CHRISTCHURCH CITY COUNCIL

BU 0680-008 EQ2
Avebury Park Pool Plant Shed
9 Eveleyn Couzins Ave, Richmond

QUALITATIVE ASSESSMENT REPORT
FINAL

- Rev B
- 25 March 2013

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Contents

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Approval

	Signature	Date	Name	Title
Author		25/03/2013	Willow Patterson-Kane	Structural Engineer
Approver		25/03/2013	Nick Calvert	Senior Structural Engineer

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1. Executive Summary

1.1. Background

A qualitative assessment was carried out on the building located in Avebury Park at 9 Eveleyn Couzins Ave, Richmond. The building is single storey and is currently utilised as a plant room for the nearby paddling pool. It is constructed from timber-framed walls with a brick veneer. The roof appears to be timber-framed with lightweight cladding. A pergola extends to the north of the building, with timber beams supported on six brick columns. The shelter and column supports are secondary structural elements. An aerial photograph illustrating this area is shown below in Figure 1. Detailed descriptions outlining the buildings age and construction type is given in Section 5 of this report.

- Figure 1 Aerial Photograph of the plant shed in Avebury Park at 9 Eveleyn Couzins Ave

The qualitative assessment includes a summary of the building damage as well as an initial assessment of the current seismic capacity compared with current seismic code loads using the Initial Evaluation Procedure (IEP).

This qualitative report for the building structure is based on the Detailed Engineering Evaluation Procedure document (draft) issued by the Structural Advisory Group on 19 July 2011 and a visual inspection on 22 May 2012.

1.2. Key Damage Observed

No external structural damage was observed during our site inspection.

1.3. Critical Structural Weaknesses

No potential critical structural weaknesses have been identified for this building.

1.4. Indicative Building Strength (from IEP and CSW assessment)

Based on the information available, and using the NZSEE Initial Evaluation Procedure, the buildings original capacity has been assessed to be in the order of 96% NBS. There was no structural damage observed during the site investigation, therefore the post earthquake capacity will not change as a result of earthquake damage.

The building has been assessed to have a seismic capacity greater than 96% NBS and is therefore not a potential earthquake risk.

1.5. Recommendations

It is recommended that:

a) There is no damage to the building that would cause it to be unsafe to occupy.
b) We consider that barriers around the building are not necessary.

2. Introduction

Sinclair Knight Merz was engaged by Christchurch City Council to prepare a qualitative assessment report for the building located in Avebury Park at 9 Eveleyn Couzins Ave following the magnitude 6.3 earthquake which occurred in the afternoon of the 22nd of February 2011 and the subsequent aftershocks.

The Qualitative Assessment uses the methodology recommended in the Engineering Advisory Group draft document “Guidance on Detailed Engineering Evaluation of Earthquake affected Non-residential Buildings in Canterbury”, issued 19 July 2011. The qualitative assessment includes a summary of the building damage as well as an initial assessment of the likely current Seismic Capacity compared with current seismic code requirements.

A qualitative assessment involves inspections of the building and a desktop review of existing structural and geotechnical information, including existing drawings and calculations, if available.

The purpose of the assessment is to determine the likely building performance and damage patterns, to identify any potential critical structural weaknesses or collapse hazards, and to make an initial assessment of the likely building strength in terms of percentage of new building standard (%NBS).

This report describes the structural damage observed during our inspection and indicates suggested remediation measures. The inspection was undertaken from floor levels and was a visual inspection only. Our report reflects the situation at the time of the inspection and does not take account of changes caused by any events following our inspection. A full description of the basis on which we have undertaken our visual inspection is set out in Section 7.

The NZ Society for Earthquake Engineering (NZSEE) Initial Evaluation Procedure (IEP) was used to assess the likely performance of the building in a seismic event relative to the New Building Standard (NBS). 100% NBS is equivalent to the strength of a building that fully complies with current codes. This includes a recent increase of the Christchurch seismic hazard factor from 0.22 to 0.3[1].

At the time of this report, no intrusive site investigation, detailed analysis, or modelling of the building structure had been carried out. The building description below is based on our visual inspections.

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[1] http://www.dbh.govt.nz/seismicity-info

3. Compliance

This section contains a brief summary of the requirements of the various statutes and authorities that control activities in relation to buildings in Christchurch at present.

3.1. Canterbury Earthquake Recovery Authority (CERA)

CERA was established on 28 March 2011 to take control of the recovery of Christchurch using powers established by the Canterbury Earthquake Recovery Act enacted on 18 April 2011. This act gives the Chief Executive Officer of CERA wide powers in relation to building safety, demolition and repair. Two relevant sections are:

Section 38 – Works

This section outlines a process in which the chief executive can give notice that a building is to be demolished and if the owner does not carry out the demolition, the chief executive can commission the demolition and recover the costs from the owner or by placing a charge on the owners' land.

Section 51 – Requiring Structural Survey

This section enables the chief executive to require a building owner, insurer or mortgagee carry out a full structural survey before the building is re-occupied.

We understand that CERA will require a detailed engineering evaluation to be carried out for all buildings (other than those exempt from the Earthquake Prone Building definition in the Building Act). It is anticipated that CERA will adopt the Detailed Engineering Evaluation Procedure document (draft) issued by the Structural Advisory Group on 19 July 2011. This document sets out a methodology for both qualitative and quantitative assessments.

The qualitative assessment is a desk-top and site inspection assessment. It is based on a thorough visual inspection of the building coupled with a review of available documentation such as drawings and specifications. The quantitative assessment involves analytical calculation of the buildings strength and may require non-destructive or destructive material testing, geotechnical testing and intrusive investigation.

It is anticipated that factors determining the extent of evaluation and strengthening level required will include:

- The importance level and occupancy of the building
- The placard status and amount of damage
- The age and structural type of the building

- Consideration of any critical structural weaknesses
- The extent of any earthquake damage

3.2. Building Act

Several sections of the Building Act are relevant when considering structural requirements:

3.2.1. Section 112 – Alterations

This section requires that an existing building complies with the relevant sections of the Building Code to at least the extent that it did prior to any alteration. This effectively means that a building cannot be weakened as a result of an alteration (including partial demolition).

3.2.2. Section 115 – Change of Use

This section requires that the territorial authority (in this case Christchurch City Council (CCC)) be satisfied that the building with a new use complies with the relevant sections of the Building Code 'as near as is reasonably practicable'. Regarding seismic capacity 'as near as reasonably practicable' has previously been interpreted by CCC as achieving a minimum of 67%NBS however where practical achieving 100%NBS is desirable. The New Zealand Society for Earthquake Engineering (NZSEE) recommend a minimum of 67%NBS.

3.2.3. Section 121 – Dangerous Buildings

The definition of dangerous building in the Act was extended by the Canterbury Earthquake (Building Act) Order 2010, and it now defines a building as dangerous if:

- in the ordinary course of events (excluding the occurrence of an earthquake), the building is likely to cause injury or death or damage to other property; or
- in the event of fire, injury or death to any persons in the building or on other property is likely because of fire hazard or the occupancy of the building; or
- there is a risk that the building could collapse or otherwise cause injury or death as a result of earthquake shaking that is less than a 'moderate earthquake' (refer to Section 122 below); or
- there is a risk that that other property could collapse or otherwise cause injury or death; or
- a territorial authority has not been able to undertake an inspection to determine whether the building is dangerous.

3.2.4. Section 122 – Earthquake Prone Buildings

This section defines a building as earthquake prone if its ultimate capacity would be exceeded in a 'moderate earthquake' and it would be likely to collapse causing injury or death, or damage to other property. A moderate earthquake is defined by the building regulations as one that would generate ground shaking 33% of the shaking used to design an equivalent new building.

3.2.5. Section 124 – Powers of Territorial Authorities

This section gives the territorial authority the power to require strengthening work within specified timeframes or to close and prevent occupancy to any building defined as dangerous or earthquake prone.

3.2.6. Section 131 – Earthquake Prone Building Policy

This section requires the territorial authority to adopt a specific policy for earthquake prone, dangerous and insanitary buildings.

3.3. Christchurch City Council Policy

Christchurch City Council adopted their Earthquake Prone, Dangerous and Insanitary Building Policy in 2006. This policy was amended immediately following the Darfield Earthquake of the 4th September 2010.

The 2010 amendment includes the following:

- A process for identifying, categorising and prioritising Earthquake Prone Buildings, commencing on 1 July 2012;
- A strengthening target level of 67% of a new building for buildings that are Earthquake Prone. Council recognises that it may not be practicable for some repairs to meet that target. The council will work closely with building owners to achieve sensible, safe outcomes;
- A timeframe of 15-30 years for Earthquake Prone Buildings to be strengthened; and,
- Repair works for buildings damaged by earthquakes will be required to comply with the above.

The council has stated their willingness to consider retrofit proposals on a case by case basis, considering the economic impact of such a retrofit.

We anticipate that any building with a capacity of less than 33%NBS (including consideration of critical structural weaknesses) will need to be strengthened to a target of 67%NBS of new building standard as recommended by the Policy.

If strengthening works are undertaken, a building consent will be required. A requirement of the consent will require upgrade of the building to comply 'as near as is reasonably practicable' with:

- The accessibility requirements of the Building Code.

- The fire requirements of the Building Code. This is likely to require a fire report to be submitted with the building consent application.

3.4. Building Code

The building code outlines performance standards for buildings and the Building Act requires that all new buildings comply with this code. Compliance Documents published by The Department of Building and Housing can be used to demonstrate compliance with the Building Code.

After the February Earthquake, on 19 May 2011, Compliance Document B1: Structure was amended to include increased seismic design requirements for Canterbury as follows:

a) Hazard Factor increased from 0.22 to 0.3 (36% increase in the basic seismic design load)
b) Serviceability Return Period Factor increased from 0.25 to 0.33 (80% increase in the serviceability design loads when combined with the Hazard Factor increase)

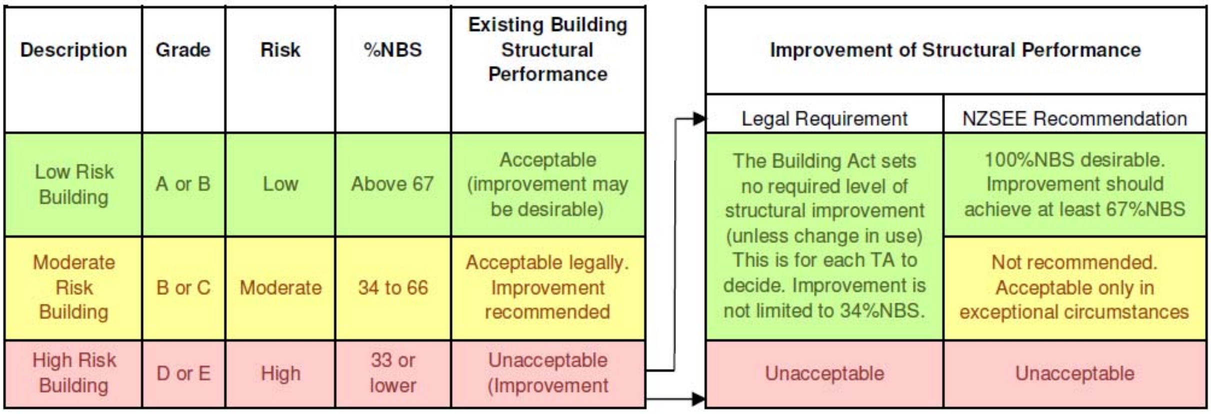
The increase in the above factors has resulted in a reduction in the level of compliance of an existing building relative to a new building despite the capacity of the existing building not changing.

4. Earthquake Resistance Standards

For this assessment, the building's earthquake resistance is compared with the current New Zealand Building Code requirements for a new building constructed on the site. This is expressed as a percentage of new building standard (%NBS). The new building standard load requirements have been determined in accordance with the current earthquake loading standard (NZS 1170.5:2004 Structural design actions - Earthquake actions - New Zealand).

