Christchurch City Council

PRK_1475_BLDG_001 EQ2
Toilets - Nicholson Park
10 Taylors Mistake Road

QUALITATIVE ASSESSMENT REPORT

FINAL

- Rev B
- 10 December 2012

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Contents

Document history and status

Revision	Date issued	Reviewed by	Approved by	Date approved	Revision type
A	23/07/2012	JE Mason	NM Calvert	23/07/2012	Draft for Client Approval
B	10/12/2012	NM Calvert	NM Calvert	10/12/2012	Final Issue

Distribution of copies

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

Printed:	10 December 2012
Last saved:	10 December 2012 12:01 PM
File name:	ZB01276.176.PRK_1475_BLDG_001 EQ2.Qualitative.Assmt.B.docx
Author:	Adam Langsford
Project manager:	Nick M. Calvert
Name of organisation:	Christchurch City Council
Name of project:	Christchurch City Council Structures Panel
Name of document:	PRK_1475_BLDG_001 EQ2 Qualitative Assessment Report
Document version:	B
Project number:	ZB01276.176

1. Executive Summary

1.1. Background

A Qualitative Assessment was carried out on the building PRK_1475_BLDG_001 EQ2 located at 10 Taylors Mistake Road. The building located on this site comprises of a public toilet servicing Nicholson park. The toilet block is located at the top of Nicholson Park just off the crest of the hill. The structure is approximately $12m^2$ and consists of a light metal clad roof on tongue and groove timber roofing supported by timber trusses. The walls are light timber framed half height with stone masonry from 1m to foundations around the perimeter and full height light timber framed separating the bathrooms. The foundations consist of perimeter strip footings with internal slab on grade floors. An aerial photograph illustrating these areas is shown below in Figure 1. Detailed descriptions outlining the buildings gravity and lateral systems are given in Section 5 of this report.

- **Figure 1: Aerial Photograph of PRK_1475_BLDG_001 EQ2 Nicholson Park**

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 2011and visual inspections on 27 June 2012. Structural drawings were not available.

1.2. Key Damage Observed

Key damage observed includes:

- Separations of plasterboard linings

1.3. Critical Structural Weaknesses

The building has no critical structural weaknesses

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 100%NBS and post earthquake capacity in the order of 100%NBS. The buildings post earthquake capacity excluding critical structural weaknesses is in the order of 100%NBS (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 100% NBS and is therefore not potentially earthquake prone.

1.5. Recommendations

It is recommended that:

a) The current placard status of the building of green 1 remain as is.

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 at 10 Taylors Mistake Road 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. Structural drawing for the building was not available. The building description below is based on a review of the drawings and our visual inspections.

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

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

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

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

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

5. Building Details

5.1. Building description

The building located on this site comprises of a public toilet servicing Nicolson park. The toilet block is located at the top of Nicholson Park just off the crest of the hill. The structure is approximately $12m^2$ and consists of a light metal clad roof on tongue and groove timber roofing supported by timber trusses. The walls are light timber framed half height with stone masonry from 1m to foundations around the perimeter and full height light timber framed separating the bathrooms. The foundations consist of perimeter strip footings with internal slab on grade floors.

Structural drawings were not available for the assessment of this building.

In the absence of drawings the building has been estimated to have been designed and constructed between 1992 and 2004 based on architecture and approximate age of in situ materials

5.2. Gravity Load resisting system

The gravity load resisting structure of the building is made up of load bearing perimeter walls consisting of stonework masonry to 1m with light timber framing from 1m to roof height (2.2m) above this is a trussed roof with light steel cladding supported by tongue and groove. A reinforced concrete slab on grade creates the ground floor area.

5.3. Seismic Load Resisting system

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

Lateral loads on the building are carried by the roof diaphragm into the timber trusses of the roof. The roof trusses transfer load into the 1.2 m deep section of light timber framed walls which rely on plasterboard interiors to transfer shear loadings. The timber walls transfer load into the connected stone masonry walls. The masonry walls are supported on strip foundations which act to take loads through in plane shear and overturning resistance through mass.

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 being either NZS1170.5 Class C (shallow soil) or NZS 1170.5 Class B (rock) from surface geology. As no investigation information is available for the site and the depth to the inferred volcanic deposits was not able to be reliably predicted, NZS 1170.5 Class C is recommended in this report.

