under:	the Resource Management Act 1991
in the matter of:	Submissions and further submissions on the Proposed Waimakariri District Plan and Variation 1
and:	Hearing Stream 12: Rezoning requests (larger scale)
and:	<b>Crichton Developments Limited</b> (Submitter 299)

Statement of evidence of Chris Thompson (Geotech) on behalf of Crichton Developments Limited in relation to Gladstone Road rezoning request

Dated: 5 March 2024

Reference: J M Appleyard (jo.appleyard@chapmantripp.com) A M Lee (annabelle.lee@chapmantripp.com)



# STATEMENT OF EVIDENCE OF CHRIS THOMPSON ON BEHALF OF CRICHTON DEVELOPMENTS LIMITED

#### INTRODUCTION

- 1 My full name is Christopher Samuel Thompson.
- I hold a Bachelor of Science (Technology) degree and am a member of Engineering New Zealand and the New Zealand Geotechnical Society. I have over 15 years of geotechnical consulting experience. During this time, I have held positions at Foundation Engineering Consultants (Graduate Geologist and Engineering Geologist), Balfour Beatty Ground Engineering (Contracts Engineer) and Coffey / Tetra Tech Coffey (Engineering Geologist to Associate Engineering Geologist).
- 3 I have undertaken a wide range of geotechnical consulting work in New Zealand, Australia and England, including design and construction monitoring for many subdivisions and developments in the Canterbury region and across New Zealand. I have also worked on large infrastructure projects at Lyttelton Port and Kawarau Falls Bridge in Queenstown. In these projects I have carried out geotechnical hazard assessments for settlement (both liquefaction induced and static) and slope stability.

#### CODE OF CONDUCT

2 Although this is not an Environment Court hearing, I note that in preparing my evidence I have reviewed the Code of Conduct for Expert Witnesses contained in Part 9 of the Environment Court Practice Note 2023. I have complied with it in preparing my evidence. I confirm that the issues addressed in this statement of evidence are within my area of expertise, except where relying on the opinion or evidence of other witnesses. I have not omitted to consider material facts known to me that might alter or detract from the opinions expressed.

#### SCOPE OF EVIDENCE

- 3 I have been asked to comment on the relief sought by Crichton Developments Limited (*Submitter 299*) in relation to the proposed Waimakariri District Plan (*Proposed Plan*). Specifically, the request to rezone land at 145-167 Gladstone Road (*Site*), Woodend to Large Lot Residential Zone (*the Proposal*).
- 4 My evidence will address:
  - 4.1 The geotechnical aspects of the Site and existing environment.

#### SUMMARY OF EVIDENCE

- 5 Crichton Developments Ltd engaged Tetra Tech Coffey (NZ) Limited to carry out a geotechnical investigation and assessment of suitability for the Proposal, near Woodend, Canterbury. I am the Project Manager for the geotechnical investigation and design for this site.
- 6 The site investigations and preliminary liquefaction assessment indicates that the site is predominantly TC1-like. Other geotechnical hazards (static settlement, erosion, slippage and inundation) are considered low risk with appropriate future engineering design.
- 7 The geotechnical assessment has considered the items required by Section 106 of the Resource Management Act. In our opinion the Site is considered geotechnically suitable for rezoning and future subdivision. Further investigations and design will be carried out at the subdivision consent stage which is (or would be) typical for a residential subdivision.

#### EVIDENCE

8 My evidence for this rezoning request remains the same as the geotechnical report and I will not repeat its contents here. Instead, I refer to this report which is attached as **Appendix 1** to this evidence.

#### CONCLUSION

9 From a geotechnical perspective, the Proposal is considered low risk (TC1-like for foundation design) due to the dense underlying sand and gravel deposits and the ability to design future structures to cope with the seismic and static settlement demands.

Dated: 5 March 2024

Chris Thompson



# 145 & 167 Gladstone Road Plan Change

### **Geotechnical Assessment Report**

Crichton Development Group Limited



Reference: 773-CHCGE332958

20 December 2023

### 145 & 167 GLADSTONE ROAD PLAN CHANGE

#### **Geotechnical Assessment Report**

### Report reference number: 773-CHCGE332958

20 December 2023

### PREPARED FOR

#### Crichton Development Group Limited C/o Inovo Projects Limited PO Box 7069 Christchurch 8240

### PREPARED BY

#### **Tetra Tech Coffey**

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### QUALITY INFORMATION

#### **Revision history**

Revision	Description	Date	Author	Reviewer	Approver
V1	Final	20/12/2023	BC	AG	AJ

#### Distribution

Report Status	No. of copies	Format	Distributed to	Date
Final	1	PDF	Michael Paterson – Inovo	20/12/2023

### CONTENTS

1.	INTRODUCTION AND SCOPE1		
2.	SITE DETAILS1		
3.	DES	(TOP STUDY	
	3.1	Existing geotechnical investigation data	
	3.2	Contaminated land considerations	
	3.3	Ground motion	
	3.4	Site subsoil classification	
4.	GRO	UND INVESTIGATION4	
5.	GRO	UND MODEL4	
	5.1	Geological setting4	
	5.2	Subsurface profile4	
		5.2.1 Western portion of the site	
		5.2.2 Eastern portion of the site	
	5.3	Groundwater regime6	
6.	GEO	TECHNICAL EVALUATION	
	6.1	Liquefaction triggering6	
	6.2	Long-term static settlement7	
	6.3	Lateral spreading7	
	6.4	Assessed technical category7	
7.	ASSE	ESSMENT OF NATURAL HAZARDS AS PER S106 RMA7	
8.	STAT	EMENT OF PROFESSIONAL OPINION8	
9.	CLOS	SURE8	

### LIST OF TABLES

Table 1: NZGD and ECan Well search data summary	.3
Table 2: Tetra Tech Coffey investigation summary	.4
Table 3: MBIE liquefaction hazard assessment results	.7
Table 4: Natural hazards assessment summary	.7

### LIST OF FIGURES

Figure 1: Proposed plan change area (red)	.2
Figure 2: Western portion of the site	.5

### APPENDICES

APPENDIX A: SITE INVESTIGATION PLAN	
APPENDIX B: INVESTIGATION DATA	
APPENDIX C: LIQUEFACTION HAZARDS ASSESSMENT	

# 1. INTRODUCTION AND SCOPE

Inovo Projects Limited, on behalf of Crichton Development Group Limited (client), has engaged Tetra Tech Coffey (NZ) Limited (Tetra Tech Coffey) to provide geotechnical services for the proposed plan change and future subdivision, with consideration of Section 106 of the Resource Management Act (RMA), of 145 & 167 Gladstone Road, Woodend. The client is seeking a land use change from Rural Lifestyle Zone (existing) to Large Lot Residential Zone (LLRZ).

Our scope of work is as follows:

- 1. Geotechnical desktop study.
- Shallow ground investigation to consist of four hand auger boreholes (HA) with accompanying dynamic cone penetration (DCP) tests to 2.0 metres below ground level (mbgl) or refusal. This also includes the installation of piezometers at selected locations for groundwater monitoring.
- 3. Deep ground investigation comprising eight cone penetrometer tests (CPT) to 20.0mbgl or refusal.
- 4. Geotechnical hazard and liquefaction assessment for equivalent technical category designation.
- 5. Geotechnical assessment report suitable to support the plan change application.

# 2. SITE DETAILS

The property located at 145 & 167 Gladstone Road, known as Lot 1-2 DP 29099, spans approximately 20.7 hectares (Ha) and is situated at the southeastern boundary of the Woodend township (Figure 1). It is bordered by Gladstone Road to the north and rural greenfield land to the east and south. The topography of the site is predominantly flat, although there is a terrace in the western section that sits approximately 2.5 - 3.0 meters (m) higher than the eastern portion. Presently, there is a single dwelling with a detached garage and sheds on 145 Gladstone Road, along with a barn shed utilized for stockfeed storage on 167 Gladstone Road. The current purpose of the site is for grazing.



Figure 1: Proposed plan change area (red)

# 3. DESKTOP STUDY

To gain a comprehensive understanding of the site, Tetra Tech Coffey conducted a desktop study. This study involved reviewing various sources of information, including the New Zealand Geotechnical Database (NZGD), the Waimakariri District Council website, the Environment Canterbury well search (ECan), and other publicly accessible sources that are relevant to the subject site. The information gathered from these sources is as follows:

### 3.1 EXISTING GEOTECHNICAL INVESTIGATION DATA

The existing investigation data is summarized in Table 1. Specific test locations can be found in Appendix A, and for a summary of the tests, Appendix B.

Source	Reference	Termination depth (mbgl)	Reason for termination
NZGD	TP_98789	2.2	Refusal (machine limit)
NZGD	BH_98795	23.9	Target Depth
NZGD	CPT_31513	19.9	Target Depth
ECan	M35/6934	20.5	Target Depth
ECan	M35/18660	23.9	Target Depth
ECan	M35/8677	15.0	Target Depth
ECan	M35/10418	23.5	Target Depth
ECan	M35/18673	2.2	Target Depth
ECan	M35/8679	15.0	Target Depth

Table 1: NZGD and ECan Well search data summary

### 3.2 CONTAMINATED LAND CONSIDERATIONS

Tetra Tech Coffey has reviewed the ECan Listed Land Use register (LLUR)<sup>1</sup>. It is important to note that the information reviewed does not constitute a full Preliminary Site Investigation (PSI) in accordance with the Resource Management (National Environmental Standard for Assessing and Managing Contaminants in Soil to Protect Human Health) Regulations 2011 (NES). However, the information is considered sufficient to meet the requirements of method 6 (2) of the NES for the identification of a Hazardous Activities and Industries List (HAIL) site.

The LLUR search did not indicate the presence of HAIL on site.

### 3.3 GROUND MOTION

The site is not in an area mapped for ground damage effects as part of the Canterbury Earthquake Sequence response. A report commissioned by ECan<sup>2</sup> mapped the site as being in an area where '*Liquefaction damage is possible*'.

### 3.4 SITE SUBSOIL CLASSIFICATION

In accordance with NZS1170.5, Section 3.1.3, a subsoil classification of "Class D – Deep or soft soil sites" can be assumed for the site.

<sup>1</sup> https://llur.ecan.govt.nz/home, retrieved September 2023.

<sup>&</sup>lt;sup>2</sup> ECan (2012), Review of liquefaction hazard information in Eastern Canterbury, including Christchurch City, and parts of Selwyn, Waimakariri and Hurunui Districts, ref. R12/83.

# 4. GROUND INVESTIGATION

Tetra Tech Coffey completed a geotechnical site investigation on 19 September 2023. This consists of four HA boreholes with DCP testing to a maximum target depth of 2.0mbgl and eight CPTs to a maximum target depth of ~20.2mbgl. Additionally, 6.0m standpipe piezometers were installed within CPT\_02 and CPT\_06.

A summary of our on-site investigation is shown in Table 2 below. The test locations are presented on our site plan in Appendix A and the test results in Appendix B.