The likely capacity of this building has been derived in accordance with the New Zealand Society for Earthquake Engineering (NZSEE) guidelines 'Assessment and Improvement of the Structural Performance of Buildings in Earthquakes' (AISPBE), 2006. These guidelines provide an Initial Evaluation Procedure that assesses a buildings capacity based on a comparison of loading codes from when the building was designed and currently. It is a quick high-level procedure that can be used when undertaking a Qualitative analysis of a building. The guidelines also provide guidance on calculating a modified Ultimate Limit State capacity of the building which is much more accurate and can be used when undertaking a Quantitative analysis.

The New Zealand Society for Earthquake Engineering has proposed a way for classifying earthquake risk for existing buildings in terms of %NBS and this is shown in Figure 2 below.

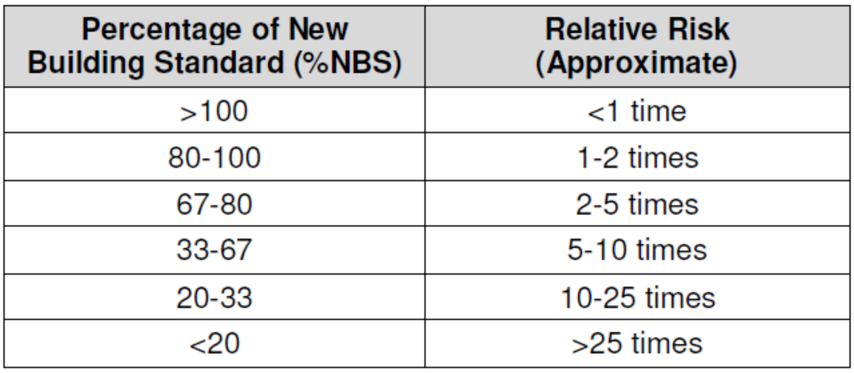


Description	Grade	Risk	%NBS	Existing Building Structural Performance	Improvement of Structural Performance	
					Legal Requirement	NZSEE Recommendation
Low Risk Building	A or B	Low	Above 67	Acceptable (improvement may be desirable)	The Building Act sets no required level of structural improvement (unless change in use) This is for each TA to decide. Improvement is not limited to 34%NBS.	100%NBS desirable. Improvement should achieve at least 67%NBS
Moderate Risk Building	B or C	Moderate	34 to 66	Acceptable legally. Improvement recommended		Not recommended. Acceptable only in exceptional circumstances
High Risk Building	D or E	High	33 or lower	Unacceptable (Improvement	Unacceptable	Unacceptable

- Figure 2: NZSEE Risk Classifications Extracted from table 2.2 of the NZSEE 2006 AISPBE Guidelines

Table 1 below provides an indication of the risk of failure for an existing building with a given percentage NBS, relative to the risk of failure for a new building that has been designed to meet current Building Code criteria (the annual probability of exceedance specified by current earthquake design standards for a building of 'normal' importance is 1/500, or 0.2% in the next year, which is equivalent to 10% probability of exceedance in the next 50 years).

- **Table 1: %NBS compared to relative risk of failure**



Percentage of New Building Standard (%NBS)	Relative Risk (Approximate)
>100	<1 time
80-100	1-2 times
67-80	2-5 times
33-67	5-10 times
20-33	10-25 times
<20	>25 times

5. Building Details

5.1. Building description

The building is located in Avebury Park at 9 Eveleyn Couzins Ave. There are several buildings on this site, but only the building currently utilised as a plant room for the nearby pool is within the scope of this assessment. The building has one storey with timber framed walls, steel strap bracing and a brick veneer and is believed to have a timber-framed, lightweight roof. A shelter extends on the north side of the building, constructed from timber beams and supported on six columns and the building. There is a four-column arrangement with 3.6m centres. The shelter and supporting columns are considered to be secondary structural elements, therefore the lateral system for the building will only include elements in the plant room structure. The ground floor appears to be supported on a concrete slab foundation. The building was believed to be designed and constructed after 1992 as the architectural drawings are dated as 1999.

Our evaluation was based on the external visual inspection carried out on 22 May 2012. Internal inspection was not able to be carried out as the building was inaccessible at the time of the inspection. Drawings were not available to verify the roof and foundation system.

5.2. Gravity Load Resisting system

It appears that the gravity loads are taken by the timber-framed walls, with direct transfer into the concrete slab foundation below.

5.3. Seismic Load Resisting system

Lateral loads acting across and along the building will be resisted by timber framing and steel strap bracing in the walls.

Note that for this building the ‘across direction’ has been taken as north-south and the ‘along direction’ has been taken as east-west.

5.4. Geotechnical Conditions

A geotechnical desktop study was carried out for this site. The main conclusions from this report are:

- In accordance with NZS1170.5 the site is likely to be seismic subsoil Class D (deep or soft soil) ground performance and properties.
- Liquefaction risk is moderate to severe at this site. The sand layers below 2m are susceptible to liquefaction and would explain the significant liquefaction observed from the aerial photographs after the recent earthquake and during the site walkover.

Additional investigations are expected to be necessary in order to perform a quantitative assessment, and they will also be required if a consent is needed or significant alterations to the structure is proposed. The following ground investigation is recommended:

- Two boreholes to a depth of 20m below ground level including SPT's and two CPT tests to refusal to obtain geotechnical parameters and ground conditions.

6. Damage Summary

SKM undertook an inspection on 22 May 2012. The following areas of damage were observed during the time of inspection:

General

1) No visual evidence of settlement was noted at this site and this site is classified as TC2 land[2]. Therefore a level survey is not required at this stage of assessment.

Building Damage

1) Warping of the timber beam in the pergola was noted, but it is believed to be caused by weathering, instead of earthquake damage.
2) Rotation of the gutter on the southeast corner was noted, but is not believed to be a result of earthquake-related damage.

Photos of the above damage can be found in Appendix 1 – Photos.

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[2] http://cera.govt.nz/maps/technical-categories

7. Initial Seismic Evaluation

7.1. The Initial Evaluation Procedure Process

This section covers the initial seismic evaluation of the building as detailed in the NZSEE 'Assessment and Improvement of the Structural Performance of Buildings in Earthquakes'. The IEP grades buildings according to their likely performance in a seismic event. The procedure is not yet recognised by the NZ Building Code but is widely used and recognised by the Christchurch City Council as the preferred method for preliminary seismic investigations of buildings[3].

The IEP is a coarse screening process designed to identify buildings that are likely to be earthquake prone. The IEP process ranks buildings according to how well they are likely to perform relative to a new building designed to current earthquake standards, as shown in Table 2. The building rank is indicated by the percent of the required New Building Standard (%NBS) strength that the building is considered to have. Earthquake prone buildings are defined as having less than 33% NBS strength which correlates to an increased risk of approximately 20 times that of 100% NBS[4]. Buildings that are identified to be earthquake prone are required by law to be followed up with a detailed assessment and strengthening work within 30 years of the owner being notified that the building is potentially earthquake prone[5].

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[3] http://resources.ccc.govt.nz/files/EarthquakeProneDangerousAndInsanitaryBuildingsPolicy2010.pdf

[4] NZSEE 2006, *Assessment and Improvement of the Structural Performance of Buildings in Earthquakes,* p 2-2

[5] http://resources.ccc.govt.nz/files/EarthquakeProneDangerousAndInsanitaryBuildingsPolicy2010.pdf

Table 2: IEP Risk classifications

Description	Grade	Risk	%NBS	Structural performance
Low risk building	A+	Low	> 100	Acceptable. Improvement may be desirable.
	A		100 to 80	
	B		80 to 67	
Moderate risk building	C	Moderate	67 to 33	Acceptable legally. Improvement recommended.
High risk building	D	High	33 to 20	Unacceptable. Improvement required.
	E		< 20	

The IEP is a simple desktop study that is useful for risk management. No detailed calculations are done and so it relies on an inspection of the building and its plans to identify the structural members and describe the likely performance of the building in a seismic event. A review of the plans is also likely to identify any critical structural weaknesses. The IEP assumes that the building was properly designed and built according to the relevant codes at the time of construction. The IEP method rates buildings based on the code used at the time of construction and some more subjective parameters associated with how the building is detailed and so it is possible that %NBS derived from different engineers may differ.

This assessment describes only the likely seismic Ultimate Limit State (ULS) performance of the building. The ULS is the level of earthquake that can be resisted by the building without catastrophic failure. The IEP does not attempt to estimate Serviceability Limit State (SLS) performance of the building, or the level of earthquake that would start to cause damage to the building[6]. This assessment concentrates on matters relating to life safety as damage to the building is a secondary consideration. SLS performance of the building can be estimated by scaling the current code levels if required.

The NZ Building Code describes that the relevant codes for NBS are primarily:

- AS/NZS 1170 Structural Design Actions
- NZS 3101:2006 Concrete Structures Standard
- NZS 3404:1997 Steel Structures Standard

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[6] NZSEE 2006, *Assessment and Improvement of the Structural Performance of Buildings in Earthquakes,* p2-9

7.2. Available Information, Assumptions and Limitations

Following our inspection on 22 May 2012, SKM carried out a preliminary structural review. The structural review was undertaken using the available information which was as follows:

- SKM site measurements and external inspection findings of the building. Please note no intrusive investigations were undertaken.
- There were no structural drawings available to carry out our review.

The following assumptions and design criteria were used in this assessment:

- Standard design assumptions for typical office and factory buildings as described in AS/NZS1170.0:2002
  - 50 year design life, which is the default NZ Building Code design life.
  - Structure Importance Level 2. This level of importance is described as ‘normal’ with medium or considerable consequence of failure.
  - Ductility level of 1.25 in both directions, based on our assessment and code requirements at the time of design.
  - Site hazard factor, Z = 0.3, NZBC, Clause B1 Structure, Amendment 11 effective from 1 August 2011

This IEP was based on our external visual inspection of the building. Since it is not a full design and construction review, it has the following limitations:

- It is not likely to pick up on any original design or construction errors (if they exist)
- Other possible issues that could affect the performance of the building such as corrosion and modifications to the building will not be identified
- The IEP deals only with the structural aspects of the building. Other aspects such as building services are not covered.

7.3. Critical Structural Weaknesses

No potential critical structural weaknesses have been identified for this building.

7.4. Qualitative Assessment Results

The building has had its capacity assessed using the Initial Evaluation Procedure based on the information available. The buildings capacity is expressed as a percentage of new building standard (%NBS) and are in the order of that shown below in Table 3. This capacity is subject to confirmation by a quantitative analysis.

Table 3: Qualitative Assessment Summary

Item	%NBS
Likely Seismic Capacity of Building	96

Our qualitative assessment found that the building is not likely to be classed as a potential earthquake risk and is probably a ‘Low Risk Building’ (capacity greater than 67% of NBS). The full IEP assessment form is detailed in Appendix 2 – IEP Reports.

8. Further Investigation

No further investigation is required at this stage as the likely seismic capacity of the building is greater than 67% NBS and no structural damage was observed.

9. Conclusion

A qualitative assessment was carried out on the building located in Avebury Park at 9 Eveleyn Couzins Ave, Richmond. The building has sustained no earthquake-related damage. The building has been assessed to have a seismic capacity in the order of 96% NBS and is therefore not a potential earthquake risk and is likely to be classified as a ‘Low Risk Building’ (capacity greater than 67% of NBS).

No further investigation is recommended at this stage.

It is recommended that:

a) There is no damage to the building that would cause it to be unsafe to occupy.

b) We consider that barriers around the building are not necessary.

10. Limitation Statement

This report has been prepared on behalf of, and for the exclusive use of, SKM's client, and is subject to, and issued in accordance with, the provisions of the contract between SKM and the Client. It is not possible to make a proper assessment of this report without a clear understanding of the terms of engagement under which it has been prepared, including the scope of the instructions and directions given to, and the assumptions made by, SKM. The report may not address issues which would need to be considered for another party if that party's particular circumstances, requirements and experience were known and, further, may make assumptions about matters of which a third party is not aware. No responsibility or liability to any third party is accepted for any loss or damage whatsoever arising out of the use of or reliance on this report by any third party.

