CHRISTCHURCH CITY COUNCIL
PRK_1415_BLDG_003 EQ2
Old School Reserve Shed
172 Major Hornbrook Rd, Mt Pleasant

QUALITATIVE ASSESSMENT REPORT

FINAL

- Rev B
- 07 March 2013

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Sinclair Knight Merz
142 Sherborne Street
Saint Albans
PO Box 21011, Edgeware
Christchurch, New Zealand
Tel: +64 3 940 4900
Fax: +64 3 940 4901
Web: www.skmconsulting.com

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Contents

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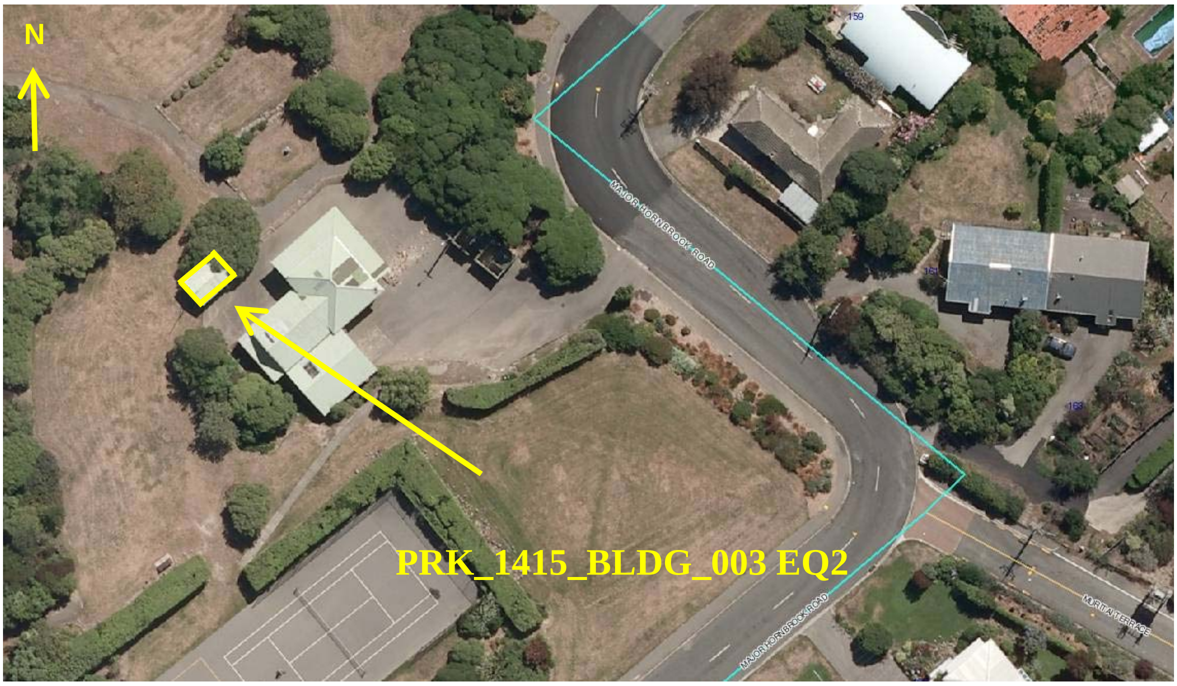
1. Executive Summary

1.1. Background

A Qualitative Assessment was carried out on PRK_1415_BLDG_003 EQ2 located in Old School Reserve at 172 Major Hornbrook Road, Mt Pleasant. The building is single storey and is currently utilised for storage. It appears to be constructed from timber-framed walls, roof and floors with a concrete piled foundation. An aerial photograph illustrating this area is shown below in Figure 1. Detailed descriptions outlining the buildings age and construction type is given in Section 5 of this report.



- **Figure 1: Aerial Photograph PRK_1415_BLDG_001 EQ2 Old School Reserve, 172 Major Hornbrook Rd**

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

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

1.2. Key Damage Observed

No external earthquake-related damage was observed during our site inspection. We did not carry out an internal inspection due to limited access.

