

eliot sinclair

518 Rangiora Woodend Road & 4 Golf Links Road, Rangiora

Prepared for CVI Projects Ltd 511185

Geotechnical Assessment Report

518 Ranaiora Woodend Road & 4 Golf Links Road, Rangiora Prepared for CVI Projects Ltd 511185

Quality Control Certificate

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Action	Name	Signature	Date
Prepared by:	Maggie Guo Geotechnical Engineer M BE(Hons) Civil	aggie Gros	6 December 2023
Reviewed by:	Nick Harwood Geotechnical Engineer Principal BE(Hons) MSc DIC MInstD CMEngNZ CPEng	N.K. Harmond	6 December 2023
Directed and approved for release by:	Claire McKeever Resource Management Planner Principal BSurv(Hons) MS+SNZ MNZPI	MRD.	6 December 2023
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Contents

1.	. Introduction										
2.	2. Scope of Works 1. Existing Data Review										
4.	Existi	ing Data Review	3								
	4.1.	Geology	3								
	4.2.	Active Faults	3								
	4.3.	MBIE Technical Categories	3								
	4.4.	Listed Land Use Register Records	3								
	4.5.	Nearby Geotechnical Data	3								
5.	Geo	4									
	5.1.	Scope	4								
	5.2.	Cone Penetration Testing	4								
	5.3.	Sonic Core Borehole Drilling Testing	5								
	5.4.	Groundwater Depth	6								
6.	Lique	7									
	6.1.	Assessment Methods	7								
	6.2.	CPT-Based Liquefaction Assessment	8								
	6.3.	SPT-Based Liquefaction Assessment	9								
	6.4.	Lateral deformation hazard	9								
	6.5.	Site-Specific Technical Category	9								
7.	Natu	ral Hazard Risk Assessment	11								
	7.1.	Introduction	11								
	7.2.	Earthquake Shaking	11								
	7.3.	Flooding	12								
	7.4.	Liquefaction Vulnerability Mapping	13								
	7.5.	Erosion and Subsidence	14								
8.	Con	clusions	14								
9.	Prop	osed District Plan Rules	14								
10.	Discl	aimer	15								



518 Rangiora Woodend Road & 4 Golf Links Road, Rangiora 511185 **eliotsinclair.co.nz** Page III

- Appendix A. Nearby Borehole and Well Records
- Appendix B. McMillan CPT Testing Records
- Appendix C. Pro-drill Borehole Drilling Testing Records
- Appendix D. CPT Based-Liquefaction Analysis Report
- Appendix E. SPT Based-Liquefaction Analysis Report



1. Introduction

Eliot Sinclair & Partners Ltd was engaged by CVI Projects Limited to compile a Geotechnical Assessment to confirm the suitability for rezoning from rural to residential land use of the site at 518 Rangiora Woodend Road and 4 Golf Links Road, Rangiora.

This report is intended to be used as technical supporting documentation to support the submission requesting site rezoning as part of the Proposed Waimakariri District Plan review.

The scope of geotechnical assessment and density of investigation positions required for the rezoning was determined in liaison with the project's Planners and with reference to MBIE/NZGS Module 2: Geotechnical investigations for earthquake engineering (2021)¹. The assessment undertaken is essentially a RMA s106 natural hazards assessment, but using a wider array of investigation positions as per Module 2, Table 2.1.

2. Scope of Works

The scope of work for this report was to:

- Review available data from the New Z ealand Geotechnical Database² (NZGD), Canterbury Maps³ and the Institute of Geological & Nuclear Sciences' (GNS) Active Faults Database⁴,
- Review the Waimakariri District Council natural hazards maps⁵,
- Undertake a site walkover to identify any possible geotechnical hazards,
- Undertake Cone Penetrometer Tests (CPTs) to a target depth of 15m bgl below ground level (bgl) or practical refusal to characterise the deep subsurface soil profile, assess the lique faction potential and future land performance,
- Undertake machine boreholes (BHs) to a target depth of 1 0m bgl below ground level (bgl) to characterise the nature and deep subsurface soil profile and assist the liquefaction analysis, and
- Prepare a Geotechnical Assessment report to summarise the general geotechnical conditions encountered across the site , comment on risk of liquefaction and assess the future ground performance as evidence for the proposed plan change.

⁵ WDC natural hazard maps: <u>https://letstalk.waimakariri.govt.nz/natural-hazards</u>



¹ New Zealand Geotechnical Society (NZGS), Module 2 - https://www.nzgs.org/libraries/earthquake-geotechnical-engineering/

² New Zealand Geotechnical Database (NZGD) - https://www.nzgd.org.nz/

³ Canterbury Maps - https://mapviewer.canterburymaps.govt.nz

⁴ GNS Active Faults Database - http://maps.gns.cri.nz/website/af/viewer.htm

3. Site Description

The site located at 518 Rangiora Woodend Road and 4 Golf Links Road, Rangiora comprises a total land area of approx. 11.3 hectares and consists of two Titles. Refer to Figure 1 for a current site layout plan. The legal descriptions of the two allotments are:

- Lot 2 DP 16884 4 Golf Links Road (0.9806ha)
- Part RS 1054 518 Rangiora Woodend Road (10.229ha)

Aside from the building locations and their driveways, the site was covered by short grass and used for grazing at the time of our site visits on 26 April and 3 October 2023. The topography of the site is generally flat with some undulations and two notable channel features (refer to Figure 1). The channels flowing from the west converge at around the centre point of 518 Rangiora Woodend Road. The channel features may be considered as "normally dry" though are part of the WDC mapped overland flow network⁶.

The Waimakariri Three Waters Map Viewer⁷ shows an existing council owned natural stormwater channel (Taranaki Stream) runs along the northern property boundary of 4 Golf Links Road and through the centre of the 518 Rangiora Woodend Road towards east. A tributary of Taranaki Stream runs across the site from northwest and converges to Taranaki Stream (refer to Figure 1). During our site work the channels were dry so are regarded as ephemeral watercourses.

The Cam River/Ruataniwha is located to the southwest of the site and the Ashley River is approximately 1.7km north of the site.



Figure 1. Site layout overlaying with contour map and overland channel feature.

⁷ Refer to WDC Three Waters Viewer: <u>https://openmaps-waimakariri.hub.arcgis.com</u>



Geotechnical Assessment Report - Version A

518 Rangiora Woodend Road & 4 Golf Links Road, Rangiora 511185 eliotsinclair.co.nz Page 2

⁶ Refer to WDC natural hazards flood mapping: <u>https://letstalk.waimakariri.govt.nz/natural-hazards</u>

4. Existing Data Review

4.1. Geology

Geological mapping⁸ of the area indicates the site is underlain with 'Modern river floodplain/low-level degradation terrace. Unweathered, variably sorted gravel/sand/silt/clay. Surfaces <2 -degree slope (Q1a)", comprising of river deposits.

4.2. Active Faults

The GNS database ⁹ indicates the site is located outside the minimum 20m fault avoidance zone recommended by the Ministry for the Environment¹⁰.

4.3. MBIE Technical Categories

The MBIE Category has mapped the site as 'N/A - Rural & Unmapped'.

4.4. Listed Land Use Register Records

The ECan 'Listed Land Use Register (LLUR) has indicated there is potential for pesticides and herbicides to have been used (HAIL A10 Activities) on 4 Golf Links Road. No LLUR records are recorded for 518 Rangiora Woodend Road.

Refer to Eliot Sinclair's Preliminary Site Investigation (PSI) Report, dated 13 June 2023 for more details.

4.5. Nearby Geotechnical Data

We have reviewed the NZGD portal and the ECan well cards database for nearby borehole logs. Relevant ECan well logs are as shown in Table 1. Refer ϕ Appendix A for the borehole and well factual logs and a location plan.

BH_189061 is located at 174 East Belt to the northwest of the site. The borehole encountered sandy silty topsoil/silty sand to 0.4m bgl, overlying interbedded silty sandy gravels and thin layers of silt to 15.08m bgl. The groundwater was recorded at around 4.1m bgl in July 2019.

BH_189062 is located at 52 Kippenberger Avenue to the west of the site. The borehole encountered sandy silty topsoil/silty sand to 1.4m bgl, overlying interb edded silty sandy gravels and gravelly silt to 15.08m bgl. The groundwater was recorded at around 4.0m bgl in July 2019.

The ground conditions are markedly naturally variable across the large site area, with a notable variable being the presence and thickness of a shallow gravel body, which had implications for the choice of ground investigation method – see later in report for details.

¹⁰ Planning for Development of Land on or Close to Active Faults: A Guideline to Assist Resource Management Planners in New Zealand (Published July 2003).



Geotechnical Assessment Report - Version A

⁸ Nathan, S., Rattenbury, M.S., Suggate, R.P. (compliers) 2002. Geology of the Greymouth area. Institute of Geological and Nuclear Sciences 1: 250 000 geological map 12. 1 sheet + 58p. Lower Hutt, New Zealand. Institute of Geological and Nuclear Sciences Limited

⁹ GNS Science - Active Faults Database

Table 1. Summary of nearby ECan Well and Bores data.

Bore or		Total Depths	Ground Water Level	
Well No.	Location	(m)	(m bgl)	Soil Profile
BW24/0207	22 Marchmont Road	18.00	2.20	Brown clayey/grey gravel at between 0.5m - 18m bgl with a thin layer of clay at between 9m – 10m bgl
M35/1837	6 Marchmont Road	6.00	2.56	Sandy gravel to 6m bgl
BW24/0632	6 Marchmont Road	14.87	2.02	Gravelly clay at between 0.3m – 4.0m bgl, overlying various gravels to 15m bgl
M35/0366	26 Golf Links Road	14.80	2.70	No data for upper 5.8m; Various gravels to 14.8m bgl
M35/7658	16 Golf Links Road	11.00	3.10	Sand/clay to 11m bgl
M35/0276	476 Rangiora Woodend Road	32.30	0.60	No data for upper 3.7m; sandy clay at between 3.7m – 10.7m, overlying various gravels with sand/clay to 32.3m bgl

5. Geotechnical Site Investigation

5.1. Scope

For the proposed activity of a plan change, the scope of geotechnical testing is to be in accordance with MBIE Guidance Module 2: Geotechnical investigations for earthquake engineering. For the site area (approx. 11.3ha) the Guidance recommends a minimum o f 12 deep tests (Table 2.1) and for these to be evenly distributed across the entire site area (Table 2.2).

5.2. Cone Penetration Testing

5.2.1. Overview

McMillan Drilling Ltd undertook 15 Cone Penetrometer Tests (CPTu) staring from 31 July to 2 August 2023 to char acterise the deeper soil profile. The CPTs were carried out in accordance with ASTM Standard D5778-12 'Test Method for Performing Electronic Friction Cone and Piezocone Penetration Testing of Soils'. The CPT test data was provided as a full electronic re cord for use in later data interpretation and analyses. Some dissipation tests were carried out in granular freedraining materials at the end of the CPT testing for groundwater level interpretation.

5.2.2. CPT Soil Behaviour Type

Refer to Appendix B for CPT records and a test location plan.

The majority of CPT tests at the northern part of 518 Rangiora Woodend Road (CPT_01, 02, 03, 03A, 04, 05, 06, 06A and 08) and 4 Golf Links Road (CPT_07 and 13) had early practical refusal on inferred dense sand or gravel to various depths extending to 1.01m – 4.86m bgl.



In the area near the southern property boundary of 518 Rangiora Woodend Road, CPT_09 indicates clay/silty clay/silty sand-like soils to around 12.3m bgl with a thin layer of clean sands to silty sands-like soil at between 2.5m – 3.0m bgl, overlying the dense sand-like soil to 12.8m bgl where testing was terminated. The dissipation test indicates the ground water level (GWL) was around 1.6m bgl.

At the location of CPT_10, the CPT data indicates interbedded silty clay/sandy silt/silty clay-like soil to 7.64m bgl with a layer of clean sand/silty sands-like soil at between 1.4m – 2.5m bgl. The dissipation test indicates the GWL is located at around 1.2m bgl.

At the location of CPT_11, the CPT data indicates interbedded clay/silty sand/silty clay-like soil to 8.7m bgl, overlying dense sand-like soil to 9.05m bgl where practical refusal has been met. The dissipation test indicates the GWL is located at around 1.2m bgl.

At the location of CPT_12, the CPT behaviour type indicates clay/silty clay to around 1.5m bgl, overlying clean sands/silty sands to 3.0m bgl, over interbedded clay/silty clay to 8.7m bgl, over clean sands/silty sands to 10.23m bgl. The dissipation test indicates the GWL is located at around 0.4m bgl.

5.3. Sonic Core Borehole Drilling Testing

Due to the shallow practical refusal for most CPTs on site, Pro-Drill Limited undertook 8 Sonic Core Boreholes (BHs) with Standard Penetration Tests (SPTs) from 3 October to 5 October 2023, as supplementary testing to characterise the deeper soil profile as investigation pairings at the shallow CPTs. Refer to Appendix C for Borehole logs and a test location plan.

The SPTs were carried out in accordance with ASTM Standard D1586-11 'Standard Test Method for Standard Penetration Test (SPT) and Split-Barrel Sampling of Soils'. The SPT hammer efficiency was calibrated in accordance with ASTM Standard D4633-10 'Standard Test Method for Energy Measurement for Dynamic Penetrometers'.

A summary of all drilled boreholes undertaken is given in Table 2.

	Address	Loc	ation	Depth	Ground Water	
BH NO.	Address	Easting	Northing	(m bgl)	Level (m bgl)	
BH_01	518 Rangiora Wooded Road	1569113	5206109	10.6	2.9	
BH_02	518 Rangiora Wooded Road	1569203	5206052	10.6	2.3	
BH_03	518 Rangiora Wooded Road	1569312	5205985	10.6	2.2	
BH_04	518 Rangiora Wooded Road	1569062	5206004	10.6	3.1	
BH_05	518 Rangiora Wooded Road	1569157	5205943	10.6	2.5	
BH_06	518 Rangiora Wooded Road	1569266	5205883	10.6	2.2	
BH_07	4 Golf Links Road	1568902	5205871	10.6	3.5	
BH_08	518 Rangiora Wooded Road	1569077	5205794	10.6	2.4	

Table 2. Summary of machine boreholes drilled.

Standard Penetration Tests were typically carried out at nominal 1.5m centres and the uncorrected N-values were recorded every 75mm intervals on the borehole logs. SPT hammer efficiencies used during the tests are 81.5% for all drilled boreholes.



Geotechnical Assessment Report - Version A

518 Rangiora Woodend Road & 4 Golf Links Road, Rangiora 511185 eliotsinclair.co.nz Page 5 The deep borehole tests undertaken at the centre and the northern half of 518 Rangiora Woodend Road, and 4 Golf Links Road indicate the depth to the shallow gravels below the ground surface is generally located at between 0.3m - 2.8m bgl with various thickness of 4.5m - 8.2m. Below that the ground is underlying the interbedded clayey silt/sand/silt to around 9m bgl, over the dense gravel to 10.6m bgl where testing was terminated.

Based on the results of both CPTs and borehole tests, we consider there is a transition of ground profile between the deep gravels and deep fine -grained soils towards the south property boundary of 518 Rangiora Woodend Road, due to a gradual reduction of t he thickness of upper gravel layers or completely missing.

5.4. Groundwater Depth

Information on the groundwater level across the site has been obtained from three datasets, being the CPT porewater pressure (u2) profiles, the CPT dissipation tests, and the driller's BH observations recorded on the borehole logs. The borehole observations may be the least reliable as they can be influenced by the process of drilling (with water used as the drill flush).

Based on our analysis, the u 2 pore water pressure profiles and the dissipation tests generally indicate the consistent groundwater depths. We noticed that the dissipation tests for CPT_12 indicates GWL at 0.4m bgl which is very shallow comparing to other GWL data at the site. We consider this is because the ground elevation gradually falls towards the eastern area, and the elevation difference across the whole site in west-east direction is around 2m, as indicated in the site contour map.

The land elevation broadly falls from north to south across the site with an elevation difference of approx. 3m. The groundwater depth data indicates a compatible trend with a deeper groundwater depth in the north and becoming shallower to the south. At the time of our fieldwork the data indicates groundwater depth as approx. 3m towards the north (CPTu04) and as shallow as 0.4m in the south (CPTu12).



6. Liquefaction Hazard Assessment

6.1. Assessment Methods

Using the most recent version of MBIE's residential guidelines and Supplement Issue 7, the calculation of CPT based liquefaction triggering was undertaken using the method outlined in Boulanger & Idriss (2014)¹¹. The estimation of post-liquefaction induced settlements for CPTu using the method outlined by Zhang et al (2002)¹². The liquefaction analysis was calculated using both CLiq¹³ and LiqSVs¹⁴.

The calculation of SPT based liquefaction trigg ering was undertaken using the method outlined in Boulanger & Idriss (2008)¹⁵.

Refer to Appendix D for CPT -based liquefaction analysis report and Appendix E for SPT -based liquefaction analysis report.

The results of deep CPTs (CPT_09 to 12) and SPTs (SPT_01 to 08)were analysed for both the Serviceability Limit State (SLS) and the Ultimate Limit State (ULS) levels of earthquake shaking as per NZGS Module 1 showing below:

- SLS1 (1:25 year return period) Case 1: M7.5, PGA 0.13g;
- SLS2 (1:25 year return period) Case 2: M6.0, PGA 0.19g; and
- ULS(1:500 year return period) M7.5, PGA 0.35g.

Based on our analysis of the CPT data we have adopted the groundwater depths interpreted from both CPT u_2 curves and the dissipation tests at each CPT test location and assumed the earthquake groundwater depths to be 0.5m higher than the static condition for the purpose of a conservative analysis.

For SPT-based liquefaction assessment we have adopted the groundwater depths measured from each drilled borehole during a static condition and assumed the earthquake groundwater depths to be 0.5 higher during a seismic loading condition for the purpose of a conservative analysis.

¹⁵ Boulanger, R. W., and Idriss, I. M. (2008). Soil Liquefaction During Earthquakes. Department of Civil and Environmental Engineering, University of California.



¹¹ Boulanger, R. W., and Idriss, I. M. (2014). *CPT and SPT based liquefaction triggering procedures*. Report No. UCD/CGM-14/01, Centre for Geotechnical Modelling, Department of Civil and Environmental Engineering, University of California, Davis, CA, 134 pp.

¹² Zhang, G., Robertson, P.K. & Brachman, R. (2002). Estimating liquefaction-induced ground settlements from CPT for level ground. Canadian Geotechnical Journal, 39(5): 1168-1180.

¹³ CLiq (version 2.3.1.14). GeoLogismiki Geotechnical Software

¹⁴ LiqSVs (version 2.0). GeoLogismiki Geotechnical Software

6.2. CPT-Based Liquefaction Assessment

6.2.1. Settlement (Sv1D)

The liquefaction-induced '*index*' settlement values were calculated using method the by Zhang et al (2002)¹² for a range of parameters that are estimated from the four basic CPT parameters (depth, cone tip resistance, skin friction and pore water pressure) and represent 'free-field' settlements. Therefore, the settlements shown in Table 3 are not an exact figure, but only index values for interpretation of relative susceptibility to the damaging effect of liquefaction.

	Depth of CPT	Liquefaction	-induced 'inde» (mm)	(' settlements	MBIE Equivalent
Test No.	test (m bgl)	SLS1 (M7.5, 0.13g)	SLS2 (M6.0, 0.19g)	ULS (M7.5, 0.35g)	land classification at test location
CPT_09	12.80	25	35	52	TC2
CPT_10	7.64	17	28	56	TC2
CPT_11	9.05	38	<mark>57</mark>	96	TC3 / TC2
CPT_12	10.23	<mark>52</mark>	<mark>59</mark>	72	<mark>TC3</mark> / <mark>TC2</mark>

Table 3. CPT-based liquefaction-induced 'index' settlement values.

Note: The "**TC3** / **TC2**" descriptor relates to our assessment that the basic CPT data analysis indicates TC3 land performance (for some SLS cases – highlighted blue), but our interrogation of the analysis outputs (refer to Appendix D) finds that TC2 land performance is expected.

6.2.2. CPT-Based Liquefaction severity number (LSN)

The liquefaction severity number (LSN) is a parameter developed to reflect the more damaging effects of shallow liquefaction on residential land and shallow foundations. The estimated LSN values for the four CPT tests are summarised in Table 4.

Table 4. Maximum LSN of analysed CPTs.

Event	Maximum LSN Range	Predominant Performance
SLS	10 - 20	Minor expression of liquefaction
ULS	30 - 40	Moderate to severe exp. of liquefaction



Geotechnical Assessment Report - Version A

6.3. SPT-Based Liquefaction Assessment

6.3.1. Settlement (S_{V1D})

The liquefaction-induced '*index*' settlement values were calculated using the software LiqSVs¹⁶ for a range of parameters that are estimated from the basic SPT parameters and represent 'free-field' settlements. Refer to Table 5.

	Liquefaction-ii	MBIE Equivalent				
Test No.	SLS1	SLS2	ULS	classification at		
	(1417.5, 0.159)	(1410.0, 0.179)	(M7.5, 0.559)	lesi loculoli		
BH_01	3	4	78	TC2		
BH_02	9	17	84	TC2		
BH_03	6	9	41	TC2		
BH_04	10	31	55	TC2		
BH_05	2	2	35	TC2		
BH_06	10	14	79	TC2		
BH_07	37	<mark>65</mark>	120	TC3 / TC2		
BH_08	16	<mark>53</mark>	97	TC3 / TC2		

Table 5.	SPT-based liquefaction-induced 'index' settlement values.
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Note: The "**TC3** / **TC2**" descriptor relates to our assessment that the basic SPT data analysis indicates TC3 land performance (for some SLS cases, and a ULS case – highlighted blue), but our interrogation of the analysis outputs (refer to Appendix E) finds that TC2 land performance is expected.

6.4. Lateral deformation hazard

The current terrain setting of the site is such that the risk of earthquake-induced lateral deformation (stretch) is relatively low.

Changes to the land during engineering design for site development shall be subject to review for potential adverse changes to lateral deformation hazard.

6.5. Site-Specific Technical Category

The broad-brush site-specific investigation and assessment of CPT and borehole records presented above determines that **equivalent TC2 land performance** is generally predicted for the site for the purposes of the Plan Change application.

The MBIE residential development guidance document (Table 3.1) provides the following index criteria for the technical categories:

¹⁶ LiqSVs (version 2.0). GeoLogismiki Geotechnical Software



Foundation Technical Category	Future land performance expectation from liquefaction	Nominal SLS land settlement	Nominal ULS land settlement	Nominal Lateral Stretch
TC1 (where confirmed)	Liquefaction damage is unlikely in a future large earthquake	0–15 mm	0–25 mm	Generally not expected
TC2 (where confirmed)	Liquefaction damage is possible in a future large earthquake	0–50 mm	0–100 mm	<50 mm
TC3 (where confirmed)	Liquefaction damage is possible in a future large earthquake	>50 mm	>100 mm	>50 mm

The MBIE guidance (Section 1.4.3) states : "TC2: Liquefaction damage is possible in future large earthquakes. Standard enhanced foundation repair and rebuild options in accordance with MBIE guidance are suitable to mitigate against this possibility."



Geotechnical Assessment Report - Version A 518 Rangiora Woodend Road & 4 Golf Links Road, Rangiora 511185 **eliotsinclair.co.nz** Page 10

7. Natural Hazard Risk Assessment

7.1. Introduction

Council can decline an application for subdivision consent if there is a significant risk from natural hazards. To determine whether there is a significant risk from natural hazards, decision -makers are guided by the requirements of RMA Section 106(1A)¹⁷. This requires a combined assessment of:

- The likelihood of natural hazards occurring (whether individual or in combination); and
- The consequences (material damage) that would result from natural hazards to land where the consent is sought, other land, or structures; and
- Any likely subsequent use of the land where the consent is sought that would accelerate, worsen, or result in material damage.

Decision-makers are required to consider the magnitude of risk of natural hazards, including natural hazards that have a high impact but low probability of occurrence. This aligns the assessment with the definition of 'effect' Section 3 of the RMA.

The RMA defines natural hazards as: Any atmospheric or earth or water related occurrence (including earthquake, tsunami, erosion, volcanic and geothermal activity, landslip, subsidence, sedimentation, wind, drought, fire, or flooding) the action of which adversely affects or may adversely affect human life, property, or other aspects of the environment.

Hazard identification is a key component of any site -specific risk assessment. The risk assessment for relevant natural hazards at the site is presented below, which considers the likelihood and consequences of the hazard at the site in the context of the proposed activity (plan change from rural to residential land use) as compared against the current site context.

We have considered the risk of falling debris, subsidence, wind, drought, fire, geothermal activity, sedimentation, climate change, sea level rise, and volcanic activity and conclude these are very unlikely to pose an unacceptable risk to life at this site.

In relation to other potential natural hazards, we comment as follows:

7.2. Earthquake Shaking

New Zealand is a seismically active country. New buildings and infrastructure will be designed, consented, and built to acceptable industry standards and New Zealand Building Code requirements As such the earthquake shaking risk to buildings will be managed to acceptable levels.

¹⁷ For the purposes of this Plan Change assessment we have adopted the s106 natural hazard assessment framework normally applied to subdivision applications. This is to give a familiar format of assessing natural hazards for land development, generally. An application for subdivision is a likely next step following the District Plan review process if this rezoning submission is successful.



7.3. Flooding

The Waimakariri Flood Hazard Map indicates the flood hazard within the Taranaki Stream (and tributaries) is Low to Medium from the 200 Year ARI rainfall event as shown in Figure 2.