Without limiting any of the above, in the event of any liability, SKM's liability, whether under the law of contract, tort, statute, equity or otherwise, is limited in as set out in the terms of the engagement with the Client.

It is not within SKM's scope or responsibility to identify the presence of asbestos, nor the responsibility of SKM to identify possible sources of asbestos. Therefore for any property pre-dating 1989, the presence of asbestos materials should be considered when costing remedial measures or possible demolition.

There is a risk of further movement and increased cracking due to subsequent aftershocks or settlement.

Should there be any further significant earthquake event, of a magnitude 5 or greater, it will be necessary to conduct a follow-up investigation, as the observations, conclusions and recommendations of this report may no longer apply Earthquake of a lower magnitude may also cause damage, and SKM should be advised immediately if further damage is visible or suspected.

11. Appendix 1 – Photos

	
Photo 1: Northeast elevation	Photo 2: East elevation
	
Photo 3: North elevation	Photo 4: West elevation

<table>
<tr><td></td><td></td></tr>
<tr><td>Photo 5: Base of brick column northeast of building.</td><td>Photo 6: Top of brick column northeast of building. Connection shown between timber beams in the shelter.</td></tr>
<tr><td></td><td></td></tr>
<tr><td>Photo 7: Steel hollow sections used as lateral supports between the timber beams of the shelter.</td><td>Photo 8: Four shelter support columns north of the building, spaced at 3.6m centres.</td></tr>
</table>

	
Photo 9: Timber beams in shelter.	Photo 10: Timber beams in shelter.
	
Photo 11: Connection in timber rafter on top of brick column.	Photo 12: Timber elements and connection on top of brick column.

	
Photo 13: Base of brick column.	Photo 14: Timber elements and connection on top of brick column
	
Photo 15: Timber elements on top of brick column.	Photo 16: Timber rafter on top of brick column.

	
Photo 17: Warped timber element on top of brick column. Not believed to be earthquake damage.	Photo 18: Dislodged gutter. Not believed to be earthquake damage.

12. Appendix 2 – IEP Reports

Table IEP-1 Initial Evaluation Procedure – Step 1

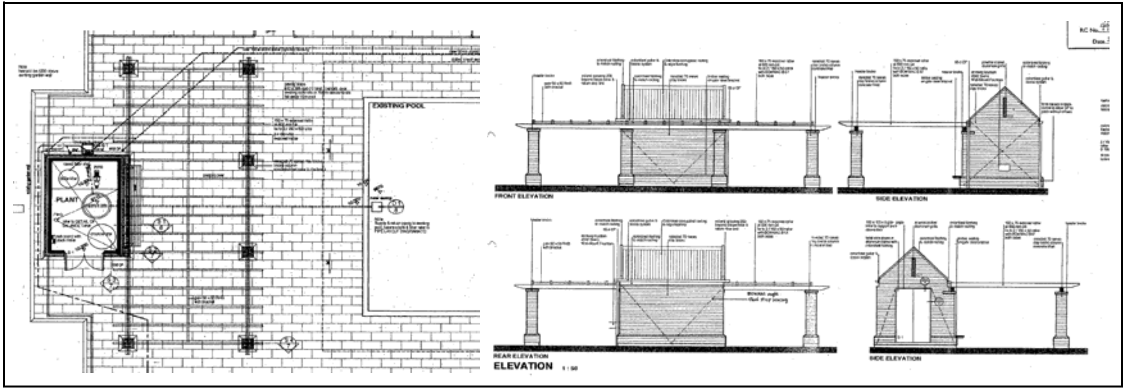
(Refer Table IEP - 2 for Step 2; Table IEP - 3 for Step 3, Table IEP - 4 for Steps 4, 5 and 6)

Building Name: Avebury Park Pool Plant Shed
Location: 9 Eveleyn Couzins Ave, Richmond
Ref. ZB01276.143
By WPK
Date 29/05/2012

Step 1 - General Information

1.1 Photos (attach sufficient to describe building)

1.2 Sketch of building plan



1.3 List relevant features

The building in Avebury Park at 9 Eveleyn Couzins Ave is one storey and is currently in use as a plant room for the nearby paddling pool. The building consists of timber framed walls with a brick veneer and a lightweight roof. There are six brick columns connected to the building by timber beams that are secondary structural elements. The columns are believed to have a minor effect on the building, therefore the main lateral load-resisting system will be the timber framing in the walls. Internal inspection was not able to be carried out as the building was inaccessible at the time of the inspection. The walls appear to be founded on a concrete slab footing. The building was believed to be designed and constructed after 1992, as the architectural drawings are dated 1999.

1.4 Note information sources

Tick as appropriate

Visual Inspection of Exterior ☑
Visual Inspection of Interior ☐
Drawings (note type) ☑ Architectural
Specifications ☐
Geotechical Reports ☑
Other (list) ☐

Table IEP-2 Initial Evaluation Procedure – Step 2

(Refer Table IEP - 1 for Step 1; Table IEP - 3 for Step 3, Table IEP - 4 for Steps 4, 5 and 6)

Building Name:	Avebury Park Pool Plant Shed	Ref.	ZB01276.143
Location:	9 Eveleyn Couzins Ave, Richmond	By	WPK
Direction Considered:	**Longitudinal & Transverse**	Date	29/05/2012

(Choose worse case if clear at start. Complete IEP-2 and IEP-3 for each if in doubt)

Step 2 - Determination of (%NBS)b

2.1 Determine nominal (%NBS) = (%NBS)nom

Pre 1935			○	See also notes 1, 3
1935-1965			○	
1965-1976	Seismic Zone;	A	○	
		B	○	
		C	○	See also note 2
1976-1992	Seismic Zone;	A	○	
		B	○	
		C	○	
1992-2004			●	

b) Soil Type

From NZS1170.5:2004, Cl 3.1.3	A or B Rock	○
	C Shallow Soil	○
	D Soft Soil	●
	E Very Soft Soil	○

From NZS4203:1992, Cl 4.6.2.2	a) Rigid	○	N-A
(for 1992 to 2004 only and only if known)	b) Intermediate	○	

c) Estimate Period, T

building Ht = 3 meters

	Longitudinal	Transverse	
Ac =	N/A	N/A	m2

Can use following:

		Longitudinal	Transverse
$T = 0.09h_n^{0.75}$	for moment-resisting concrete frames	○ MRCF	○ MRCF
$T = 0.14h_n^{0.75}$	for moment-resisting steel frames	○ MRSF	○ MRSF
$T = 0.08h_n^{0.75}$	for eccentrically braced steel frames	○ EBSF	○ EBSF
$T = 0.06h_n^{0.75}$	for all other frame structures	● Others	● Others
$T = 0.09h_n^{0.75}/A_c^{0.5}$	for concrete shear walls	○ CSW	○ CSW
T <= 0.4sec	for masonry shear walls	○ MSW	○ MSW

Where hn = height in m from the base of the structure to the uppermost seismic weight or mass.
Ac = ΣAi(0.2 + Lwi/hn)2
Ai = cross-sectional shear area of shear wall i in the first storey of the building, in m2
lwi = length of shear wall i in the first storey in the direction parallel to the applied forces, in m
with the restriction that lwi/hn shall not exceed 0.9

Longitudinal	Transverse	
0.1	0.1	Seconds

d) (%NBS)nom determined from Figure 3.3

Longitudinal	22.2	$(\%NBS)_{nom}$
Transverse	22.2	$(\%NBS)_{nom}$

			Factor
Note 1:	For buildings designed prior to 1965 and known to be designed as public buildings in accordance with the code of the time, multiply (%NBS)nom by 1.25.	No	1
	For buildings designed 1965 - 1976 and known to be designed as public buildings in accordance with the code of the time, multiply (%NBS)nom by 1.33 - Zone A or 1.2 - Zone B	No	1
Note 2:	For reinforced concrete buildings designed between 1976 -1984 (%NBS)nom by 1.2	No	1
Note 3:	For buildings designed prior to 1935 multiply (%NBS)nom by 0.8 except for Wellington where the factor may be taken as 1.	No	1

Longitudinal	22.2	$(\%NBS)_{nom}$
Transverse	22.2	$(\%NBS)_{nom}$

Continued over page

Table IEP-2 Initial Evaluation Procedure – Step 2 continued

Building Name:	Avebury Park Pool Plant Shed	Ref.	ZB01276.143
Location:	9 Eveleyn Couzins Ave, Richmond	By	WPK
Direction Considered:	**Longitudinal & Transverse**	Date	29/05/2012

(Choose worse case if clear at start. Complete IEP-2 and IEP-3 for each if in doubt)

2.2 Near Fault Scaling Factor, Factor A

If T < 1.5sec, Factor A = 1

a) Near Fault Factor, N(T,D) 1
(from NZS1170.5:2004, Cl 3.1.6)

b) Near Fault Scaling Factor = 1/N(T,D)

Factor A	1.00

2.3 Hazard Scaling Factor, Factor B

Select Location: Christchurch

a) Hazard Factor, Z, for site
(from NZS1170.5:2004, Table 3.3)

Z = 0.3
Z 1992 = 0.8

Auckland	0.6	Palm Nth	1.2
Wellington	1.2	Dunedin	0.6
Christchurch	0.8	Hamilton	0.67

b) Hazard Scaling Factor Type Z 1992 above

For pre 1992 = 1/Z
\# For 1992 onwards = Z 1992/Z

(Where Z 1992 is the NZS4203:1992 Zone Factor from accompanying Figure 3.5(b))

Factor B	2.67

2.4 Return Period Scaling Factor, Factor C

a) Building Importance Level 2
(from NZS1170.0:2004, Table 3.1 and 3.2)

b) Return Period Scaling Factor from accompanying Table 3.1

Factor C	1.00

2.5 Ductility Scaling Factor, D

a) Assessed Ductility of Existing Structure, μ
(shall be less than maximum given in accompanying Table 3.2)

Longitudinal	**1.25**	μ Maximum = 6
Transverse	**1.25**	μ Maximum = 6

b) Ductility Scaling Factor

For pre 1976 = k_μ
For 1976 onwards = 1

(where k_μ is NZS1170.5:2005 Ductility Factor, from accompanying Table 3.3)

Longitudinal	**Factor D**	1.00
Transverse	**Factor D**	1.00

2.6 Structural Performance Scaling Factor, Factor E

Select Material of Lateral Load Resisting System

Longitudinal Timber
Transverse Timber

a) Structural Performance Factor, S_p
from accompanying Figure 3.4

Longitudinal	Sp	0.93
Transverse	Sp	0.93

b) Structural Performance Scaling Factor

Longitudinal	$1/S_p$	**Factor E**	1.08
Transverse	$1/S_p$	**Factor E**	1.08

2.7 Baseline %NBS for Building, $(\%NBS)_b$

(equals $(\%NSB)_{nom}$ x A x B x C x D x E)

Longitudinal	64.0	(%NBS)b
Transverse	64.0	(%NBS)b

Table IEP-3 Initial Evaluation Procedure – Step 3

(Refer Table IEP - 1 for Step 1; Table IEP - 2 for Step 2, Table IEP - 4 for Steps 4, 5 and 6)

Building Name: Avebury Park Pool Plant Shed
Location: 9 Eveleyn Couzins Ave, Richmond
Direction Considered: **a) Longitudinal**
(Choose worse case if clear at start. Complete IEP-2 and IEP-3 for each if in doubt)

Ref. ZB01276.143
By WPK
Date 29/05/2012

Step 3 - Assessment of Performance Achievement Ratio (PAR)

(Refer Appendix B - Section B3.2)

Critical Structural Weakness	**Effect on Structural Performance** (Choose a value - Do not interpolate)	**Building Score**

3.1 Plan Irregularity

	Severe	Significant	Insignificant		
Effect on Structural Performance	○	○	●	**Factor A**	1
Comment					

3.2 Vertical Irregularity

	Severe	Significant	Insignificant		
Effect on Structural Performance	○	○	●	**Factor B**	1
Comment					

3.3 Short Columns

	Severe	Significant	Insignificant		
Effect on Structural Performance	○	○	●	**Factor C**	1
Comment					

3.4 Pounding Potential

(Estimate D1 and D2 and set D = the lower of the two, or =1.0 if no potential for pounding)

a) Factor D1: - Pounding Effect
Select appropriate value from Table

Note:
Values given assume the building has a frame structure. For stiff buildings (eg with shear walls), the effect of pounding may be reduced by taking the co-efficient to the right of the value applicable to frame buildings.