1.3. Critical Structural Weaknesses

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

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

Based on the information available, and using the NZSEE Initial Evaluation Procedure, the buildings original capacity has been assessed to be of the order of 58% NBS. No damage was observed during the site investigation therefore the post earthquake capacity will not change as a result of earthquake damage.

The building has been assessed to have a seismic capacity less than 67% NBS and is therefore a potential earthquake risk.

We do not recommend that a quantitative assessment is carried out in this case given the small scale of the building and the very low consequences of failure.

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 in Old School Reserve at 172 Major Hornbrook 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 draft document "Guidance on Detailed Engineering Evaluation of Earthquake affected Non-residential Buildings in Canterbury", issued 19 July 2011. The qualitative assessment includes a summary of the building damage as well as an initial assessment of the likely current Seismic Capacity compared with current seismic code requirements.

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

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

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

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

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

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

3. Compliance

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

3.1. Canterbury Earthquake Recovery Authority (CERA)

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

Section 38 – Works

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

Section 51 – Requiring Structural Survey

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

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

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

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

- The importance level and occupancy of the building
- The placard status and amount of damage
- The age and structural type of the building
- Consideration of any critical structural weaknesses
- The extent of any earthquake damage

3.2. Building Act

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

3.2.1. Section 112 – Alterations

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

3.2.2. Section 115 – Change of Use

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

3.2.3. Section 121 – Dangerous Buildings

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

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

3.2.4. Section 122 – Earthquake Prone Buildings

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

3.2.5. Section 124 – Powers of Territorial Authorities

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

3.2.6. Section 131 – Earthquake Prone Building Policy

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

3.3. Christchurch City Council Policy

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

The 2010 amendment includes the following:

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

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

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

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

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

3.4. Building Code

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

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

a) Hazard Factor increased from 0.22 to 0.3 (36% increase in the basic seismic design load)

b) Serviceability Return Period Factor increased from 0.25 to 0.33 (80% increase in the serviceability design loads when combined with the Hazard Factor increase)

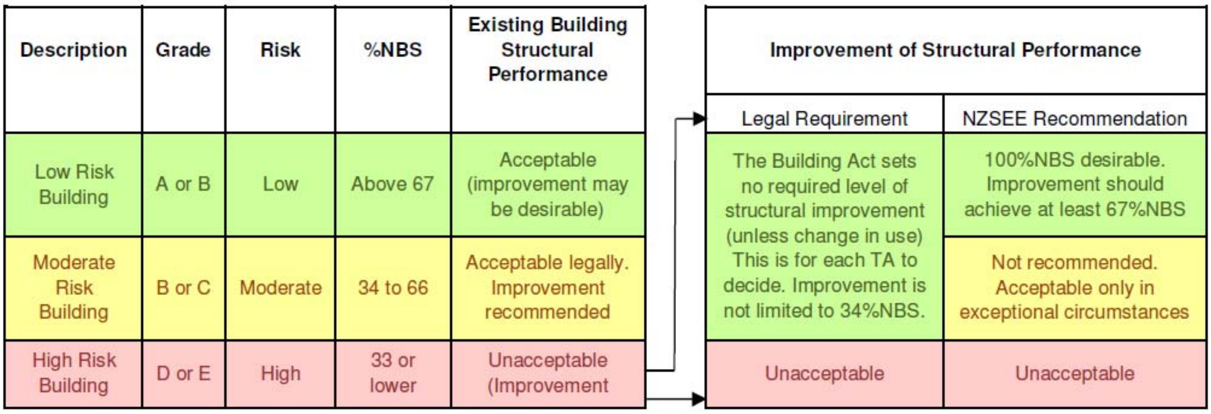
The increase in the above factors has resulted in a reduction in the level of compliance of an existing building relative to a new building despite the capacity of the existing building not changing.