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Refer to Eliot Sinclair's Flood Impact Assessment Report¹⁸ for flood modelling details of the site.

Figure 2. Current level of flood hazard at the site (Waimakariri Flood Hazard Map, October 2023).

¹⁸ Flood Impact Assessment – 4 Golf Links Road and 518 Rangiora Woodend Road, Rangiora, Version A, Ref: 511185, prepared by Eliot Sinclair, dated 10 October 2023.



Geotechnical Assessment Report - Version A

518 Rangiora Woodend Road & 4 Golf Links Road, Rangiora 511185 eliotsinclair.co.nz Page 12

7.4. Liquefaction Vulnerability Mapping

The WDC liquefaction vulnerability mapping¹⁹ indicates a liquefaction boundary line going across the site which identified the eastern two-thirds of the site as "Liquefaction damage is possible", and the western third of the site as "Liquefaction damage is unlikely". Refer to Figure 3.

However, we consider this is a regional scale map with the boundary between the two area s being relatively arbitrary at the site-specific scale.



Figure 3. Liquefaction vulnerability map (WDC Natural Hazards map, October 2023).

Our broad-brush site-specific investigation and assessment of CPT and borehole records presented above determines that **equivalent TC2 land performance** is generally predicted for the site for the purposes of the rezoning submission request.

¹⁹ WDC natural hazards mapping: <u>https://letstalk.waimakariri.govt.nz/natural-hazards</u>



511185 eliotsinclair.co.nz Page 13

7.5. Erosion and Subsidence

The site is gently undulating. At the time of our site walkover inspection, we did not find any obvious evidence of significant erosion or subsidence. We have reviewed the aerial photographs for the channel features and consider that it is unlikely for proposed buildings being affected by erosion as the building will be set outside of channels. Appropriate design of infrastructure and buildings will manage the risk of erosion to acceptable levels.

There are no identified special / unusual ground conditions that would raise concern for a Plan Change rezoning request regarding subsidence. Subsidence risk will be managed to acceptable levels via normal investigation and engineering design practices for infrastructure and buildings.

An Erosion and Sediment Control Plan should be in place for any earthworks or construction at the site, in accordance with normal earthworks management practices.

8. Conclusions

Based on our geotechnical investigation, we consider the site at 518 Rangiora Woodend Road and 4 Golf Links Road is suitable for rezoning from rural to residential land use.

We consider the site can be rezoned and that natural hazards can be mitigated through good development design and practice to ensure the safety of infrastructure, buildings and people.

9. Proposed District Plan Rules

No rules to manage geotechnical risk are proposed.

There are no special conditions of the site identified that warrant geotechnical risk management measures beyond those that fal I within normal infrastructure and building investigation and design practices.



10. Disclaimer

This report has been prepared by Eliot Sinclair & Partners Limited ("Eliot Sinclair") only for the intended purpose as a Natural Hazards Risk Assessment for a Plan Change application. Our analysis is based on our inspection of the site and geotechnical testing.

The report is based on:

- Information shown on NZS3604:2011, WestMaps, Beca Regional Liquefaction Report, and GNS's Active Faults Database.
- Ministry of Business, Innovation and Employment's (MBIE) December 2012 guidelines.
- Factual borehole and CPT records.

Where data supplied by CVI Projects Ltd or other external sources have been relied upon, it has been assumed that the information is correct unless otherwise stated. No responsibility is accepted by Eliot Sinclair for incomplete or inaccurate data supplied by other parties.

Whilst every care has been taken during our investigation and interpretation of the subsurface conditions to ensure that the conclusions drawn, and the opinions and recommendations expressed are correct at the time of reporting, Eliot Sinclair has not performed an assessment of all possible conditions or circumstances that may exist at the site. Variations in condit ions may occur between investigatory locations and there may be conditions such as subsoil strata and features that were not detected by the scope of the investigation that was carried out or have been covered over or obscured over time. Additionally, on-going seismicity in the general area may lead to deterioration of ground conditions that could not have been anticipated at the time of writing this report. Eliot Sinclair does not provide any warranty, either express or implied, that all conditions wittonform exactly to the assessments contained in this report.

The exposure of conditions that vary from those described in this report, or occurrence of additional strong seismicity, or any future update of MBIE's guidelines may require a review of our recommendations. Eliot Sinclair should be contacted to confirm the validity of this report should any of these occur.

This report has been prepared for the benefit of CVI Projects Ltd and the regulatory authority for the purposes as stated above. This report is specifically prepared for the proposed Plan Change application and should not be used to support any future consent application without prior review and approval by Eliot Sinclair. No liability is accepted by Eliot Sinclair or any of their employee s with respect to the use of this report, in whole or in part, for any other purpose or by any other party.



Appendix A. Nearby Borehole and Well Records





NZGD ID: BH_189061

Ó	urecon	BOREHOLE RECORD	HOLE NO.			BH1	
	aurecongroup.com						506685
	Westpark - Inch Land Geotechn						
FROJECT	Rangiora						
METHOD	SNC	CO-ORDINATES (NZTM)	SHE	ET	1	of	2
MACHINE &	& NO. Geoprobe 8140LS - Track	E 1568297 N 5206283	DAT	E from	01/07/2019	to	02/07/2019
FLUSHING M	EDIUM Water	ORIENTATION VERTICAL	GRC	UND-LE	VEL +	28.00	m RL



	Progress	Water level (m) shift start/ end	Water Recovery %	Total core Recovery %	Solid core Recovery %	R.Q.D.	Fracture Index	Tests	Samples	Reduced Level	00.0 (m)	Legend		STRATA DESCRIPTION SUBORDINATE FRACTION, MAJOR FRACTION, MINOR FRACTION, COLOUR, STRUCTURE, STREMGTH, MOISTURE CONDITION GRADING, BEDDING, PLASTICITY, ETC (NZ GEOTECHNICAL SOCIETY - FIELD DESCRIPTION OF SOIL AND ROCK)	Instrument/ Backfill
RK - INCH LAND.GPJ Library: AGS 4_0.GLB Date: 30 July 2019	Progree	shift start/ end	Water	Barrier Contraction Contractio	Solid or Recover	R.Q.D.	Fracturi Fracturi	Tests (15, 14, 13, 13, 9, 10) N = + 45/450 mm (22, 20, 18, 15, 16, 11) N = + 60/445 mm (16, 30, 25, 22, 13) N = + 60/350 mm	Samples Type Ref Depth 0.00	+27.85 +27.60 +23.60		0 0	Sandy non-p Silty S moist; sand, yellow round 1.60m Sandy yellow to coa coarse	A GRAVEL with some silt and trace cobbles; // Some silt and trace cobbles; // GRAVEL with some silt and trace cobbles; // Some silt and trace silt and trace cobbles; // Some silt and trace si	
EHOLE RECORD WITH INSTALLATION II Project: WESTPA	Sm Lar	all Distur qe Distur	bed S	355 ample	e			(11, 11, 8, 7, 6, 10) N = 31/450 mm (13, 33, 40, 20) N = 60/265 mm						REMARKS	
Report ID: AGS4 BOR	SP ⁻ Thi U10 Poo S	r Liner Sa n Wall Un 00 Undist cket Pene ton Samp	ample Idistui urbed trome ole	rbed Samp ster To	Samp ple est	le								Elevations from LINZ Data Service 1m LIDAR, accurate to 4/- 5 Elevations from LINZ Data Service 1m LIDAR, accurate to 1m. Static water levels: 4.50m bgl at casing depth of 15.08; 2/07/2019, 1:30pm. 4.1 bgl in piezometer standpipe; 4/07/2019, 2.00pm	om. o +/- 10m
<u>۳</u>											- - - -				
							Wat Imp Sta Per	ter Level pression Pack ndard Penetr meability Tes zometer / Sta	ter Test ation Test t ndpipe Tip	LOGG DATE CHEC	ED <u>F. </u> 05/ KED <u>S.</u>	MONTE /07/2019 MCRAE	<u>ITH</u>		

Packer Test 23/07/2019 DATE

1.1

Aurecon, Level 2 Iwikau Building, 93 Cambridge Terrace, Christchurch 8013. Tel: 03 366 0821 Fax: christchurch@aurecongroup.com

NZGD ID: BH_189061 NZGD ID: BH_189061

	BOREHOLE RECORD		HOLE	E NO.			BH1
			PRO	JECT NO.			506685
Westpark - Inch Land Geotechni PROJECT Rangiora	cal Investigation						
METHOD SNC	CO-ORDINATES (NZTM)	SHE	ΞT	2		of	2
MACHINE & NO. Geoprobe 8140LS - Track	E 1568297 N 5206283	DATE	E from	01/07/2	019	to	02/07/2019
FLUSHING MEDIUM Water	ORIENTATION VERTICAL	GRO	UND-LI	EVEL	+28	.00	m RL



Г				,										1	
	Drilling Progress	Water level (m) shift start/ end	Water Recovery %	Total core Recovery %	Solid core Recovery %	R.Q.D.	Fracture Index	Tests	Samples	Reduced Level	0 (m)	Legend		STRATA DESCRIPTION SUBORDINATE FRACTION, MAJOR FRACTION, MINOR FRACTION, COLOUR, STRUCTURE, STRENGTH, MOISTURE CONDITION GRADING, BEDDING, PLASTICITY, ETC (NZ GEOTECHNICAL SOCIETY - FIELD DESCRIPTION OF SOIL AND ROCK)	Instrument/ Backfill
RECORD WITH INSTALLATION Project: WESTPARK - INCH LAND.GPJ Library: AGS 4_0.GLB Date: 30 July 2019								(15, 23, 21, 19, 18, 2), N = 60/385 mm (21, 26, 23, 27, 10) N = 60/330 mm (18, 17, 18, 15, 12, 11) N = 56/450 mm (14, 20, 22, 25, 13) N = 60/330 mm		+15.60 +15.10 +13.50 +12.92	12.40	$ \begin{array}{c} \circ \circ$	SILT v dense to sub Silty s moist; sand, SILT v plastic Er	with minor sand and gravel; brownish grey. <i>Very</i> , moist, low plasticity; gravel, medium, sub-rounded -angular; sand, fine to coarse. andy GRAVEL; light brownish grey. <i>Very dense</i> , gravel, fine to coarse, sub-rounded to sub-angular; fine to coarse; silt, low plasticity. with minor sand; light brown. <i>Very dense</i> , dry, low ity; sand, fine. d of Sonic core drilling at 15.08m, on 02/07/2019 <i>Termination Reason:</i> Target depth reached.	
Report ID: AGS4 BOREHOLE I	- Sm ↓ Lai Ø SP I Thi ■ U10 → Po m Pis	all Distur ge Distur T Liner Sa in Wall Ur 00 Undist cket Pene ton Samp	bed S bed S ample ndistu urbed trome	ample ample rbed \$ Sampleter Te	e Samp ple est	le	I			I	I	I		REMARKS Coordinates from handheld GPS, accurate to +/- Elevations from LINZ Data Service 1m LIDAR, accurate t 1m. Static water levels: 4.50m bgl at casing depth of 15.08; 2/07/2019, 1:30pm. 4 bgl in piezometer standpipe; 4/07/2019, 2.00pm	5m. to +/- .10m
_											- - - - -				
-	 					¥ ↓ ↓	Wat Imp Star Perr	er Level ression Pack ndard Penetr neability Tes	er Test ation Test	LOGG DATE	ED <u>F. I</u>	MONTE	ITH		



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NZGD ID: BH_189061 NZGD ID: BH_189062

aurecon	BOREHOLE RECORD		HOLE	E NO.			BH2
and a congroup con			PRO	JECT NO) .		506685
Westpark - Inch Land Geotechn PROJECT Rangiora	ical Investigation	-					
METHOD SNC	CO-ORDINATES (NZTM)	SHE	ET	1		of	2
MACHINE & NO. Geoprobe 8140LS - Track	E 1568436 N 5205930	DATE	E from	02/07	/2019	to	03/07/2019
FLUSHING MEDIUM Water	ORIENTATION VERTICAL	GRO	UND-LE	EVEL	+2	6.90	m RL



											· · · · ·		
Progress	Water level (m) shift start/ end	Water Recovery %	Total core Recovery %	Solid core Recovery %	R.Q.D.	Fracture Index	Tests	Samples	Reduced Level	0 0 (m)	Legend	STRATA DESCRIPTION SUBORDINATE FRACTION, MAJOR FRACTION, MINOR FRACTION, COLOUR, STRUCTURE, STRENGTH, MOISTURE CONDITION GRADING, BEDDING, PLASTICITY, ETC (NZ GEOTECHNICAL SOCIETY - FIELD DESCRIPTION OF SOIL AND ROCK)	Instrument/ Backfill
			100					Type Ref Depth 0.00	+26.40	0.50	$\frac{\sqrt{1}}{1} \cdot \frac{\sqrt{1}}{1} \cdot \frac{\sqrt{1}}{1}$	Sandy SILT with trace rootlets; dark brown. <i>Firm</i> , moist, non-plastic; sand, fine. (TOPSOIL)	
											× · · · · · · · · · · · · · · · · · · ·	Sity SAND; yellowish brown. <i>Medium dense</i> , moist. Sand, fine; silt, non-plastic.	
			65				(4, 4, 1, 2, 4, 6) N = 13/450 mm		+25.50	1.40	× * * * * * * * * * * * * *	Silty sandy GRAVEL with minor cobble; yellowish brown. <i>Medium dense</i> , moist; gravel, fine to coarse, rounded to sub-rounded; sand, fine to coarse; silt, non-plastic.	
	Ţ		6				(8, 7, 4, 3, 3, 5) N = 15/450 mm		+23.40	- - - - - - - - - - - - - - - - - - -	80 x 80 80	Silty sandy GRAVEL; yellowish brown. <i>Medium dense</i> , moist; gravel, fine to medium, rounded to sub-rounded; sand, fine to coarse; silt, non-plastic.	
			P P P P P P P P P P P P P P P P P P P				(6, 4, 4, 3, 2, 3) N = 12/450 mm		+22.46	- 4.44 		GRAVEL with minor cobble; yellowish brown. <i>Medium dense</i> , moist; gravel, fine to coarse, rounded to sub-rounded. (Drilled with water, fines lost)	
			and a second sec				(8, 7, 9, 7, 7, 7) N = 30/450 mm		+20.50	6.40		Silty sandy GRAVEL with minor cobble; yellowish brown. <i>Medium dense to dense</i> , moist; gravel, fine to coarse, rounded to sub-rounded; sand, fine to coarse; silt	
			Part and a second secon				(6, 10, 10, 8, 7, 8) N = 33/450 mm		+19.40	7.50		GRAVEL with minor cobble; yellowish brown. <i>Dense</i> , moist; gravel, fine to coarse, rounded to sub-rounded. (Drilled with water, fines lost)	
			100				(12, 19, 19, 19, 20, 2) N = 60/385 mm		+17.90	- - - - - - - -		Silty sandy GRAVEL with minor cobble; yellowish brown. <i>Dense</i> , moist; gravel, fine to coarse, rounded to sub-rounded; sand, fine to coarse; silt, non-plastic.	
Sm Lar SP1 Thi U10 Poc Pist	all Disturi ge Disturi f Liner Sa n Wall Un 0 Undistu ket Pene ton Samp	bed S bed S imple distu urbed trome le	ample ample rbed s Samp eter Te	e e Samp ple est	le			I	l	I		REMARKS Coordinates from handheld GPS, accurate to +/- Elevations from LINZ Data Service 1m LIDAR, accurate 1m. Static water levels: 4.00m bgl at casing depth of 15.08; 3/07/2019, 8:50pm	5m. to +/-
						Wate Impo Star Perr Piez Pacl In-si	er Level ression Pack ndard Penetr neability Tes cometer / Sta ker Test itu Vane She	ter Test ation Test t ndpipe Tip ar Test	LOGG DATE CHEC DATE	ED <u>F. I</u> <u>05/</u> KED <u>S.</u> _23/	MONTE 07/2019 MCRAE	ITH	
	Salbou Smi Lary SPT Thin Pist	Small Disturn Large Disturn SPT Liner Sa Thin Wall Un U100 Undisturn Pocket Pene Piston Samp	Small Disturbed S Large Disturbed S SPT Liner Sample Thin Wall Undisturbed Piston Sample	Small Disturbed Sample SPIECOL Small Disturbed Sample SPIECOL Small Disturbed Sample SPIECOL SPIECOL Small Disturbed Sample SPIECOL SP	Small Disturbed Sample Large Disturbed Sample Large Disturbed Sample Pocket Penetrometer Test Piston Sample	Small Disturbed Sample Large Disturbed Sample SPT Liner Sample Thin Wall Undisturbed Sample Pocket Penetrometer Test Piston Sample	sealed water <	Small Disturbed Sample Small Disturbed Sample Small Disturbed Sample 100 Pocket Penetometer Test 100 Place Test Vater Level Impression Pack 100 Thin Wall Undisturbed Sample 100 Small Disturbed Sample 100 Piston Sample	Water evel (m) start/ end Somples start/ and above end Tests Samples pre Tests Samples Tests Sample Tests Sample Tests Sample Tests Sample Tests Sample <th>Water start/ star/ start/ start/ start/ start/ start/ start/ start/ st</th> <th>Water start/ stard/ start/ start/ start/ start/ start/ start/ start/ s</th> <th>Water shift s</th> <th>Bit Sector Stand Bescher From Stand Bescher F</th>	Water start/ star/ start/ start/ start/ start/ start/ start/ start/ st	Water start/ stard/ start/ start/ start/ start/ start/ start/ start/ s	Water shift s	Bit Sector Stand Bescher From Stand Bescher F

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NZGD ID: BH_189062 NZGD ID: BH_189062

	BOREHOLE RECORD		HOLE	E NO.			BH2
			PRO	JECT NO.			506685
Westpark - Inch Land Geotechni PROJECT Rangiora	cal Investigation						
METHOD SNC	CO-ORDINATES (NZTM)	SHE	ΞT	2		of	2
MACHINE & NO. Geoprobe 8140LS - Track	E 1568436 N 5205930	DATE	from	02/07/20)19	to	03/07/2019
FLUSHING MEDIUM Water	ORIENTATION VERTICAL	GRO	UND-LE	EVEL	+26.9	90	m RL



	Drilling Progress	Water level (m) shift start/ end	Water Recovery %	Total core Recovery %	Solid core Recovery %	R.Q.D.	Fracture Index	Tests	Samples	Reduced Level	00.01 Depth (m)	Legend	STRATA DESCRIPTION SUBORDINATE FRACTION, MAJOR FRACTION, MINOR FRACTION, COLOUR, STRUCTURE, STREMSTH, MOISTURE CONDITION GRADING, BEDDING, PLASTICITY, ETC (NZ GEOTECHNICAL SOCIETY - FIELD DESCRIPTION OF SOIL AND ROCK)	Backfill
30 July 2019	-			300				(9, 13, 12, 12, 13, 15) N = 52/450 mm (13, 24, 19, 18, 14, 9) N = 60/387 mm (19, 30, 28, 20, 12) N = 60/360 mm					12.00m Becomes wet.	
ND.GPJ Library: AGS 4_0.GLB Date:	-							(7, 19, 22, 22, 16) N = + 60/360 mm		+12.40	- 14.50 - 15.08	0 x 0 x 0 x 0 x 0 x 0 x 0 x 0 x	Gravelly SILT with minor sand; yellowish brown with some orange mottling. Very stiff to hard , moist, non-plastic; gravel, fine to medium, sub-rounded; sand, fine.	
ALLATION Project: WESTPARK - INCH LA	-													
ort ID: AGS4 BOREHOLE RECORD WITH INSTAL	- Sm ; Lar [] SP [] Thi [] U10 >> Poo	all Distur ge Distur T Liner Sa n Wall Ur 00 Undist :ket Pene	bed S bed S ample adistu urbed	ample ample rbed s Samp eter Te	e e Samp ple est	le							REMARKS Coordinates from handheld GPS, accurate to +/- 5 Elevations from LINZ Data Service 1m LIDAR, accurate to 1m. Static water levels: 4.00m bgl at casing depth of 15.08; 3/07/2019, 8:50pm	im. +/-
Repo	∾e Pis	ton Samp	ble				- Wate Imp Star Perr Ŝ Piez	er Level ression Pack Idard Penetr neability Tes ometer / Sta	ter Test ation Test tt ndpipe Tip	LOGG DATE CHEC	ED <u>F. 1</u> 05/	MONTE 07/2019	ITH Э	
	I					~	Pacl In-si	ker Test itu Vane She	ar Test	DATE	23/	07/2019)	

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NZGD ID: BH_189062

		-
		-
	Water Level Impression Packer Test	LOGGED F. MONTEITH
Ц́	Standard Penetration Test	DATE 05/07/2019
1.1		CHECKEDS. MCRAE
	 ✓ In-situ Vane Shear Test 	DATE <u>23/07/2019</u>

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Borelog for well BW24/0207

Grid Reference (NZTM): 1569103 mE, 5206099 mN Location Accuracy: 10 - 50m Ground Level Altitude: 25.2 m +MSD Accuracy: < 2.5 m Driller: East Coast Drilling Drill Method: Air Rotary Borelog Depth: 18.0 m Drill Date: 15-Jul-2014



Scale(m)	Water Level	Depth(m)		Full Drillers Description	Formation Code
Scale(m)	2.20 2.20	Depth(m)		Full Drillers Description Brown TOPSOIL. Unsaturated (dry or moist). Brown clayey GRAVEL (2 - 60 MM). Unsaturated (dry or moist).	Code
10		9.00m _		Grey CLAY. Unsaturated (dry or moist). Grey GRAVEL (2 - 60 MM). Saturated (water-bearing).	
15		18.00m	000000 000000 000000 000000 000000 00000		

Grid Reference (NZTM): 1569000 mE, 5206049 mN Location Accuracy: 50 - 300m Ground Level Altitude: 25.2 m +MSD Accuracy: < 2.5 m Driller: Not Known Drill Method: Unknown Borelog Depth: 6.0 m Drill Date: 01-Feb-1982





Borelog for well BW24/0632

Grid Reference (NZTM): 1569031 mE, 5206011 mN Location Accuracy: 50 - 300m Ground Level Altitude: 25.2 m +MSD Accuracy: < 2.5 m Driller: Hydrill Drill Method: Dual Rotary Borelog Depth: 15.0 m Drill Date: 05-Aug-2021



Scale(m)	Water Level	Depth(n	1)	Full Drillers Description	Formation Code
		0.30m	A A A A A A	Brown TOPSOIL. Saturated	
			0=0=0	Yellow gravelly CLAY., Unsaturated	
			=0=0=	(dry or moist).	
H			0-0-0		
			2222		
			-2-2-		
2	.02		$O \equiv O \equiv C$		
Π 2	02		=0=0=		
			0-0-0		
			12101		
1			= =		
			22020		
			=0=0=		
		4.00m	0-0-0		
Н			0==0==0==	Grey silty GRAVEL (2 - 60 MM)	
				Saturated (water-bearing).	
1			000		
			F=0==0==0		
			0==0==0==		
			==0==0==0		
-			0==0==0==		
			n=n=n=n		
			0==0==0==		
-		7.00m	00		
			0_0_0	Yellow clayey GRAVEL (2 - 60 MM) Saturated (water-bearing)	
			=0=0=	Gatalated (water-beamig).	
			0=0=0		
-			-0-0-		
			0-0-0		
			$\equiv 0 \equiv 0 \equiv$		
			0=0=0		
			-0-0-		
0.1			5-5-2		
•		10.00m	0==0==0==	Grev silty GRAVEL (2 - 60 MM).	
			000	Saturated (water-bearing).	
			F= 0 == 0 == 0		
			0==0==0==		
П			0==0==0		
			0==0==0==		
		CONTRACTOR -	0==0==0		
-		12.00m	00000	Grev GRAVEL (2 - 60 MM). Saturated	
				(water-bearing).	
			DVVVVO		
			000000		
			D000000		
			000000		
			000000		
H			000000		
			hanana		
			000000		
		15.00-			

Grid Reference (NZTM): 1568873 mE, 5205963 mN Location Accuracy: 1 - 2m Ground Level Altitude: 26.1 m +MSD Accuracy: < 0.1 m Driller: Clemence Drilling Contractors Drill Method: Cable Tool Borelog Depth: 14.8 m Drill Date: 08-Apr-1999





Grid Reference (NZTM): 1568905 mE, 5205894 mN Location Accuracy: 2 - 15m Ground Level Altitude: 25.8 m +MSD Accuracy: < 0.5 m Driller: George Wheeler Welldrilling Drill Method: Rotary/Percussion Borelog Depth: 11.0 m Drill Date: 19-Mar-1997



Carola (ar)	Water	Death (m)			Formation
Scale(m)	Level	Deptn(m)	NYNYN A	Topsoil	SP
		0.34m _	and and	Notice seed	
10 -		1.40m		relow sand	SF
-				Yellow clay, fine gravel	SP
		2.80m _	0=0=0=0=0	Pea metal sand	SP
5					
		9.50m -	•••••	Yellow day sand fine chingle	CP.
10		10.50m	······································	r ellow olay sand line sniftgre	Gr
		10.00m _	0:0:0::	Grey medium shingle pea metal	SP
		11.00m	0.0.0		

Grid Reference (NZTM): 1569300 mE, 5205779 mN Location Accuracy: 50 - 300m Ground Level Altitude: 23.6 m +MSD Accuracy: < 2.5 m Driller: McMillan Drilling Ltd Drill Method: Unknown Borelog Depth: 32.3 m Drill Date: 01-Mar-1972



