CHRISTCHURCH CITY COUNCIL

BU 0572-001 EQ2
Edgar McIntosh Park – Plant Room
Condell Avenue, Papanui

QUALITATIVE ASSESSMENT REPORT

FINAL

- Rev B
- 05 November 2012

CHRISTCHURCH CITY COUNCIL
BU 0572-001 EQ2
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Condell Avenue, Papanui
QUALITATIVE ASSESSMENT REPORT

FINAL

- Rev A
- 05 November 2012

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Contents

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1. Executive Summary

1.1. Background

A Qualitative Assessment was carried out on building BU 0572-001 EQ2 located at Edgar McIntosh Park on Condell Avenue, Papanui. This building is a single storey structure that is used as a plant room for the paddling pool at Edgar McIntosh Park. An aerial photograph illustrating the buildings location is shown below in Figure 1. Detailed descriptions outlining the buildings age and construction type is given in Section 5 of this report.

- **Figure 1: Aerial Photograph of BU 0572-001 EQ2 Located at Edgar McIntosh Park**

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

This Qualitative report for the building structure is based on the Detailed Engineering Evaluation Procedure document (draft) issued by the Structural Advisory Group on 19 July 2011 and our visual inspection carried out on the 19 April 2012.

1.2. Key Damage Observed

Key damage observed includes:-

- Minor damage to the brick veneer.

A summary of the damage observed is given in Section 6. Please note that we were unable to carry out an internal inspection and as result the damage outlined in Section 6 is external damage only. An internal inspection can be carried out if requested by the Christchurch City Council.

1.3. Critical Structural Weaknesses

No critical structural weaknesses were observed during our visual inspection.

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 71%NBS. No damage was observed during our site investigation. Due to this the post earthquake capacity is also in the order of 71%NBS. This assessment has been made without structural drawings and is accordingly limited

As noted above our analysis indicates that the current seismic capacity of the building is in the order of 71% NBS and therefore is not a potentially earthquake prone building.

1.5. Recommendations

It is recommended that:

a) No placard was displayed however we believe that the current placard status should be Green 2.

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

2. Introduction

Sinclair Knight Merz was engaged by the Christchurch City Council to prepare a qualitative assessment report for building BU 0572-001 EQ2 located at Edgar McIntosh Park, Papanui 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 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 have been carried out. No structural drawings were available for this building therefore the description outlined in Section 5 is based only on our visual inspection carried out on the 19 April 2012.

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[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 33%NBS (including consideration of critical structural weaknesses) will need to be strengthened to a target of 67%NBS of new building standard as recommended by the Policy.

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

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

3.4. Building Code

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

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

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

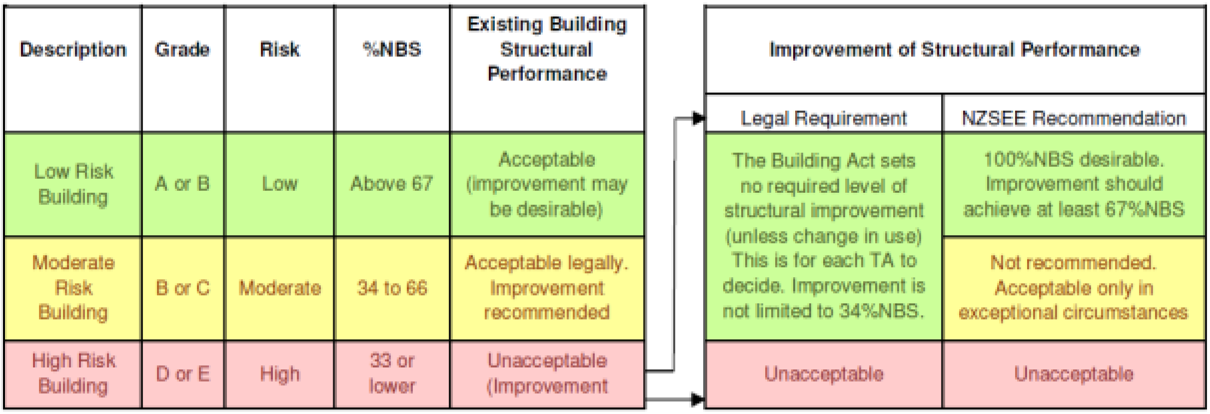
The increase in the above factors has resulted in a reduction in the level of compliance of an existing building relative to a new building despite the capacity of the existing building not changing.

4. Earthquake Resistance Standards

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

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

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

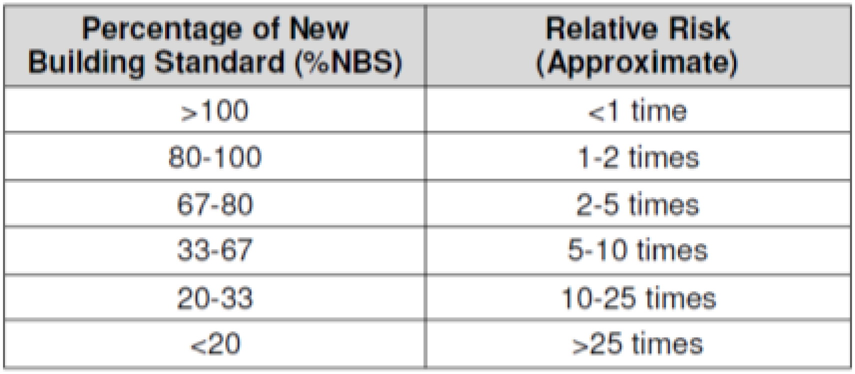


Description	Grade	Risk	%NBS	Existing Building Structural Performance	Improvement of Structural Performance	
					Legal Requirement	NZSEE Recommendation
Low Risk Building	A or B	Low	Above 67	Acceptable (improvement may be desirable)	The Building Act sets no required level of structural improvement (unless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

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

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

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



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

5. Building Details

5.1. Building Description

Our evaluation was based on our external site investigation conducted on the 19 April 2012. Building BU 0572-001 EQ2 is a single storey building that is used as a Plant Room for the paddling pool at Edgar McIntosh Park. No structural drawings were available for this building nor were we able to carry out an internal inspection. Due to this we are unable to confirm the buildings construction. However we have been able to make an educated assumption on likely construction based on the buildings size, age and cladding. We believe that roof and walls are constructed from timber framing. The cladding to the roof is a light-weight corrugated steel whereas the cladding to the walls is a brick. The building is supported on concrete foundations and has a concrete floor slab. The footprint of this building is approximately 4.0m x 2.0m and is 4.0m high. Based on the architecture and the condition of this structure we believe that this building was constructed sometime in the 1990's and as a result have taken a construction period of 1992-2004 for our assessment.