- 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 bore logs 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 least preferred method has been in assessing the site subsoil class. However, a site specific study may result in a revision to the assessed site subsoil class.
- Liquefaction risk has been assessed as low for the 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

SKM undertook inspections on the 27th of June 2012. The following areas of damage were observed during the time of inspection:

1) Hairline-0.4mm cracking of the concrete floor slab radiating from floor penetrations in both toilets. Photos 9 and 10
2) Separations opening at joints of internal plasterboard linings

   Photos 7 and 8

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].

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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 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 27th June 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 for a building of less than 30m^2 footprint}
  - Ductility level of 1, based on our assessment and code requirements at the time of design. Due to reliance on plasterboard lining over 1.2m height assume non ductile response
  - 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 TC1 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

The building has no critical structural weaknesses:

7.5. Qualitative Assessment Results

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

Table 3: Qualitative Assessment Summary

Item	%NBS
Building excluding CSW's	100%

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.

No further investigation is required to confirm our initial findings.

8. Further Investigation

No further investigation is required

9. Conclusion

A qualitative assessment was carried out on the building located at 10 Taylors Mistake Road. The building has sustained minor damage to internal linings and hairline cracking to concrete elements around the drainage penetrations. A building consent is not likely to be required to repair the damage noted in section 6.

The building has been assessed to have a seismic capacity in the order of 100% NBS and is therefore not potentially earthquake prone and is likely to be classified as a 'low Risk Building' (capacity greater than 67% of NBS).

No Critical Structural Weaknesses have been identified.

It is recommended that the structure continue to be used with full occupancy as the structure has been designed to recent codes, is a small structure of importance level 1 with low risk to life safety or damage to property.

It is recommended that:

a) The current placard status of the building of green1 remain as is.

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: View looking east at the structures	Photo 2: North side of the building showing construction – Steel cladding, timber roof trusses, light timber framed walls and stone masonry
	
Photo 3: Close up of timber truss	Photo 4: Timber trusses spaced at approx 800mm crs.

	
Photo 5: Trusses connected using nails plates which do not appear to have suffered damage	Photo 6: Tongue and groove roofing supports

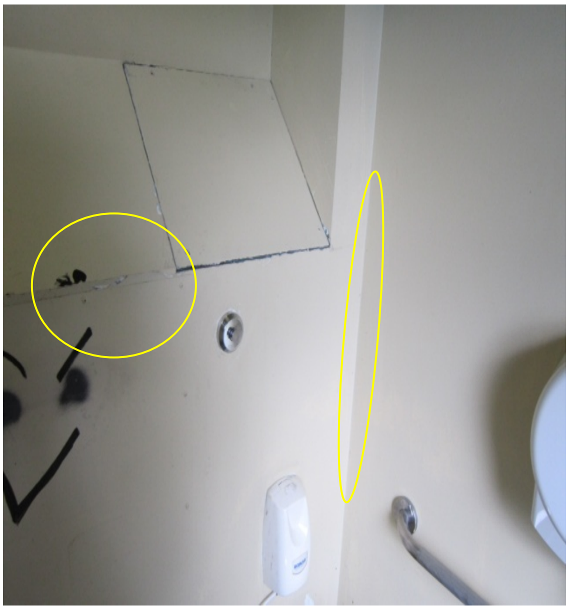
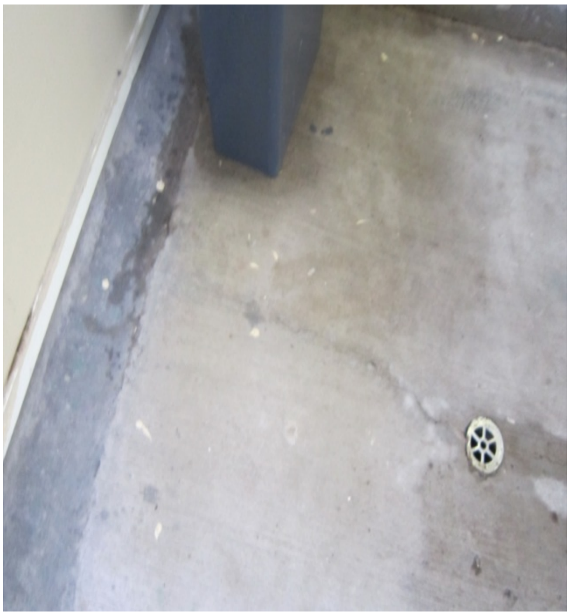