4. Earthquake Resistance Standards

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

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

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

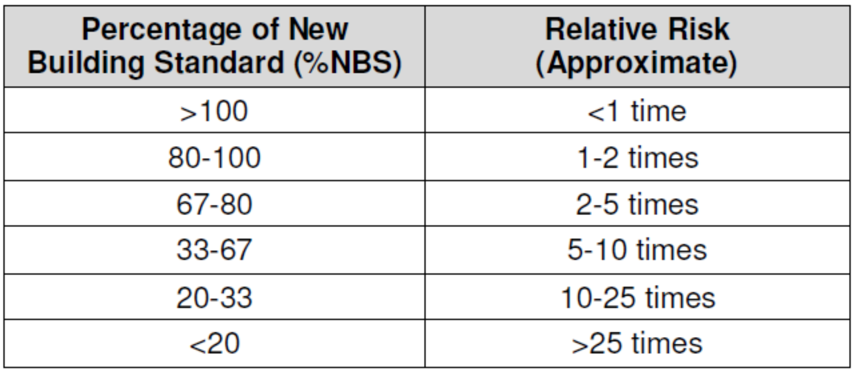


Description	Grade	Risk	%NBS	Existing Building Structural Performance	Improvement of Structural Performance	
					Legal Requirement	NZSEE Recommendation
Low Risk Building	A or B	Low	Above 67	Acceptable (improvement may be desirable)	The Building Act sets no required level of structural improvement (unless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

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

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

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



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

5. Building Details

5.1. Building description

The building is located in Old School Reserve at 172 Major Hornbrook Road. There are three buildings on this site, but only the shed is within the scope of this assessment. The building has one storey that is currently utilised for storage. The building is assumed to be constructed from timber-framed walls, with weatherboard cladding and a timber-framed roof. The 80x50mm timber rafters are at 450mm centres. The timber floor is supported by 150x50mm timber joists at 475mm centres spanning across the building with a support mid-span from a 150x50mm timber bearer. The building is supported by 150mm diameter concrete piles around the perimeter, with six along the building and three across. The 200mm deep piles have 450mm square concrete footings at ground level, with an unknown depth. On the west side of the building, two piles are believed to have been replaced by 130mm square timber piles with concrete footings. It is assumed the building was designed and constructed in the 1950’s.

Our evaluation was based on the external visual inspection carried out on 19 July 2012. Internal inspection was not able to be carried out as the building was inaccessible at the time of the inspection. Drawings were not available to verify the foundation system and the date of construction.

5.2. Gravity Load Resisting system

It appears that the gravity loads are taken by the timber framing in the roof, and then into the timber-framed walls. The load is carried through to the joists and into the piles below.

5.3. Seismic Load Resisting system

Lateral loads acting across and along the building are assumed to be resisted by bracing in the timber-framed walls.

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

5.4. Geotechnical Conditions

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

- In accordance with NZS1170.5 the site is likely to be seismic subsoil Class C (shallow soil site) ground performance and properties.

- Ground damage caused by an earthquake on sloping land with this particular site's ground characteristics would likely be in the form of a slope failure or rock fall. However, no evidence of slope failure such as surface ruptures or toe bulges were observed during the site walkover or on aerial photographs.

If future significant structural alterations are proposed which require building consent, additional investigations recommended are:

- Two hand augers near to the building to a depth of approximately 3m to confirm the ground conditions and the depth to the basalt layer.
- Two dynamic cone penetration tests to estimate likely properties of the soil near the surface.

6. Damage Summary

SKM undertook an inspection on 19 July 2012. The following areas of damage were observed during the time of inspection:

General

1) No visual evidence of settlement was noted at this site, therefore a level survey is not required at this stage of assessment.

Building Damage

1) No earthquake-related external damage was observed during our site inspection.
2) Gaps opening up between the timber elements throughout the building were noted, but this is likely due to the age of the building and is not earthquake-related damage.
3) Cracking through the timber weatherboards were noted throughout the building, but this is likely due to the age of the building and is not earthquake-related damage.
4) Missing timber elements on the north soffit was noted, but this is not earthquake-related damage.

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

7. Initial Seismic Evaluation

7.1. The Initial Evaluation Procedure Process

This section covers the initial seismic evaluation of the building as detailed in the NZSEE 'Assessment and Improvement of the Structural Performance of Buildings in Earthquakes'. The IEP grades buildings according to their likely performance in a seismic event. The procedure is not yet recognised by the NZ Building Code but is widely used and recognised by the Christchurch City Council as the preferred method for preliminary seismic investigations of buildings[2].

