CHRISTCHURCH CITY COUNCIL

PRK_1566_BLDG_051 EQ2
Peacock Fountain Pumphouse
Rolleston Ave

QUALITATIVE ASSESSMENT REPORT
FINAL

- Rev B
- 26 March 2013

CHRISTCHURCH CITY COUNCIL

PRK_1566_BLDG_051 EQ2
Botanic Gardens – Peacock Fountain Pump House
Rolleston Ave

QUALITATIVE ASSESSMENT REPORT

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Contents

Document history and status

Revision	Date issued	Reviewed by	Approved by	Date approved	Revision type
A	8/10/2012	J Carter	N Calvert	8/10/2012	Draft for Client Approval
B	26/03/2013	N Calvert	N Calvert	26/03/2013	Final for Issue

Approval

	Signature	Date	Name	Title
Author		26/03/2013	Oliver Kingsnorth	Structural Engineer
Approver		26/03/2013	Nick Calvert	Senior Structural Engineer

Distribution of copies

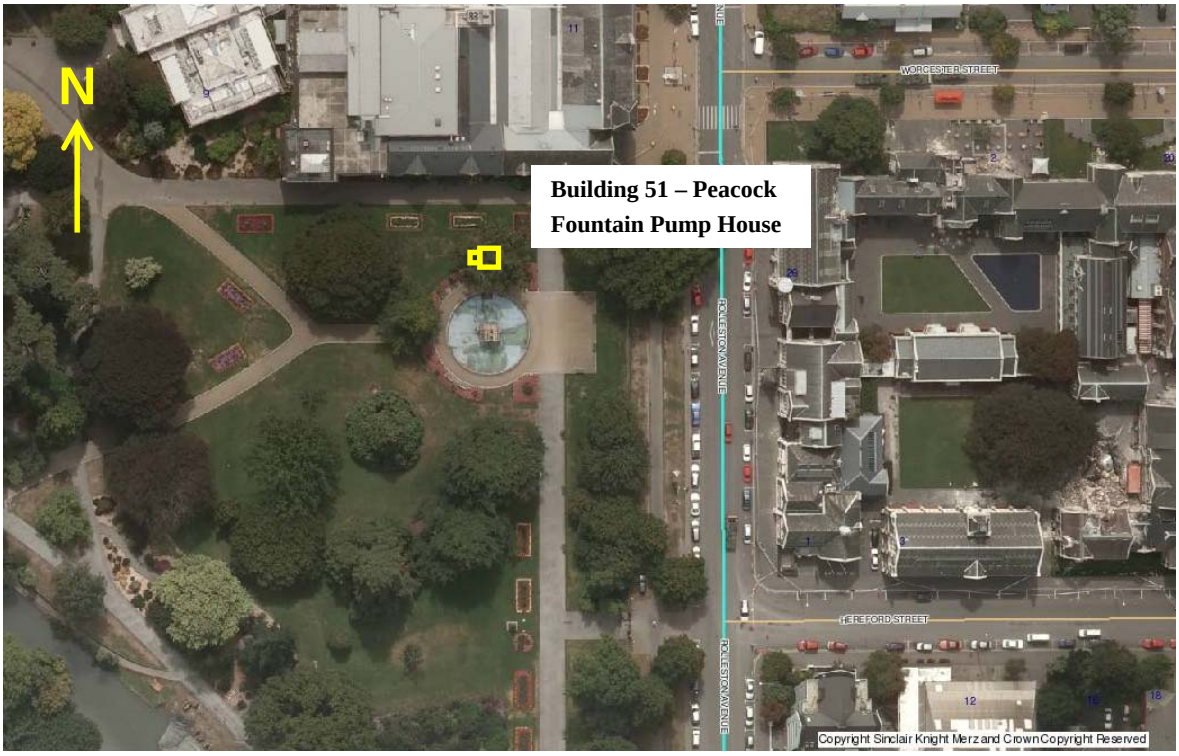
Revision	Copy no	Quantity	Issued to
A	1	1	Christchurch City Council
B	1	1	Christchurch City Council

Printed:	26 March 2013
Last saved:	26 March 2013 09:42 AM
File name:	ZB01276.093.PRK_1566_BLDG_051 EQ2.Qualitative.Assmt.B.docx
Author:	Oliver Kingsnorth
Project manager:	Nick Calvert
Name of organisation:	Christchurch City Council
Name of project:	Christchurch City Council Structures Panel
Name of document:	CCC, Botanic Gardens, Peacock Fountain Pump House, PRK_1566_BLDG_051 EQ2
Document version:	B
Project number:	ZB01276.093

1. Executive Summary

1.1. Background

A Qualitative Assessment was carried out on the Peacock Fountain Pump House located at the Botanic Gardens. The pump house is a small timber framed structure with copper roof sheeting. A lean-to frame is attached to the west side of the main structure. The structure houses a pump for the adjacent fountain and some maintenance equipment. An aerial photograph illustrating this structure is shown below in Figure 1. A detailed description outlining the buildings age and construction type are given in Section 5 of this report.



- **Figure 1** Aerial Photograph of the Botanic Gardens showing the location of Building 51

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, visual inspections on 26 April 2012.

1.2. Key Damage Observed

No structural damage was observed at the time of the inspection.

Non-structural damage noted includes damage to the external lining on the roof of the lean-to.

1.3. Critical Structural Weaknesses

No critical structural weaknesses have been identified.

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 83% NBS. Damage to the structure does not alter the strength of the building and therefore the post earthquake capacity remains the same. This assessment has been made without structural drawings and is accordingly limited.

The building has been assessed to have a seismic capacity in the order of 83% NBS and is therefore not earthquake prone.

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 on Rolleston Ave, Christchurch City 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 document "Guidance on Detailed Engineering Evaluation of Earthquake affected Non-residential Buildings in Canterbury" (part 2 revision 5 dated 19/07/2011 and part 3 draft revision dated 13/12/2011). 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 7.2.

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. Construction drawings were not made available. The building description below is based on a visual inspection only.

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

3. Compliance

This section contains a 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 34%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

Building 51 is a timber framed pump house and maintenance shed located in the Botanic Gardens on Rolleston Ave, Christchurch City. The structure is approximately 1.6m square with a 1m square lean-to attached to the west side of the shed. The structure has a concrete slab foundation and copper roof sheeting.

It is estimated that the structure was built in 1996 when the fountain was reconstructed at its current location.

No structural drawings were made available at the time this report was produced.

5.2. Gravity Load Resisting system

Gravity loading is resisted in bearing by the perimeter walls of the structure and transmitted to ground via the slab foundation.

5.3. Seismic Load Resisting system

For the purposes of this report the longitudinal direction of the building is defined as being the east-west direction and the transverse direction is defined as being in the north-south direction.

Lateral loads on the building are resisted by shear in the timber framed walls.

5.4. Geotechnical Conditions

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

- The site has been assessed as NZS1170.5 Class D (deep or soft soil) from adjacent borehole logs.
- The ultimate bearing capacity of a shallow strip footing on this site is estimated to be in the region of 150-300 kPa. This may be revised by a site specific investigation.
- Liquefaction risk is low at this site.

Unless a change of use is intended for the site we do not believe that any further geotechnical investigations are required. Specific ground investigation should be undertaken if significant alterations or new structures are proposed. If any excavations are required on the site further investigation of the potential for contamination should be undertaken. The full geotechnical desktop study can be found in Appendix 4 – Geotechnical Desktop Study

6. Damage Summary

6.1. Damage Summary

SKM undertook an inspection of the building from floor level on 26 April 2012. No structural damage to the building was observed at the time of the inspection.

Some damage was found to the external lining on the lean-to on the west side of the structure (see Photo 2). The damage does not alter the strength of the structure and poses a durability issue. It is not clear whether this damage has been caused by the recent earthquakes.

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

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[2].

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 grade is indicated by the percent of the required New Building Standard (%NBS) strength that the building is considered to have. A building is earthquake prone for the purposes of this Act if, having regard to its condition and to the ground on which it is built, and because of its construction, the building—

a) will have its ultimate capacity exceeded in a moderate earthquake (as defined in the regulations); and
b) would be likely to collapse causing—
    i. injury or death to persons in the building or to persons on any other property; or
    ii. damage to any other property.

A moderate earthquake is defined as 'in relation to a building, an earthquake that would generate shaking at the site of the building that is of the same duration as, but that is one-third as strong as, the earthquake shaking (determined by normal measures of acceleration, velocity and displacement) that would be used to design a new building at the site.'

An earthquake prone building will have an increased risk that its strength will be exceeded due to earthquake actions of approximately 10 times (or more) than that of a building having a capacity in excess of 100% NBS (refer Table 1)[3]. Buildings in Christchurch City that are identified as being 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[4].

[2] http://resources.ccc.govt.nz/files/EarthquakeProneDangerousAndInsanitaryBuildingsPolicy2010.pdf
[3] NZSEE June 2006, *Assessment and Improvement of the Structural Performance of Buildings in Earthquakes,* p 2-13
[4] 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 collapse or other forms of 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[5]. This assessment concentrates on matters relating to life safety as damage to the building is a secondary consideration.

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

- AS/NZS 1170 Structural Design Actions
- NZS 3101:2006 Concrete Structures Standard
- NZS 3404:1997 Steel Structures Standard
- NZS4230:2004 Design of Reinforced Concrete Masonry Structures
- NZS 3603:1993 Timber Structures Standard
- NZS 3604:2011 Timber Framed Buildings

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

7.2. Design Criteria and Limitations

Following our inspection on the 26 April 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 inspection findings of the building. Please note no intrusive investigations were undertaken.
- Structural drawings were not available

The design criteria used to undertake the assessment include:

- 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 1 since the total floor area is <30m^2 and represents structures presenting a low degree of hazard to life and other property.
  - Ductility level of 1.5, based on our assessment and code requirements at the time of design. The structure's primary lateral load resisting system consists of timber framing which has a high level of ductility.
  - Site hazard factor, Z = 0.3, NZBC, Clause B1 Structure, Amendment 11 effective from 1 August 2011

This IEP was based on our 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.
- The IEP does not involve a detailed analysis or an element by element code compliance check.

7.3. Survey

There was no visible settlement of the structure, nor was there any significant ground movement issues around the building. The building is adjacent to land which is zoned TC2 under the CERA Residential Technical Categories Map. The combination of these factors means that we do not recommend that any survey be undertaken at this point.

7.4. Critical Structural Weaknesses

No critical structural weaknesses for the building were observed during our visual inspection.

7.5. Qualitative Assessment Results

The capacity of the building has been assessed using the Initial Evaluation Procedure based on the information available. The building's capacity is expressed as a percentage of new building standard (%NBS) and is 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
Pump House and Lean-to	83

Our qualitative assessment found that the building is likely to be classed as 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 deemed necessary for this building

9. Conclusion

A qualitative assessment was carried out for Building 51 - Peacock Fountain Pump House located at Botanic Gardens. No structural damage was observed to the structure. The building has been assessed to have a seismic capacity in the order of 100% NBS and is therefore not earthquake prone and is likely to be classified as a 'Low Risk Building' (capacity greater than 67% of NBS).

No further investigation is deemed necessary for the structure.

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: The north elevation of the pump house	Photo 2: Damage to the external cladding in the north west corner of the pump house lean-to

12. Appendix 2 – IEP Reports

Table IEP-1 Initial Evaluation Procedure – Step 1

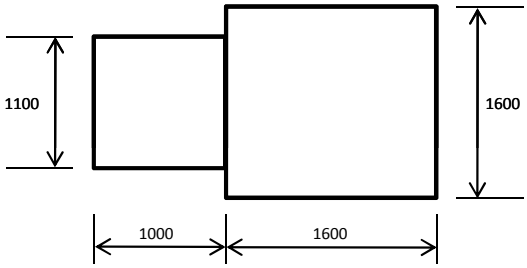
(Refer Table IEP - 2 for Step 2; Table IEP - 3 for Step 3, Table IEP - 4 for Steps 4, 5 and 6)

Building Name:	Botanic Gardens - Building 51 - Peacock Fountain Pump House	Ref.	ZB01276.093
Location:	Rolleston Ave, Christchurch City	By	OAK
		Date	8/10/2012

Step 1 - General Information

1.1 Photos (attach sufficient to describe building)

1.2 Sketch of building plan



1.3 List relevant features

Building 51 is a timber framed pump house and maintenance shed located in the Botanic Gardens on Rolleston Ave, Christchurch City. The structure is approximately 1.6m square with a 1m square lean-to attached to the west side of the shed. The structure has a concrete slab foundation and copper roof sheeting.