Photo 7: Separations of internal lining along joint lines	Photo 8: Typical separation of linings in corners

	
Photo 9: Cracking propagating through floor slab from drainage penetration hairline ~ 0.4mm cracks	Photo 10: Similar cracking in both toilets

12. Appendix 2 – IEP Reports

Table IEP-1 **Initial Evaluation Procedure – Step 1**

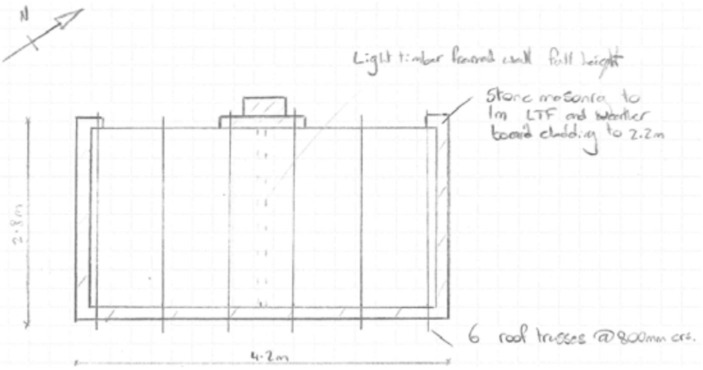
(Refer Table IEP - 2 for Step 2; Table IEP - 3 for Step 3, Table IEP - 4 for Steps 4, 5 and 6)

Building Name:	**PRK_1475_BLDG_001 EQ2 Nicholson Park**	Ref.	**ZB01276.176**
Location:	10 Taylors Mistake Road	By	AFL
	Taylors mistake, Christchurch	Date	23/07/2012

Step 1 - General Information

1.1 Photos (attach sufficient to describe building)

1.2 Sketch of building plan



1.3 List relevant features

The structures design period has been assumed to be 1992 to 2004 as no structural drawings were available. The structure consists of light metal cladding on a tongue and groove timber roofing supported by six timber roof trusses spaced at spporximately 800mm centres an example of these trusses is shown above in the right hand photo. The exterior walls are light timber framed from 2.2m down to 1m with weatherboard exterior and plasterboard interior, below the timber walls are Stone masonry walls. The internal dividing wall is full height light timber framed with plasterboard lining both sides. The foundation is a concrete pad across the entire footprint.

1.4 Note information sources

Tick as appropriate

Visual Inspection of Exterior	✓	
Visual Inspection of Interior	✓	
Drawings (note type)	☐	Arch/Strut
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)

SKM

Building Name:	**PRK_1475_BLDG_001 EQ2 Nicholson Park**	Ref.	**ZB01276.176**
Location:	10 Taylors Mistake Road	By	AFL
Direction Considered:	**Longitudinal & Transverse**	Date	23/07/2012

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

Step 2 - Determination of (%NBS)b

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

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

b) Soil Type

From NZS1170.5:2004, Cl 3.1.3	A or B Rock	○	
	C Shallow Soil	◉	
	D Soft Soil	○	
	E Very Soft Soil	○	
From NZS4203:1992, Cl 4.6.2.2	a) Rigid	○	N-A
(for 1992 to 2004 only and only if known)	b) Intermediate	◉	

c) Estimate Period, T

building Ht = 3.2 meters

	Longitudinal	Transverse	
Ac =			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	22.6	$(\%NBS)_{nom}$
Transverse	22.6	$(\%NBS)_{nom}$

		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	22.6	$(\%NBS)_{nom}$
Transverse	22.6	$(\%NBS)_{nom}$

Continued over page

Building Name:	PRK_1475_BLDG_001 EQ2 Nicholson Park	Ref.	ZB01276.176
Location:	10 Taylors Mistake Road	By	AFL
Direction Considered:	Longitudinal & Transverse	Date	23/07/2012

(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	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	72.3	(%NBS)b
Transverse	72.3	(%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:	**PRK_1475_BLDG_001 EQ2 Nicholson Park**	Ref.	**ZB01276.176**
Location:	10 Taylors Mistake Road	By	AFL
Direction Considered:	**a) Longitudinal**	Date	23/07/2012