Scale(m)	Level	Depth(m)		Full Drillers Description	Formation Code
			No Log No Log No og No Log No Log No No Log No Log No No Log No Log No og No Log No Log No No Log No Log No No Log No Log No	Existing hole	SP
5		3.70m _	bg No Log No Log I	Sandy clay	SP
10		10.70m _		Gravel(Brown) slight clay	RI
		12.20m _		Tight gravel(Brown) and clay	RI
15		17.40m _	000=00 00000=0 000000 000000 000000	Gravel(Brown) and sand	RI
20		22.60m		Clau	Di
25		23.20m _		Gravel(Brown) and sand	RI
		26.79m _	0000000	Tight claybound gravel Gravel(Brown) slight clay and sand	RI
30		32.29m	0.000		
Appendix B. McMillan CPT Testing Records



Legend

xx m Shallow practical refusal dept

xx m Deep practical refusal depth

CPT Dissipation Tests

Kippenberger Ave

CPT Test Location Plan angiora Woodend Road and 4 Golf Links Road

CPTu001 🔍 CPTu002 2.48m GWD=1.7m CPTu004 4.86m CPTu003A CPTu003 GWD=2.7m CPTu005 1.69m GWD not proven 2.94m GWD=2.1m СРТи006А СРТи006 1.89m CPTu007 CPTu013 1.11m GWD not proven CPTu008 **CPTu009** CPTu010 12.8m 7.64m GWD=1.2 GWD=1.6m CPTu011 9.05m GWD=1.2m CPTu012 10.23m Ima GWD=0.4m ar Technologies

CONE PENETRATION TEST (CPT) REPORT MCMILLAN Drilling

Client: Eliot Sinclair & Partners Ltd

Location:518 Rangiora Woodend Road, Rangiora

Printed:04/08/2023

	Standards: ISO 22476-1:2012 - /	Application Clas	s 2				Effective R	silty sands R efusal Dense sand to gravelly
	Zero load outputs (MPa)							Tipsand
sroc	Tip Resistance			GaugeStiff sar	nd to clayey	2 Clay - orga	nic soil	7
S S		Clien	t: F	liot Sinclair	& Partne	3 Clays: clay t	o silty clay	8
GSt	MCMILLAN Dri	lina —	L			4 Silt mixture	s: clayey silt	9
ore		Proje	ct:		dand Paa			
Ϋ́	Notes & Limitations		510 Kar	igiora woo	иени коа		Remarks	5
÷	Data shown on this report has been assessed to	provide a blasic in	terpretation in terms	of Soil Behavio	ur Type (SBT) and vari	ious geotechnical s	oil	
Ξ	and Site Locationers 1481Rangebrad Vowele	her Road, Rangi	artson and K.L. Cab	al, Guide to Co	one Penetration lest	ing for Geotechni	al	
ate	ar Grid Beference: 1569-114 4200-516206	a guide for	geotecnnical use, ar	nd should be car	efully reviewed by the	e user. No warranty	IS tv	
Jer 1	for any use of the results in any design or review	w The user should	be fully aware of the	esign parameter	limitations of any m	ot assume any habit	()	
B	data shown in this report.	Datum: Ground	be fully aware of th	e techniques and	Sheet 1 of 1			
					SC		I	cand
	Local Fristian	RAW DATA		1.	(Saliu
- h	Local Friction			l l	iciinoingter			

	Standards: ISO 22476-1:2012 -	- Application Cla	ss 2				Eff	ective R	silty sands efusal Dense sand to gravelly
	Zero load outputs (MPa)								Tipsand
roc	Tip Resistance			GaugeStiff sar	nd to clayey	2	Clay - organic	soil	7
ğ		Clie	nt:	liot Sinclair	& Partne	3	Clays: clay to s	ilty clay	8
GS b	MCMILLAN Dri	lling				4	Silt mixtures: c	layey silt	9
ē.		IIII Y Proj	ect:		· · · -				
ပို	Notes & Limitations	_	518 Rar	ngiora Woo	odend Roa		1	Remarks	
Ē	Data shown on this report has been assessed t	o provide a basic i	nterpretation in terms	s of Soil Behavio	ur Type (SBT) and va	rious geo	otechnical soil		
ated w	and step Locationers 18 ing nget advoct	iehed Riðaðd, Kallog I only as a guide fo	r geotechnical use, ar	oal, Guide to Co nd should be care	one Penetration Tes efully reviewed by th	sting for he user. N	Geotechnical No warranty is		
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iroc	Tip Resistance			GaugeStiff sar	nd to clayey	2	Clay - organic	soil	7
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-GS b	MCMILLAN Drill	ina -					4	Silt mixtures:	clayey silt	PTu0t13	k silty
ch Core	Notes & Limitations	provide a haric i	ect: 518 Rar	ngiora Woo	dend F	Road, F	Rangi	Ora otechnical soil	No.: Remarks	21758	
ierated wit	ind នា៖ខែា សមត្ថការអា ទេ កម្ពុជាក្រោង ប្រមាជនាងទោះទោះ ប្រើក្រុង ing ing ing ing ing ing ing ing ing ing	hed Riðad, íRafny nly as a guide fo 8735 angrof NhéNg	person and K.L. Cab r geotechnical use, ar	al, Guide to Co ad should be car Design paramete	one Peneti efully revie rs shown a	ration Tes wed by the RigiOpt	tDate he user.	r1689260503ical No warranty is The Dig4iability	5		
den	or any use of the results in any design or review lata shown in this report.	atum: Ground	d be fully aware of the	e techniques and	d limitation	is of any i	method	Geomil Pant	ther 100	Sheet 1 of 1	
	clayStiff fine-grained	RAW DATA				SOIL E (NON	EHAV	IOUR TYPE MALISED)	ESTIM	ATED PARA	METERS

PointID:

Sounding:

seanang.						
	E. Diaz Farias	E. Diaz Farias		Termination		
	Pagani Piezocone - C	ompression	Predrill:			
				Target Depth		
			Collapse:			
				Effective		
				Refusal		
	Before test	After test		Тір		
				Gauge		
				Inclinometer	,	
	Zero load outputs (MPa)				✓	
	Tip Resistance 24.3466 24.3518	Local Friction 0.2561	0.2563			
	Pore Pressure 2.9479	2.9484		Other		
					-	
PointID						
Fointib.	CF10002					
Sounding:	1					
	Operator: E. Diaz Farias		Date: 1/8/2023			
	Cone Type: Pagani Piezocone - Co	mpression	Predrill: 0.00m	Termination	1	
	Cone Reference: MKS364		Water Level: 1.58m	Target Dept	h	
	Cone Area Ratio: 0.79		Collapse: 1.90m			
				Effective Refusa	al	
	Zero load outputs (MPa) Before test	After test		Tij	р	
	Tip Resistance 24.3623 24.2	2736		Gaug	e	
	Local Friction 0.2564	0.2569		Inclinomete	er	
	Pore Pressure 2.9480	2.9455		Othe	er	



PointID: Sounding:

CPTu003

1 Operator: E. Diaz Farias Cone Type: Pagani Piezocone - Compression Cone Reference: 000328 Cone Area Ratio: 0.79

Date: 1/8/2023
Predrill: 0.00m
Water Level: -
Collapse: 1.30m

Termination Target Depth

Effective Refusal

Mc MILLAN Drilling

PointID: Sounding:	CPTu001 1 Operator: E. Dia: Cone Type: Pagar Cone Reference: MKS36 Cone Area Ratio: 0.79	z Farias ii Piezocone - C 4	Compression	Date: ^{1/8/2023} 0.00m - Water Level: - 1.70m Collapse:	Termination
		Before test	After test		Effective Refusal Tip Gauge
	Zara laad autputs (MDa)	Poforo tort	After test		Inclinometer
	Zero loau outputs (IVIPa)				Пр
		ice 28.6852 28.	6903		Gauge
	Local Friction	0.2388	0.2394		Inclinometer
	Pore Pressure	2.9794	2.9783		Other

PointID: Sounding:

CPTu003A

1 Operator: E. Diaz Farias Cone Type: Pagani Piezocone - Compression Cone Reference: MKS364 Cone Area Ratio: 0.79

Date: 1/8/2023 Predrill: 0.00m Water Level: 1.65m Collapse: 1.70m

Termination Target Depth

Effective Refusal

Tip Gauge Inclinometer Other



PointID: Sounding:

CPTu004

Zero load outputs (MPa)

1 Operator: E. Diaz Farias Cone Type: Pagani Piezocone - Compression Cone Reference: 000328 Cone Area Ratio: 0.79

Before test After test

Date: 1/8/2023 Predrill: 0.00m Water Level: -Collapse: 2.40m

Termination Target Depth

Effective Refusal

Tip



PointID:

Sounding

Sounding:				
	E. Diaz Farias		Date:	Termination
	Pagani Piezocone - G	Compression	Predrill:	
			Water Level: Collapse:	Target Depth
				Effective
				Refusal
	Before test	After test		Tip
				Gauge
				Inclinometer
	Tip Resistance 28.7056 28.	6801		Gauge
	Local Friction 0.2376	0.2398		Inclinometer
	2.9808	2.9779		
	Zero load outputs (MPa)			\checkmark
	Tip Resistance 24.3466 24.2736	Local Friction 0.2566	0.2569	
	Pore Pressure 2.9480	2.9463		Other
				•
PointID:	CPTu006			
Soundina:	1			
... <i>.</i> ..	Operator: E. Diaz Farias		Date: 1/8/2023	
	Cone Type: Pagani Piezocone - Co	ompression	Predrill: 0.00m	Termination
	Cone Reference: MKS364		Water Level: -	Target Depth
	Cone Area Ratio: 0.79		Collapse: 1.10m	5
			•	Effective Refusal
	Zero load outputs (MPa) Before test	After test		Tip
	Tip Resistance 24.3205 24.	2370		Gauge
	Local Friction 0.2573	0.2563		Inclinometer
	Pore Pressure 2.9481	2.9469		Other
PointID:	CPTu006A			
Sounding	1			
sounding.	Operator: E. Diaz Farias		Date: 1/0/2022	
	Cone Type: Pagani Piezocone - Co	ompression	Date: 1/8/2023	Tormination
			Fleatini: 0.00m	remination



PointID	CPTu005				
	1				
Sounding:	Operator:			1/8/2022	
	Cone Type:	Farias		Date: 1/0/2023	Termination
	Cone Reference: MKS364 Cone Area Ratio: 0.79		compression	Water Level: 1.40m	Target Depth
				Collapse:	Effective
					Refusal
		Before test	After test		Tip
					Gauge
					Inclinometer
	Cone Reference: 000328			Water Level: -	Target Depth
	Cone Area Ratio: 0.79			Collapse: 0.60m	
	Zoro load outputs (MPa)	Rofora tost	Aftor tost		
	Tin Resistan	ce 28 6852 28	6495		Gauge
	Local Friction	0.2371	0.2375		Inclinometer
	Pore Pressure	2.9791	2.9794		Other
PointID [.]	CPTu007				
Sounding.	1				
bounding.	Operator: E. Diaz	Farias		Date: 2/8/2023	
	Cone Type: Pagani I	Piezocone - Co	ompression	Predrill: 0.00m	Termination
	Cone Reference: MKS36	4		Water Level: -	Target Depth
	Cone Area Ratio: 0.79			Collapse: 1.50m	
					Effective Refusal
	Zero load outputs (MPa)	Before test	After test		Тір
	Tip Resistan	ce 24.2110 24.	2527		Gauge
	Local Friction	0.2564	0.2563		Inclinometer
	Pore Pressure	2.9480	2.9491		Other
					├

PointID: Sounding:

CPTu008

1 Operator: E. Diaz Farias Cone Type: Pagani Piezocone - Compression Cone Reference: MKS364

Date: 31/7/2023 Predrill: 0.00m Water Level: 1.10m



Generated with Core-GS by Geroc



Pore Pressure Other

PointID:

Sounding:					
	E. Diaz	Farias		Date:	Termination
	Pagani	Piezocone -	Compression	Predrill: Water Level: Collapso:	Target Depth
		Pofovo tost	A fear toot	Conapse.	Effective Refusal
		before test	Arter test		Gauge
	Cone Area Ratio: 0.79			Collapse: 1.80m	
					Effective Refusal
	Zero load outputs (MPa)	Before test	After test		Tip
	TIP Resistant	Ce 24.3623 24	0.3466		Gauge
	Local Friction	2.9490	0.2558 2.9487		Inclinometer
	CPTu009				
	1				
	Operator:			31/7/2023	
	Cone Type:			0.00m	
	Cone Reference: 000328			0.80m	
	Cone Area Ratio: 0.79			2.30m	
	Zero load outputs (MPa)				1
	Tip Resistance 28	8.7312 28.669	9 Local Friction 0.2382	0.2389	
	Pore Pressure 2	2.9804	2.9790		Other
					\checkmark
PointID					
FUIIIID.					
sounding.	I Operator: E. Diaz E	ariac		Date: 21/7/2022	
	Cone Type: Pagani P	Piezocone - C	ompression	Date: 31/7/2023	Termination
	Cone Reference: MKS364	4	ompression	Water Level: -	Target Depth
	Cone Area Ratio: 0.79			Collapse: 1.55m	5 1
					Effective Refusal
	Zero load outputs (MPa)	Before test	After test		Тір
	Tip Resistance	ce 24.1901 24	1.2892		Gauge
	Local Friction	0.2563	0.2564		Inclinometer
	Pore Pressure 2	2.9439	2.9464		Other
PointID:	CPTu011				
Sounding:	1				
	Operator: E. Diaz F	arias		Date: 31/7/2023	
	Cone Type: Pagani F	Piezocone - C	ompression	Predrill: 0.00m	Termination

McMILLAN Drilling

PointID:

Sounding:

E. Diaz Farias Pagani Piezocone - Compression	Date: Predrill: Water Level: Collapse:	Termination Target Depth
Before test After test Cone Reference: MKS364 Cone Area Ratio: 0.79	Water Level: 1.10m Collapse: 1.80m	Tip Gauge
Zero load outputs (MPa)Before testAfter testTip Resistance24.268324.2892Local Friction0.25700.2563Pore Pressure2.94752.9219		Effective Refusal Tip Gauge Inclinometer Other
CPTu012		
1 Operator: E. Diaz Farias Cone Type: Pagani Piezocone - Compression Cone Reference: 000328 Cone Area Ratio: 0.79 Zero load outputs (MPa) Before test After test	Date: 31/7/2023 Predrill: 0.00m Water Level: 1.10m Collapse: 1.80m	Termination Target Depth Effective Refusal Tip
Tip Resistance 28.6699 28.6954 Local Friction 0.2393 0.2393 Pore Pressure 2.9797 2.9791		Gauge Inclinometer Other

PointID: Sounding:

PointID: Sounding:

CPTu013

1 Operator: E. Diaz Farias Cone Type: Pagani Piezocone - Compression Cone Reference: MKS364

Date: 1/8/2023 Predrill: 0.00m Water Level: -





Pore Pressure Other

PointID:

Sounding:

E. Dia	z Farias		Date:	Termination
Pagai	ni Piezocone - (Compression	Predrill:	
			Water Level:	Target Depth
			Collapse:	
				Effective
				Refusal
	Before test	After test		Тір
				Gauge
				Inclinometer
Cone Area Ratio: 0.79			Collapse: 1.70m	
				Effective Refusal
Zero load outputs (MPa)	Before test	After test		Тір
Tip Resista	nce 24.3362 24.	3623		Gauge
Local Friction	0.2562	0.2559		Inclinometer
	2.9491	2.9497		



DISSIPATION TESTS

PointID:

















DISSIPATION TESTS







DISSIPATION TESTS























CPT CALIBRATION AND TECHNICAL NOTES

These notes describe the technical specifications and associated calibration references pertaining to the Pagani piezocone types measuring cone resistance, sleeve friction, inclination and pore pressure (piezocone, 10cm²)

Dimensions

Dimensional specifications are detailed below. All tolerances are routinely checked prior to testing and measurements taken are electronically recorded. All records are kept on file and available on request.

	Тір	Friction	Pore Pressure	Inclination
Maximum Measuring Range:	50 - 100 MPa	1.60 MPa	2.50 MPa	0° - 20°
Resolution:	24 bit	24 bit	24 bit	12 bit
Accuracy:	0.005 MPa	0.04 MPa	0.04 MPa	0.5°

Length:	320 mm	Weight:	1.8 kg
Diameter:	35.8 mm	Opening angle of bit:	60°
Cone base area:	10 cm²	Side sleeve surfaces:	150 cm ²
Cone area ratio:	Varies - refer to cone certificate	Tip and Local Friction sensor displacement:	80 mm



Technical specifications



CONE CERTIFICATES


MCMILLAN Drilling



BRATION CERTIFICATE N° Z012/23

na tarato):

P-C 000328 PORE PRESSURE 2500

0509

TILT ANGLE

330350

Zeland E.

tent system:

tel carico applicato)

MENSOR CPC 4000

41000V56 Silicon Pressure Transducer

CONE CERTIFICATES



MCMILLAN Drilling



BRATION CERTIFICATE N° Z011/23

Mks364 ema tarato) :

PORE PRESSURE

10633 2500

TILT ANGLE 20 342363

on Zeland aent system: del carico applicato)

MENSOR CPC 4000

41000V56 Silicon Pressure Transducer

Appendix C. Pro-drill Borehole Drilling Testing Records







Refusal Depth: 10.23m bgl M/D/diag



OCTOBER 06, 2023 DRILLING REPORT PREPARED FOR

ELIOT SINCLAIR

#JOB-2144 – 518 Rangiora Woodend Rd and 4 Golf Links Road

518 Rangiora Woodend Road

Pro-Drill (Auck) Ltd 11 Alpito Place, Pukekohe, Auckland, New Zealand www.prodrill.co.nz 0800 477 637



HOLE NAME	BH-01	DATE	04.10.2023
LOCATION	E 1569113 N 5206109 518 Rangiora Woodend Road	JOB #	JOB-2144
CUSTOMER	Eliot Sinclair Maggie Guo,64 20 4185 3681 MG@eliotsinclair.co.nz	RIG ID	FRASTE CRS XL1 (HE: 81.5%)

DRILL LOGS

0.0m	1442 hrs	FRASTE CRS XLI (HE: 81.5%)
0.0m	1442 hrs	Sonic
10.6m	1608 hrs	Sonic casing type 10.6m casing depth

SPT TEST

1.5m	4/5/6/6/8/9	N=29
3.0m	4/7/8/7/8/6	N=29
4.5m	4/4/3/3/2/5	N=13
6.1m	7/10/11/12/11/9	N=43
7.6m	5/4/6/5/6/5	N=22
9.1m	2/3/3/3/5/5	N=16
10.6m	7/7/10/8/7/6	N=31

🗱 WATER + INSTALLS

2.9m Water level

0.0m		Clay
0.3m		Gravel
	*****	0.11



9.4m





HOLE NAME	ВН-02	DATE	04.10.2023
LOCATION	E 1569203 N 5206052 518 Rangiora Woodend Road	JOB #	JOB-2144
CUSTOMER	Eliot Sinclair Maggie Guo,64 20 4185 3681 MG@eliotsinclair.co.nz	RIG ID	FRASTE CRS XL1 (HE: 81.5%)

DRILL LOGS

0.0m	1123 hrs	FRASTE CRS XL1 (HE: 81.5%)
0.0m	1123 hrs	Sonic
10.6m	1426 hrs	Sonic casing type 10.6m casing depth

SPT TEST

1.5m	5/6/8/8/7/7	N=30
3.0m	5/6/5/3/5/5	N=18
4.5m	17/12/10/7/5/5	N=27
6.1m	2/2/2/2/3/3	N=10
7.6m	4/3/3/3/5/5	N=16
9.1m	7/7/8/9/8/7	N=32
10.6m	7/11/8/8/8/12	N=36

WATER + INSTALLS

2.3m Water level

0.0m		Clay
0.2m		Sand
0.5	0000	



8.4m	* *	Silt
9.0m	0000 0000 0000 0000	Gravel





HOLE NAME	вн-03	DATE	04.10.2023
LOCATION	E 1569312 N 5205985 518 Rangiora Woodend Road	JOB #	JOB-2144
CUSTOMER	Eliot Sinclair Maggie Guo,64 20 4185 3681 MG@eliotsinclair.co.nz	RIG ID	FRASTE CRS XL1 (HE: 81.5%)

DRILL LOGS

0.0m	0854 hrs	FRASTE CRS XLI (HE: 81.5%)
0.0m	0854 hrs	Sonic
10.6m	1047 hrs	Sonic casing type 10.6m casing depth

SPT TEST

1.5m	6/5/5/6/7/6	N=24		
3.0m	6/7/7/9/8/8	N=32		
4.5m	6/6/5/5/5/6	N=21		
6.1m	5/5/6/6/7/7	N=26		
7.6m	5/7/6/3/2/1	N=12		
9.1m	9/8/12/16/16/6	N=50	For 45mm	
10.6m	4/7/9/10/10/10	N=39		

🗱 WATER + INSTALLS

2.2m Water level

0.0m		Clay
0.3m		Gravel
	*****	0'lt



9.1m





HOLE NAME	BH-04	DATE	05.10.2023
LOCATION	E 1569062 N 5206004 518 Rangiora Woodend Road	JOB #	JOB-2144
CUSTOMER	Eliot Sinclair Maggie Guo,64 20 4185 3681 MG@eliotsinclair.co.nz	RIG ID	FRASTE CRS XL1 (HE: 81.5%)

DRILL LOGS

0.0m	0740 hrs	FRASTE CRS XL1 (HE: 81.5%)
0.0m	0740 hrs	Sonic

1.5m	4/4/4/2/4	N=14
3.0m	3/7/8/7/6/6	N=27
4.5m	3/5/5/6/5/5	N=21
6.1m	3/3/5/5/5/6	N=21
7.6m	9/5/4/3/1/1	N=9
9.1m	9/9/10/11/9/10	N=40
10.6m	7/9/9/11/10/12	N=42

WATER + INSTALLS

3.1m Water level

0.0m		Clay
0.3m		Sand
1.3m	00000 00000000000000000000000000000000	Gravel
7.9m	**** **** **** ****	Silt



8.9m



HOLE NAME	BH-05	DATE	05.10.2023
LOCATION	E 1569157 N 5205943 518 Rangiora Woodend Road	JOB #	JOB-2144
CUSTOMER	Eliot Sinclair Maggie Guo,64 20 4185 3681 MG@eliotsinclair.co.nz	RIG ID	FRASTE CRS XL1 (HE: 81.5%)

DRILL LOGS

0.0m	1034 hrs	FRASTE CRS XL1 (HE: 81.5%)
0.0m	1034 hrs	Sonic
10.6m	1258 hrs	Sonic casing type 10.6m casing depth

SPT TEST

1.5m	6/6/5/5/7/7	N=24	
3.0m	3/9/9/8/6/11	N=34	
4.5m	9/8/5/12/10/6	N=33	
6.1m	1/1/2/2/3/4	N=11	
7.6m	1/4/3	N=8	
9.1m	3/4/7/8/8/10	N=33	
10.6m	7/12/11/16/17/6	N=50	For 25mm

WATER + INSTALLS

2.5m Water level

0.0m		Clay
0.4m	00000 00000000000000000000000000000000	Gravel
	****	0'lt



9.0m





HOLE NAME	ВН-06	DATE	03.10.2023
LOCATION	E 1569266 N 5205883 518 Rangiora Woodend Road	JOB #	JOB-2144
CUSTOMER	Eliot Sinclair Maggie Guo,64 20 4185 3681 MG@eliotsinclair.co.nz	RIG ID	FRASTE CRS XL1 (HE: 81.5%)

DRILL LOGS

0.0m	1144 hrs	FRASTE CRS XL1 (HE: 81.5%)
0.0m	1144 hrs	Sonic
10.6m	1519 hrs	Sonic casing type 10.6m casing depth

SPT TEST

1.5m	5/7/6/7/6/8	N=27
3.0m	8/8/11/9/6/5	N=31
4.5m	4/11/9/9/7/10	N=35
6.1m	3/3/3/4/3/2	N=12
7.6m	4/5/8/5/7/7	N=27
9.1m	2/2/3/2/4/4	N=13
10.6m	7/8/9/9/7/8	N=33

🗱 WATER + INSTALLS

2.2m Water level

0.0m		Clay
0.5m	**** **** **** **** ****	Silt
0.7	0000	Onemial



8.4m		Sand
9.8m	00000 00000 000000 000000	Gravel





HOLE NAME	BH-07	DATE	05.10.2023
LOCATION	E 1568902 N 5205871 518 Rangiora Woodend Road	JOB #	JOB-2144
CUSTOMER	Eliot Sinclair Maggie Guo,64 20 4185 3681 MG@eliotsinclair.co.nz	RIG ID	FRASTE CRS XL1 (HE: 81.5%)

DRILL LOGS

0.0m	1357 hrs	FRASTE CRS XLI (HE: 81.5%)
0.0m	1357 hrs	Sonic

1.5m	6/6/11/9/12/13	N=45
3.0m	4/5/4/5/3/3	N=15
4.5m	4/4/5/4/5/5	N=19
6.1m	4/5/4/3/2/3	N=12
7.6m	1/3/3	N=7
9.1m	5/5/7/5/6/10	N=28
10.6m	9/9/9/9/10/9	N=37

WATER + INSTALLS

3.5m Water level

0.0m		Clay
1.1m		Gravel
6.5m	**** **** **** ****	Silt
8.9m	0000 0000 0000	Gravel





HOLE NAME	вн-08	DATE	03.10.2023
LOCATION	E 1569077 N 5205794 518 Rangiora Woodend Road	JOB #	JOB-2144
CUSTOMER	Eliot Sinclair Maggie Guo,64 20 4185 3681 MG@eliotsinclair.co.nz	RIG ID	FRASTE CRS XL1 (HE: 81.5%)

DRILL LOGS

0.0m	0904 hrs	FRASTE CRS XL1 (HE: 81.5%)
0.0m	0904 hrs	Sonic
10.6m	1117 hrs	Sonic casing type 10.6m casing depth

SPT TEST

1.5m	1/1/1/1	N=3
3.0m	4/4/5/5/4/5	N=19
4.5m	3/2/4/4/2/3	N=13
6.1m	6/7/8/8/7/8	N=31
7.6m	2/1/1/1/2	N=5
9.1m	11/10/12/11/11/13	N=47
10.6m	9/11/10/11/11/9	N=41

WATER + INSTALLS

2.4m Water level

0.0m		Clay
0.2m	**** **** **** ****	Silt
0.0	0000	



7.3m	* *	Silt
9.1m	0000 0000 0000 0000	Gravel



PRO-DRILL

0800 477 637

www.prodrill.co.nz 11 Alpito Place, Pukekohe, Auckland, New Zealand

This report was prepared in line with the New Zealand Ground Investigation Specification. Interpretation should be by a suitably qualified specialist.