It is estimated that the structure was built in 1996 when the fountain was reconstructed at its current location.

No structural drawings were made available at the time this report was produced.

1.4 Note information sources

	Tick as appropriate
Visual Inspection of Exterior	☑
Visual Inspection of Interior	☑
Drawings (note type)	☐
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:	Botanic Gardens - Building 51 - Peacock Fountain Pump House	Ref.	ZB01276.093
Location:	Rolleston Ave, Christchurch City	By	OAK
Direction Considered:	**Longitudinal & Transverse**	Date	8/10/2012

(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 = 2.5 meters

	Longitudinal	Transverse
Ac =		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	
0.4	0.4	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

Building Name:	Botanic Gardens - Building 51 - Peacock Fountain Pump House	Ref.	ZB01276.093
Location:	Rolleston Ave, Christchurch City	By	OAK
Direction Considered:	**Longitudinal & Transverse**	Date	8/10/2012
(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 1
(from NZS1170.0:2004, Table 3.1 and 3.2)

b) Return Period Scaling Factor from accompanying Table 3.1 **Factor C** 1.20

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	1.5	μ Maximum =	6
Transverse	1.5	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	0.85
Transverse	Sp	0.85

b) Structural Performance Scaling Factor

Longitudinal	$1/S_p$	**Factor E**	1.18
Transverse	$1/S_p$	**Factor E**	1.18

2.7 Baseline %NBS for Building, $(\%NBS)_b$
(equals $(\%NSB)_{nom}$ x A x B x C x D x E)

Longitudinal	83.6	(%NBS)b
Transverse	83.6	(%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:	Botanic Gardens - Building 51 - Peacock Fountain Pump House	Ref.	ZB01276.093
Location:	Rolleston Ave, Christchurch City	By	OAK
Direction Considered:	**a) Longitudinal**	Date	8/10/2012

(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)

Effect on Structural Performance	Severe	Significant	Insignificant	
	○ 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

Record rationale for choice of Factor F:

3.7 Performance Achievement Ratio (PAR)
(equals A x B x C x D x E x F) **PAR** 1

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:	Botanic Gardens - Building 51 - Peacock Fountain Pump House	Ref.	ZB01276.093
Location:	Rolleston Ave, Christchurch City	By	OAK
Direction Considered:	**b) Transverse**	Date	8/10/2012

(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)

Effect on Structural Performance	Severe	Significant	Insignificant	
	○ 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

Record rationale for choice of Factor F:

3.7 Performance Achievement Ratio (PAR)
(equals A x B x C x D x E x F) **PAR** 1

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:	Botanic Gardens - Building 51 - Peacock Fountain Pump House	Ref.	ZB01276.093
Location:	Rolleston Ave, Christchurch City	By	OAK
Direction Considered:	**Longitudinal & Transverse**	Date	8/10/2012
(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)	83	83
4.2 Performance Achievement Ratio (PAR) (from Table IEP - 2)	1.00	1.00
4.3 PAR x Baseline $(\%NBS)_b$	83	83
4.4 Percentage New Building Standard (%NBS) (Use lower of two values from Step 4.3)		83

Step 5 - Potentially Earthquake Prone?
(Mark as appropriate)

%NBS ≤ 33 NO

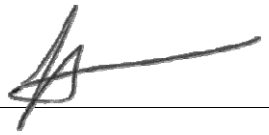
Step 6 - Potentially Earthquake Risk?

%NBS < 67 NO

Step 7 - Provisional Grading for Seismic Risk based on IEP

Seismic Grade A

Evaluation Confirmed by



Signature

James Carter Name

1017618 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:	Peacock Fountain Pump House			Reviewer:	James Carter
	Unit	No:	Street	CPEng No:	1017618
Building Address:	Building 51, Botanic Gardens		Rolleston Ave, Christchurch City	Company:	SKM
Legal Description:				Company project number:	ZB01276.093
				Company phone number:	03 940 4900
	Degrees	Min	Sec		
GPS south:				Date of submission:	26-Mar
GPS east:				Inspection Date:	26/04/2012
				Revision:	B
Building Unique Identifier (CCC):	PRK_1566_BLDG_051 EQ2			Is there a full report with this summary?	yes

Site

Site slope:	flat	Max retaining height (m):	
Soil type:	mixed	Soil Profile (if available):	0-1m: fill/top soil 1-3m: sand and sand/silt mixtures 3-11m: gravely sand or gravel 11-23m: sand and sand/silt mixtures 23+m: gravelly sand or gravel
Site Class (to NZS1170.5):	D		
Proximity to waterway (m, if <100m):		If Ground improvement on site, describe:	
Proximity to clifftop (m, if < 100m):			
Proximity to cliff base (m,if <100m):		Approx site elevation (m):	

Building

No. of storeys above ground:	1	single storey = 1		Ground floor elevation (Absolute) (m):	
Ground floor split?				Ground floor elevation above ground (m):	
Storeys below ground	0				
Foundation type:	raft slab			if Foundation type is other, describe:	
Building height (m):	3.00			height from ground to level of uppermost seismic mass (for IEP only) (m):	2.5
Floor footprint area (approx):					
Age of Building (years):	16			Date of design:	1992-2004
Strengthening present?	no			If so, when (year)?	
				And what load level (%g)?	
Use (ground floor):	other (specify)			Brief strengthening description:	
Use (upper floors):					
Use notes (if required):	Pump house and storage				
Importance level (to NZS1170.5):	IL1				

Gravity Structure

Gravity System:	load bearing walls		
Roof:	timber framed	rafter type, purlin type and cladding:	Timber framing with copper roof sheeting
Floors:	concrete flat slab	slab thickness (mm)	Unknown
Beams:			
Columns:			
Walls:			

Lateral load resisting structure

Lateral system along:	lightweight timber framed walls	**Note: Define along and across in detailed report!**	note typical wall length (m)	1.6
Ductility assumed, μ:	2.00			
Period along:		0.00	estimate or calculation?	
Total deflection (ULS) (mm):			estimate or calculation?	
maximum interstorey deflection (ULS) (mm):			estimate or calculation?	
Lateral system across:	lightweight timber framed walls		note typical wall length (m)	1.6
Ductility assumed, μ:	2.00			
Period across:		0.00	estimate or calculation?	
Total deflection (ULS) (mm):			estimate or calculation?	
maximum interstorey deflection (ULS) (mm):			estimate or calculation?	

Separations:

north (mm):		leave blank if not relevant
east (mm):		
south (mm):		
west (mm):		

Non-structural elements

Stairs:			
Wall cladding:	plaster system	describe	Thin cementious fibre board
Roof Cladding:	Metal	describe	Thin copper sheeting
Glazing:			
Ceilings:			
Services(list):			

Available documentation

Architectural	none	original designer name/date	
Structural	none	original designer name/date	
Mechanical	none	original designer name/date	
Electrical	none	original designer name/date	
Geotech report	full	original designer name/date	

Damage

Site:

(refer DEE Table 4-2) Site performance:	1	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 how damage ratio arrived at:	
	Describe (summary):	No structural damage recorded		
Across	Damage ratio:	0%	$Damage\_Ratio = \frac{(\%NBS(before) - \%NBS(after))}{\%NBS(before)}$	
	Describe (summary):	No structural damage recorded		
Diaphragms	Damage?:	no	Describe:	
CSWs:	Damage?:	no	Describe:	
Pounding:	Damage?:	no	Describe:	
Non-structural:	Damage?:	yes	Describe:	Damage to external lining on lean-to

Recommendations

Level of repair/strengthening required:	minor non-structural		Describe:	Damage to external lining on lean-to
Building Consent required:	no		Describe:	
Interim occupancy recommendations:	full occupancy		Describe:	
Along	Assessed %NBS before:	83%	%NBS from IEP below	If IEP not used, please detail assessment methodology: Qualitative Assessment carried out includes NZSEE IEP (refer to SKM report)
	Assessed %NBS after:	83%		
Across	Assessed %NBS before:	83%	%NBS from IEP below	
	Assessed %NBS after:	83%		

14. Appendix 4 – Geotechnical Desktop Study

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Christchurch City Council - Structural Engineering Service

Geotechnical Desk Study

SKM project number	ZB01276
SKM project site number	093
Address	Rolleston Ave
Report date	27 August 2012
Author	David Bae
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:

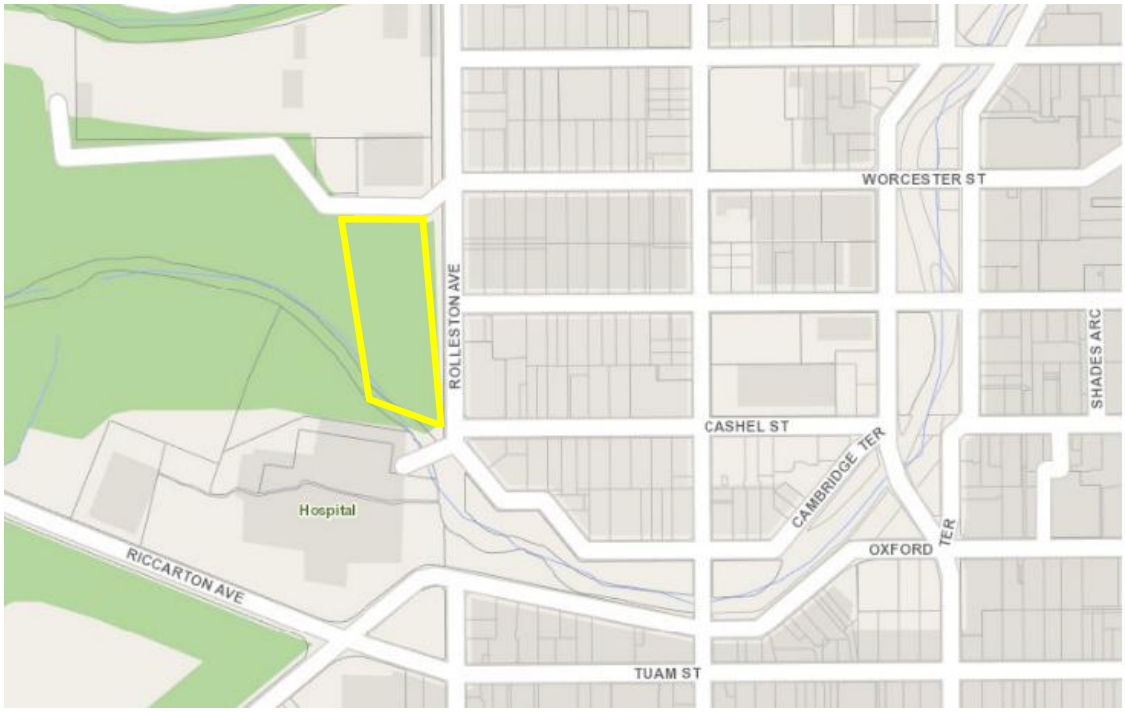
- Published geology
- Publically available borehole records
- Liquefaction records
- Aerial photography
- Council files
- A preliminary site walkover

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.

4. Site location

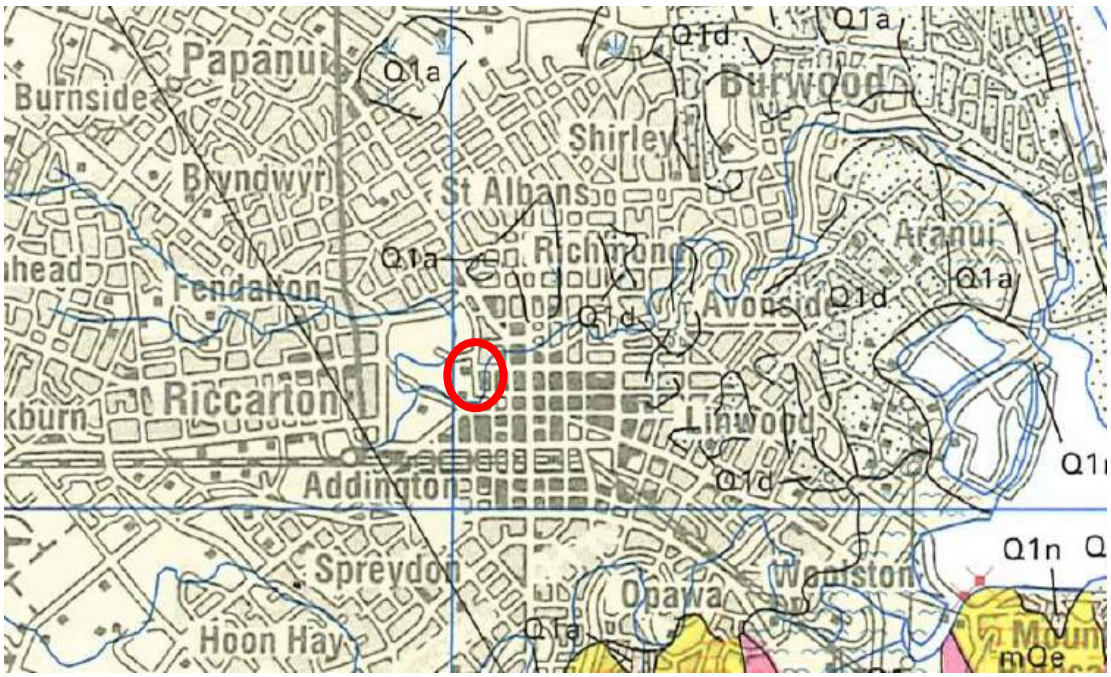


- **Figure 1 – Site location (courtesy of LINZ http://viewers.geospatial.govt.nz)**

The structure is located on 7 Rolleston Avenue at grid reference 1569883 E, 5179969 N (NZTM).