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

Step 3 - Assessment of Performance Achievement Ratio (PAR)

(Refer Appendix B - Section B3.2)

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

3.4 Pounding Potential

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

a) Factor D1: - Pounding Effect

Select appropriate value from Table

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

Factor D1 1

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

b) Factor D2: - Height Difference Effect

Select appropriate value from Table

Factor D2 1

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

Factor D 1

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

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

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

3.6 Other Factors

For < 3 storeys - Maximum value 2.5,

otherwise - Maximum value 1.5. No minimum. **Factor F** 1.4

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 1.4

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

Building Name:	PRK_1475_BLDG_001 EQ2 Nicholson Park	Ref.	ZB01276.176
Location:	10 Taylors Mistake Road	By	AFL
Direction Considered:	b) Transverse	Date	23/07/2012

(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

Effect on Structural Performance: Severe ○ / Significant ○ / Insignificant ◉ — **Factor A** 1

Comment

3.2 Vertical Irregularity

Effect on Structural Performance: Severe ○ / Significant ○ / Insignificant ◉ — **Factor B** 1

Comment

3.3 Short Columns

Effect on Structural Performance: Severe ○ / Significant ○ / Insignificant ◉ — **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 ○ 0.5 / Significant ○ 0.7 / Insignificant ◉ 1 — **Factor E** 1

3.6 Other Factors

For < 3 storeys - Maximum value 2.5,

otherwise - Maximum value 1.5. No minimum. — **Factor F** 1.4

Record rationale for choice of Factor F:

Due to the size of the structure and the light weight construction the seismic loading will not govern, Little to no damage present.

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

PAR 1.4

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:	**PRK_1475_BLDG_001 EQ2 Nicholson Park**	Ref.	**ZB01276.176**
Location:	10 Taylors Mistake Road	By	AFL
Direction Considered:	**Longitudinal & Transverse**	Date	23/07/2012

(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)	72	72
4.2 Performance Achievement Ratio (PAR) (from Table IEP - 2)	1.40	1.40
4.3 PAR x Baseline $(\%NBS)_b$	101	101

4.4 Percentage New Building Standard (%NBS) (Use lower of two values from Step 4.3): **101**

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] Signature

NICK CALVERT Name

242062 CPEng. No

Relationship between Seismic Grade and % NBS :

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

13. Appendix 3 – CERA Standardised Report Form

Location

Building Name:	PRK_1475_BLDG_001 EQ2	Reviewer:	NICK CALVERT
	Unit / No: 10 / Street	CPEng No:	242062
Building Address:	Nicholson Park, 10 Taylors Mistake	Company:	Sinclair Knight Merz
Legal Description:		Company project number:	ZB01276.176
		Company phone number:	027 320 7967
	Degrees / Min / Sec		
GPS south:		Date of submission:	
GPS east:		Inspection Date:	27/06/2012
		Revision:	A
Building Unique Identifier (CCC):		Is there a full report with this summary?	yes

Site

Site slope:	slope >1 in 5	Max retaining height (m):	
Soil type:		Soil Profile (if available):	
Site Class (to NZS1170.5):	C		
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):	121.00

Building

No. of storeys above ground:	1 (single storey = 1)	Ground floor elevation (Absolute) (m):	121.00
Ground floor split?	no	Ground floor elevation above ground (m):	0.05
Storeys below ground	0		
Foundation type:	mat slab	if Foundation type is other, describe:	
Building height (m):	3.40	height from ground to level of uppermost seismic mass (for IEP only) (m):	3
Floor footprint area (approx):	12		
Age of Building (years):	15	Date of design:	
Strengthening present?	no	If so, when (year)?	
		And what load level (%g)?	
Use (ground floor):	public	Brief strengthening description	
Use (upper floors):			
Use notes (if required):			
Importance level (to NZS1170.5):	IL1		

Gravity Structure

Gravity System:	load bearing walls		
Roof:	timber truss	truss depth, purlin type and cladding	100x50 truss members, 1.2m bottom chord to apex, steel cladding on tongue and groove timber no purlins
Floors:	concrete flat slab	slab thickness (mm)	100
Beams:			NA
Columns:			NA
Walls:	load bearing stone	#N/A	

Lateral load resisting structure

Note: Define along and across in detailed report!