🕂 Magnetize

This report was created in Magnetize[™], using the LIVE GEO[™] Powerup www.magnetize.co.nz

Appendix D. CPT Based-Liquefaction Analysis Report



Cone

- 0
- 0.5
- 1

Input parameters and analysis data

Analysis method:	B&I (2014)
Fines correction method:	B&I (2014)
Points to test:	Based on Ic value
Earthquake magnitude M _w :	7.50
Peak ground acceleration:	0.13
Depth to water table (insitu):	1.60 m

resistance

N/A No Yes Sands only Yes 10.00 m



Liquefaction analysis overall plots

CRR plot	FS Plot		Liquefaction severity number	Vertical settlements	
- 00000	-	-	-	-	
- 0.50.50.50.50.5	-	-	-	-	
- 11111	-	-	-	-	
- interpreta tion plots	-	-	-	I -	

Friction Ratio



Project file: G:\Jobs\51\511185\Docs\Geo\Geotech Report\CPT-Based Liquefaction Assessment\CPT 09-12_Liquefaction Assessment.clq

-					
-					
-					
0					
0.5					
1					
Depth to GWT (erthq.): Average results interval: Ic cut-off value:	1.10 m 3 2.60 applied: 1. Sensit	Fill weight: Transition detect. applied: ive	SBT legen	d	
fine grained	· · · · · · · · · · · · · · · · · · ·				
Unit weight calculation: like behavior applied: 2 Use fill: applied: Fill height:	Based on SBT C 2. Organic material No Limit dep N/A	lay oth			
Lir Lir	mit depth: 3. Clay	to			
CPT	name: CPT09_SL	S1			

N/A No Yes Sands only Yes 10.00 m :

This software is licensed to: Eliot Sinclair & Partners Ltd

Liquefaction analysis overall plots

CRR plot				FS Plot		Liquefaction severity number Vertical set		tlements		
-	00000		-		-		-		_	
-	0.50.50.50.50.5		-		-		-		-	
-	11111		-		-		-		-	
-		Soil	-		-		-		-	

Behaviour Type



Project file: G:\Jobs\51\511185\Docs\Geo\Geotech Report\CPT-Based Liquefaction Assessment\CPT 09-12_Liquefaction Assessment.clq





CLiq v.2.3.1.15 - CPT Liquefaction Assessment Software - Report created on: 23/10/2023, 2:10:47 pm CPT name: CPT09_SLS1

N/A No Yes Sands only Yes 10.00 m





Liquefaction analysis overall plots

Project file: G:\Jobs\51\511185\Docs\Geo\Geotech Report\CPT-Based Liquefaction Assessment\CPT 09-12_Liquefaction Assessment.clq




Liquefaction analysis overall plots

Project file: G:\Jobs\51\511185\Docs\Geo\Geotech Report\CPT-Based Liquefaction Assessment\CPT 09-12_Liquefaction Assessment.clq



pm

	CRR plot	FS Plot		Liquefaction severity number	Vertical settlements	
-		-	-	· · · -		00000
-		-	-	-	-	0.50.50.50.50.5
-		-	-	-	-	1 1
-	1	-	-	-	-	
	-					CPT name: CPT09_ULS



Project file: G:\Jobs\51\511185\Docs\Geo\Geotech Report\CPT-Based Liquefaction Assessment\CPT 09-12_Liquefaction Assessment.clq





7.50

0.13

Earthquake magnitude M_w: Peak ground acceleration:

Depth to water table (insitu): 1.20 m

olor scheme

Severe damage N/A Almost certain it will liquefy No Major expression of liquefaction Very likely to liquefy Moderate to severe exp. of liquefaction Yes Liquefaction and no liq. are equally likely Sands only Moderate expression of liquefaction Yes Unlike to liquefy Minor expression of liquefaction 10.00 m Little to no expression of liquefaction Almost certain it will not liquefy

5





olor scheme

Severe damage Major expression of liquefaction Moderate to severe exp. of liquefaction N/A No Almost certain it will liquefy Very likely to liquefy Yes Liquefaction and no liq. are equally likely Moderate expression of liquefaction Minor expression of liquefaction Sands only Yes Unlike to liquefy Ē 10.00 m Little to no expression of liquefaction Almost certain it will not liquefy

- 0	
- 0.5	4
- 1	
Depth to GWT (erthq.): 0.70 m Fill weight: Average results interval: 3 Transition detect. applied: Ic cut-off value: 2.60	SBT legend
fine grained	
Unit weight calculation: Based on SBT Clay like behavior applied: 2. Organic material Use fill: No Limit depth	
applied: Fill height: N/A	
silty clay	
CPT name: CPT10_SLS1	

-	00000	-	-	-	
- ,	0.50.50.50.50.5	-	-	-	-
	11111	-	-	-	' -
-		-	-	-	·

Soil Behaviour Type

olor scheme

N/A No Yes Sands only Yes 10.00 m	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	Severe damage Major expression of liquefaction Moderate to severe exp. of liquefaction Moderate expression of liquefaction Minor expression of liquefaction Little to no expression of liquefaction
--	--	--



CLiq v.2.3.1.15 - CPT Liquefaction Assessment Software - Report created on: 23/10/2023, 2:12:00 pm CPT name: CPT10_SLS1



- 0 - 0.5					
- 1 _ 0 1.5 2 CRR 8	0.2 0.4 (& CSR	0.6 0 0.5 Factor of safet	1 ty	- Depth to water table (insitu): 1.20 m Fill height: N/A 0 10 20 30 40 50 60 0 0.5 1 1.5 I SN Settlement (cm) D	0 isplacement (cm)
Input parameters and Analysis method:	analysis data B&I (2014) B&I (2014)	Depth to GWT (erthq.):	0.70 m	Fill weight:	
Points to test: Earthquake magnitude M _w :	Based on Ic value 7.50	Ic cut-off value: Unit weight calculation: Ba	2.60 ased on SBT	K _a applied: Clay like behavior applied: Limit depth applied: Limit depth:	
Peak ground acceleration:	0.13	Use fill:	No		

CLiq v.2.3.1.15 - CPT Liquefaction Assessment Software - Report created on: 23/10/2023, 2:12:00 pm

N/A No Yes Sands only Yes 10.00 m 2



Project file: G:\Jobs\51\511185\Docs\Geo\Geotech Report\CPT-Based Liquefaction Assessment\CPT 09-12_Liquefaction Assessment.clq



N/A
No
Yes
Sands only
Yes
10.00 m



Almost certain it will not liquefyLittle to no expression of liquefaction

2















		•		<i>,</i> ,					
_ CRR plot		_ FS Plo	t		Liquefaction severity number	Vertical settlements	Vertical settlements		
	0.50.50.50.50.5	-	-		-	-			
- :. - CRR	11111 0 0.2 & CSR	- - 0.4 0.6 Factor of safe	- 0 0.5 1 - ty	1.5	2 -	-			
Input parameters an Analysis method:	d analysis data B&I (2014)	Depth to GWT (erthq.):	0.70 m						
Fines correction method:	B&I (2014)	Average results interval:	3						
Points to test:	Based on Ic value	Ic cut-off value:	2.60						
Earthquake magnitude M _w :	7.50	Unit weight calculation:	Based on SBT						
Peak ground acceleration:	0.35	Use fill:	No						
Depth to water table (insitu): 1.20 m	Fill height:	N/A						
0 10 20 30 LSN	40 50 60 0	2 4 Settlement (cm)		0 Displacemer	it (cm)				

Fill weight: Transition detect. applied: K_{σ} applied: Clay like behavior applied: Limit depth applied: Limit depth: CLiq v.2.3.1.15 - CPT Liquefaction Assessment Software - Report created on: 23/10/2023, 2:13:52 pm



Liquefaction analysis overall plots

Cone

- 0
- 0.5
- 1
- _

Input parameters and analysis data

Analysis method:	B&I (2014)
Fines correction method:	B&I (2014)
Points to test:	Based on Ic value
Earthquake magnitude M _w :	7.50
Peak ground acceleration:	0.13
Depth to water table (insitu):	1.20 m

resistance





Friction Ratio

- 0	CRR plot	-	FS Plot	-	Liquefaction severi	ity number	Vertical set	lements _
- , 0	.50.50.50.50.5	-		-		-		-
- / 1	.1111	-		-		-		-
Depth to GWT (erthq.) Average results interval): 0.70 m al: 3 2.60	Fill weight: Transition detect. applied:	SBT lege	end		-		-
fine grained	K_{σ} applied: 1. Sensiti	ive						
Unit weight calculation like behavior applied: Use fill: applied:	a: Based on SBT C 2. Organic material No Limit dep	lay oth						
Fill height: silty clay	N/A Limit depth: 3. Clay	r to						

CPT name: CPT11_SLS1



-	0	
-	0.5	
-	1	
-	•	

Soil Behaviour Type

N/A No Yes Sands only Yes 10.00 m •



CLiq v.2.3.1.15 - CPT Liquefaction Assessment Software - Report created on: 23/10/2023, 2:12:43 pm CPT name: CPT11_SLS1





-	CRR plot 00000		-		FS F	Plot		_ Liquefaction	n severity number	Vertical sett	lements _	
-	0.50.50.50.50.5		-					-	-		-	
- 1	11111		-					-	-	•	-	
- • 1.5	0 0.2 2	0.4	-	0.6	0	0.5	1	– etect. applied: K_{σ} applied:	-	•	-	
CRR & CSR			Factor of safety					Clay like behavior applied: Limit depth applied:				

Limit depth:

Liq v.2.3.1.15 - CPT Liquefaction Assessment Software - Report created on: 23/10/2023, 2:12:43 m

Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	0.70 m
Fines correction method:	B&I (2014)	Average results interval:	3
Points to test:	Based on Ic value	Ic cut-off value:	2.60
Earthquake magnitude M _w :	7.50	Unit weight calculation:	Based on SBT
Peak ground acceleration:	0.13	Use fill:	No
Depth to water table (insitu):	1.20 m	Fill height:	N/A
0 10 20 30 · LSN	40 50 60 0	1 2 3 Settlement (cm)	0 Displacement
(cm)			

Fill weight: T r







CLig v.2.3.1.15 - CPT Liguefaction Assessment Software - Report created on: 23/10/2023, 2:13:50

pm



	CRR plot	FS Plot	Lie	quefaction severity number	Vertical settlements	
-	•	-	-	· · · -		00000
-		-	-	-	J -	0.50.50.50.50.5
-	1	-	-	-	• _	11111
-	•	-	-	-	-	CPT name:
						CPT11 ULS



Project file: G:\Jobs\51\511185\Docs\Geo\Geotech Report\CPT-Based Liquefaction Assessment\CPT 09-12_Liquefaction Assessment.clq



Project file: G:\Jobs\51\511185\Docs\Geo\Geotech Report\CPT-Based Liquefaction Assessment\CPT 09-12_Liquefaction Assessment.clq

-				-					-	-		-	
-				-					-	-		-	
-	•			-					-	-		-	
- 1.5	0 2	0.2	0.4	-	0.6	0	0.5	1	- on detect. applied: K_{σ} applied:	-	I	-	I
	CRR	& CSR			Fac	tor of sa	afety		Clay like behavior applied: Limit depth applied: Limit depth:				

7

CLiq v.2.3.1.15 - CPT Liquefaction Assessment Software - Report created on: 23/10/2023, 2:13:53 pm Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	0.70 m
Fines correction method:	B&I (2014)	3	
Points to test:	Based on Ic value	Ic cut-off value:	2.60
Earthquake magnitude M _w :	7.50	Unit weight calculation:	Based on SBT
Peak ground acceleration:	0.35	.35 Use fill:	
Depth to water table (insitu):	1.20 m	Fill height:	N/A
0 10 20 30 4 LSN	40 50 60 0	2 4 6 Settlement (cm)	8 0 Displacement

(cm)

Fill weight:

1	
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vere damage			
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derate to severe exp. of liquefaction		_	_
derate expression of liquefaction			
or expression of liquefaction			
le to no expression of liquefaction			
	Almost certain it will not liquefy		



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-	-		-	-	I
-	-		-	-	-
- '	-		-	-	- I
-	-	basic interpr etatio n plots	-	-	1 - 1
Cor	ne resistance	Friction Ratio			

olor scheme

vere damage jor expression of liquefaction derate to severe exp. of liquefaction derate expression of liquefaction or expression of liquefaction

le to no expression of liquefaction

Almost certain it will not liquefy

- -
- -
- _

Input parameters and analysis data

Analysis method: Fines correction method:	B&I (2014) B&I (2014)	Depth to GWT (erthq.) Average results interva): 0.10 m al: 3	Fill weight: Transition detect. applied:				
Points to test:	Based on Ic value	Ic cut-off value:	2.60					
	K_{σ} applied:	1. Sensitive fine grained						
Earthquake magnitude M _w : 7.5	50 Unit weight calculation	: Based on SBT Clay like beh	navior applied: 2.					
Organic material Peak ground acceleration: 0.13 Use fill: No Limit depth applied:								
Depth to water table (insitu): 0.40 m		Fill height:	N/A					
		Limit depth: 3. (Clay to silty clay					

.

CLiq v.2.3.1.15 - CPT Liquefaction Assessment Software - Report created on: 20/11/2023, 12:25:43 pm

CPT name: CPT12_SLS1

-

SBT legend

-	-		-	-	
-	-		-	-	-
_ •	-		-	-	
-	Soil	Behaviour Type	-	-	-

blor scheme vere damage jor expression of liquefaction derate expression of liquefaction derate expression of liquefaction or expression of liquefaction le to no expression of liquefaction Almost certain it will not liquefy



CPT name: CPT12_SLS1


Liquefaction analysis overall plots

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-

2

7.50 0.13

N/A No Yes Sands only Yes 10.00 m

Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	0.10 m	Fill weight:
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_{σ} applied:
Earthquake magnitude M _w :		Unit weight calculation:	Based on SBT	Clay like behavior applied:
Peak ground acceleration:		Use fill:	No	Limit depth applied:
Depth to water table (insitu)	: 0.40 m	Fill height:	N/A	Limit depth:

CLiq v.2.3.1.15 - CPT Liquefaction Assessment Software - Report created on: 20/11/2023, 12:25:51 pm Project file: G:\Jobs\51\511185\Docs\Geo\Geotech Report\CPT-Based Liquefaction Assessment\CPT 09-12_Liquefaction Assessment.clq

F.S. color scheme

N/A

No

Yes

Yes

Sands only

10.00 m

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

LSN color scheme

F

Severe damage Major expression of liquefaction Moderate to severe exp. of liquefaction Moderate expression of liquefaction Minor expression of liquefaction Little to no expression of liquefaction



6.00

0.19

Liquefaction analysis overall plots

_	CRR plot	_	FS Plot	-	Liquefaction severity number	Vertical settlem	ients _			
-	0 0	0 -		-	-		-	0	~	0
- '	0.50.50.50.50.5	-		-	-		-			
11111		-		-	-		-			4

CPT name: CPT12 ULS

Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	0.10 m
Fines correction method:	B&I (2014)	Average results interval:	3
Points to test:	Based on Ic value	Ic cut-off value:	2.60
Earthquake magnitude M _w :		Unit weight calculation:	Based on
Peak ground acceleration:		Use fill:	No
Depth to water table (insitu):	: 0.40 m	Fill height:	N/A

n to GWT (erthq.):	0.10 m	F
ge results interval:	3	Т
t-off value:	2.60	k
weight calculation:	Based on SBT	C
ill:	No	L
eight:	N/A	L

ill weight:	N/A
ransition detect. applied:	No
σ applied:	Yes
lay like behavior applied:	Sands only
imit depth applied:	Yes
imit depth:	10.00 m

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

LSN color scheme

_

Severe damage Major expression of liquefaction Moderate to severe exp. of liquefaction Moderate expression of liquefaction Minor expression of liquefaction Little to no expression of liquefaction

CLiq v.2.3.1.15 - CPT Liquefaction Assessment Software - Report created on: 20/11/2023, 12:25:53 pm Project file: G:\Jobs\51\511185\Docs\Geo\Geotech Report\CPT-Based Liquefaction Assessment\CPT 09-12_Liquefaction Assessment.clq



Lateral displacements

7.50 0.35

Liquefaction analysis overall plots

_	CRR plot	_	FS Plot	_	Liquefaction severity number	Vertical sett	lements			
-	0 0	0 -	▼	-	-		-	0	•	0
- '	0.50.50.50.50.5	-		-	-		-			
11111		-		-	-		-			6



Eliot Sinclair & Partners Ltd Geotechnical Engineering 20 Troup Drive, Christchurch https://www.eliotsinclair.co.nz/

Project title : Liquefaction Assessment - 511185

Location : 518 Rangiora Woodend Road & 4 Golf Links Road

Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	0.10 r
Fines correction method:	B&I (2014)	Average results interval:	3
Points to test:	Based on Ic value	Ic cut-off value:	2.60
Earthquake magnitude M _w :		Unit weight calculation:	Based
Peak ground acceleration:		Use fill:	No
Depth to water table (insitu):	: 0.40 m	Fill height:	N/A

erthq.):	0.10 m	Fill weight:
interval:	3	Transition detect. applied:
:	2.60	K_{σ} applied:
ulation:	Based on SBT	Clay like behavior applied:
	No	Limit depth applied:
	N/A	Limit depth:

CLiq v.2.3.1.15 - CPT Liquefaction Assessment Software - Report created on: 20/11/2023, 12:25:55 pm Project file: G:\Jobs\51\511185\Docs\Geo\Geotech Report\CPT-Based Liquefaction Assessment\CPT 09-12_Liquefaction Assessment.clq

F.S. color scheme

N/A

No

Yes

Yes

Sands only

10.00 m

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

LSN color scheme

Severe damage Major expression of liquefaction Moderate to severe exp. of liquefaction Moderate expression of liquefaction Minor expression of liquefaction Little to no expression of liquefaction

40.00-LSN color scheme 38.00 Severe damage Major expression of liquefaction 36.00 Moderate to severe exp. of liquefaction Moderate expression of liquefaction 34.00 32.35 Minor expression of liquefaction 32.00 Little to no expression of liquefaction 30.00 **Basic statistics** 28.00 -Total CPT number: 12 26.00 -42% little liquefaction 24.00 -22.401 20.00 - 20.00 42% minor liquefaction 8% moderate liquefaction 8% moderate to major liquefaction 16.7 15.726 0% major liquefaction 16.00 13.983 0% severe liquefaction 12.621 14.00 12.00 10.128 8.612 10.00 8.288 7.132 8.00-4.654 6.00-4.151 4.00-2.00-0.00 CPT09_SLS2 CPT10_SLS2 CPT11_SLS2 CPT12_SLS2 CPT09_ULS CPT10_ULS CPT11_ULS CPT12_ULS CPT09_SLS1 CPT10_SLS1 CPT11_SLS1 CPT12_SLS1 CPTu Name

Overall Liquefaction Severity Number report



Eliot Sinclair & Partners Ltd

Geotechnical Engineering 20 Troup Drive, Christchurch https://www.eliotsinclair.co.nz /



Project title : Liquefaction Assessment - 511185 Location : 518 Rangiora Woodend Road & 4 Golf Links Road



Overall vertical settlements report



CLiq v.2.3.1.15 - CPT Liquefaction Assessment Software Project file: G:\Jobs\51\511185\Docs\Geo\Geotech Report\CPT-Based Liquefaction Assessment\CPT 09-12_Liquefaction Assessment.clq 1

Appendix E. SPT Based-Liquefaction Analysis Report





SPT BASED LIQUEFACTION ANALYSIS REPORT

Project title : Liquefa	action Assessment - 511	L185 Location : 518 Rangiora Woodend Road & 4 Golf Links Road Borehole
Name : BH01_SLS1 :: Input parameters :	and analysis properties	::
Analysis method: Fines correction method: Sampling method: Borehole diameter: Rod length: Hammer energy ratio:	Idriss & Boulanger 2014 Idriss & Boulanger 2014 Standard Sample 65 mm to 11 5mm 1.50 0.82	G.W.T. (in-situ):2.90EQ site conditions:Same as initialG.W.T. (earthq.):2.40Earthquake magnitude Mw:7.50Peak ground acceleration:0.13SPT results rounding mode:
		CSR vs CKK plot

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0

0.1

0.2 0.3

CSR & CRR

0.5

0.4

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10.5-

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11

20

30

SPT Blow Count

40

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CLiq v.2.3.1.15 - CPT Liquefaction Assessme	ent Software - Report created	on: 17/10/2023, 9:59:59 am
---	-------------------------------	----------------------------

CPT name: BH01_SLS1

												CSR*
1	1.65	20.00	0.00	33.00	0.00	33.00	0.99	0.084	1.10	1.94	1.00	2.000
2	3.14	20.00	7.26	62.80	0.00	55.54	0.98	0.094	1.10	1.72	1.00	0.085
3	4.65	20.00	22.07	93.00	0.00	70.93	0.96	0.107	1.04	1.24	1.00	0.103
4	6.25	20.00	37.77	125.00	0.00	87.23	0.95	0.115	1.04	2.20	1.00	0.111
5	7.75	20.00	52.48	155.00	0.00	102.52	0.93	0.118	1.00	1.38	1.00	0.119
6	9.25	19.00	67.20	183.50	0.00	116.30	0.91	0.121	0.99	1.24	1.00	0.123
7	10.75	20.00	81.91	213.50	0.00	131.59	0.89	0.121	0.96	1.58	1.00	2.000

Abbreviations _

Depth: Depth from free surface where SPT was performed (m) during u_0 : eq. σ_v : Water pressure at test point (kPa) during eq. σ_v' : Total overburden pressure at test point (kPa) during eq. r_d : Effective overburden pressure based on GWT during earthquake CSR: (kPa) during eq. Nonlinear shear mass factor CVClic Stress Patio																
MSF: K₀: CSR*:	$\begin{array}{llllllllllllllllllllllllllllllllllll$															
:: Cycl results	ic Resi: s ::	stance	Ratio ((CRR) n	umeric											
No	Depth (kPa	Fines (a) (kPa	u₀ σν σ'∖)	, N _{SPT} (m	ı) % (k	(Pa)	Cℕ	CR	Св	Cs	CE	N 1(60)	Δ(N1)60	N1(60),cs	CRR 7.5	F.S.
1	1.65	2.42	0.00	33.00	33.00	29	1.52	0.80	1.00	1.00	0.82	29	0.00	29	4.000	2.00
2	3.14	0.00	2.35	62.80	60.45	29	1.23	0.85	1.00	1.00	0.82	25	0.00	25	0.290	2.00



3	4.65	0.00 17	.17 93	.00 75.83	3 13	1.16	0.95 1	00 1.00	0.82	12	0.00	12	0.132	1.28		
4	6.25	0.00	32.86	125.00	92.14	43	3 1.03	0.95	1.00	1.00	0.82	34	0.00	34	0.909	2.00
5	7.75	0.00	47.58	155.00	107.42	2 22	0.97	0.95	1.00	1.00	0.82	17	0.00	17	0.174	1.47
6	9.25	1.50	62.29	183.50	121.2	1 16	5 0.91	1.00	1.00	1.00	0.82	12	0.00	12	0.132	1.08
7	10.75	0.00	77.01	213.50	136.49	9 31	0.88	1.00	1.00	1.00	0.82	22	0.00	22	4.000	2.00
Abbrevi Depth: Weight: $u_0: \sigma_v:$ $\sigma_v':$ Nspt: $C_N:$ $C_E:$	ations Depth Soil ur Water Total o Effecti Numbo Overbo Energy	from free nit weight pressure overburde ve overbu er of blow urden pres y ratio fact	surface from pre at test po n pressur rden pres s count in ssure fac tor	where SPT vious test bint (kPa) re at test p ssure base n the field tor	was p point to point (k d on in (blows)	erform curre Pa) situ G /30 cn	ned (m) ent (kN/i GWT (kP n)	m³) a)		C _B : C _R : C _S : N ₁₍₆₀₎ : N _{1(60),cs} : CRR _{7.5} : E S	Bore Rod Sam Num Fines S Num fines Cycli	hole dian length fa pling met ber of blo s correction ber of blo c Resista	neter facto ctor hod factor ows correc on ows correc nce Ratio f	r ted for (ted for (for M _w 7	50% energy 50% energy .50	and