Reference	Termination depth (mbgl)	Reason for termination
CPT_01	8.2	Refusal in inferred gravel (Qc~40MPa)
CPT_02	11.5	Refusal in inferred gravel (Qc~57MPa)
CPT_03	1.9	Refusal in inferred gravel (Qc~53MPa)
CPT_04	8.6	Refusal in inferred gravel (Qc~40MPa)
CPT_05	9.7	Refusal in inferred gravel (Qc~30MPa)
CPT_06	11.2	Refusal in inferred gravel (Qc~60MPa)
CPT_07	11.9	Refusal in inferred gravel (Qc~65MPa)
CPT_08	20.2	Target Depth (Qc~46MPa)
HA01	1.4	Refusal on gravel
HA02	2.0	Target Depth
HA03	1.1	Refusal on gravel
HA04	2.0	Target Depth

Table 2: Tetra Tech Coffey investigation summary

# 5. GROUND MODEL

### 5.1 GEOLOGICAL SETTING

The geological map<sup>3</sup> of the area indicates that the site is underlain by "*Grey river alluvium beneath plains and low level terraces (Q1a)*".

### 5.2 SUBSURFACE PROFILE

The site has been divided into two distinct subsurface profiles, separated by an east-facing terrace that gradually increases in height to a maximum of approximately 3.0m. Figure 2 illustrates the subsurface conditions for the western portion of the site, while Figure 3 depicts the eastern portion. To present an indicative ground profile, we have calculated an average on-site and nearby CPT trace using the geometric

<sup>&</sup>lt;sup>3</sup> Forsyth, P.J.; Barrell, D.J.A.; Jongens, R. (compilers) 2008: Geology of the Christchurch area: scale 1:250,000. Lower Hutt: GNS Science. Institute of Geological & Nuclear Sciences 1:250,000 geological map 16. 67 p. + 1 folded map.

mean, which is represented by the red trace. Based on our interpretation, the following is a summary of the subsurface soil profiles.

### 5.2.1 Western portion of the site

- Figure 2 utilises CPT\_01, 06, 07 and 08.
- There is generally a surficial topsoil layer ranging between 0.4 0.6m thick.
- From loose sandy material to ~ 2.0mbgl to medium dense silty sand to very stiff sandy silt to depths of up to ~6.0mbgl.
- Dense to very dense sand/gravelly sand between ~6.0 to at least 20.0mbgl
- The presence of a very stiff silt to clayey silt layer between ~16.0 -19.0mbgl.



#### Figure 2: Western portion of the site

### 5.2.2 Eastern portion of the site

- Figure 3 utilises CPT\_02, 03, 04, 08 and 31513.
- There is generally a surficial topsoil layer ranging between 0.3 0.5m thick.
- Dense to very dense gravelly silty sand to depths of up to ~4.5mbgl.
- Very stiff silt to clayey silt between ~4.5 6.0mbgl.
- Very dense sand/gravelly sand to at least 20.0mbgl with a sandy silt lens between ~16.5 18.0mbgl (also present in the western portion of the site).



Figure 3: Eastern portion of the site

### 5.3 GROUNDWATER REGIME

Based on our geotechnical investigation and nearby well logs and boreholes, the groundwater regime assessed at the site is as follows:

- Standing groundwater was not encountered in our Tetra Tech Coffey HAs.
- Site-specific CPTs indicate a groundwater level between 2.0mbgl and 5.5mbgl. Deepest groundwater was observed in the southwest of the site and shallowing towards the northwest.
- Standing groundwater was measured within the piezometers at the end of the day in CPT\_02 and CPT\_06 to be 2.5mbgl and 3.6mbgl respectively.
- ECan Well M35/18660 measured groundwater to be at ~5.1mbgl in the month of February 2012.

For analysis purposes, a groundwater level of 2.5mbgl below existing ground surface has been assumed.

# 6. GEOTECHNICAL EVALUATION

### 6.1 LIQUEFACTION TRIGGERING

Tetra Tech Coffey has carried out a liquefaction hazard assessment in accordance with MBIE<sup>Error! Bookmark not defined.</sup> and NZGS Guidelines<sup>4</sup> to assess the liquefaction hazard at the site. Design earthquakes in our assessment were serviceability limit state (SLS); Mw=6.0, PGA=0.19g, SLS: Mw=7.5, PGA=0.13g and ultimate limit state (ULS): Mw=7.5, PGA=0.35g.

Based on our analysis and given that medium dense gravelly sand and very stiff silt to clayey silt, liquefaction susceptibility is considered to be low in future earthquake events. Actual total settlements under SLS or ULS earthquake loading may be greater due to foundation loading. Liquefaction analysis results are presented in Appendix C and summarised in Table 3.

<sup>&</sup>lt;sup>4</sup> New Zealand Geotechnical Society (NZGS) 2021: Earthquake geotechnical engineering practice Module 3; Identification, assessment and mitigation of liquefaction hazards.

Seismic case	Average free-field settlement (mm), range in brackets	Represent	tative liquefaction severity number (LSN), range in brackets
SLS (M <sub>w</sub> 6.0/0.19g)	~14 (0 to 29)	3 (0 to 6)	Little to no liquefaction expression
SLS (M <sub>w</sub> 7.5/0.13g)	~6 (0 to 12)	1 (0 to 2)	Little to no liquefaction expression
ULS (M <sub>w</sub> 7.5/0.35g)	~32 (0 to 64)	8 (0 to 16)	Little to no liquefaction expression

#### Table 3: MBIE liquefaction hazard assessment results

### 6.2 LONG-TERM STATIC SETTLEMENT

Static load-induced settlement typically occurs in areas underlain by soft, compressible soils as a result of increase overburden loads. As the site is generally underlain by medium dense to dense sand to sandy gravel, Tetra Tech Coffey considers the potential for static settlement for the site to be low for standard residential construction loads.

### 6.3 LATERAL SPREADING

Given the generally flat topography and lack of continuous liquefiable layers across the site, the risk of lateral spreading within the terrace area is considered to be low.

### 6.4 ASSESSED TECHNICAL CATEGORY

Based on our Tetra Tech Coffey site observations, investigation and analyses, a foundation technical category, as per MBIE, of *"TC1-like"* for foundation design is appropriate for the proposed development site.

# 7. ASSESSMENT OF NATURAL HAZARDS AS PER S106 RMA

As per the requirements of Section 106 of the Resource Management Act (RMA) (2017), an assessment of the natural geotechnical hazards that may affect the site has been undertaken. These are summarised in Table 4 below.

Based on our assessment, we consider the site is suitable for a plan change from Rural Lifestyle Zone (existing) to Large Lot Residential Zone (LLRZ).

#### Table 4: Natural hazards assessment summary

Natural Hazard	Assessment
Erosion	No erosion was observed within the exposed east-facing terrace and through the site. The susceptibility to erosion is considered to be low.
Falling debris	Given the sites flat topography and lack of potential sources for falling debris, this is considered to be negligible.
Slippage	The risk of slope failure along the terrace is considered to be low.
Subsidence	Refer to Section 6.
Inundation	Low.

# 8. STATEMENT OF PROFESSIONAL OPINION

Our assessment has considered the items required by Section 106 of the RMA and in our opinion the site is considered geotechnically suitable for Plan Change and future residential construction. We consider the site is suitable for development subject to further investigation and design at the subdivision consent stage. Additional geotechnical investigation is required to refine the ground model and address any geotechnical risks based on the mapped geology and on-site testing carried out to date, the site is considered TC1-like.

# 9. CLOSURE

This report has been prepared solely for the use of Crichton Development Group Ltd, their professional advisors and the Waimakariri District Council (WDC) in relation to the specific project described herein. No liability is accepted in respect of its use for any other purpose or by any other person or entity. It is recommended that all other parties seek professional geotechnical advice to satisfy themselves as to its on-going suitability for their intended use.

The subsurface information has been obtained solely from discrete test locations, which by their nature only provide information about a relatively small volume of subsoils, as such, there may be special conditions pertaining to this site which have not been disclosed by the investigation and which have not been taken into account in the report. If variations in the subsoils occur from those described or are assumed to exist, then the matter should be referred back to us immediately.

If you have any queries or you require any further clarification on any aspects of this report, please contact the undersigned.

For and on behalf of Tetra Tech Coffey

Prepared by

Benjamin Chau BSc PMEG Engineering Geologist

Reviewed and authorised by



Andreas Giannakogiorgos BSc MSc DIC CMEngNZ CPEng IntPE (NZ) Senior Principal Geotechnical Engineer



# IMPORTANT INFORMATION ABOUT YOUR TETRA TECH COFFEY REPORT

As a client of Tetra Tech Coffey you should know that site subsurface conditions cause more construction problems than any other factor. These notes have been prepared by Tetra Tech Coffey to help you interpret and understand the limitations of your report.

### Your report is based on project specific criteria

Your report has been developed on the basis of your unique project specific requirements as understood by Tetra Tech Coffey and applies only to the site investigated. Project criteria typically include the general nature of the project; its size and configuration; the location of any structures on the site; other site improvements; the presence of underground utilities; and the additional risk imposed by scope-of-service limitations imposed by the client. Your report should not be used if there are any changes to the project without first asking Tetra Tech Coffey to assess how factors that changed subsequent to the date of the report affect the report's recommendations. Tetra Tech Coffey cannot accept responsibility for problems that may occur due to changed factors if they are not consulted.

#### Subsurface conditions can change

Subsurface conditions are created by natural processes and the activity of man. For example, water levels can vary with time, fill may be placed on a site and pollutants may migrate with time. Because a report is based on conditions which existed at the time of subsurface exploration, decisions should not be based on a report whose adequacy may have been affected by time. Consult Tetra Tech Coffey to be advised how time may have impacted on the project.

### Interpretation of factual data

Site assessment identifies actual subsurface conditions only at those points where samples are taken and when they are taken. Data derived from literature and external data source review, sampling and subsequent laboratory testing are interpreted by geologists, engineers or scientists to provide an opinion about overall site conditions, their likely impact on the proposed development and recommended actions. Actual conditions may differ from those inferred to exist, because no professional, no matter how qualified, can reveal what is hidden by earth, rock and time. The actual interface between materials may be far more gradual or abrupt than assumed based on the facts obtained. Nothing can be done to change the actual site conditions which exist, but steps can be taken to reduce the impact of unexpected conditions. For this reason, owners should retain the services of Tetra Tech Coffey through the development stage, to identify variances, conduct additional tests if required, and recommend solutions to problems encountered on site.

### Your report will only give preliminary recommendations

Your report is based on the assumption that the site conditions as revealed through selective point sampling are indicative of actual conditions throughout an area. This assumption cannot be substantiated until project implementation has commenced and therefore your report recommendations can only be regarded as preliminary. Only Tetra Tech Coffey, who prepared the report, is fully familiar with the background information needed to assess whether or not the report's recommendations are valid and whether or not changes should be considered as the project develops. If another party undertakes the implementation of the recommendations of this report there is a risk that the report will be misinterpreted and Tetra Tech Coffey cannot be held responsible for such misinterpretation.

### Your report is prepared for specific purposes and persons

To avoid misuse of the information contained in your report it is recommended that you confer with Tetra Tech Coffey before passing your report on to another party who may not be familiar with the background and the purpose of the report. Your report should not be applied to any project other than that originally specified at the time the report was issued.

### Interpretation by other design professionals

Costly problems can occur when other design professionals develop their plans based on misinterpretations of a report. To help avoid misinterpretations, retain Tetra Tech Coffey to work with other project design professionals who are affected by the report. Have Tetra Tech Coffey explain the report implications to design professionals affected by them and then review plans and specifications produced to see how they incorporate the report findings.

