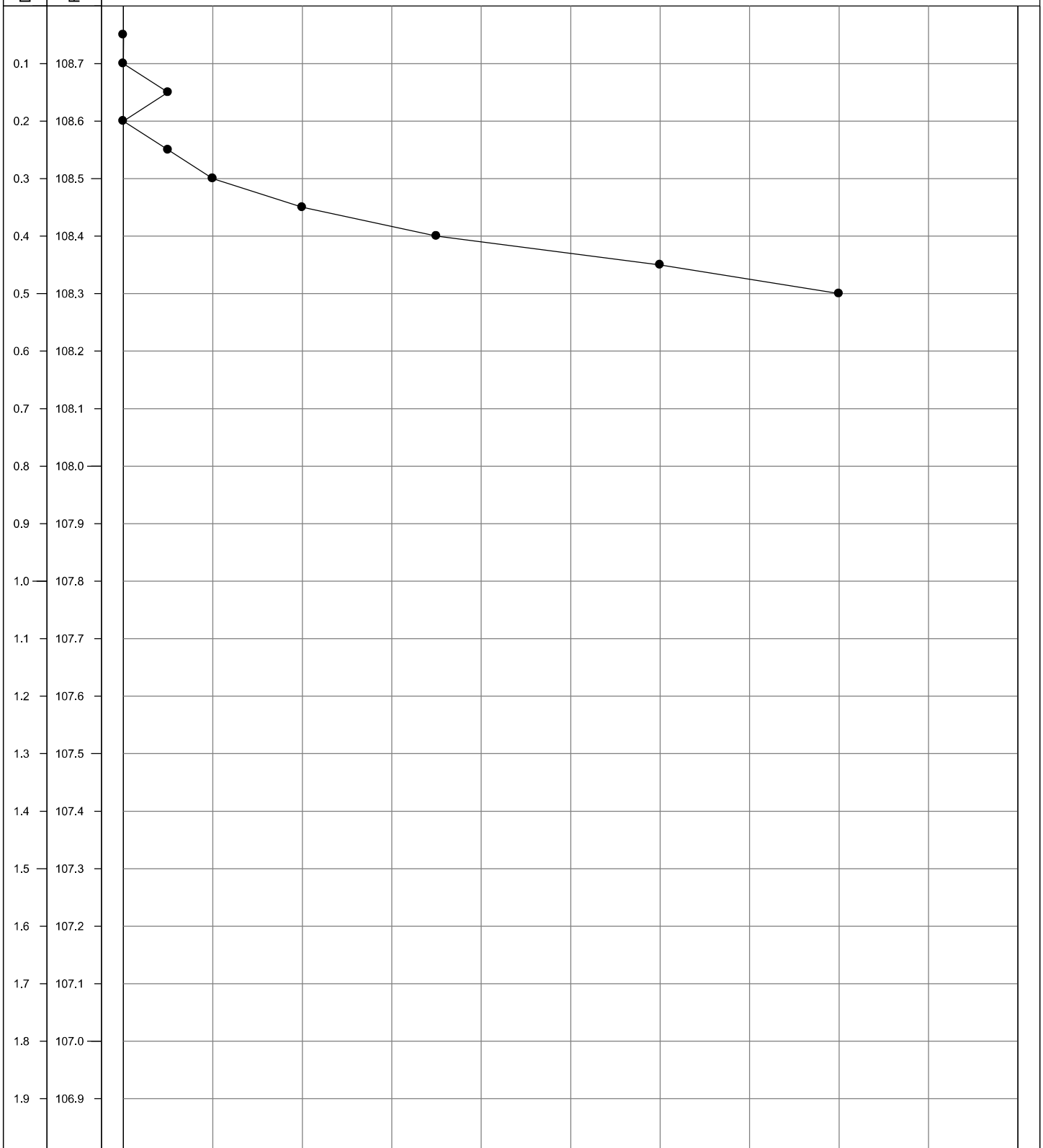
For Explanation of Symbols and Abbreviations See Key Sheet

DCP Report

Borehole ID: AR112275-GE-DCP-006

Project:	Project Velocity - 43-47 Allens Rd (Ashburton)	**Project number:**	3160491/AR112275
Site location:	43-47 Allens Rd, Allenton, Ashburton	**Client name:**	Kainga Ora
Location:	Centre of back yard.	**Coordinate system:**	NZTM2000
		Northing:	5139921.6
		Easting:	1498864.8
		Vertical datum:	LVD
		Ground level (mRL):	108.80
		Location method:	Survey

Dynamic Cone Penetrometer Blow Count



Date started:	05/04/2023	**Date end:**	05/04/2023
Logged by:	JB	**Tested by:**	Beca Limited
Equipment:	9Kg DCP	**Method:**	NZS 4402.6.5.2:1988

Comments:
Terminated on contact with inferred gravel unit.

For Explanation of Symbols and Abbreviations See Key Sheet

E

Appendix E – Raw CPT Data

6 April 2023
Our Ref: 1020961.0057.0.0/Rep01
Customer Ref: 6232030

Kainga Ora – Homes and Communities
107 Carlton Gore Road
Newmarket
Auckland 1023

Attention: David Dobson

Dear David

43 - 47 Allens Road, Ashburton

Site Report – Piezocone Penetration Testing

Customer's Instructions

We were instructed to complete:

- Three Piezocone 100 MPa penetration tests CPT01, CPT02, and CPT03 to a target depth of 20 m or refusal.

Specifications

None issued.

Date of Procedures

5th April 2023

Locations

Test locations were determined by the customer.

The attached plan provides indicative locations only and is not to scale. All other information we provide regarding location should be referenced to the asset owner.

Coordinates are provided in the CPT plots.

a Method used to determine locations: GPS\GNSS (Handheld)
b Method used to determine RL: GPS\GNSS (Handheld)
c Expected accuracy for location: 10 m
d Expected accuracy for elevation: 10 m

Method

ISO 22476-1: 2012(E) - Geotechnical investigation and testing – Field testing – Part 1: Electrical cone and piezocone penetration test

Results

The following is attached:

- CPT plots.
- Probe calibration certificate.

Raw CPTu data files have been supplied via email.

Test Remarks

Test IDs	CPT01, CPT02, CPT03
Operator	CHES
Machine	Ingenjörsfirman Geotech AB 220, capacity 200 kN
Cone	Probe No 4592
	Porewater Pressure Location u_2, Glycerine Saturated
Friction Reducer	Ring type, Outer diameter 46mm, Amount 1, Located at 0.50m behind the base of the cone

CPT01 -

Target Depth:	20m
Predrill Depth:	0m
Penetration Length:	2.02m
Actual Depth:	2.02m
Operation Date:	05/04/2023
Coordinates:	NZTM - N 5139882 E 1498865 116m (amsl)
Ground Water Level:	N/A
Test Notes:	Test refusal at 2.02m > 45 MPa, anchor failure
Other Tests:	None

	qc (MPa)	fs (kPa)	u2 (kPa)
$Baseline_{Inital}$	11.11	133.90	261.30
$Baseline_{(Initial - Final)}$	-0.02	0.50	0.50
% of $MSO_{(Initial - Final)}$	-0.04	0.10	3.23
Max Measure value	48.69	498.30	15.50

Meets ISO 22476-1:2012 - Application class 3

CPT02 -

Target Depth:	20m
Predrill Depth:	0m
Penetration Length:	0.5m
Actual Depth:	0.5m
Operation Date:	05/04/2023
Coordinates:	NZTM - N 5139907 E 1498858 116m (amsl)
Ground Water Level:	N/A
Test Notes:	Test refusal at 0.5m > 13MPa, anchor failure
Other Tests:	None

	qc (MPa)	fs (kPa)	u2 (kPa)
$Baseline_{Inital}$	11.07	133.80	261.20
$Baseline_{(Initial - Final)}$	-0.01	0.00	-1.00
% of $MSO_{(Initial - Final)}$	-0.07	0.00	-15.15
Max Measure value	13.26	77.10	6.60

Meets ISO 22476-1:2012 - Application class 4

CPT03 -

Target Depth:	20m
Predrill Depth:	0m
Penetration Length:	0.96m
Actual Depth:	0.96m
Operation Date:	05/04/2023
Coordinates:	NZTM - N 5139903 E 1498891 116m (amsl)
Ground Water Level:	N/A
Test Notes:	Test refusal at 0.96m > 70MPa, danger of breaking equipment
Other Tests:	None

	qc (MPa)	fs (kPa)	u2 (kPa)
$Baseline_{Inital}$	11.08	133.80	261.00
$Baseline_{(Initial - Final)}$	0.00	-0.90	0.00
% of $MSO_{(Initial - Final)}$	0.01	-0.20	0.00
Max Measure value	71.36	453.80	16.90

Meets ISO 22476-1:2012 - Application class 3

Raw Data: The data presented in this report is factual and based on the results of CPTu testing undertaken with reasonable diligence. Any interpretation of the data is the sole responsibility of the user.

Measured Water Levels: Where water level measurements are reported, the depth was determined immediately after the test with an electronic water level meter. Where water level measurement was not successful, a hydrostatic line of best fit was added to the CPTu plot and is noted in the report as 'assumed'.

Penetration Speed: Adding 1 m length rods requires a pause in penetration and the testing is therefore non-continuous. Where materials may damage equipment, penetration speed is reduced to protect equipment and limit inclination deviation. Penetration speed is recorded in the tab data and when reduced to <20 mm/second is not in accordance with the test method.

Tip Resistance (q_c): The CPTu plots show tip resistance as q_c.

The static pore water pressure line shown is assumed to be hydrostatic from the phreatic surface. The validity of this assumption must be checked by the user.

Pore Pressure (u_2): The test method for taking pore pressure readings may not be suitable for the type of material being tested. Therefore, the corrected or calculated parameters bases on u_2 values are not included in this report.

Friction Ratio (Rf): There is no offset between tip resistance and sleeve friction used for friction ratio determination.

General Remarks

This report has been prepared for the benefit of Kainga Ora – Homes and Communities, with respect to the particular brief given to us and it cannot be relied upon in other contexts or for any other purpose without our prior review and agreement.

The inherent uncertainties of site investigation work, mean the nature and continuity of subsoil away from the test location could vary from the data logged.

Material descriptions are not covered under the IANZ endorsement of this report.

As agreed, we have forwarded a copy of our unlocked spreadsheets. We take no responsibility for alteration or loss of data in the electronic transfer/transmittal, or manipulation of the data after it has been transmitted.

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

If we can be of any further assistance, feel free to get in touch. Contact details are provided at the bottom of the letterhead page.

GEOTECHNICS LTD

Report approved by:

.....
Jeremy Brokenshire
Project Manager
Key Technical Person

Authorised for Geotechnics by:

.....
Alan Benton
Project Director

ACCREDITED IANZ TESTING LABORATORY

All tests reported herein have been performed in accordance with the laboratory's scope of accreditation

6-Apr-23
t:\geotechnicsgroup\projects\1020961\1020961.0057 - ko 43-47 allens road\workingmaterial\processing\20230405.juwa.1020961.0057.0.0.rep01.43 - 47 allens road.docx

Legend	
CPT Location	△

GEOTECHNICS	**LOCATION PLAN**	**43 – 47 Allens Road, Ashburton – 5th April 2023**						Locations are indicative only	
45A Parkhouse Road Wigram Christchurch		Site	43 – 47 Allens Road	Our Ref	1020961.0057.0.0/Rep01	Drawn By	JUWA	Date	6/04/23
		Location	Ashburton	Customer Ref	6232030	Checked By	JEBR	Date	6/04/23
		Project	G CH KO 43 - 47 Allens Road	Lab Ref	N/A	Scale	Not to Scale		N

Aerial photograph sourced from Google Earth (Copyright 2023).

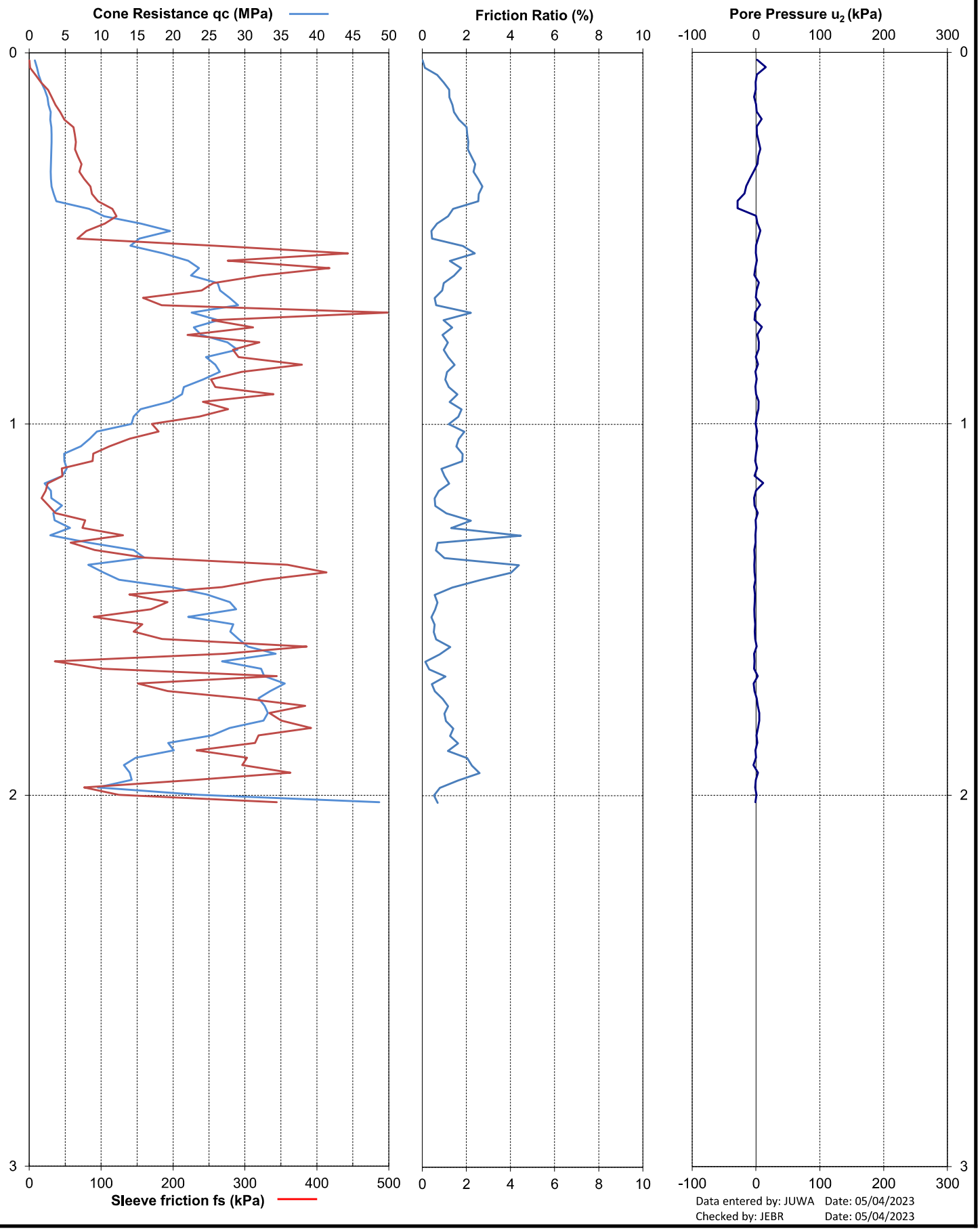
CPT01 43 Allens Road, Ashburton - 05 April, 2023

Pre-Drill:	0m	**NZTM**	1498865mE 5139882mN 116m(amsl)
Assumed GWL:	N/A	**Other Tests:**	None
Operator:	CHES	**Comments:**	Test refusal at 2.02m > 45 MPa, anchor failure
Located By:	Hand GPS/GE (el)		

45a Parkhouse Rd, Christchurch
e. christchurch@geotechnics.co.nz
p.+64 (0)3 361 0300

GEOTECHNICS

Geotechnics Ref: 1020961.0057.0.0/REP01



Data entered by: JUWA Date: 05/04/2023
Checked by: JEBR Date: 05/04/2023

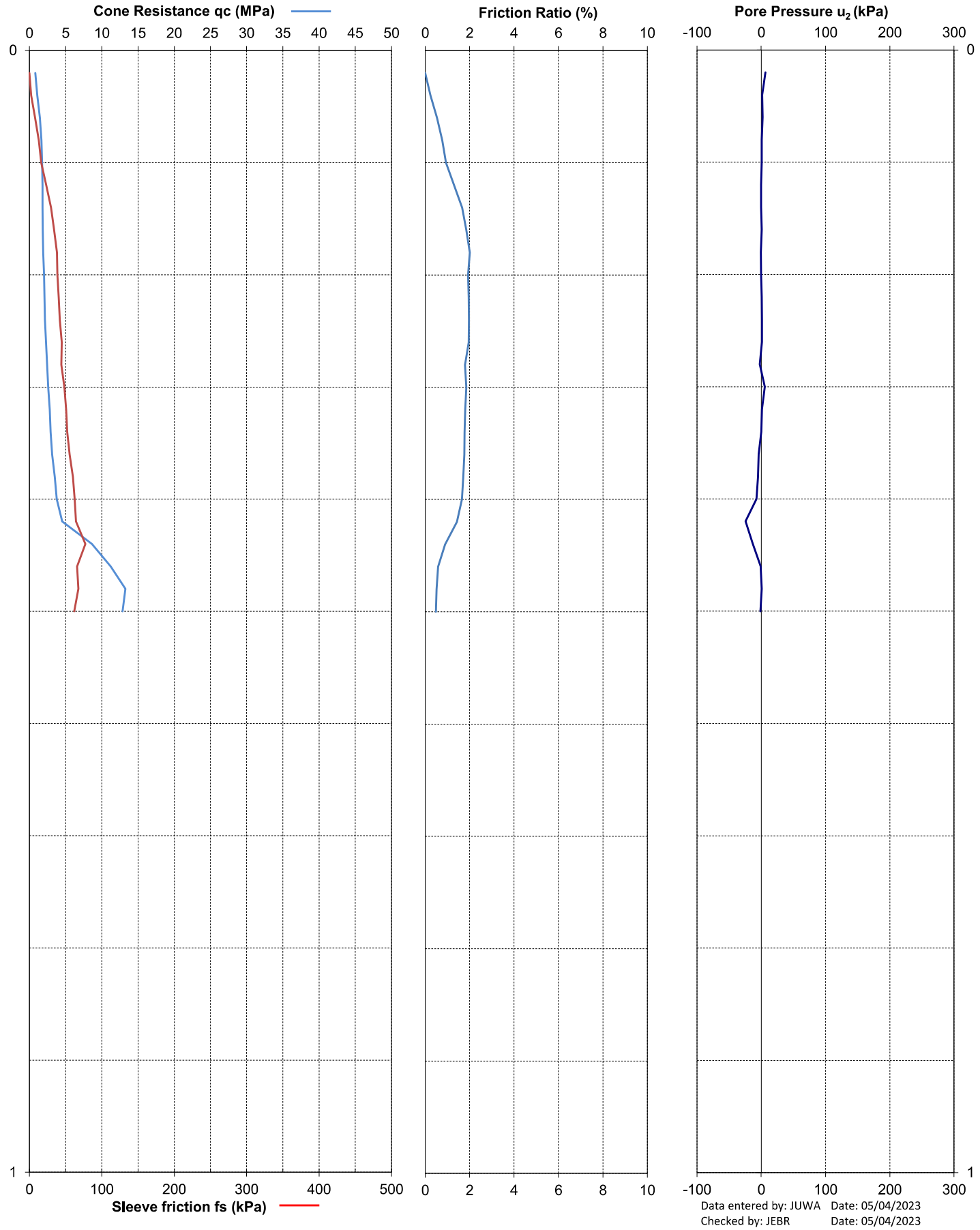
CPT02 45 Allens Road, Ashburton - 05 April, 2023

Pre-Drill:	0m	**NZTM**	1498858mE 5139907mN 116m(amsl)
Assumed GWL:	N/A	**Other Tests:**	None
Operator:	CHES	**Comments:**	Test refusal at 0.5m > 13MPa, anchor failure
Located By:	Hand GPS/GE (el)		

45a Parkhouse Rd, Christchurch
e. christchurch@geotechnics.co.nz
p.+64 (0)3 361 0300