Factor D1 1

Table for Selection of Factor D1	Severe	Significant	Insignificant
Separation	0<Sep<.005H	.005<Sep<.01H	Sep>.01H
Alignment of Floors within 20% of Storey Height	○ 0.7	○ 0.8	● 1
Alignment of Floors not within 20% of Storey Height	○ 0.4	○ 0.7	○ 0.8

b) Factor D2: - Height Difference Effect
Select appropriate value from Table

Factor D2 1

Table for Selection of Factor D2	Severe	Significant	Insignificant
Separation	0<Sep<.005H	.005<Sep<.01H	Sep>.01H
Height Difference > 4 Storeys	○ 0.4	○ 0.7	○ 1
Height Difference 2 to 4 Storeys	○ 0.7	○ 0.9	○ 1
Height Difference < 2 Storeys	○ 1	○ 1	● 1

Factor D 1

(Set D = lesser of D1 and D2 or..
set D = 1.0 if no prospect of pounding)

3.5 Site Characteristics - (Stability, landslide threat, liquefaction etc)

	Severe	Significant	Insignificant		
Effect on Structural Performance	○ 0.5	○ 0.7	● 1	**Factor E**	1

3.6 Other Factors

For < 3 storeys - Maximum value 2.5,

otherwise - Maximum value 1.5. No minimum. **Factor F** 1.5

Record rationale for choice of Factor F:

Small-sized building with no apparent structural damage.

3.7 Performance Achievement Ratio (PAR)
(equals A x B x C x D x E x F)

PAR 1.5

Table IEP-3 **Initial Evaluation Procedure – Step 3**

(Refer Table IEP - 1 for Step 1; Table IEP - 2 for Step 2, Table IEP - 4 for Steps 4, 5 and 6)

Building Name:	Avebury Park Pool Plant Shed	Ref.	ZB01276.143
Location:	9 Eveleyn Couzins Ave, Richmond	By	WPK
Direction Considered:	**b) Transverse**	Date	29/05/2012

(Choose worse case if clear at start. Complete IEP-2 and IEP-3 for each if in doubt)

Step 3 - Assessment of Performance Achievement Ratio (PAR)

(Refer Appendix B - Section B3.2)

Critical Structural Weakness	**Effect on Structural Performance** (Choose a value - Do not interpolate)			**Building Score**
	Severe	Significant	Insignificant	
3.1 Plan Irregularity Effect on Structural Performance	○	○	●	**Factor A** 1
Comment				
3.2 Vertical Irregularity Effect on Structural Performance	○	○	●	**Factor B** 1
Comment				
3.3 Short Columns Effect on Structural Performance	○	○	●	**Factor C** 1
Comment				

3.4 Pounding Potential

(Estimate D1 and D2 and set D = the lower of the two, or =1.0 if no potential for pounding)

a) Factor D1: - Pounding Effect

Select appropriate value from Table

Note:
Values given assume the building has a frame structure. For stiff buildings (eg with shear walls), the effect of pounding may be reduced by taking the co-efficient to the right of the value applicable to frame buildings.

Factor D1 1

Table for Selection of Factor D1	Severe	Significant	Insignificant
Separation	0<Sep<.005H	.005<Sep<.01H	Sep>.01H
Alignment of Floors within 20% of Storey Height	○ 0.7	○ 0.8	● 1
Alignment of Floors not within 20% of Storey Height	○ 0.4	○ 0.7	○ 0.8

b) Factor D2: - Height Difference Effect

Select appropriate value from Table

Factor D2 1

Table for Selection of Factor D2	Severe	Significant	Insignificant
Separation	0<Sep<.005H	.005<Sep<.01H	Sep>.01H
Height Difference > 4 Storeys	○ 0.4	○ 0.7	○ 1
Height Difference 2 to 4 Storeys	○ 0.7	○ 0.9	○ 1
Height Difference < 2 Storeys	○ 1	○ 1	● 1

Factor D 1

(Set D = lesser of D1 and D2 or..
set D = 1.0 if no prospect of pounding)

3.5 Site Characteristics - (Stability, landslide threat, liquefaction etc)

	Severe	Significant	Insignificant	
Effect on Structural Performance	○ 0.5	○ 0.7	● 1	**Factor E** 1

3.6 Other Factors

For < 3 storeys - Maximum value 2.5,

otherwise - Maximum value 1.5. No minimum.

Factor F 1.5

Record rationale for choice of Factor F:

Small-sized building with no apparent structural damage.

3.7 Performance Achievement Ratio (PAR)
(equals A x B x C x D x E x F)

PAR 1.5

Table IEP-4

Initial Evaluation Procedure – Steps 4, 5 and 6

(Refer Table IEP - 1 for Step 1; Table IEP - 2 for Step 2, Table IEP - 3 for Step 3)

Building Name:	Avebury Park Pool Plant Shed	Ref.	ZB01276.143
Location:	9 Eveleyn Couzins Ave, Richmond	By	WPK
Direction Considered:	**Longitudinal & Transverse**	Date	29/05/2012

(Choose worse case if clear at start. Complete IEP-2 and IEP-3 for each if in doubt)

Step 4 - Percentage of New Building Standard (%NBS)

	Longitudinal	Transverse
4.1 Assessed Baseline (%NBS)$_b$ (from Table IEP - 1)	64	64
4.2 Performance Achievement Ratio (PAR) (from Table IEP - 2)	1.50	1.50
4.3 PAR x Baseline (%NBS)$_b$	96	96

4.4 Percentage New Building Standard (%NBS) **96**

(Use lower of two values from Step 4.3)

Step 5 - Potentially Earthquake Prone?

(Mark as appropriate)

%NBS ≤ 33 NO

Step 6 - Potentially Earthquake Risk?

%NBS < 67 NO

Step 7 - Provisional Grading for Seismic Risk based on IEP

Seismic Grade **A**

Evaluation Confirmed by

Signature

Nick Calvert Name

242062 CPEng. No

Relationship between Seismic Grade and % NBS :

Grade:	A+	A	B	C	D	E
%NBS:	> 100	100 to 80	80 to 67	67 to 33	33 to 20	< 20

13. Appendix 3 – CERA Standardised Report Form

Detailed Engineering Evaluation Summary Data V1.11

Location

Building Name: Avebury Park Pool Plant Shed

Unit No: Street

Building Address: 9 Eveleyn Couzins Ave, Richmond

Legal Description:

Degrees Min Sec

GPS south:

GPS east:

Building Unique Identifier (CCC): BU 0680-008 EQ2

Reviewer: N Calvert

CPEng No: 242062

Company: SKM

Company project number: ZB01276.143

Company phone number: 09 928 5500

Date of submission: 25-Mar

Inspection Date: 22/05/2012

Revision: B

Is there a full report with this summary? yes

Site

Site slope: flat

Soil type:

Site Class (to NZS1170.5): D

Proximity to waterway (m, if <100m):

Proximity to clifftop (m, if < 100m):

Proximity to cliff base (m,if <100m):

Max retaining height (m):

Soil Profile (if available):

If Ground improvement on site, describe:

Approx site elevation (m):

Building

No. of storeys above ground: 1 single storey = 1

Ground floor split? no

Storeys below ground 0

Foundation type: mat slab

Building height (m): 3.00

Floor footprint area (approx): 48

Age of Building (years): 20

Ground floor elevation (Absolute) (m):

Ground floor elevation above ground (m):

if Foundation type is other, describe:

height from ground to level of uppermost seismic mass (for IEP only) (m): 3

Date of design: 1976-1992

Strengthening present? no

Use (ground floor): public

Use (upper floors):

Use notes (if required):

Importance level (to NZS1170.5): IL2

If so, when (year)?

And what load level (%g)?

Brief strengthening description:

Gravity Structure

Gravity System: frame system

Roof: timber framed

Floors: concrete flat slab

Beams: timber

Columns: timber

Walls: non-load bearing

rafter type, purlin type and cladding: Assumed timber rafters & purlins and lightweight steel cladding

slab thickness (mm): Unknown

type:

typical dimensions (mm x mm): Unknown

0

Lateral load resisting structure

Lateral system along: lightweight timber framed walls

Ductility assumed, μ: 1.25

Period along: 0.10 0.00

Total deflection (ULS) (mm): 10

maximum interstorey deflection (ULS) (mm):

Note: Define along and across in detailed report!

note typical wall length (m): 3.6

estimate or calculation? estimated

estimate or calculation? estimated

estimate or calculation? estimated

Lateral system across: lightweight timber framed walls

Ductility assumed, μ: 1.25

Period across: 0.10 0.00

Total deflection (ULS) (mm): 10

maximum interstorey deflection (ULS) (mm):

note typical wall length (m): 2

estimate or calculation? estimated

estimate or calculation? estimated

estimate or calculation? estimated

Separations:

north (mm):

east (mm):

south (mm):

west (mm):

leave blank if not relevant

Non-structural elements

Stairs:

Wall cladding:

Roof Cladding: Metal

Glazing:

Ceilings:

Services(list):

describe: coloursteel corrugated sheeting

Available documentation

Architectural: partial — original designer name/date: R & A Design, October 1999

Structural: none — original designer name/date:

Mechanical: none — original designer name/date:

Electrical: none — original designer name/date:

Geotech report: partial — original designer name/date:

Damage

Site:

(refer DEE Table 4-2)

Site performance:

Describe damage:

Settlement: none observed — notes (if applicable):

Differential settlement: none observed — notes (if applicable):

Liquefaction: none apparent — notes (if applicable):

Lateral Spread: none apparent — notes (if applicable):

Differential lateral spread: none apparent — notes (if applicable):

Ground cracks: none apparent — notes (if applicable):

Damage to area: none apparent — notes (if applicable):

Building:

Current Placard Status: green

Along Damage ratio: 0%

Describe (summary): No damage observed

Describe how damage ratio arrived at: No structural damage noted, therefore the capacity of the building will not be diminished.

Across Damage ratio: 0%

Describe (summary): No damage observed

$$Damage\_Ratio = \frac{(\%NBS(before) - \%NBS(after))}{\%NBS(before)}$$

Diaphragms Damage?: no — Describe:

CSWs: Damage?: no — Describe:

Pounding: Damage?: no — Describe:

Non-structural: Damage?: no — Describe:

Recommendations

Level of repair/strengthening required: none — Describe:

Building Consent required: no — Describe:

Interim occupancy recommendations: full occupancy — Describe:

Along Assessed %NBS before: 96% %NBS from IEP below

Assessed %NBS after: 96%

If IEP not used, please detail assessment methodology: Qualitative Assessment carried out includes NZSEE IEP (refer to SKM report).

Across Assessed %NBS before: 96% %NBS from IEP below

Assessed %NBS after: 96%

14. Appendix 4 – Geotechnical Desktop Study

Christchurch City Council - Structural Engineering Service

Geotechnical Desk Study

SKM project number	ZB01276
SKM project site number	107 and 143
Address	Avebury Park Toilets/Pigeon Club and Paddling Pool - 9 & 11 Eveleyn Couzins Avenue
Report date	August 2012
Author	Chris Ritchie / Dominic Hollands
Reviewer	Leah Bateman
Approved for issue	Yes

1. Introduction

This report outlines the geotechnical information that Sinclair Knight Merz (SKM) has been able to source from our database and other sources in relation to the property listed above. We understand that this information will be used as part of an initial qualitative Detailed Engineering Evaluation (DEE), and will be supplemented by more detailed information and investigations to allow detailed scoping of the repair or rebuild of the building.