### Data should not be separated from the report

The report as a whole presents the findings of the site assessment and the report should not be copied in part or altered in any way. Logs, figures, drawings, etc. are customarily included in our reports and are developed by scientists, engineers or geologists based on their interpretation of field logs (assembled by field personnel) and laboratory evaluation of field samples. These logs etc. should not under any circumstances be redrawn for inclusion in other documents or separated from the report in any way.

### Geoenvironmental concerns are not at issue

Your report is not likely to relate any findings, conclusions, or recommendations about the potential for hazardous materials existing at the site unless specifically required to do so by the client. Specialist equipment, techniques, and personnel are used to perform a geoenvironmental assessment. Contamination can create major health, safety and environmental risks. If you have no information about the potential for your site to be contaminated or create an environmental hazard, you are advised to contact Tetra Tech Coffey for information relating to geoenvironmental issues.

### Rely on Tetra Tech Coffey for additional assistance

Tetra Tech Coffey is familiar with a variety of techniques and approaches that can be used to help reduce risks for all parties to a project, from design to construction. It is common that not all approaches will be necessarily dealt with in your site assessment report due to concepts proposed at that time. As the project progresses through design towards construction, speak with Tetra Tech Coffey to develop alternative approaches to problems that may be of genuine benefit both in time and cost.

### Responsibility

Reporting relies on interpretation of factual information based on judgement and opinion and has a level of uncertainty attached to it, which is far less exact than the design disciplines. This has often resulted in claims being lodged against consultants, which are unfounded. To help prevent this problem, a number of clauses have been developed for use in contracts, reports and other documents. Responsibility clauses do not transfer appropriate liabilities from Tetra Tech Coffey to other parties but are included to identify where Tetra Tech Coffey's responsibilities begin and end. Their use is intended to help all parties involved to recognise their individual responsibilities. Read all documents from Tetra Tech Coffey closely and do not hesitate to ask any questions you may have.

# APPENDIX A: SITE INVESTIGATION PLAN



	no.	description	drawn	approved	date	drawn BC	$\Lambda$	
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145 & 167 Gladstone Road, Woodend Plan Change

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Geotechnical Inves	tigation Locations F	Plan
10: 773-CHCGE332958	drawing no: 01	<sup>rev:</sup> A

# APPENDIX B: INVESTIGATION DATA



Location: Woodend

#### CPT: CPT\_01

Total depth: 8.22 m





Location: Woodend

### CPT: CPT\_02

Total depth: 11.45 m





Location: Woodend

#### CPT: CPT\_03

Total depth: 1.91 m





Location: Woodend

#### CPT: CPT\_04

Total depth: 8.58 m





Location: Woodend

#### Cone resistance qt **Sleeve friction** SBTn Index Soil Behaviour Type Pore pressure u 0 0 0 0 0 DRILL OUT DRILL OUT Organic soil Clay & silty clay DRILL OUT DRILL OUT DRILL OUT 0.5 0.5 0.5 0.5 0.5 1 1 1 1 1 Sand & silty sand 1.5 1.5 1.5 1.5 1.5 Sand & silty sand 2 2 2 2 2 · Silty sand & sandy silt 2.5 2.5 2.5 2.5 Sand & silty sand Silty sand & sandy silt Silty sand & sandy silt 2.5 3 3 3 3 3 . 3.5 3.5 3.5 3.5 3.5 Sand & silty sand 4 4 · 4 4 4 Sand & silty sand 4.5 4.5 4.5 4.5 4.5 Sand Silty sand & sandy silt Sand & silty sand 5 5 5 · 5 5 Silty sand & sandy silt 5.5 5.5 5.5 5.5 5.5 Sand & silty sand 6 6 6 6 6 Silty sand & sandy silt Sand & silty sand 6.5 6.5 6.5 6.5 6.5 Sand & silty sand Depth (m) Depth (m) Depth (m) Depth (m) Depth (m) 7 7 7 · 7 7 Sand 7.5 7.5 7.5 7.5 7.5 -8 8 8 8 8 Sand & silty sand 8.5 8.5 8.5 8.5 8.5 9 9 9 9 9 9.5 9.5 9.5 9.5 9.5 Sand 10 10 10 10 10 10.5 10.5 10.5 10.5 10.5 11 11 11 11-11 11.5 11.5 11.5 11.5 11.5 12 12. 12 12-12 . 12.5 12.5 12.5 12.5 12.5 13 13 13 13. 13 13.5 13.5 13.5 13.5 13.5 14 14 14 14 14 14.5 14.5 14.5 14.5 14.5 15 15 15 15 15-50 100 150 200 250 10 20 30 40 50 0 2 4 6 8 1012141618 0 0 0 1 2 3 4 Tip resistance (MPa) Friction (kPa) Pressure (kPa) SBT (Robertson, 2010) Ic

#### CPT: CPT\_05

Total depth: 9.68 m



Location: Woodend

#### CPT: CPT\_06

Total depth: 11.18 m





Location: Woodend

#### CPT: CPT\_07

Total depth: 11.92 m





Location: Woodend





\_\_\_\_\_

CPT: CPT\_08

Total depth: 20.15 m



Crichton Development Group Limited client:

principal: -

#### project: 145 - 167 Gladstone Road

# logged by:

Borehole ID.

project no.

date started:

date completed:

sheet:

HA01

773-CHCGE332958

19 Sep 2023

19 Sep 2023

1 of 1

BC

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ſ	posit	ion:	Not S	Spec	ified					surface elevation: Not Specified	a	angle fro	om horizoi	ntal: 90°		DCP id.: -
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	drill	ing i	nfor	natio	on			mate	rial sub	stance						
	method & support	- nenetration		water	samples & field tests	RL (m)	depth (m)	graphic log	soil group symbol	material description SOIL NAME: plasticity or particle characteristics, colour, secondary and minor components	moisture condition	consistency / relative density	vane shear ⊕remoulded ⊚peak (kPa)	DCP (blows/ 100 mm	soil d addi	origin, structure and itional observations
CDF_0_10_0.4_LBRARY GLB rev:CDF_0_10_00.4 2021-09-30 Log COF BOREHOLE: NON CORED + DCP_773-CHCGE332865 167 GLADSTONE: GPJ < <drawingfile>&gt; 20/122023 11:08</drawingfile>	HA H			Not Encountered	VS 129/ 55 kPa				ML SM	SILT: non plastic to low plasticity, brown, with minor to some fine grained sand. SILT: non plastic to low plasticity, pale brown-grey, with minor fine grained sand. Silty SAND: fine grained, pale grey to orange-brown with orange staining. 1.3 m: with trace of fine grained gravel Hand Auger HA01 terminated at 1.35 m Refusal on gravel	D-M	VSt			ALLUVI	L
	metil DT AD AS HA W RR * e.g. B T	hod diat aug aug har was rock bit AD, blan TC	tube ger dri ger sc nd aug shbord k rolle showr /T nk bit bit	lling* rewin jer e r	g* suffix	supp M r C c pend wate	port nud asing etration	N no res rangin refusa Oct-12 wa el on date er inflow er outflow	nil istance g to ater : shown	samples & field tests       B     bulk disturbed sample       D     disturbed sample       E     environmental sample       SS     split spoon sample       U##     undisturbed sample ##mm diameter       HP     hand penetrometer (kPa)       N     standard penetration test (SPT)       N*     SPT - sample recovered       Nc     SPT with solid cone       VS     vane shear; peak/remouded (kPa)       R     refusal       HB     hammer bouncing	moistur D dr M moi W we S sa Wp pla WI liq	I group s terial des ad on AS re condit y pist turated astic limit uid limit	symbol & scription 1726:2017 tion		consistency VS S F St VSt H F b VL L MD D D VD	y / relative density very soft soft firm stiff very stiff hard friable very loose loose medium dense dense very dense



Crichton Development Group Limited client:

#### principal: -

#### project: 145 - 167 Gladstone Road

### location: Woodend Canterbury

Borehole ID.	HA02
sheet:	1 of 1
project no.	773-CHCGE332958
date started:	19 Sep 2023
date completed:	19 Sep 2023
logged by:	BC
checked by:	ΔΙ

	aut	лі. -		,ouenu,	Jui		ur y					neekee by.	7.V
pos	osition: Not Specified rill model: Hand Auger								surface elevation: Not Specified	a	ingle fro	om horizontal: 90°	DCP id.: -
dril	l mo	del: Ha	and A	Auger					drilling fluid: -	h	ole dia	meter : 50 mm	vane id.: 1508
dr	rillin	g info	mati	ion			mate	rial sub	stance				
method &	support	penetration	water	samples & field tests	RL (m)	depth (m)	graphic log	soil group symbol	material description SOIL NAME: plasticity or particle characteristics, colour, secondary and minor components	moisture condition	consistency / relative density	vane DCP shear @remoulded @peak 100 mn	<ul> <li>soil origin, structure and additional observations</li> </ul>
B0:11 CZ0Z/		3 5 <del>-</del>				-	$\left  \begin{array}{c} \\ \\ \\ \\ \\ \end{array} \right $	SM	SILTY SAND: fine grained, pale brown.	D - M			TOPSOIL
			ered			- 0.5		SP	SAND: fine grained, pale yellow-brown with orange staining, and some silt.		L		ALLUVIUM
	z		Not Encount			- 1.0 — - -							         
						- 1.5 - -							         
						20							
						2.5			Hand Auger HA02 terminated at 2.0 m Target depth				
M D AL AS H W R F e.( B T V	etho T S A R	diatube auger d auger s hand au washbo rock roll bit show AD/T blank bi TC bit V bit	rilling crewi iger re er /n by t	* ng* suffix	supj M r C c pene wate	port nud casing etration er er leve wate	N ⊢ no res rangin ⊲ refusa Dct-12 wa el on date er inflow er outflow	nil istance g to ater shown	samples & field tests       B     bulk disturbed sample       D     disturbed sample       E     environmental sample       SS     split spoon sample       U##     undisturbed sample ##mm diameter       HP     hand penetrometer (kPa)       N     standard penetration test (SPT)       N*     SPT - sample recovered       Nc     SPT with solid cone       VS     vane shear; peak/remouded (kPa)       R     refusal       HB     hammer bouncing	soi ma base moistuu D dry M ma W we S sa Wp pla WI liqu	terial de d on AS re condi / pist t turated stic limit uid limit	symbol & scription 1726:2017 tion	consistency / relative density         VS       very soft         S       soft         F       firm         St       stiff         VSt       very stiff         H       hard         Fb       friable         VL       very loose         L       loose         MD       medium dense         D       dense         VD       very dense



client: Crichton Development Group Limited

principal: -

#### project: 145 - 167 Gladstone Road

# logged by:

Borehole ID.

project no.

date started:

date completed:

sheet:

HA03

773-CHCGE332958

19 Sep 2023

19 Sep 2023

1 of 1

BC

	locati	on:	Wo	odend,	Car	nterb	ury				С	hecked l	by:	AJ
	positio	n: Not	Spec	cified					surface elevation: Not Specified	а	ingle fro	om horizor	ntal: 90°	DCP id.: -
	drill mo	rill model: Hand Auger drilling information							drilling fluid: -	h	ole dia	meter : 50	mm	vane id.: 1508
	drillin	rilling information					mate	rial sub	stance		>	1		
	method & support	1 2 penetration 3	water	samples & field tests	RL (m)	depth (m)	graphic log	soil group symbol	material description SOIL NAME: plasticity or particle characteristics, colour, secondary and minor components	moisture condition	consistency / relative densit	vane shear ⊕ remoulded ⊚ peak (kPa) 05 00 000	DCP (blows/ 100 mm)	soil origin, structure and additional observations
11:09						-	$\left \right\rangle$	ML	<b>SILT</b> : non plastic to low plasticity, pale brown, with minor fine grained sand.	D - M				TOPSOIL
<drawingfile>&gt; 20/12/2023</drawingfile>	HA		Not Encountered			- 0.5— -		SM	Silty SAND: fine grained, pale brown-grey with orange staining.		L			- ALLUVIUM - - - -
FONE.GPJ <						- 1.0				М	MD			-
CDF_0_10_004_LIBRARY.GLB rev:CDF_0_10_00.4 2021-09-30 Log_COF BOREHOLE: NON CORED + DCP_773-CHCGE332958 167 GLADSTC									1.0 m: with trace of fine grained gravel Hand Auger HA03 terminated at 1.1 m Refusal on gravel					
	metho DT AD AS HA W RR * e.g. B T V	d diatube auger c auger s hand au washbc rock rol bit shov AD/T blank b TC bit V bit	rilling crewir iger re ler vn by : t	, ng* suffix	sup M r C c pen	etration	N no res rangin ⊲ refusa Oct-12 wa el on date er inflow er outflow	nil istance ig to ater e shown	samples & field tests       B     bulk disturbed sample       D     disturbed sample       E     environmental sample       SS     split spoon sample       U##     undisturbed sample ##mm diameter       HP     hand penetrometer (kPa)       N     standard penetration test (SPT)       N*     SPT - sample recovered       Nc     SPT with solid cone       VS     vane shear; peak/remouded (kPa)       R     refusal       HB     hammer bouncing	soil ma base moistur D dry M mo W we S sa Wp pla WI liqu	d on AS terial de d on AS re condi / pist turated ustic limit uid limit	symbol & scription 1726:2017 tion	G S S S V H F V L L M U V	Konsistency / relative density       /S     very soft       /S     soft       Image: S     firm       St     stiff       /St     very stiff       Image: A     hard       Image: B     friable       /L     very loose       .     loose       /D     medium dense       /D     very dense



Crichton Development Group Limited client:

principal: -

#### project: 145 - 167 Gladstone Road

#### Woodend, Canterbury location:

Borehole ID.	HA04
sheet:	1 of 1
project no.	773-CHCGE332958
date started:	19 Sep 2023
date completed:	19 Sep 2023
logged by:	BC
checked by:	AJ

р	ositic	n: Not	Spe	cified					surface elevation: Not Specified	a	ingle fro	om horizontal: 9	)°	DCP id.: -
d	rill m	odel: Ha	and A	Auger					drilling fluid: -	ł	ole dia	meter : 50 mm		vane id.: 1508
E	drilliı	ng infoi	mati	on			mate	rial sub	stance			1	1	
method &	support	2 penetration	water	samples & field tests	RL (m)	depth (m)	graphic log	soil group symbol	material description SOIL NAME: plasticity or particle characteristics, colour, secondary and minor components	moisture condition	consistency / relative density	vane DC shear ⊕remoulded ⊚peak 100 n (kPa) 00 00 00 00 00 00 00 00 00 00 00 00 00	soi m) ad	l origin, structure and ditional observations
-ile>> 20/12/2023 11:09	•					- - 0.5—		SM	Silty SAND: fine grained, pale brown, with trace of fine grained gravel.	D - M			「  TOPSC                     	DIL
GE332958 167 GLADSTONE.GPJ < <drawingf HA</drawingf 	Z		Not Encountered			- - 1.0- - - - - - -		SP	SAND: fine grained, pale yellow-brown with orange mottling, and minor to some silt.		L			IUM -
									Hand Auger HA04 terminated at 2.0 m Target depth					-
00.4 2021-09-30 Log COF BOR						- 2.5 — - -								-
ייושרישה ושאלא אישר ושאיטרי						3.0								- - - - -
; ; ; ; ; ; ; ; ; ; ; ; ; ; ; ; ; ; ;	metho DT AD AS HA N RR €.g. 3 T	bit show AD/T blank bi TC bit V bit	rilling crewi iger re er n by t	* ng* suffix	sup M r C c pene wate	ort nud asing etration C ∞ Pr V 10.0 leve wate	no ree rangin refuss Oct-12 w el on date er inflow er outflov	nil istance ig to ater shown	samples & field tests         B       bulk disturbed sample         D       disturbed sample         E       environmental sample         SS       split spoon sample         U##       undisturbed sample ###mm diameter         HP       hand penetrometer (kPa)         N       standard penetration test (SPT)         N*       SPT - sample recovered         Nc       SPT with solid cone         VS       vane shear; peak/remouded (kPa)         R       refusal         HB       hammer bouncing	soi ma base moistu D dr M mc W we S sa Wp pla Wp pla WI liq	I group s terial de d on AS re condir / oist st turated astic limit uid limit	symbol & scription 1726:2017	consisten VS S F St VSt H Fb VL L MD D VD	cy / relative density very soft soft firm stiff very stiff hard friable very loose loose medium dense dense very dense

	æ	) N	W	4		BOREHOLE LOG					Job N Hole	lo: Z1 No: B	873603 H204		
											Shee	t: 1 of	3		-
M	VH NE	EW ZEAL	AND LT	D.	Client: I	NZTA					Starte	ed: 31	/01/12		
Ha 6 H	zeldea łazeld	an Busine ean Roac	ss Park		Project:	NZTA Woodend Bypass					Finish	ned: 0	2/02/12		
Ch	ristchu	urch 8024	1		Hole Lo	cation Refer to: Factual Report					Logge	ed: JJ			
Fa	x: 03 3	366 7780			Descrip	tion:					Chec	ked: S	SBG		
					Easting	: 2484041m Northing: 5764868m	Inc	linatio	n: Ve	ertical	RL S	urface	2:		
					Diamete	er (Int/Ext): /					Datur	n:			
		Samples	Shear Vane	Stan Penet	dard ration	Material Description	E	ery %	ery %				tions		
	E)		(kPa) ਜ਼	Te r î	sts 	(Logging carried out in accordance with Guidelines	Run	Secove	Secov	- Bo		ater	serva		ç
h (m	ation		rrength/	llows ating // n/300m	ue/ ial Da	for the Field Classification of Soil and Rock for Engineering Purposes. New Zealand Geotechnical	lth of	Core F	Core F	hic L	ture	wpur	r Ob		llatio
Dept	Elev	Type	Peak St Residua	E (Se 75mm 225mr	N Val Refus	300iety, 2003)	Leng	Total (	Solid	Grap	Mois Conc	Grou	Othe		Insta
	-					Silty TOPSOIL, dark greyish brown soft	2)			<u></u>	dry				
	-					Clayey SILT, brown very soft		80		× <u>··</u> ×	<u></u>				
	-					(0. MISSING (i.e. not recovered)	<u>//</u> (			<u>^_×</u>	-0				
1.0	-						_	<u> </u>			ist				
	-			1//1/0/1/1	3	Fine to medium SAND, yellowish brown (1	3) [			× · · ·	stio				
	-					Silty CLAY, brownish grey mottled orange firm, low plasticity				× × ×	mo				
2.0	-					(1.) Silty fine to medium SAND, brown	<u>8)</u> 1.52	85		·× · . · . · . · .× .	et				
						(2.	4)			× · . · . · · ×	ĭt ≪				
				0//0/0/0/0	0	Silty CLAY, brownish grey mottled orange firm, low plasticity					nois	V			
3.0	-			0//0/0/0/0		(2. Silty CLAY, with some fine sand, grev very soft	7)			× ×	_	9/2 \D1			
							1.50	100		×	wet	4			
	-	Tub sample				(3.	7)								
10	-					Silty fine to coarse SAND, dark grey (3.8)	5)			× · . · . × ×	¥				
74.0	-			0//0/0/0/0	0	Silty CLAY, brownish grey very soft				××	et	$\Box$			E
al.con	-	Pushtube sample				(4	7) 0.56	100		×  ×	3	172 \TD -			
vhglob						Organic SILT, with some clay, dark brown very soft,			1						E
같  5.0 	-	Bulk sample				low plasticity, Fibrous organics	0.96	100			nois				
ch w	-					(5.	5)				-				
stchur	-			5//4/6/6/6	22	coarse gravel, grey			1			AT			B
	-										ted	Additional water levels at time of drilling were			
oodeno	-						1.52	100			tura	4.8/m (31/01/2012) and 5.1m (02/02/2012)		ŀ	·
ss, Wo											sat				
Bypa Bypa	-					(7.1)	B)								
odend				8//4/4/4/4	16	Fine to coarse GRAVEL, with minor coarse sand,			1	0.00					
A Woo	-					-				· 0 · 0					
NZI 8.0	-						1.52	100		0.0.0				-	
73603	]									00.0	1			ŀ	
ot: Z16		Bulk sample								· O & C . O. O					
Projec	-			19//10/11/12	/14 47	(	9)			000.0					
	-					Silty fine to coarse GRAVEL, with minor fine to coarse sand, brownish grey				0x0°0 x0 / x0	Ited			-	
LAND	-						1.52	100		×0 ~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~	tura				
V ZEA						(9.	9)				sa				
Drillin	g Metho y-perco	od: u <b>ssion</b>	Cas	ing:		Remarks:	-			-					
≧ Contr	actor:		Flus	sh:											
Equip	ment T	ype:				Borehole Completion:									
≍ Geop	1000 81	140LS SON	IC .												