GEOTECHNICS

Geotechnics Ref: 1020961.0057.0.0/REP01



Data entered by: JUWA Date: 05/04/2023
Checked by: JEBR Date: 05/04/2023

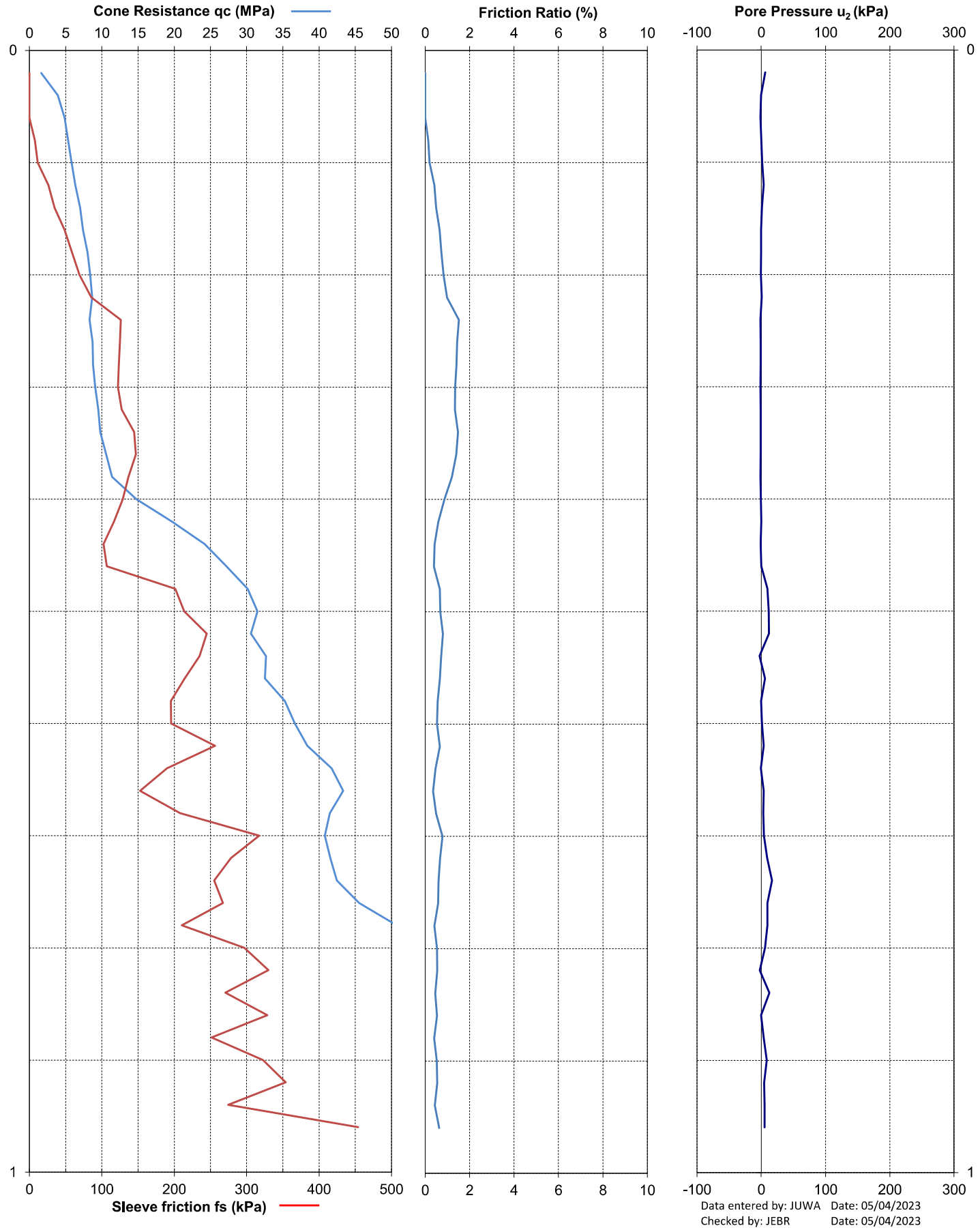
CPT03 47 Allens Road, Ashburton - 05 April, 2023

45a Parkhouse Rd, Christchurch
e. christchurch@geotechnics.co.nz
p.+64 (0)3 361 0300

GEOTECHNICS

Pre-Drill:	0m	**NZTM**	1498891mE 5139903mN 116m(amsl)
Assumed GWL:	N/A	**Other Tests:**	None
Operator:	CHES	**Comments:**	Test refusal at 0.96m > 70MPa, danger of breaking equipment
Located By:	Hand GPS/GE (el)		

Geotechnics Ref: 1020961.0057.0.0/REP01



Data entered by: JUWA Date: 05/04/2023
Checked by: JEBR Date: 05/04/2023

F

Appendix F – Liquefaction Assessment Results

Beca Ltd
Level 2, ANZ Center
267 High Street, Christchurch, 8011
www.beca.com

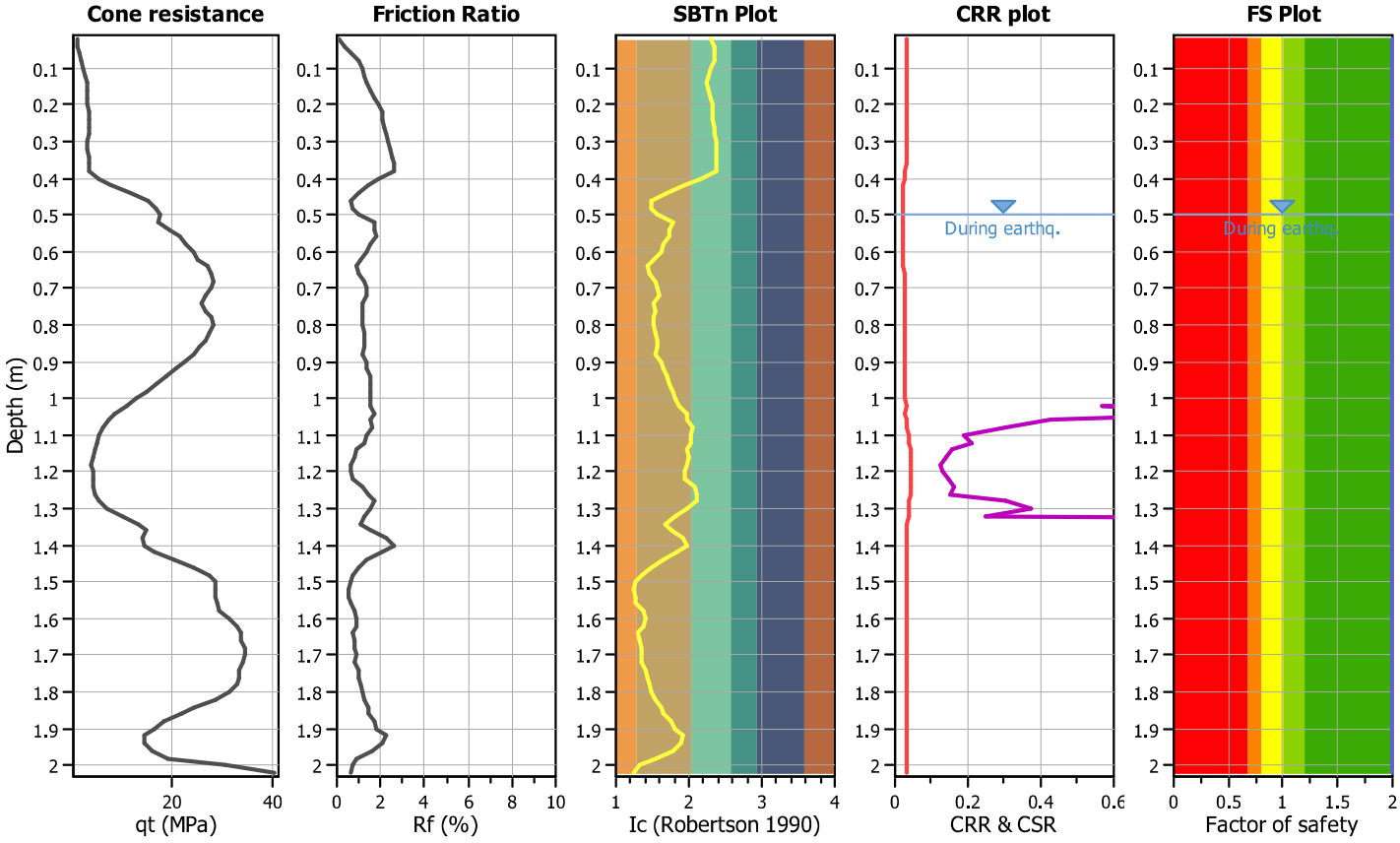
LIQUEFACTION ANALYSIS REPORT

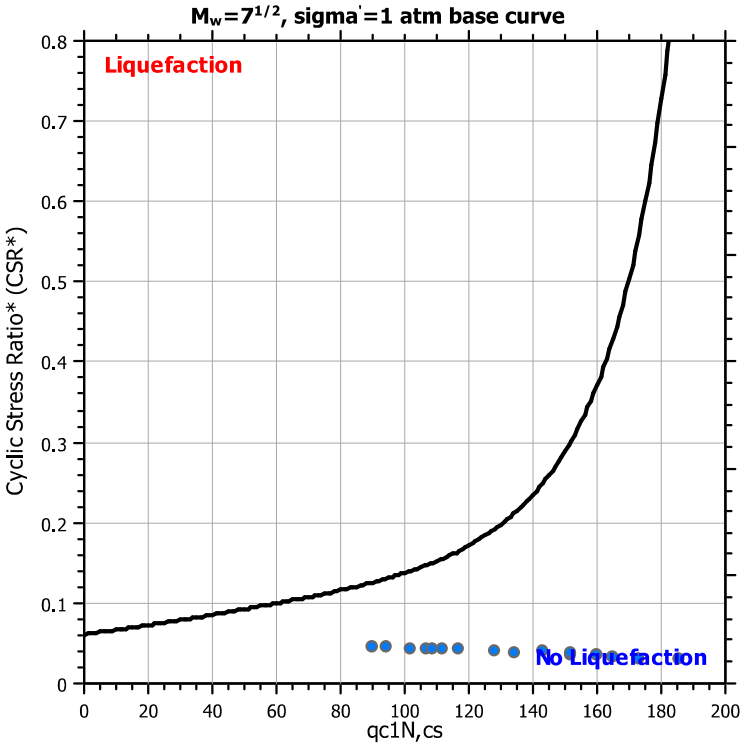
Project title : Kainga Ora Project Velocity **Location : 43-47 Allens Road, Ashburton**

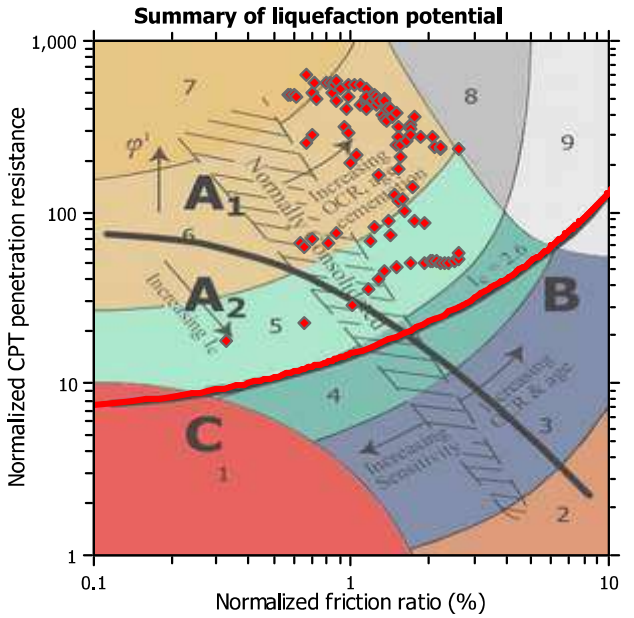
CPT file : CPT01 SLS

Input parameters and analysis data

Analysis method:	B&I (2014)	G.W.T. (in-situ):	0.50 m	Use fill:	No	Clay like behavior applied:	Sand & Clay
Fines correction method:	B&I (2014)	G.W.T. (earthq.):	0.50 m	Fill height:	N/A	Limit depth applied:	No
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth:	N/A
Earthquake magnitude M_w:	6.10	Ic cut-off value:	2.60	Trans. detect. applied:	No	MSF method:	Method
Peak ground acceleration:	0.06	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		

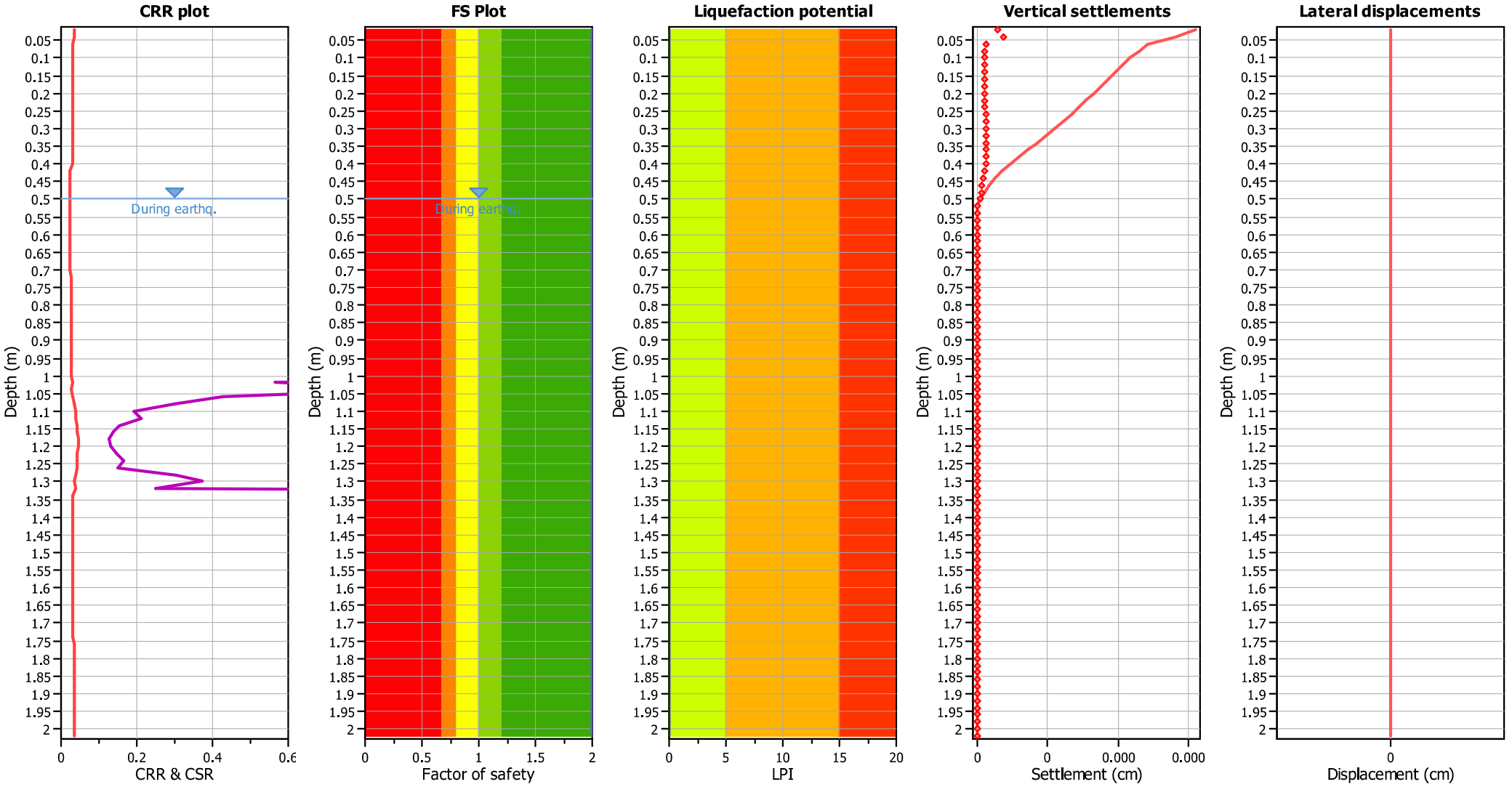






Zone A_1: Cyclic liquefaction likely depending on size and duration of cyclic loading
Zone A_2: Cyclic liquefaction and strength loss likely depending on loading and ground geometry
Zone B: Liquefaction and post-earthquake strength loss unlikely, check cyclic softening
Zone C: Cyclic liquefaction and strength loss possible depending on soil plasticity, brittleness/sensitivity, strain to peak undrained strength and ground geometry

Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	0.50 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.10	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.06	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	0.50 m	Fill height:	N/A	Limit depth:	N/A

F.S. color scheme

- Almost certain it will liquefy
- Very likely to liquefy
- Liquefaction and no liq. are equally likely
- Unlike to liquefy
- Almost certain it will not liquefy

LPI color scheme

- Very high risk
- High risk
- Low risk

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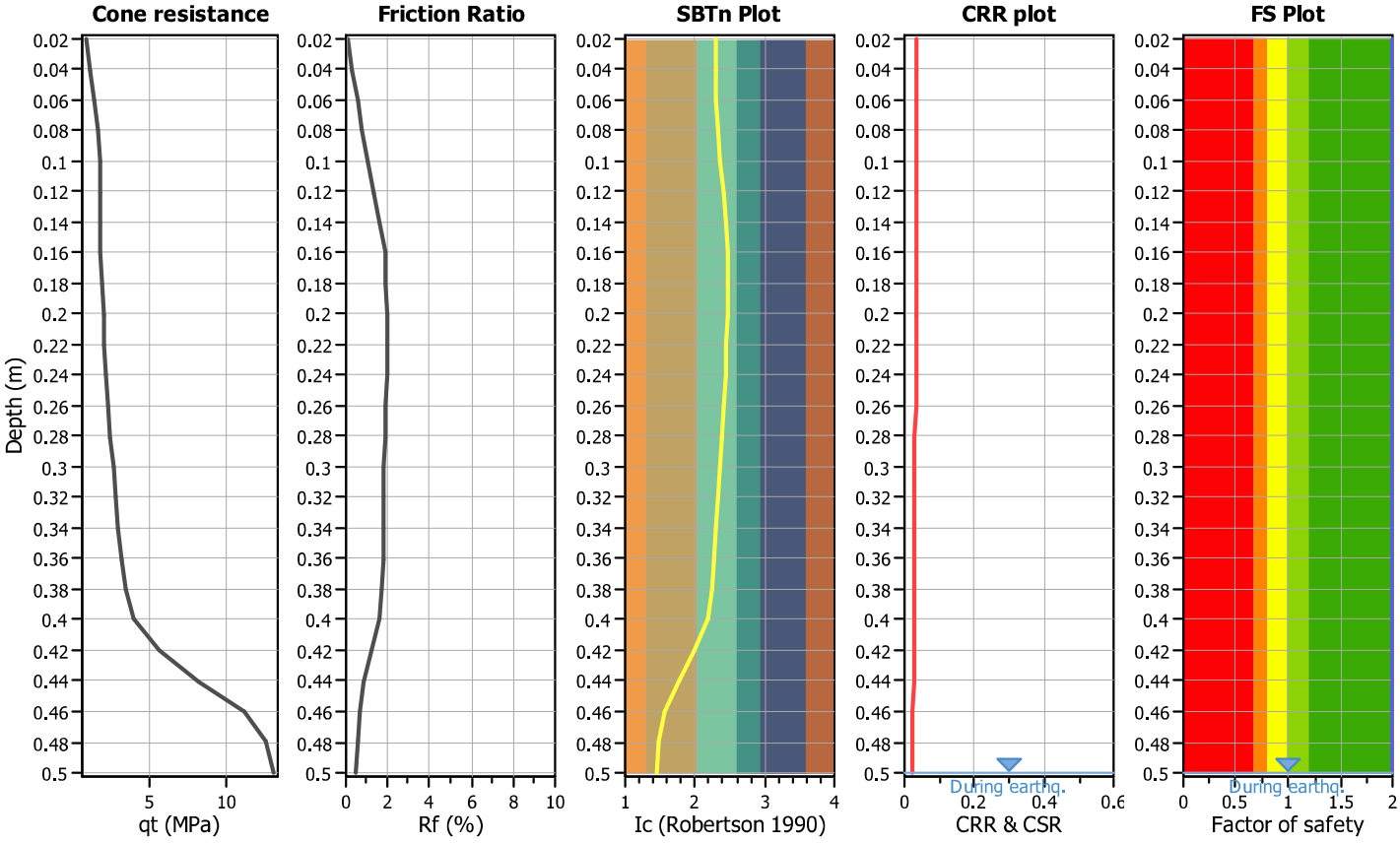
LIQUEFACTION ANALYSIS REPORT

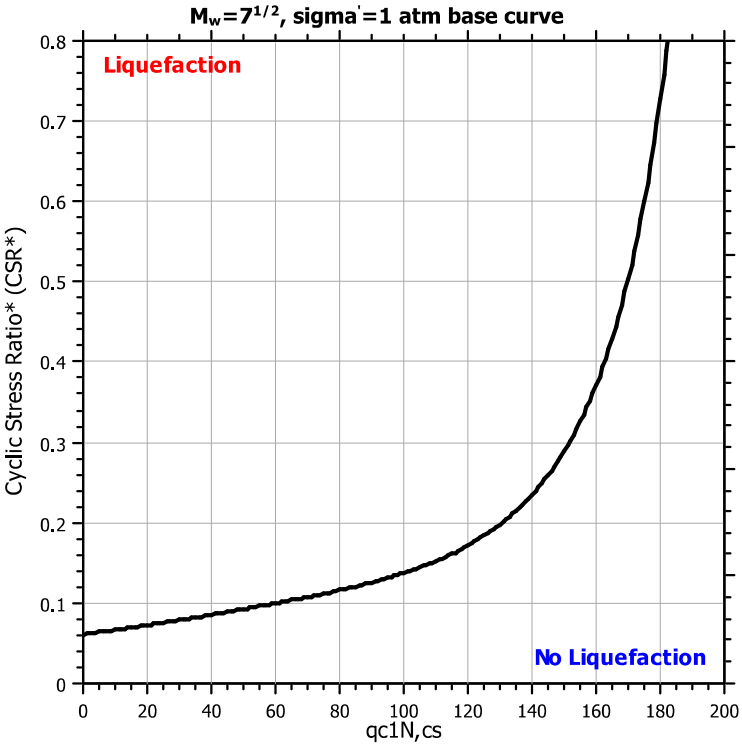
Project title : Kainga Ora Project Velocity **Location : 43-47 Allens Road, Ashburton**