5.2. Gravity Load Resisting System

As detailed above we believe that the roof structure is constructed from timber framing and is supported on timber walls. The brick walls observed during our external inspection are cladding elements only and will not provide part of the gravity load resisting system.

5.3. Seismic Load Resisting System

For the lateral analysis of this building the 'across direction' has been taken as north-south whereas the 'along direction' has been taken as east-west.

Since we were unable to carry out an internal inspection or review any structural drawings we are unable to confirm the seismic load resisting system. However since the building is believed to have been constructed between 1992-2004 then it should have been designed and constructed to the current codes of this time and as a result have a sufficient lateral load resisting system. This is likely to be formed with galvanised light-weight steel strap or angle bracing present in the roof and 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).
- Liquefaction risk is expected to be low to moderate for this site.
- A more detailed set of ground investigations would be required if consent is required or significant alteration to the structures on site is proposed.

The full geotechnical desktop study can be found in Appendix 4 – Geotechnical Desk Study.

6. Damage Summary

SKM undertook inspections on the 19 April 2012. Please note that we were unable to carry out an internal inspection and as result the damage outlined below is for external damage only. An internal inspection can be carried out if requested by the Christchurch City Council.

6.1. Damage Summary

The following was observed during the time of inspection:

1) Various capping bricks around the top of the foundations have come loose or fallen off. Similar damage also occurs around the base of the pergola columns. (PHOTO 5, 6, 7 & 8)
2) Guttering along the north face has been damaged, however this most likely due to the heavy snow loads experienced in Christchurch in 2011 and therefore is not earthquake damage. (PHOTO 2 & 3)
3) No visual evidence of settlement was noted at this site. Therefore a level survey is not required at this stage of assessment.

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: IEP Risk classifications. 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].

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[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 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

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[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 19 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 or internal investigations were undertaken.
- No structural drawings were available for this building.

The design criteria used to undertake the assessment include:

- Standard design criteria for 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, based on our assessment and code requirements at the time of design.
- Site hazard factor, Z = 0.3, NZBC, Clause B1 Structure, Amendment 11 effective from 1 August 2011

This IEP was based on our 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 were there any significant ground movement issues around the building. The building is zoned as either TC2 under the CERA Residential Technical Categories Map. Due to these factors we do not recommend that any survey be undertaken at this stage of the assessment.

7.4. Critical Structural Weaknesses

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

7.5. Qualitative Assessment Results

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

Table 3: Qualitative Assessment Summary

Item	%NBS
Buildings likely Seismic Capacity	71

Our qualitative assessment found that the building is likely to be classed as a ‘Low Risk Building’ (capacity between 67% and 100% of NBS). The full IEP assessment form is detailed in Appendix 2 – IEP Report.

8. Further Investigation

Due to the likely seismic rating of this building and the lack of any structural damage no further investigation is required at this stage.

9. Conclusion

A qualitative assessment was carried out on building BU 0572-001 EQ2, located at Edgar McIntosh Park, Papanui. This building has been assessed to have a likely seismic capacity greater than 100% NBS and is therefore a ‘Low Risk Building’ (capacity greater than 67% of NBS).

Due to the likely seismic rating of this building and the lack of any structural damage no further investigation is required at this stage.

It is recommended that:

a) No placard was displayed however we believe that the current placard status should be Green 2.

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: Plant Room – West elevation	Photo 2: Plant Room – North-West Corner
	
Photo 3: Plant Room – North Elevation	Photo 4: Plant Room – South Elevation

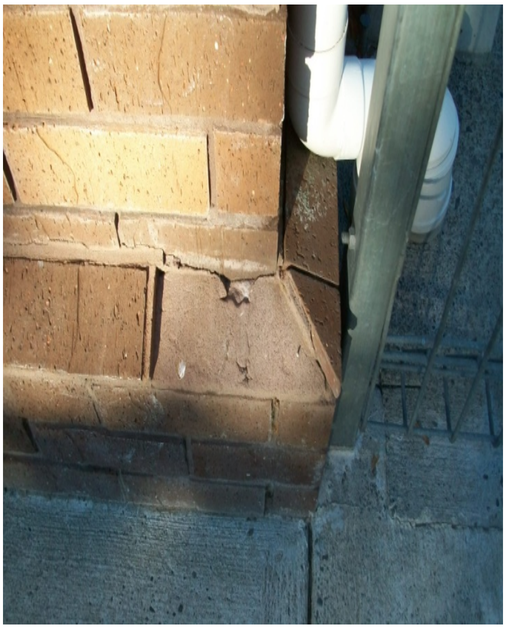	
Photo 5: Missing Capping Brick at the Top of The Foundation	Photo 6: Missing Capping Bricks at the Top of The Foundation
	
Photo 7: Pergola Column	Photo 8: Missing Capping Bricks

12. Appendix 2 – IEP Report

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:	BU 0572-001 EQ2 - Plant Room	Ref.	ZB01276.061
Location:	Edgar McIntosh Park	By	KW
		Date	21/03/2012

Step 1 - General Information

1.1 Photos (attach sufficient to describe building)

1.2 Sketch of building plan

1.3 List relevant features

Building CCC-BU 0572-001 is a single storey building that is used as a Plant Room for the paddling pool at Edgar McIntosh Park. No structural drawings were available for this building nor were we able to carry out an internal inspection. Due to this we are unable to confirm the buildings construction. However we have been able to make an educated assumption on likely construction based on the buildings size, age and cladding. We believe that roof and walls are constructed from timber framing. The cladding to the roof is a light-weight corrugated steel whereas the cladding to the walls is brick. The building is supported on concrete foundations and has a concrete floor slab. The footprint of this building is approximately 4.0m x 2.0m and is 4.0m high.