				W	4		BOREHOLE LOG					Job N Hole I	lo: Z1 No: B	873603 8H204	
						Client: I	ΝΖΤΑ					Starte	l:∠01 ≥d:31	. 3	
	MWI Haze	H NE	W ZEAL	AND LT ss Park	D .	Project:	: NZTA Woodend Bypass					Finish	ned: 0	)2/02/12	
	6 Ha Chris	zelde stchu	ean Road Irch 8024	1 1		Location	n: Woodend, Christchurch					Logge	ed: JJ	J	
	Tel: ( Fax:	03 36 03 3	66 7449 66 7780			Hole Lo Descrip	ocation Refer to: Factual Report otion:					Chec	ked: \$	SBG	
					-	Easting	j: 2484041m Northing: 5764868m	Ir	clinat	on: Ve	ertical	RL SI	urface	e:	
						Diamete	er (Int/Ext): /					Datur	n:		
			Samples	Shear Vane	Stan Penet	dard ration	Material Description	1	(III) %	sry %				tions	
	~	(L)		(kPa) 둘	Te	sts	(Logging carried out in accordance with Guidelines			Recove	bo		ater	servat	c
	m) (n	ation	0	trength/ al Strenç	slows ating // n/150mn	lue/ sal Da	for the Field Classification of Soil and Rock for Engineering Purposes. New Zealand Geotechnical Society 2005)	30 44	Core F	Core F	hic L	ture	mpur	q0 L	Illatio
	Dept	Elev	Type	Peak St Residua	E (Se 75mm 225mr	N Val Refus	300lety, 2003)		Total	Solid	Grap	Mois Cone	Grot	Othe	Insta
Ī	-						Silty fine to medium SAND, with minor fine gravel, light brownish grey Bands of sandy fine gravel at 10	).7			× · . · . · . · .× .				
	-				13////8/9/8	3 32	- 10.8m and 11.5 - 11.6m[continued]				·× · . · . · . · .× .				
	-						1		_		·× · . · . · . · .× .				
	11.0-							1.	52 10		·× · . · . · . · × .				
	-						(11	1.6)			·× · . · .				
	-				10//7/7/9/1	1 34	Silty fine to coarse SAND, with trace of fine gravel, grey Predominantly fine sand	_		-	× · · ·				
	12.0-		Bulk								·× · . · . · . · .× .				••••
	-		Jumpie					1.	52 10		·× · . · . · . · .× .				
	-										× · . · .				
	13.0										·× · . · .				
	_				50//		Band of sandy fine gravel with some silt 13.4 -			1	$\mathbf{x}$	5			
	-					1.301111	13.55m				· · · · · · · · · · · · · · · · · · ·	atec			
N	14.0							1.	52 10		× · · · ·	atur			
:u/wo:	-										^ . .×	0			
lobal.o											· · · × ·				
mwhg	15. <del>0</del>				11//6/10/10/	20 46					· . · .× . ·× · . · .				
www.							-				· . · .× . ·× · . · .				
hurch	-							1.	52 50		$\begin{vmatrix} \cdot & \cdot & \cdot \\ \cdot & \cdot & \cdot \\ \cdot & \cdot & \cdot & \cdot \\ \cdot & \cdot &$				
Christo	16.0-						(10	5.1)			· . · .× . ·× · . · .				
end, C	-					_	Silty medium to coarse GRAVEL, with trace of fine			_					
Wood					13//13/14/15	/19 50+	(10 Silk CLAX with prices fire and area had	5.3)				-			
/pass,	17 Q						Sing CLAT, with minor line saild, grey hard					wet			
and By							(1)	7,4)	52 55						
Woode	-						Silty fine to coarse GRAVEL, with some fine to				× Øxo Ø	1			
VZTA					24//13/13/11	/13 50	grey with some brown lenses	,		-	× ~ × ×				
1603, 1	18.0- - -										R A R				
Z1873	-							1	52 75		XU OXU	ited			••••
oject:								<sup>1</sup> .	~ / 3		02-02-00 8 & 8	tura			••••
TD. Pr	19.0										N N N	sa			
ND L	-				28//14/10/11	/12 47	1	$\vdash$	+	-	×0,5×0				•••
ZEAL∕	-					_					LA L				
NEW	Drilling I	Metho	d:	Cas	l sing:		Remarks:					1		<u> </u>	· · · ·
HWM	Contrac	tor:	1551011	Flue	sh:										
33/12	McMilla Fauinm	ans ent Tu	ne.	110			Borehole Completion:								
26/(	Geopro	be 81	40LS Soni	ic											

			IWI	4			BOREHC	DLE LOG					Job N Hole I Sheet	lo: Z1 No: B :: 3 of	1873603 3H204 f 3	
					Client: I	NZTA							Starte	ed: 31	1/01/12	
MV Ha:	VH NE zeldea	EW ZEAL	AND LT		Project:	NZTA Wooden	d Bypass						Finish	ned: 0	)2/02/12	
6 F Ch	lazeld ristchu	ean Road Jrch 8024	1 4	-	Locatio	n: Woodend, Ch	ristchurch						Logge	ed: JJ	J	
Tel Fax	: 03 3 k: 03 3	66 7449 366 7780			Hole Lo Descrip	cation Refer to: tion:	Factual Report						Check	ked: S	SBG	
				ľ	Easting	: 2484041m	Northing: 57	764868m	Incli	natio	n: Ve	ertical	RL SI	urface	e:	
				Ī	Diamete	er (Int/Ext): /							Datun	n:		
			Shear	Stan	dard		Material Descripti	on	Ê	%	%				suc	
	Ê	Samples	Vane (kPa)	Tes	ation				sun (	covery	covery	5		er	rvatio	
(E	i) lioi		igth/ trength	ss // Bc // 000m/)	/ Data	(Logging can for the Fiel	ried out in accordance d Classification of Soil Purposes New Zealar	with Guidelines and Rock for	ofF	re Re	re Re	ic Lo	ion ion	dwat	Obse	ation
epth	evat	ype	ak Strer sidual S	Blov (Seatii 5mm/11	Value efusal	Ligineening	Society, 2005)	d Geolechnica	ength	tal Co	olid Co	raph	oistu ondit	roun	ther (	stalla
Ő		E Bulk	Re	5,7	Zĸ	Silty fine to coa	rse GRAVEL with	some fine to	1.50	_₽ 100	S	U ×	ΣŬ	G	Õ	<u> </u>
	-	sample				medium sand, v	vith trace of fine to r	nedium cobbles,				× × ×				
-	-					5.,						×0 =×0 \$ \$ \$				
21.6				26//11/11/12/	15 49											
												NON NO				
-	-								1.54	80		°&° ≈	q			
22.0												\$ \$ \$	rate			
22.6	-											×0 -×0 & × &	atu			· · · ·
-	-			37//28	50+/								0			
	-				225mm	1						BOX BO				
23.6	2								1.52	80		X & X ≈ ≈				
												× × × × × × × × × ×				
	-							(23.9)				80° - 80				
24.6	2					Borehole termin	ated at 23.9m due t	o Target Depth				<u> </u>				
om/nz																
obal.c	-			27//15/15/15/	11 50+											
16 Mul 25.6																
L.WWW	-															
- nrch	-															
Irristch																
ਨ 26.6 ਤੁ	-															
- ooder	-															
ISS, W	-															
ad 27.€	2															
odend	-															
A Wo	-															
28.G	- H															
73603	-															
t: Z18	-															
Projec																
- 29.6	'] ]															
AND .	-															
ZEAL	-															
S ⊒ Z Z Rotar	g Metho	d: ussion	Cas	sing:	1	Remarks:			I	I	1	1		I	1	I
	actor:		Flus	sh:												
Equin	IIans ment Tr	vpe:				Borehole C	ompletion:									
Geop	robe 81	40LS Son	ic													

	()) ММН				TEST PIT LOG						Job No: Z1873603 Hole No: TP123 Sheet: 1 of 1				
					Client: NZTA					Started: 08/12/11					
	MWH Hazelo	NEW Z dean Bu	EALAND	) LTD ark	Project: NZTA Woodend Bypass						Finished: 08/12/11				
	6 Haze Christ	eldean F church	Road 8024		Location: Woodend, Christchurch						- Logged: JJ				
	Tel: 03 Fax: 0	3 366 74 3 366 7	449 780		Test Pit Location Refer to: Factual Report Description:					Che	cked: SE	G			
					Equipment Type: 5.5ton Wheeled Excavator					RL	Surface:				
					Easting: 2484181m Northing: 5764432m					Dati	um:				
			h/ igth		Material Description			tion		Scala Penetration					
			rengt Strer a)			_		condit	(BIOWS/ TOUT			nm)			
	(m)	les	ak St dual (kP	(Logging Classific	carried out in accordance with Guidelines for the Field ation of Soil and Rock for Engineering Purposes. New	ic log	ages	nre c	+DETE ACCOF +DETE	RMINATION RDANCE W RMINATION	I OF "GOOD GRC ITH NZS 3604: 19 I OF PENETRATI	UND" IN 199 DN RESISTANCE	ation	(E	
	lepth	Samp	Resi		Zealand Geotechnical Society, 2005)	Jraph	Seep	noist	A SOL	N ACCORI	4 5 6	5 4402: 1988 7 8 9	ustallo	lepth	
F	0		+	Sandy TOP:	SOIL, with some silt, and some roots, greyish brown	<u><u> </u></u>									
-	-					<u>17 · x1·17 · x</u>	•					•		<b>7</b> -	
-	0.2					1/2· \1/2· \								0.2	
-	-					<u> </u>		oist						i –	
-	_ 0.4					$\frac{i_{i}}{\cdots}$	1	E					>> <b>•</b>	0. <u>4</u>	
	-					<u></u> 5	•						18	- 1	
	_ 0.6				(0.	6)								0. <u>6</u>	
	_			Silty fine SA	ND, yellowish brown loose										
	0.8													0.8	
	-						-				+				
	_ 1.0	Bulk sample					ļ					7		• 1. <u>0</u>	
-	_	Tub sample					ļ							-	
zu/uz	_ 1.2						ļ							1.2	
bal.cc	-						+								
olghwr	_ 1.4						ł	oist						1. <u>4</u>	
m.m	_						ļ	Ĕ							
nrch v	_ 1.6						ł							1. <u>6</u>	
Iristch	_						-							i	
nd, Ct	_ 1.8						ļ							1. <u>8</u>	
Voode							ļ				II				
ass, \	- 20										Ī			20	
nd Byr	_ 2.0						ł							2.0_	
Voode	-				(2	2)	ł					$ \downarrow    $			
	Test pit terminated at 2.2m due to Limit of equipment												_	12.2	
1603, N	-												1	-	
Z1873	_ 2.4										/	$\left  \right $		2.4	
oject:	-										-			-	
TD. Pr	_ 2.6													2. <u>6</u>	
AND L	-												ı	_	
ZEAL	_ 2.8											$\langle$		2.8	
NEW	_												>>•		
HMM												-		3.0	
33/12	Notes:									Con	tractor: Ful	ton Hogan			
26/(															
Grid Reference (NZTM): 1573878 mE, 5203129 mN Location Accuracy: 50 - 300m Ground Level Altitude: 7.1 m +MSD Accuracy: < 2.5 m Driller: McMillan Drilling Ltd Drill Method: Rotary Rig Borelog Depth: 20.5 m Drill Date: 17-Oct-1994



	Water				Formation
Scale(m)	Level	Depth(m		Full Drillers Description	Code
-		0.30m		Lignt Brown earth- top soil Brown sand	SP
ļ		3.80m	00	Grey sand and some gravel	сн
5					
15			0 0 0 0		
		16.79m	1000000000	Grov around	D
		18.50m		Grey graveis	KI.
20		20.50m		Brown stained gravels	RI

Grid Reference (NZTM): 1574305 mE, 5203256 mN Location Accuracy: 2 - 15m Ground Level Altitude: 6.8 m +MSD Accuracy: < 0.1 m Driller: McNeill Drilling Co. Ltd Drill Method: Rotary/Percussion Borelog Depth: 15.0 m Drill Date: 03-Apr-2000



Carela (m)	Water	and the family		E. Ballers Description	Formation
Scale(m)	Level D	eptn(m)		Full Drillers Description	Code
			0.0.0	Dense Grey/Brown gravel, trace wet sand. Gravel- fine to coarse, subrounded to subangular	SP
3					
	2.0	00m _	<u>v. u. u.</u>		
	23			Very dense gravel	SP
H	3.0	00m _	000000000000000000000000000000000000000	3 (	
		10m		very sort clay, some sit, minor subrounded fine to medium gravel, trace organics, wet, highly plastic	SP
н	1.0	-		Very soft clay, some silt, with	SP
5	5 (	00m		moderately thin layer of brown/Black organic clay, moist, highly plastic	
				Dense Grey fine to medium sand, wet	СН
	8.0	00m		Denne Crewford to made an and	
	9.0	10-		Dense Grey fine to medium sand, trace subangular medium gravels, wet	СН
	10	00m		Very dense gravel, no recovery	СН
10				Very dense Grey medium to coarse sand, wet	СН
	11	.00m	0.0.0	Very dense Grey fine to medium sand with layers of Grey subangular to subrounded, fine gravel, wet	СН
2	12	.00m _		Very dense Grey fine to medium sand, trace subrounded medium gravel, wet	СН
	13	.00m		Very dense Grey fine to medium sand, trace coarse sand, wet	сн
	15	.00m		Very dense Grey fine sand, trace subrounded fine gravel, wet	СН