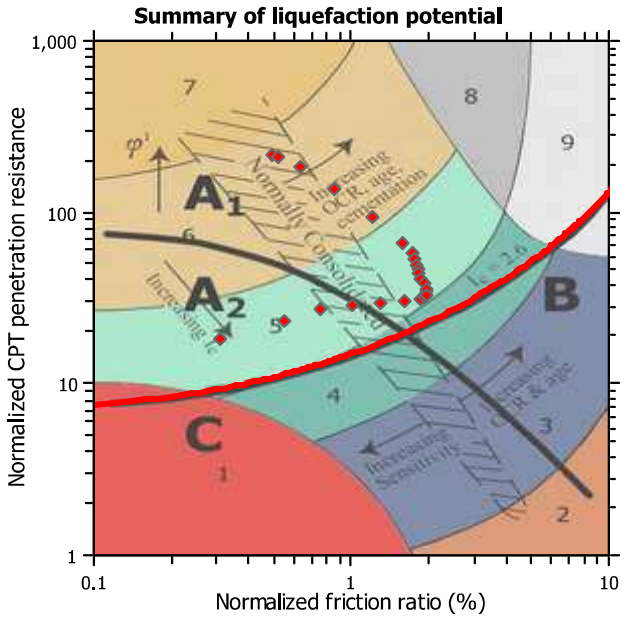
CPT file : CPT02 SLS

Input parameters and analysis data

Analysis method:	B&I (2014)	G.W.T. (in-situ):	0.50 m	Use fill:	No	Clay like behavior applied:	Sand & Clay
Fines correction method:	B&I (2014)	G.W.T. (earthq.):	0.50 m	Fill height:	N/A	Limit depth applied:	No
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth:	N/A
Earthquake magnitude M_w:	6.10	Ic cut-off value:	2.60	Trans. detect. applied:	No	MSF method:	Method
Peak ground acceleration:	0.06	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		

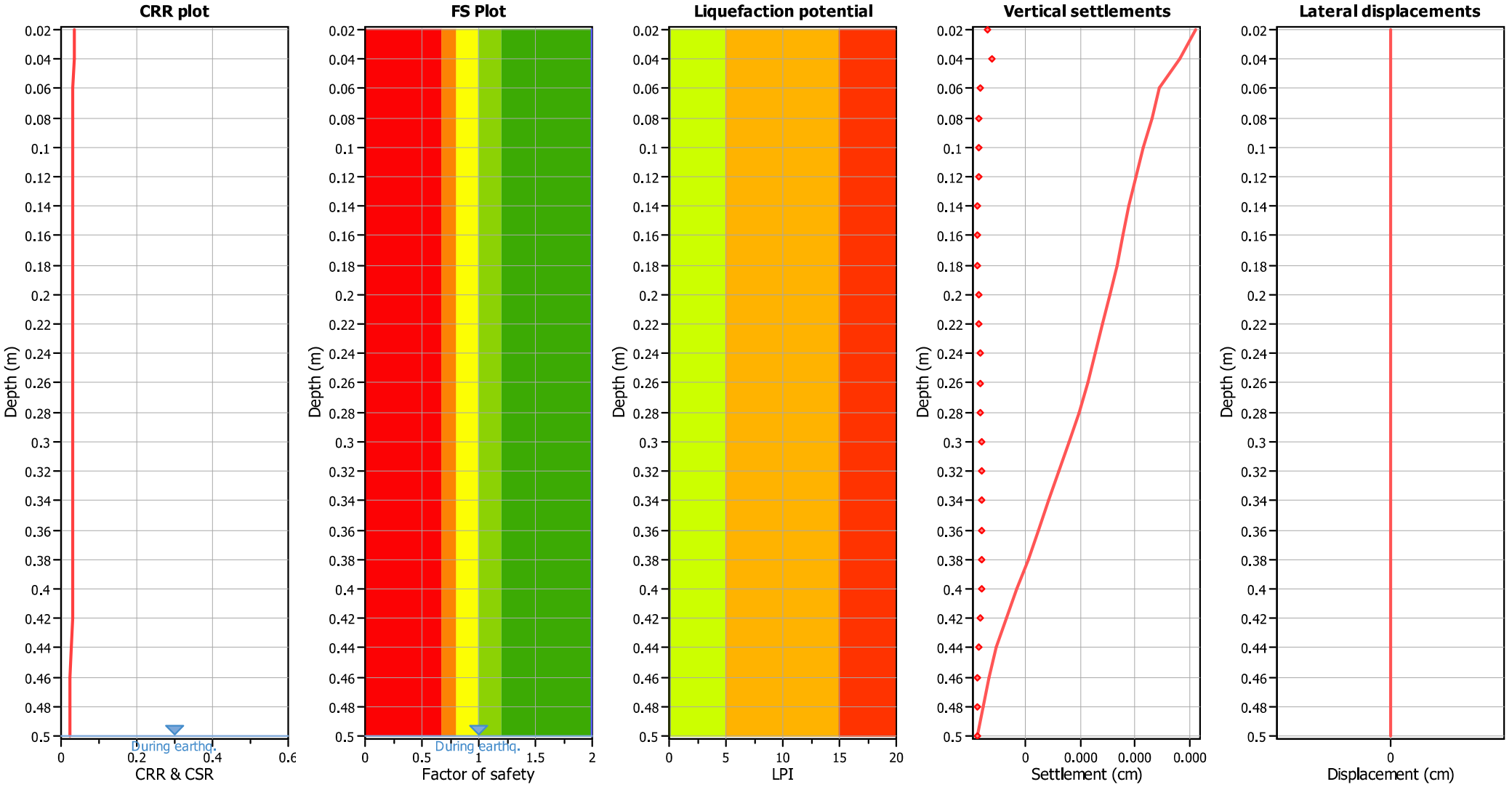






Zone A_1: Cyclic liquefaction likely depending on size and duration of cyclic loading
Zone A_2: Cyclic liquefaction and strength loss likely depending on loading and ground geometry
Zone B: Liquefaction and post-earthquake strength loss unlikely, check cyclic softening
Zone C: Cyclic liquefaction and strength loss possible depending on soil plasticity, brittleness/sensitivity, strain to peak undrained strength and ground geometry

Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	0.50 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.10	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.06	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	0.50 m	Fill height:	N/A	Limit depth:	N/A

F.S. color scheme

- Almost certain it will liquefy
- Very likely to liquefy
- Liquefaction and no liq. are equally likely
- Unlike to liquefy
- Almost certain it will not liquefy

LPI color scheme

- Very high risk
- High risk
- Low risk

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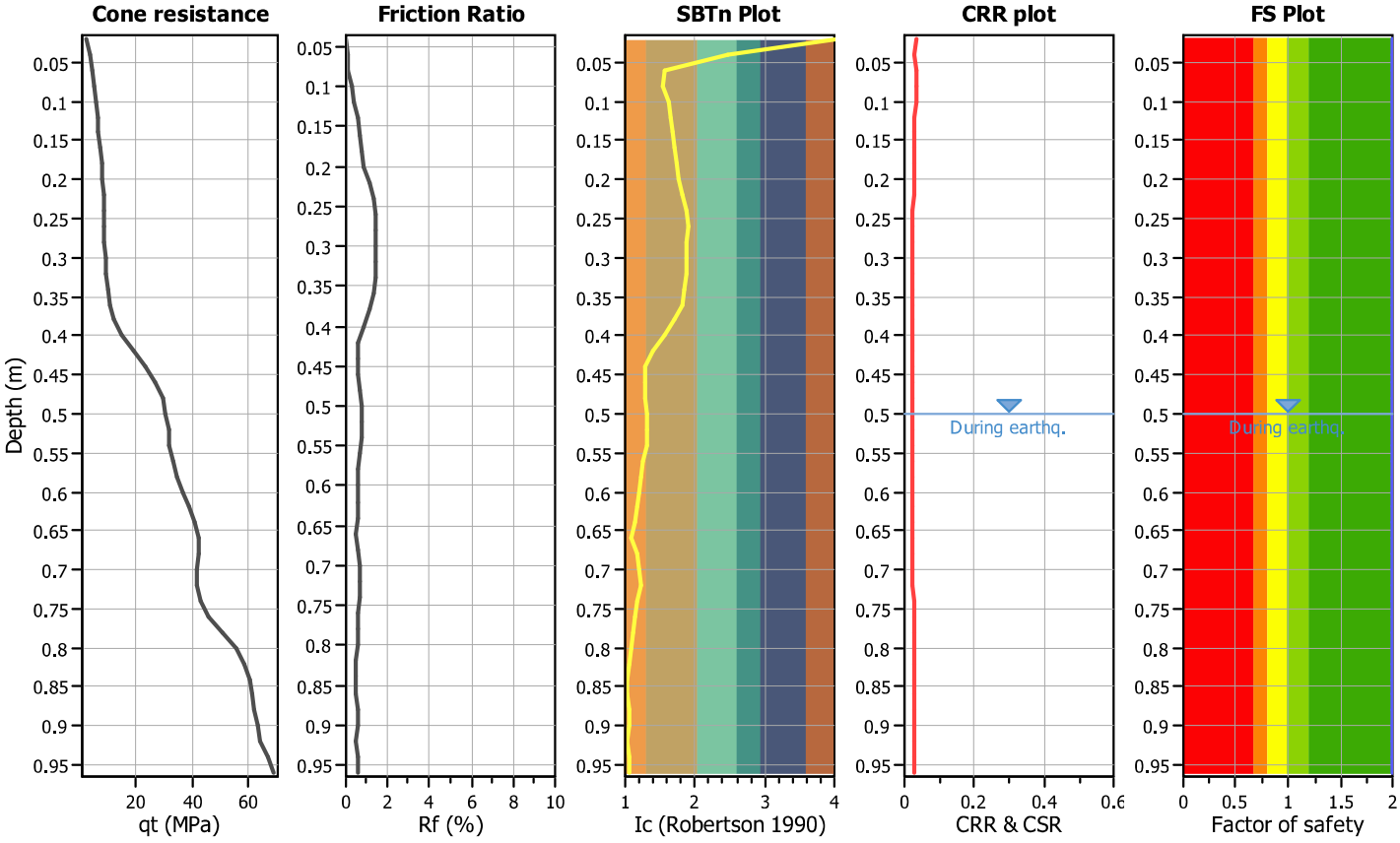
LIQUEFACTION ANALYSIS REPORT

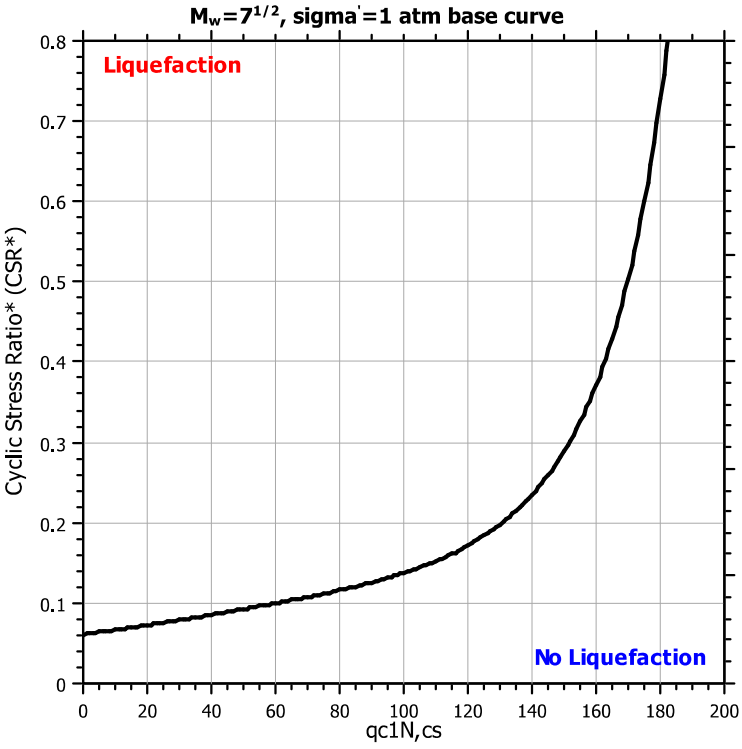
Project title : Kainga Ora Project Velocity **Location : 43-47 Allens Road, Ashburton**

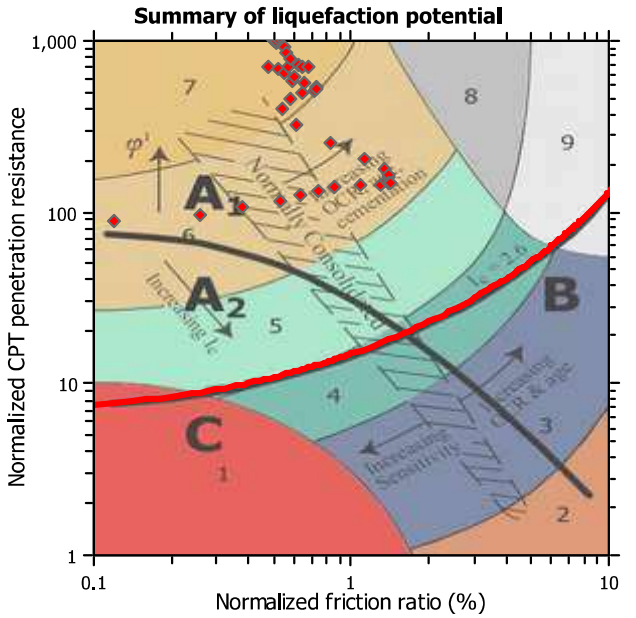
CPT file : CPT03 SLS

Input parameters and analysis data

Analysis method:	B&I (2014)	G.W.T. (in-situ):	0.50 m	Use fill:	No	Clay like behavior applied:	Sand & Clay
Fines correction method:	B&I (2014)	G.W.T. (earthq.):	0.50 m	Fill height:	N/A	Limit depth applied:	No
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth:	N/A
Earthquake magnitude M_w:	6.10	Ic cut-off value:	2.60	Trans. detect. applied:	No	MSF method:	Method
Peak ground acceleration:	0.06	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		

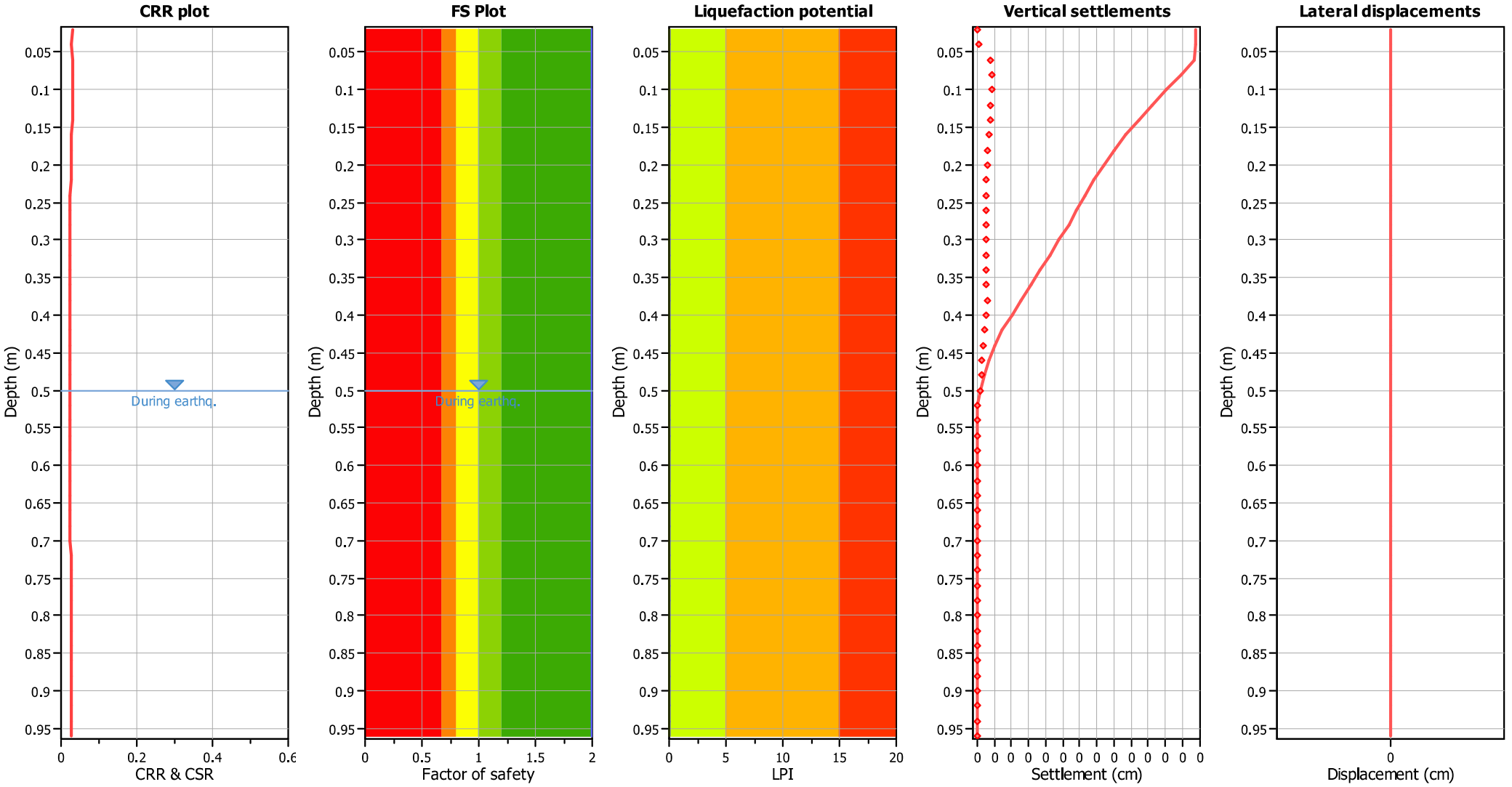






Zone A_1: Cyclic liquefaction likely depending on size and duration of cyclic loading
Zone A_2: Cyclic liquefaction and strength loss likely depending on loading and ground geometry
Zone B: Liquefaction and post-earthquake strength loss unlikely, check cyclic softening
Zone C: Cyclic liquefaction and strength loss possible depending on soil plasticity, brittleness/sensitivity, strain to peak undrained strength and ground geometry

Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	0.50 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.10	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.06	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	0.50 m	Fill height:	N/A	Limit depth:	N/A

F.S. color scheme

- Almost certain it will liquefy
- Very likely to liquefy
- Liquefaction and no liq. are equally likely
- Unlike to liquefy
- Almost certain it will not liquefy

LPI color scheme

- Very high risk
- High risk
- Low risk

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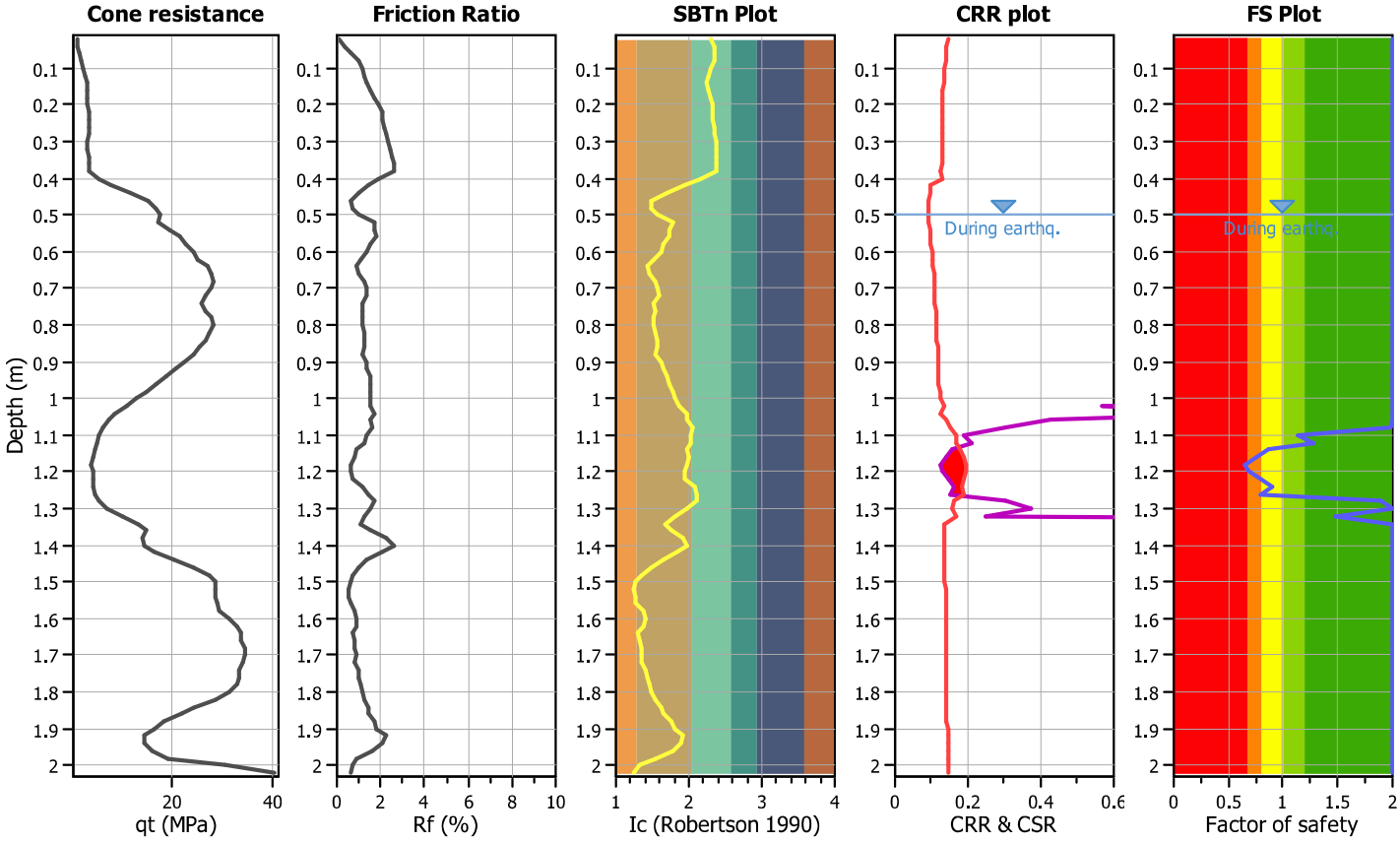
LIQUEFACTION ANALYSIS REPORT