1.4 Note information sources

Tick as appropriate

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

Inspection Date - 19/04/2012

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:	BU 0572-001 EQ2 - Plant Room	Ref.	ZB01276.061
Location:	Edgar McIntosh Park	By	KW
Direction Considered:	**Longitudinal & Transverse**	Date	21/03/2012

(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	○
(for 1992 to 2004 only and only if known)	b) Intermediate	●

c) Estimate Period, T

building Ht = 3 meters

	Longitudinal	Transverse	
Ac =	4	4	m2
	○ MRCF	○ MRCF	
	○ MRSF	○ MRSF	
	○ EBSF	○ EBSF	
	● Others	● Others	
	○ CSW	○ CSW	
	○ MSW	○ MSW	

Can use following:

$T = 0.09h_n^{0.75}$	for moment-resisting concrete frames
$T = 0.14h_n^{0.75}$	for moment-resisting steel frames
$T = 0.08h_n^{0.75}$	for eccentrically braced steel frames
$T = 0.06h_n^{0.75}$	for all other frame structures
$T = 0.09h_n^{0.75}/A_c^{0.5}$	for concrete shear walls
$T <= 0.4sec$	for masonry shear walls

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

Longitudinal	Transverse	
0.1	**0.1**	Seconds

d) (%NBS)nom determined from Figure 3.3

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

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

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

Continued over page

Table IEP-2 Initial Evaluation Procedure – Step 2 continued

Building Name:	BU 0572-001 EQ2 - Plant Room	Ref.	ZB01276.061
Location:	Edgar McIntosh Park	By	KW
Direction Considered:	**Longitudinal & Transverse**	Date	21/03/2012

(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

Type Z 1992 above

b) **Hazard Scaling Factor**

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	μ Maximum = 6
Transverse	1	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	1.00
Transverse	Sp	1.00

b) **Structural Performance Scaling Factor**

Longitudinal	$1/S_p$	**Factor E**	1.00
Transverse	$1/S_p$	**Factor E**	1.00

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

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

Longitudinal	71.0	(%NBS)b
Transverse	71.0	(%NBS)b

Table IEP-3 Initial Evaluation Procedure – Step 3

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

Building Name:	BU 0572-001 EQ2 - Plant Room	Ref.	ZB01276.061
Location:	Edgar McIntosh Park	By	KW
Direction Considered:	**a) Longitudinal**	Date	21/03/2012

(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**

3.1 Plan Irregularity

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

3.2 Vertical Irregularity

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

3.3 Short Columns

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

3.4 Pounding Potential

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

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

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

Factor D1 1

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

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

Factor D2 1

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

Factor D 1

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

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

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

3.6 Other Factors

For < 3 storeys - Maximum value 2.5,

otherwise - Maximum value 1.5. No minimum.

Factor F 1

Record rationale for choice of Factor F:

Since this is a small light-weight timber structure an F factor >1 could be justified, however since the %NBS is over 67 an F factor greater than 1 does not need to be considered.

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:	BU 0572-001 EQ2 - Plant Room	Ref.	ZB01276.061
Location:	Edgar McIntosh Park	By	KW
Direction Considered:	**b) Transverse**	Date	21/03/2012

(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**

3.1 Plan Irregularity

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

3.2 Vertical Irregularity

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

3.3 Short Columns

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

3.4 Pounding Potential

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

a) Factor D1: - Pounding Effect

Select appropriate value from Table

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

Factor D1 1

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

b) Factor D2: - Height Difference Effect

Select appropriate value from Table

Factor D2 1

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

Factor D 1

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

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

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

3.6 Other Factors

For < 3 storeys - Maximum value 2.5,

otherwise - Maximum value 1.5. No minimum.

Factor F 1

Record rationale for choice of Factor F:

Since this is a small light-weight timber structure an F factor >1 could be justified, however since the %NBS is over 67 an F factor greater than 1 does not need to be considered.

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:	BU 0572-001 EQ2 - Plant Room	Ref.	ZB01276.061
Location:	Edgar McIntosh Park	By	KW
Direction Considered:	**Longitudinal & Transverse**	Date	21/03/2012

(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)	71	71
4.2 Performance Achievement Ratio (PAR) (from Table IEP - 2)	1.00	1.00
4.3 PAR x Baseline (%NBS)$_b$	71	71
4.4 Percentage New Building Standard (%NBS) (Use lower of two values from Step 4.3)		71

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 B

Evaluation Confirmed by

TW Robertson

Signature

Trevor Robertson Name

28892 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: BU 0572-001 EQ2

Unit | No: | Street

Building Address: Plant Room - Edgar McIntosh Park | | Condell Avenue, Papanui

Legal Description:

Degrees | Min | Sec

GPS south:

GPS east:

Building Unique Identifier (CCC):

Reviewer: **Trevor Robertson**

CPEng No: **28892**

Company: SKM

Company project number: ZB01276.061

Company phone number: 09 940 4900

Date of submission:

Inspection Date: 19/04/2012

Revision: A

Is there a full report with this summary? yes

Site

Site slope: flat

Soil type: mixed

Site Class (to NZS1170.5): D

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

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

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

Max retaining height (m):

Soil Profile (if available): refer to geotech desktop study attached within our qualitative report

If Ground improvement on site, describe:

Approx site elevation (m):

Building

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

Ground floor split? no

Storeys below ground: 0

Foundation type: strip footings

Building height (m): 4.00

Floor footprint area (approx): 8

Age of Building (years): 18

Ground floor elevation (Absolute) (m): 0.00

Ground floor elevation above ground (m): 0.20

if Foundation type is other, describe:

height from ground to level of uppermost seismic mass (for IEP only) (m): 4.00

Date of design: 1992-2004

Strengthening present? no

If so, when (year)?

And what load level (%g)?

Brief strengthening description:

Use (ground floor): other (specify)

Use (upper floors):

Use notes (if required): Paddling Pool Plant Room

Importance level (to NZS1170.5): IL1

Gravity Structure

Gravity System: frame system

Roof: timber truss

Floors: concrete flat slab

Beams: timber

Columns: load bearing walls

Walls:

truss depth, purlin type and cladding: timber truss (assumed) supporting light weight profiled steel cladding

slab thickness (mm): 125mm (assumed)

type: timber purlins & trusses to roof, no beams to floor slab

typical dimensions (mm x mm): 100x50 timber stud (assumed)

Walls are load bearing timber frame

Lateral load resisting structure

Note: Define along and across in detailed report!

Lateral system along: other (note)

Ductility assumed, μ: 1.00

Period along: 0.10 | 0.00

Total deflection (ULS) (mm): 5

maximum interstorey deflection (ULS) (mm): 0

describe system: timber framed with light-weight bracing (assumed)

estimate or calculation? estimated

estimate or calculation? estimated

estimate or calculation?