5. Review of available information

5.1 Geological maps



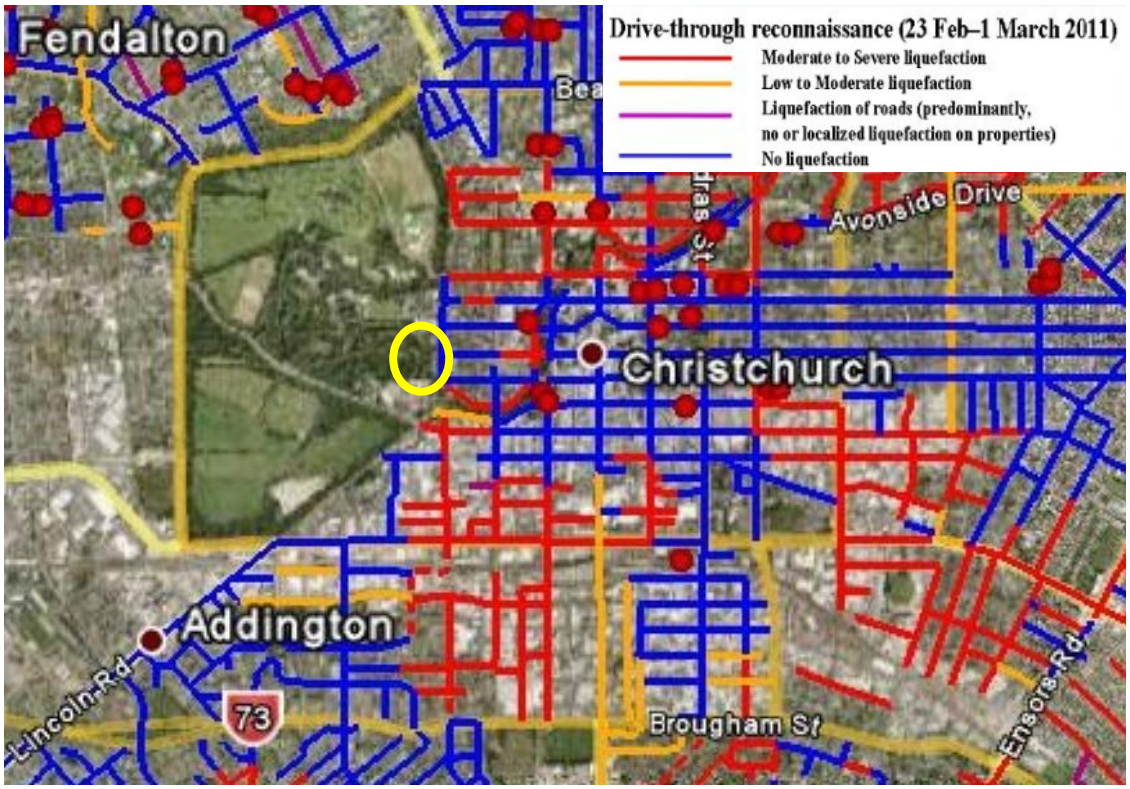
- **Figure 2 – Regional geological map (Forsyth et al, 2008). Site marked in red.**

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

The regional geological map shows the area to be underlain by Holocene deposits comprising predominantly alluvial sand and silt overbank deposits of the Springston Formation.

5.2 Liquefaction map

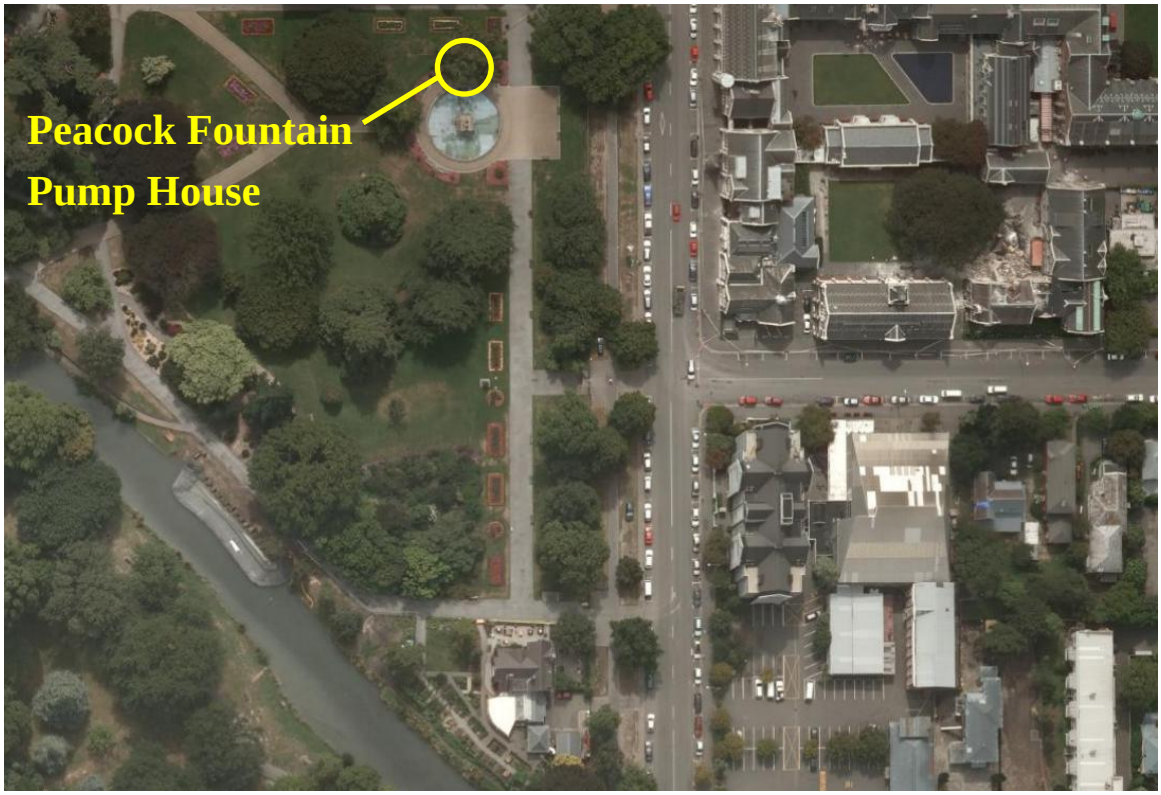
Following the 22 February 2011 earthquake event a drive through reconnaissance of the general Christchurch area was undertaken from 23 February until 1 March by M Cubrinovsko and M Taylor of Canterbury University.



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

Their findings show no liquefaction on Rolleston Avenue to the west of the site.

5.3 Aerial photography



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

Aerial photography shows no evidence of liquefaction or other land damage due to the 22 February earthquake. Additionally, no significant damage to the structure is visible in the aerial photograph.

5.4 CERA classification

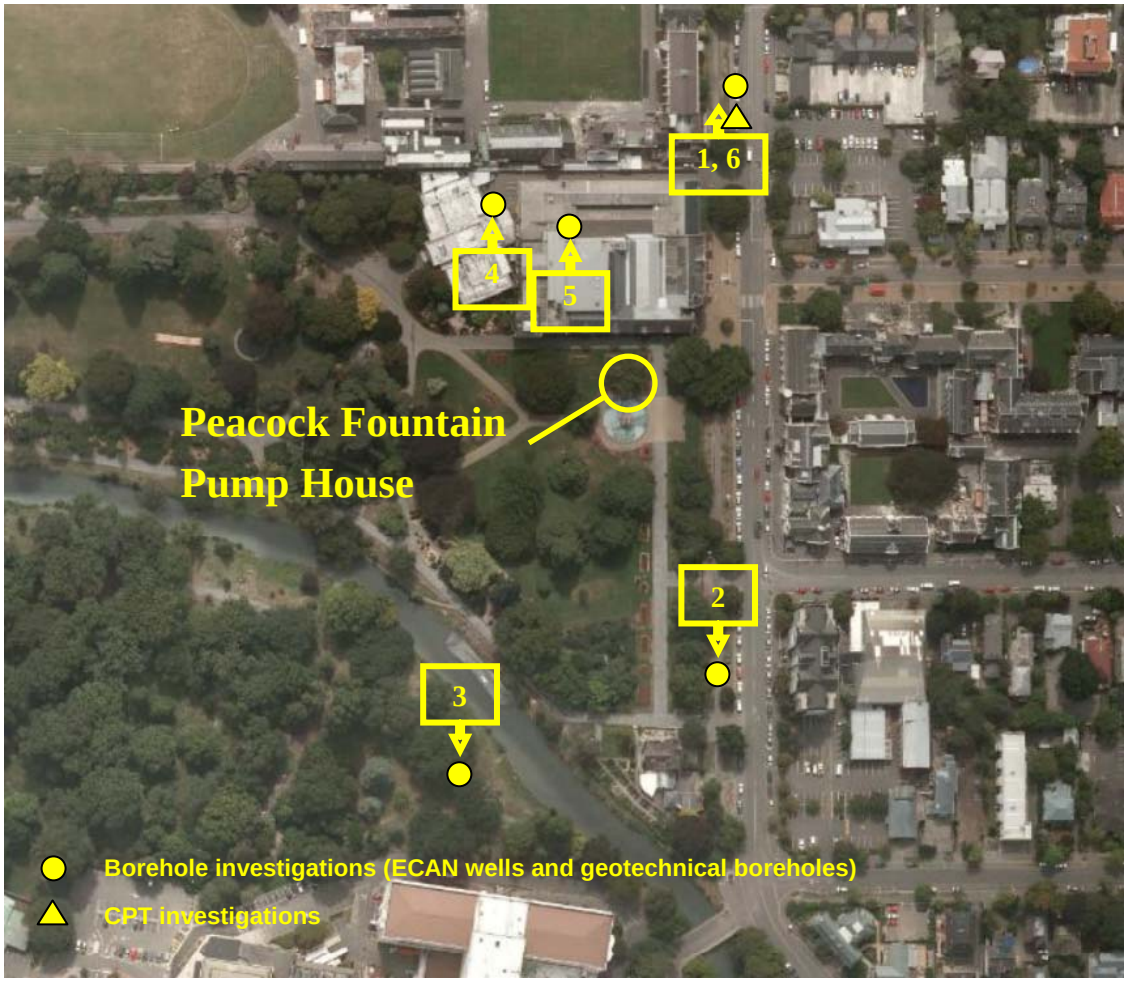
A review of the LINZ website (http://viewers.geospatial.govt.nz/) shows that the site is:

- Zone: Green
- DBH Technical Category – N/A – Urban Non residential

5.5 Historical land use

Reference to historical documents, (e.g. Appendix A) shows that the site was recorded as grassland in 1856. However, the area immediately north of the site was recorded as swamp or marshland. It is therefore possible that soft or peat material could be present at the site.

5.6 Existing ground investigation data



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

Where available logs from these investigation locations are attached to this report (Appendix B), and the results are summarised in Section 6.1 and Appendix C.

5.7 Council property files

Council property files were not available for the structure on site at the time of writing this report.

5.8 Site walkover

A site walkover was conducted by an SKM engineer on 3 May 2012.

.51 Peacock Foundation Pump House

The structure was timber framed building with timber wall cladding, copper roof, and slab on grade foundations.

Minor separation between internal wall linings and damage to the roof of the lean-to at nail points was observed; otherwise no obvious structural damage was noted from the external site inspection. Additionally, there was no evidence of liquefaction or any land damage around the site.