Lateral system along:	other (note)	describe system	half height masonry stone half height light timber framed with plasterboard
Ductility assumed, μ:	1.00		non ductile
Period along:	0.20 (0.00)	estimate or calculation?	estimated
Total deflection (ULS) (mm):	60	estimate or calculation?	estimated
maximum interstorey deflection (ULS) (mm):	60	estimate or calculation?	estimated
Lateral system across:	other (note)	describe system	half height masonry stone half height light timber framed with plasterboard
Ductility assumed, μ:	1.00		non ductile
Period across:	0.20 (0.00)	estimate or calculation?	estimated
Total deflection (ULS) (mm):	60	estimate or calculation?	estimated
maximum interstorey deflection (ULS) (mm):	60	estimate or calculation?	estimated

Separations:

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

Non-structural elements

Stairs:			
Wall cladding:	plaster system	describe	half height plaster board around perimeter with full height plasterboard central wal
Roof Cladding:	Metal	describe	corrugated steel
Glazing:	timber frames		
Ceilings:	strapped or direct fixed		Weather board diaphragm
Services(list):			

Available documentation

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

Damage

Site: (refer DEE Table 4-2)

Site performance:	mid range damage from shaking and slips	Describe damage:	Cracking to floor slab around drainage penetrations + separations of internal plasterboard linings
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:	slight	notes (if applicable):	Rock slides

Building:

	Current Placard Status:	green		
Along	Damage ratio:	0%	Describe how damage ratio arrived at:	minor structural damage
	Describe (summary):			
Across	Damage ratio:	0%		
	Describe (summary):			
Diaphragms	Damage?:	yes	Describe:	plasterboard diaphragms separated
CSWs:	Damage?:	no	Describe:	
Pounding:	Damage?:	no	Describe:	
Non-structural:	Damage?:	yes	Describe:	floor slabs around drainage penetrations

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

Recommendations

	Level of repair/strengthening required:	minor structural	Describe:	Plasterboard separations
	Building Consent required:	no	Describe:	minor work
	Interim occupancy recommendations:	full occupancy	Describe:	Low risk structure
Along	Assessed %NBS before:	100% (%NBS from IEP below)	If IEP not used, please detail assessment methodology:	SKM IEP
	Assessed %NBS after:	100%		
Across	Assessed %NBS before:	100% (%NBS from IEP below)		
	Assessed %NBS after:	100%		

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	176
Address	Nicholson Park - 10 Taylors Mistake Road
Report date	16 July 2012
Author	Ananth Balachandra
Reviewer	Leah Bateman
Approved for issue	No

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 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
- A preliminary site walkover