Lateral system across: other (note)

Ductility assumed, μ: 1.00

Period across: 0.10 | 0.00

Total deflection (ULS) (mm): 5

maximum interstorey deflection (ULS) (mm): 0

describe system: timber framed with light-weight bracing (assumed)

estimate or calculation? estimated

estimate or calculation? estimated

estimate or calculation?

Separations:

north (mm): | leave blank if not relevant

east (mm):

south (mm):

west (mm):

Non-structural elements

Stairs: | n/a

Wall cladding: brick or tile | describe (note cavity if exists): 100mm brick venner, cavity unknown

Roof Cladding: Metal | describe: Light weight profiled steel cladding

Glazing: | no windows present

Ceilings: none | n/a

Services(list): unknown

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: none | original designer name/date:

Damage

Site:
(refer DEE Table 4-2)

Site performance: 1

Describe damage: minor cracking to concrete slab around paddling pool

Settlement: none observed | notes (if applicable):

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

Liquefaction: none apparent | notes (if applicable):

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

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

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

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

Building:

Current Placard Status: green

Along — Damage ratio: 0%

Describe (summary): minor cracking to brick venner

Describe how damage ratio arrived at: non-structural damage observed only

Across — Damage ratio: 0%

Describe (summary): minor cracking to brick venner

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

Diaphragms — Damage?: no | Describe:

CSWs: — Damage?: no | Describe:

Pounding: — Damage?: no | Describe:

Non-structural: — Damage?: yes | Describe: minor cracking to brick venner

Recommendations

Level of repair/strengthening required: minor non-structural | Describe: repair cracking to brick venner - refer to Section 6, Qualitative Report

Building Consent required: yes | Describe:

Interim occupancy recommendations: full occupancy | Describe:

Along — Assessed %NBS before: 71% | %NBS from IEP

Assessed %NBS after: 71%

If IEP not used, please detail assessment methodology: Qualitative Assesment carried out includes NZSEE IEP - refer to SKM report

Across — Assessed %NBS before: 71% | %NBS from IEP

Assessed %NBS after: 71%

Official Use only:

Accepted By:

Date:

14. Appendix 4 – Geotechnical Desk Study

Sinclair Knight Merz
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Saint Albans
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Fax: +64 3 940 4901
Web: www.globalskm.com

Christchurch City Council - Structural Engineering Service

Geotechnical Desk Study

SKM project number	ZB01276
SKM project site number	061 to 062 inclusive
Address	Edgar MacIntosh Park, 177 Condell Avenue
Report date	22 May 2012
Author	Ananth Balachandra
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:

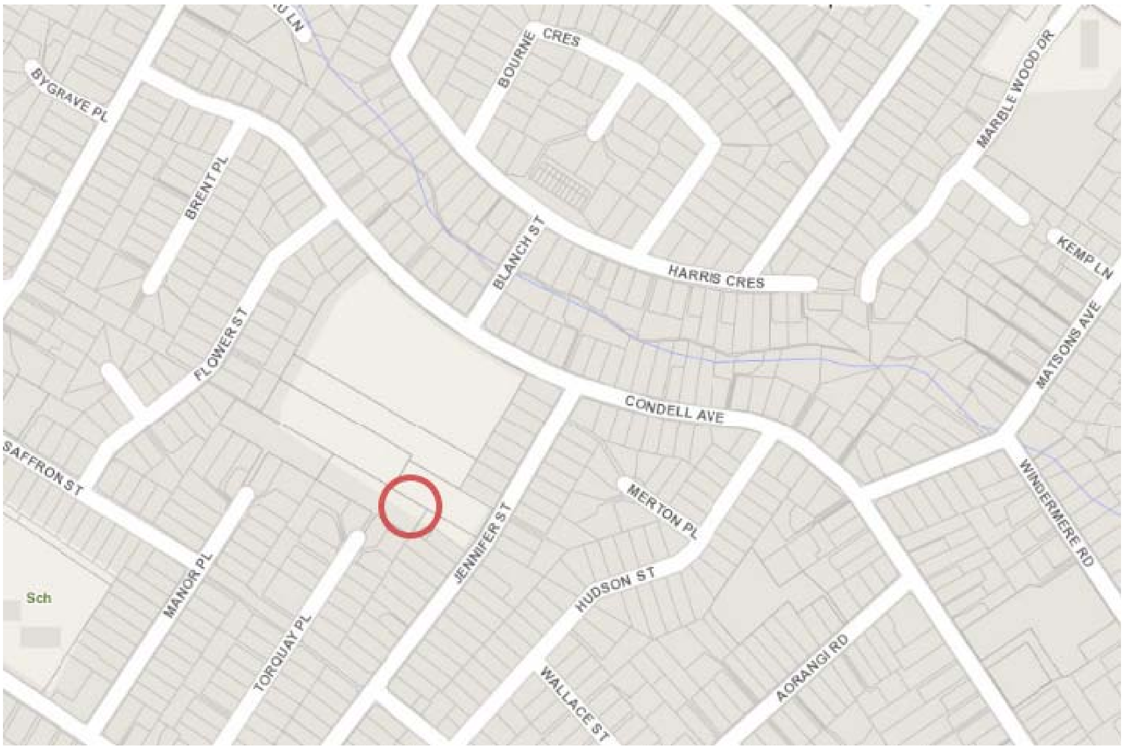
- Published geology
- Publically available borehole records
- Liquefaction records
- Aerial photography
- Council files
- A preliminary site walkover