2. Scope

This geotechnical desk top study incorporates information sourced from:

- Published geology
- Publically available borehole records
- Liquefaction records
- Aerial photography
- Council files
- A preliminary site walkover

3. Limitations

This report was prepared to address geotechnical issues relating to the specific site in accordance with the scope of works as defined in the contract between SKM and our Client. This report has been prepared on behalf of, and for the exclusive use of, our Client, and is subject to, and issued in accordance with, the provisions of the contract between SKM and our Client. The findings presented in this report should not be applied to another site or another development within the same site without consulting SKM.

The assessment undertaken by SKM was limited to a desktop review of the data described in this report. SKM has not undertaken any subsurface investigations, measurement or testing of materials from the site. In preparing this report, SKM has relied upon, and presumed accurate, any information (or confirmation of the absence thereof) provided by our Client, and from other sources as described in the report. Except as otherwise stated in this report, SKM has not attempted to verify the accuracy or completeness of any such information.

This report should be read in full and no excerpts are to be taken as representative of the findings. It must not be copied in parts, have parts removed, redrawn or otherwise altered without the written consent of SKM.

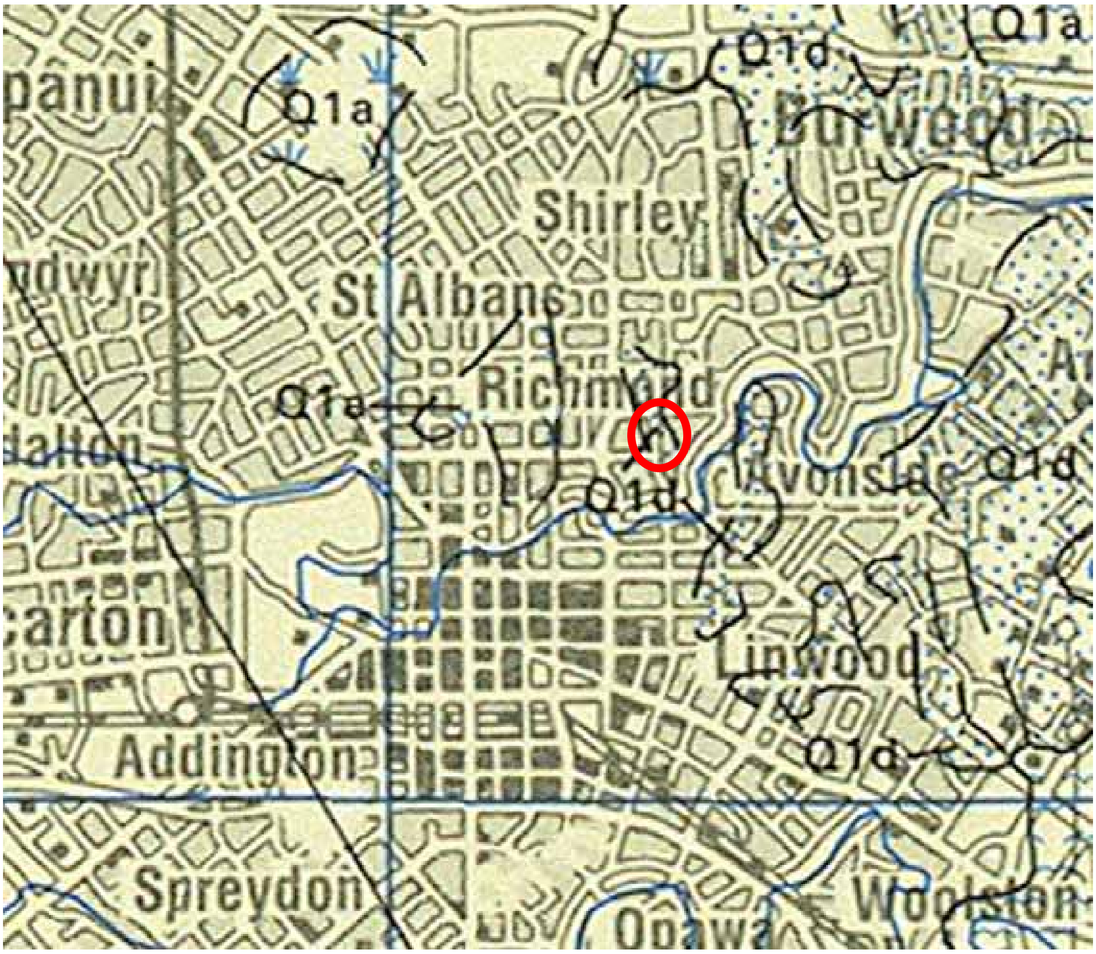
4. Site location

- **Figure 1 – Site location (courtesy of LINZ http://viewers.geospatial.govt.nz)**

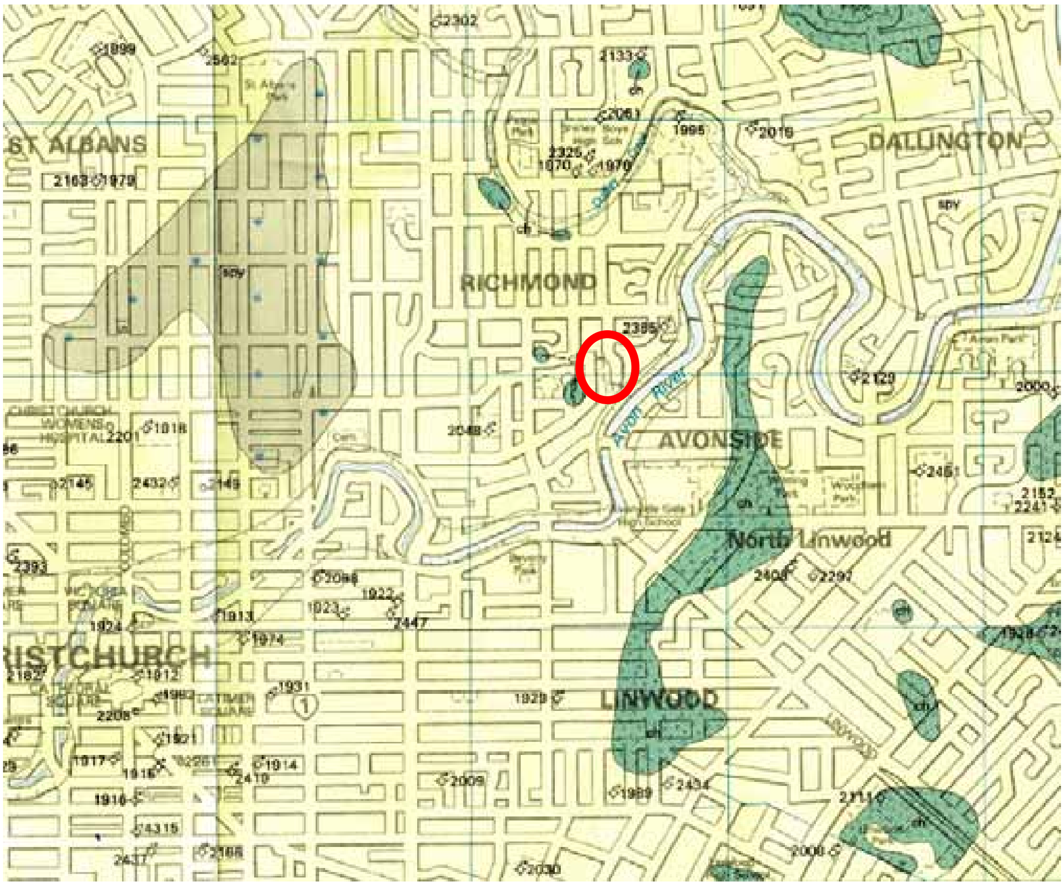
The structures is located at 9 & 11 Eveleyn Couzins Avenue, grid reference 1572536 E, 5181358 N (NZTM).

5. Review of available information

5.1 Geological maps



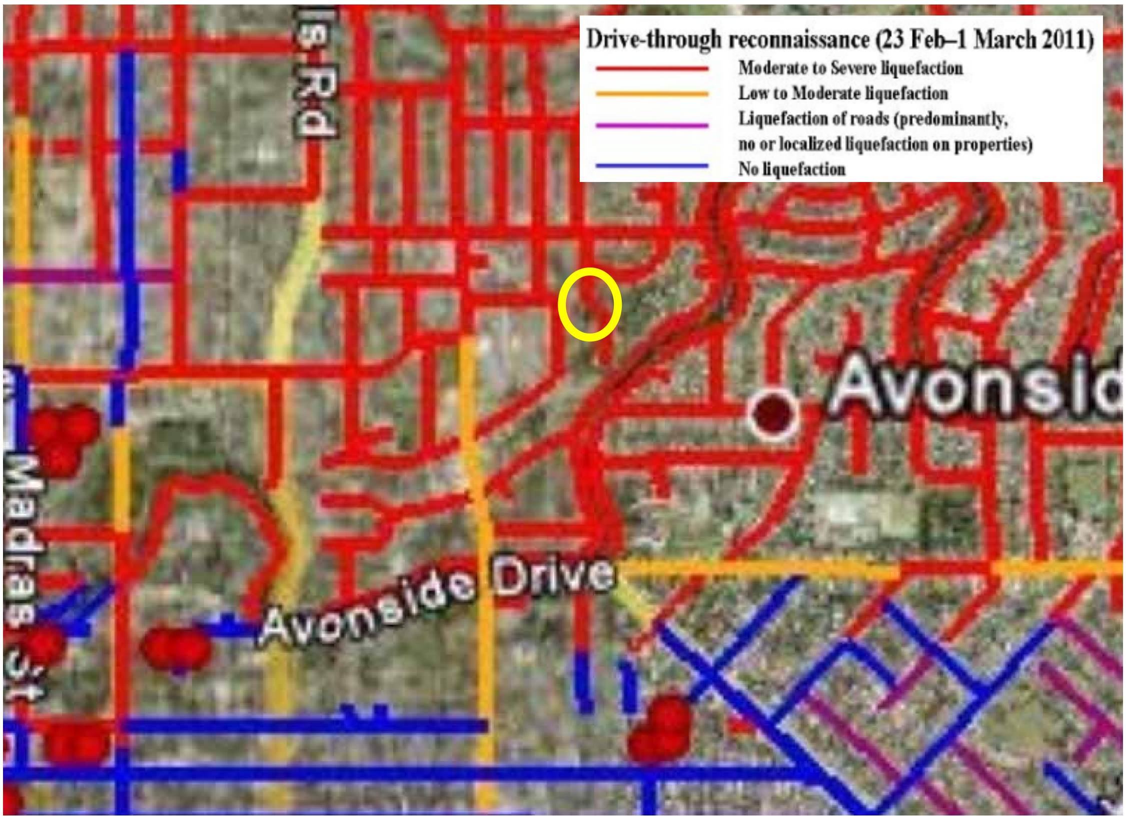
- **Figure 2 – Regional geological map (Forsyth et al, 2008). Site marked in red.**



- **Figure 3 – Local geological map (Brown et al, 1992). Site marked in red.**

The site is shown to be underlain by Holocene deposits comprising predominantly alluvial sand and silt overbank deposits of the Springston Formation.

5.2 Liquefaction map



- **Figure 4 – Liquefaction map (Cubrinovski & Taylor, 2011). Site marked in yellow.**

Following the 22 February 2011 event drive through reconnaissance was undertaken from 23 February until 1 March by M Cubrinovsko and M Taylor of Canterbury University. Their findings show moderate to severe liquefaction on all streets surrounding the site.

5.3 Aerial photography

- **Figure 5 – Aerial photography from 24 Feb 2011 (http://viewers.geospatial.govt.nz/)**

Aerial photography shows significant liquefaction after the 22 Feb 2011 event, particularly on the site at the location of the toilets and Pigeon Club building, as well as on the streets to the east and south of the site. Large lateral spreading cracks can be seen within the road and properties near the river.

5.4 CERA classification

A review of the LINZ website (http://viewers.geospatial.govt.nz/) shows that the site is:

- Zone: Green
- Urban Non-residential

Immediately to the south and east of the site the residential area is classified Red Zone. The residential areas north and west of the site is classified TC3.