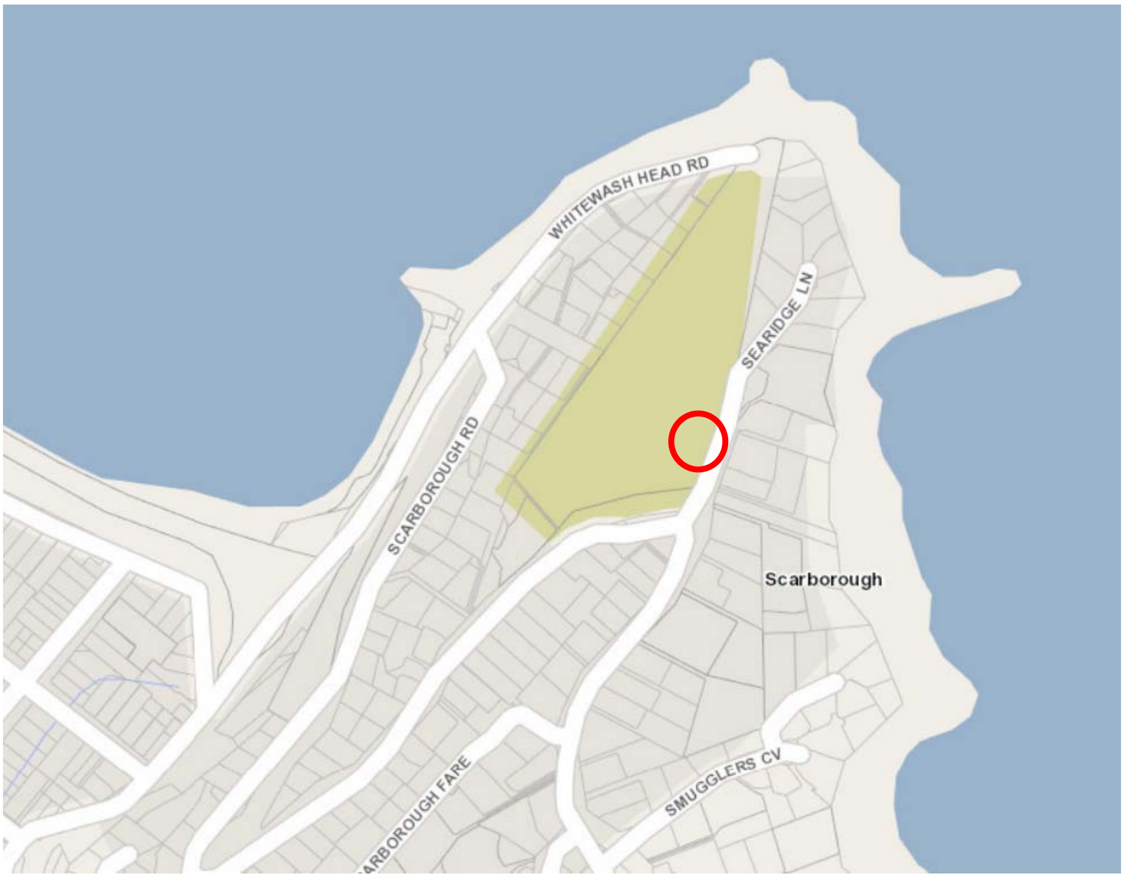
3. Limitations

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

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

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

4. Site location