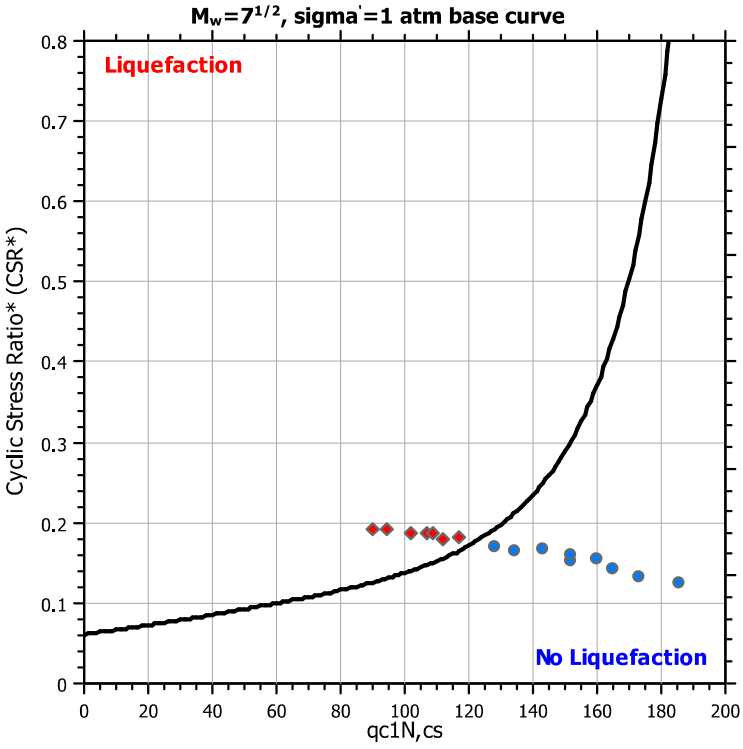
Project title : Kainga Ora Project Velocity **Location : 43-47 Allens Road, Ashburton**

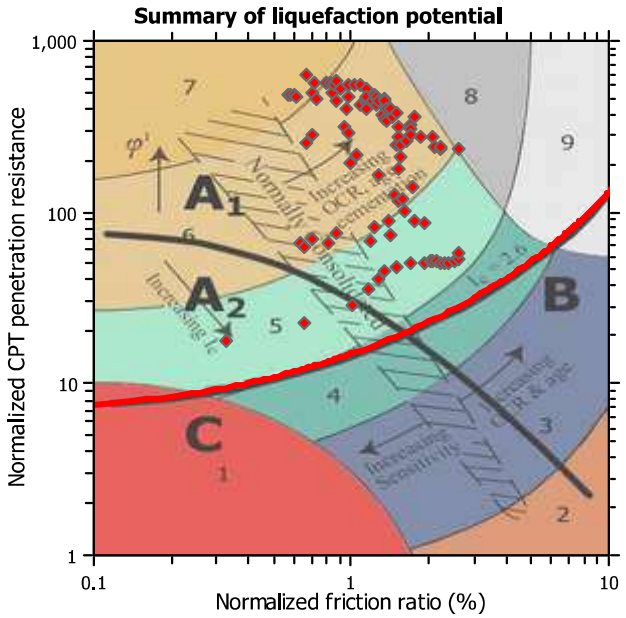
CPT file : CPT01 ULS

Input parameters and analysis data

Analysis method:	B&I (2014)	G.W.T. (in-situ):	0.50 m	Use fill:	No	Clay like behavior applied:	Sand & Clay
Fines correction method:	B&I (2014)	G.W.T. (earthq.):	0.50 m	Fill height:	N/A	Limit depth applied:	No
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth:	N/A
Earthquake magnitude M_w:	6.10	Ic cut-off value:	2.60	Trans. detect. applied:	No	MSF method:	Method
Peak ground acceleration:	0.26	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		

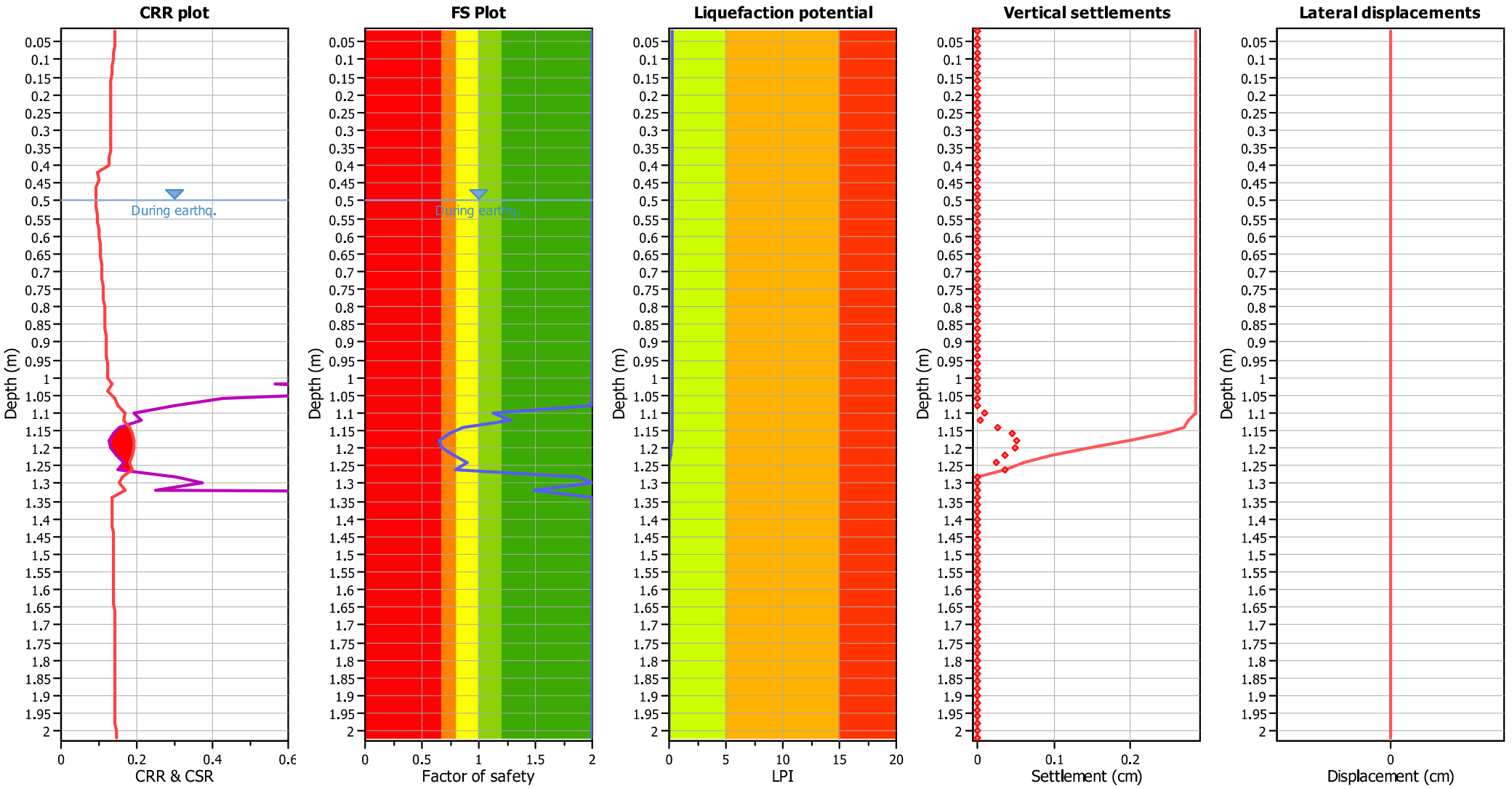






Zone A_1: Cyclic liquefaction likely depending on size and duration of cyclic loading
Zone A_2: Cyclic liquefaction and strength loss likely depending on loading and ground geometry
Zone B: Liquefaction and post-earthquake strength loss unlikely, check cyclic softening
Zone C: Cyclic liquefaction and strength loss possible depending on soil plasticity, brittleness/sensitivity, strain to peak undrained strength and ground geometry

Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	0.50 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.10	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.26	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	0.50 m	Fill height:	N/A	Limit depth:	N/A

F.S. color scheme

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- Liquefaction and no liq. are equally likely
- Unlike to liquefy
- Almost certain it will not liquefy

LPI color scheme

- Very high risk
- High risk
- Low risk

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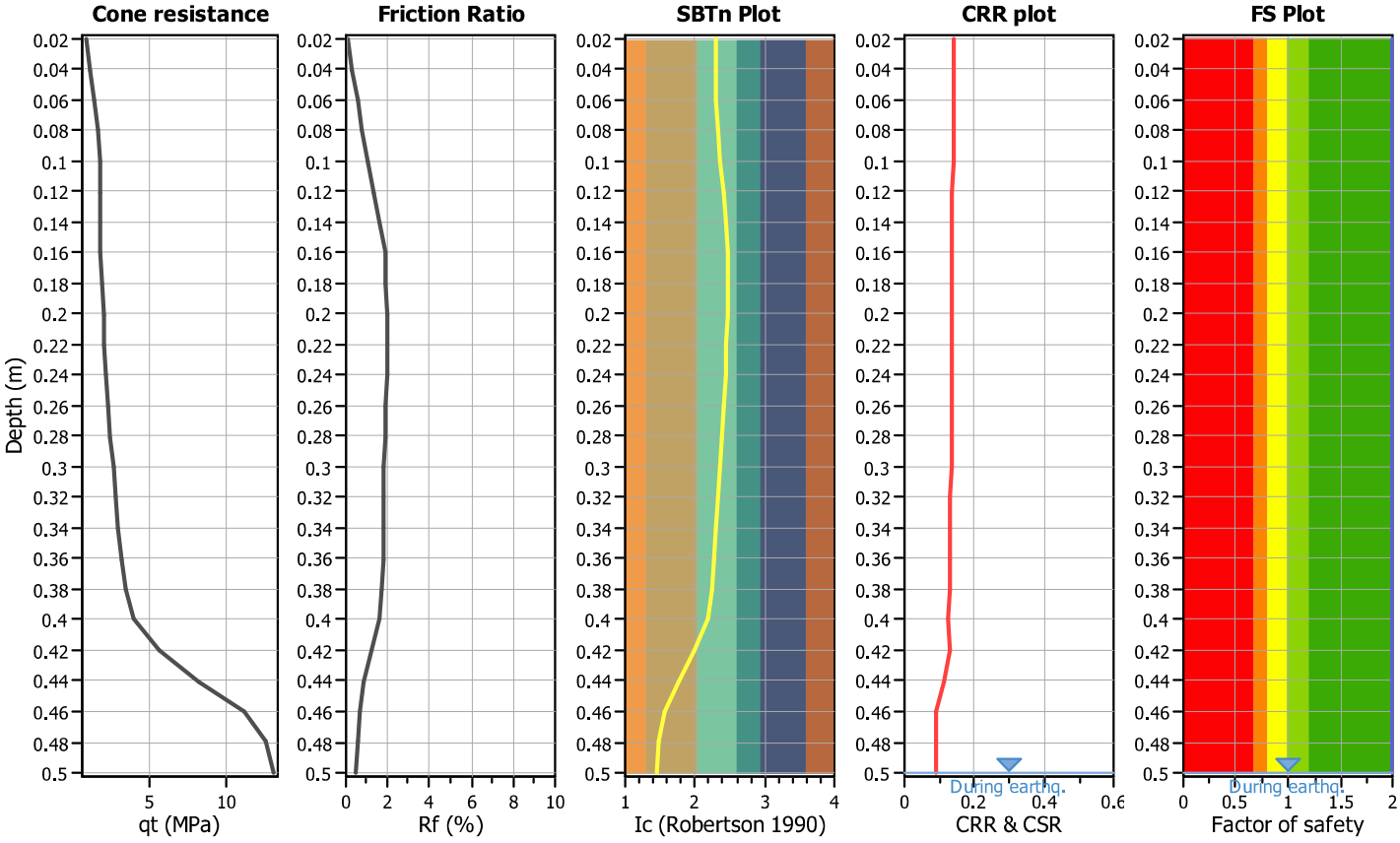
LIQUEFACTION ANALYSIS REPORT

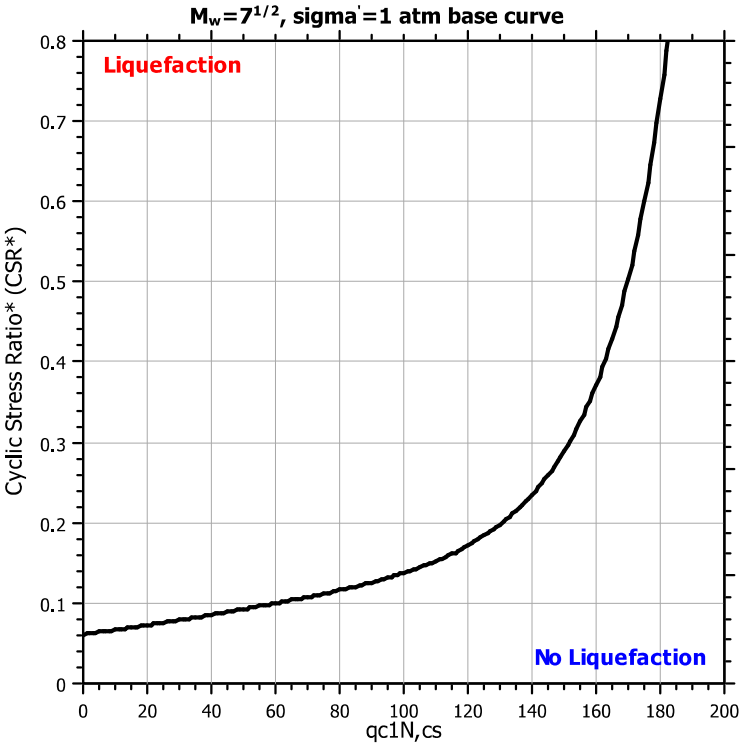
Project title : Kainga Ora Project Velocity **Location : 43-47 Allens Road, Ashburton**

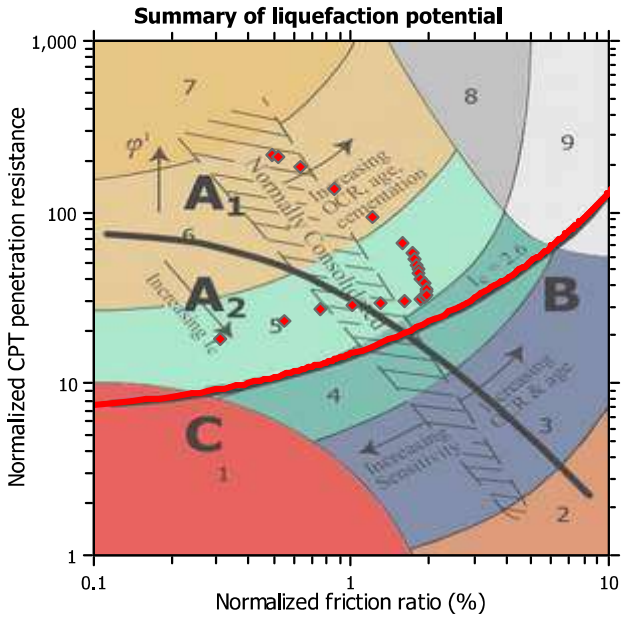
CPT file : CPT02 ULS

Input parameters and analysis data

Analysis method:	B&I (2014)	G.W.T. (in-situ):	0.50 m	Use fill:	No	Clay like behavior applied:	Sand & Clay
Fines correction method:	B&I (2014)	G.W.T. (earthq.):	0.50 m	Fill height:	N/A	Limit depth applied:	No
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth:	N/A
Earthquake magnitude M_w:	6.10	Ic cut-off value:	2.60	Trans. detect. applied:	No	MSF method:	Method
Peak ground acceleration:	0.26	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		

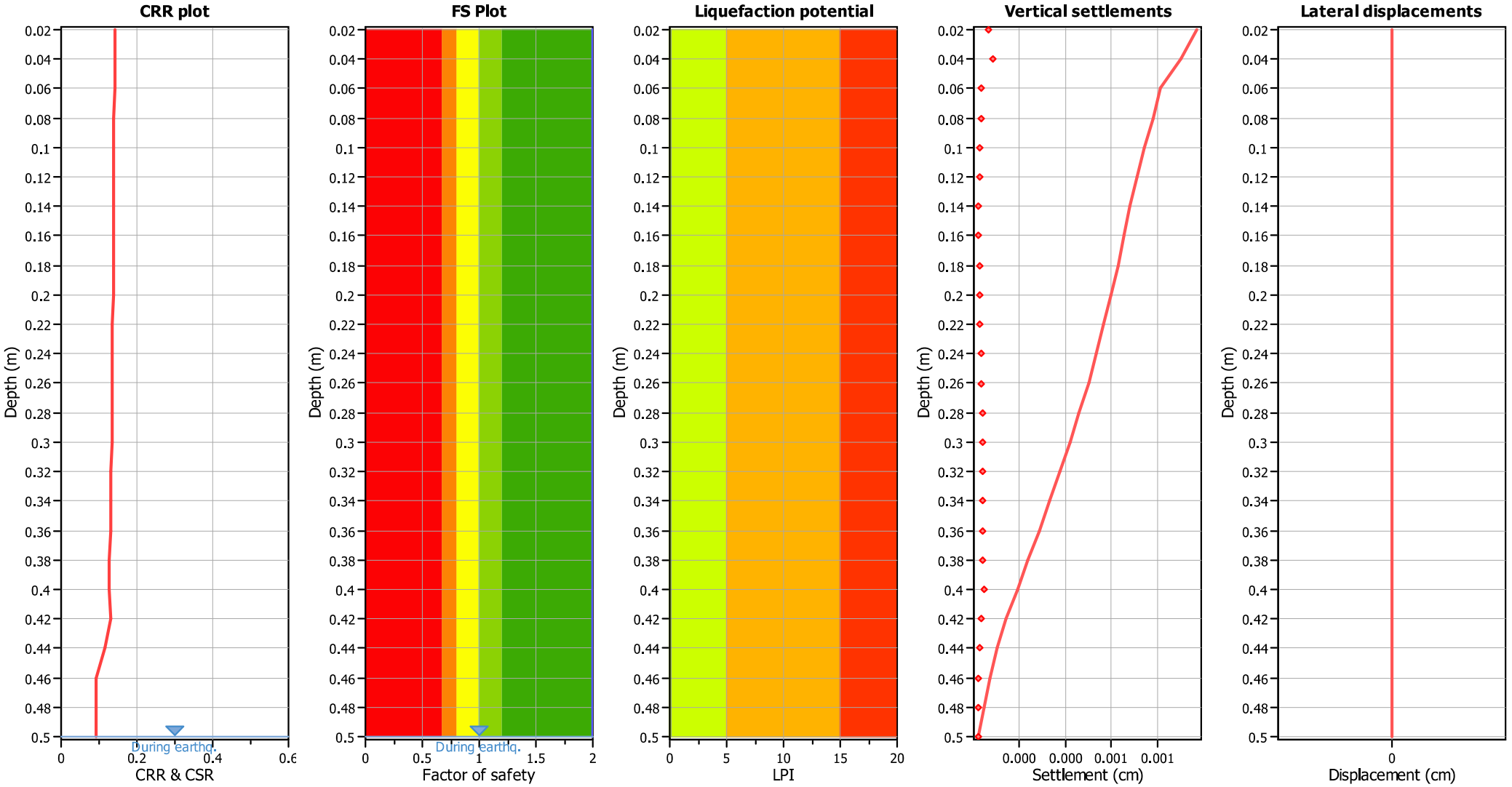






Zone A_1: Cyclic liquefaction likely depending on size and duration of cyclic loading
Zone A_2: Cyclic liquefaction and strength loss likely depending on loading and ground geometry
Zone B: Liquefaction and post-earthquake strength loss unlikely, check cyclic softening
Zone C: Cyclic liquefaction and strength loss possible depending on soil plasticity, brittleness/sensitivity, strain to peak undrained strength and ground geometry

Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	0.50 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.10	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.26	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	0.50 m	Fill height:	N/A	Limit depth:	N/A