- **Figure 7 - Overview of the pump house**

- **Figure 8 - Damage to the roof of the lean-to**

6. Conclusions and recommendations

6.1 Site geology

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

Depth range (mBGL)	Soil type
0 - 2	Top soil / Silt mixtures
2 - 8	Medium dense to dense gravelly sand and gravel
8 - 13	Loose to medium dense sand and silty sand
13 - 18	Very loose to loose to silt and sandy silt
18 - 22	Soft to stiff silt. Layers of very dense sand
22 - 24+	Very dense Riccarton gravels

6.2 Seismic site subsoil class

The site has been assessed as NZS 1170.5 Class D (soft or deep soil) using nearby borehole investigation data.

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.

In this case the second preferred method has been used to make the assessment however the distance to the nearest ground investigation information is 65 m. It is therefore possible that site specific investigation could revise the site class though this is considered unlikely.

6.3 Building Performance

The performance to date suggests that the building foundations are adequate for their current purpose.

6.4 Ground performance and properties

The liquefaction risk for the site is likely to be low. The gravel layers inferred to be underlying the site are not liquefiable, and no evidence of liquefaction near the site was observed during the reconnaissance undertaken shortly after the 22 February earthquake or during the site walkover undertaken by a SKM engineer. However, there may be lenses of sand present in the sandy gravel layers that are potentially liquefiable.

Some variation in the underlying geology was noted in the available investigation data. However, generally the investigations indicate top soil / loose silt mixtures (present up to 2 m BGL) to be underlain by medium dense to dense sandy gravel. Therefore, for the purposes of carrying out a quantitative DEE for the structure on site, the following geotechnical parameters are recommended.

Parameter	Silt mixtures	Sand and sandy gravel
Effective angle of friction	28	35
Apparent cohesion	1 kPa	0 kPa
Unit weight	17 kN/m^3	18 kN/m^3
Ultimate bearing capacity of a shallow strip footing	150 kPa	300 kPa

NOTE: These figures are based on historical geotechnical data from outside the site for the purposes of preliminary structural assessment. These parameters should not be used for consent or design purposes and site specific investigations are required to confirm ground conditions. Further geotechnical investigations could potentially increase the ultimate bearing capacity stated above.

6.5 Further investigations

No further geotechnical investigations would be needed to undertaken a quantitative DEE for the structure on site. If significant alterations to the existing structure or if a new structure is proposed on site, additional investigations may be needed to confirm the recommended ground parameters and the assessed liquefaction risk on site.

7. References

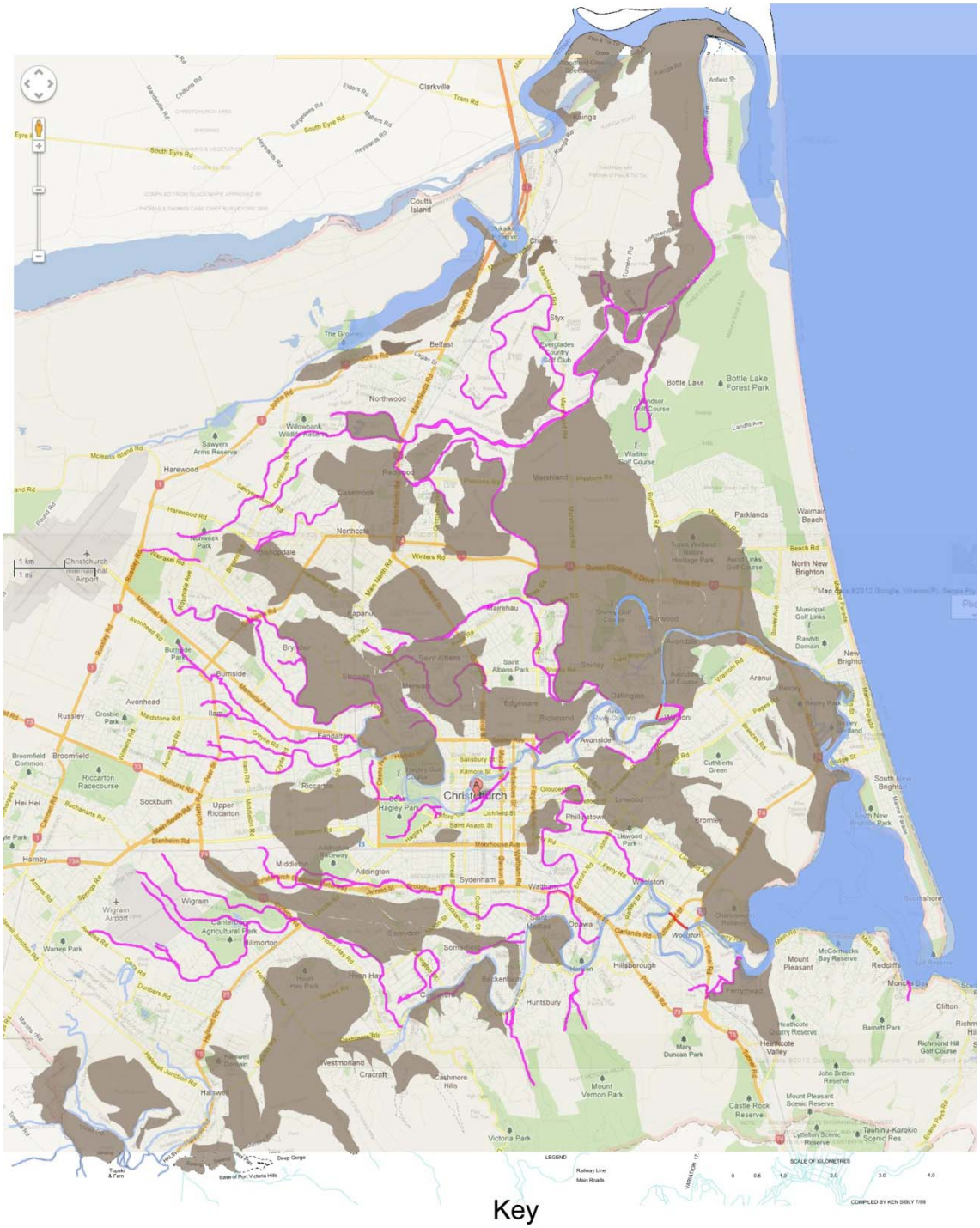
Cubrinovski & Taylor, 2011. Liquefaction map summarising preliminary assessment of liquefaction in urban areas following the 2010 Darfield Earthquake.

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

Key

- Previous creeks/rivers
- Existing creeks/rivers
- New creeks/rivers
- Swamp/Marshland

Appendix B – Existing ground investigation logs

TONKIN & TAYLOR LTD

BOREHOLE LOG

BOREHOLE No: CBD 14
Hole Location: Rolleston Ave

SHEET 1 OF 7

PROJECT: CHRISTCHURCH CITY 2011 EARTHQUAKE		LOCATION: CENTRAL CITY	JOB No: 52000.3400
CO-ORDINATES	5741830.5 mN 2479897.12 mE	DRILL TYPE: Direct Push	HOLE STARTED: 21/8/11
		DRILL METHOD: Sonic Vibration	HOLE FINISHED: 22/8/11
R.L.	6.60 m		DRILLED BY: DCN
DATUM	NZMG	DRILL FLUID: N/A	LOGGED BY: CP 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)	COMPRESSIVE STRENGTH (MPa)	DEFECT SPACING (mm)	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.
HAND DIG FILL. (Potholed for services check and backfilled.)			0	PRE-DUG				6.5	0								Fill: Borehole drilled through pre-dug and backfilled pothole.
								6.0	0.5								0.5
								5.5	1.0								1.0
YALDHURST MEMBER OF THE SPRINGSTON FORMATION (ALLUVIAL)				SPT		1/2/5 N=7		5.0	1.5		SW	W	L				1.5 Fine to medium SAND with trace silt, brown. Loose, wet.
			76	SONIC VIBRATION		✱FC	B	4.5	2.0								2.0
								4.0	2.5								2.5 2.75m to 3.0m no recovery
				SPT		3/2/4 N=6		3.5	3.0								3.0
								3.0	3.5								3.5 - contains minor gravel. Gravel is medium to coarse, subrounded to subangular.
			86	SONIC VIBRATION		✱FC	B	2.5	4.0								4.0 - contains buried wood 4.35m to 4.5m no recovery
				SPT		3/5/6 N=11		2.0	4.5				MD				4.5 - becoming medium dense
									5								- contains some buried wood

TONKIN & TAYLOR LTD

BOREHOLE LOG

BOREHOLE No: CBD 14
Hole Location: Rolleston Ave

PROJECT: CHRISTCHURCH CITY 2011 EARTHQUAKE		LOCATION: CENTRAL CITY	JOB No: 52000.3400
CO-ORDINATES	5741830.5 mN 2479897.12 mE	DRILL TYPE: Direct Push	HOLE STARTED: 21/8/11
		DRILL METHOD: Sonic Vibration	HOLE FINISHED: 22/8/11
R.L.	6.60 m		DRILLED BY: DCN
DATUM	NZMG	DRILL FLUID: N/A	LOGGED BY: CP 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)	COMPRESSIVE STRENGTH (MPa)	DEFECT SPACING (mm)	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 MEMBER OF THE SPRINGSTON FORMATION (ALLUVIAL)			100	SONIC VIBRATION				1.5			SW	W	MD				Fine to medium SAND with trace silt and minor gravel, grey. Medium dense, wet.
									5.5		SW	W	MD				Medium to coarse SAND, brown. Medium dense, wet. 5.5
								1.0			GW	W	D				Sandy, fine to coarse GRAVEL, brown. Dense, wet. Gravel is subangular to subrounded. Sand is medium to coarse. - moderateley thin sand lense
									6.0								6.0
				SPT		11/18/27 N=45		0.5									6.15m to 6.45m no recovery
			67	SONIC VIBRATION				0.0	6.5								6.5
									7.0								7.0
								-0.5									7.15m to 7.5m no recovery
									7.5								7.5
				SPT		10/17/22 N=39		-1.0									7.85m to 7.95m no recovery - contains trace cobbles
			90	SONIC VIBRATION				-1.5	8.0								8.0
									8.5								8.5
								-2.0			ML	M	F				SILT with some fibrous wood, bluish grey. Firm, moist, low plasticity. 8.9m to 9.0m no recovery - contains trace fibrous wood
				SPT		1/2/4 N=6		-2.5	9.0								9.0
									9.5								9.5
			90	SONIC VIBR.				-3.0	10								

TONKIN & TAYLOR LTD

BOREHOLE LOG

BOREHOLE No: CBD 14
Hole Location: Rolleston Ave

SHEET 3 OF 7

PROJECT: CHRISTCHURCH CITY 2011 EARTHQUAKE		LOCATION: CENTRAL CITY	JOB No: 52000.3400
CO-ORDINATES	5741830.5 mN 2479897.12 mE	DRILL TYPE: Direct Push	HOLE STARTED: 21/8/11 HOLE FINISHED: 22/8/11
R.L.	6.60 m	DRILL METHOD: Sonic Vibration	DRILLED BY: DCN
DATUM	NZMG	DRILL FLUID: N/A	LOGGED BY: CP 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)	COMPRESSIVE STRENGTH (MPa)	DEFECT SPACING (mm)	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 MEMBER OF THE SPRINGSTON FORMATION (ALLUVIAL)						✱PSD WS	B	-3.5		ML	M	F				SILT with trace fibrous wood, bluish grey. Firm, moist, low plasticity.
								10.5								10.4m to 10.5m no recovery
CHRISTCHURCH FORMATION (MARINE & ESTUARINE)				SPT		1/6/7 N=13		-4.0		SW	M	MD				Medium to coarse SAND, brown. Medium dense, moist. 10.5
			86	SONIC VIBRATION		✱FC	B	11.0 -4.5								- contains trace gravel. Gravel is fine to medium, subangular to subrounded. 11.0
								11.5 -5.0								11.5
								11.85m to 12.0m no recovery								
				SPT		4/9/11 N=20		12.0 -5.5								12.0
						✱FC	B	12.5 -6.0								- becoming grey 12.5
			86	SONIC VIBRATION												- becoming fine to medium SAND with some silt
								13.0 -6.5								13.0
								13.35m to 13.5m no recovery								
				SPT		9/11/27 N=38		13.5 -7.0				D				- contains trace silt. Becoming dense. 13.5
						✱FC	B	14.0 -7.5								- contains minor shells, silt absent 14.0
			81	SONIC VIBRATION		✱PSD WS	B			ML	W	VS				SILT with minor sand, grey. Very soft, wet, low plasticity. Sand is fine.
								14.5 -8.0								14.5
								14.8m to 15.0m no recovery								
								15								