CLiq v.2.3.1.15 - CPT Liquefaction Assessment Software - Report created on: 17/10/2023, 9:59:59 am

SPT BASED LIQUEFACTION ANALYSIS REPORT

Project title : Liquefa	action Assessment - 511	185 Location : 518 F	Rangiora Wo	oodend Road & 4 Golf	Links Road Borehole
Name : BH01_SLS2					
:: Input parameters	and analysis properties				
Analysis method:	Idriss & Boulanger 2014	G.W.T. (in-situ):	2.90	EQ site conditions:	Same as initial
Fines correction method:	Idriss & Boulanger 2014	G.W.T. (earthq.):	2.40		
Sampling method:	Standard Sample	Earthquake magnitude M _w :	6.00		
Borehole diameter:	65 mm to 11 5mm	Peak ground acceleration:	0.19		
Rod length:	1.50	SPT results rounding mode	: Nearest		
Hammer energy ratio:	0.82				





CLiq v.2.3.1.15 - CPT Liquefaction Assessment Software - Report created on: 17/10/2023, 10:02:03 am

CPT name: BH01_SLS2

												CSR*	
1	1.65	20.00	0.00	33.00	0.00	33.00	0.98	0.121	1.10	1.94	1.48	2.000	
													_



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2	3.15	20.00	7.36	63.00	0.00	55.64	0.96	0.134	1.10	1.72	1.48	0.085	
3	4.65	20.00	22.07	93.00	0.00	70.93	0.93	0.150	1.04	1.24	1.48	0.127	
4	6.25	20.00	37.77	125.00	0.00	87.23	0.89	0.158	1.04	2.20	1.48	0.088	
5	7.75	20.00	52.48	155.00	0.00	102.52	0.85	0.160	1.00	1.38	1.48	0.130	
6	9.25	19.00	67.20	183.50	0.00	116.30	0.82	0.159	0.99	1.24	1.48	0.142	
7	10.75	20.00	81.91	213.50	0.00	131.59	0.78	0.156	0.96	1.58	1.48	2.000	

Abbreviations

Dep u₀: σ _v ': r _d : CSF MSI K ₀ : CSF	oth: R: =: R*:	Depth t eq. Water Total o Effectiv (kPa) c Cyclic S Effectiv Magniti CSR ful	from fre pressure verburd /e overb during e Stress R /e overb ude Sca Ily adjus	e at tes len pres ourden eq. Nonl atio ourden aling Fa sted	ce whe t point ssure a pressu inear s stress ctor	ere SPT (kPa) d It test po re based hear ma factor	was pe uring e bint (kF l on GV lss fact	rform q. a) dui VT dui or	ed (m ring e ring e) duri q. arthq	ing uake								
:: re	Cycli sults	c Resis	stance	Ratio ((CRR)	numer	ic												
	No	Depth (kPa	Fines u	ι₀σνσ'∖)	, N sрт ((m) %	(kPa)	CN	CR	Св	Cs	CE	N 1(60)	Δ(N1)60	N 1(60),c	s CRR7.5	F.S.		
	1	1.65	2.42	0.00	33.00	33.00) 29	1.52	0.80	1.00	1.00	0.82	29	0.00	29	4.000	2.00		
	2	3.15	0.00	2.45	63.00	0 60.55	5 29	1.23	0.85	1.00	1.00	0.82	25	0.00	25	0.290	2.00		
	3	4.65	0.00	17.17	93.00	0 75.83	3 13	1.16	0.95	1.00	1.00	0.82	12	0.00	12	0.132	1.04		
	4	6.25	0.00) 32.	86 1	25.00	92.14	43	31	.03	0.95	1.00	1.00	0.82	34	0.00	34	0.909	2.00
	5	7.75	0.00) 47.	.58 1	55.00	107.4	2 22	2 0	.97	0.95	1.00	1.00	0.82	17	0.00	17	0.174	1.34
	6	9.25	1.50) 62.	.29 1	83.50	121.2	1 16	5 0	.91	1.00	1.00	1.00	0.82	12	0.00	12	0.132	0.94
	7	10.75	0.00) 77.	.01 2	213.50	136.4	9 3:	1 0	.88	1.00	1.00	1.00	0.82	22	0.00	22	4.000	2.00
Abi Dep Wei u_0: σ_v': Nsp ⁻ C_N: C_E:	o revi oth: ight: σ _v :	ations Depth Soil un Water Total Effect Numb Overb Energ	n from fi nit weig pressu overbur ive over ive over ive of bl purden p y ratio 1	ree surf ht from re at te den pre rburden ows cou oressure factor	face wh previoust point essure pressure unt in t e facto	nere SPT ous test at (kPa) at test p ure base the field r	was p point to point (k d on ir (blows	erforn o curre Pa) i situ (/30 cr	ned (r ent (k GWT (n)	n) N/m³ (kPa))		C _B : C _R : C _S : ΔN1(60);c N1(60),cs: CRR _{7.5} : F.S.:	Boreh Rod le Samp Numb Fines Numb fines Cyclic Factor	ole diam ength fac ling met er of blo correctio er of blo Resistar of safe	neter factor ctor hod factor ows correct ows correct wws correct nce Ratio f ty against	r ted for ted for for M _w 7 liquefac	60% energy 60% energy '.50 ction	and

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SPT BASED LIQUEFACTION ANALYSIS REPORT







Eliot Sinclair & Partners Ltd Geotechnical Engineering 20 Troup Drive, Christchurch

https://www.eliotsinclair.co.nz/





CPT name: BH01_ULS

												CSR*	
1	1.65	20.00	0.00	33.00	0.00	33.00	0.99	0.226	1.10	1.94	1.00	2.000	
2	3.15	20.00	7.36	63.00	0.00	55.64	0.98	0.253	1.10	1.72	1.00	0.230	
3	4.65	20.00	22.07	93.00	0.00	70.93	0.96	0.288	1.04	1.24	1.00	0.278	
4	6.25	20.00	37.77	125.00	0.00	87.23	0.95	0.308	1.04	2.20	1.00	0.298	
5	7.75	20.00	52.48	155.00	0.00	102.52	0.93	0.319	1.00	1.38	1.00	0.319	
6	9.25	19.00	67.20	183.50	0.00	116.30	0.91	0.325	0.99	1.24	1.00	0.330	
7	10.75	20.00	81.91	213.50	0.00	131.59	0.89	0.327	0.96	1.58	1.00	2.000	

Abbreviations

Depth from free surface where SPT was performed (m) during Depth:

u₀:

eq. Water pressure at test point (kPa) during eq. σ_v :

Total overburden pressure at test point (kPa) during eq. σ,':

Effective overburden pressure based on GWT during earthquake

r_d: (kPa) during eq. Nonlinear shear mass factor CSR:

Cyclic Stress Ratio MSF:

Effective overburden stress factor Kσ:

Magnitude Scaling Factor CSR*:

CSR fully adjusted

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Cyclie	Cyclic Stress Ratio fully adjusted (CSR*) numeric results ::																	
No	Depth (m)	We (kN,	ight /m³)	u₀ (kPa)	σ _v (kPa	E)	xt. Lo (kPa	oad 1)	σ' (kP	a)	rd	CS	R	Κσ	MSF _{max}	MSF		
:: Cycl result:	lic Resis s ::	stance	Ratio ((CRR) n	umeric													
No	Depth (kPa	Fines u ı) (kPa	.ı₀ σ _v σ' _v	N _{SPT} (m) % (k	Pa)	Cℕ	CR	Св	Cs	CE	N 1(60)	Δ(N1)6	0 N 1(60),	cs CRR7.5	F.S.		
1	1.65	2.42	0.00	33.00	33.00	29	1.52	0.80	1.00	1.00	0.82	29	0.00	29	4.000	2.00		
2	3.15	0.00	2.45	63.00	60.55	29	1.23	0.85	1.00	1.00	0.82	25	0.00	25	0.290	1.26		
3	4.65	0.00	17.17	93.00	75.83	13	1.16	0.95	1.00	1.00	0.82	12	0.00	12	0.132	0.48		
4	6.25	0.00) 32.	86 12	5.00 9	92.14	43	3 1.	03	0.95	1.00	1.00	0.82	34	0.00	34	0.909	2.00
5	7.75	0.00) 47.	58 15	5.00 1	07.42	22	2 0.	97	0.95	1.00	1.00	0.82	17	0.00	17	0.174	0.54
6	9.25	1.50	62.	29 18	3.50 1	21.21	. 16	6 0.	91	1.00	1.00	1.00	0.82	12	0.00	12	0.132	0.40
7	10.75	0.00) 77.	01 213	3.50 1	36.49	31	. 0.	88	1.00	1.00	1.00	0.82	22	0.00	22	4.000	2.00
													50% energy 50% energy .50 tion	, r and				

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SPT BASED LIQUEFACTION ANALYSIS REPORT

Project title : Liquefa Name : BH02_SLS1	action Assessment - 511	185 Location : 518 F	Rangiora W	oodend Road & 4 Golf	Links Road Borehole
:: input parameters	and analysis properties :	ii ii			
Analysis method:	Idriss & Boulanger 2014	G.W.T. (in-situ):	2.30	EQ site conditions:	Same as initial
Fines correction method:	Idriss & Boulanger 2014	G.W.T. (earthq.):	1.80		
Sampling method:	Standard Sample	Earthquake magnitude M _w :	7.50		
Borehole diameter:	65 mm to 11 5mm	Peak ground acceleration:	0.13		
Rod length:	1.50	SPT results rounding mode:	Nearest		
Hammer energy ratio:	0.82				



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No	Depth (m)	Weight (kN/m³)	u₀ (kPa)	σ _v (kPa)	Ext. Load (kPa)	σ' _` (kPa)	rd	CSR	Κσ	MSF _{max}	MSF	
2	3.15	20.00	13.24	63.00	0.00	49.76	0.98	0.105	1.08	1.38	1.00	0.097
3	4.65	20.00	27.96	93.00	0.00	65.04	0.96	0.117	1.07	1.67	1.00	0.109
4	6.25	20.00	43.65	125.00	0.00	81.35	0.95	0.123	1.02	1.17	1.00	0.121
5	7.75	20.00	58.37	155.00	0.00	96.63	0.93	0.126	1.00	1.24	1.00	0.125
6	9.25	20.00	73.08	185.00	0.00	111.92	0.91	0.127	0.98	1.72	1.00	0.129
7	10.75	20.00	87.80	215.00	0.00	127.20	0.89	0.126	0.96	1.82	1.00	2.000

Abbreviations

Depth from free surface where SPT was performed (m) during Depth: u₀: eq. Water pressure at test point (kPa) during eq. σ_v: Total overburden pressure at test point (kPa) during eq. σ_v': Effective overburden pressure based on GWT during earthquake r_d: (kPa) during eq. Nonlinear shear mass factor CSR: Cyclic Stress Ratio MSF: Effective overburden stress factor Kσ: Magnitude Scaling Factor CSR*: CSR fully adjusted

:: Cyclic Resistance Ratio (CRR) numeric results ::

No	Depth (kPa	Fines u) (kPa	.,	N _{SPT} (n	1) % (kPa)	CN	CR	Св	Cs	CE	N 1(60)	Δ(N1)60	N1(60),c	CRR7.5	F.S.		
1	1.65	1.86	0.00	33.00	33.00	30	1.50	0.80	1.00	1.00	0.82	30	0.00	30	4.000	2.00		
2	3.15	0.00	8.34	63.00	54.66	18	1.33	0.85	1.00	1.00	0.82	17	0.00	17	0.174	1.80		
3	4.65	0.00	23.05	93.00	69.95	27	1.16	0.95	1.00	1.00	0.82	24	0.00	24	0.268	2.00		
4	6.25	0.00) 38.	75 12	5.00	86.25	1) 1	.09	0.95	1.00	1.00	0.82	9	0.00	9	0.111	0.92
5	7.75	0.00	53.	46 15	5.00	101.54	4 10	51	.00	0.95	1.00	1.00	0.82	12	0.00	12	0.132	1.06
6	9.25	0.00	68.	18 18	5.00	116.82	2 3	2 0	.94	1.00	1.00	1.00	0.82	25	0.00	25	0.290	2.00
7	10.75	0.00	0 82.	89 21	5.00	132.11	L 3	50	.90	1.00	1.00	1.00	0.82	27	0.00	27	4.000	2.00
h	-																	

Abbreviations
Depth: Depth from free s

Depth:	Depth from free surface where SPT was performed (m)	C _B :	Borehole diameter factor
Weight	Soil unit weight from previous test point to current (kN/m ³)	C _R :	Rod length factor
u ₀ : σ _v :	Water pressure at test point (kPa)	Cs:	Sampling method factor
σ,':	Total overburden pressure at test point (kPa)	N1(60):	Number of blows corrected for 60% energy
NSPT:	Effective overburden pressure based on in situ GWT (kPa)		Fines correction
C _N .	Number of blows count in the field (blows/30 cm)	ΔIN1(60),CS	Number of blows corrected for 60% energy and
C	Overburden pressure factor	IN1(60),cs:	fines
CE.	Energy ratio factor	CRR _{7.5} :	Cyclic Resistance Ratio for M _w 7.50
		F.S.:	Factor of safety against liquefaction





SPT BASED LIQUEFACTION ANALYSIS REPORT





0

0.1

0.2

CSR & CRR

0.3

0.5

0.4

10

20

SPT Blow Count

30





CPT name: BH02_SLS2

												CSR*
1	1.65	20.00	0.00	33.00	0.00	33.00	0.98	0.121	1.10	2.00	1.48	2.000
2	3.15	20.00	13.24	63.00	0.00	49.76	0.96	0.150	1.08	1.38	1.48	0.112
3	4.65	20.00	27.96	93.00	0.00	65.04	0.93	0.164	1.07	1.67	1.48	0.109
4	6.25	20.00	43.65	125.00	0.00	81.35	0.89	0.169	1.02	1.17	1.48	0.150
5	7.75	20.00	58.37	155.00	0.00	96.63	0.85	0.169	1.00	1.24	1.48	0.148
6	9.25	20.00	73.08	185.00	0.00	111.92	0.82	0.167	0.98	1.72	1.48	0.118
7	10.75	20.00	87.80	215.00	0.00	127.20	0.78	0.163	0.96	1.82	1.48	2.000

Abbreviations

Depth: u_0 : σ_v : σ_v' : r_d : CSR: MSF: K_σ : CSR*: :: Cycli results	Depth eq. Water Total c Effectiv (kPa) c Cyclic : Effectiv Magnit CSR fu ic Resis	from free pressur overburco ve overb during e Stress R ve overb cude Sca illy adjus stance	ee surfa e at tes den pres pourden p eq. Nonl tatio pourden s aling Fac sted Ratio (ce where t point (I ssure at i pressure inear she stress fac ctor	e SPT wa (Pa) dur test poin based o car mass ctor umeric	ing e t (kF n GV fact	erform eq. 2a) du 27 du 20r	ed (m ring ea) durir q. arthqu	ng ake						
No	Depth (kPa	Fines (a) (kPa	י∘ מי מ'י)	N _{SPT} (m	ı) % (k	Pa)	Cℕ	CR	Св	Cs	CE	N 1(60)	Δ(N1)60	N1(60),cs	CRR7.5	F.S.
1	1.65	1.86	0.00	33.00	33.00	30	1.50	0.80	1.00	1.00	0.82	30	0.00	30	4.000	2.00
2	3.15	0.00	8.34	63.00	54.66	18	1.33	0.85	1.00	1.00	0.82	17	0.00	17	0.174	1.55



3	4.65	0.00 23	8.05 93.	.00 69.95	5 27	1.16 ().95 1.0	00 1.00	0.82	24	0.00	24	0.268	2.00		
4	6.25	0.00	38.75	125.00	86.25	10	1.09	0.95	1.00	1.00	0.82	9	0.00	9	0.111	0.74
5	7.75	0.00	53.46	155.00	101.54	16	1.00	0.95	1.00	1.00	0.82	12	0.00	12	0.132	0.90
6	9.25	0.00	68.18	185.00	116.82	32	0.94	1.00	1.00	1.00	0.82	25	0.00	25	0.290	2.00
7	10.75	0.00	82.89	215.00	132.11	. 36	0.90	1.00	1.00	1.00	0.82	27	0.00	27	4.000	2.00
Abbrevi Depth: Weight: $u_0: \sigma_V:$ $\sigma_V':$ N _{SPT} : $C_N:$ $C_E:$	iations Depth Soil ur Water Total Effecti Numb Overb Energ	from free hit weight pressure overburde ive overbu er of blow urden pre y ratio fac	surface of from pre- at test po n pressur Inden pre- s count in ssure fact tor	where SPT vious test bint (kPa) re at test p ssure base n the field tor	was po point to point (kl d on in (blows/	erforme o currer Pa) situ GV (30 cm)	ed (m) nt (kN/m WT (kPa))		C _B : C _R : C _S : N1(60): ΔN1(60),cs: CRR7.5: F.S.:	Bore Rod Sam Fines ⁵ Num fines Cycli Fact	hole dian length fa pling met ber of blo s correctio ber of blo c Resista or of safe	neter facto ctor hod factor ows correc ows correc ows correc nce Ratio f	r ted for 6 ted for 6 for M _w 7.	50% energy 50% energy 50 tion	and

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SPT BASED LIQUEFACTION ANALYSIS REPORT

Project title : Liquefa	action Assessment - 511	185 Location : 518 F	Rangiora Wo	oodend Road & 4 Golf	Links Road Borehole
Name : BH02_ULS					
:: Input parameters	and analysis properties				
Analysis method:	Idriss & Boulanger 2014	G.W.T. (in-situ):	2.30	EQ site conditions:	Same as initial
Fines correction method:	Idriss & Boulanger 2014	G.W.T. (earthq.):	1.80		
Sampling method:	Standard Sample	Earthquake magnitude M _w :	7.50		
Borehole diameter:	65 mm to 11 5mm	Peak ground acceleration:	0.35		
Rod length:	1.50	SPT results rounding mode	: Nearest		
Hammer energy ratio:	0.82				



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CPT name: BH02_ULS

												CSR*	
1	1.65	20.00	0.00	33.00	0.00	33.00	0.99	0.226	1.10	2.00	1.00	2.000	
													-



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2	3.15	20.00	13.24	63.00	0.00	49.76	0.98	0.282	1.08	1.38	1.00	0.260	
3	4.65	20.00	27.96	93.00	0.00	65.04	0.96	0.314	1.07	1.67	1.00	0.294	
4	6.25	20.00	43.65	125.00	0.00	81.35	0.95	0.331	1.02	1.17	1.00	0.324	
5	7.75	20.00	58.37	155.00	0.00	96.63	0.93	0.338	1.00	1.24	1.00	0.337	
6	9.25	20.00	73.08	185.00	0.00	111.92	0.91	0.341	0.98	1.72	1.00	0.347	
7	10.75	20.00	87.80	215.00	0.00	127.20	0.89	0.340	0.96	1.82	1.00	2.000	

Abbreviations

De u ₀ : σ _v : r _d : CSI MS K _σ : CSI	oth: ג: F: ג*:	Depth eq. Water Total o Effectiv (kPa) o Cyclic S Effectiv Magnit	from fro pressur verburd ve overl during e Stress F ve overl ude Sca	ee surfa e at tes den pres burden eq. Nonl Ratio burden aling Fa	ice wher it point (ssure at pressure inear sh stress fa ctor	e SPT (kPa) di test po based ear ma actor	was pe uring e bint (kP l on GV ss fact	erforme eq. va) dur VT dur or	ed (m ring e ring e	ı) dur q. arthq	ing uake								
::	Cycli	ic Resis	stance	Ratio ((CRR) r	numeri	ic												
re	sults No	: :: Depth (kPa	Fines (u₀σνσ'∖)	, Nspt (r	n) % ((kPa)	Cℕ	CR	Св	Cs	CE	N 1(60)	Δ(N1)60	N 1(60),0	s CRR7.5	F.S.		
	1	1.65	1.86	0.00	33.00	33.00) 30	1.50	0.80	1.00	1.00	0.82	30	0.00	30	4.000	2.00		
	2	3.15	0.00	8.34	63.00	54.66	5 18	1.33	0.85	1.00	1.00	0.82	17	0.00	17	0.174	0.67		
	3	4.65	0.00	23.05	93.00	69.95	5 27	1.16	0.95	1.00	1.00	0.82	24	0.00	24	0.268	0.91		
	4	6.25	0.0	0 38	.75 12	5.00	86.25	10) 1	.09	0.95	1.00	1.00	0.82	9	0.00	9	0.111	0.34
	5	7.75	0.0	0 53	.46 15	5.00	101.54	4 16	51	.00	0.95	1.00	1.00	0.82	12	0.00	12	0.132	0.39
	6	9.25	0.0	0 68	.18 18	85.00	116.8	2 32	2 0	.94	1.00	1.00	1.00	0.82	25	0.00	25	0.290	0.84
	7	10.75	0.0	0 82	.89 21	5.00	132.1	1 36	50	.90	1.00	1.00	1.00	0.82	27	0.00	27	4.000	2.00
Ab De We u ₀ : σ _v ': N _{SP} C _E :	brevi oth: ight: σ _v : τ:	10.750.0082.89215.00132.11360.901.00riationsDepth from free surface where SPT was performed (m)Soil unit weight from previous test point to current (kN/m³)Water pressure at test point (kPa)Total overburden pressure at test point (kPa)Effective overburden pressure based on in situ GWT (kPa)Number of blows count in the field (blows/30 cm)Overburden pressure factorEnergy ratio factor											$C_{B}: \\ C_{R}: \\ C_{S}: \\ N_{1(60)}: \\ \Delta N_{1(60),cs}: \\ CRR_{7.5}: \\ F.S.: \\ CRR_{7.5}: \\ CR$	Boreh Rod le Sampl Numb Fines Numb fines Cyclic Factor	ole diam ength fac ing met er of blo correctio er of blo Resistar	neter factor ctor hod factor wws correct on wws correct nce Ratio fo ty against l	ed for 6 ed for 6 or M _w 7. iquefact	0% energy 0% energy 50 tion	and

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SPT BASED LIQUEFACTION ANALYSIS REPORT





10

20

30

SPT Blow Count

40

50

0

0.1

0.2

0.3

CSR & CRR

0.4

0.5



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https://www.eliotsinclair.co.nz/





CPT name: BH03_SLS1

												CSR*	
1	1.65	20.00	0.00	33.00	0.00	33.00	0.99	0.084	1.10	1.72	1.00	2.000	
2	3.15	20.00	14.22	63.00	0.00	48.78	0.98	0.107	1.10	1.88	1.00	0.097	
3	4.65	20.00	28.94	93.00	0.00	64.06	0.96	0.118	1.06	1.45	1.00	0.112	
4	6.25	20.00	44.64	125.00	0.00	80.36	0.95	0.124	1.03	1.58	1.00	0.120	
5	7.75	20.00	59.35	155.00	0.00	95.65	0.93	0.127	1.00	1.17	1.00	0.126	
6	9.25	20.00	74.07	185.00	0.00	110.93	0.91	0.128	0.97	2.20	1.00	0.131	
7	10.75	20.00	88.78	215.00	0.00	126.22	0.89	0.127	0.96	1.94	1.00	2.000	

Abbreviations

Depth from free surface where SPT was performed (m) during Depth:

u₀:

eq. Water pressure at test point (kPa) during eq. σ_v :

Total overburden pressure at test point (kPa) during eq. σ,':

Effective overburden pressure based on GWT during earthquake r_d:

(kPa) during eq. Nonlinear shear mass factor CSR:

Cyclic Stress Ratio MSF:

Effective overburden stress factor Kσ:

Magnitude Scaling Factor CSR*:

CSR fully adjusted

Cycli	c Stress	Ratio	fully a	djusted	(CSR	*) nur	neric	resu	Its ::									
No	Depth (m)	We (kN)	ight /m³)	u₀ (kPa)	σ (kP	v E 'a)	Ext. Lo (kPa	oad a)	σ' (kP	v Pa)	rd	CS	R	Κσ	MSF _{max}	MSF		
: Cyc esult	lic Resis s ::	stance	Ratio ((CRR) n	umeri	с												
No	Depth (kPa	Fines (J₀ σ៴ σ'ν	NSPT (N	ı) % ((kPa)	Cℕ	CR	Св	Cs	CE	N 1(60)	Δ(N1)60) N 1(60),	cs CRR7.5	F.S.		
1	1.65	3.43	0.00	33.00	33.00	24	1.57	0.80	1.00	1.00	0.82	25	0.00	25	4.000	2.00		
2	3.15	7.04	9.32	63.00	53.68	32	1.27	0.85	1.00	1.00	0.82	28	0.14	28	0.384	2.00		
3	4.65	0.00	24.03	93.00	68.97	21	1.19	0.95	1.00	1.00	0.82	19	0.00	19	0.194	1.74		
4	6.25	0.00) 39.	73 12	5.00	85.27	26	5 1	.08	0.95	1.00	1.00	0.82	22	0.00	22	0.233	1
5	7.75	0.00) 54.	45 15	5.00	100.5	5 12	2 1	.00	0.95	1.00	1.00	0.82	9	0.00	9	0.111	0
6	9.25	0.00) 69.	16 18	5.00	115.84	4 50	0 0	.96	1.00	1.00	1.00	0.82	39	0.00	39	3.025	2
7	10.75	0.00	83.	88 21	5.00	131.12	2 39	9 0	.91	1.00	1.00	1.00	0.82	29	0.00	29	4.000	2
bbrev epth: /eight: ງ: σ _v : γ': spt: _N : ε:	iations Depth Soil u Water Total Effect Numb Overb Energ	n from fi nit weig pressu overbur ive over over of bl ourden p y ratio	ree surfa jht from ire at tea rden pre rburden ows cou oressure factor	ace whe previou st point essure at pressur unt in the factor	re SPT s test ((kPa) t test p e base e field	was p point to oint (k d on in (blows)	erform o curre Pa) i situ (/30 cn	ned (r ent (k GWT (n)	n) N/m³ (kPa))		C _B : C _R : C _S : N1(60): ΔN1(60),cs: CRR7.5: F.S.:	Boref Rod I Samp Numl Fines Numl fines Cyclic Facto	nole dian ength fa bling met ber of blo correctioner of blo correctioner of blo correctioner of blo correctioner of blo correctioner of blo	neter facto ctor thod factor ows correc on ows correc nce Ratio f	r .ted for 6 .ted for 6 for M _w 7. liquefac	50% energy 50% energy .50 tion	/ / an