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

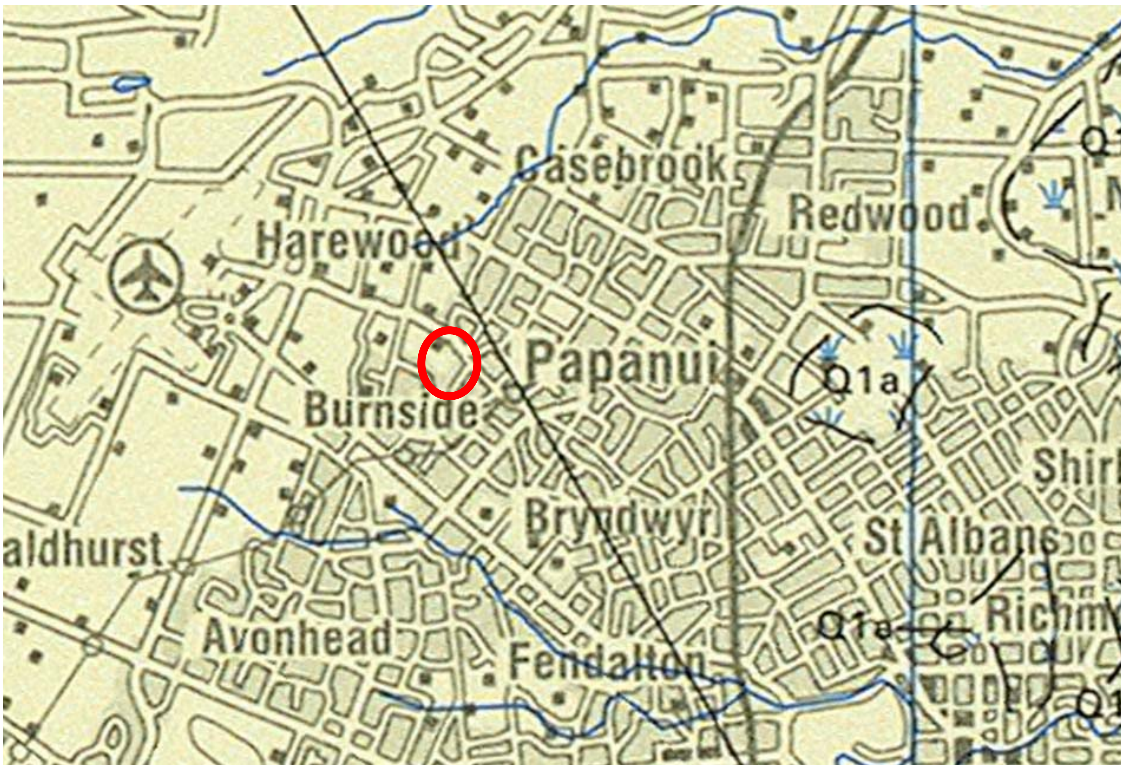


- **Figure 1 – Site location (courtesy of LINZ http://viewers.geospatial.govt.nz)**

These structures are located on at the back of Torquay place at an approximate grid reference 1567136 E, 5183703 N (NZTM). The entrance to the Edgar MacIntosh Park is on Condell Ave.

5. Review of available information

5.1 Geological maps



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

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

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

5.2 Liquefaction map

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

However, the reconnaissance did not extend to the location of the site.

5.3 Aerial photography

- **Figure 4 – Aerial photography from 24 Feb 2011 (http://viewers.geospatial.govt.nz/)**

The aerial photograph of the site following the 22nd February earthquake shows relatively little to no damage to the area adjacent to the paddling pool and plant shed. No liquefied ejecta or other surface evidence of liquefaction occurring on site 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) – adjacent properties are TC2

5.5 Historical land use

Reference to historical documents (eg Appendix A) shows that immediately south east of the site, the area was recorded as swamp or marshland. Therefore, there is a possibility that at least part of the site is underlain by soft or peat material.

5.6 Existing ground investigation data

- **Figure 5 – Local boreholes from Project Orbit and ECAN GIS (https://canterburyrecovery.projectorbit.com/) and (http://arcims.ecan.govt.nz/ecanmapping/)**

Where available logs from these investigation locations are attached to this report (Appendix B), and the results are summarised in Appendix C. A summarised inference of the available geotechnical investigation data is provided in section 6.1.

5.7 Council property files

Available council property files and drawings for the site relate to the proposed extension to the Papanui bowling club building and Edgar MacIntosh Park Cricket Club pavilion structure.

No relevant information regarding the concerned structures or general ground condition of the site was obtained from available council property files.

5.8 Site walkover

A site walkover was conducted by a SKM engineer on 16 April 2012.

The paddling pool appears to be poured in-situ concrete, with a surrounding concrete slab. The plant shed is located on this slab and is a small brick shed with a sheet metal roof. There does not appear to be any damage to the pool itself or the plant shed however, the slab surrounding the pool has some cracking. Minor cracks extend from the edge of the pool; more significant cracking occurs where there is seating located towards the edge on the southern side of the pool.

There was no further land damage noted on the grassed area surrounding the playground, there is no evidence of liquefaction having occurred. However, there is slight differential settlement of some concrete paving around the park area.

- **Figure 5 Overview of shed with the paddling pool visible in the background**

- **Figure 6 Observed cracking around the seating area near the paddling pool**

- **Figure 7 Observed cracking around the seating area**

6. Conclusions and recommendations

6.1 Site geology

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

Depth range (mBGL)	Soil type
0 - 0.4	Top soil
0.4 - 1	Silt mixtures containing damp silty sand with minor sand
1 - 2	Sand and silty sand
2 - 9	Mainly silt mixtures containing sandy silt and clayey silt
9 - 17.5	Clay and silty clay
17.5 - 17.9	Silty sand to clean sand

It should be noted that all available investigation data for the site are located a considerable distance away from the site, with investigation data below a depth of 3m being located approximately 450m from the site. Additionally, considerable variation was observed between investigations identified as 02 and 04 in section 5.6. However, these investigations are separated by a distance of approximately 900m. It is expected that site specific investigations would be needed if a more detailed understanding of the geology underlying the site is required.

From the description of the core samples recovered it expected that the ground water table would be at a depth of approximately 0.5 m to 2.0 m below ground level.

6.2 Seismic site subsoil class

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

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

In this case the third preferred method has been used to make the assessment. It is possible that further site specific study could result in the assessed site subsoil class being revised.

6.3 Building Performance

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

6.4 Ground performance and properties

Liquefaction risk is expected to be low to moderate for this site. No liquefaction was observed at the site however, slight differential settlement of paving was noted during the external site walkover, indicating possible post liquefaction consolidation of the ground. The silt mixture inferred to be present beneath the site, in particular sandy silt mixtures, is likely to be susceptible to liquefaction.

Available investigation data were generally located a significant distance away from the site. The nearest investigation was approximately 300m from the site. As there is potential for variability in the shallow soil layer, an estimation of ground properties that could be reasonably relied upon for quantitative DEE could not be provided based on available information. It is recommended that if a quantitative DEE is to be done for the site, further investigations are undertaken to assess the ground properties.

6.5 Further investigations

If a quantitative DEE is to be performed for the site, additional investigations are recommended in order to assess the ground properties on site. Additional investigations that are expected to be adequate are:

- Two hand augers to a depth of 3m to identify the composition of the shallow soil layer. If the shallow layer is identified to be too dense to effectively hand auger to a depth of 3m, two trial pits to a depth of 3m would be necessary
- Two dynamic cone penetration tests to estimate shallow soil properties

A more detailed set of ground investigations would be required if consent is required or significant alteration to the structures on site is proposed.