T+T DATATEMPLATE.GDT eek

TONKIN & TAYLOR LTD

BOREHOLE LOG

BOREHOLE No: CBD 14
Hole Location: Rolleston Ave

SHEET 4 OF 7

PROJECT: CHRISTCHURCH CITY 2011 EARTHQUAKE		LOCATION: CENTRAL CITY	JOB No: 52000.3400
CO-ORDINATES	5741830.5 mN 2479897.12 mE	DRILL TYPE: Direct Push	HOLE STARTED: 21/8/11
		DRILL METHOD: Sonic Vibration	HOLE FINISHED: 22/8/11
R.L.	6.60 m		DRILLED BY: DCN
DATUM	NZMG	DRILL FLUID: N/A	LOGGED BY: CP 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)	COMPRESSIVE STRENGTH (MPa)	DEFECT SPACING (mm)	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 (MARINE & ESTUARINE)			100	SPT		1/0/1 N=1		-8.5		ML	W	VS				SILT with minor sand, grey. Very soft, wet, low plasticity. Sand is fine.
			100	SONIC VIBRATION		✱FC	B	-9.0 / 15.5								
								-9.5 / 16.0								
				SPT		2/1/3 N=4		-10.0 / 16.5								
			100	SONIC VIBRATION						SW	M	L				Fine to medium SAND with minor silt and shells, grey. Loose, moist.
								-10.5 / 17.0								
								-11.0 / 17.5								
				SPT		4/7/18 N=25		-11.5 / 18.0				MD				- becoming medium dense
								-12.0 / 18.5								
			100	SONIC VIBRATION		✱FC	B	-12.5 / 19.0								
								-13.0 / 19.5								
				SPT		3/9/14 N=23		20								

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TONKIN & TAYLOR LTD

BOREHOLE LOG

BOREHOLE No: CBD 14
Hole Location: Rolleston Ave

SHEET 5 OF 7

PROJECT: CHRISTCHURCH CITY 2011 EARTHQUAKE		LOCATION: CENTRAL CITY	JOB No: 52000.3400
CO-ORDINATES	5741830.5 mN 2479897.12 mE	DRILL TYPE: Direct Push	HOLE STARTED: 21/8/11
		DRILL METHOD: Sonic Vibration	HOLE FINISHED: 22/8/11
R.L.	6.60 m		DRILLED BY: DCN
DATUM	NZMG	DRILL FLUID: N/A	LOGGED BY: CP 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)	COMPRESSIVE STRENGTH (MPa)	DEFECT SPACING (mm)	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 (MARINE & ESTUARINE)			100	SONIC VIBRATION		✱FC	B	-13.5 / 20.5		SP	M	MD				Silty, fine SAND, bluish grey. Medium dense, moist.
				SPT		4/6/9 N=15		-14.0 / 21.0								
			100	SONIC VIBRATION				-14.5 / 21.5		ML	W	F				SILT with minor organics and trace interbedded sand, bluish grey. Firm, wet, low plasticity.
								-15.0 / 22.0								
								-15.5 / 22.5		SW	M	MD				Silty, fine to medium SAND, brown. Medium dense, moist.
				SPT		3/4/7 N=11		-16.0 / 23.0		SW	M	MD				Gravelly, fine to coarse SAND, orange brown. Medium dense, moist. Gravel is fine to coarse, subangular to subrounded.
			67	SONIC VIBRATION				-16.5 / 23.5		GW	M	VD				Sandy, fine to coarse GRAVEL, grey. Very dense, moist. Gravel is subangular to subrounded. Sand is medium to coarse.
RICCARTON GRAVELS								-17.0 / 24.0								23.65m to 24.0m no recovery
				SPT		31/50 for 120mm N>50		-17.5 / 24.5								24.3m to 24.8m no recovery
			58	SONIC VIBRATION				-18.0 / 25								

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TONKIN & TAYLOR LTD

BOREHOLE LOG

BOREHOLE No: CBD 14
Hole Location: Rolleston Ave

SHEET 6 OF 7

PROJECT: CHRISTCHURCH CITY 2011 EARTHQUAKE		LOCATION: CENTRAL CITY	JOB No: 52000.3400
CO-ORDINATES	5741830.5 mN 2479897.12 mE	DRILL TYPE: Direct Push	HOLE STARTED: 21/8/11
		DRILL METHOD: Sonic Vibration	HOLE FINISHED: 22/8/11
R.L.	6.60 m		DRILLED BY: DCN
DATUM	NZMG	DRILL FLUID: N/A	LOGGED BY: CP 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)	COMPRESSIVE STRENGTH (MPa)	DEFECT SPACING (mm)

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.

RICCARTON GRAVELS

GW | M | VD

Sandy, fine to coarse GRAVEL with rare cobbles, grey. Very dense, moist. Gravel is subangular to subrounded. Sand is medium to coarse.

-18.5 / 25.5

58 — SPT — 28/50 for 115mm N>50

-19.0 / 26.0

58 — SONIC VIBRATION

25.8m to 26.3m no recovery

-19.5 / 26.5

-20.0 / 27.0

SPT — 18/36/14 for 50mm N>50

-20.5 / 27.5

42 — SONIC VIBRATION

27.25m to 28.0m no recovery

-21.0 / 28.0

-21.5 / 28.5

SPT — 22/50 for 90mm N>50

28.5m to 29.1m no recovery

-22.0 / 29.0

72 — SONIC VIBRATION

-22.5 / 29.5

-23.0 / 30

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TONKIN & TAYLOR LTD

BOREHOLE LOG

BOREHOLE No: CBD 14
Hole Location: Rolleston Ave

PROJECT: CHRISTCHURCH CITY 2011 EARTHQUAKE		LOCATION: CENTRAL CITY	JOB No: 52000.3400
CO-ORDINATES	5741830.5 mN 2479897.12 mE	DRILL TYPE: Direct Push	HOLE STARTED: 21/8/11
		DRILL METHOD: Sonic Vibration	HOLE FINISHED: 22/8/11
R.L.	6.60 m		DRILLED BY: DCN
DATUM	NZMG	DRILL FLUID: N/A	LOGGED BY: CP 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)	COMPRESSIVE STRENGTH (MPa)	DEFECT SPACING (mm)	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.
RICCARTON GRAVELS				SPT		24/50 for 100mm N>50		-23.5		GW	M	VD				Sandy, fine to coarse GRAVEL, grey. Very dense, moist. Gravel is subangular to subrounded. Sand is medium to coarse.
																End of borehole at 30.25mbgl. Open standpipe piezometer installed. Please see attached diagram in Appendix F.

30.5 -24.0
31.0 -24.5
31.5 -25.0
32.0 -25.5
32.5 -26.0
33.0 -26.5
33.5 -27.0
34.0 -27.5
34.5 -28.0
35

T+T DATATEMPLATE.GDT eek

TONKIN & TAYLOR LTD

BOREHOLE LOG

BOREHOLE No: CBD 21
Hole Location: Opposite Hereford St on Rolleston Ave

SHEET 1 OF 7

PROJECT: CHRISTCHURCH CITY 2011 EARTHQUAKE		LOCATION: CENTRAL CITY	JOB No: 52000.3400
CO-ORDINATES	5741640.19 mN 2479897.99 mE	DRILL TYPE: Rotary	HOLE STARTED: 5/7/11
		DRILL METHOD: Triple Tube	HOLE FINISHED: 7/7/11
R.L.	6.36 m		DRILLED BY: Pro-Drill
DATUM	NZMG	DRILL FLUID: Mud	LOGGED BY: RKH 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.
HAND DIG FILL. (Potholed for services check and backfilled.)			0	PRE-DUG				6.0	0.5								Fill: Borehole drilled through pre-dug and backfilled pothole.
								5.5	1.0								
YALDHURST MEMBER OF THE SPRINGSTON FORMATION (ALLUVIAL)				SPT		5/4/4/ 3/5/6 N=18		5.0	1.5		GW	M	MD				Fine to coarse GRAVEL with some sand and minor silt, grey. Medium dense, moist. Gravel is subrounded. Sand is fine to coarse. Some fines washed away during drilling process.
			55	HQTT				4.5	2.0								1.8m to 1.95m no recovery
								4.0	2.5								
								3.5	3.0								2.8m to 3.5m no recovery
				SPT		8/6/6/ 8/10/16 N=40		3.0	3.5				D				- becoming dense
								2.5	4.0								3.8m to 3.95m no recovery
			33	HQTT				2.0	4.5								4.3m to 5.0m no recovery
								1.5	5								

TONKIN & TAYLOR LTD

BOREHOLE LOG

BOREHOLE No: CBD 21
Hole Location: Opposite Hereford St on Rolleston Ave

PROJECT: CHRISTCHURCH CITY 2011 EARTHQUAKE		LOCATION: CENTRAL CITY	JOB No: 52000.3400
CO-ORDINATES	5741640.19 mN 2479897.99 mE	DRILL TYPE: Rotary	HOLE STARTED: 5/7/11
		DRILL METHOD: Triple Tube	HOLE FINISHED: 7/7/11
R.L.	6.36 m		DRILLED BY: Pro-Drill
DATUM	NZMG	DRILL FLUID: Mud	LOGGED BY: RKH 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 MEMBER OF THE SPRINGSTON FORMATION (ALLUVIAL)				SPT		7/14/13/ 9/9/5 N=36		1.0	5.5		GW	W	D				Fine to coarse GRAVEL with some sand and minor silt, grey. Dense, wet. Gravel is subrounded. Sand is fine to coarse. Some fines washed away during drilling process.
			33	HQTT				0.5	6.0								5.8m to 6.5m no recovery
				SPT		6/8/9/ 13/10/10 N=42		0.0	6.5								
			33	HQTT				-0.5	7.0								7.3m to 8.0m no recovery
				SPT		6/7/7 /7/7/7 N=28		-1.0	7.5				MD				- becoming medium dense
			24	HQTT				-1.5	8.0								8.25m to 8.45m no recovery
				SPT		4/5/6/ 7/4/6 N=23		-2.0	8.5								8.7m to 9.5m no recovery
								-2.5	9.0								
								-3.0	9.5								
								-3.5	10								

TONKIN & TAYLOR LTD

BOREHOLE LOG

BOREHOLE No: CBD 21
Hole Location: Opposite Hereford St on Rolleston Ave

PROJECT: CHRISTCHURCH CITY 2011 EARTHQUAKE		LOCATION: CENTRAL CITY	JOB No: 52000.3400
CO-ORDINATES	5741640.19 mN 2479897.99 mE	DRILL TYPE: Rotary	HOLE STARTED: 5/7/11
		DRILL METHOD: Triple Tube	HOLE FINISHED: 7/7/11
R.L.	6.36 m		DRILLED BY: Pro-Drill
DATUM	NZMG	DRILL FLUID: Mud	LOGGED BY: RKH 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 MEMBER OF THE SPRINGSTON FORMATION (ALLUVIAL)			48	HQTT				-4.0	10.5								10.0m to 11.0m no recovery
								-4.5	11.0		SW	W	D				10.5
CHRISTCHURCH FORMATION (MARINE & ESTUARINE)				SPT		2/4/12 /7/7/7 N=33		-5.0	11.5								Fine to medium SAND with some silt, grey. Dense, wet. 11.2m to 12.895m no recovery
			0	HQTT				-5.5	12.0								11.5
								-6.0	12.5				VD				12.0
				SPT		6/6/10/ 15/20/5 for 20mm N>50		-6.5	13.0								- becoming very dense 12.5
			100	HQTT		✱FC	B	-7.0	13.5								- 100mm bed of trace shells 13.0
						✱FC	B	-7.5	14.0		ML	W	S				13.5
				SPT		0/0/0/ 0/0/0 N=0		-8.0	14.5								SILT with trace rootlets, yellowish grey. Soft, wet, low plasticity. 14.0
			76	HQTT				-8.5	15								14.45m to 14.7m no recovery 14.5