Grid Reference (NZTM): 1574196 mE, 5202722 mN Location Accuracy: 2 - 15m Ground Level Altitude: 5.2 m +MSD Accuracy: < 0.1 m Driller: Not Known Drill Method: Rotary/Percussion Borelog Depth: 15.0 m Drill Date: 04-Apr-2000



Scale(m)	Water Level Dec	oth(m)	Full Drillers Description	Formation Code
		100 C C C C C C C C C C C C C C C C C C	Very loose Grey mottled or fine sand	ISP.
			* * * minor sit wet	SF
			* * *	
200	1.00	)m (* * * * * *	* * * *	
П		0::0:	Very loose Grey fine to med sand,	SP
		p:: 0::0	trace silt, trace wood, wet	
		10::0		
	2000	0::0:		
- H	2.00	)m <u>processo</u>		
		IO==O==	Very soft Grey mottled or clay, some	SP
			silt, subrounded fine gravel, wet nignly	
		E=0==0	EEO plastic	
2.00	3.00			
H			Loose Grey fine to med sand, minor	SP
	3.30		silt, wet	
			Very soft Grey speckled be clay, some	SP
			silt, wet, highly plastic. Becoming	
	4.00		some organics	
		<u>w-w-</u>	Very soft Brown organic clay, some	SP
		-x-x.	silt, wet, highly plastic. Becoming Grey	10104
		x-x-7	Clay, trace organics, trace sand	
¥	5.00	<u> </u>	<u>w</u> —	
°	5.00		Firm Grev clay some silt_trace wood	SP
		-0-0	> - 4 wet, highly plastic	SP
		0-0-	· · ·	
		=0=0		
200		0.0.		
		6-6-		
		-0-0	5-0	
		0-0-	0	
	03/03/05	-0-0		
	7.00	)m <u>9-9-</u>		
			Med dense Grey coarse sand, minor	CH
			subrounded the gravel, minor the	
		* * * * * *	s e s	
	8 00	lm h h h h h h		
	0.00		Med dense Grey coarse sand, some	CH
			+ + + subrounded fine gravel, trace silt, wet	
	9.00	)m <u>*****</u>	* * *	
			Very dense Grey fine to coarse sand,	СН
			+ + + trace subangular med gravel, wet	
			6 6 6	
10	10.0	0		
10	10.0		Dense Grev fine cend minor silt wet	CH
			s s s	C.A.
			1.5.4.	
2223	11.0	0m * * * * * *	4 4 4	
			Dense Grey fine to med sand, wet	CH
			- + +	
H				
			(* * * )	
	13.0	0m	3.3.5	
Н	.5.0		Very dense Grey fine sand, minor silt.	CH
			* * * wet	
	14.0	00m + + + + + +	1.1.1	
		0:0::	Med dense Grey mottled or gravel,	CH
		1	trace sand, wet. Gravel- fine to	
		0.0.0	Coarse, subrounded to angular	
	15.0	0m D::0::0	D:::0	
	10.0	CALLER AND A LOCAL DAMAGE AND A LOCAL		

Grid Reference (NZTM): 1574418 mE, 5202900 mN Location Accuracy: 50 - 300m Ground Level Altitude: 6.3 m +MSD Accuracy: < 2.5 m Driller: Clemence Drilling Contractors Drill Method: Rotary/Percussion Borelog Depth: 23.5 m Drill Date: 21-Dec-2004



Seale (m)	Water	Death (m)		Full Drillers Description	Formation
Scale(m)	Level	0.20m -		Topsoil	Code
		0.2011	000000	Yellow claybound gravel	
Н			000000		
- 11 -			000000		
			000000		
- 11 -			000000		
			0000000		
1			000000		
H			000000		
		4.80m	000000		
5		15	000000	Blue claybound gravel	
			200,000		
-			000000		
			000000		
100			0000000		
			000000		
			000000		
			200000		
			000000		
			000000		
10			000000		
			000000		
			000000		
Η			200000		
			000000		
8		12.00m _	000000	Blue sand	
4					
Ц					
15					
22					
		10.00-			
1		18.00m		Silty grey clay	12
				2007 C 100 C 100 C	
1					
20		20.00m	00000000	Weterheering gravel	0
			0000000000	water-bearing graver	
Ц			000000000		
		-	000000000000000000000000000000000000000		
			0000000000		
			000000000000000000000000000000000000000		
			0000000000		
П		23.50m	0000000000		

Grid Reference (NZTM): 1574039 mE, 5203247 mN Location Accuracy: 2 - 15m Ground Level Altitude: 7.4 m +MSD Accuracy: < 0.5 m Driller: McMillan Drilling Ltd Drill Method: Sonic Borelog Depth: 23.9 m Drill Date: 02-Feb-2012



Sector	Water	Death		Sell Dellara Description	Formation
Scale(	mj Level	Deptnin	No no	Silty TOPSOIL, dark greyish brown,	Code
		0.30m		Clayey SILT, brown, DRY	
		0.70m	No Log No Log No	Not recovered	
3		1.10m	og No Log No Log f	Fine to medium SAND vollewish	
		1.30m		brown, MOIST	
		1.80m		orange firm, low plasticity, MOIST	
8				Silty fine to medium SAND, brown, WET	
		2.40m		Sitty CLAV, brownish area mottled	
		2.70m		orange of Million John States	
20				WET	
		3.70m		Situ fine to coarse SAND, dark area	
34		3.85m	2222	WET	
				Sitty CLAT, brownish grey, WET	
		4.70m	2222	Organic SILT with some clay dark	
5	5.10		EEEEEE	brown low plasticity, fibrous organics,	
	5.10	5.50m		MOIST	
		0.0011	00.	Fine to medium SAND, with trace of medium to coarse gravel grav MOIST	
3.00					
1		7.40	D. O		
		(.16m	0.0.0	Fine to coarse GRAVEL, with minor	
			0.00	coarse sand, dank grey, we r	
- 5			P. O. O. q		
			0.0.0		
		9.00m	1:0:0:0	Situ fine to second CRAVEL with	
				minor fine to coarse sand, brownish	
			b. o. o.d	grey, wordt	
10		9.90m	·····	Silty fine to medium SAND, with minor	
			· · · o · · · ·	fine gravel, light brownish grey bands of sandy fine gravel at 10.7-10.8m and	
			00	11.5-11.6m, MOIST	
			0		
			d d		
		11.60m		Silty fine SAND with trace of fine	
				gravel, grey band of sandy fine gravel with some sitt at 13 4-13 55m	
			b o	becomes more saturated with depth	
			po.		
2			0		
			0		
			0		
24			0		
			P. O		
			O C		
15			00.		
			0		
			0.0.0		
		15 10-			
		16.30m	0.0.0	Silty medium to coarse GRAVEL, with	
				Sity CLAY, with minor fine sand, grey,	
2.80				WE.	
		17.40m			
		1991.85	0:.0::0::	Silty fine to coarse GRAVEL, with some fine to medium sand, with trace	
			0.0.0	of fine to medium cobbles, grey bands of gravelis silt at 17.8-18m and	
				20.66-21.1m, colour becomes brown at 19.5-19.7m, 20.3-20.5m and	
			0.00.0.0	23-23.9m	
			0:0:0:		
			0.0.0		
20			0.0.0.0		
10000			0:0.0		
			0::0::0		
			0.0.0		
Π			2.0.0		
			0:0:0:		
			0:00:0		
Π			0:0:0:		
			0.0.0		
Η			p::0::0::(		
			0:0:0:		
		23.90m	2:0:0:C		

Borelog for well M35/18673 Grid Reference (NZTM): 1574179 mE, 5202812 mN Location Accuracy: 2 - 15m Ground Level Altitude: m +MSD Accuracy: Driller: McMillan Drilling Ltd Drill Method: Machine Dug Borelog Depth: 2.2 m Drill Date: 08-Dec-2011





# APPENDIX C: LIQUEFACTION HAZARDS ASSESSMENT



Location: 145 & 167 Gladstone Road, Woodend



## CPT: CPT\_01

Total depth: 8.22 m



Location: 145 & 167 Gladstone Road, Woodend

### **Cone resistance** Friction Ratio Soil Behaviour Type CRR plot Vertical settlements 0 0 0. 0 -Sand & silty sand 255 Sand & silty sand 1 -1 -1 -1 : 1 -Sand Sand 2 -2 -2 -And the 2 -2 - $\bigtriangledown$ Sand During earthq. 3 -3 3 -Sand Sand & silty sand 3 -3-Sand & silty sand Sand Clay Organic soil 4-4. 4 -4-4 5 -5-5 5. 5 -Clay & silty clay 6 6 6-6. 6 7. 7 7-7-7. Sand & silty sand 8. 8-8. 8-8. Sand Sand & silty sand (E) Sand Sand & silty sand do Sand & silty sand do Depth (m) 9-9 9 9-9. Depth (m) Depth (m) Depth (m) 10. 10 10-10-10-11 11-11 11 11 Sand 12 12 12. 12. 12 13 13 13 13. 13 14 14 14 14 14 15 15. 15. 15 15-16. 16. 16-16 16 17 17. 17. 17 17 18 18 18. 18 18 19 19 19 19 19 20-20 20 20-20 10 15 20 25 30 2 4 6 8 10 12 14 16 18 0.05 0 5 0 2 4 6 8 10 0 0 0.2 0.4 0.6 0 0.1 qt (MPa) Rf (%) SBT (Robertson et al. 1986) CRR & CSR Settlement (cm) Analysis method: B&I (2014) G.W.T. (in-situ): 2.50 m Use fill: No Clay like behavior B&I (2014) 2.50 m Fill height: N/A applied: Fines correction method: G.W.T. (earthq.): Points to test: Based on Ic value Average results interval: Fill weight: N/A Limit depth applied: No 3 Limit depth: Earthquake magnitude M<sub>w</sub>: 7.50 Ic cut-off value: 2.60 Trans. detect. applied: No N/A Peak ground acceleration: 0.13 Unit weight calculation: Based on SBT $K_{\sigma}$ applied: Yes MSF method: Method based