7. References

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

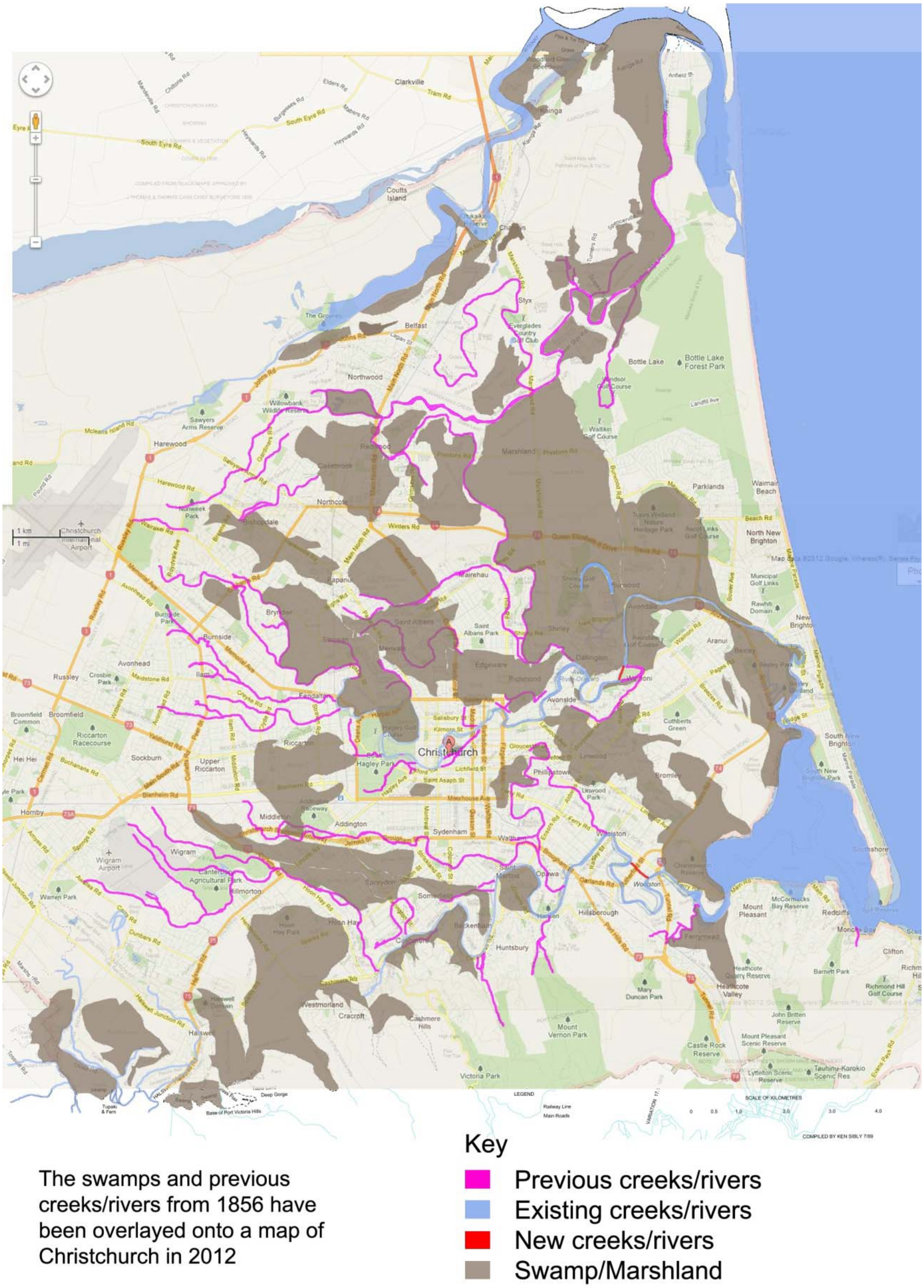
Cubrinovski & Taylor, 2011. Liquefaction map summarising preliminary assessment of liquefaction in urban areas following the 2010 Darfield Earthquake.

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

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

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

Appendix A – Christchurch 1856 land use

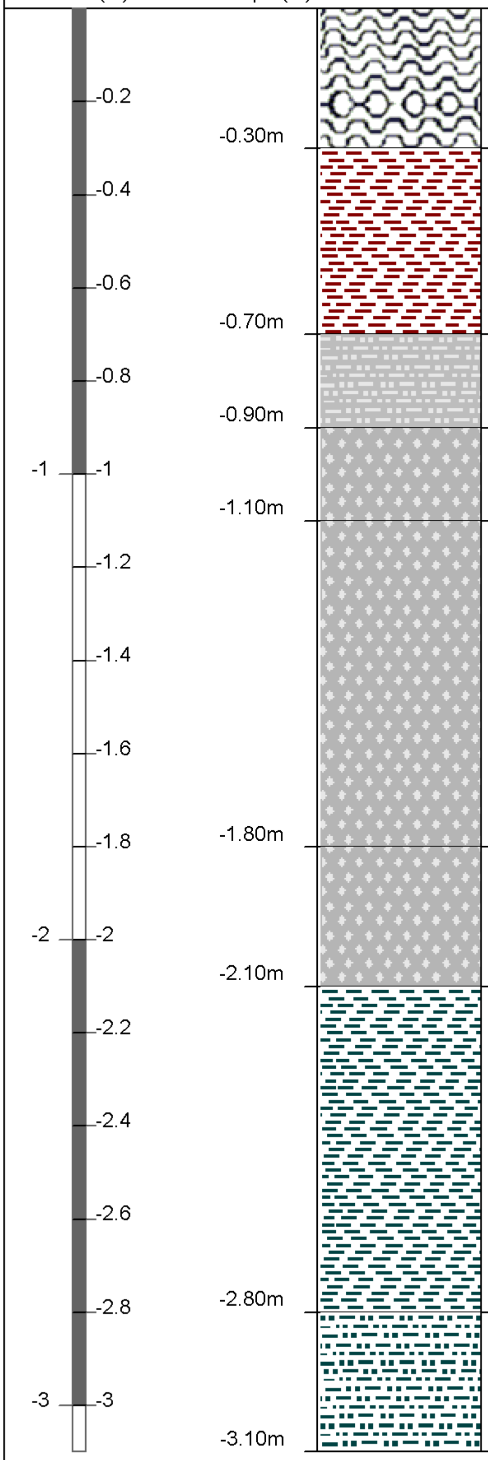


The swamps and previous creeks/rivers from 1856 have been overlayed onto a map of Christchurch in 2012