TONKIN & TAYLOR LTD

BOREHOLE LOG

BOREHOLE No: CBD 21
Hole Location: Opposite Hereford St on Rolleston Ave

PROJECT: CHRISTCHURCH CITY 2011 EARTHQUAKE		LOCATION: CENTRAL CITY	JOB No: 52000.3400
CO-ORDINATES	5741640.19 mN 2479897.99 mE	DRILL TYPE: Rotary	HOLE STARTED: 5/7/11
		DRILL METHOD: Triple Tube	HOLE FINISHED: 7/7/11
R.L.	6.36 m		DRILLED BY: Pro-Drill
DATUM	NZMG	DRILL FLUID: Mud	LOGGED BY: RKH 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 (MARINE & ESTUARINE)								-9.0	15.5		SW	W	VL				Silty, fine to medium SAND with trace shells, grey. Very loose, wet.
				SPT		1/0/0/ 0/0/0 N=0		-9.5									SPT result is anomalously low due to heaving sands.
			57	HQTT		*FC	B	-10.0	16.0								15.95m to 16.3m no recovery
								-10.5	16.5								
				SPT		0/0/1/ 1/1/1 N=4		-11.0	17.0								
			76	HQTT				-11.5	17.5								17.45m to 17.7m no recovery
				SPT		0/0/0/ 0/0/0 N=0		-12.0	18.0								
								-12.5	18.5								SPT result is anomalously low due to heaving sands.
			76	HQTT				-13.0	19.0								18.95m to 19.2m no recovery
								-13.5	19.5								
									20								

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BOREHOLE LOG

BOREHOLE No: CBD 21
Hole Location: Opposite Hereford St on Rolleston Ave

PROJECT: CHRISTCHURCH CITY 2011 EARTHQUAKE		LOCATION: CENTRAL CITY	JOB No: 52000.3400
CO-ORDINATES	5741640.19 mN 2479897.99 mE	DRILL TYPE: Rotary	HOLE STARTED: 5/7/11
		DRILL METHOD: Triple Tube	HOLE FINISHED: 7/7/11
R.L.	6.36 m		DRILLED BY: Pro-Drill
DATUM	NZMG	DRILL FLUID: Mud	LOGGED BY: RKH 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)	COMPRESSIVE STRENGTH (MPa)	DEFECT SPACING (mm)	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 (MARINE & ESTUARINE)				SPT		0/0/0/ 0/0/0 N=0		-14.0	20.5		ML	W	S				SILT with minor sand, grey. Soft, wet, low plasticity. Sand is fine. 20.2m to 20.8m no recovery 20.5
			67	HQTT		✱FC	B	-14.5	21.0		ML	W	St				SILT, bluish grey. Stiff, wet, low plasticity. 21.0
				SPT		2/2/4/ 4/5/6 N=19		-15.0 -15.5	21.5								21.5
			48	HQTT				-16.0	22.0 22.5								21.95m to 22.5m no recovery 22.0 22.5 - thin layer of amorphous peat
								-16.5	23.0		SW	W	MD				Silty, fine to medium SAND, grey. Medium dense, wet. 23.0
RICCARTON GRAVELS				SPT		4/9/25/25 for 70mm N>50		-17.0	23.5		GW	W	VD				Sandy, fine to coarse GRAVEL, grey. Very dense, wet. Gravel is subangular to subrounded. 23.3m to 23.45m no recovery 23.5
			21	HQTT				-17.5	24.0								23.7m to 25.75m no recovery 24.0
			18	SPT HQTT		25/25 for 70mm N>50		-18.0 -18.5	24.5 25								24.5

T+T DATATEMPLATE.GDT eek

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BOREHOLE LOG

BOREHOLE No: CBD 21
Hole Location: Opposite Hereford St on Rolleston Ave

PROJECT: CHRISTCHURCH CITY 2011 EARTHQUAKE		LOCATION: CENTRAL CITY	JOB No: 52000.3400
CO-ORDINATES	5741640.19 mN 2479897.99 mE	DRILL TYPE: Rotary	HOLE STARTED: 5/7/11
		DRILL METHOD: Triple Tube	HOLE FINISHED: 7/7/11
R.L.	6.36 m		DRILLED BY: Pro-Drill
DATUM	NZMG	DRILL FLUID: Mud	LOGGED BY: RKH 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	WEATHERING / MOISTURE CONDITION	STRENGTH/DENSITY CLASSIFICATION	SHEAR STRENGTH (kPa)	COMPRESSIVE STRENGTH (MPa)	DEFECT SPACING (mm)	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.
RICCARTON GRAVELS								-19.0	25.5								23.7m to 25.75m no recovery 25.5
								-19.5	26.0		GW	W	VD				Sandy, fine to coarse GRAVEL, grey. Very dense, wet. Gravel is subangular to subrounded. Fines washed away during drlling process. 26.0
			36	SPT		10/15/18/ 20/12 for 20mm N>50		-20.0	26.5								26.5
				HQTT				-20.5	27.0								26.7m to 27.8m no recovery 27.0
				SPT		6/18/ 26/24 for 40mm N>50		-21.0	27.5								27.5
			16	HQTT				-21.5	28.0								28.0m to 29.2m no recovery 28.0
				SPT		10/10/ 15/20/15 for 20mm N>50		-22.0	28.5								28.5
				HQTT				-22.5	29.0								29.0
			17					-23.0	29.5								29.5
								-23.5	30								29.65m to 30.94m no recovery

TONKIN & TAYLOR LTD

BOREHOLE LOG

BOREHOLE No: CBD 21
Hole Location: Opposite Hereford St on Rolleston Ave

PROJECT: CHRISTCHURCH CITY 2011 EARTHQUAKE		LOCATION: CENTRAL CITY	JOB No: 52000.3400
CO-ORDINATES	5741640.19 mN 2479897.99 mE	DRILL TYPE: Rotary	HOLE STARTED: 5/7/11
		DRILL METHOD: Triple Tube	HOLE FINISHED: 7/7/11
R.L.	6.36 m		DRILLED BY: Pro-Drill
DATUM	NZMG	DRILL FLUID: Mud	LOGGED BY: RKH 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)	COMPRESSIVE STRENGTH (MPa)	DEFECT SPACING (mm)	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.
RICCARTON GRAVELS			0	SPT		12/10/10/ 15/15/10 for 60mm N>50		-24.0 30.5 -24.5								29.65m to 30.935m no recovery
								31.0 -25.0 31.5 -25.5 32.0 -26.0 32.5 -26.5 33.0 -27.0 33.5 -27.5 34.0 -28.0 34.5 -28.5 35								**End of borehole at 30.935mbgl.** Open standpipe piezometer installed. Please see attached diagram in Appendix F.

TONKIN & TAYLOR LTD

BOREHOLE LOG

BOREHOLE No: CBD 48
Hole Location: Christchurch Hospital
SHEET 1 OF 5

PROJECT: CHRISTCHURCH CITY 2011 EARTHQUAKE		LOCATION: CENTRAL CITY	JOB No: 52000.3400
CO-ORDINATES	5741559.98 mN 2479772.7 mE	DRILL TYPE: Rotary	HOLE STARTED: 25/9/11
		DRILL METHOD: HQTT	HOLE FINISHED: 26/9/11
R.L.	5.21 m		DRILLED BY: Pro-Drill
DATUM	NZMG	DRILL FLUID: Mud	LOGGED BY: CP 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	WEATHERING / MOISTURE CONDITION	STRENGTH/DENSITY CLASSIFICATION	SHEAR STRENGTH (kPa)	COMPRESSIVE STRENGTH (MPa)	DEFECT SPACING (mm)	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.
HAND DIG FILL. (Potholed for services check and backfilled.)			0	PRE-DUG				5.0	0								Fill: Borehole drilled through pre-dug and backfilled pothole.
								4.5	0.5								0.5
								4.0	1.0								1.0
YALDHURST MEMBER OF THE SPRINGSTON FORMATION (ALLUVIAL)				SPT		2/5/5/ 7/9/9 N=30		3.5	1.5		SW	M	D				1.5 Fine to medium SAND with minor silt, brownish grey. Dense, moist.
											GW	M	D				Sandy, fine to coarse GRAVEL, brownish grey. Dense, moist. Gravel is subangular to subrounded. Sand is fine to coarse.
			39	HQTT				3.0	2.0								1.95 to 2.9m no recovery 2.0
								2.5	2.5								2.5
								2.0	3.0								- fines washed away during drilling process. Becoming grey. 3.0
									3.5				MD				- contains fine to coarse sand. Becoming brownish grey.
				SPT		8/7/7/ 4/4/4 N=19		1.5									- becoming medium dense 3.5 to 4.85m no recovery 3.5
			14	HQTT				1.0	4.0								4.0
								0.5	4.5								4.5
									5								- fines washed away during drilling process

T+T DATATEMPLATE.GDT eek

TONKIN & TAYLOR LTD

BOREHOLE LOG

BOREHOLE No: CBD 48
Hole Location: Christchurch Hospital
SHEET 2 OF 5

PROJECT: CHRISTCHURCH CITY 2011 EARTHQUAKE		LOCATION: CENTRAL CITY	JOB No: 52000.3400
CO-ORDINATES	5741559.98 mN 2479772.7 mE	DRILL TYPE: Rotary	HOLE STARTED: 25/9/11 HOLE FINISHED: 26/9/11
R.L.	5.21 m	DRILL METHOD: HQTT	DRILLED BY: Pro-Drill
DATUM	NZMG	DRILL FLUID: Mud	LOGGED BY: CP 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)	COMPRESSIVE STRENGTH (MPa)	DEFECT SPACING (mm)	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 MEMBER OF THE SPRINGSTON FORMATION (ALLUVIAL)				SPT		4/4/7/ 7/7/7 N=28		0.0	5.5		GW	M	MD				Sandy, fine to coarse GRAVEL, brownish grey. Dense, moist. Gravel is subangular to subrounded. Sand is fine to coarse.
			24	HQTT				-0.5	6.0								5.25 to 6.25m no recovery
								-1.0	6.5								- fines washed away during drilling process
				SPT		4/6/6/ 5/5/4 N=20		-1.5	7.0								- contains minor fine to coarse sand - contains trace cobbles 6.75 to 7.9m no recovery
			10	HQTT				-2.0	7.5								- fines washed away during drilling process
				SPT		4/7/6/ 5/2/2 N=15		-2.5	8.0		SW	M	MD				Gravelly, fine to coarse SAND, grey. Medium dense, moist. Gravel is fine to coarse, subangular to subrounded. - contains buried wood 8.3 to 8.7m no recovery
			60	HQTT				-3.0	8.5								
								-3.5	9.0		GW	W	D				Medium to coarse GRAVEL, grey. Dense, wet. Gravel is subangular to subrounded. 8.8 to 9.0m no recovery
			18	HQTT				-4.0	9.5		ML	W	F				SILT with minor sand, grey. Firm, wet, low plasticity. Sand is fine to medium. 9.1 to 10.0m no recovery
				SPT		3/42/ 1/1/1 N=5		-4.5	10								

T+T DATATEMPLATE.GDT eek

TONKIN & TAYLOR LTD

BOREHOLE LOG

BOREHOLE No: CBD 48
Hole Location: Christchurch Hospital
SHEET 3 OF 5

PROJECT: CHRISTCHURCH CITY 2011 EARTHQUAKE		LOCATION: CENTRAL CITY	JOB No: 52000.3400
CO-ORDINATES	5741559.98 mN 2479772.7 mE	DRILL TYPE: Rotary	HOLE STARTED: 25/9/11
		DRILL METHOD: HQTT	HOLE FINISHED: 26/9/11
R.L.	5.21 m		DRILLED BY: Pro-Drill
DATUM	NZMG	DRILL FLUID: Mud	LOGGED BY: CP 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)	COMPRESSIVE STRENGTH (MPa)	DEFECT SPACING (mm)	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 (MARINE & ESTUARINE)			62	HQTT		✱FC	B	-5.0	10.5		SW	M	L				Fine to medium SAND with trace silt, grey. Loose, moist.
								-5.5									- silt absent. Sand is fine to coarse.
				SPT		1/1/2/ 3/3/3 N=11		-6.0	11.0				MD				10.55 to 11.0m no recovery
			57	HQTT		✱FC	B	-6.5	11.5								- contains trace silt. Becoming medium dense.
								-7.0	12.0								11.75 to 12.05m extremely closely spaced silt laminae
				SPT		1/1/1/ 1/1/2 N=5		-7.5	12.5		ML	M	F				12.05 to 12.5m no recovery
			86	HQTT		✱FC	B	-8.0	13.0								SILT with trace shells and interbedded sand, grey. Firm, moist, low plasticity.
								-8.5	13.5								- sand and shells absent - contains minor fine sand
				SPT		0/0/1/ 0/1/1 N=3		-9.0	14.0		SW	M	VL				13.9 to 14.0m no recovery
			90	HQTT		✱FC	B	-9.5	14.5								Silty, fine to medium SAND, grey. Very loose, moist.
									15								- sand becoming fine