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SPT BASED LIQUEFACTION ANALYSIS REPORT

Project title : Liquefa	action Assessment - 511	185 Location : 518 F	Rangiora W	oodend Road & 4 Golf	Links Road Borehole
Name : Drid5_5E52					
:: Input parameters	and analysis properties :				
Analysis method:	Idriss & Boulanger 2014	G.W.T. (in-situ):	2.20	EQ site conditions:	Same as initial
Fines correction method:	Idriss & Boulanger 2014	G.W.T. (earthq.):	1.70		
Sampling method:	Standard Sample	Earthquake magnitude M _w :	6.00		
Borehole diameter:	65 mm to 11 5mm	Peak ground acceleration:	0.19		
Rod length:	1.50	SPT results rounding mode:	Nearest		
Hammer energy ratio:	0.82	-			



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No	Depth (m)	Weight (kN/m³)	u₀ (kPa)	σ _v (kPa)	Ext. Load (kPa)	σ', (kPa)	rd	CSR	Kσ	MSF _{max}	MSF	
2	3.15	20.00	14.22	63.00	0.00	48.78	0.96	0.153	1.10	1.88	1.48	0.091
3	4.65	20.00	28.94	93.00	0.00	64.06	0.93	0.166	1.06	1.45	1.48	0.123
4	6.25	20.00	44.64	125.00	0.00	80.36	0.89	0.171	1.03	1.58	1.48	0.123
5	7.75	20.00	59.35	155.00	0.00	95.65	0.85	0.171	1.00	1.17	1.48	0.154
6	9.25	20.00	74.07	185.00	0.00	110.93	0.82	0.168	0.97	2.20	1.48	0.101
7	10.75	20.00	88.78	215.00	0.00	126.22	0.78	0.164	0.96	1.94	1.48	2.000

Abbreviations

Depth from free surface where SPT was performed (m) during Depth: u₀: eq. Water pressure at test point (kPa) during eq. σ_v: Total overburden pressure at test point (kPa) during eq. σ_v': Effective overburden pressure based on GWT during earthquake r_d: (kPa) during eq. Nonlinear shear mass factor CSR: Cyclic Stress Ratio MSF: Effective overburden stress factor Kσ: Magnitude Scaling Factor CSR*: CSR fully adjusted

:: Cyclic Resistance Ratio (CRR) numeric results ::

No	Depth (kPa	Fines u ı) (kPa)	ι₀ σν σ'ν)	N _{SPT} (m) % (I	kPa)	Cℕ	CR	Св	Cs	CE	N 1(60)	Δ(N1)60	N1(60),œ	CRR 7.5	F.S.		
1	1.65	3.43	0.00	33.00	33.00	24	1.57	0.80	1.00	1.00	0.82	25	0.00	25	4.000	2.00		
2	3.15	7.04	9.32	63.00	53.68	32	1.27	0.85	1.00	1.00	0.82	28	0.14	28	0.384	2.00		
3	4.65	0.00	24.03	93.00	68.97	21	1.19	0.95	1.00	1.00	0.82	19	0.00	19	0.194	1.58		
4	6.25	0.00) 39.7	73 125	5.00	85.27	26	51.	08	0.95	1.00	1.00	0.82	22	0.00	22	0.233	1.90
5	7.75	0.00) 54.4	45 155	5.00	100.55	12	2 1.	00	0.95	1.00	1.00	0.82	9	0.00	9	0.111	0.72
6	9.25	0.00	69.1	16 185	5.00	115.84	50	0.	96	1.00	1.00	1.00	0.82	39	0.00	39	3.025	2.00
7	10.75	0.00) 83.8	38 215	5.00	131.12	39	90.	91	1.00	1.00	1.00	0.82	29	0.00	29	4.000	2.00
h novi	ations																	

Abbrev	iations		
Depth: Weight: u ₀ : σ _v : σ _v ': N _{SPT} : C _N : C _E :	Depth from free surface where SPT was performed (m) Soil unit weight from previous test point to current (kN/m ³) Water pressure at test point (kPa) Total overburden pressure at test point (kPa) Effective overburden pressure based on in situ GWT (kPa) Number of blows count in the field (blows/30 cm) Overburden pressure factor Energy ratio factor	C _B : C _R : C _S : N ₁₍₆₀₎ : ΔN _{1(60),cs} : N _{1(60),cs} : CRR _{7,5} : F.S.:	Borehole diameter factor Rod length factor Sampling method factor Number of blows corrected for 60% energy Fines correction Number of blows corrected for 60% energy and fines Cyclic Resistance Ratio for M _w 7.50 Factor of safety against liquefaction

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SPT BASED LIQUEFACTION ANALYSIS REPORT





0

0.1

0.2

CSR & CRR

0.3

0.4

0.5

10

20

30

SPT Blow Count

40

50



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CPT name: BH03_ULS

												CSR*
1	1.65	20.00	0.00	33.00	0.00	33.00	0.99	0.226	1.10	1.72	1.00	2.000
2	3.15	20.00	14.22	63.00	0.00	48.78	0.98	0.288	1.10	1.88	1.00	0.262
3	4.65	20.00	28.94	93.00	0.00	64.06	0.96	0.319	1.06	1.45	1.00	0.301
4	6.25	20.00	44.64	125.00	0.00	80.36	0.95	0.335	1.03	1.58	1.00	0.324
5	7.75	20.00	59.35	155.00	0.00	95.65	0.93	0.342	1.00	1.17	1.00	0.340
6	9.25	20.00	74.07	185.00	0.00	110.93	0.91	0.344	0.97	2.20	1.00	0.354
7	10.75	20.00	88.78	215.00	0.00	126.22	0.89	0.343	0.96	1.94	1.00	2.000

Abbreviations _

Depth: u_0 : σ_v : σ_v' : r_d : CSR: MSF: V:	Depth from nee surface where Sr F was performed (iff) during u_0 : eq. σ_v : Water pressure at test point (kPa) during eq. σ_v : Total overburden pressure at test point (kPa) during eq. σ_v : Effective overburden pressure based on GWT during earthquake CSR: (kPa) during eq. Nonlinear shear mass factor MSF: Cyclic Stress Ratio κ_v : Effective overburden stress factor															
CSR*: CSR*: resul	SR*: Magnitude Scaling Factor CSR fully adjusted															
N	o Depth (kPa	Fines (a) (kPa	u₀ σν σ'∖)	v N _{SPT} (n	1) % (k	(Pa)	CN	CR	Св	Cs	CE	N 1(60)	Δ(N1)60	N1(60),cs	CRR7.5	F.S.
1	1.65	3.43	0.00	33.00	33.00	24	1.57	0.80	1.00	1.00	0.82	25	0.00	25	4.000	2.00
2	3.15	7.04	9.32	63.00	53.68	32	1.27	0.85	1.00	1.00	0.82	28	0.14	28	0.384	1.46



3	4.65	0.00 2	4.03 93	.00 68.97	7 21	1.19	0.95	1.00 1	.00 0.	.82	19	0.00	19	0.194	0.65		
4	6.25	0.00	39.73	125.00	85.27	26	5 1.0	8 0.9	95 1.	.00	1.00	0.82	22	0.00	22	0.233	0.72
5	7.75	0.00	54.45	155.00	100.5	5 12	2 1.0	0.9	95 1.	.00	1.00	0.82	9	0.00	9	0.111	0.33
6	9.25	0.00	69.16	185.00	115.84	4 50	0.9	6 1.0	00 1.	.00	1.00	0.82	39	0.00	39	3.025	2.00
7	10.75	0.00	83.88	215.00	131.12	2 39	0.9	1 1.0	00 1.	.00	1.00	0.82	29	0.00	29	4.000	2.00
Abbrevi Depth: Weight: $u_0: \sigma_V:$ $\sigma_V':$ N _{SPT} : $C_N:$ $C_E:$	iations Depth Soil un Water Total Effect Numb Overb Energ	from free nit weight pressure overburde ive overburde overburden overb ourden pre y ratio fac	e surface t from pre at test p en pressu urden pre vs count i essure fac ctor	where SPT evious test oint (kPa) re at test p issure base n the field tor	was p point to point (k d on ir (blows	erform curre Pa) situ G /30 cn		$C_{B}: \\ C_{R}: \\ C_{S}: \\ N_{1(60)}: \\ \Delta N_{1(60),cs}: \\ CRR_{7.5}: \\ F.S.: $	Bore Rod Sam Num Fines Num fines Cycli Facto	hole diam length fac pling met ber of blo s correctio ber of blo c Resistan	neter factor tor hod factor wws correct on wws correct nce Ratio fo ty against l	ed for 6 ed for 6 or M _w 7.	0% energy 0% energy 50	and			

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SPT BASED LIQUEFACTION ANALYSIS REPORT

Project title : Liquefa	action Assessment - 511	185 Location : 518 F	Rangiora Wo	oodend Road & 4 Golf	Links Road Borehole									
Name : BH04_SLS1														
:: Input parameters and analysis properties ::														
Analysis method:	Idriss & Boulanger 2014	G.W.T. (in-situ):	3.10	EQ site conditions:	Same as initial									
Fines correction method:	Idriss & Boulanger 2014	G.W.T. (earthq.):	2.60	-										
Sampling method:	Standard Sample	Earthquake magnitude M _w :	7.50											
Borehole diameter:	65 mm to 11 5mm	Peak ground acceleration:	0.13											
Rod length:	1.50	SPT results rounding mode	: Nearest											
Hammer energy ratio:	0.82													





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CPT name: BH04_SLS1

												CSR*	
1	1.65	20.00	0.00	33.00	0.00	33.00	0.99	0.084	1.10	1.32	1.00	2.000	
													_


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2	3.15	20.00	5.40	63.00	0.00	57.60	0.98	0.091	1.08	1.62	1.00	0.084	
3	4.65	20.00	20.11	93.00	0.00	72.89	0.96	0.104	1.04	1.45	1.00	0.100	
4	6.25	20.00	35.81	125.00	0.00	89.19	0.95	0.112	1.01	1.38	1.00	0.110	
5	7.75	20.00	50.52	155.00	0.00	104.48	0.93	0.116	1.00	1.14	1.00	0.117	
6	9.25	20.00	65.24	185.00	0.00	119.76	0.91	0.118	0.96	2.06	1.00	0.123	
7	10.75	20.00	79.95	215.00	0.00	135.05	0.89	0.119	0.94	2.00	1.00	2.000	

Abbreviations

De u_0 : σ_v : σ_v ': r_d : CSI MS	pth: R: F:	Depth eq. Water Total o Effectiv (kPa) o Cyclic S	from fre pressure verburd ve overt during e Stress R	e surfa e at tes den pres ourden eq. Nonl Ratio	ce whe t point ssure at pressur inear st	re SPT (kPa) d t test po e basec near ma	was pe uring e bint (kF I on GV iss fact	erform eq. Pa) dui VT dui or	ed (m ring e ring e) duri q. arthq	ing uake								
K₀: CS	R*:	Magnit CSR fu	ude Sca Ily adjus	aling Fac	ctor	actor													
:: re	Cycli sults	ic Resis	stance	Ratio ((CRR)	numer	ic												
	No	Depth	Fines L	י∘ ס _י ס'∖	, NSPT (m) % ((kPa)	CN	CR	Св	Cs	CE	N 1(60)	Δ(N1)60	N 1(60),d	s CRR 7.5	F.S.		
	1	1.65	4.67) 0.00	33.00	33.00) 14	1.70	0.80	1.00	1.00	0.82	15	0.00	15	4.000	2.00		
	2	3.15	0.96	0.49	63.00	62.51	27	1.22	0.85	1.00	1.00	0.82	23	0.00	23	0.249	2.00		
	3	4.65	9.20	15.21	93.00	77.79	9 21	1.13	0.95	1.00	1.00	0.82	18	0.80	19	0.194	1.95		
	4	6.25	0.00) 30.	90 1	25.00	94.10	2	1 1.	.04	0.95	1.00	1.00	0.82	17	0.00	17	0.174	1.58
	5	7.75	0.00) 45.	62 1	55.00	109.3	89	0	.96	0.95	1.00	1.00	0.82	7	0.00	7	0.098	0.84
	6	9.25	0.00	0 60.	33 1	85.00	124.6	7 40	0 0	.93	1.00	1.00	1.00	0.82	31	0.00	31	0.555	2.00
	7	10.75	0.00) 75.	05 2	15.00	139.9	5 42	2 0	.89	1.00	1.00	1.00	0.82	30	0.00	30	4.000	2.00
Ab	brevi	ations																	
De We u₀: σ _v ': NsF C _N : C _E :	pth: ight: σ _v :	ations Depth from free surface where SPT was performed (m) Soil unit weight from previous test point to current (kN/m ³) Water pressure at test point (kPa) Total overburden pressure at test point (kPa) Effective overburden pressure based on in situ GWT (kPa) Number of blows count in the field (blows/30 cm) Overburden pressure factor Energy ratio factor											C _B : C _R : C _S : ΔN1(60),c N1(60),cs: CRR _{7.5} : F.S.:	Boreh Rod le Samp Numb Fines Numb fines Cyclic Factor	ole diam ength fac ling met er of blo correctio er of blo Resistan	leter factor ctor hod factor wws correct on wws correct nce Ratio f ty against	r ted for (ted for (for M _w 7 liquefac	60% energy 60% energy .50 tion	and

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CPT name: BH04_SLS2

												CSR*
1	1.65	20.00	0.00	33.00	0.00	33.00	0.98	0.121	1.10	1.32	1.48	2.000
2	3.15	20.00	5.40	63.00	0.00	57.60	0.96	0.129	1.08	1.62	1.48	0.087
3	4.65	20.00	20.11	93.00	0.00	72.89	0.93	0.146	1.04	1.45	1.48	0.110
4	6.25	20.00	35.81	125.00	0.00	89.19	0.89	0.154	1.01	1.38	1.48	0.123
5	7.75	20.00	50.52	155.00	0.00	104.48	0.85	0.157	1.00	1.14	1.48	0.145
6	9.25	20.00	65.24	185.00	0.00	119.76	0.82	0.156	0.96	2.06	1.48	0.099
7	10.75	20.00	79.95	215.00	0.00	135.05	0.78	0.153	0.94	2.00	1.48	2.000

Abbreviations

Depth from free surface where SPT was performed (m) during Depth: eq.

u₀:

Water pressure at test point (kPa) during eq. σ_v :

Total overburden pressure at test point (kPa) during eq. σ,':

Effective overburden pressure based on GWT during earthquake r_d:

(kPa) during eq. Nonlinear shear mass factor CSR:

Cyclic Stress Ratio MSF:

Effective overburden stress factor Kσ:

Magnitude Scaling Factor CSR*:

CSR fully adjusted

ı

Cyclie	c Stress	Ratio	fully ac	djusted	(CSR*	*) nur	neric	resu	lts ::									
No	Depth (m)	We (kN)	ight /m³)	u₀ (kPa)	σ. (kPa	, E a)	ixt. Lo (kPa	oad 1)	σ' (kP	v a)	rd	CS	R	Κσ	MSF _{max}	MSF		
: Cycl esult	ic Resis s ::	stance	Ratio (CRR) n	umeri	С												
No	Depth (kPa	Fines u ı) (kPa)	ι₀ σν σ'ν)	N _{SPT} (m	ı) % (kPa)	Cℕ	CR	Св	Cs	CE	N 1(60)	Δ(N1)6	0 N 1(60),	∝ CRR7.5	F.S.		
1	1.65	4.67	0.00	33.00	33.00	14	1.70	0.80	1.00	1.00	0.82	15	0.00	15	4.000	2.00		
2	3.15	0.96	0.49	63.00	62.51	27	1.22	0.85	1.00	1.00	0.82	23	0.00	23	0.249	2.00		
3	4.65	9.20	15.21	93.00	77.79	21	1.13	0.95	1.00	1.00	0.82	18	0.80	19	0.194	1.77		
4 5	6.25 7.75	0.00) 30.9	90 12 62 15	5.00	94.10 109.38	21 3 9	0	.04 .96	0.95	1.00	1.00	0.82	7	0.00	7	0.174	0.68
6	9.25	0.00) 60.	33 18	5.00	124.67	7 40) ()	.93	1.00	1.00	1.00	0.82	31	0.00	31	0.555	2.00
7	10.75	0.00) 75.	05 21	5.00	139.95	5 42	2 0	.89	1.00	1.00	1.00	0.82	30	0.00	30	4.000	2.00
bbrev epth: /eight: .: σ _v : /: 	10.750.0075.05215.00139.95420.891.001viationsDepth from free surface where SPT was performed (m):Soil unit weight from previous test point to current (kN/m³)Water pressure at test point (kPa)Total overburden pressure at test point (kPa)Effective overburden pressure based on in situ GWT (kPa)Number of blows count in the field (blows/30 cm)Overburden pressure factorEnergy ratio factor												Borel Rod I Samp Numl Fines S Numl fines Cyclic Facto	nole dian ength fa bling met ber of blo correctioner of blo ber of blo c Resista or of safe	neter facto ctor chod factor ows correc on ows correc nce Ratio 1 ty against	ted for ted for ted for for M _w 7 liquefac	60% energy 60% energy .50 :tion	and

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Project title : Liquefa	action Assessment - 511	185 Location : 518 F	Rangiora Wo	oodend Road & 4 Golf	Links Road Borehole
:: Input parameters	and analysis properties :				
		•			
Analysis method:	Idriss & Boulanger 2014	G.W.T. (in-situ):	3.10	EQ site conditions:	Same as initial
Fines correction method:	Idriss & Boulanger 2014	G.W.T. (earthq.):	2.60		
Sampling method:	Standard Sample	Earthquake magnitude M _w :	7.50		
Borehole diameter:	65 mm to 11 5mm	Peak ground acceleration:	0.35		
Rod length:	1.50	SPT results rounding mode:	Nearest		
Hammer energy ratio:	0.82	-			



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No	Depth (m)	Weight (kN/m³)	u₀ (kPa)	σ _v (kPa)	Ext. Load (kPa)	σ', (kPa)	rd	CSR	Κσ	MSF _{max}	MSF	
2	3.15	20.00	5.40	63.00	0.00	57.60	0.98	0.244	1.08	1.62	1.00	0.225
3	4.65	20.00	20.11	93.00	0.00	72.89	0.96	0.280	1.04	1.45	1.00	0.269
4	6.25	20.00	35.81	125.00	0.00	89.19	0.95	0.302	1.01	1.38	1.00	0.297
5	7.75	20.00	50.52	155.00	0.00	104.48	0.93	0.313	1.00	1.14	1.00	0.314
6	9.25	20.00	65.24	185.00	0.00	119.76	0.91	0.319	0.96	2.06	1.00	0.331
7	10.75	20.00	79.95	215.00	0.00	135.05	0.89	0.321	0.94	2.00	1.00	2.000

Abbreviations

Depth from free surface where SPT was performed (m) during Depth: u₀: eq. Water pressure at test point (kPa) during eq. σ_v: Total overburden pressure at test point (kPa) during eq. σ_v': Effective overburden pressure based on GWT during earthquake r_d: (kPa) during eq. Nonlinear shear mass factor CSR: Cyclic Stress Ratio MSF: Effective overburden stress factor Kσ: Magnitude Scaling Factor CSR*: CSR fully adjusted

:: Cyclic Resistance Ratio (CRR) numeric results ::

	No	Depth (kPa	Fines ι a) (kPa	.u₀σνσ'ν)	, N _{SPT} (m	ı) % (kPa)	Cℕ	CR	Св	Cs	CE	N 1(60)	Δ(N1)60	N 1(60),c	s CRR 7.5	F.S.		
	1	1.65	4.67	0.00	33.00	33.00	14	1.70	0.80	1.00	1.00	0.82	15	0.00	15	4.000	2.00		
	2	3.15	0.96	0.49	63.00	62.51	27	1.22	0.85	1.00	1.00	0.82	23	0.00	23	0.249	1.11		
	3	4.65	9.20	15.21	93.00	77.79	21	1.13	0.95	1.00	1.00	0.82	18	0.80	19	0.194	0.72		
	4	6.25	0.00	J 30.	90 12	5.00	94.10	2	11.	.04	0.95	1.00	1.00	0.82	17	0.00	17	0.174	0.59
	5	7.75	0.00	0 45.	.62 15	5.00	109.38	3 9	0.	.96	0.95	1.00	1.00	0.82	7	0.00	7	0.098	0.31
	6	9.25	0.00	0 60.	.33 18	5.00	124.67	7 4(D 0.	.93	1.00	1.00	1.00	0.82	31	0.00	31	0.555	1.68
	7	10.75	0.00	0 75.	.05 21	5.00	139.95	5 42	20.	.89	1.00	1.00	1.00	0.82	30	0.00	30	4.000	2.00
A hh		atlana																	

Abbreviations

Depth:	Depth from free surface where SPT was performed (m)	C _B :	Borehole diameter factor
Weight:	Soil unit weight from previous test point to current (kN/m ³)	C _R :	Rod length factor
u ₀ : σ _v :	Water pressure at test point (kPa)	Cs:	Sampling method factor
σ,':	Total overburden pressure at test point (kPa)	N1(60):	Number of blows corrected for 60% energy
NSPT'	Effective overburden pressure based on in situ GWT (kPa)		Fines correction
C _N :	Number of blows count in the field (blows/30 cm)	ΔIN1(60),cs	Number of blows corrected for 60% energy and
C ₋ :	Overburden pressure factor	IN1(60),cs:	fines
CE.	Energy ratio factor	CRR _{7.5} :	Cyclic Resistance Ratio for M _w 7.50
		F.S.:	Factor of safety against liquefaction





SPT BASED LIQUEFACTION ANALYSIS REPORT





10.5

0

0.1

0.2

CSR & CRR

0.3

0.4

0.5

10

20

30

SPT Blow Count

40

50



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CPT name: BH05_SLS1

												CSR*
1	1.65	20.00	0.00	33.00	0.00	33.00	0.99	0.084	1.10	1.72	1.00	2.000
2	3.15	20.00	11.28	63.00	0.00	51.72	0.98	0.101	1.05	1.11	1.00	0.096
3	4.65	20.00	26.00	93.00	0.00	67.00	0.96	0.113	1.08	1.94	1.00	0.105
4	6.25	19.00	41.69	123.40	0.00	81.71	0.95	0.121	1.02	1.32	1.00	0.118
5	7.75	19.00	56.41	151.90	0.00	95.49	0.93	0.125	1.01	1.21	1.00	0.124
6	9.25	20.00	71.12	181.90	0.00	110.78	0.91	0.126	0.98	1.77	1.00	0.128
7	10.75	20.00	85.84	211.90	0.00	126.06	0.89	0.126	0.93	2.20	1.00	2.000

Abbreviations

Depth: u_0 : σ_v : σ_v' : r_d : CSR: MSF: K_σ : CSR*:	Depth eq. Water Total of Effectiv (kPa) of Cyclic Effectiv Magnit CSR fu	from free pressur overburd ve overb during e Stress R ve overb cude Sca illy adjus	e surfa e at tes den pres ourden eq. Nonl datio ourden sted	t point (l ssure at pressure inear she stress fa ctor	e SPT w kPa) dur test poir based c ear mass ctor	as pe ing e it (kF on G\ s fact	erform eq. Pa) du VT du cor	ed (m ring ea ring ea) durir q. arthqu	ake						
:: Cycl results	CSR fully adjusted Cyclic Resistance Ratio (CRR) numeric sults ::															
No	Depth (kPa	Fines ι a) (kPa	.,	, N _{SPT} (m	ı) % (k	Pa)	Cℕ	Cr	Св	Cs	CE	N 1(60)	Δ(N1)60	N1(60),cs	CRR 7.5	F.S.
1	1.65	1.32	0.00	33.00	33.00	24	1.57	0.80	1.00	1.00	0.82	25	0.00	25	4.000	2.00
2	3.15	0.00	6.38	63.00	56.62	4	1.44	0.85	1.00	1.00	0.82	4	0.00	4	0.080	0.84