Appendix B – Existing ground investigation logs

Borelog for well M35/17562

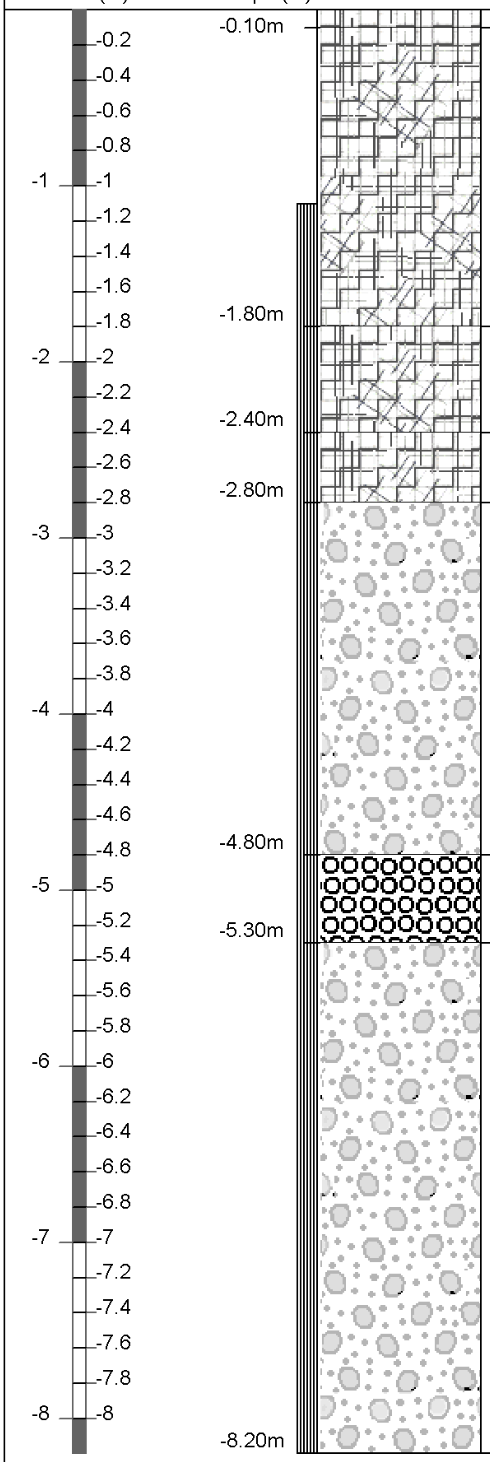
Gridref: M35:77302-45508 Accuracy : 3 (1=high, 5=low)
Ground Level Altitude : 15.93 +MSD
Well name : CCC BorelogID 7641
Drill Method : Not Recorded
Drill Depth : -3.1m Drill Date : 19/07/2007



Depth(m)	Full Drillers Description	Formation Code
-0.30m	topsoil	
-0.70m	mottled brown damp silt	
-0.90m	mottled grey damp sand / silt (50/50)	
-1.10m	mottled grey damp sand	
-1.80m	mottled grey damp sand	
-2.10m	mottled grey wet sand	
-2.80m	blue / grey puggy wet silt	
-3.10m	blue / grey wet silt / sand (80/20)	

Borelog for well M35/11353

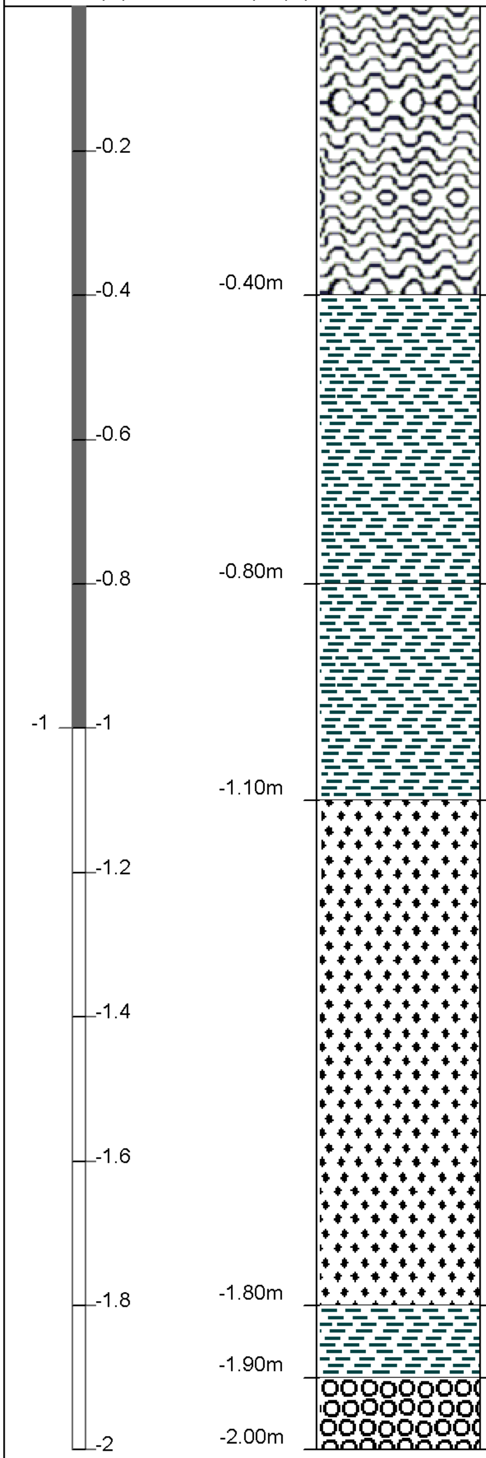
Gridref: M35:7679-4511 Accuracy : 4 (1=high, 5=low)
Ground Level Altitude : 15.86 +MSD
Driller : McMillan Water Wells Ltd
Drill Method : Push Tube
Drill Depth : -8.2m Drill Date : 17/05/2006



Depth(m)	Full Drillers Description	Formation Code
-0.10m	concrete	fi
-1.80m	sandy GRAVEL (fill), brown, no odour, no sample from 1.8m - 2.4m	fi
-2.40m	no sample	fi
-2.80m	sandy GRAVEL (fill), brown, no odour	fi
-4.80m	sandy GRAVEL; grey, dense, saturated, slight petrol odour	sp
-5.30m	GRAVEL (up to 20mm), gravel poorly graded, rounded, no odour	sp
-8.20m	very sandy GRAVEL; grey, dense, saturated, no odour	sp