T+T DATATEMPLATE.GDT eek

TONKIN & TAYLOR LTD

BOREHOLE LOG

BOREHOLE No: CBD 48
Hole Location: Christchurch Hospital
SHEET 4 OF 5

PROJECT: CHRISTCHURCH CITY 2011 EARTHQUAKE		LOCATION: CENTRAL CITY	JOB No: 52000.3400
CO-ORDINATES	5741559.98 mN 2479772.7 mE	DRILL TYPE: Rotary	HOLE STARTED: 25/9/11 HOLE FINISHED: 26/9/11
R.L.	5.21 m	DRILL METHOD: HQTT	DRILLED BY: Pro-Drill
DATUM	NZMG	DRILL FLUID: Mud	LOGGED BY: CP 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)	COMPRESSIVE STRENGTH (MPa)	DEFECT SPACING (mm)	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 (MARINE & ESTUARINE)								-10.0 / 15.5		ML	M	F				Sandy SILT, grey. Firm, moist, low plasticity. Sand is fine.
						✱FC	B									15.4 to 15.5 no recovery
				SPT		0/0/1/ 1/2/1 N=5		-10.5 / 16.0		SW	M	L				Fine to medium SAND with some silt, grey. Loose, moist.
			100	HQTT		✱FC	B	-11.0 / 16.5								
				SPT		0/0/0/ 0/0/1 N=1		-11.5 / 17.0		ML	M	VS				SILT with trace shells and minor sand, grey. Very soft, moist, low plasticity. Sand is fine.
			100	HQTT		✱FC	B	-12.0 / 17.5		SW	M	VL				Fine to medium SAND with some silt, grey. Very loose, moist.
				SPT		0/0/0/ 1/1/1 N=3		-12.5 / 18.0		ML	MW	S				- becoming silty SILT with trace sand, grey. Soft, moist, low plasticity.
			90	HQTT		✱FC	B	-13.0 / 18.5								- contains minor organics
								-13.5 / 19.0								
								-14.0 / 19.5								
								-14.5 / 20								

T+T DATATEMPLATE.GDT eek

TONKIN & TAYLOR LTD

BOREHOLE LOG

BOREHOLE No: CBD 48
Hole Location: Christchurch Hospital
SHEET 5 OF 5

PROJECT: CHRISTCHURCH CITY 2011 EARTHQUAKE		LOCATION: CENTRAL CITY	JOB No: 52000.3400
CO-ORDINATES	5741559.98 mN 2479772.7 mE	DRILL TYPE: Rotary	HOLE STARTED: 25/9/11
		DRILL METHOD: HQTT	HOLE FINISHED: 26/9/11
R.L.	5.21 m		DRILLED BY: Pro-Drill
DATUM	NZMG	DRILL FLUID: Mud	LOGGED BY: CP CHECKED: BMcD

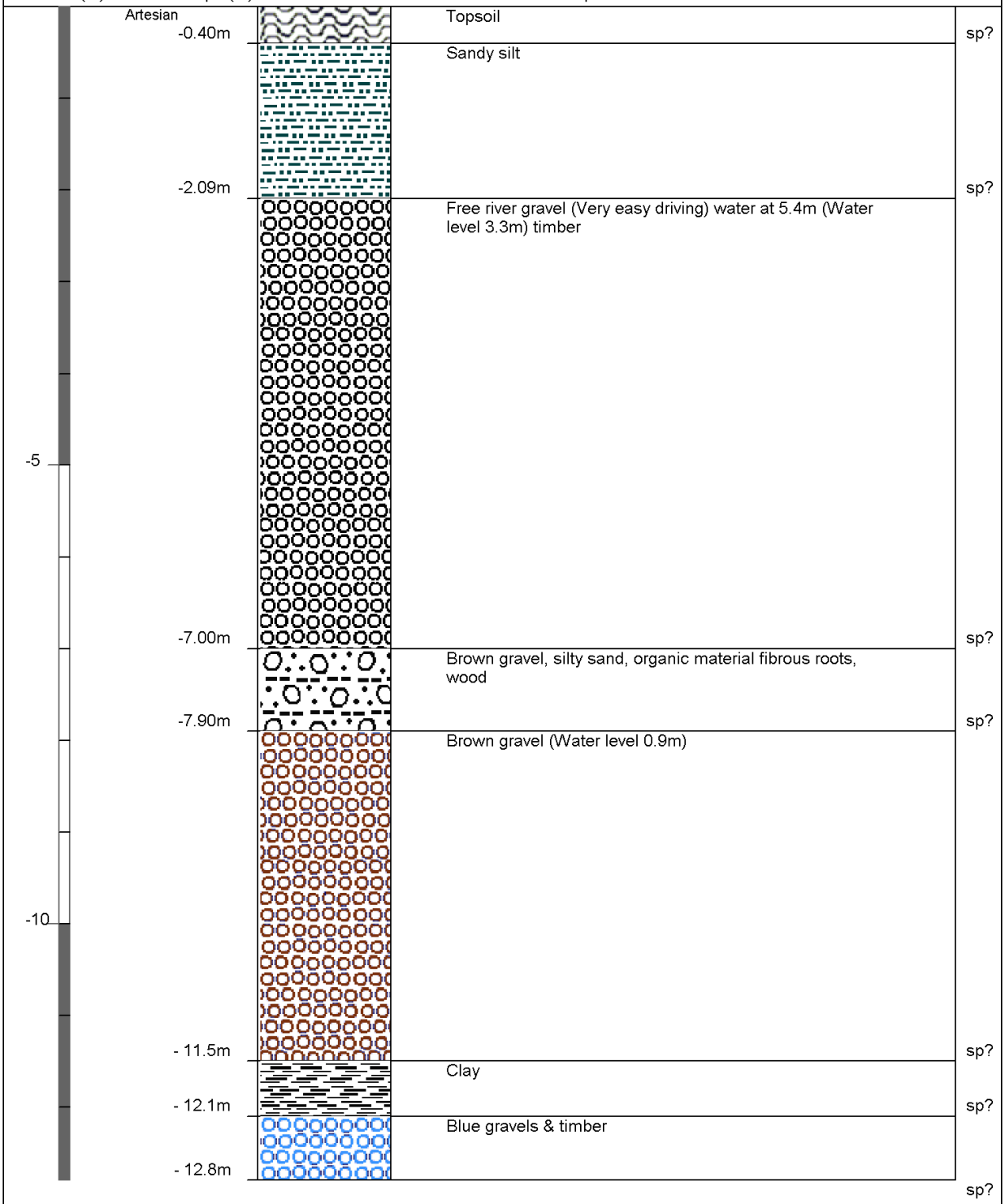
GEOLOGICAL										ENGINEERING DESCRIPTION								
GEOLOGICAL UNIT, GENERIC NAME, ORIGIN, MINERAL COMPOSITION.	FLUID LOSS	WATER	CORE RECOVERY (%)	METHOD	CASING	TESTS	SAMPLES	R.L. (m)	DEPTH (m)	GRAPHIC LOG	CLASSIFICATION SYMBOL	MOISTURE CONDITION / WEATHERING	STRENGTH/DENSITY CLASSIFICATION	SHEAR STRENGTH (kPa)	COMPRESSIVE STRENGTH (MPa)	DEFECT SPACING (mm)	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 (MARINE & ESTUARINE)				SPT		2/2/3/ 2/3/3 N=11		-15.0			SP	M	MD				Fine SAND with some silt, bluish grey. Medium dense, moist.
			100	HQTT				-15.5	20.5		ML	M	St				SILT with trace organics and sand, brownish grey. Stiff, moist, low plasticity. 20.5 20.65 to 20.9m organics absent, bluish grey
								-16.0	21.0								21.0
				SPT		1/11/24/26 for 70mm N>50		-16.5	21.5		SP	M	VD				21.5 Fine SAND with some silt, brownish grey. Very dense, moist. 21.8 to 22.7m no recovery
RICCARTON GRAVELS								-17.0	22.0								22.0
			25	HQTT				-17.5	22.5		GW	W	VD				22.5 Medium to coarse GRAVEL with trace cobbles, grey. Very dense, wet. Gravel is subangular to subrounded. Fines washed away during drilling process.
				SPT		10/12/11/ 12/11/13 N=47		-18.0	23.0				D				23.0 23.0 to 23.3m no recovery - becoming sandy, fine to coarse gravel, dense.
			36	HQTT				-18.5	23.5								23.5 - fines washed away during drilling process
								-19.0	24.0								24.0 **End of borehole at 24mbgl.** Open standpipe piezometer installed. Please see attached diagram in Appendix F.
								-19.5	24.5								24.5
									25								

T+T DATATEMPLATE.GDT eek

Borelog for well M35/2265

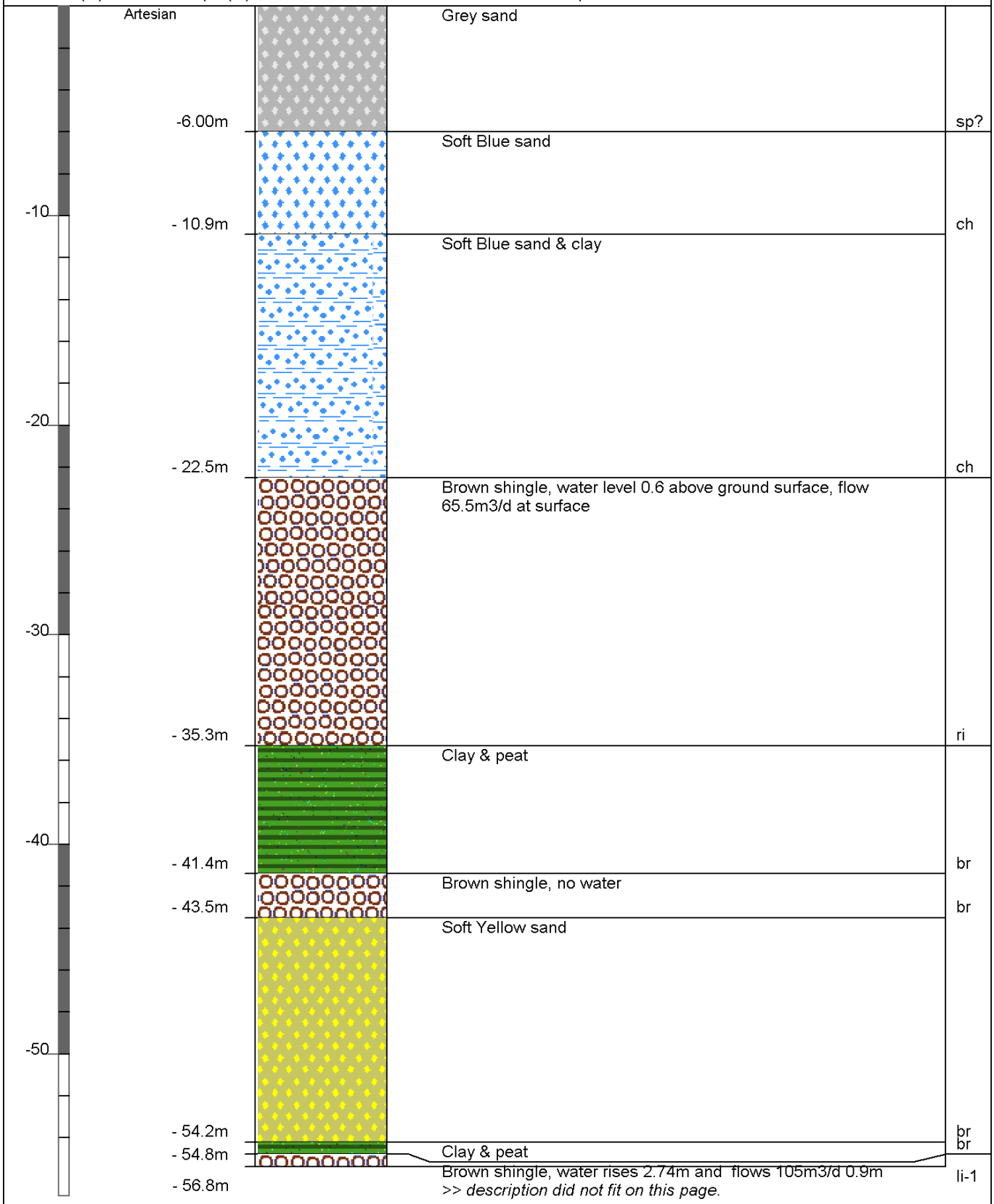
Gridref: M35:798-418 Accuracy : 4 (1=high, 5=low)
Ground Level Altitude : 7.8 +MSD
Driller : Canterbury Drilling Company
Drill Method : Unknown
Drill Depth : -12.8m Drill Date :