F.S. color scheme

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LPI color scheme

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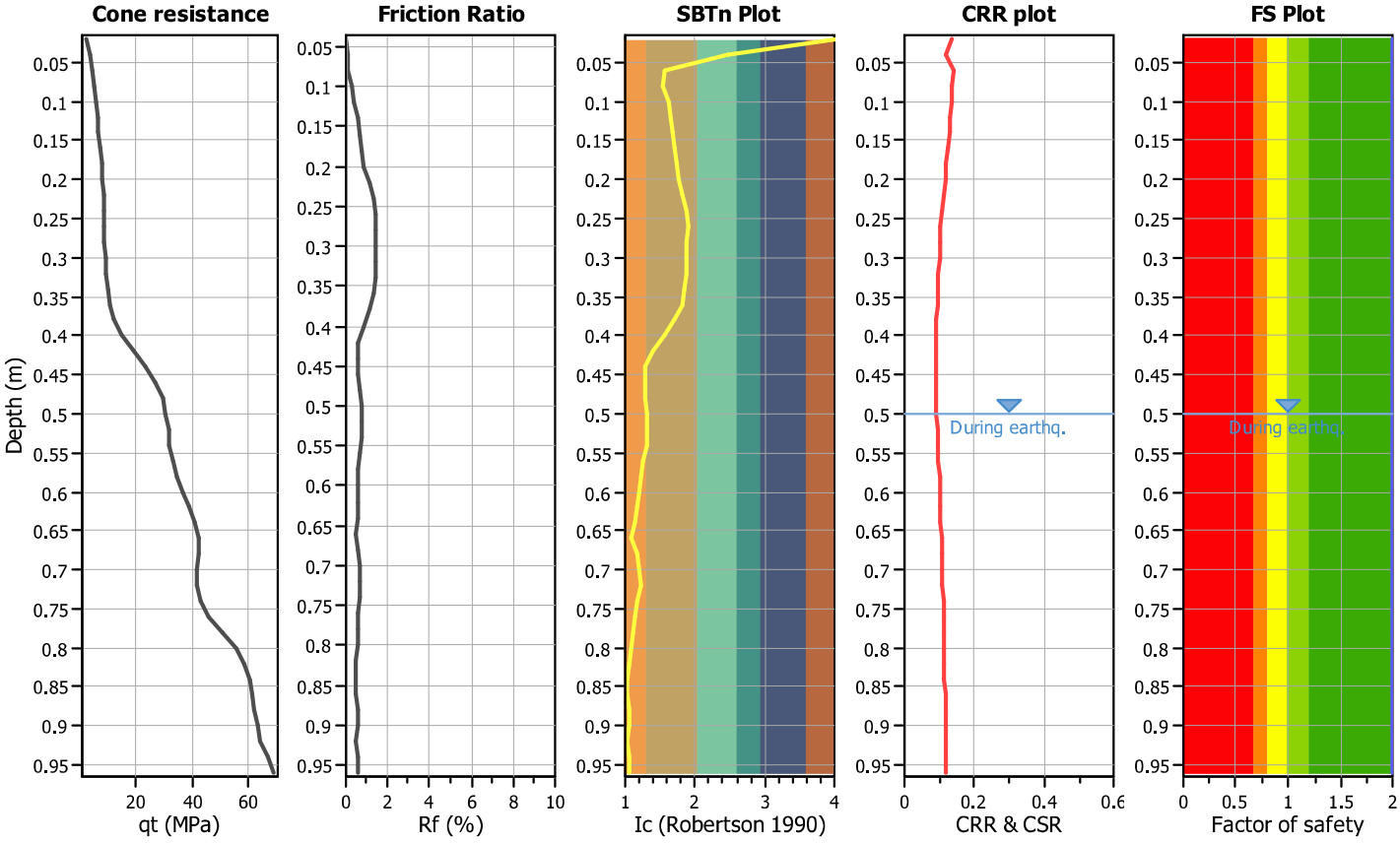
LIQUEFACTION ANALYSIS REPORT

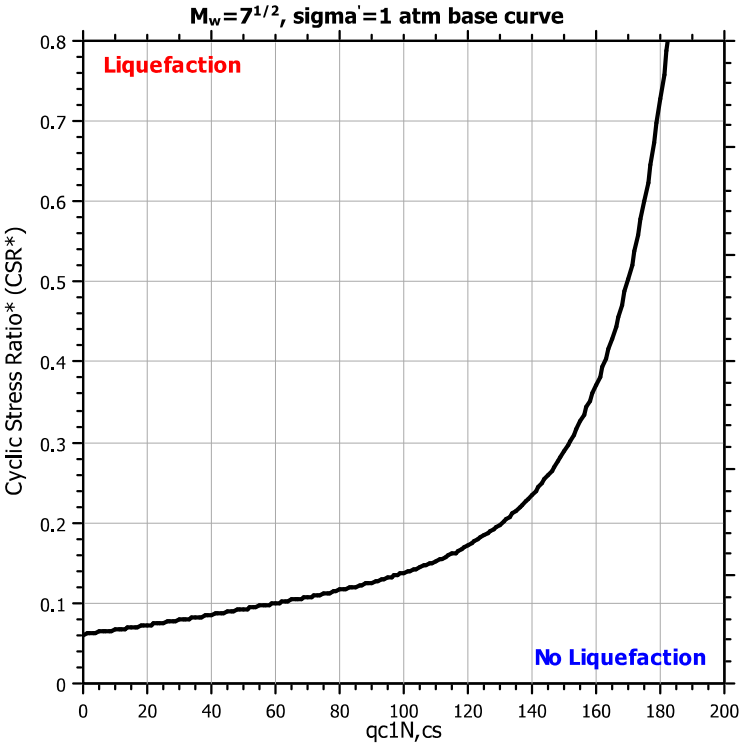
Project title : Kainga Ora Project Velocity **Location : 43-47 Allens Road, Ashburton**

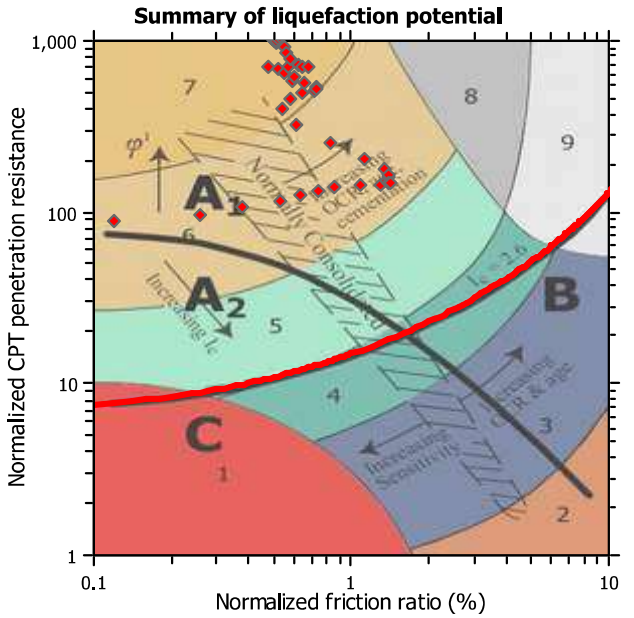
CPT file : CPT03 ULS

Input parameters and analysis data

Analysis method:	B&I (2014)	G.W.T. (in-situ):	0.50 m	Use fill:	No	Clay like behavior applied:	Sand & Clay
Fines correction method:	B&I (2014)	G.W.T. (earthq.):	0.50 m	Fill height:	N/A	Limit depth applied:	No
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth:	N/A
Earthquake magnitude M_w:	6.10	Ic cut-off value:	2.60	Trans. detect. applied:	No	MSF method:	Method
Peak ground acceleration:	0.26	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		







Zone A_1: Cyclic liquefaction likely depending on size and duration of cyclic loading
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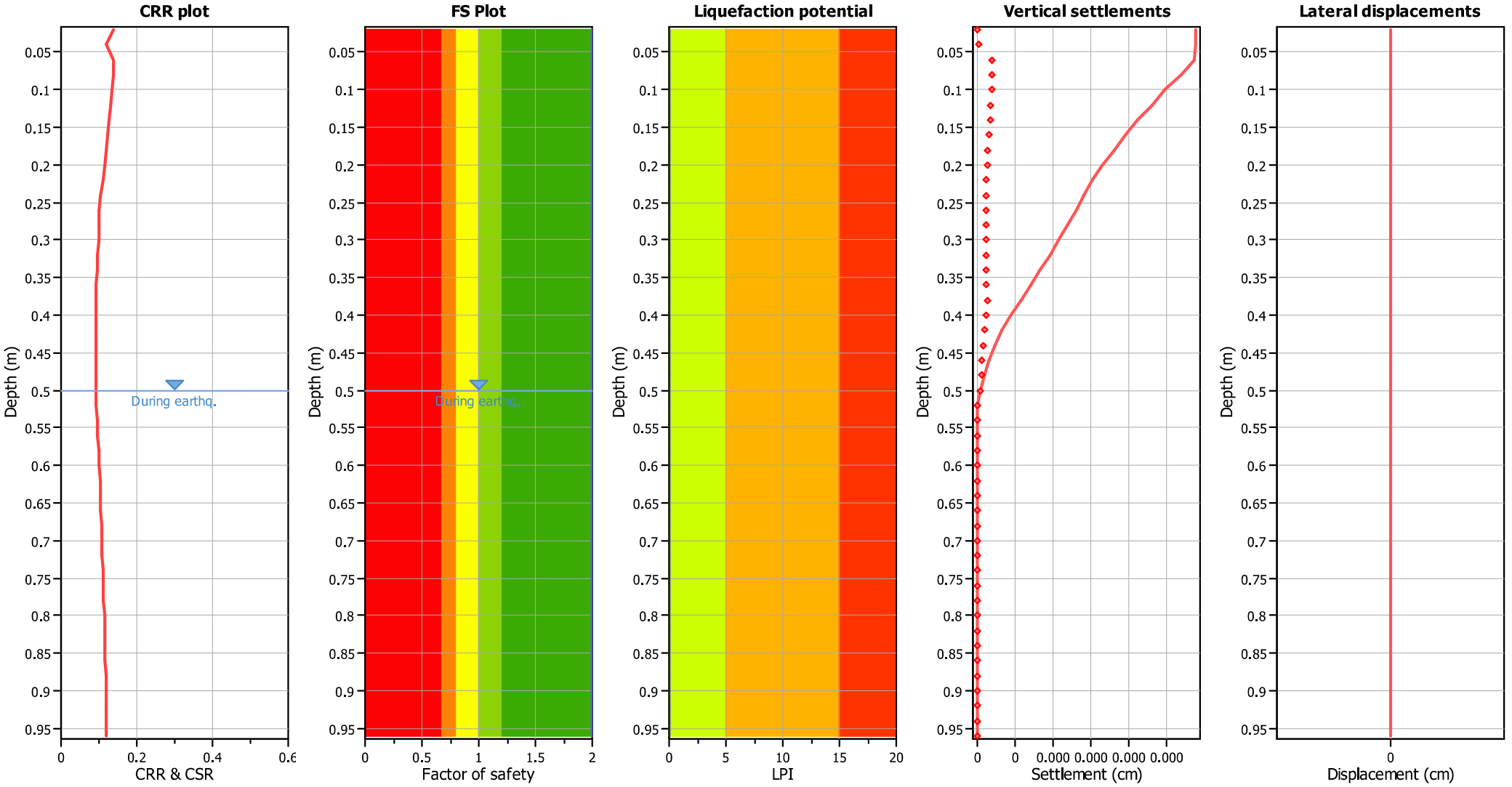
Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	0.50 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.10	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.26	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	0.50 m	Fill height:	N/A	Limit depth:	N/A

F.S. color scheme

- Almost certain it will liquefy
- Very likely to liquefy
- Liquefaction and no liq. are equally likely
- Unlike to liquefy
- Almost certain it will not liquefy

LPI color scheme

- Very high risk
- High risk
- Low risk

G

Appendix G – Bearing Capacity Calculation Sheets

Job Name	Job Number	Date
Kainga Ora - Project Velocity	3160491	6 April 2023
Site Address		**Engineer**
43-47 Allens Road		KB

GE - Determination of Bearing Pressures and California Bearing Ratios

AR112275-GE-DCP-001

M.J. STOCKWELL
DETERMINATION OF ALLOWABLE PRESSURE UNDER SMALL STRUCTURES
CALIFORNIA BEARING RATIO

Reference: Stockwell M.J. (1977). Determination of allowable bearing pressure under small structures. *New Zealand Engineering,* 132 - 135.

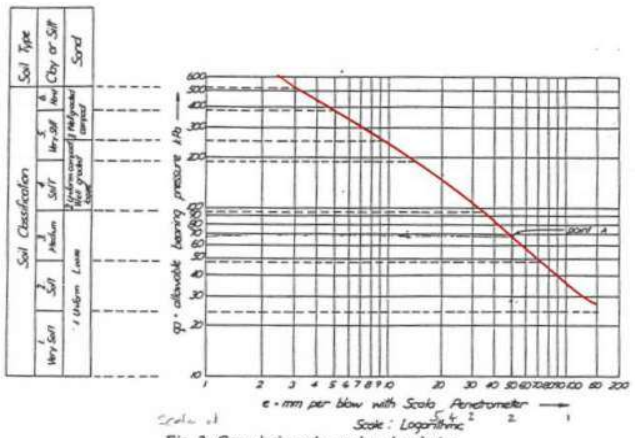


Fig. 2: Correlation of e and qa for design.

Gound Level (mRL)			108.60				
Depth (mm)			m RL	Measured No. Blows / 100mm	e mm/blow	Stockwell - qa kPa	Stockwell - qu kPa
0	-	100	108.5	2	50.0	67	200
100	-	200	108.4	3	33.3	100	300
200	-	300	108.3	7	14.3	170	510
300	-	400	108.2	7	14.3	170	510
400	-	500	108.1	10	10.0	220	660
500	-	600	108.0	11	9.1	240	720
600	-	700	107.9	28	3.6		
700	-	800	107.8				
800	-	900	107.7				
900	-	1000	107.6				
1000	-	1100	107.5				
1100	-	1200	107.4				
1200	-	1300	107.3				
1300	-	1400	107.2				
1400	-	1500	107.1				
1500	-	1600	107.0				
1600	-	1700	106.9				
1700	-	1800	106.8				
1800	-	1900	106.7				
1900	-	2000	106.6				

Job Name	Job Number	Date
Kainga Ora - Project Velocity	3160491	6 April 2023
Site Address		**Engineer**
43-47 Allens Road		KB

GE - Determination of Bearing Pressures and California Bearing Ratios

AR112275-GE-DCP-002

M.J. STOCKWELL
DETERMINATION OF ALLOWABLE PRESSURE UNDER SMALL STRUCTURES
CALIFORNIA BEARING RATIO

Reference: Stockwell M.J. (1977). Determination of allowable bearing pressure under small structures. *New Zealand Engineering,* 132 - 135.

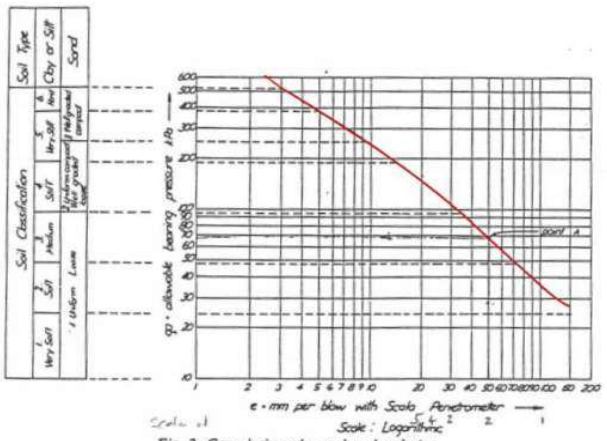


Fig. 2: Correlation of e and qa for design.

Gound Level (mRL)			108.70				
Depth (mm)				Measured No. Blows / 100mm	e mm/blow	Stockwell - qa kPa	Stockwell - qu kPa
0	-	100	108.6	2	50.0	67	200
100	-	200	108.5	4	25.0	116	348
200	-	300	108.4	5	20.0	135	405
300	-	400	108.3	18	5.6		
400	-	500	108.2	16	6.3		
500	-	600	108.1				
600	-	700	108.0				
700	-	800	107.9				
800	-	900	107.8				
900	-	1000	107.7				
1000	-	1100	107.6				
1100	-	1200	107.5				
1200	-	1300	107.4				
1300	-	1400	107.3				
1400	-	1500	107.2				
1500	-	1600	107.1				
1600	-	1700	107.0				
1700	-	1800	106.9				
1800	-	1900	106.8				
1900	-	2000	106.7				

Job Name	Job Number	Date
Kainga Ora - Project Velocity	3160491	6 April 2023
Site Address		**Engineer**
43-47 Allens Road		KB

GE - Determination of Bearing Pressures and California Bearing Ratios

AR112275-GE-DCP-003

M.J. STOCKWELL
DETERMINATION OF ALLOWABLE PRESSURE UNDER SMALL STRUCTURES
CALIFORNIA BEARING RATIO

Reference: Stockwell M.J. (1977). Determination of allowable bearing pressure under small structures. *New Zealand Engineering,* 132 - 135.

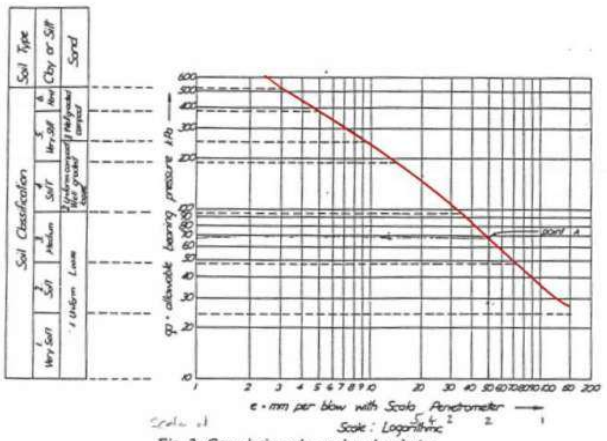


Fig. 2: Correlation of e and qa for design.

Gound Level (mRL)			108.68				
Depth (mm)				Measured No. Blows / 100mm	e mm/blow	Stockwell - qa kPa	Stockwell - qu kPa
0	-	100	108.6	1	100.0	33	100
100	-	200	108.5	2	50.0	67	200
200	-	300	108.4	2	50.0	67	200
300	-	400	108.3	3	33.3	100	300
400	-	500	108.2	6	16.7	150	450
500	-	600	108.1	20	5.0		
600	-	700	108.0	20	5.0		
700	-	800	107.9	14	7.1		
800	-	900	107.8	15	6.7		
900	-	1000	107.7	17	5.9		
1000	-	1100	107.6				
1100	-	1200	107.5				
1200	-	1300	107.4				
1300	-	1400	107.3				
1400	-	1500	107.2				
1500	-	1600	107.1				
1600	-	1700	107.0				
1700	-	1800	106.9				
1800	-	1900	106.8				
1900	-	2000	106.7				

Job Name	Job Number	Date
Kainga Ora - Project Velocity	3160491	6 April 2023
Site Address		**Engineer**
43-47 Allens Road		KB

GE - Determination of Bearing Pressures and California Bearing Ratios

AR112275-GE-DCP-004

M.J. STOCKWELL
DETERMINATION OF ALLOWABLE PRESSURE UNDER SMALL STRUCTURES
CALIFORNIA BEARING RATIO

Reference: Stockwell M.J. (1977). Determination of allowable bearing pressure under small structures. *New Zealand Engineering,* 132 - 135.

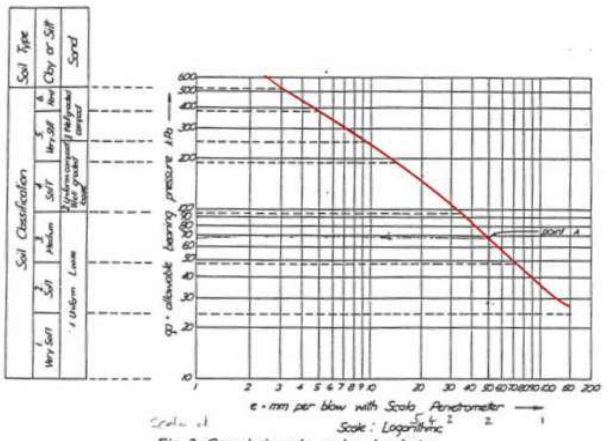


Fig. 2: Correlation of e and qa for design.

Gound Level (mRL)			108.72				
Depth (mm)				Measured No. Blows / 100mm	e mm/blow	Stockwell - qa kPa	Stockwell - qu kPa
0	-	100	108.6	1	100.0	33	100
100	-	200	108.5	1	100.0	33	100
200	-	300	108.4	2	50.0	67	200
300	-	400	108.3	5	20.0	135	405
400	-	500	108.2	18	5.6		
500	-	600	108.1	32	3.1		
600	-	700	108.0				
700	-	800	107.9				
800	-	900	107.8				
900	-	1000	107.7				
1000	-	1100	107.6				
1100	-	1200	107.5				
1200	-	1300	107.4				
1300	-	1400	107.3				
1400	-	1500	107.2				
1500	-	1600	107.1				
1600	-	1700	107.0				
1700	-	1800	106.9				
1800	-	1900	106.8				
1900	-	2000	106.7				

Job Name	Job Number	Date
Kainga Ora - Project Velocity	3160491	6 April 2023
Site Address		**Engineer**
43-47 Allens Road		KB

GE - Determination of Bearing Pressures and California Bearing Ratios

AR112275-GE-DCP-005

M.J. STOCKWELL
DETERMINATION OF ALLOWABLE PRESSURE UNDER SMALL STRUCTURES
CALIFORNIA BEARING RATIO

Reference: Stockwell M.J. (1977). Determination of allowable bearing pressure under small structures. *New Zealand Engineering,* 132 - 135.

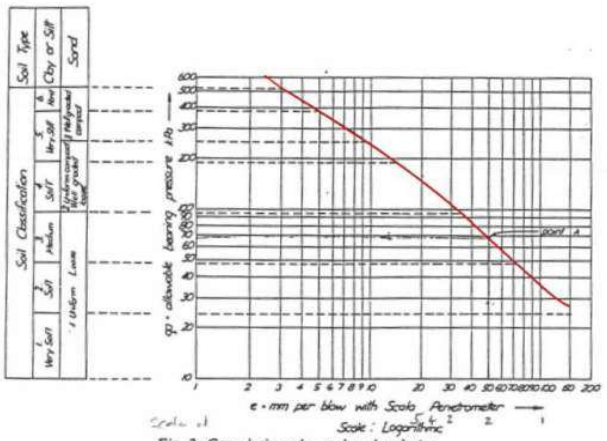


Fig. 2: Correlation of e and qa for design.