3	4.65	0.00 21	.09 93	.00 71.91	L 33	1.13	0.95 1	.00 1.00	0.82	29	0.00	29	0.429	2.00		
4	6.25	28.50	36.79	123.40	86.61	11	1.0	3 0.95	1.00	1.00	0.82	10	5.30	15	0.156	1.32
5	7.75	27.60	51.50	151.90	100.40) 8	1.0	0.95	1.00	1.00	0.82	6	5.25	11	0.125	1.01
6	9.25	0.00	66.22	181.90	115.68	33	0.9	5 1.00	1.00	1.00	0.82	26	0.00	26	0.316	2.00
7	10.75	0.00	80.93	211.90	130.97	7 50	0.9	2 1.00	1.00	1.00	0.82	38	0.00	38	4.000	2.00
Abbrevil Depth: Weight: u ₀ : σ _v : σ _v ': N _{SPT} : C _N : C _E :	iations Depth Soil un Water Total Effect Numb Overb Energ	from free nit weight pressure overburder ive overbu er of blow urden pres y ratio fact	surface from pre at test po n pressur rden pres s count in ssure fac tor	where SPT vious test bint (kPa) re at test p ssure base n the field tor	was po point to point (kl ed on in (blows/	erform curre Pa) situ G /30 cm	ied (m) nt (kN/ GWT (kF เ)	'm³) 2a)		C _B : C _R : C _S : N1(60): ΔN1(60),cs: CRR7.5: F.S.:	Bore Rod Sam Num Fines ³ Num fines Cycli	hole diam length fa- pling met ber of blo correction ber of blo c Resista	neter facto ctor hod factor ows correc on ows correc nce Ratio f	r ted for (ted for (for Mw 7	50% energy 50% energy .50	and

CLiq v.2.3.1.15 - CPT Liquefaction Assessment Software - Report created on: 17/10/2023, 10:20:05 am

Project title : Liquefa	action Assessment - 511	185 Location : 518 I	Rangiora Wo	oodend Road & 4 Golf	Links Road Borehole
Name : BH05_SLS2					
:: Input parameters	and analysis properties				
Analysis method:	Idriss & Boulanger 2014	G.W.T. (in-situ):	2.50	EQ site conditions:	Same as initial
Fines correction method:	Idriss & Boulanger 2014	G.W.T. (earthq.):	2.00	-	
Sampling method:	Standard Sample	Earthquake magnitude M _w :	6.00		
Borehole diameter:	65 mm to 11 5mm	Peak ground acceleration:	0.19		
Rod length:	1.50	SPT results rounding mode	: Nearest		
Hammer energy ratio:	0.82				





CLiq v.2.3.1.15 - CPT Liquefaction Assessment Software - Report created on: 17/10/2023, 10:20:51 am

CPT name: BH05_SLS2

												CSR*	
1	1.65	20.00	0.00	33.00	0.00	33.00	0.98	0.121	1.10	1.72	1.48	2.000	



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Troup Drive, Christchurch

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2	3.15	20.00	11.28	63.00	0.00	51.72	0.96	0.144	1.05	1.11	1.48	0.129
3	4.65	20.00	26.00	93.00	0.00	67.00	0.93	0.159	1.08	1.94	1.48	0.094
4	6.25	20.00	41.69	125.00	0.00	83.31	0.89	0.165	1.02	1.32	1.48	0.136
5	7.75	20.00	56.41	155.00	0.00	98.59	0.85	0.166	1.00	1.21	1.48	0.147
6	9.25	20.00	71.12	185.00	0.00	113.88	0.82	0.164	0.98	1.72	1.48	0.117
7	10.75	20.00	85.84	215.00	0.00	129.16	0.78	0.160	0.93	2.20	1.48	2.000

Abbreviations

Dej u ₀ : σ _v ': r _d : CSI K _σ : CSI	oth: ג: F: ג*:	Depth eq. Water Total o Effectiv (kPa) o Cyclic S Effectiv Magnit CSR fu	from fro pressur verburg ve over during e Stress F ve over tude Sca lly adju	ee surfa re at tes den pre burden eq. Non Ratio burden aling Fa isted	ace whe st point ssure a pressu linear s stress ctor	ere SPT : (kPa) d at test po re based :hear ma factor	was pe uring e bint (kF l on GV lss fact	erform eq. 'a) du VT du or	ed (m ring e ring e) duri q. arthq	ing uake								
:: re	Cycli sults	ic Resis	stance	Ratio	(CRR)	numer	ic												
	No	Depth	Fines	u₀ σ _v σ'	v N SPT ((m) %	(kPa)	Cℕ	CR	Св	Cs	CE	N1(60)	Δ(N1)60	N 1(60),d	s CRR7.5	F.S.		
	1	1.65	1.32	0.00	33.00	0 33.00) 24	1.57	0.80	1.00) 1.00	0.82	25	0.00	25	4.000	2.00		
	2	3.15	0.00	6.38	63.00	0 56.62	2 4	1.44	0.85	1.00	0 1.00	0.82	4	0.00	4	0.080	0.62		
	3	4.65	0.00	21.09	93.00	0 71.93	L 33	1.13	0.95	1.00	0 1.00	0.82	29	0.00	29	0.429	2.00		
	4	6.25	28.5	50 36	.79 1	25.00	88.21	. 1	1 1	.07	0.95	1.00	1.00	0.82	10	5.30	15	0.156	1.15
	5	7.75	27.6	50 51	.50 1	155.00	103.5	8 0	8 0	.99	0.95	1.00	1.00	0.82	6	5.25	11	0.125	0.85
	6	9.25	0.0	0 66	.22 1	185.00	118.7	8 3	3 0	.94	1.00	1.00	1.00	0.82	25	0.00	25	0.290	2.00
	7	10.75	0.0	0 80	.93 2	215.00	134.0	7 5	0 0	.92	1.00	1.00	1.00	0.82	38	0.00	38	4.000	2.00
Total overburden pressure at test point (kPa) during eq. rd: Effective overburden pressure based on GWT during earthquake CSR: (kPa) during eq. Nonlinear shear mass factor Cyclic Stress Ratio Kaite and the stress factor CSR: (KPa) during eq. Nonlinear shear mass factor Cyclic Stress Ratio Cyclic Stress Ratio Kaite and the stress factor CSR: Magnitude Scaling Factor CSR (KPa) during eq. (kPa) CN CR CR Cs Cs Nation A(N1)oo A(N1)oo A(N1)oo A(N1)oo IS Cyclic Resistance Ratio (CRR) numeric results :: No Depth Fines u.o dv d'v Nsrr (m) % (kPa) CN CR CR Cs Cs Cs Nation A(N1)oo A(N1)oo A(N1)oo A(N1)oo 1 1.65 1.32 0.00 33.00 33.00 24 1.57 0.80 1.00 0.82 25 0.00 22 2 3.15 0.00 63.8 63.00 56.62 4 1.44 0.85 1.00 0.82 29 0.00 22 4 6.25 28.00 35.00 18.2			ole diam ength fac ling met er of blo correctio er of blo Resistar r of safe	neter facto ctor hod factor ows correc on ows correc nce Ratio f ty against	r ted for ted for for M _w 7 liquefac	60% energy 60% energy 7.50 ction	and												



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SPT BASED LIQUEFACTION ANALYSIS REPORT





10.5

0

0.1

0.2

CSR & CRR

0.3

0.4

0.5

11

10

20

30

SPT Blow Count

40

50



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CPT name: BH05_ULS

												CSR*	
1	1.65	20.00	0.00	33.00	0.00	33.00	0.99	0.226	1.10	1.72	1.00	2.000	
2	3.15	20.00	11.28	63.00	0.00	51.72	0.98	0.272	1.05	1.11	1.00	0.259	
3	4.65	20.00	26.00	93.00	0.00	67.00	0.96	0.305	1.08	1.94	1.00	0.282	
4	6.25	20.00	41.69	125.00	0.00	83.31	0.95	0.323	1.02	1.32	1.00	0.316	
5	7.75	20.00	56.41	155.00	0.00	98.59	0.93	0.332	1.00	1.21	1.00	0.331	
6	9.25	20.00	71.12	185.00	0.00	113.88	0.91	0.335	0.98	1.72	1.00	0.342	
7	10.75	20.00	85.84	215.00	0.00	129.16	0.89	0.335	0.93	2.20	1.00	2.000	

Abbreviations

Depth from free surface where SPT was performed (m) during Depth: eq.

u₀:

Water pressure at test point (kPa) during eq. σ_v :

Total overburden pressure at test point (kPa) during eq. σ,':

Effective overburden pressure based on GWT during earthquake r_d:

(kPa) during eq. Nonlinear shear mass factor CSR:

Cyclic Stress Ratio MSF:

Effective overburden stress factor Kσ:

Magnitude Scaling Factor CSR*:

CSR fully adjusted

... .

:: Cycli	c Stress	Ratio fully	adjusted	(CSR*) n	umeric	resu	ts ::									
No	Depth (m)	Weight (kN/m³	u₀) (kPa)	σ _v (kPa)	Ext. L (kPa	oad a)	σ' (kP	a)	rd	CS	SR	Κσ	MSF _{max}	MSF		
:: Cyc result	lic Resis s ::	tance Rati	o (CRR) n	umeric												
No	Depth (kPa	Fines u₀σ _v) (kPa)	σ' _ν N _{SPT} (m	ı) % (kPa) C _N	CR	Св	Cs	CE	N 1(60)	Δ(N1)6	0 N 1(60)	.cs CRR7.5	F.S.		
1	1.65	1.32 0.0	0 33.00	33.00 24	1.57	0.80	1.00	1.00	0.82	25	0.00	25	4.000	2.00		
2	3.15	0.00 6.3	8 63.00	56.62 4	1.44	0.85	1.00	1.00	0.82	4	0.00	4	0.080	0.31		
3	4.65	0.00 21.0	9 93.00	71.91 33	3 1.13	0.95	1.00	1.00	0.82	29	0.00	29	0.429	1.52		
4	6.25	28.50	36.79 12	5.00 88.2	21 1	1 1.	.07	0.95	1.00	1.00	0.82	10	5.30	15	0.156	0.49
5	7.75	27.60	51.50 15	5.00 103.	50 8	B 0.	.99	0.95	1.00	1.00	0.82	6	5.25	11	0.125	0.38
6	9.25	0.00	56.22 18	5.00 118.	78 3	3 0.	.94	1.00	1.00	1.00	0.82	25	0.00	25	0.290	0.85
7	10.75	0.00	80.93 21	5.00 134.	07 5	0 0.	.92	1.00	1.00	1.00	0.82	38	0.00	38	4.000	2.00
Abbrev Depth:	iations Depth	from free s	urface wher	re SPT was	perforn	ned (m	ı)			C _B :	Borel	hole diar	neter factoi			
Veight:	Soil un	it weight fro	om previous	s test point	to curre	ent (kl	√/m³)			C _R :	Rod I	ength fa	ctor			
10:	Water	pressure at	test point ((kPa)		·				Cs:	Samp	oling met	hod factor			
J _v :	Total c	overburden i	oressure at	test point (kPa)					N1(60):	Numi	ber of bl	ows correct	ed for 6	50% enerav	
љ ′ :	Effectiv	ve overburd	kPa)			AN1(60)	s Fines	correctio	n		57					
	Numbe		n)				N1(60)	. Num	her of bl	ows correct	ed for 4	50% energy	and fines			
• • • • • •					5,50 C)							nco Dotio f		E0	
-N•	Overbi	uruen press								CKK7.5	Cyclic	L RESIST	псе кацо т	ur ™ _w 7	.50	
E:	Energy	/ ratio facto	•							F.S.:	Facto	or of safe	ety against	liquefac	tion	

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SPT BASED LIQUEFACTION ANALYSIS REPORT

Project title : Liquefaction Assessment - 511185 Location : 518 Rangiora Woodend Road & 4 Golf Links Road Borehole Name : BH06_SLS1 :: Input parameters and analysis properties ::

Analysis method:	Idriss & Boulanger 2014	G.W.T. (in-situ):	2.20	EQ site conditions:	Same as initial
Fines correction method:	Idriss & Boulanger 2014	G.W.T. (earthq.):	1.70		
Sampling method:	Standard Sample	Earthquake magnitude M _w :	7.50		
Borehole diameter:	65 mm to 11 5mm	Peak ground acceleration:	0.13		
Rod length:	1.50	SPT results rounding mode:	Nearest		
Hammer energy ratio:	0.82				



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0.99

0.084

1.10

1.82

1.00

2.000

33.00

0.00

33.00

1.65

1

20.00

0.00

No	Depth (m)	Weight (kN/m³)	u₀ (kPa)	σ _v (kPa)	Ext. Load (kPa)	σ' _` (kPa)	rd	CSR	Kσ	MSF _{max}	MSF	
2	3.15	20.00	14.22	63.00	0.00	48.78	0.98	0.107	1.10	1.88	1.00	0.097
3	4.65	20.00	28.94	93.00	0.00	64.06	0.96	0.118	1.10	2.06	1.00	0.108
4	6.25	20.00	44.64	125.00	0.00	80.36	0.95	0.124	1.02	1.19	1.00	0.122
5	7.75	20.00	59.35	155.00	0.00	95.65	0.93	0.127	1.01	1.53	1.00	0.126
6	9.25	19.00	74.07	183.50	0.00	109.43	0.91	0.128	0.99	1.19	1.00	0.129
7	10.75	20.00	88.78	213.50	0.00	124.72	0.89	0.128	0.97	1.67	1.00	2.000

Abbreviations

Depth from free surface where SPT was performed (m) during Depth: u₀: eq. Water pressure at test point (kPa) during eq. σ_v: Total overburden pressure at test point (kPa) during eq. σ_v': Effective overburden pressure based on GWT during earthquake r_d: (kPa) during eq. Nonlinear shear mass factor CSR: Cyclic Stress Ratio MSF: Effective overburden stress factor Kσ: Magnitude Scaling Factor CSR*: CSR fully adjusted

:: Cyclic Resistance Ratio (CRR) numeric results ::

No	Depth (kPa	Fines u ı) (kPa)	ι₀ σν σ'ν)	N _{SPT} (m	ı) % (kPa)	Cℕ	CR	Св	Cs	CE	N 1(60)	Δ(N1)60	N1(60),cs	CRR7.5	F.S.		
1	1.65	0.00	0.00	33.00	33.00	27	1.53	0.80	1.00	1.00	0.82	27	0.00	27	4.000	2.00		
2	3.15	0.00	9.32	63.00	53.68	31	1.27	0.85	1.00	1.00	0.82	28	0.00	28	0.384	2.00		
3	4.65	0.00	24.03	93.00	68.97	35	1.15	0.95	1.00	1.00	0.82	31	0.00	31	0.555	2.00		
4	6.25	0.00	39.7	73 12	5.00	85.27	12	21.	10	0.95	1.00	1.00	0.82	10	0.00	10	0.118	0.9
5	7.75	0.00) 54.4	45 15	5.00	100.55	5 27	71.	.00	0.95	1.00	1.00	0.82	21	0.00	21	0.219	1.7
6	9.25	1.50	69.1	16 18	3.50	114.34	13	30.	.94	1.00	1.00	1.00	0.82	10	0.00	10	0.118	0.9
7	10.75	0.00	83.8	88 21	3.50	129.62	2 33	30.	.90	1.00	1.00	1.00	0.82	24	0.00	24	4.000	2.0

Abbreviations

Depth:	Depth from free surface where SPT was performed (m)	C _B :	Borehole diameter factor
Weight:	Soil unit weight from previous test point to current (kN/m ³)	C _R :	Rod length factor
$u_0: \sigma_v:$	Water pressure at test point (kPa)	Cs:	Sampling method factor
σ,':	Total overburden pressure at test point (kPa)	N1(60)	Number of blows corrected for 60% energy
N _{CDT} .	Effective overburden pressure based on in situ GWT (kPa)	N1(00).	Fines correction
	Number of blows count in the field (blows/30 cm)	ΔN1(60),cs	Number of blows corrected for 60% energy and
C _N .	Overburden pressure factor	N1(60),cs:	fines
CE.	Energy ratio factor	CRR _{7.5} :	Cyclic Resistance Ratio for M _w 7.50
		F.S.:	Factor of safety against liquefaction













CPT name: BH06_SLS2

												CSR*
1	1.65	20.00	0.00	33.00	0.00	33.00	0.98	0.121	1.10	1.82	1.48	2.000
2	3.15	20.00	14.22	63.00	0.00	48.78	0.96	0.153	1.10	1.88	1.48	0.091
3	4.65	20.00	28.94	93.00	0.00	64.06	0.93	0.166	1.10	2.06	1.48	0.092
4	6.25	20.00	44.64	125.00	0.00	80.36	0.89	0.171	1.02	1.19	1.48	0.150
5	7.75	20.00	59.35	155.00	0.00	95.65	0.85	0.171	1.01	1.53	1.48	0.128
6	9.25	19.00	74.07	183.50	0.00	109.43	0.82	0.169	0.99	1.19	1.48	0.153
7	10.75	20.00	88.78	213.50	0.00	124.72	0.78	0.165	0.97	1.67	1.48	2.000

Abbreviations

Depth: u_0 : σ_v : σ_v' : r_d : CSR: MSF: K_σ : CSR*: :: Cycl results	Depth eq. Water Total c Effectiv (kPa) c Cyclic : Effectiv Magnit CSR fu ic Resis	from free pressur overburco ve overb during e Stress R ve overb cude Sca illy adju: stance	ee surfa e at tes den pres purden p q. Nonl tatio purden s aling Fac sted Ratio (ce where t point (l ssure at i pressure inear she stress fa ctor	e SPT wa kPa) dur test poir based c ear mass ctor umeric	as pe ing e it (kF on GV s fact	erform eq. Pa) du WT du cor	ed (m ring ea) durir q. arthqu	ng ake						
No	Depth	Fines ι	ı₀ σ _v σ'∖	, N _{SPT} (m	ı) % (k	Pa)	Cℕ	Cr	Св	Cs	CE	N 1(60)	Δ(N1)60	N 1(60),cs	CRR 7.5	F.S.
	(kPa	a) (kPa)		<i>,</i> ,	•										
1	1.65	0.00	0.00	33.00	33.00	27	1.53	0.80	1.00	1.00	0.82	27	0.00	27	4.000	2.00
2	3.15	0.00	9.32	63.00	53.68	31	1.27	0.85	1.00	1.00	0.82	28	0.00	28	0.384	2.00



3	4.65	0.00 24	1.03 93	.00 68.97	7 35	1.15	0.95	1.00 1.0	0.82	31	0.00	31	0.555	2.00		
4	6.25	0.00	39.73	125.00	85.27	12	2 1.1	0 0.95	1.00	1.00	0.82	10	0.00	10	0.118	0.79
5	7.75	0.00	54.45	155.00	100.55	5 27	' 1.0	0 0.95	1.00	1.00	0.82	21	0.00	21	0.219	1.70
6	9.25	1.50	69.16	183.50	114.34	4 13	8 0.9	4 1.00	1.00	1.00	0.82	10	0.00	10	0.118	0.77
7	10.75	0.00	83.88	213.50	129.62	2 33	8 0.9	0 1.00	1.00	1.00	0.82	24	0.00	24	4.000	2.00
AbbreviationsDepth:Depth from free surface where SPT was performed (m)Weight:Soil unit weight from previous test point to current (kN/m ³) $u_0: \sigma_v$:Water pressure at test point (kPa) σ_v ':Total overburden pressure at test point (kPa)NSPT:Effective overburden pressure based on in situ GWT (kPa) C_N :Number of blows count in the field (blows/30 cm) C_E :Overburden pressure factor											Bore Rod Sam Num Fines Sum fines Cycli	hole dian length fa pling met ber of blo s correction ber of blo s c Resista	neter facto ctor chod factor ows correc on ows correc nce Ratio f	r ted for 6 ted for 6 for M _w 7.	50% energy 50% energy 50	and

CLiq v.2.3.1.15 - CPT Liquefaction Assessment Software - Report created on: 17/10/2023, 10:24:41 am

Project title : Liquefa	action Assessment - 511	185 Location : 518 F	Rangiora Wo	oodend Road & 4 Golf	Links Road Borehole
Name : BH06_ULS					
:: Input parameters	and analysis properties :				
Analysis method:	Idriss & Boulanger 2014	G.W.T. (in-situ):	2.20	EQ site conditions:	Same as initial
Fines correction method:	Idriss & Boulanger 2014	G.W.T. (earthq.):	1.70		
Sampling method:	Standard Sample	Earthquake magnitude M _w :	7.50		
Borehole diameter:	65 mm to 11 5mm	Peak ground acceleration:	0.35		
Rod length:	1.50	SPT results rounding mode	: Nearest		
Hammer energy ratio:	0.82				





CLiq v.2.3.1.15 - CPT Liquefaction Assessment Software - Report created on: 17/10/2023, 10:30:09 am

CPT name: BH06_ULS

												CSR*	
1	1.65	20.00	0.00	33.00	0.00	33.00	0.99	0.226	1.10	1.82	1.00	2.000	
													-



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2	3.15	20.00	14.22	63.00	0.00	48.78	0.98	0.288	1.10	1.88	1.00	0.262	
3	4.65	20.00	28.94	93.00	0.00	64.06	0.96	0.319	1.10	2.06	1.00	0.291	
4	6.25	20.00	44.64	125.00	0.00	80.36	0.95	0.335	1.02	1.19	1.00	0.328	
5	7.75	20.00	59.35	155.00	0.00	95.65	0.93	0.342	1.01	1.53	1.00	0.339	
6	9.25	19.00	74.07	183.50	0.00	109.43	0.91	0.346	0.99	1.19	1.00	0.348	
7	10.75	20.00	88.78	213.50	0.00	124.72	0.89	0.345	0.97	1.67	1.00	2.000	

Abbreviations

De u_0 : σ_v : r_d : r_d : CSI K_σ : CSI	pth: R: F: R*:	Depth eq. Water Total o Effectiv (kPa) o Cyclic S Effectiv Magnit CSR fu	from fre pressur verburc ve overl luring e Stress R ve overl ude Sca Ily adju	ee surfa den pres burden eq. Nonl Ratio burden aling Fa sted	ce whe t point ssure at pressure inear sh inear sh stress fa	re SPT (kPa) di test po e based hear ma actor	was pe uring e bint (kF l on GV ss fact	erform eq. va) dui VT dui or	ed (m ring e ring e) duri q. arthq	uake								
:: re	Cycli sults No	ic Resis ::: Depth (kPa	stance Fines () (kPa	Ratio (μο σν σ'ι	(CRR) / Nspt (1	numeri n) % (ic (kPa)	CN	CR	Св	Cs	CE	N 1(60)	Δ(N 1)60	N 1(60),c	s CRR7.5	F.S.		
	1	1.65	0.00	0.00	33.00	33.00) 27	1.53	0.80	1.00	1.00	0.82	27	0.00	27	4.000	2.00		
	2	3.15	0.00	9.32	63.00	53.68	31	1.27	0.85	1.00	1.00	0.82	28	0.00	28	0.384	1.46		
	3	4.65	0.00	24.03	93.00	68.97	35	1.15	0.95	1.00	1.00	0.82	31	0.00	31	0.555	1.91		
	4	6.25	0.00	0 39.	73 12	25.00	85.27	1	2 1	.10	0.95	1.00	1.00	0.82	10	0.00	10	0.118	0.36
	5	7.75	0.00	0 54.	.45 1	55.00	100.5	5 27	7 1	.00	0.95	1.00	1.00	0.82	21	0.00	21	0.219	0.64
	6	9.25	1.50	0 69.	.16 18	33.50	114.3	4 13	3 0	.94	1.00	1.00	1.00	0.82	10	0.00	10	0.118	0.34
	7	10.75	0.00	0 83.	.88 2	13.50	129.6	2 33	3 0	.90	1.00	1.00	1.00	0.82	24	0.00	24	4.000	2.00
											$C_{B}: \\ C_{R}: \\ C_{S}: \\ N_{1(60)}: \\ \Delta N_{1(60),cs}: \\ CRR_{7.5}: \\ F.S.: \\ CRR_{7.5}: \\ CR$	Boreh Rod le Samp Numb Fines Numb fines Cyclic Factol	ole diam ength fac ling metl er of blo correctio er of blo Resistar r of safet	eter factor tor hod factor wws correcto wws corrector wws corrector nce Ratio for ty against li	ed for 6 ed for 6 or M _w 7. iquefact	0% energy 0% energy 50 ion	and		

CLiq v.2.3.1.15 - CPT Liquefaction Assessment Software - Report created on: 17/10/2023, 10:30:09 am

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SPT BASED LIQUEFACTION ANALYSIS REPORT





0

0.1

0.2

CSR & CRR

0.3

0.5

0.4

20

30

SPT Blow Count

40

10



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CPT name: BH07_SLS1

												CSR*	
1	1.65	20.00	0.00	33.00	0.00	33.00	0.99	0.084	1.10	2.20	1.00	2.000	
2	3.15	20.00	1.47	63.00	0.00	61.53	0.98	0.085	1.05	1.26	1.00	0.081	
3	4.65	20.00	16.19	93.00	0.00	76.81	0.96	0.099	1.03	1.38	1.00	0.096	
4	6.25	20.00	31.88	125.00	0.00	93.12	0.95	0.107	1.01	1.17	1.00	0.107	
5	7.75	19.00	46.60	153.50	0.00	106.90	0.93	0.112	0.99	1.19	1.00	0.113	
6	9.25	20.00	61.31	183.50	0.00	122.19	0.91	0.115	0.97	1.53	1.00	0.118	
7	10.75	20.00	76.03	213.50	0.00	137.47	0.89	0.116	0.95	1.77	1.00	2.000	

Abbreviations

Depth from free surface where SPT was performed (m) during Depth: eq.

 u_0 :

Water pressure at test point (kPa) during eq. σ_v :

Total overburden pressure at test point (kPa) during eq. σ,':

Effective overburden pressure based on GWT during earthquake r_d:

(kPa) during eq. Nonlinear shear mass factor CSR:

Cyclic Stress Ratio MSF:

Effective overburden stress factor Kσ:

Magnitude Scaling Factor CSR*:

CSR fully adjusted

..