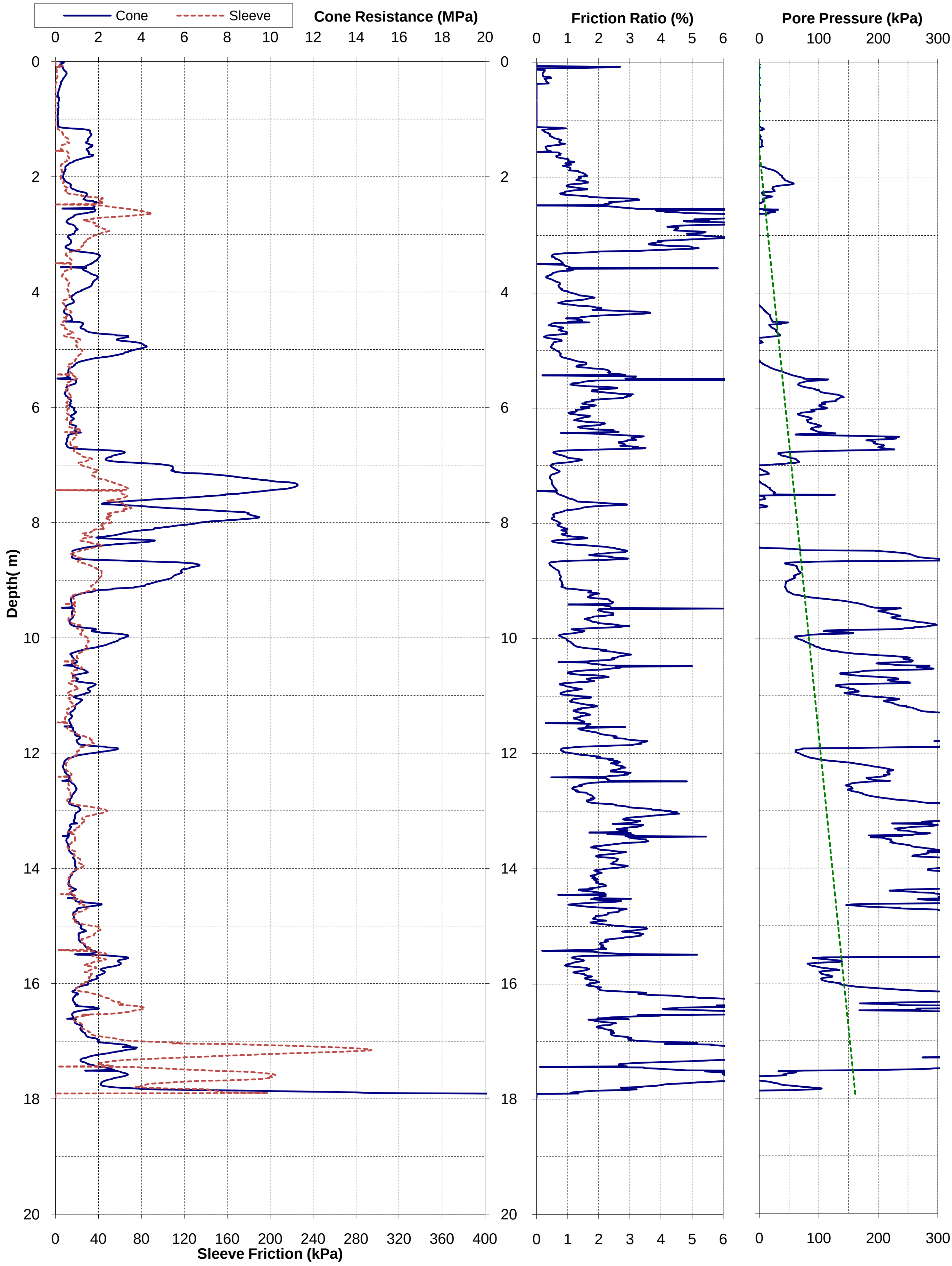
Borelog for well M35/16252

Gridref: M35:76829-45343 Accuracy : 3 (1=high, 5=low)
Ground Level Altitude : 16.54 +MSD
Well name : CCC BorelogID 5682
Drill Method : Not Recorded
Drill Depth : -2m Drill Date : 20/12/2005



Water Level	Depth(m)	Full Drillers Description	Formation Code
	-0.40m	topsoil	
	-0.80m	dry silt	
	-1.10m	mottled damp silt	
	-1.80m	mottled damp sand	
	-1.90m	mottled wet silt	
	-2.00m	shingle	

Project:	Darfield 2010 Earthquake - EQC Ground Investigations		**Page:**	1 of 1	**CPT-BDL-02**
Test Date:	3-Dec-2010	**Location:**	Bishopdale	**Operator:**	Perry
Pre-Drill:	1.2m	**Assumed GWL:**	1.5mBGL	**Located By:**	Survey GPS
Position:	2477136.3mE	5745760.9mN	16.31mRL	**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
Type *		BH	BH	BH	CPT
Ref		M35-17562	M35-11353	M35-16252	BDL-02
Depth (m)		3.1	8.2	2	17.9
Distance from site (m)		280	420	300	450
Ground water level (mBGL)		N/A			
Simplified recorded geological profile (depth below ground level to top of stratum, m)	0	N/A	🟧 Fill	N/A	▦
	0.5	▦	🟧 Fill	▦	▦
	1	🟨	🟧 Fill	🟨	🟩
	1.5	🟨	N/A	▦	🟩
	2	▦	🟧		🟩
	2.5	▦	🟧		🟦
	3		🟧		🟦
	3.5		🟧		🟩
	4		🟧		▦
	4.5		🟧		🟩
	5		🟧		🟩
	5.5		🟧		▦
	6		🟧		▦
	6.5		🟧		🟩
	7		🟧		🟩
	7.5		🟧		🟩
	8		🟧		🟩
	8.5				🟨
	9				🟦
	9.5				🟦
	10				🟦
	10.5				🟦
	11				🟦
	11.5				🟦
	12				🟦
	12.5				
	13				🟦
	13.5				🟦
	14				🟦
	14.5				🟦
	15				🟦
	15.5				🟦
	16				🟦
	16.5				🟦
	17				🟦
	17.5				🟨
	18				
	18.5				

*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