Gound Level (mRL)			108.55				
Depth (mm)				Measured No. Blows / 100mm	e mm/blow	Stockwell - qa kPa	Stockwell - qu kPa
0	-	100	108.5	2	50.0	67	200
100	-	200	108.4	3	33.3	100	300
200	-	300	108.3	3	33.3	100	300
300	-	400	108.2	9	11.1	200	600
400	-	500	108.1				
500	-	600	108.0				
600	-	700	107.9				
700	-	800	107.8				
800	-	900	107.7				
900	-	1000	107.6				
1000	-	1100	107.5				
1100	-	1200	107.4				
1200	-	1300	107.3				
1300	-	1400	107.2				
1400	-	1500	107.1				
1500	-	1600	107.0				
1600	-	1700	106.9				
1700	-	1800	106.8				
1800	-	1900	106.7				
1900	-	2000	106.6				

Job Name	Job Number	Date
Kainga Ora - Project Velocity	3160491	6 April 2023
Site Address		**Engineer**
43-47 Allens Road		KB

GE - Determination of Bearing Pressures and California Bearing Ratios

AR112275-GE-DCP-006

M.J. STOCKWELL
DETERMINATION OF ALLOWABLE PRESSURE UNDER SMALL STRUCTURES
CALIFORNIA BEARING RATIO

Reference: Stockwell M.J. (1977). Determination of allowable bearing pressure under small structures. *New Zealand Engineering,* 132 - 135.

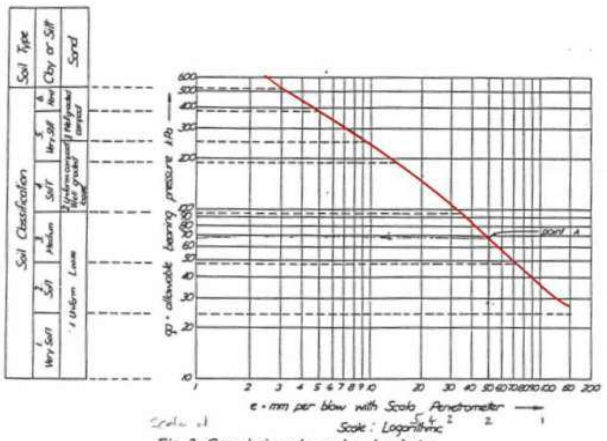


Fig. 2: Correlation of e and qa for design.

Gound Level (mRL)			108.80				
Depth (mm)				Measured No. Blows / 100mm	e mm/blow	Stockwell - qa kPa	Stockwell - qu kPa
0	-	100	108.7	0			
100	-	200	108.6	1	100.0	33	100
200	-	300	108.5	3	33.3	100	300
300	-	400	108.4	11	9.1	240	720
400	-	500	108.3	28	3.6		
500	-	600	108.2				
600	-	700	108.1				
700	-	800	108.0				
800	-	900	107.9				
900	-	1000	107.8				
1000	-	1100	107.7				
1100	-	1200	107.6				
1200	-	1300	107.5				
1300	-	1400	107.4				
1400	-	1500	107.3				
1500	-	1600	107.2				
1600	-	1700	107.1				
1700	-	1800	107.0				
1800	-	1900	106.9				
1900	-	2000	106.8				

Job Name	Job Number	Date
Kainga Ora - Project Velocity	3160491	6 April 2023
Site Address		**Engineer**
43-47 Allens Road		KB

GE - Determination of Bearing Pressures and California Bearing Ratios

AR112275-GE-HA-001

M.J. STOCKWELL
DETERMINATION OF ALLOWABLE PRESSURE UNDER SMALL STRUCTURES
CALIFORNIA BEARING RATIO

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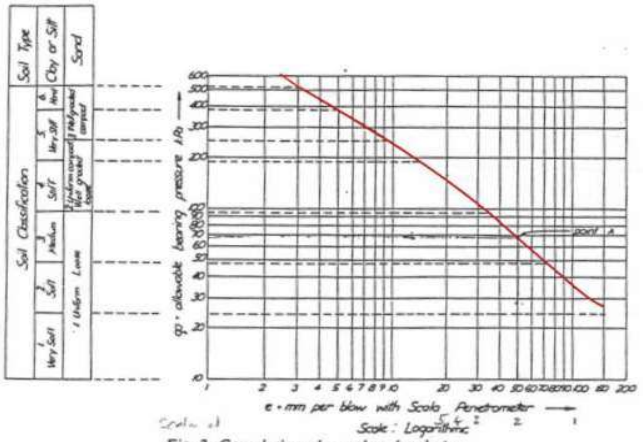

Fig. 2: Correlation of e and qa for design.

Gound Level (mRL)			108.55				
Depth (mm)			m RL	Measured No. Blows / 100mm	e mm/blow	Stockwell - qa kPa	Stockwell - qu kPa
0	-	100	108.5	1	100.0	33	100
100	-	200	108.4	2	50.0	67	200
200	-	300	108.3	2	50.0	67	200
300	-	400	108.2	17	5.9		
400	-	500	108.1	21	4.8		
500	-	600	108.0	16	6.3		
600	-	700	107.9				
700	-	800	107.8				
800	-	900	107.7				
900	-	1000	107.6				
1000	-	1100	107.5				
1100	-	1200	107.4				
1200	-	1300	107.3				
1300	-	1400	107.2				
1400	-	1500	107.1				
1500	-	1600	107.0				
1600	-	1700	106.9				
1700	-	1800	106.8				
1800	-	1900	106.7				
1900	-	2000	106.6				

Job Name	Job Number	Date
Kainga Ora - Project Velocity	3160491	6 April 2023
Site Address		**Engineer**
43-47 Allens Road		KB

GE - Determination of Bearing Pressures and California Bearing Ratios

AR112275-GE-HA-002

M.J. STOCKWELL
DETERMINATION OF ALLOWABLE PRESSURE UNDER SMALL STRUCTURES
CALIFORNIA BEARING RATIO

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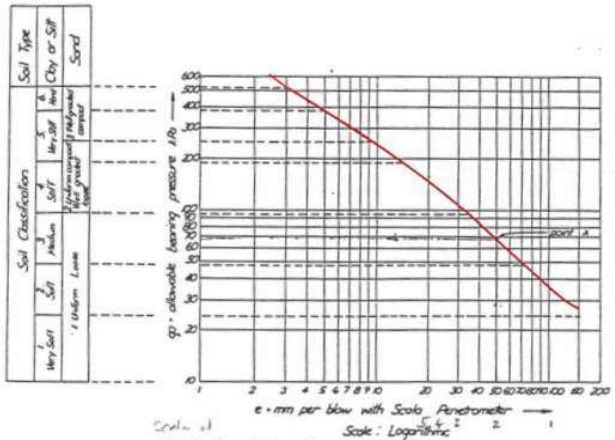

Fig. 2: Correlation of e and qa for design.

Gound Level (mRL)			108.69				
Depth (mm)			m RL	Measured No. Blows / 100mm	e mm/blow	Stockwell - qa kPa	Stockwell - qu kPa
0	-	100	108.6	1	100.0	33	100
100	-	200	108.5	3	33.3	100	300
200	-	300	108.4	4	25.0	116	348
300	-	400	108.3	9	11.1	200	600
400	-	500	108.2	22	4.5		
500	-	600	108.1				
600	-	700	108.0				
700	-	800	107.9				
800	-	900	107.8				
900	-	1000	107.7				
1000	-	1100	107.6				
1100	-	1200	107.5				
1200	-	1300	107.4				
1300	-	1400	107.3				
1400	-	1500	107.2				
1500	-	1600	107.1				
1600	-	1700	107.0				
1700	-	1800	106.9				
1800	-	1900	106.8				
1900	-	2000	106.7				

Job Name	Job Number	Date
Kainga Ora - Project Velocity	3160491	6 April 2023
Site Address		**Engineer**
43-47 Allens Road		KB

GE - Determination of Bearing Pressures and California Bearing Ratios

AR112275-GE-HA-003 Page 1

M.J. STOCKWELL
DETERMINATION OF ALLOWABLE PRESSURE UNDER SMALL STRUCTURES
CALIFORNIA BEARING RATIO

Reference: Stockwell M.J. (1977). Determination of allowable bearing pressure under small structures. *New Zealand Engineering,* 132 - 135.

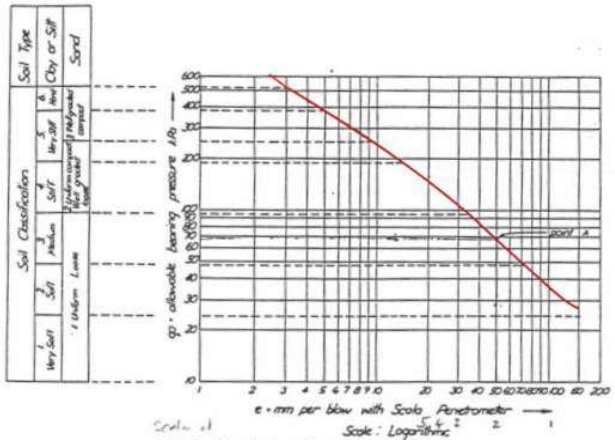

Fig. 2: Correlation of e and qa for design.

Gound Level (mRL)			108.69				
Depth (mm)			m RL	Measured No. Blows / 100mm	e mm/blow	Stockwell - qa kPa	Stockwell - qu kPa
0	-	100	108.6	1	100.0	33	100
100	-	200	108.5	2	50.0	67	200
200	-	300	108.4	2	50.0	67	200
300	-	400	108.3	3	33.3	100	300
400	-	500	108.2	3	33.3	100	300
500	-	600	108.1	8	12.5	195	585
600	-	700	108.0	16	6.3		
700	-	800	107.9	17	5.9		
800	-	900	107.8	15	6.7		
900	-	1000	107.7				
1000	-	1100	107.6				
1100	-	1200	107.5				
1200	-	1300	107.4				
1300	-	1400	107.3				
1400	-	1500	107.2				
1500	-	1600	107.1				
1600	-	1700	107.0				
1700	-	1800	106.9				
1800	-	1900	106.8				
1900	-	2000	106.7				

Job Name	Job Number	Date
Kainga Ora - Project Velocity	3160491	6 April 2023
Site Address		**Engineer**
43-47 Allens Road		KB

GE - Determination of Bearing Pressures and California Bearing Ratios

AR112275-GE-HA-004

M.J. STOCKWELL
DETERMINATION OF ALLOWABLE PRESSURE UNDER SMALL STRUCTURES
CALIFORNIA BEARING RATIO

Reference: Stockwell M.J. (1977). Determination of allowable bearing pressure under small structures. *New Zealand Engineering,* 132 - 135.

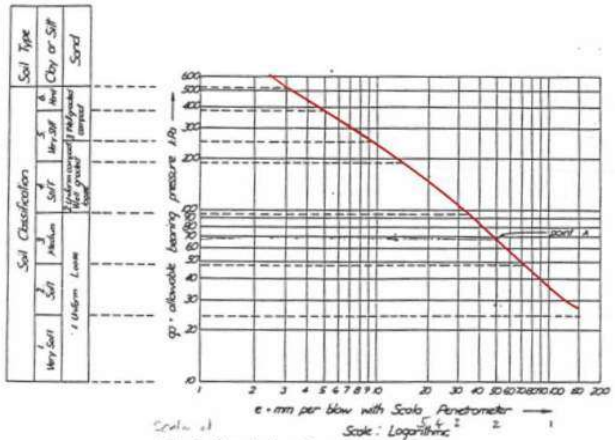

Fig. 2: Correlation of e and qa for design.

Gound Level (mRL)			108.72				
Depth (mm)				Measured No. Blows / 100mm	e mm/blow	Stockwell - qa kPa	Stockwell - qu kPa
0	-	100	108.6	3	33.3	100	300
100	-	200	108.5	5	20.0	135	405
200	-	300	108.4	4	25.0	116	348
300	-	400	108.3	6	16.7	150	450
400	-	500	108.2	10	10.0	220	660
500	-	600	108.1				
600	-	700	108.0				
700	-	800	107.9				
800	-	900	107.8				
900	-	1000	107.7				
1000	-	1100	107.6				
1100	-	1200	107.5				
1200	-	1300	107.4				
1300	-	1400	107.3				
1400	-	1500	107.2				
1500	-	1600	107.1				
1600	-	1700	107.0				
1700	-	1800	106.9				
1800	-	1900	106.8				
1900	-	2000	106.7				

Job Name	Job Number	Date
Kainga Ora - Project Velocity	3160491	6 April 2023
Site Address		**Engineer**
43-47 Allens Road		KB

GE - Determination of Bearing Pressures and California Bearing Ratios

AR112275-GE-HA-005

M.J. STOCKWELL
DETERMINATION OF ALLOWABLE PRESSURE UNDER SMALL STRUCTURES
CALIFORNIA BEARING RATIO

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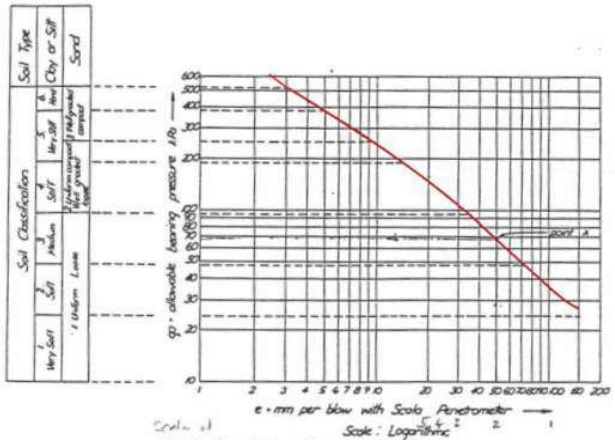

Fig. 2: Correlation of e and qa for design.

Gound Level (mRL)			108.61				
Depth (mm)				Measured No. Blows / 100mm	e mm/blow	Stockwell - qa kPa	Stockwell - qu kPa
0	-	100	108.5	4	25.0	116	348
100	-	200	108.4	7	14.3	170	510
200	-	300	108.3	9	11.1	200	600
300	-	400	108.2	21	4.8		
400	-	500	108.1				
500	-	600	108.0				
600	-	700	107.9				
700	-	800	107.8				
800	-	900	107.7				
900	-	1000	107.6				
1000	-	1100	107.5				
1100	-	1200	107.4				
1200	-	1300	107.3				
1300	-	1400	107.2				
1400	-	1500	107.1				
1500	-	1600	107.0				
1600	-	1700	106.9				
1700	-	1800	106.8				
1800	-	1900	106.7				
1900	-	2000	106.6				

Job Name	Job Number	Date
Kainga Ora - Project Velocity	3160491	6 April 2023
Site Address		**Engineer**
43-47 Allens Road		KB

GE - Determination of Bearing Pressures and California Bearing Ratios

AR112275-GE-HA-006

M.J. STOCKWELL
DETERMINATION OF ALLOWABLE PRESSURE UNDER SMALL STRUCTURES
CALIFORNIA BEARING RATIO

Reference: Stockwell M.J. (1977). Determination of allowable bearing pressure under small structures. *New Zealand Engineering,* 132 - 135.

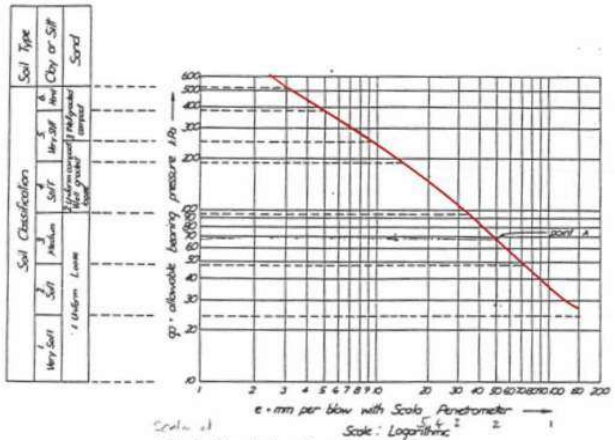

Fig. 2: Correlation of e and qa for design.

Gound Level (mRL)			108.74				
Depth (mm)				Measured No. Blows / 100mm	e mm/blow	Stockwell - qa kPa	Stockwell - qu kPa
0	-	100	108.6	2	50.0	67	200
100	-	200	108.5	4	25.0	116	348
200	-	300	108.4	4	25.0	116	348
300	-	400	108.3	21	4.8		
400	-	500	108.2				
500	-	600	108.1				
600	-	700	108.0				
700	-	800	107.9				
800	-	900	107.8				
900	-	1000	107.7				
1000	-	1100	107.6				
1100	-	1200	107.5				
1200	-	1300	107.4				
1300	-	1400	107.3				
1400	-	1500	107.2				
1500	-	1600	107.1				
1600	-	1700	107.0				
1700	-	1800	106.9				
1800	-	1900	106.8				
1900	-	2000	106.7				

Job Name	Job Number	Date
Kainga Ora - Project Velocity	3160491	11 April 2023
Site Address		Engineer
43-47 Allens Road		JB

GE - Determination of Bearing Pressures and California Bearing Ratios

AR112275-GE-ST-001

M.J. STOCKWELL
DETERMINATION OF ALLOWABLE PRESSURE UNDER SMALL STRUCTURES
CALIFORNIA BEARING RATIO

Reference: Stockwell M.J. (1977). Determination of allowable bearing pressure under small structures. *New Zealand Engineering,* 132 - 135.

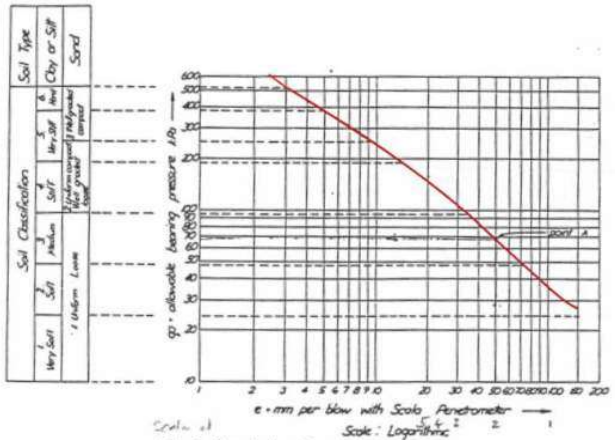

Fig. 2: Correlation of e and qa for design.

Gound Level (mRL)			108.69				
Depth (mm)				Measured No. Blows / 100mm	e mm/blow	Stockwell - qa kPa	Stockwell - qu kPa
0	-	100	108.6	1	100.0	33	100
100	-	200	108.5	3	33.3	100	300
200	-	300	108.4	4	25.0	116	348
300	-	400	108.3	9	11.1	200	600
400	-	500	108.2	26	3.8		
500	-	600	108.1	16	6.3		
600	-	700	108.0				
700	-	800	107.9				
800	-	900	107.8				
900	-	1000	107.7				
1000	-	1100	107.6				
1100	-	1200	107.5				
1200	-	1300	107.4				
1300	-	1400	107.3				
1400	-	1500	107.2				
1500	-	1600	107.1				
1600	-	1700	107.0				
1700	-	1800	106.9				
1800	-	1900	106.8				
1900	-	2000	106.7				

Job Name	Job Number	Date
Kainga Ora - Project Velocity	3160491	11 April 2023
Site Address		Engineer
43-47 Allens Road		JB

GE - Determination of Bearing Pressures and California Bearing Ratios

AR112275-GE-ST-002

M.J. STOCKWELL
DETERMINATION OF ALLOWABLE PRESSURE UNDER SMALL STRUCTURES
CALIFORNIA BEARING RATIO

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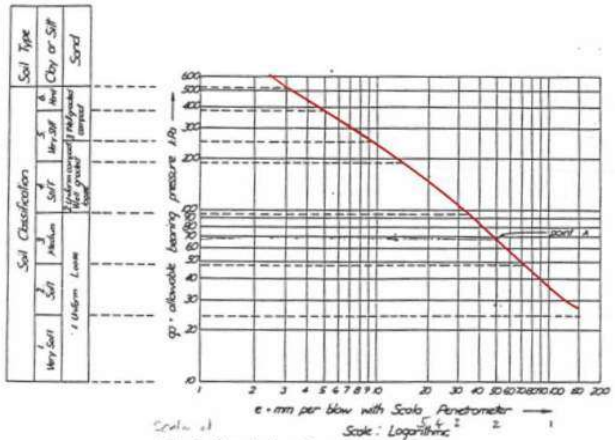

Fig. 2: Correlation of e and qa for design.

Gound Level (mRL)			108.75				
Depth (mm)				Measured No. Blows / 100mm	e mm/blow	Stockwell - qa kPa	Stockwell - qu kPa
0	-	100	108.5	3	33.3	100	300
100	-	200	108.4	4	25.0	116	348
200	-	300	108.3	6	16.7	150	450
300	-	400	108.2	13	7.7		
400	-	500	108.1	9	11.1	200	600
500	-	600	108.0				
600	-	700	107.9				
700	-	800	107.8				
800	-	900	107.7				
900	-	1000	107.6				
1000	-	1100	107.5				
1100	-	1200	107.4				
1200	-	1300	107.3				
1300	-	1400	107.2				
1400	-	1500	107.1				
1500	-	1600	107.0				
1600	-	1700	106.9				
1700	-	1800	106.8				
1800	-	1900	106.7				
1900	-	2000	106.6				

Job Name	Job Number	Date
Kainga Ora - Project Velocity	3160491	11 April 2023
Site Address		Engineer
43-47 Allens Road		JB

GE - Determination of Bearing Pressures and California Bearing Ratios

AR112275-GE-ST-003

M.J. STOCKWELL
DETERMINATION OF ALLOWABLE PRESSURE UNDER SMALL STRUCTURES
CALIFORNIA BEARING RATIO

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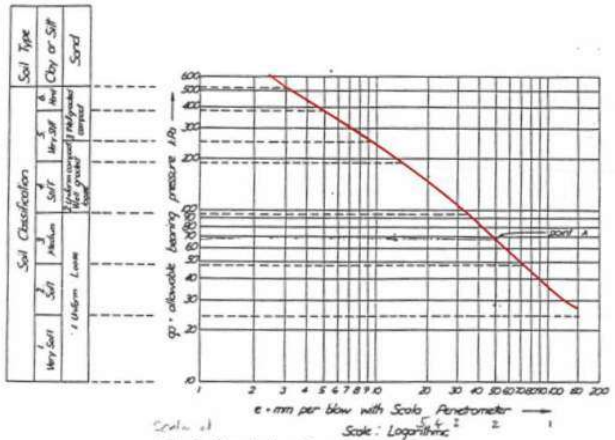


Fig. 2: Correlation of e and qa for design.