:: Cyclic Stress Ratio fully adjusted (CSR*) numeric results ::																		
No	Depth (m)	We (kN	ight /m³)	u₀ (kPa)	σ _v (kPa)	E:	kt. Lo (kPa	oad)	σ' (kP	, a)	rd	cs	R	Κσ	MSF _{max}	MSF		
:: Cycl result	Cyclic Resistance Ratio (CRR) numeric sults ::																	
No	Depth (kPa	Fines u) (kPa	.,	N _{SPT} (m	ı) % (k	Pa)	Cℕ	CR	Св	Cs	CE	N 1(60)	Δ(N1)6	0 N 1(60),	∝ CRR7.5	F.S.		
1	1.65	2.40	0.00	33.00	33.00	45 1	1.39	0.80	1.00	1.00	0.82	42	0.00	42	4.000	2.00		
2	3.15	0.00	0.00	63.00	63.00	15 1	1.27	0.85	1.00	1.00	0.82	13	0.00	13	0.140	1.74		
3	4.65	0.00	11.28	93.00	81.72	19 1	1.11	0.95	1.00	1.00	0.82	17	0.00	17	0.174	1.82		
4	6.25	0.00) 26.	98 12	5.00 9	8.02	12	1.0)2	0.95	1.00	1.00	0.82	9	0.00	9	0.111	1.04
5	7.75	27.6	0 41.	69 15	3.50 1	11.81	7	0.9	95	0.95	1.00	1.00	0.82	5	5.25	10	0.118	1.04
6	9.25	0.00	56.	41 18	3.50 1	27.09	28	0.9	91	1.00	1.00	1.00	0.82	21	0.00	21	0.219	1.85
7	10.75	0.00) 71.	12 21	3.50 1 [.]	42.38	37	0.8	38	1.00	1.00	1.00	0.82	26	0.00	26	4.000	2.00
AbbreviationsDepth:Depth from free surface where SPT was performed (m)CWeight:Soil unit weight from previous test point to current (kN/m³)C $u_0: \sigma_v$:Water pressure at test point (kPa)C σ_v' :Total overburden pressure at test point (kPa)CNspr:Effective overburden pressure based on in situ GWT (kPa)A C_N :Overburden pressure factorA C_e :Energy ratio factorC										C _B : C _R : C _S : N1(60): ΔN1(60),cs: CRR7.5: F.S.:	Borel Rod I Samp Numl Fines Numl fines Cyclic Facto	nole dian ength fa bling met ber of blo correction ber of blo c Resista or of safe	neter facto ctor chod factor ows correc on ows correc nce Ratio f ety against	r ted for ted for for M _w 7 liquefac	60% energy 60% energy .50 :tion	and		

CLiq v.2.3.1.15 - CPT Liquefaction Assessment Software - Report created on: 17/10/2023, 10:32:03 am

Project title : Liquefa	Project title : Liquefaction Assessment - 511185 Location : 518 Rangiora Woodend Road & 4 Golf Links Road Borehole Name : BH07 SLS2												
Name : BH07_SLS2	ame : BH07_SLS2												
:: Input parameters	and analysis properties :	:											
Analysis method:	Idriss & Boulanger 2014	G.W.T. (in-situ):	3.50	EQ site conditions:	Same as initial								
Fines correction method:	Idriss & Boulanger 2014	G.W.T. (earthq.):	3.00										
Sampling method:	Standard Sample	Earthquake magnitude M _w :	6.00										
Borehole diameter:	65 mm to 11 5mm	Peak ground acceleration:	0.19										
Rod length:	1.50	SPT results rounding mode:	Nearest										
Hammer energy ratio:	0.82												



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No	Depth (m)	Weight (kN/m³)	u₀ (kPa)	σ _v (kPa)	Ext. Load (kPa)	σ' _` (kPa)	rd	CSR	Kσ	MSF _{max}	MSF	
2	3.15	20.00	1.47	63.00	0.00	61.53	0.96	0.121	1.05	1.26	1.48	0.099
3	4.65	20.00	16.19	93.00	0.00	76.81	0.93	0.138	1.03	1.38	1.48	0.109
4	6.25	20.00	31.88	125.00	0.00	93.12	0.89	0.148	1.01	1.17	1.48	0.133
5	7.75	19.00	46.60	153.50	0.00	106.90	0.85	0.152	1.00	1.12	1.48	0.142
6	9.25	20.00	61.31	183.50	0.00	122.19	0.82	0.152	0.97	1.53	1.48	0.118
7	10.75	20.00	76.03	213.50	0.00	137.47	0.78	0.150	0.95	1.77	1.48	2.000

Abbreviations

Depth from free surface where SPT was performed (m) during Depth: u₀: eq. Water pressure at test point (kPa) during eq. σ_v: Total overburden pressure at test point (kPa) during eq. σ_v': Effective overburden pressure based on GWT during earthquake r_d: (kPa) during eq. Nonlinear shear mass factor CSR: Cyclic Stress Ratio MSF: Effective overburden stress factor Kσ: Magnitude Scaling Factor CSR*: CSR fully adjusted

:: Cyclic Resistance Ratio (CRR) numeric results ::

No	Depth (kPa	Fines ua ı) (kPa)	₀ σ _v σ' _v N	_{SPT} (m) %	(kPa)	Cℕ	CR	Св	Cs	CE	N 1(60)	Δ(N1)60	N 1(60),cs	CRR 7.5	F.S.		
1	1.65	2.40	0.00 3	3.00 33.00) 45	1.39	0.80	1.00	1.00	0.82	42	0.00	42	4.000	2.00		
2	3.15	0.00	0.00 6	3.00 63.00) 15	1.27	0.85	1.00	1.00	0.82	13	0.00	13	0.140	1.41		
3	4.65	0.00	11.28 9	3.00 81.72	2 19	1.11	0.95	1.00	1.00	0.82	17	0.00	17	0.174	1.60		
4	6.25	0.00	26.98	125.00	98.02	12	2 1.0	02	0.95	1.00	1.00	0.82	9	0.00	9	0.111	0.8
5	7.75	7.60	41.69	153.50	111.81	. 7	0.9	94 (0.95	1.00	1.00	0.82	5	0.26	5	0.086	0.6
6	9.25	0.00	56.41	183.50	127.09	28	3 0.9	91	1.00	1.00	1.00	0.82	21	0.00	21	0.219	1.8
7	10.75	0.00	71.12	213.50	142.38	37	7 0.8	88	1.00	1.00	1.00	0.82	26	0.00	26	4.000	2.0

Abbreviations

Depth:	Depth from free surface where SPT was performed (m)	C _B :	Borehole diameter factor
Weight:	Soil unit weight from previous test point to current (kN/m ³)	C _R :	Rod length factor
u ₀ : σ _v :	Water pressure at test point (kPa)	Cs:	Sampling method factor
σ,':	Total overburden pressure at test point (kPa)	N1(60)	Number of blows corrected for 60% energy
NSPT'	Effective overburden pressure based on in situ GWT (kPa)		Fines correction
C _N .	Number of blows count in the field (blows/30 cm)	ΔIN1(60),cs	Number of blows corrected for 60% energy and
C ₋ .	Overburden pressure factor	N1(60),cs:	fines
CE.	Energy ratio factor	CRR _{7.5} :	Cyclic Resistance Ratio for M _w 7.50
		F.S.:	Factor of safety against liquefaction











CLiq v.2.3.1.15 - CPT Lique	efaction Assessment Software -	· Report created on:	17/10/2023, 10:34:24 am
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CPT name: BH07_ULS

												CSR*
1	1.65	20.00	0.00	33.00	0.00	33.00	0.99	0.226	1.10	2.20	1.00	2.000
2	3.15	20.00	1.47	63.00	0.00	61.53	0.98	0.228	1.05	1.26	1.00	0.217
3	4.65	20.00	16.19	93.00	0.00	76.81	0.96	0.266	1.03	1.38	1.00	0.257
4	6.25	20.00	31.88	125.00	0.00	93.12	0.95	0.289	1.01	1.17	1.00	0.287
5	7.75	19.00	46.60	153.50	0.00	106.90	0.93	0.303	0.99	1.19	1.00	0.304
6	9.25	20.00	61.31	183.50	0.00	122.19	0.91	0.310	0.97	1.53	1.00	0.318
7	10.75	20.00	76.03	213.50	0.00	137.47	0.89	0.313	0.95	1.77	1.00	2.000

Abbreviations

Depth: u_0 : σ_v : σ_v' : r_d : CSR: MSF: K_σ : CSR*:	Depth eq. Water Total c Effectiv (kPa) c Cyclic S Effectiv Magnit CSR fu	from free pressure overburce ve overh during e Stress R ve overh cude Sca illy adju	e at tes den pres ourden j eq. Nonl tatio ourden s aling Fac	ce where t point (l ssure at pressure inear she stress fa ctor	e SPT wa kPa) dur test poin based o ear mass ctor	ing e t (kF n GV fact	erform eq. 2a) du VT du or	ed (m) ring ea ring ea) durir q. arthqu	ig ake						
:: Cycli results	:: Cyclic Resistance Ratio (CRR) numeric results ::															
F.S. No Depth Fines u _o σ _v σ' _v N _{SPT} (m) % (kPa) C_N C_R C_B C_S C_E N ₁ (60) Δ(N ₁)60 N ₁ (60),cs CRR _{7.5} (kPa) (kPa)															F.S.	
1	1.65	2.40	0.00	33.00	33.00	45	1.39	0.80	1.00	1.00	0.82	42	0.00	42	4.000	2.00
2	3.15	0.00	0.00	63.00	63.00	15	1.27	0.85	1.00	1.00	0.82	13	0.00	13	0.140	0.64



3	4.65	0.00	11.28 93	3.00 81.72	2 19	1.11	0.95	1.00	1.00	0.82	17	0.00	17	0.174	0.68		
4	6.25	0.00	26.98	125.00	98.02	12	21.	02	0.95	1.00	1.00	0.82	9	0.00	9	0.111	0.39
5	7.75	27.60	41.69	153.50	111.8	L 7	0.	95	0.95	1.00	1.00	0.82	5	5.25	10	0.118	0.39
6	9.25	0.00	56.41	183.50	127.09	9 28	3 0.	91	1.00	1.00	1.00	0.82	21	0.00	21	0.219	0.69
7	10.75	0.00	71.12	213.50	142.38	3 37	7 0.	88	1.00	1.00	1.00	0.82	26	0.00	26	4.000	2.00
Abbrevi Depth: Weight: $u_0: \sigma_v: \sigma_v': \sigma_v': N_{SPT}: C_N: C_E:$	ations Depth Soil ur Water Total o Effecti Numb Overb Energ	from free nit weigh pressure overburd ive overb er of blo urden pr y ratio fa	ee surface t from pre e at test p len pressu purden pre ws count ressure fac actor	where SPT evious test point (kPa) ure at test p essure base in the field ctor	was p point to point (k d on in (blows)	erform curre Pa) situ (/30 cn	ned (m ent (kN GWT (l n)	ı) V/m³) kPa))		C _B : C _R : C _S : N1(60): ΔN1(60),cs: CRR7.5: F.S.:	Bore Rod Samı Num Fines Num fines Cycli Facto	hole dian length fa pling met ber of blo s correction ber of blo c Resista or of safe	neter factor ctor hod factor ows correct on ows correct nce Ratio fo ty against l	ed for 6 ed for 6 or M _w 7. iquefact	0% energy 0% energy 50 ion	and

CLiq v.2.3.1.15 - CPT Liquefaction Assessment Software - Report created on: 17/10/2023, 10:34:24 am

Project title : Liquefa	action Assessment - 511	185 Location : 518 F	Rangiora Wo	odend Road & 4 Golf	Links Road Borehole
Name : BH08_SLS1					
:: Input parameters	and analysis properties				
Analysis method:	Idriss & Boulanger 2014	G.W.T. (in-situ):	2.40	EQ site conditions:	Same as initial
Fines correction method:	Idriss & Boulanger 2014	G.W.T. (earthq.):	1.90		
Sampling method:	Standard Sample	Earthquake magnitude M _w :	7.50		
Borehole diameter:	65 mm to 11 5mm	Peak ground acceleration:	0.13		
Rod length:	1.50	SPT results rounding mode	: Nearest		
Hammer energy ratio:	0.82				





CLiq v.2.3.1.15 - CPT Liquefaction Assessment Software - Report created on: 17/10/2023, 10:36:04 am

CPT name: BH08_SLS1

												CSR*	
1	1.65	19.00	0.00	31.35	0.00	31.35	0.99	0.084	1.10	1.15	1.00	2.000	



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2	3.15	20.00	12.26	61.35	0.00	49.09	0.98	0.104	1.09	1.38	1.00	0.095	
3	4.65	20.00	26.98	91.35	0.00	64.37	0.96	0.116	1.04	1.24	1.00	0.111	
4	6.25	20.00	42.67	123.35	0.00	80.68	0.95	0.122	1.04	1.77	1.00	0.118	
5	7.75	19.00	57.39	151.85	0.00	94.46	0.93	0.126	1.01	1.17	1.00	0.125	
6	9.25	20.00	72.10	181.85	0.00	109.75	0.91	0.127	0.98	2.20	1.00	0.130	
7	10.75	20.00	86.82	211.85	0.00	125.03	0.89	0.127	0.95	2.06	1.00	2.000	

Abbreviations

Depth: Depth from free surface where SPT was performed (m) during eq.

Water pressure at test point (kPa) during eq. u₀:

- Total overburden pressure at test point (kPa) during eq. σ,:
- Effective overburden pressure based on GWT during earthquake σ_v':
- (kPa) during eq. Nonlinear shear mass factor r_d:
- Cvclic Stress Ratio CSR:

Effective overburden stress factor MSF:

Magnitude Scaling Factor K_σ:

CSR fully adjusted CSR*:

:: re	Cycl sults	ic Resi s ::	stance l	Ratio (CRR) n	umeri	С											
	No	Depth (kPa	Fines u a) (kPa)	Ιο σ ν σ'ν	, N spt (п	ı) %	(kPa)	Cℕ	CR	Св	Cs	CE	N 1(60)	Δ(N1)60	N 1(60),d	s CRR 7.5	F.S.	
	1	1.65	22.66	0.00	31.35	31.35	53	1.70	0.80	1.00	1.00	0.82	3	4.85	8	4.000	2.00	
	2	3.15	2.49	7.36	61.35	53.99	9 19	1.34	0.85	1.00	1.00	0.82	17	0.00	17	0.174	1.82	
	3	4.65	0.00	22.07	91.35	69.28	3 13	1.22	0.95	1.00	1.00	0.82	12	0.00	12	0.132	1.20	
	4	6.25	0.00	37.	77 123	3.35	85.58	31	1.	07 (0.95	1.00	1.00	0.82	26	0.00	26	
	5	7.75	27.60) 52.4	48 151	L.85	99.37	5	1.	01 (0.95	1.00	1.00	0.82	4	5.25	9	
	6	9.25	0.00	67.	20 181	L.85	114.65	5 47	7 0.	96	1.00	1.00	1.00	0.82	38	0.00	38	
	7	10.75	0.00	81.	91 211	L.85	129.94	4 41	0.	92	1.00	1.00	1.00	0.82	31	0.00	31	
Ab De We	brevi pth: ight:	7 10.75 0.00 81.91 211.85 129.94 41 0.92 1.00 1.00 1.00 0.82 31 0.00 31 previations oth: Depth from free surface where SPT was performed (m) C_B : Borehole diameter factor inht: Soil unit weight from previous test point to current (kN/m ³) C_B : Borehole diameter factor														-		

u ₀ : σ _v :	Water pressure at test point (kPa)	Cs:	S
σ,':	Total overburden pressure at test point (kPa)	N1(60)*	Ν
Nent	Effective overburden pressure based on in situ GWT (kPa)	ANI	F
Cut	Number of blows count in the field (blows/30 cm)	ΔIN1(60),cs	Ν
CN.	Outstand and an annear the stand	N1(60) cs	c

Overburden pressure factor C_E: Energy ratio factor

Rod length facto Sampling method factor lumber of blows corrected for 60% energy ines correction lumber of blows corrected for 60% energy and fines CRR7.5: Cyclic Resistance Ratio for $M_{\scriptscriptstyle W}\,7.50$ F.S.: Factor of safety against liquefaction

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2.00

0.89

2.00

2.00



SPT BASED LIQUEFACTION ANALYSIS REPORT





10.5-

0

0.1

0.3

CSR & CRR

0.4

0.5

0.2

11

10

20

30

SPT Blow Count

40



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CPT name: BH08_SLS2

												CSR*	
1	1.65	19.00	0.00	31.35	0.00	31.35	0.98	0.121	1.10	1.15	1.48	2.000	
2	3.15	20.00	12.26	61.35	0.00	49.09	0.96	0.148	1.09	1.38	1.48	0.111	
3	4.65	20.00	26.98	91.35	0.00	64.37	0.93	0.162	1.04	1.24	1.48	0.136	
4	6.25	20.00	42.67	123.35	0.00	80.68	0.89	0.168	1.04	1.77	1.48	0.111	
5	7.75	19.00	57.39	151.85	0.00	94.46	0.85	0.170	1.01	1.17	1.48	0.153	
6	9.25	20.00	72.10	181.85	0.00	109.75	0.82	0.167	0.98	2.20	1.48	0.100	
7	10.75	20.00	86.82	211.85	0.00	125.03	0.78	0.163	0.95	2.06	1.48	2.000	

Abbreviations

Depth: Depth from free surface where SPT was performed (m) during eq.

 u_0 : Water pressure at test point (kPa) during eq.

 σ_v : Total overburden pressure at test point (kPa) during eq.

 σ_v ': Effective overburden pressure based on GWT during earthquake

rd: (kPa) during eq. Nonlinear shear mass factor

CSR: Cyclic Stress Ratio

MSF: Effective overburden stress factor

 K_{σ} : Magnitude Scaling Factor

CSR*: CSR fully adjusted

:: Cyclic Stress Ratio fully adjusted (CSR*) numeric results ::																		
No	Depth (m)	Wei (kN/	ght m³)	u₀ (kPa)	σ _v (kPa)	E	xt. Lo (kPa	oad)	σ'、 (kPa	, a)	۲d	CS	R	Κσ	MSF _{max}	MSF		
:: Cycl result:	lic Resis s ::	stance I	Ratio (CRR) nı	Imeric													
No	Depth (kPa	Fines u a) (kPa)	ο σ ν σ' ν	Nspt (m) % (k	Pa)	CN	CR	Св	Cs	C⊧	N 1(60)	Δ(N1)6	0 N 1(60)	,œ CRR 7.5	F.S.		
1	1.65	22.66	0.00	31.35	31.35	3	1.70	0.80	1.00	1.00	0.82	3	4.85	8	4.000	2.00		
2	3.15	2.49	7.36	61.35	53.99	19	1.34	0.85	1.00	1.00	0.82	17	0.00	17	0.174	1.57		
3	4.65	0.00	22.07	91.35	69.28	13	1.22	0.95	1.00	1.00	0.82	12	0.00	12	0.132	0.97		
4	6.25	0.00	37.7	7 123	.35 8	5.58	31	1.0)7 (0.95	1.00	1.00	0.82	26	0.00	26	0.316	2.00
5	7.75	27.60) 52.4	8 151	.85 99	9.37	5	1.0	01 (0.95	1.00	1.00	0.82	4	5.25	9	0.111	0.73
6	9.25	0.00	67.2	20 181	.85 11	4.65	47	0.9	96	1.00	1.00	1.00	0.82	38	0.00	38	2.273	2.00
7	10.75	0.00	81.9	91 211	.85 12	9.94	41	0.9	92	1.00	1.00	1.00	0.82	31	0.00	31	4.000	2.00
710.750.0081.91211.85129.94410.921.001.000.82310.00314.0002.00AbbreviationsDepth:Depth from free surface where SPT was performed (m)Weight:Soil unit weight from previous test point to current (kN/m³) $u_0: \sigma_v$:Water pressure at test point (kPa) σ_v :Total overburden pressure at test point (kPa) N_{SPT} :Effective overburden pressure based on in situ GWT (kPa) N_{Nemer} of blows count in the field (blows/30 cm) C_R :Number of blows corrected for 60% energy $N_{1(60),cs}$: $C_R:$ $C_RR_7.5$: <t< td=""></t<>																		

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Project title : Liquefa	action Assessment - 511	185 Location : 518 F	Rangiora W	oodend Road & 4 Golf	Links Road Borehole
Name : Drivo_ULS					
:: Input parameters	and analysis properties :				
		•			
Analysis method:	Idriss & Boulanger 2014	G.W.T. (in-situ):	2.40	EQ site conditions:	Same as initial
Fines correction method:	Idriss & Boulanger 2014	G.W.T. (earthq.):	1.90		
Sampling method:	Standard Sample	Earthquake magnitude M _w :	7.50		
Borehole diameter:	65 mm to 11 5mm	Peak ground acceleration:	0.35		
Rod length:	1.50	SPT results rounding mode:	Nearest		
Hammer energy ratio:	0.82	_			



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N SPT plot CSR vs CRR plot 0 1 CRR CPT CSR N(SPT) N1(60) N1(60)cs 0.5 - CRR 1 2 1.5 2 3 2.5 3 4 3.5 4. 5 4.5-Depth (m) Depth (m) 5 6 5.5 6 7 6.5 7 8 7.5 8 9 8.5 9 10 9.5 10 11 10.5 10 20 30 40 0.1 0.2 0.3 0.4 0.5 0 SPT Blow Count CSR & CRR CRR 7.50 clean sand curve 0.60 Liquefaction Fully Adjusted Cyclic Stress Ratio, CSR* 0.50 0.40 0 0 0.30 • 0 0.20 0.10 **No Liquefaction** 0.00 5 50 0 10 15 20 25 30 35 40 45 Corrected Blow Count N1(60),cs



CPT name: BH08_ULS



No	Depth (m)	Weight (kN/m³)	u₀ (kPa)	σ _v (kPa)	Ext. Load (kPa)	σ' _` (kPa)	rd	CSR	Kσ	MSF _{max}	MSF	
2	3.15	20.00	12.26	61.35	0.00	49.09	0.98	0.279	1.09	1.38	1.00	0.257
3	4.65	20.00	26.98	91.35	0.00	64.37	0.96	0.311	1.04	1.24	1.00	0.298
4	6.25	20.00	42.67	123.35	0.00	80.68	0.95	0.329	1.04	1.77	1.00	0.317
5	7.75	19.00	57.39	151.85	0.00	94.46	0.93	0.339	1.01	1.17	1.00	0.337
6	9.25	20.00	72.10	181.85	0.00	109.75	0.91	0.342	0.98	2.20	1.00	0.351
7	10.75	20.00	86.82	211.85	0.00	125.03	0.89	0.341	0.95	2.06	1.00	2.000

Abbreviations

Depth: Depth from free surface where SPT was performed (m) during eq.

- u₀: Water pressure at test point (kPa) during eq.
- $\sigma_{v:} \qquad \mbox{Total overburden pressure at test point (kPa) during eq.}$
- σ_{v} ': Effective overburden pressure based on GWT during earthquake
- rd: (kPa) during eq. Nonlinear shear mass factor
- CSR: Cyclic Stress Ratio
- MSF: Effective overburden stress factor
- K_{σ} : Magnitude Scaling Factor
- CSR*: CSR fully adjusted

:: Cyclic Resistance Ratio (CRR) numeric results ::																			
r	lo D	Depth (kPa	Fines u a) (kPa)	ο σ ν σ' ν	, N spt (п	1) % ((kPa)	C _N	C _R	Св	Cs	CE	N 1(60)	Δ(N1)60	N1(60),	ය CRR _{7.5}	F.S.		
	L	1.65	22.66	0.00	31.35	31.35	3	1.70	0.80	1.00	1.00	0.82	3	4.85	8	4.000	2.00		
-	2	3.15	2.49	7.36	61.35	53.99	19	1.34	0.85	1.00	1.00	0.82	17	0.00	17	0.174	0.68		
	3	4.65	0.00	22.07	91.35	69.28	13	1.22	0.95	1.00	1.00	0.82	12	0.00	12	0.132	0.44		
4		6.25	0.00	37.	77 123	3.35	85.58	31	. 1.()7 ().95	1.00	1.00	0.82	26	0.00	26	0.316	1.00
5		7.75	27.60) 52.4	48 15:	1.85	99.37	5	1.0	01 ().95	1.00	1.00	0.82	4	5.25	9	0.111	0.33
6		9.25	0.00	67.	20 18:	1.85	114.65	5 47	0.9	96 1	1.00	1.00	1.00	0.82	38	0.00	38	2.273	2.00
7	1	10.75	0.00	81.	91 21:	1.85	129.94	41	0.9	92 1	1.00	1.00	1.00	0.82	31	0.00	31	4.000	2.00
br	evia	tions																	

Depth:	Depth from free surface where SPT was performed (m)	C _B :	Borehole diameter factor
Weight:	Soil unit weight from previous test point to current (kN/m ³)	C _R :	Rod length factor
u ₀ : σ _v :	Water pressure at test point (kPa)	Cs:	Sampling method factor
σ _v ':	Total overburden pressure at test point (kPa)	N1(60)	Number of blows corrected for 60% energy
Nept.	Effective overburden pressure based on in situ GWT (kPa)		Fines correction
	Number of blows count in the field (blows/30 cm)	ΔIN1(60),cs	Number of blows corrected for 60% energy and
C _N .	Overburden pressure factor	N1(60),cs:	fines
CE.	Energy ratio factor	CRR7.5:	Cyclic Resistance Ratio for M _w 7.50
		F.S.:	Factor of safety against liquefaction

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