5.5 Historical land use

Reference to historical documents (e.g. Appendix A) shows that the site lies adjacent to, or on the boundary of, land that was recorded as marshland or swamp in 1856. The historical records also identify a river traversing the site. It is therefore possible that soft or liquefiable ground would be present near the site. Given the relatively low accuracy of these historical documents, it should be considered possible that old swamp deposits are present on the site.

5.6 Existing ground investigation data

- **Figure 6 – Local boreholes from Project Orbit and SKM files (https://canterburyrecovery.projectorbit.com/)**

Where available logs from these investigation locations are attached to this report (Appendix B), and the results are summarised in Appendix C.

5.7 Council property files

The available council records for the site are limited to documents relating to the construction of a brick and timber pergola and a filter shed, and are associated with the existing paddling pool. While no foundation drawing of the proposed building are included with the building plans it is most probable that the filter shed has a concrete slab foundation. No details regarding the ground conditions underlying the site was found from the council records.

5.8 Site walkover

Two separate site walkovers were undertaken by SKM engineers. The initial visit was carried out on 20 May 2012 and focussed on ground damage associated with the toilet block and Pigeon Club building. The second visit, on 11 June 2012, centred on land damage associated with the paddling pool area.

The toilet block and the Pigeon Club building are built on a gentle slope which lowers down to a flat area in the paddling pool is located.

The toilet block building comprised red brick double walled cladding, an iron roof, and a probable concrete perimeter/slab foundation. The Pigeon Club building comprised masonry blocks cladding, tin roof and concrete slab foundation. The paddling pool is concrete lined with the filter shed comprising brick cladding, an iron roof and probable slab foundation. The pergola has red brick columns and timber frame.

The toilet block had extensive earthquake related damage with most of one side’s cladding collapsed as well as multiple cracks in other areas of cladding. The Pigeon Club building had moderate cladding damage with step cracks in the masonry cladding common. Recent mortar repairs to the cladding cracks were observed. There did not appear to be any damage to the paddling pool filter shed.

Although the asphalt paving appeared relatively undamaged there was common sand and silt ejecta close to the toilet and club buildings.

In the paddling pool area there were ground undulations on the grassed area, playing area and paving surrounding the pool. The concrete slabs around the pool were tilted and undulating.

The site is located 50 m north west of the Avon River and lateral spreading was evident on the road along the river.

- **Figure 7 Overview of the toilet block and Pigeon Club structures**

- **Figure 8 Evidence of sand and silt ejecta close by the toilet block and Pigeon Club buildings.**

- **Figure 9 Undulating paving next to the paddling pool, and damage to the fence and concrete slabs, relating to earthquake ground damage.**

- **Figure 10 Lateral spreading ground damage along the Avon River.**

6. Conclusions and recommendations

6.1 Site geology

An interpretation of the most relevant local investigation suggests that the site is underlain by:

Depth range (mBLG)	Soil type
0 - 2	Clayey silt
2 +	Sand and sandy Gravel

6.2 Seismic site subsoil class

The site has been assessed as NZS1170.5 Class D (deep or soft soil).

As described in NZS1170, the preferred site classification method is from site periods based on four times the shear wave travel time through material from the surface to the underlying rock. The next preferred methods are from borelogs including measurement of geotechnical properties or by evaluation of site periods from Nakamura ratios or from recorded earthquake motions. Lacking this information, classification may be based on boreholes with descriptors but no geotechnical measurements. The least preferred method is from surface geology and estimates of the depth to underlying rock.

The absence of deep boreholes or deep geophysics near the site has resulted in the use of the least preferred method. It is therefore possible that site specific investigation could revise the site class.

6.3 Building Performance

Although detailed records of the existing foundations are not available, the performance to date suggests that they are adequate for their current purpose.

6.4 Ground performance and properties

Liquefaction risk is moderate to severe at this site. The sand layers below 2 m are susceptible to liquefaction and would explain the significant liquefaction observed from the aerial photographs after the recent earthquake and during the site walkover. The nearby CPT and borehole logs suggest a soft fine-grained layer (clayey silt) at the near surface and sand (probably fine) at shallow depths. These layers are potentially liquefiable. However, the sandy gravel common at moderate depth are unlikely to be susceptible to liquefaction. All available ground investigation data was greater than 50 m away from the site. Therefore an estimation of the ground properties has not been provided in this desk study. Additional investigations closer to the site would be required to perform a full quantitative DEE.

6.5 Further investigations

A mentioned above additional investigations are expected to be necessary in order to perform a quantitative DEE, they will also be required if a consent is required or significant alterations to the structures are proposed. We recommend the following ground investigation:

- 2 boreholes to a depth of 20 m below ground level including SPTs and two 2 Cone Penetrometer (CPT) tests to refusal to obtain geotechnical parameters and ground conditions.

7. References

Brown LJ, Weeber JH, 1992. Geology of the Christchurch urban area. Scale 1:25,000. Institute of Geological & Nuclear Sciences geological map 1.

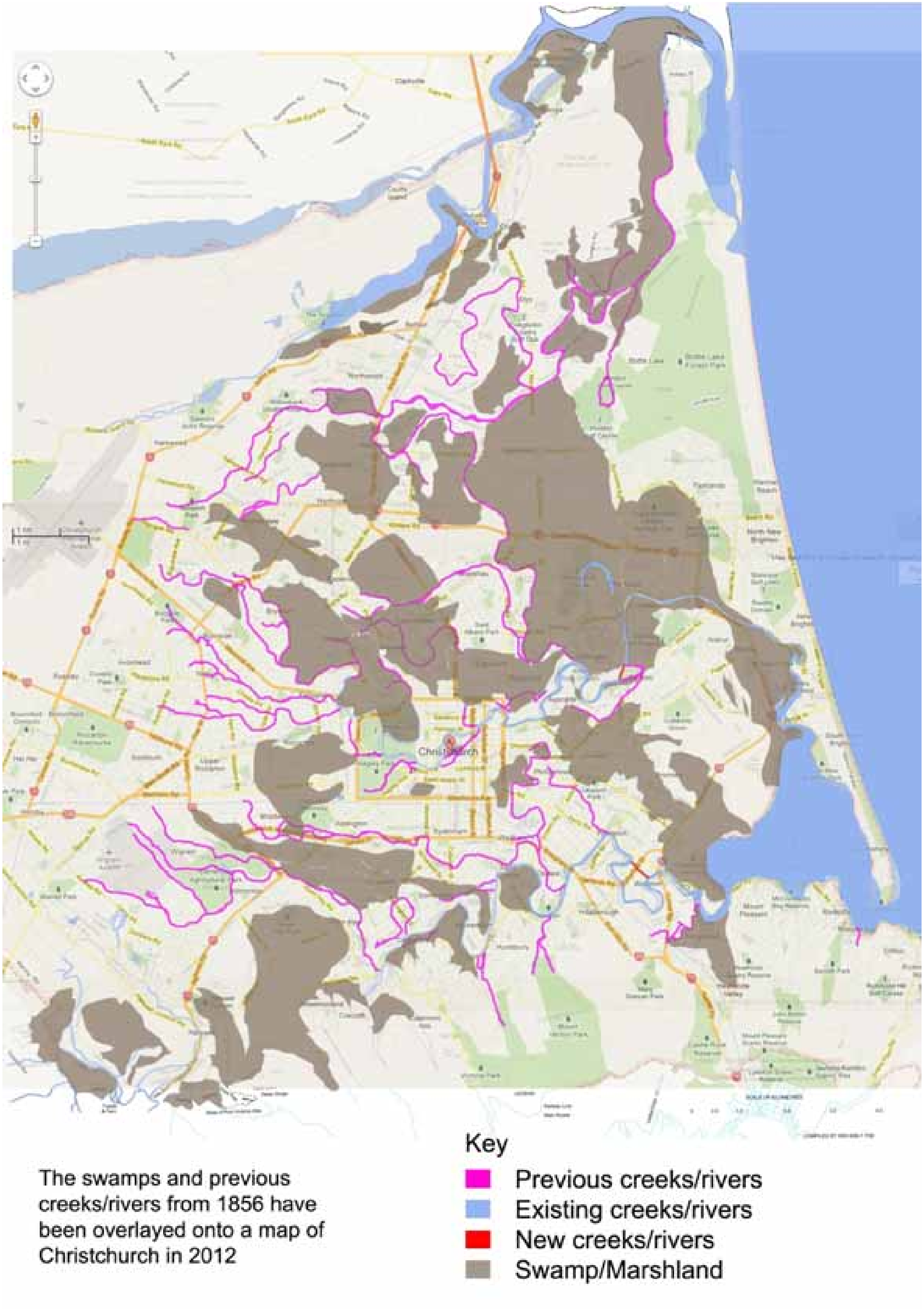
Cubrinovski & Taylor, 2011. Liquefaction map summarising preliminary assessment of liquefaction in urban areas following the 2010 Darfield Earthquake.

Forsyth PJ, Barrell DJA, Jongens R, 2008. Geology of the Christchurch area. Institute of Geological & Nuclear Sciences geological map 16.

Land Information New Zealand (LINZ) geospatial viewer (http://viewers.geospatial.govt.nz/)

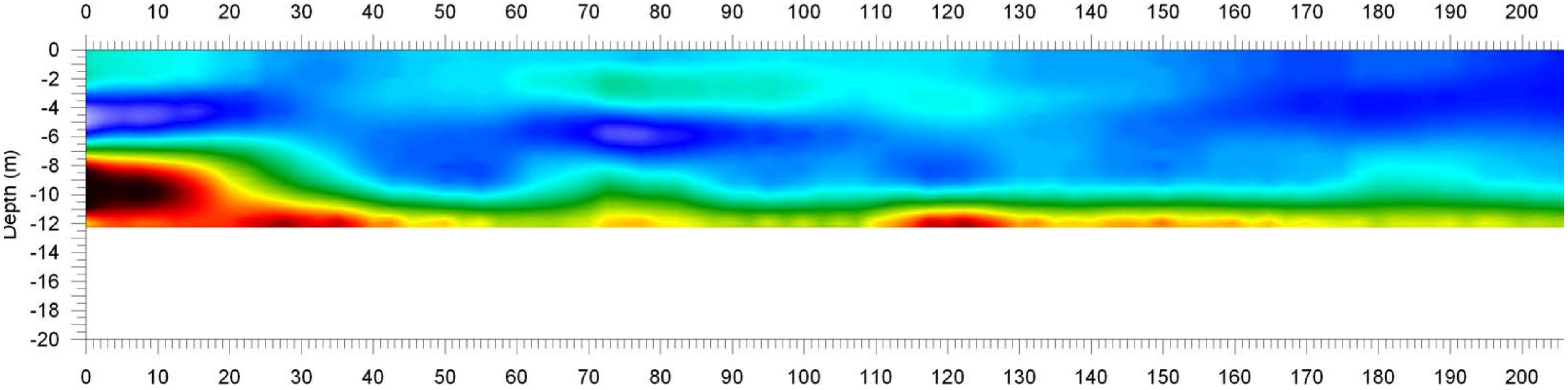
EQC Project Orbit geotechnical viewer (https://canterburyrecovery.projectorbit.com/)