Gound Level (mRL)			108.78				
Depth (mm)				Measured No. Blows / 100mm	e mm/blow	Stockwell - qa kPa	Stockwell - qu kPa
0	-	100	108.6	1	100.0	33	100
100	-	200	108.5	4	25.0	116	348
200	-	300	108.4	3	33.3	100	300
300	-	400	108.3	9	11.1	200	600
400	-	500	108.2	10	10.0	220	660
500	-	600	108.1				
600	-	700	108.0				
700	-	800	107.9				
800	-	900	107.8				
900	-	1000	107.7				
1000	-	1100	107.6				
1100	-	1200	107.5				
1200	-	1300	107.4				
1300	-	1400	107.3				
1400	-	1500	107.2				
1500	-	1600	107.1				
1600	-	1700	107.0				
1700	-	1800	106.9				
1800	-	1900	106.8				
1900	-	2000	106.7				

H

Appendix H – CBR Calculation Sheets

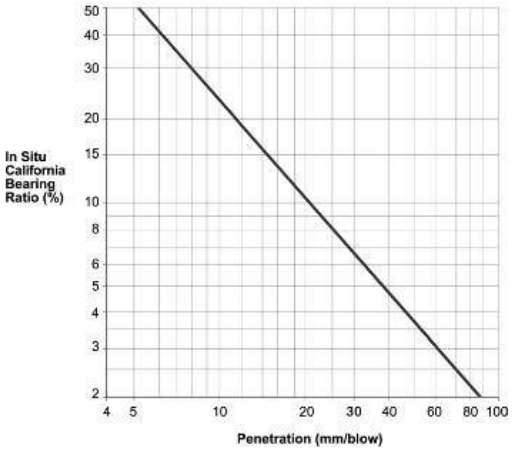
Job Name	Job Number	Date
Kainga Ora - Project Velocity	3160491	26 January 2023
Site Address		**Engineer**
43-47 Allens Road		KB

GE - Determination of Bearing Pressures and California Bearing Ratios

AR112275-GE-DCP-001

AUSTROADS
Part 2: Pavement Structural Design
CALIFORNIA BEARING RATIO

Reference: Austroads Ltd. (2017). *Guide to Pavement Technology Part 2: Pavement Structural Design.* Sydney: Austroads Ltd. (Section 5.5.2, Figure 5.3)



Ground Level (mRL, CDD)			108.60			
Depth (mm)			m RL	Measured No. Blows / 100mm	e mm/blow	Austroads - Correlated CBR (%)
0	-	*100*	*108.5*	2	*50.0*	*3.5*
100	-	*200*	*108.4*	3	*33.3*	*6.0*
200	-	*300*	*108.3*	7	*14.3*	*15.0*
300	-	400	*108.2*	7	14.3	15.0
400	-	500	*108.1*	10	10.0	20.0
500	-	600	*108.0*	11	9.1	25.0
600	-	700	*107.9*	28	3.6	60.0
700	-	800	*107.8*			
800	-	900	*107.7*			
900	-	1000	*107.6*			
1000	-	1100	*107.5*			
1100	-	1200	*107.4*			
1200	-	1300	*107.3*			
1300	-	1400	*107.2*			
1400	-	1500	*107.1*			

Weighted Average	32.0

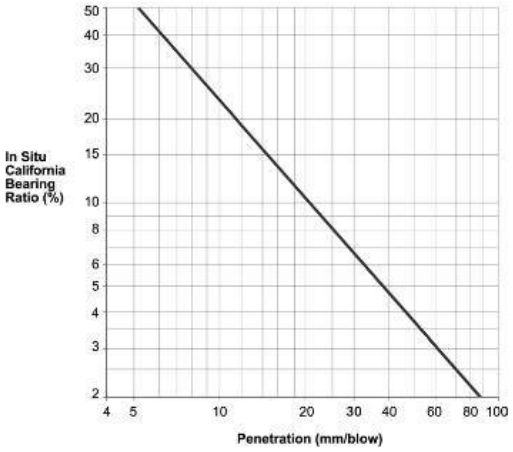
Job Name	Job Number	Date
Kainga Ora - Project Velocity	3160491	26 January 2023
Site Address		**Engineer**
43-47 Allens Road		KB

GE - Determination of Bearing Pressures and California Bearing Ratios

AR10XXXX-GE-DCP-002

AUSTROADS
Part 2: Pavement Structural Design
CALIFORNIA BEARING RATIO

Reference: Austroads Ltd. (2017). *Guide to Pavement Technology Part 2: Pavement Structural Design.* Sydney: Austroads Ltd. (Section 5.5.2, Figure 5.3)



Ground Level (mRL, CDD)			108.70			
Depth (mm)			m RL	Measured No. Blows / 100mm	e mm/blow	Austroads - Correlated CBR (%)
0	-	*100*	*108.6*	2	*50.0*	*3.5*
100	-	*200*	*108.5*	4	*25.0*	*8.0*
200	-	*300*	*108.4*	5	*20.0*	*10.0*
300	-	400	*108.3*	18	5.6	45.0
400	-	500	*108.2*	16	6.3	40.0
500	-	600	*108.1*			
600	-	700	*108.0*			
700	-	800	*107.9*			
800	-	900	*107.8*			
900	-	1000	*107.7*			
1000	-	1100	*107.6*			
1100	-	1200	*107.5*			
1200	-	1300	*107.4*			
1300	-	1400	*107.3*			
1400	-	1500	*107.2*			
Weighted Average						42.5

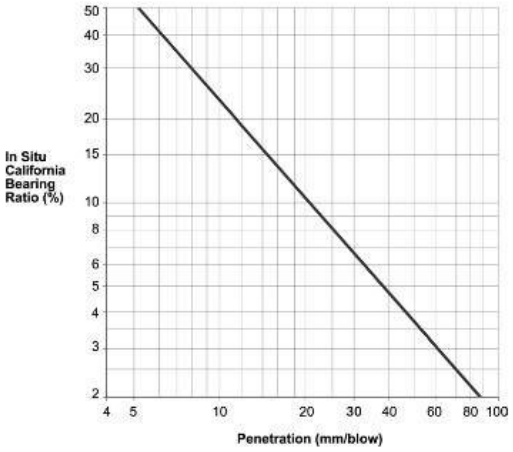
Job Name	Job Number	Date
Kainga Ora - Project Velocity	3160491	26 January 2023
Site Address		Engineer
43-47 Allens Road		KB

GE - Determination of Bearing Pressures and California Bearing Ratios

AR112275-GE-DCP-003

AUSTROADS
Part 2: Pavement Structural Design
CALIFORNIA BEARING RATIO

Reference: Austroads Ltd. (2017). *Guide to Pavement Technology Part 2: Pavement Structural Design.* Sydney: Austroads Ltd. (Section 5.5.2, Figure 5.3)



Ground Level (mRL, CDD)			108.68			
Depth (mm)			m RL	Measured No. Blows / 100mm	e mm/blow	Austroads - Correlated CBR (%)
0	-	*100*	*108.6*	1	*100.0*	*1.5*
100	-	*200*	*108.5*	2	*50.0*	*3.5*
200	-	*300*	*108.4*	2	*50.0*	*3.5*
300	-	400	*108.3*	3	33.3	6.0
400	-	500	*108.2*	6	16.7	12.0
500	-	600	*108.1*	20	5.0	50.0
600	-	700	*108.0*	20	5.0	50.0
700	-	800	*107.9*	14	7.1	30.0
800	-	900	*107.8*	15	6.7	35.0
900	-	1000	*107.7*	17	5.9	40.0
1000	-	1100	*107.6*			
1100	-	1200	*107.5*			
1200	-	1300	*107.4*			
1300	-	1400	*107.3*			
1400	-	1500	*107.2*			

Weighted Average	27.5

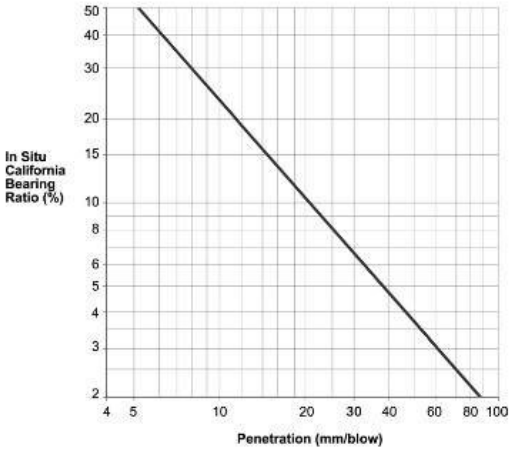
Job Name	Job Number	Date
Kainga Ora - Project Velocity	3160491	26 January 2023
Site Address		**Engineer**
43-47 Allens Road		KB

GE - Determination of Bearing Pressures and California Bearing Ratios

AR112275-GE-DCP-004

AUSTROADS
Part 2: Pavement Structural Design
CALIFORNIA BEARING RATIO

Reference: Austroads Ltd. (2017). *Guide to Pavement Technology Part 2: Pavement Structural Design.* Sydney: Austroads Ltd. (Section 5.5.2, Figure 5.3)



Ground Level (mRL, CDD)			108.72			
Depth (mm)			m RL	Measured No. Blows / 100mm	e mm/blow	Austroads - Correlated CBR (%)
0	-	*100*	*108.6*	1	*100.0*	*1.5*
100	-	*200*	*108.5*	1	*100.0*	*1.5*
200	-	*300*	*108.4*	2	*50.0*	*3.5*
300	-	400	*108.3*	5	20.0	10.0
400	-	500	*108.2*	18	5.6	45.0
500	-	600	*108.1*	32	3.1	60.0
600	-	700	*108.0*			
700	-	800	*107.9*			
800	-	900	*107.8*			
900	-	1000	*107.7*			
1000	-	1100	*107.6*			
1100	-	1200	*107.5*			
1200	-	1300	*107.4*			
1300	-	1400	*107.3*			
1400	-	1500	*107.2*			

Weighted Average	38.3

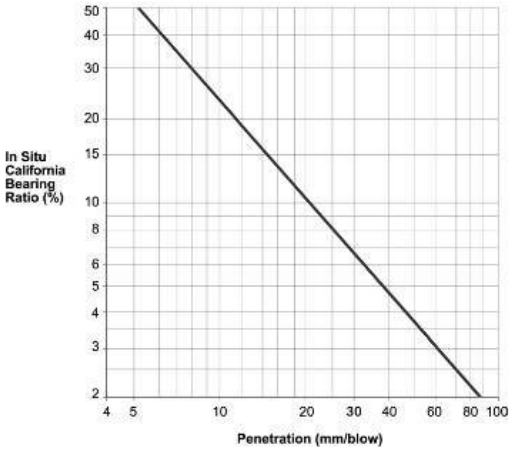
Job Name	Job Number	Date
Kainga Ora - Project Velocity	3160491	26 January 2023
Site Address		**Engineer**
43-47 Allens Road		KB

GE - Determination of Bearing Pressures and California Bearing Ratios

AR112275-GE-DCP-005

AUSTROADS
Part 2: Pavement Structural Design
CALIFORNIA BEARING RATIO

Reference: Austroads Ltd. (2017). *Guide to Pavement Technology Part 2: Pavement Structural Design.* Sydney: Austroads Ltd. (Section 5.5.2, Figure 5.3)



Ground Level (mRL, CDD)			108.55			
Depth (mm)			m RL	Measured No. Blows / 100mm	e mm/blow	Austroads - Correlated CBR (%)
0	-	*100*	*108.5*	2	*50.0*	*3.5*
100	-	*200*	*108.4*	3	*33.3*	*6.0*
200	-	*300*	*108.3*	3	*33.3*	*6.0*
300	-	400	*108.2*	9	11.1	20.0
400	-	500	*108.1*			
500	-	600	*108.0*			
600	-	700	*107.9*			
700	-	800	*107.8*			
800	-	900	*107.7*			
900	-	1000	*107.6*			
1000	-	1100	*107.5*			
1100	-	1200	*107.4*			
1200	-	1300	*107.3*			
1300	-	1400	*107.2*			
1400	-	1500	*107.1*			

Weighted Average	20.0

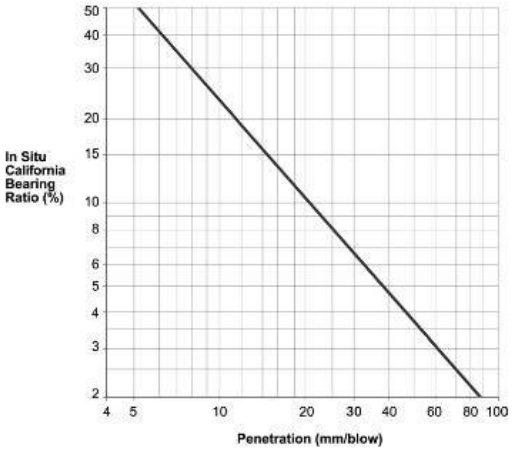
Job Name	Job Number	Date
Kainga Ora - Project Velocity	3160491	26 January 2023
Site Address		**Engineer**
43-47 Allens Road		KB

GE - Determination of Bearing Pressures and California Bearing Ratios

AR112275-GE-DCP-006

AUSTROADS
Part 2: Pavement Structural Design
CALIFORNIA BEARING RATIO

Reference: Austroads Ltd. (2017). *Guide to Pavement Technology Part 2: Pavement Structural Design.* Sydney: Austroads Ltd. (Section 5.5.2, Figure 5.3)



Ground Level (mRL, CDD)			108.80			
Depth (mm)			m RL	Measured No. Blows / 100mm	e mm/blow	Austroads - Correlated CBR (%)
0	-	*100*	*108.7*	0		
100	-	*200*	*108.6*	1	*100.0*	*1.5*
200	-	*300*	*108.5*	3	*33.3*	*6.0*
300	-	400	*108.4*	11	9.1	25.0
400	-	500	*108.3*	28	3.6	60.0
500	-	600	*108.2*			
600	-	700	*108.1*			
700	-	800	*108.0*			
800	-	900	*107.9*			
900	-	1000	*107.8*			
1000	-	1100	*107.7*			
1100	-	1200	*107.6*			
1200	-	1300	*107.5*			
1300	-	1400	*107.4*			
1400	-	1500	*107.3*			

Weighted Average	42.5

Job Name	Job Number	Date
Kainga Ora - Project Velocity	3160491	6 April 2023
Site Address		Engineer
43-47 Allens Road		KB

GE - Determination of Bearing Pressures and California Bearing Ratios

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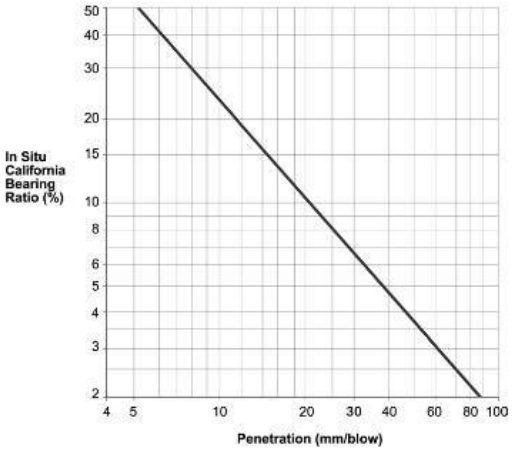
AUSTROADS
Part 2: Pavement Structural Design
CALIFORNIA BEARING RATIO

Reference: Austroads Ltd. (2017). *Guide to Pavement Technology Part 2: Pavement Structural Design.* Sydney: Austroads Ltd. (Section 5.5.2, Figure 5.3)



Ground Level (mRL, CDD)			108.55			
Depth (mm)			m RL	Measured No. Blows / 100mm	e mm/blow	Austroads - Correlated CBR (%)
0	-	*100*	*108.5*	1	*100.0*	*1.5*
100	-	*200*	*108.4*	2	*50.0*	*3.5*
200	-	*300*	*108.3*	2	*50.0*	*3.5*
300	-	400	*108.2*	17	5.9	40.0
400	-	500	*108.1*	21	4.8	50.0
500	-	600	*108.0*	16	6.3	40.0
600	-	700	*107.9*			
700	-	800	*107.8*			
800	-	900	*107.7*			
900	-	1000	*107.6*			
1000	-	1100	*107.5*			
1100	-	1200	*107.4*			
1200	-	1300	*107.3*			
1300	-	1400	*107.2*			
1400	-	1500	*107.1*			

Weighted Average	43.3

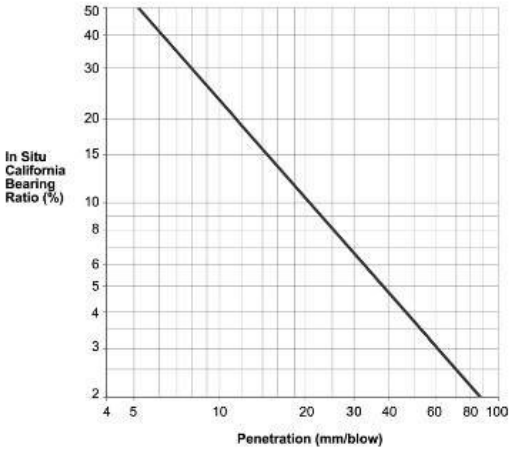
Job Name	Job Number	Date
Kainga Ora - Project Velocity	3160491	6 April 2023
Site Address		**Engineer**
43-47 Allens Road		KB

GE - Determination of Bearing Pressures and California Bearing Ratios

AR112275-GE-HA-002

AUSTROADS
Part 2: Pavement Structural Design
CALIFORNIA BEARING RATIO

Reference: Austroads Ltd. (2017). *Guide to Pavement Technology Part 2: Pavement Structural Design.* Sydney: Austroads Ltd. (Section 5.5.2, Figure 5.3)



Ground Level (mRL, CDD)			108.69			
Depth (mm)			m RL	Measured No. Blows / 100mm	e mm/blow	Austroads - Correlated CBR (%)
0	-	*100*	*108.6*	1	*100.0*	*1.5*
100	-	*200*	*108.5*	3	*33.3*	*6.0*
200	-	*300*	*108.4*	4	*25.0*	*8.0*
300	-	400	*108.3*	9	11.1	20.0
400	-	500	*108.2*	22	4.5	55.0
500	-	600	*108.1*			
600	-	700	*108.0*			
700	-	800	*107.9*			
800	-	900	*107.8*			
900	-	1000	*107.7*			
1000	-	1100	*107.6*			
1100	-	1200	*107.5*			
1200	-	1300	*107.4*			
1300	-	1400	*107.3*			
1400	-	1500	*107.2*			

Weighted Average	37.5

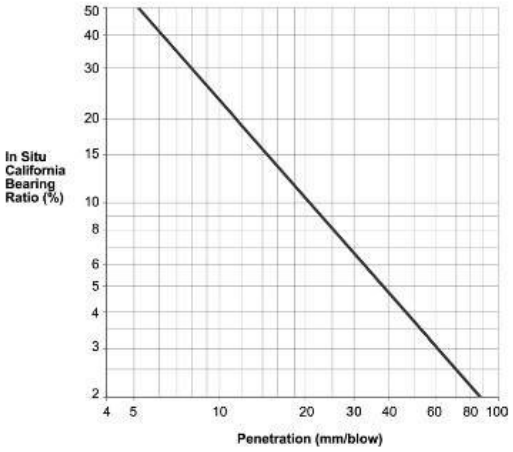
Job Name	Job Number	Date
Kainga Ora - Project Velocity	3160491	6 April 2023
Site Address		**Engineer**
43-47 Allens Road		KB

GE - Determination of Bearing Pressures and California Bearing Ratios

AR112275-GE-HA-003

AUSTROADS
Part 2: Pavement Structural Design
CALIFORNIA BEARING RATIO

Reference: Austroads Ltd. (2017). *Guide to Pavement Technology Part 2: Pavement Structural Design.* Sydney: Austroads Ltd. (Section 5.5.2, Figure 5.3)



Ground Level (mRL, CDD)			108.69			
Depth (mm)			m RL	Measured No. Blows / 100mm	e mm/blow	Austroads - Correlated CBR (%)
0	-	*100*	*108.6*	1	*100.0*	*1.5*
100	-	*200*	*108.5*	2	*50.0*	*3.5*
200	-	*300*	*108.4*	2	*50.0*	*3.5*
300	-	400	*108.3*	3	33.3	6.00
400	-	500	*108.2*	3	33.3	6.00
500	-	600	*108.1*	8	12.5	17.00
600	-	700	*108.0*	16	6.3	40.00
700	-	800	*107.9*	17	5.9	40.00
800	-	900	*107.8*	15	6.7	35.00
900	-	1000	*107.7*			
1000	-	1100	*107.6*			
1100	-	1200	*107.5*			
1200	-	1300	*107.4*			
1300	-	1400	*107.3*			
1400	-	1500	*107.2*			