Environment Canterbury Regional Council

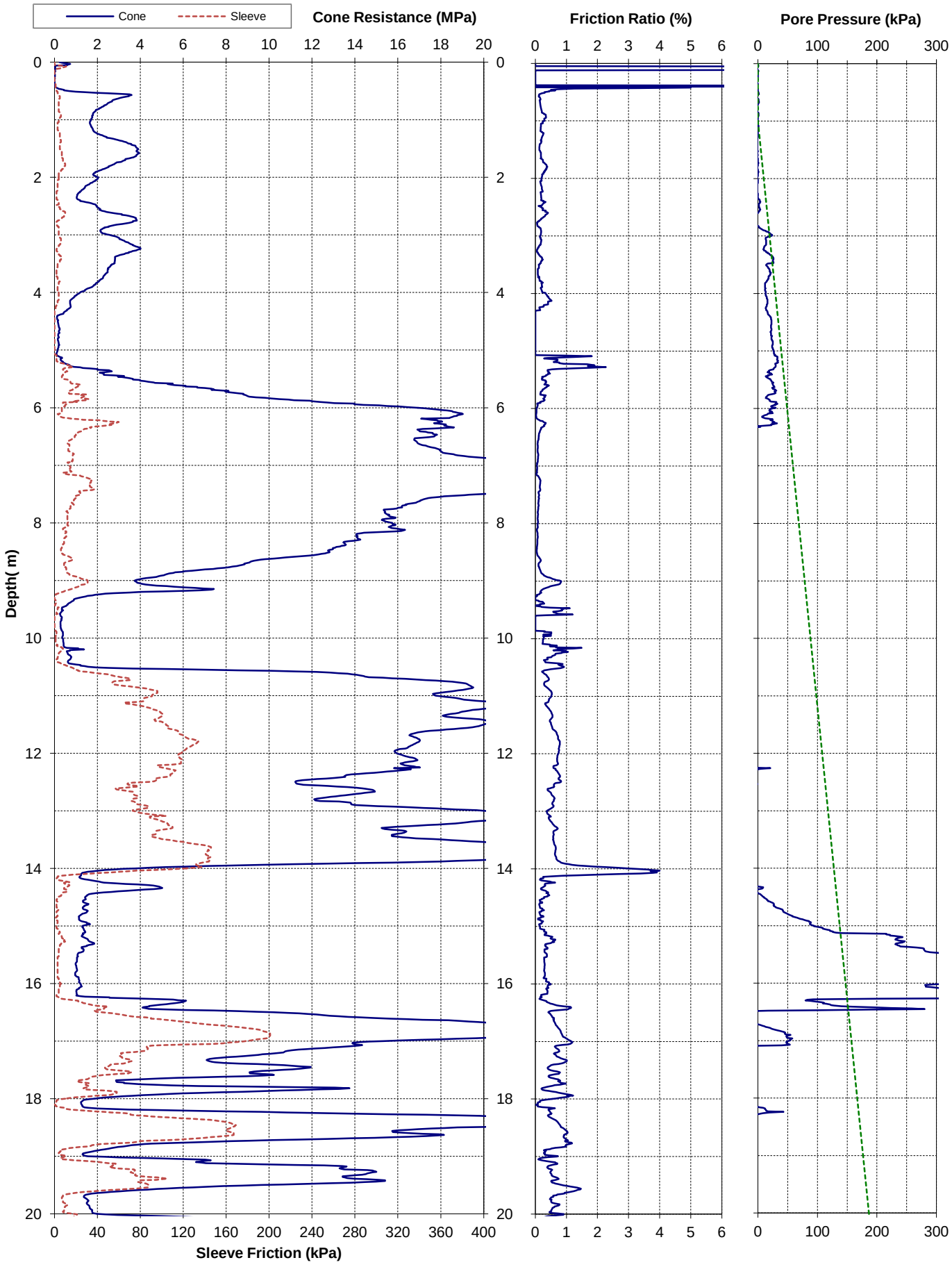


Borelog for well M35/2564

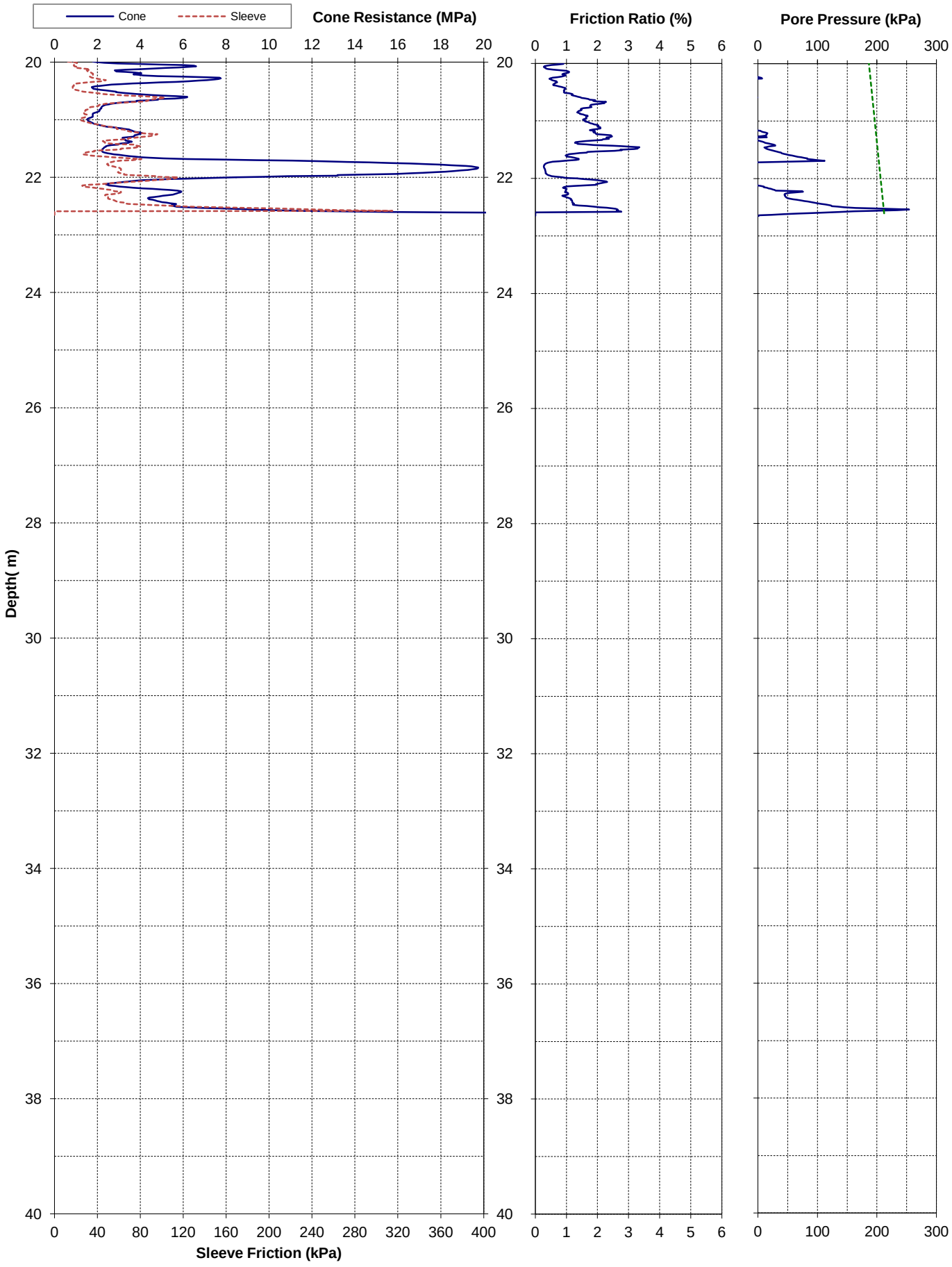
Gridref: M35:7983-4178 Accuracy : 3 (1=high, 5=low)
Ground Level Altitude : 6.78 +MSD
Driller : Job Osborne (& Co/Ltd)
Drill Method : Hydraulic/Percussion
Drill Depth : -55.4m Drill Date : 23/04/1894



Project:	Christchurch 2011 Earthquake - CCC Ground Investigations			Page: 1 of 2	CPT-CBD-47P
Test Date:	31-Oct-2011	Location:	Central City	Operator:	Perry
Pre-Drill:	5m	Assumed GWL:	1mBGL	Located By:	Survey GPS
Position:	2479897.1mE	5741829.5mN	6.584mRL	Coord. System:	NZMG & MSL
Other Tests:				Comments:	



Project:	Christchurch 2011 Earthquake - CCC Ground Investigations			Page: 2 of 2	CPT-CBD-47P
Test Date:	31-Oct-2011	Location:	Central City	Operator:	Perry
Pre-Drill:	1.5m	Assumed GWL:	1mBGL	Located By:	Survey GPS
Position:	2479897.1mE	5741829.5mN	6.584mRL	Coord. System:	NZMG & MSL
Other Tests:				Comments:	



Appendix C – Geotechnical Investigation Summary

■ Table 1 Summary of most relevant investigation data

ID	1	2	3	4	5
Type *	BH	BH	BH	WW	WW
Ref	BH-CBD-14	BH-CBD-21	BH-CBD-48	M35-2265	M35-2564
Depth (m)	30.25	30.94	24	12.8	56.8
Ground water level (mBGL)	-	-	-	Artesian	Artesian
Simplified recorded geological profile (depth below ground level to top of stratum, m) 0	Fill	Fill	Fill		
1	Fill	Fill	Fill		
2		MD	D		
3		MD	MD		
4		D	N/A		
5		D	MD		
6		D	MD		
7		D	MD		
8		MD	MD		
9		MD	F		
10		MD	L		
11		D	MD		
12		D	MD		
13		VD	F		
14		S	VL		
15		VL	L		
16		VL	L		
17		VL	VS		
18		VL	S		
19		VL	S		
20		S	St		
21		St	VD		
22		St	VD		
23		VD	D		
24		VD			
25		VD			
Greater depths					

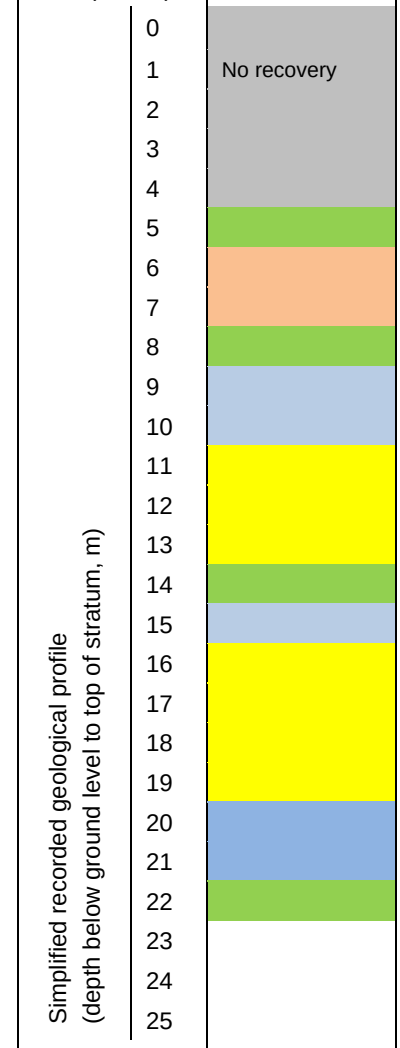
*BH: Borehole, HA: Hand Auger, WW: Water Well, CPT: Cone Penetration Test

Sensitive or organic clay/silt
Clay to silty clay
Clayey silt to silt
Silty sand to silt
Clayey sand
Sand
Gravelly sand or gravel

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

ID	6
Type *	CPT
Ref	CPT-CBD-47P
Depth (m)	22.65
Ground water level (mBGL)	1.0***

Simplified recorded geological profile (depth below ground level to top of stratum, m)



Greater depths

*BH: Borehole, HA: Hand Auger, WW: Water Well, CPT: Cone Penetration Test
** Ground water level likely to be artesian
*** Assumed ground water level

Sensitive or organic clay/silt
Clay to silty clay
Clayey silt to silt
Silty sand to silt
Clayey sand
Sand
Gravelly sand or gravel

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