Appendix A – Christchurch 1856 land use

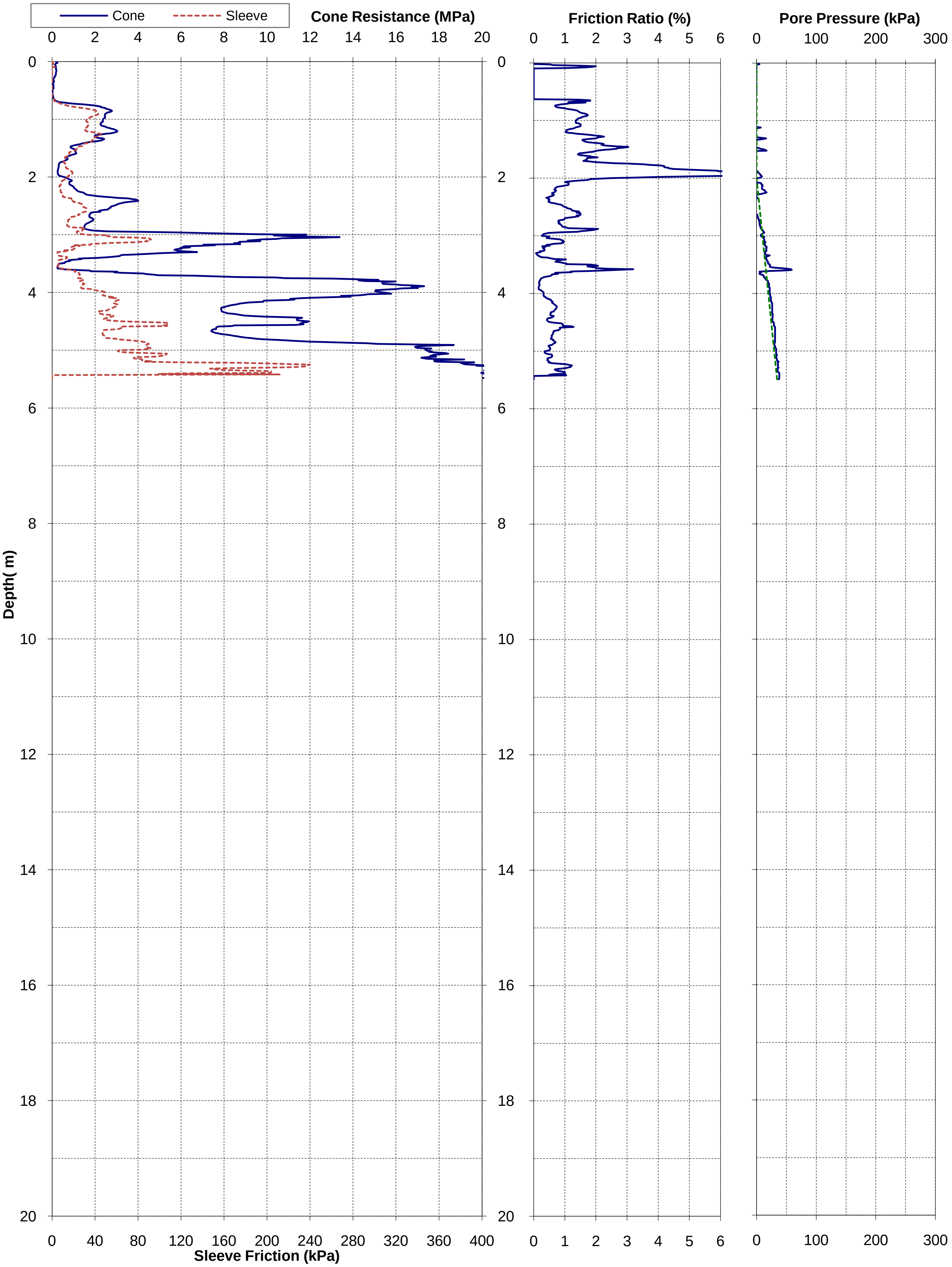


The swamps and previous creeks/rivers from 1856 have been overlayed onto a map of Christchurch in 2012

Appendix B – Existing ground investigation logs


0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150
160
170
180
190
200
Depth (m)
0
-2
-4
-6
-8
-10
-12
-14
-16
-18
-20

Project:	Darfield 2010 Earthquake - EQC Ground Investigations		**Page:**	1 of 1	**CPT-AVS-11**
Test Date:	16-Nov-2010	**Location:**	Avonside	**Operator:**	Perry
Pre-Drill:	0.8m	**Assumed GWL:**	2mBGL	**Located By:**	Survey GPS
Position:	2482695.1mE	5742925.6mN	2.39mRL	**Coord. System:**	NZMG & MSL
Other Tests:				**Comments:**	



TONKIN & TAYLOR LTD

BOREHOLE LOG

BOREHOLE No: RCH-01
Hole Location:
BH-RCH-01-Richmond

SHEET 1 OF 5

PROJECT: Darfield 2010 Earthquake - EQC Ground Investigations
LOCATION: Richmond
JOB No: 51731.001

CO-ORDINATES: 5742995.74, 2482719.46
R.L.: 2.63 m
DATUM: Lyttleton 1937
DRILL TYPE: Rotary
DRILL METHOD: Water Flush
DRILL FLUID: N/A
HOLE STARTED: 24/1/11
HOLE FINISHED: 26/1/11
DRILLED BY: McMillan
LOGGED BY: ZDP
CHECKED: BMcD

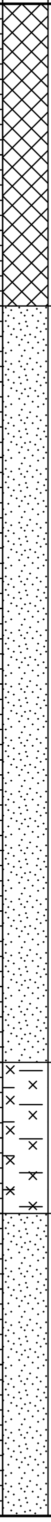
GEOLOGICAL: GEOLOGICAL UNIT, GENERIC NAME, ORIGIN, MINERAL COMPOSITION.

ENGINEERING DESCRIPTION: SOIL DESCRIPTION: Soil type, minor components, plasticity or particle size, colour. ROCK DESCRIPTION: Substance: Rock type, particle size, colour, minor components. Defects: Type, inclination, thickness, roughness, filling.

Columns: FLUID LOSS; WATER; CORE RECOVERY (%); METHOD; CASING; TESTS; SAMPLES; R.L. (m); DEPTH (m); GRAPHIC LOG; CLASSIFICATION SYMBOL; MOISTURE CONDITION / WEATHERING; STRENGTH/DENSITY CLASSIFICATION; SHEAR STRENGTH (kPa) 10 25 50 100 200; COMPRESSIVE STRENGTH (MPa) 1 5 20 50 100 250; DEFECT SPACING (mm) 50 250 1000 2000

R.L. (m): 2.5, 2.0, 1.5, 1.0, 0.5, 0.0, -0.5, -1.0, -1.5, -2.0

DEPTH (m): 0.5, 1.0, 1.5, 2.0, 2.5, 3.0, 3.5, 4.0, 4.5, 5



DEPTH (m)	GEOLOGICAL UNIT	METHOD	TESTS	SAMPLES	CLASSIFICATION SYMBOL	MOISTURE CONDITION	STRENGTH/DENSITY CLASSIFICATION	SOIL DESCRIPTION
0.0	FILL. (Potholed for services check and backfilled.)					D	VL	FILL. (Borehole drilled through pre-dug and backfilled pothole.)
1.0	YALDHURST FORMATION (Alluvial)				SW	W		Fine to medium SAND, grey. Wet, well graded.
2.0		BAGGED SAMPLE	✱FC	B				
3.0			✱FC	B				
			1/0/4 N=4	■ ■				
3.5			✱FC	B	ML		VS	Sandy SILT with trace organics, grey. Wet, low plasticity. Sand is fine.
4.0					SW		VL	Fine to medium SAND, grey. Wet, well graded.
							VD	
5			✱FC	B				

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BOREHOLE LOG

BOREHOLE No: RCH-01
Hole Location:
BH-RCH-01-Richmond

SHEET 2 OF 5

PROJECT: Darfield 2010 Earthquake - EQC Ground Investigations LOCATION: Richmond JOB No: 51731.001

CO-ORDINATES	5742995.74 2482719.46	DRILL TYPE: Rotary	HOLE STARTED: 24/1/11
		DRILL METHOD: Water Flush	HOLE FINISHED: 26/1/11
R.L.	2.63 m		DRILLED BY: McMillan
DATUM	Lyttleton 1937	DRILL FLUID: N/A	LOGGED BY: ZDP CHECKED: BMcD

GEOLOGICAL | ENGINEERING DESCRIPTION

GEOLOGICAL UNIT, GENERIC NAME, ORIGIN, MINERAL COMPOSITION.	FLUID LOSS	WATER	CORE RECOVERY (%)	METHOD	CASING	TESTS	SAMPLES	R.L. (m)	DEPTH (m)	GRAPHIC LOG	CLASSIFICATION SYMBOL	MOISTURE CONDITION / WEATHERING	STRENGTH/DENSITY CLASSIFICATION	SHEAR STRENGTH (kPa) 10 25 50 100 200	COMPRESSIVE STRENGTH (MPa) 1 5 20 50 100 250	DEFECT SPACING (mm) 50 250 1000 2000	SOIL DESCRIPTION Soil type, minor components, plasticity or particle size, colour. ROCK DESCRIPTION Substance: Rock type, particle size, colour, minor components. Defects: Type, inclination, thickness, roughness, filling.
YALDHURST FORMATION (Alluvial)				BAGGED SAMPLE				-2.5			SW	W	VL				Fine to medium SAND, grey. Wet, well graded. - trace medium, rounded gravel
						3/1/10 N=11							MD				
								-3.0	5.5								
						*FC	B		6.0		GW						Sandy, fine to medium GRAVEL, grey. Wet, well graded. Sand is fine to coarse.
								-3.5									
								-4.0	6.5								
								-4.5	7.0								
						5/4/11 N=15											
								-5.0	7.5								
								-5.5	8.0								
								-6.0	8.5								
								-6.5	9.0				VD				
						10/20/46 N=>50											
								-7.0	9.5								
									10								

TONKIN & TAYLOR LTD

BOREHOLE LOG

BOREHOLE No: RCH-01
Hole Location:
BH-RCH-01-Richmond

SHEET 3 OF 5

PROJECT: Darfield 2010 Earthquake - EQC Ground Investigations LOCATION: Richmond JOB No: 51731.001

CO-ORDINATES	5742995.74 2482719.46	DRILL TYPE: Rotary	HOLE STARTED: 24/1/11
		DRILL METHOD: Water Flush	HOLE FINISHED: 26/1/11
R.L.	2.63 m		DRILLED BY: McMillan
DATUM	Lyttleton 1937	DRILL FLUID: N/A	LOGGED BY: ZDP CHECKED: BMcD

GEOLOGICAL — ENGINEERING DESCRIPTION

GEOLOGICAL UNIT, GENERIC NAME, ORIGIN, MINERAL COMPOSITION. | FLUID LOSS | WATER | CORE RECOVERY (%) | METHOD | CASING | TESTS | SAMPLES | R.L. (m) | DEPTH (m) | GRAPHIC LOG | CLASSIFICATION SYMBOL | MOISTURE CONDITION / WEATHERING | STRENGTH/DENSITY CLASSIFICATION | SHEAR STRENGTH (kPa) 10 25 50 100 200 | COMPRESSIVE STRENGTH (MPa) 1 5 20 50 100 250 | DEFECT SPACING (mm) 50 250 1000 2000

SOIL DESCRIPTION
Soil type, minor components, plasticity or particle size, colour.

ROCK DESCRIPTION
Substance: Rock type, particle size, colour, minor components.
Defects: Type, inclination, thickness, roughness, filling.