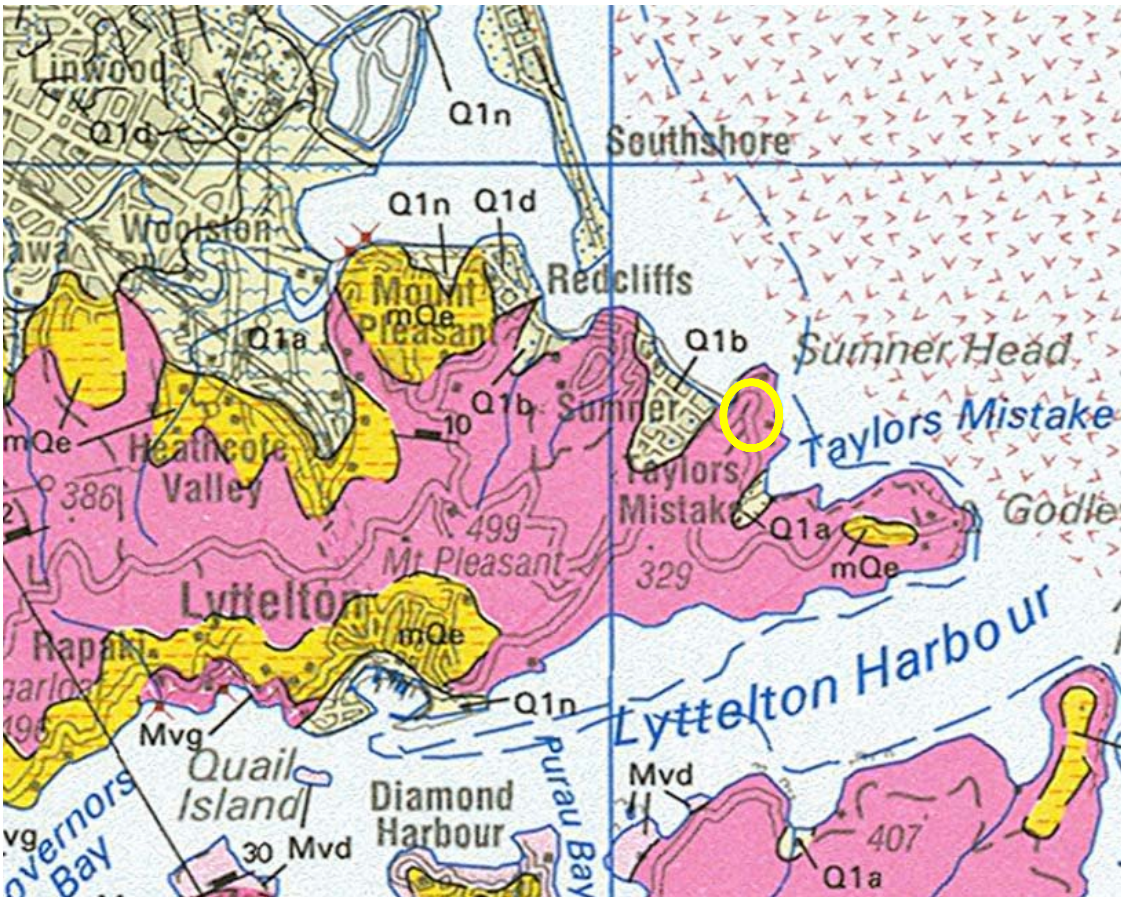


- **Figure 1 – Site location (courtesy of LINZ http://viewers.geospatial.govt.nz)**

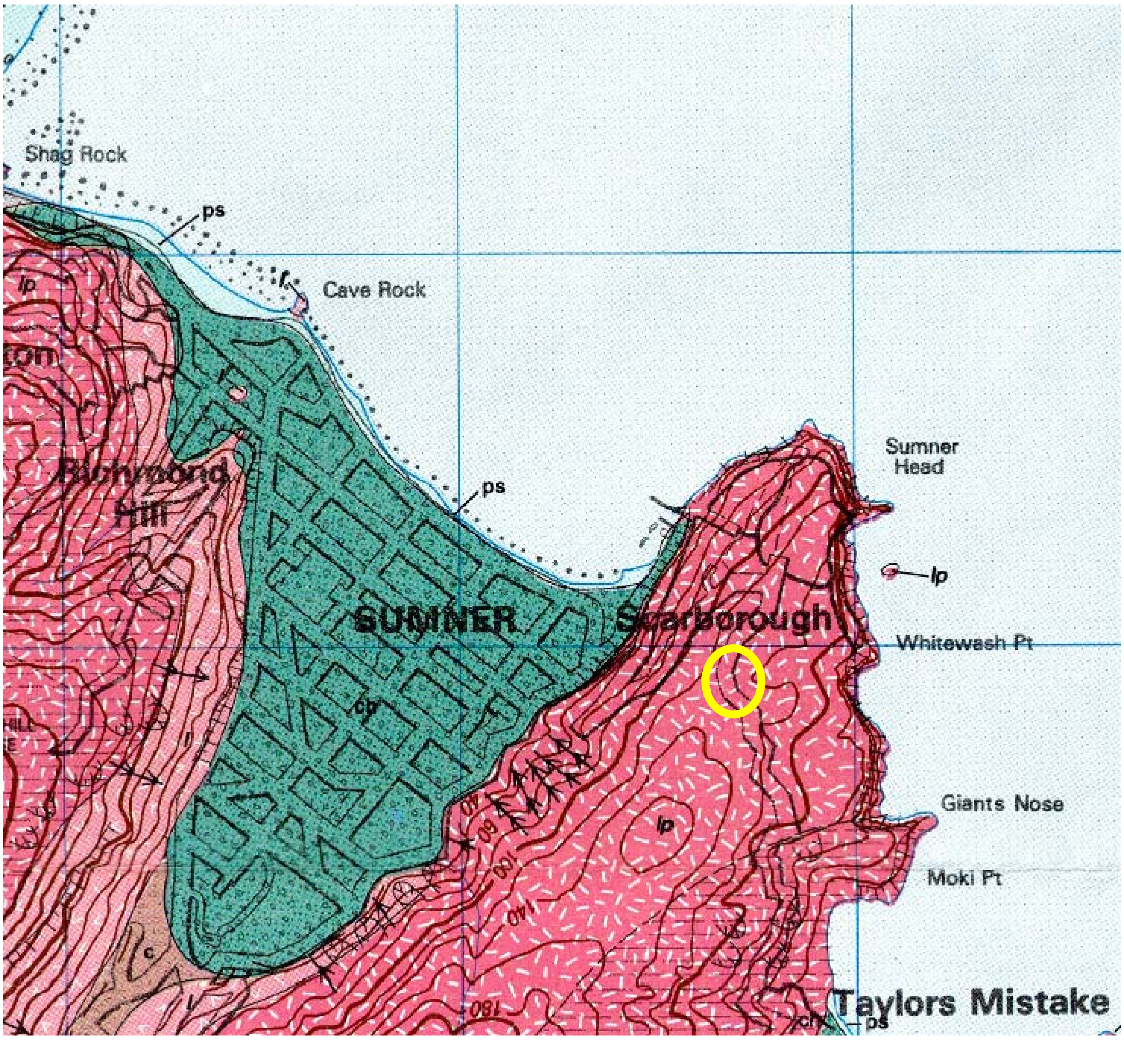
The structure is located on 10 Taylors Mistake Road at grid reference 1581799 E, 5175602 N (NZTM).