Weighted Average	18.3

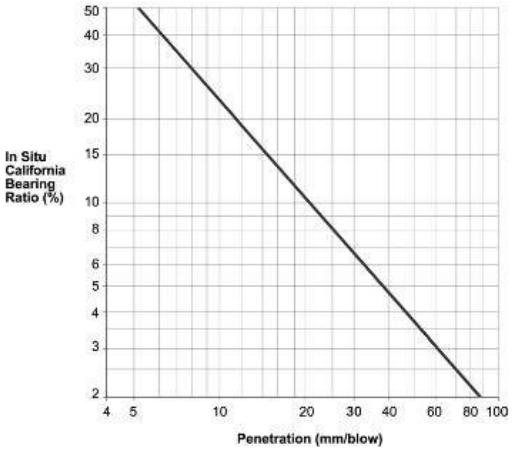
Job Name	Job Number	Date
Kainga Ora - Project Velocity	3160491	6 April 2023
Site Address		**Engineer**
43-47 Allens Road		KB

GE - Determination of Bearing Pressures and California Bearing Ratios

AR112275-GE-HA-004

AUSTROADS
Part 2: Pavement Structural Design
CALIFORNIA BEARING RATIO

Reference: Austroads Ltd. (2017). *Guide to Pavement Technology Part 2: Pavement Structural Design.* Sydney: Austroads Ltd. (Section 5.5.2, Figure 5.3)



Ground Level (mRL, CDD)			108.72			
Depth (mm)			m RL	Measured No. Blows / 100mm	e mm/blow	Austroads - Correlated CBR (%)
0	-	*100*	*108.6*	3	*33.3*	*6.0*
100	-	*200*	*108.5*	5	*20.0*	*10.0*
200	-	*300*	*108.4*	4	*25.0*	*8.0*
300	-	400	*108.3*	6	16.7	12.0
400	-	500	*108.2*	10	10.0	20.0
500	-	600	*108.1*			
600	-	700	*108.0*			
700	-	800	*107.9*			
800	-	900	*107.8*			
900	-	1000	*107.7*			
1000	-	1100	*107.6*			
1100	-	1200	*107.5*			
1200	-	1300	*107.4*			
1300	-	1400	*107.3*			
1400	-	1500	*107.2*			

Weighted Average	16.0

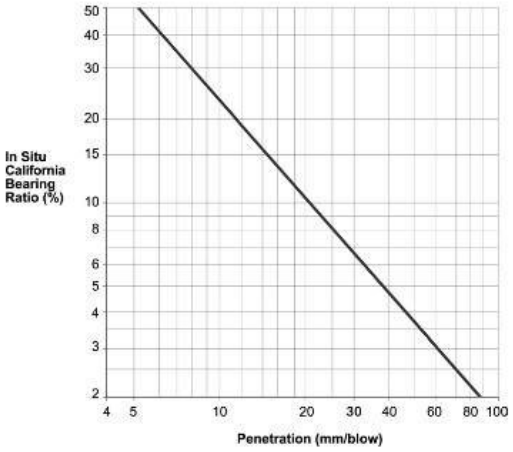
Job Name	Job Number	Date
Kainga Ora - Project Velocity	3160491	6 April 2023
Site Address		**Engineer**
43-47 Allens Road		KB

GE - Determination of Bearing Pressures and California Bearing Ratios

AR112275-GE-HA-005

AUSTROADS
Part 2: Pavement Structural Design
CALIFORNIA BEARING RATIO

Reference: Austroads Ltd. (2017). *Guide to Pavement Technology Part 2: Pavement Structural Design.* Sydney: Austroads Ltd. (Section 5.5.2, Figure 5.3)



Ground Level (mRL, CDD)			108.61			
Depth (mm)			m RL	Measured No. Blows / 100mm	e mm/blow	Austroads - Correlated CBR (%)
0	-	*100*	*108.5*	4	*25.0*	*8.0*
100	-	*200*	*108.4*	7	*14.3*	*15.0*
200	-	*300*	*108.3*	9	*11.1*	*20.0*
300	-	400	*108.2*	21	4.8	50.0
400	-	500	*108.1*			
500	-	600	*108.0*			
600	-	700	*107.9*			
700	-	800	*107.8*			
800	-	900	*107.7*			
900	-	1000	*107.6*			
1000	-	1100	*107.5*			
1100	-	1200	*107.4*			
1200	-	1300	*107.3*			
1300	-	1400	*107.2*			
1400	-	1500	*107.1*			

Weighted Average	50.0

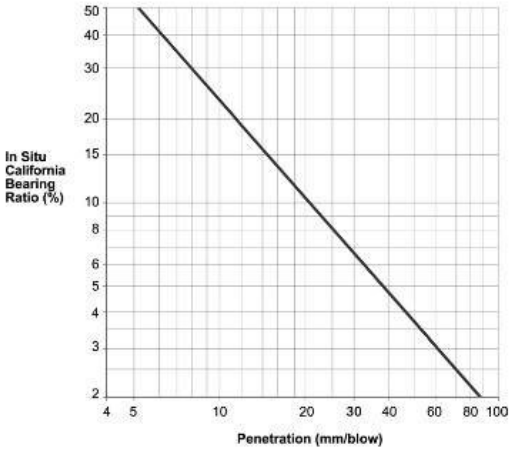
Job Name	Job Number	Date
Kainga Ora - Project Velocity	3160491	6 April 2023
Site Address		**Engineer**
43-47 Allens Road		KB

GE - Determination of Bearing Pressures and California Bearing Ratios

AR112275-GE-HA-006

AUSTROADS
Part 2: Pavement Structural Design
CALIFORNIA BEARING RATIO

Reference: Austroads Ltd. (2017). *Guide to Pavement Technology Part 2: Pavement Structural Design.* Sydney: Austroads Ltd. (Section 5.5.2, Figure 5.3)



Ground Level (mRL, CDD)			108.74			
Depth (mm)			m RL	Measured No. Blows / 100mm	e mm/blow	Austroads - Correlated CBR (%)
0	-	*100*	*108.6*	2	*50.0*	*3.5*
100	-	*200*	*108.5*	4	*25.0*	*8.0*
200	-	*300*	*108.4*	4	*25.0*	*8.0*
300	-	400	*108.3*	21	4.8	50.0
400	-	500	*108.2*			
500	-	600	*108.1*			
600	-	700	*108.0*			
700	-	800	*107.9*			
800	-	900	*107.8*			
900	-	1000	*107.7*			
1000	-	1100	*107.6*			
1100	-	1200	*107.5*			
1200	-	1300	*107.4*			
1300	-	1400	*107.3*			
1400	-	1500	*107.2*			

Weighted Average	50.0

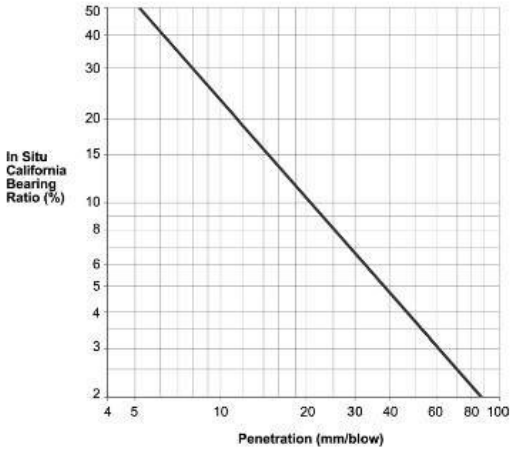
Job Name	Job Number	Date
Kainga Ora - Project Velocity	3160491	11 April 2023
Site Address		Engineer
43-47 Allens Road		JB

GE - Determination of Bearing Pressures and California Bearing Ratios

AR112275-GE-ST-001

AUSTROADS
Part 2: Pavement Structural Design
CALIFORNIA BEARING RATIO

Reference: Austroads Ltd. (2017). *Guide to Pavement Technology Part 2: Pavement Structural Design.* Sydney: Austroads Ltd. (Section 5.5.2, Figure 5.3)



Ground Level (mRL, CDD)			108.69			
Depth (mm)			m RL	Measured No. Blows / 100mm	e mm/blow	Austroads - Correlated CBR (%)
0	-	*100*	*108.5*	1	*100.0*	*1.5*
100	-	*200*	*108.4*	3	*33.3*	*6.0*
200	-	*300*	*108.3*	4	*25.0*	*8.0*
300	-	400	*108.2*	9	11.1	20.0
400	-	500	*108.1*	26	3.8	60.0
500	-	600	*108.0*	16	6.3	40.0
600	-	700	*107.9*			
700	-	800	*107.8*			
800	-	900	*107.7*			
900	-	1000	*107.6*			
1000	-	1100	*107.5*			
1100	-	1200	*107.4*			
1200	-	1300	*107.3*			
1300	-	1400	*107.2*			
1400	-	1500	*107.1*			
Weighted Average						40.0

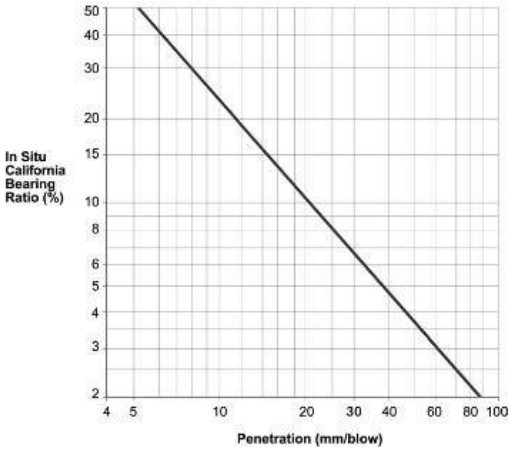
Job Name	Job Number	Date
Kainga Ora - Project Velocity	3160491	11 April 2023
Site Address		Engineer
43-47 Allens Road		JB

GE - Determination of Bearing Pressures and California Bearing Ratios

AR112275-GE-ST-002

AUSTROADS
Part 2: Pavement Structural Design
CALIFORNIA BEARING RATIO

Reference: Austroads Ltd. (2017). *Guide to Pavement Technology Part 2: Pavement Structural Design.* Sydney: Austroads Ltd. (Section 5.5.2, Figure 5.3)



Ground Level (mRL, CDD)			108.75			
Depth (mm)			m RL	Measured No. Blows / 100mm	e mm/blow	Austroads - Correlated CBR (%)
0	-	*100*	*108.6*	3	*33.3*	*6.0*
100	-	*200*	*108.5*	4	*25.0*	*8.0*
200	-	*300*	*108.4*	6	*16.7*	*12.0*
300	-	400	*108.3*	13	7.7	30.0
400	-	500	*108.2*	9	11.1	20.0
500	-	600	*108.1*			
600	-	700	*108.0*			
700	-	800	*107.9*			
800	-	900	*107.8*			
900	-	1000	*107.7*			
1000	-	1100	*107.6*			
1100	-	1200	*107.5*			
1200	-	1300	*107.4*			
1300	-	1400	*107.3*			
1400	-	1500	*107.2*			

Weighted Average	25.0

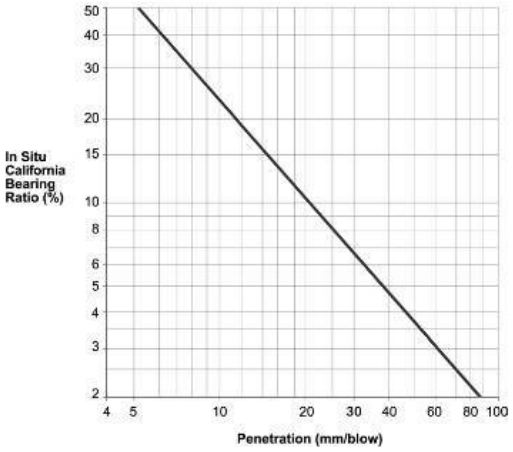
Job Name	Job Number	Date
Kainga Ora - Project Velocity	3160491	11 April 2023
Site Address		Engineer
43-47 Allens Road		JB

GE - Determination of Bearing Pressures and California Bearing Ratios

AR112275-GE-ST-003

AUSTROADS
Part 2: Pavement Structural Design
CALIFORNIA BEARING RATIO

Reference: Austroads Ltd. (2017). *Guide to Pavement Technology Part 2: Pavement Structural Design.* Sydney: Austroads Ltd. (Section 5.5.2, Figure 5.3)



Ground Level (mRL, CDD)			108.78			
Depth (mm)			m RL	Measured No. Blows / 100mm	e mm/blow	Austroads - Correlated CBR (%)
0	-	*100*	*108.6*	1	*100.0*	*1.5*
100	-	*200*	*108.5*	4	*25.0*	*8.0*
200	-	*300*	*108.4*	3	*33.3*	*6.0*
300	-	400	*108.3*	9	11.1	20.00
400	-	500	*108.2*	10	10.0	20.00
500	-	600	*108.1*			
600	-	700	*108.0*			
700	-	800	*107.9*			
800	-	900	*107.8*			
900	-	1000	*107.7*			
1000	-	1100	*107.6*			
1100	-	1200	*107.5*			
1200	-	1300	*107.4*			
1300	-	1400	*107.3*			
1400	-	1500	*107.2*			

Weighted Average	20.0

I

Appendix I – Geotechnical PS1 Producer Statement

PRODUCER STATEMENT – PS1
DESIGN

BUILDING CODE CLAUSE(S): B1 **JOB NUMBER:** 3160491
ISSUED BY: Beca Limited
(Engineering Design Firm)
TO: Kainga Ora
(Owner/Developer)
TO BE SUPPLIED TO: Consentium
(Building Consent Authority)
IN RESPECT OF: Geotechnical design of foundations for new state houses and subdivision of land
(Description of Building Work)
AT: 43, 45 and 47 Allens Road, Allenton, Ashburton
(Address, Town/City)
LEGAL DESCRIPTION: Lot 10, DP 12797 and Lots 3 and 4, DP 21833 **N/A** ☐

We have been engaged by the owner/developer referred to above to provide *(Extent of Engagement)*:
Geotechnical design services for new state house development and subdivision of land
in respect of the requirements of the Clause(s) of the Building Code specified above for Part only , as specified in the Schedule, of the proposed building work.

The design carried out by us has been prepared in accordance with:

- ☐ Compliance documents issued by the Ministry of Business, Innovation & Employment *(Verification method/acceptable solution)* and/or;
- ☑ Alternative solution as per the attached Schedule.

The proposed building work covered by this producer statement is described on the drawings specified in the Schedule, together with the specification, and other documents set out in the Schedule.

On behalf of the Engineering Design Firm, and subject to:

- Site verification of the following design assumptions: Depth to 200kPa geotechnical ultimate bearing capacity. .
- All proprietary products meeting their performance specification requirements;

I believe on reasonable grounds that:

- the building, if constructed in accordance with the drawings, specifications, and other documents provided or listed in the Schedule, will comply with the relevant provisions of the Building Code and that;
- the persons who have undertaken the design have the necessary competency to do so.

I recommend the CM 3 level of **construction monitoring**.

I, *(Name of Engineering Design Professional)* Samuel Glue , am:

- ☑ CPEng number 248637

and hold the following qualifications BE Hons (Civil)

The Engineering Design Firm holds a current policy of Professional Indemnity Insurance no less than $200,000
The Engineering Design Firm is a member of ACE New Zealand.

SIGNED BY *(Name of Engineering Design Professional)*: Samuel Glue
(Signature below):

ON BEHALF OF *(Engineering Design Firm)*: Beca Limited Date: 17/04/2023

Note: This statement has been prepared solely for the Building Consent Authority named above and shall not be relied upon by any other person or entity. Any liability in relation to this statement accrues to the Engineering Design Firm only. As a condition of reliance on this statement, the Building Consent Authority accepts that the total maximum amount of liability of any kind arising from this statement and all other statements provided to the Building Consent Authority in relation to this building work, whether in tort or otherwise, is limited to the sum of $200,000.

This form is to accompany **Form 2 of the Building (Forms) Regulations 2004** for the application of a Building Consent.

SCHEDULE to PS1

Please include an itemised list of all referenced documents, drawings, or other supporting materials in relation to this producer statement below:

11 Rowley Street, Hoon Hay, Christchurch. Geotechnical Design Report

GUIDANCE ON USE OF PRODUCER STATEMENTS

Information on the use of Producer Statements and Construction Monitoring Guidelines can be found on the Engineering New Zealand website
https://www.engineeringnz.org/engineer-tools/engineering-documents/producer-statements/

Producer statements were first introduced with the Building Act 1991. The producer statements were developed by a combined task committee consisting of members of the New Zealand Institute of Architects (NZIA), Institution of Professional Engineers New Zealand (now Engineering New Zealand), Association of Consulting and Engineering New Zealand (ACE NZ) in consultation with the Building Officials Institute of New Zealand (BOINZ). The original suite of producer statements has been revised at the date of this form to ensure standard use within the industry.

The producer statement system is intended to provide Building Consent Authorities (BCAs) with part of the reasonable grounds necessary for the issue of a Building Consent or a Code Compliance Certificate, without necessarily having to duplicate review of design or construction monitoring undertaken by others.

PS1 DESIGN Intended for use by a suitably qualified independent engineering design professional in circumstances where the BCA accepts a producer statement for establishing reasonable grounds to issue a Building Consent;

PS2 DESIGN REVIEW Intended for use by a suitably qualified independent engineering design review professional where the BCA accepts an independent design professional's review as the basis for establishing reasonable grounds to issue a Building Consent;

PS3 CONSTRUCTION Forms commonly used as a certificate of completion of building work are Schedule 6 of NZS 3910:2013 or Schedules E1/E2 of NZIA's SCC 2011[2]

PS4 CONSTRUCTION REVIEW Intended for use by a suitably qualified independent engineering construction monitoring professional who either undertakes or supervises construction monitoring of the building works where the BCA requests a producer statement prior to issuing a Code Compliance Certificate.

This must be accompanied by a statement of completion of building work (Schedule 6).

The following guidelines are provided by ACE New Zealand and Engineering New Zealand to interpret the Producer Statement.

Competence of Engineering Professional
This statement is made by an engineering firm that has undertaken a contract of services for the services named, and is signed by a person authorised by that firm to verify the processes within the firm and competence of its personnel.

The person signing the Producer Statement on behalf of the engineering firm will have a professional qualification and proven current competence through registration on a national competence-based register such as a Chartered Professional Engineer (CPEng).

Membership of a professional body, such as Engineering New Zealand provides additional assurance of the designer's standing within the profession. If the engineering firm is a member of ACE New Zealand, this provides additional assurance about the standing of the firm.

Persons or firms meeting these criteria satisfy the term "suitably qualified independent engineering professional".

Professional Indemnity Insurance
As part of membership requirements, ACE New Zealand requires all member firms to hold Professional Indemnity Insurance to a minimum level.

The PI Insurance minimum stated on the front of this form reflects standard practice for the relationship between the BCA and the engineering firm.

Professional Services during Construction Phase
There are several levels of service that an engineering firm may provide during the construction phase of a project (CM1-CM5 for engineers[3]). The building Consent Authority is encouraged to require that the service to be provided by the engineering firm is appropriate for the project concerned.

Requirement to provide Producer Statement PS4
Building Consent Authorities should ensure that the applicant is aware of any requirement for producer statements for the construction phase of building work at the time the building consent is issued as no design professional should be expected to provide a producer statement unless such a requirement forms part of the Design Firm's engagement.

Refer Also:

1. Conditions of Contract for Building & Civil Engineering Construction NZS 3910: 2013
2. NZIA Standard Conditions of Contract SCC 2011
3. Guideline on the Briefing & Engagement for Consulting Engineering Services (ACE New Zealand/Engineering New Zealand 2004)
4. PN01 Guidelines on Producer Statements

www.acenz.org.nz
www.engineeringnz.org

J

Appendix J – Statement of Professional Opinion

Statement of Professional Opinion on the Suitability of Land for Subdivision

(Appendix I to the Infrastructure Design Standard)

Issued by: Beca Limited
(Geotechnical engineering firm or suitably qualified engineer)

To: Kainga Ora
(Owner/Developer)

To be supplied to: Ashburton District Council
(Territorial authority)

In respect of: State housing development and land subdivision
(Description of proposed infrastructure/land development)

At: 43, 45 and 47 Allens Road, Allenton, Ashburton
(Address)

I Samuel Birdling Glue on behalf of Beca Limited
(Geotechnical engineer) *(Geotechnical engineering firm)*

hereby confirm:

1. I am a suitably qualified and experienced geotechnical engineer and was retained by the owner/developer as the geotechnical engineer on the above proposed development.

2. My/the geotechnical assessment report, dated April 2023 has been carried out in accordance with the Department of Building and Housing *Guidelines for geotechnical investigation and assessment of subdivisions* and includes:
   (i) Details of and the results of my/the site investigations.
   (ii) A liquefaction assessment.
   (iii) An assessment of rockfall and slippage, including hazards resulting from seismic activity.
   (iv) An assessment of the slope stability and ground bearing capacity confirming the location and appropriateness of building sites.
   (v) Recommendations proposing measures to avoid, remedy or mitigate any potential hazards on the land subject to the application, in accordance with the provisions of Section 106 of the Resource Management Act 1991.

3. In my professional opinion, I consider that Council is justified in granting consent incorporating the following conditions:

   Foundations to be TC1 waffle slab foundation system on a 200mm thick reinforced gravel raft and designed for 200kPa geotechnical ultimate bearing capacity.

4. This professional opinion is furnished to the territorial authority and the owner/developer for their purposes alone, on the express condition that it will not be relied upon by any other person and does not remove the necessity for the normal inspection of foundation conditions at the time of erection of any building.

5. This certificate shall be read in conjunction with my/the geotechnical report referred to in Clause 2 above, and shall not be copied or reproduced except in conjunction with the full geotechnical completion report.

6. The geotechnical engineering firm issuing this statement holds a current policy of professional indemnity insurance of no less than $ 200,000
(Minimum amount of insurance shall be commensurate with the current amounts recommended by IPENZ, ACENZ, TNZ, INGENIUM.)

..... Date: 17/04/2023
(Signature of Engineer)

Qualifications and experience:

BE Civil (Hons), CPEng, CMEngNZ, 16 years experience in Geotechnical Engineering design.