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## CPT: CPT\_02

Total depth: 11.45 m



Location: 145 & 167 Gladstone Road, Woodend



## CPT: CPT\_03

Total depth: 1.91 m



Location: 145 & 167 Gladstone Road, Woodend



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### 4

CPT: CPT\_04

Total depth: 8.58 m



Location: 145 & 167 Gladstone Road, Woodend



## 5

CPT: CPT\_05

Total depth: 9.68 m



Location: 145 & 167 Gladstone Road, Woodend

### **Cone resistance** Friction Ratio Soil Behaviour Type CRR plot Vertical settlements Silty sand & sand Silty sand & sand Clay & silty clay Silty sand & sand Clay & silty clay Clay & silty clay Silty sand & sand Clay & silty clay Silty sand & sand Clay & silty clay Ω 0 0 -0 -1-1 -1 1 -1 2 -2 2 -2 -2 $\bigtriangledown$ 3-3 3 -3-3 Sand & silty sand Clay & silty clay 4 -4 -4-4 4 5 5. Clay Clay & silty clay Clay 5-5-5 6. 6 6-6. 6 7 7 7-7. 7-Sand & silty sand 8. 8-8-8. 8-Depth (m) 9. 9 9 9. 9-Depth (m) Depth (m) Depth (m) Depth (m) Sand Sand & silty sand 10-10. 10 10-10-Sand & silty sand ۶ 11 11. 11 11 11 Sand 12 12 -12 12-12-13 13 13 13. 13 14 14 14 14 14 15 15. 15. 15 15-16. 16-16 16 16 17 17. 17. 17 17 18 18. 18 18 18 19 19 19 19 19 20-20 20 20-20 10 15 20 25 2 4 6 8 10 12 14 16 18 0.4 0 5 30 0 2 4 6 8 10 0 0 0.2 0.4 0.6 0 0.2 0.6 0.8 qt (MPa) Rf (%) SBT (Robertson et al. 1986) CRR & CSR Settlement (cm) Analysis method: B&I (2014) G.W.T. (in-situ): 2.50 m Use fill: No Clay like behavior B&I (2014) 2.50 m G.W.T. (earthq.): Fill height: N/A applied: Fines correction method: Points to test: Based on Ic value Average results interval: Fill weight: N/A Limit depth applied: No 3 Limit depth: Earthquake magnitude M<sub>w</sub>: 7.50 Ic cut-off value: 2.60 Trans. detect. applied: No N/A Peak ground acceleration: 0.13 Unit weight calculation: Based on SBT $K_{\sigma}$ applied: Yes MSF method: Method based

## CPT: CPT\_06

Total depth: 11.18 m



Location: 145 & 167 Gladstone Road, Woodend



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Total depth: 11.92 m



### Project: SLS M7.5/0.13g

## CPT: CPT\_08

Total depth: 20.15 m





Location: 145 & 167 Gladstone Road, Woodend

### **Cone resistance** Friction Ratio Soil Behaviour Type CRR plot Vertical settlements 0 Λ 0 0 -3 Sand & silty sand 1 -1 -1 -1 -1 Sand & silty sand 2 -2 -2 -2 -2 Sand & silty sand 3 -3 -3 -3-3 Sand & silty sand Sand & silty sand Sand Sand Silty sand & sand Clay & silty clay Clay & silty clay Sand 4-4-4-4-5 5 5 5 -5-6 6 6. 6 Sand & silty sand Sand & silty sand 7-7 7 7 7. Sand & silty sand 8 8. 8-8-8-Silty sand & sand Sand & silty sand (E) Sand 9-9 9 9-9. Depth (m) Depth (m) Depth (m) Depth (m) 10. 10 10-10-10-11 11 11-11 11 Sand & silty sand 12 12 -12-12-12-Sand 13 13 13-13-13-Sand & silty sand Sand 14-14-14 14 14 Sand & silty sand 15-15-15 15 15-Sand 16 16-16-16 16-Sand & silty sand Sand & silty sand Clay & silty clay 17 17 17 17-17 Clay & silty clay 18 18 18-18. 18 Sand Sand 19 19 19. 19-19 Sand Ş Sand 20-20 20 20 20 10 15 20 25 2 4 6 8 10 12 14 16 18 0 5 30 0 2 4 6 8 10 0 0 0.2 0.4 0.6 0 0.1 0.2 0.3 0.4 qt (MPa) Rf (%) SBT (Robertson et al. 1986) CRR & CSR Settlement (cm) Analysis method: B&I (2014) G.W.T. (in-situ): 2.50 m Use fill: No Clay like behavior B&I (2014) 2.50 m applied: G.W.T. (earthq.): Fill height: N/A Fines correction method: Points to test: Based on Ic value Average results interval: Fill weight: N/A Limit depth applied: No 3 Limit depth: Earthquake magnitude M<sub>w</sub>: 7.50 Ic cut-off value: 2.60 Trans. detect. applied: No N/A Peak ground acceleration: 0.13 Unit weight calculation: Based on SBT $K_{\sigma}$ applied: Yes MSF method: Method based

## CPT: CPT\_31513

Total depth: 19.88 m



Location: 145 & 167 Gladstone Road, Woodend

### **Cone resistance** Friction Ratio Soil Behaviour Type CRR plot Vertical settlements 0 0. 0. 0 -Silty sand & sand Clay Clay & silty clay Silty sand & sand Sand & silty sand 1 -1 -1 1 -1 -2 -2 -2 -2 -2 - $\bigtriangledown$ During earthq 3 -3. 3 -3-3-Silty sand & sand 4-4 -4 -4 -4 5. 5 -5-5 -5 -Sand & silty sand 6. 6. 6. 6-6. 7 7 -7. 7. 7-Sand 8 -8-8 8-8. 9 9-9 9 9-Depth (m) Depth (m) Depth (m) Depth (m) Depth (m) 10. 10 -10-10-10-11 11 11 11 11 12 12 -12 12-12-13 13 13 13. 13 14 14 14 14 14 15 15 15 -15-15-16. 16 16-16 16 17 17. 17. 17 17-18 18 18. 18 18 19 19 19 19 19 20-20 20-20 20 10 15 20 25 30 2 4 6 8 10 12 14 16 18 0.001 0.001 0.002 0.002 0.003 0 5 0 2 4 6 8 10 0 0 0.2 0.4 0.6 0 qt (MPa) Rf (%) SBT (Robertson et al. 1986) CRR & CSR Settlement (cm) Analysis method: B&I (2014) G.W.T. (in-situ): 2.50 m Use fill: No Clay like behavior B&I (2014) 2.50 m applied: Fines correction method: G.W.T. (earthq.): Fill height: N/A Points to test: Based on Ic value Average results interval: Fill weight: N/A Limit depth applied: No 3 Limit depth: Earthquake magnitude M<sub>w</sub>: 6.00 Ic cut-off value: 2.60 Trans. detect. applied: No N/A Peak ground acceleration: 0.19 Unit weight calculation: Based on SBT $K_{\sigma}$ applied: Yes MSF method: Method based

## CPT: CPT\_01

Total depth: 8.22 m



Location: 145 & 167 Gladstone Road, Woodend

### **Cone resistance** Friction Ratio Soil Behaviour Type CRR plot Vertical settlements 0 0 0 0 -Sand & silty sand 255 Sand & silty sand 1 -1 -1 -1 : 1 -Sand Sand 2 -2 -2 -And the 2 -2 - $\bigtriangledown$ Sand During earthq. 3 -3 3 -Sand Sand & silty sand 3 -3-Sand & silty sand Sand Clay Organic soil 4-4. 4 -4-4 5 -5-5 5. 5 -Clay & silty clay 6 6 6. 6. 6 7. 7 7-7-7. Sand & silty sand 8. 8-8. 8-8-Sand Sand & silty sand (E) Sand Sand & silty sand do Sand & silty sand do Depth (m) 9-9 9 9-9. Depth (m) Depth (m) Depth (m) 10. 10 10-10-10-11 11 11 11-11 Sand 12 12 12. 12. 12-13 13 13 13. 13 14 14 14 14 14 15 15 15. 15-15-16. 16. 16-16 16 17 17. 17. 17 17 18 18 18. 18 18 19 19 19 19 19 20-20 20 20-20 10 15 20 25 30 2 4 6 8 10 12 14 16 18 0 5 0 2 4 6 8 10 0 0 0.2 0.4 0.6 0 0.1 0.2 qt (MPa) Rf (%) SBT (Robertson et al. 1986) CRR & CSR Settlement (cm) Analysis method: B&I (2014) G.W.T. (in-situ): 2.50 m Use fill: No Clay like behavior B&I (2014) 2.50 m Fill height: N/A applied: Fines correction method: G.W.T. (earthq.): Points to test: Based on Ic value Average results interval: Fill weight: N/A Limit depth applied: No 3 Limit depth: Earthquake magnitude M<sub>w</sub>: 6.00 Ic cut-off value: 2.60 Trans. detect. applied: No N/A Peak ground acceleration: 0.19 Unit weight calculation: Based on SBT $K_{\sigma}$ applied: Yes MSF method: Method based

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## 2

CPT: CPT\_02

Total depth: 11.45 m



Location: 145 & 167 Gladstone Road, Woodend



## CPT: CPT\_03

Total depth: 1.91 m



Location: 145 & 167 Gladstone Road, Woodend



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CPT: CPT\_04 Total depth: 8.58 m



Location: 145 & 167 Gladstone Road, Woodend



## CPT: CPT\_05

Total depth: 9.68 m



### Location: 145 & 167 Gladstone Road, Woodend

## CPT: CPT\_06

Total depth: 11.18 m





Location: 145 & 167 Gladstone Road, Woodend

### **Cone resistance** Friction Ratio Soil Behaviour Type CRR plot Vertical settlements 0 0 0 -0 -Silty sand & sand Clay & silty clay Clay & silty clay 1 -1 -1 -1 Clay & silty clay 2 2 2 -2 -2 -Silty sand & sand Silty sand & sand Clay $\bigtriangledown$ During earthq 3 3 3 -3 -Clay & silty clay Clay 4 -4-4 Clay & silty clay Clay 5 5-5 -5-5 Organic soil 6 6 6. 6 6 7. 7 7-7. 7-Sand & silty sand 8. 8-8-8. 8-Depth (m) 9-Sand 9 9 9-9. Depth (m) Depth (m) Depth (m) Depth (m) Sand & silty sand 10. 10 10-10-10-11 11-11-11 11 ξ 12 12 12-12-12-13 13 13 13. 13-14 14 14 14 14 15 15. 15. 15 15-16. 16-16 16 16 17 17. 17. 17 17-18 18. 18 18 18 19 19 19 19 19 20-20 20 20-20 10 15 20 25 2 4 6 8 10 12 14 16 18 0 5 30 0 2 4 6 8 10 0 0 0.2 0.4 0.6 0 0.5 1 1.5 2 2.5 qt (MPa) Rf (%) SBT (Robertson et al. 1986) CRR & CSR Settlement (cm) Analysis method: B&I (2014) G.W.T. (in-situ): 2.50 m Use fill: No Clay like behavior B&I (2014) 2.50 m G.W.T. (earthq.): Fill height: N/A applied: Fines correction method: Points to test: Based on Ic value Average results interval: Fill weight: N/A Limit depth applied: No 3 Limit depth: Earthquake magnitude M<sub>w</sub>: 6.00 Ic cut-off value: 2.60 Trans. detect. applied: No N/A Peak ground acceleration: 0.19 Unit weight calculation: Based on SBT $K_{\sigma}$ applied: Yes MSF method: Method based