5. Review of available information

5.1 Geological maps



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



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

The site is shown to be underlain by deposits from Mt Pleasant formation comprising dark grey, plagioclase-pyroxene-amphibole, phyric hawaite through to grey-green trachyte with interbedded red-brown pyroclastic deposits.

5.2 Liquefaction map

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

Aerial photograph of the site taken shortly after the 22 February event shows no visible surface evidence of any land damage or damage to the property or neighbouring properties..

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 (Port Hills and Banks Peninsula)

5.5 Historical land use

No historical land use map or other information pertaining to the historical use of the land area was available at the time of writing this report.

5.6 Existing ground investigation data

No existing ground investigation data was available near the site.

5.7 Council property files

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

5.8 Site walkover

An external site walkover was conducted by an SKM engineer on 12 July 2012.

The building was noted to be a light weight timber structure with stone masonry around the lower 1 m of the walls, sheet metal roof and slab on grade foundation. A crack less than a 1 mm wide was noted in the concrete ground slab in the northern toilet. It is difficult to determine whether this is related to construction or the earthquakes. No cracking was noted in the hard pack gravel paths around the toilet building.

The building is constructed on a cut to fill? platform and there is a small boulder retaining wall (0.5 m high) to the west of the building. No damage was noted to the wall or fill area.

A 5mm gap/separation was noted between two of the stairs approximately 10 and 15 m west of the building. The movement is localised to the individual steps and is likely due to settlement of the fill immediately below the steps.

Liquefaction or lateral spread would not be expected at this site as the soils beneath the site are loess and no mass land movement has been noted in this area.

- **Figure 5 - Overview of the building (western wall).**

- **Figure 6 – 10 mm crack in between steps approximately 15m west of the building.**

- **Figure 7 – 5 mm crack between steps approximately 10m west of the building.**

6. Conclusions and recommendations

6.1 Site geology

As no investigation data was available near the site, it was not possible to provide a detailed interpretation of site geology.

However, from local geological maps and our understanding of the general geology of the area, it is expected the site geology would consist of shallow loess layer underlain by volcanic ash and rock.

6.2 Seismic site subsoil class

The site has been assessed as being either NZS1170.5 Class C (shallow soil) or NZS 1170.5 Class B (rock) from surface geology. As no investigation information is available for the site and the depth to the underlying rock could not be reliably estimated, NZS 1170.5 Class C is recommended as the seismic site subsoil class in this report.

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 least preferred method has been in assessing the site subsoil class. However, a site specific study may result in a revision to the assessed site subsoil class.

6.3 Building performance

Even though detailed records of the existing foundation were not available at the time of writing this report, the performance to date suggests that the foundations are adequate for their current purpose.

6.4 Ground performance and properties

Liquefaction risk has been assessed as low for the site.

No clear evidence of liquefaction was noted in the aerial photographs taken shortly after the 22 February earthquake or during the external site walkover undertaken by an SKM engineer. The composition of any fill or top soil layer is not known. However, the loess layer and volcanic deposits inferred to be present beneath the site are not susceptible to liquefaction.

It is our understanding that tension cracks approximately 150 to 200 m east of the site have been noted, properties near the edge of the steepe slope side have been deemed to be uninhabitable due to the high risk of cliff collapse. However, it is expected due to the distance from the slope there is a low risk of any tension crack or land movement at this site.

An estimate of ground properties has not been provided in this report due to the lack of investigation data in the area. If ground properties are required in order to undertaken a quantitative DEE assessment of the structure on site, it is expected that additional investigations would be required.

6.5 Further investigations

If a quantitative DEE is to be undertaken on site additional investigations would be required to assess the composition of the shallow soil layer. Additional investigations recommended are:

- Two trial pits to a minimum depth of 3 m or rock, which whichever is shallower

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/)