GEOLOGICAL UNIT	METHOD	TESTS	DEPTH (m)	CLASSIFICATION SYMBOL	MOISTURE CONDITION	STRENGTH/DENSITY CLASSIFICATION	SOIL DESCRIPTION
YALDHURST FORMATION (Alluvial)	BAGGED SAMPLE			GW	W	VD	Sandy, fine to medium GRAVEL, grey. Wet, well graded. Sand is fine to coarse.
		N=>50					
CHRISTCHURCH FORMATION (Coastal)			13.0	SP			Fine SAND, grey. Wet, poorly graded.
		N=>50					
		2/3/5 N=8					- low SPT value possibly due to drilling method

DEPTH (m)	R.L. (m)
	-7.5
10.5	
	-8.0
11.0	
	-8.5
11.5	
	-9.0
12.0	
	-9.5
12.5	
	-10.0
13.0	
	-10.5
13.5	
	-11.0
14.0	
	-11.5
14.5	
	-12.0
15	

TONKIN & TAYLOR LTD

BOREHOLE LOG

BOREHOLE No: RCH-01
Hole Location:
BH-RCH-01-Richmond

SHEET 4 OF 5

PROJECT: Darfield 2010 Earthquake - EQC Ground Investigations
LOCATION: Richmond
JOB No: 51731.001

CO-ORDINATES 5742995.74
2482719.46
R.L. 2.63 m
DATUM Lyttleton 1937

DRILL TYPE: Rotary
DRILL METHOD: Water Flush
DRILL FLUID: N/A

HOLE STARTED: 24/1/11
HOLE FINISHED: 26/1/11
DRILLED BY: McMillan
LOGGED BY: ZDP
CHECKED: BMcD

GEOLOGICAL										ENGINEERING DESCRIPTION							
GEOLOGICAL UNIT, GENERIC NAME, ORIGIN, MINERAL COMPOSITION.	FLUID LOSS	WATER	CORE RECOVERY (%)	METHOD	CASING	TESTS	SAMPLES	R.L. (m)	DEPTH (m)	GRAPHIC LOG	CLASSIFICATION SYMBOL	MOISTURE CONDITION \ WEATHERING	STRENGTH/DENSITY CLASSIFICATION	SHEAR STRENGTH (kPa) 10 25 50 100 200	COMPRESSIVE STRENGTH (MPa) 1 5 20 50 100 250	DEFECT SPACING (mm) 50 250 1000 2000	SOIL DESCRIPTION Soil type, minor components, plasticity or particle size, colour. ROCK DESCRIPTION Substance: Rock type, particle size, colour, minor components. Defects: Type, inclination, thickness, roughness, filling.
CHRISTCHURCH FORMATION (Coastal)				BAGGED SAMPLE		N=>50 N=>50		-12.5 -13.0 -13.5 -14.0 -14.5 -15.0 -15.5 -16.0 -16.5 -17.0	15.5 16.0 16.5 17.0 17.5 18.0 18.5 19.0 19.5 20		SP	W	VD				Fine SAND, grey. Wet, poorly graded. 15.5 16.0 16.5 17.0 17.5 18.0 18.5 19.0 19.5

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BOREHOLE LOG

BOREHOLE No: RCH-01
Hole Location:
BH-RCH-01-Richmond
SHEET 5 OF 5

PROJECT: Darfield 2010 Earthquake - EQC Ground Investigations	LOCATION: Richmond	JOB No: 51731.001
CO-ORDINATES 5742995.74 2482719.46	DRILL TYPE: Rotary	HOLE STARTED: 24/1/11 HOLE FINISHED: 26/1/11
R.L. 2.63 m	DRILL METHOD: Water Flush	DRILLED BY: McMillan
DATUM Lyttleton 1937	DRILL FLUID: N/A	LOGGED BY: ZDP CHECKED: BMcD

GEOLOGICAL

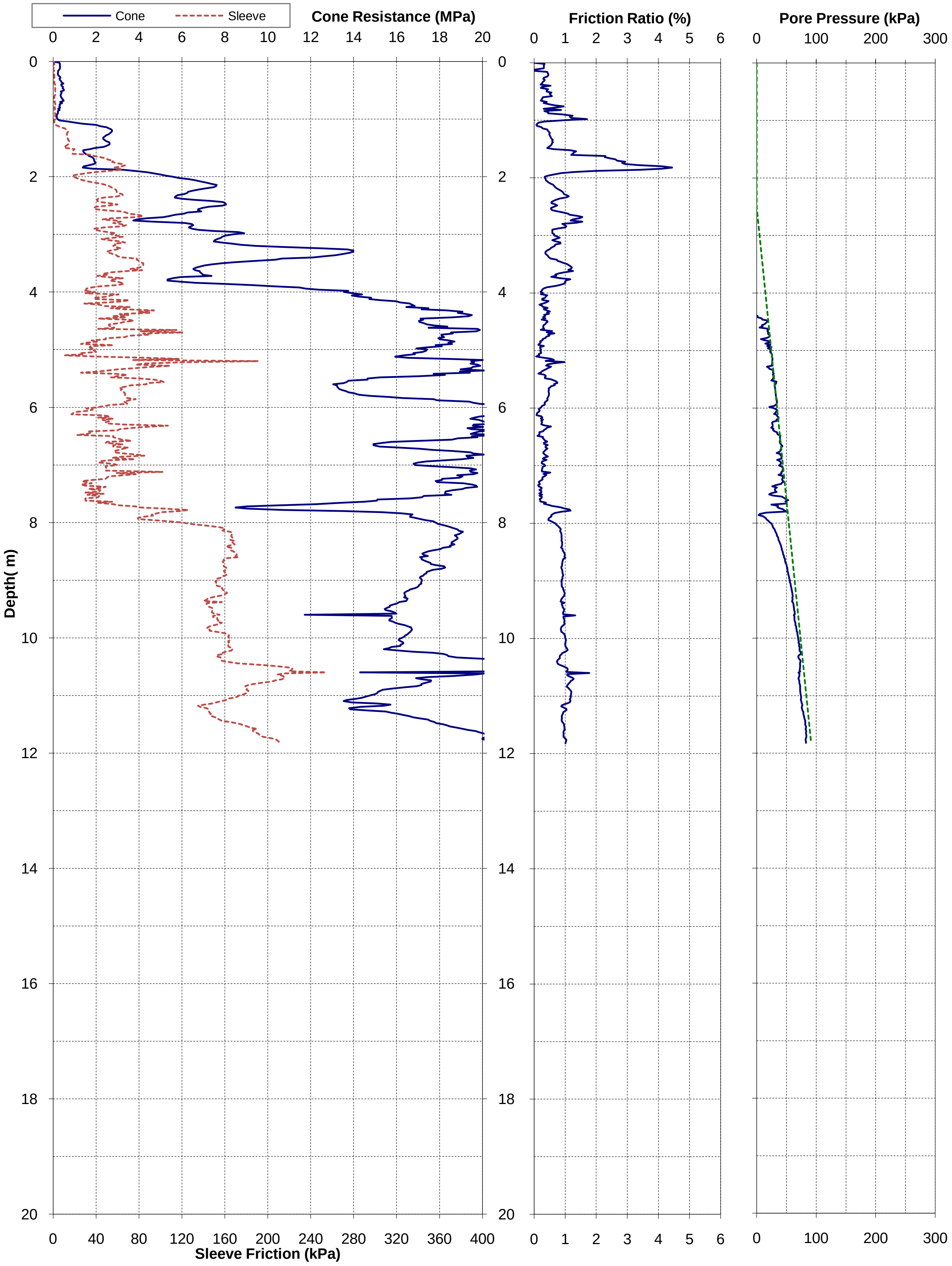
ENGINEERING DESCRIPTION

GEOLOGICAL UNIT, GENERIC NAME, ORIGIN, MINERAL COMPOSITION.	FLUID LOSS	WATER	CORE RECOVERY (%)	METHOD	CASING	TESTS	SAMPLES	DEPTH (m)	CLASSIFICATION SYMBOL	MOISTURE CONDITION / WEATHERING	STRENGTH/DENSITY CLASSIFICATION	SHEAR STRENGTH (kPa) 10 25 50 100 200	COMPRESSIVE STRENGTH (MPa) 1 5 20 50 100 250	DEFECT SPACING (mm) 50 250 1000 2000	SOIL DESCRIPTION Soil type, minor components, plasticity or particle size, colour. ROCK DESCRIPTION Substance: Rock type, particle size, colour, minor components. Defects: Type, inclination, thickness, roughness, filling.
CHRISTCHURCH FORMATION (Coastal)				BAGGED SAMPLE				to 22.0	SP	W	VD				Fine SAND, grey. Wet, poorly graded.
POSSIBLE RICCARTON GRAVEL? (Aquifer)								22.0 – 23.0	GW						Sandy, fine to coarse GRAVEL, grey. Wet, well graded, rounded. Sand is fine to coarse. - wood
								23.0							**End of borehole at 23mbgl.**

R.L. (m): -17.5, -18.0, -18.5, -19.0, -19.5, -20.0, -20.5, -21.0, -21.5, -22.0

DEPTH (m): 20.5, 21.0, 21.5, 22.0, 22.5, 23.0, 23.5, 24.0, 24.5, 25

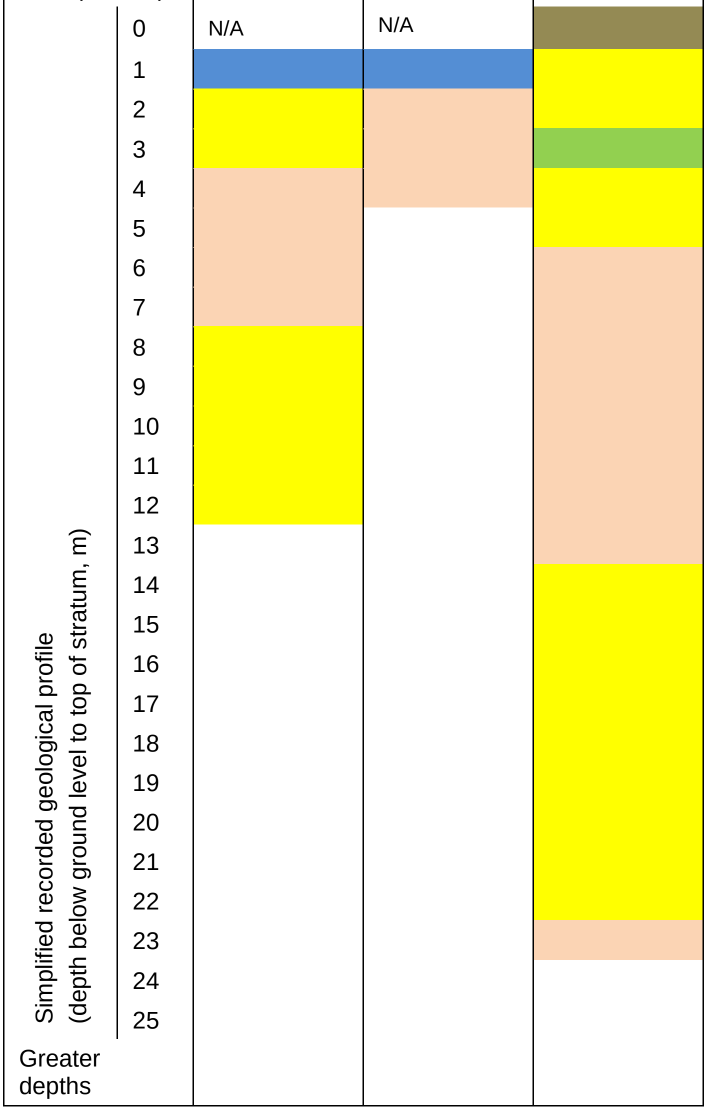
Project:	Christchurch 2011 Earthquake - EQC Ground Investigations				**Page:** 1 of 1		**CPT-RCH-37**
Test Date:	30-May-2011	**Location:**	Richmond	**Operator:**	Geotech		
Pre-Drill:	1.2m	**Assumed GWL:**	2.5mBGL	**Located By:**	Survey GPS		
Position:	2482472.1mE	5742941.2mN	3.87mRL	**Coord. System:**	NZMG & MSL		
Other Tests:				**Comments:**			



Appendix C – Geotechnical Investigation Summary

Table 1 Summary of most relevant investigation data

ID	1	2	3
B	CPT	CPT	BH
Ref	RCH-37	AVS-11	RCH-01
Depth (m)	12	5	23
Distance from site (m)	77	120	153
Ground water level (m BGL)	2	2	N/A



*BH: Borehole, HA: Hand Auger, WW: Water Well, CPT: Cone Penetration Test

🟪 Sensitive or organic clay/silt
🟦 Clay to silty clay
🟦 Clayey silt to silt
🟩 Silty sand to silt
🟩 Clayey sand
🟨 Sand
🟧 Gravelly sand or gravel
🟫 Fill

VL = very loose, L = loose, MD = medium dense, D = dense, VD = very dense
VS = very soft, So = soft, F = firm, St = stiff, VS = very stiff, H = hard