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Total depth: 11.92 m

CPT: CPT\_07

7



### Location: 145 & 167 Gladstone Road, Woodend

### **Cone resistance** Friction Ratio Soil Behaviour Type CRR plot Vertical settlements Ω 0 0 0 -Silty sand & sand Clay & silty clay 1-1 1 -1 Clay Clay 2 2. 2 -2 -2 - $\bigtriangledown$ Clay Sand & silty sand During earthq. 3 3 3 -3-3 Clay & silty clay Organic soil Silty sand & sand 4 4 -4-5 -5 5-5 -5 Clay Organic soil Sand & silty sand 6 6 6. 6. 7 7 7-7 7-Sand & silty sand 8-8-8-8. 8-Depth (m) 9-9 9 9-9. Depth (m) Depth (m) Depth (m) Depth (m) Sand Sand & silty sand Sand & silty sand 10. 10 10-10-10-11 11-11 11 11 Sand & silty sand 12 12 -12-12-12-Sand 13 13 13-13 13-14 14 · 14-14-14 Sand & silty sand 15 -15-15-15 15-Sand Sand Clay & silty clay 16 16-16-16 16-17 17 17. 17-17-Silty sand & sand ۶ 18 18 18 18. 18 Clay Sand Sand Sand cla 19 19 19 19-19 20-20 20 20 20 10 15 20 25 2 4 6 8 10 12 14 16 18 0 5 30 0 2 4 6 8 10 0 0 0.2 0.4 0.6 0 1 2 qt (MPa) Rf (%) SBT (Robertson et al. 1986) CRR & CSR Settlement (cm) Analysis method: B&I (2014) G.W.T. (in-situ): 2.50 m Use fill: No Clay like behavior B&I (2014) 2.50 m applied: G.W.T. (earthq.): Fill height: N/A Fines correction method: Points to test: Based on Ic value Average results interval: Fill weight: N/A Limit depth applied: No 3 Limit depth: Earthquake magnitude M<sub>w</sub>: 6.00 Ic cut-off value: 2.60 Trans. detect. applied: No N/A Peak ground acceleration: 0.19 Unit weight calculation: Based on SBT $K_{\sigma}$ applied: Yes MSF method: Method based

## CPT: CPT\_08

Total depth: 20.15 m



Location: 145 & 167 Gladstone Road, Woodend

### **Cone resistance** Friction Ratio Soil Behaviour Type CRR plot Vertical settlements Λ 0 0 0 --2-Sand & silty sand 1 -1 -1 -1 -1 Sand & silty sand 2 -2 -2 -2 -2 Sand & silty sand 3 -3 3 -3 -3-Sand & silty sand Sand & silty sand Sand Sand Silty sand & sand Clay & silty clay Clay & silty clay Sand 4-4-4-4-5 -5 5 5 5. 6 6 6. 6 Sand & silty sand Sand & silty sand 7. 7 7 7 7-Sand & silty sand 8 8-8. 8-8-Silty sand & sand Sand & silty sand (E) Sand 9-9 9 9-9. Depth (m) Depth (m) Depth (m) Depth (m) 10. 10 10-10-10-11 11 11-11 11 Sand & silty sand 12 12 -12-12-12 Sand 13 13 13-13-13 Sand & silty sand Sand 14-14-14 14 14 Sand & silty sand 15-15-15 15 15-Sand 16 16-16-16 16-Sand & silty sand Sand & silty sand Clay & silty clay 17 17 17 17-17 Clay & silty clay 18 18 18-18. 18 Sand Sand 19 19 19. 19-19 Sand Ş Sand 20-20 20 20 20 10 15 20 25 2 4 6 8 10 12 14 16 18 0.2 0.4 0 5 30 0 2 4 6 8 10 0 0 0.4 0.6 0 0.2 0.6 0.8 qt (MPa) Rf (%) SBT (Robertson et al. 1986) CRR & CSR Settlement (cm) Analysis method: B&I (2014) G.W.T. (in-situ): 2.50 m Use fill: No Clay like behavior B&I (2014) 2.50 m applied: G.W.T. (earthq.): Fill height: N/A Fines correction method: Points to test: Based on Ic value Average results interval: Fill weight: N/A Limit depth applied: No 3 Limit depth: Earthquake magnitude M<sub>w</sub>: 6.00 Ic cut-off value: 2.60 Trans. detect. applied: No N/A Peak ground acceleration: 0.19 Unit weight calculation: Based on SBT $K_{\sigma}$ applied: Yes MSF method: Method based

## CPT: CPT\_31513

Total depth: 19.88 m



Location: 145 & 167 Gladstone Road, Woodend

### **Cone resistance Friction Ratio** Norm. Soil Behaviour Type CRR plot **Vertical settlements** 0-0. 0 0 0-Sand & silty sand Clay & silty clay Clay 1-1 1 1 Clay & silty clay 2 2 -2 -2 -2. $\nabla$ ing earthc 3. 3-3 -3-3. 4 4 4-4-4 Sand & silty sand 5 5 5 -5-5 -6 6 6-6. 6 7-7 7 7. 7 Sand 8-8 8 8. 8 9 9. Depth (m) 9 9 q Depth (m) Depth (m) Depth (m) Depth (m) 10 10-10-10-10 11 11 11 11 11 12 12 12 12-12 13-13 13 13. 13 14 14 14 14 14 15 15 15 15 15 16 16. 16-16 16 17 17. 17 17. 17 18 18. 18. 18-18 19 19 19 19-19 20 20-20-20-20-25 10 15 20 4 6 8 10 12 14 16 18 5 30 10 0 2 0.2 0.4 0 0 2 4 6 8 0 0.6 0 2 qt (MPa) Rf (%) SBTn (Robertson 1990) CRR & CSR Settlement (cm) Analysis method: Use fill: B&I (2014) G.W.T. (in-situ): 2.50 m No Clay like behavior Fines correction method: B&I (2014) G.W.T. (earthq.): 2.50 m Fill height: N/A applied: Points to test: Based on Ic value Average results interval: 3 Fill weight: N/A Limit depth applied: No Earthquake magnitude M...: 7.50 Ic cut-off value: 2.60 Trans. detect. applied: Limit depth: N/A No Peak ground acceleration: 0.35 Unit weight calculation: Based on SBT $K_{\alpha}$ applied: Yes MSF method: Method based

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Total depth: 8.22 m



Location: 145 & 167 Gladstone Road, Woodend

### Norm. Soil Behaviour Type **Cone resistance Friction Ratio** CRR plot **Vertical settlements** 0-0 0 0 0 Sand & silty sand Sand & silty sand Sand Sand Sand & silty sand Clay 1 1 1. 1 2 2 -2 -2 -2. $\bigtriangledown$ ring earthc 3 3 3 – 3-3. 4 4-4-4 5-5-5-5 5. Clay 6 6 6 6. 6 7 7 7-7. 7 Sand & silty sand 8 8 8 8-8-Sand 9 – 9 9 Sand & silty sand 9 q Depth (m) Depth (m) Depth (m) Depth (m) Depth (m) Sand 10 10-10-10-10-Sand & silty sand 11 11 11 11 11 Sand & silty sand 12 12 12 12-12 13-13 13 13 13 14 14 14 14 14 15 15 15 15 15 16 16. 16-16 16-17 17. 17 17. 17 18 18. 18. 18-18 19 19 19 19-19 20-20 20-20-20-10 15 20 25 4 6 8 10 12 14 16 18 5 30 10 0 2 0.2 0.4 0.1 0.2 0.3 0.4 0 0 2 4 6 8 0 0.6 0 qt (MPa) Rf (%) SBTn (Robertson 1990) CRR & CSR Settlement (cm) Analysis method: Use fill: B&I (2014) G.W.T. (in-situ): 2.50 m No Clay like behavior Fines correction method: B&I (2014) G.W.T. (earthq.): 2.50 m Fill height: N/A applied: Points to test: Based on Ic value Average results interval: 3 Fill weight: N/A Limit depth applied: No Earthquake magnitude M...: 7.50 Ic cut-off value: 2.60 Trans. detect. applied: Limit depth: N/A No Peak ground acceleration: 0.35 Unit weight calculation: Based on SBT $K_{\alpha}$ applied: Yes MSF method: Method based

CLiq v.3.5.2.22 - CPTU data presentation & interpretation software - Report created on: 13/12/2023, 10:50:39 Project file: G:\GENZ\Projects\03 TETRALINX PROJECTS\330000 - 339000\332958 - 145 & 167 Gladstone Road\07 ANALYSES & DESIGN\145 & 167 Gladstone Road.clq

## CPT: CPT\_02

Total depth: 11.45 m



Project: ULS M7.5/0.35g

CPT: CPT\_03

Total depth: 1.91 m





Location: 145 & 167 Gladstone Road, Woodend

### CPT: CPT\_04

Total depth: 8.58 m





Location: 145 & 167 Gladstone Road, Woodend



## CPT: CPT\_05

Total depth: 9.68 m



Project: ULS M7.5/0.35g

### CPT: CPT\_06

Total depth: 11.18 m





Project: ULS M7.5/0.35g

### CPT: CPT\_07

Total depth: 11.92 m





Project: ULS M7.5/0.35g

### CPT: CPT\_08

Total depth: 20.15 m





Location: 145 & 167 Gladstone Road, Woodend

### **Cone resistance Friction Ratio** Norm. Soil Behaviour Type CRR plot **Vertical settlements** 0-0 0 0 0 Sand & silty sand 1 1. 1 1 Sand & silty sand Sand 2 2 -2 -2 -2 Sand & silty sand 3 3 3 – 3-3-Sand Sand & silty sand Sand & silty sand Sand & silty sand Clay & silty clay Clay & silty clay 4 4-4 4 5 5-5 -5 6 6-Sand 6. 6 6 Silty sand & sandy Silty sand & sandy - "IIIIII 7 7 7-7-7 Sand & silty sand 8 8 8-8-8. Silty sand & sandy 9 9-Sand & silty sand 9. 9 q Depth (m) Depth (m) Depth (m) E Depth (m) Depth 10 10-10-10-10-Sand Sand 11 11-11 11 11 12 12. 12-12-12-Sand & silty sand 13 13-13-13-13-Sand 14 14. 14-14 14 Sand & silty sand 15 15 15-15-15-Sand 16 16. 16-16-16-Sand & silty sand Sand & silty sand Clay & silty clay 17 17 17-17-17 Clay Sand & silty sand Sand & silty sand Sand & silty sand 18-18 18. 18. 18-19-19 19 19-19 Sand & silty sand 20 20. 20-20-20 10 15 20 25 5 30 10 4 6 8 10 12 14 16 18 0.2 0.4 2 3 0 0 2 4 6 8 0 2 0 0.6 0 1 4 qt (MPa) Rf (%) SBTn (Robertson 1990) CRR & CSR Settlement (cm) Use fill: Analysis method: B&I (2014) G.W.T. (in-situ): 2.50 m No Clay like behavior Fines correction method: B&I (2014) G.W.T. (earthq.): 2.50 m Fill height: N/A applied: Points to test: Based on Ic value Average results interval: 3 Fill weight: N/A Limit depth applied: No Ic cut-off value: 2.60 Limit depth: N/A Earthquake magnitude M...: 7.50 Trans. detect. applied: No Peak ground acceleration: 0.35 Unit weight calculation: Based on SBT $K_{\alpha}$ applied: Yes MSF method: Method based

## CPT: CPT\_31513

Total depth: 19.88 m



### Project title : SLS M7.5/0.13g

Location : 145 & 167 Gladstone Road, Woodend



## **Overall Liquefaction Severity Number report**



### Project title : SLS M6.0/0.19g

Location : 145 & 167 Gladstone Road, Woodend



## **Overall Liquefaction Severity Number report**


## Project title : ULS M7.5/0.35g

Location : 145 & 167 Gladstone Road, Woodend



## **Overall Liquefaction Severity Number report**