The IEP is a coarse screening process designed to identify buildings that are likely to be earthquake prone. The IEP process ranks buildings according to how well they are likely to perform relative to a new building designed to current earthquake standards, as shown in Table 2. The building rank is indicated by the percent of the required New Building Standard (%NBS) strength that the building is considered to have. Earthquake prone buildings are defined as having less than 33% NBS strength which correlates to an increased risk of approximately 20 times that of 100% NBS[3]. Buildings that are identified to be earthquake prone are required by law to be followed up with a detailed assessment and strengthening work within 30 years of the owner being notified that the building is potentially earthquake prone[4].

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	

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

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

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

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

This assessment describes only the likely seismic Ultimate Limit State (ULS) performance of the building. The ULS is the level of earthquake that can be resisted by the building without catastrophic failure. The IEP does not attempt to estimate Serviceability Limit State (SLS) performance of the building, or the level of earthquake that would start to cause damage to the building[5]. This assessment concentrates on matters relating to life safety as damage to the building is a secondary consideration. SLS performance of the building can be estimated by scaling the current code levels if required.

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

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

7.2. Available Information, Assumptions and Limitations

Following our inspection on 19 July 2012, SKM carried out a preliminary structural review. The structural review was undertaken using the available information which was as follows:

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

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

- Standard design assumptions for typical office and factory buildings as described in AS/NZS1170.0:2002
  - 50 year design life, which is the default NZ Building Code design life.

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

  - Structure Importance Level 1. This level of importance is described as ‘low’ with small or moderate consequence of failure.
  - Ductility level of 1.25 in both directions, based on our assessment and code requirements at the time of design.
  - Site hazard factor, Z = 0.3, NZBC, Clause B1 Structure, Amendment 11 effective from 1 August 2011

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

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

7.3. Critical Structural Weaknesses

No critical structural weaknesses have been identified in this building.

7.4. Qualitative Assessment Results

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

Table 3: Qualitative Assessment Summary

Item	%NBS
Likely Seismic Capacity of Building	58

Our qualitative assessment found that the building is likely to be classed as a potential earthquake risk and probably a ‘Moderate Risk Building’ (capacity less than 67% of NBS). The full IEP assessment form is detailed in Appendix 2 – IEP Reports.

8. Further Investigation

Due to the lack of structural drawings and the likely seismic capacity of the building being less than 67% NBS, a quantitative assessment would generally be recommended, but is not required as it is greater than 33% NBS. However, we recommend that a quantitative assessment is not carried out in this case given the small scale of the building and the very low consequences of failure.

If a quantitative assessment is carried out then intrusive investigations will be required to confirm the following structural details:

- Internal bracing layout and size of elements.
- Sizes of foundation elements.
- Roof connection sizes and layouts.

A Building Consent would likely be required to strengthen the building.

9. Conclusion

A qualitative assessment was carried out on the building located in Old School Reserve at 172 Major Hornbrook Road, Mt Pleasant. The building has sustained no external earthquake-related damage. The building has been assessed to have a seismic capacity of the order of 58%NBS and is therefore a potential earthquake risk and is likely to be classified as a ‘Moderate Risk Building’ (capacity less than 67% of NBS).

Further investigation is generally recommended to confirm our initial findings and to establish possible strengthening concepts. However, due to the small scale of the building, the very low consequences of failure and its likely seismic capacity being greater than 33% NBS, no further work will be recommended. But if the building is to be strengthened, Building Consent will likely be required.

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.

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: North elevation	Photo 2: West elevation
	
Photo 3: South elevation	Photo 4: East elevation

Photo 5: Gaps opening up between timber elements on north soffit.

Photo 6: Missing timber elements on north soffit.

Photo 7: Longitudinal cracks in timber element on north wall.

Photo 8: Gaps opening up between timber elements on north soffit.

	
Photo 9: Loose timber element on north side of the building at roof level.	Photo 10: 150mm diameter concrete pile on northeast corner of building.
	
Photo 11: 150x50mm timber bearer spanning along the building at mid-span resting on concrete pile.	Photo 12: 150x50mm timber joists at 475mm centres spanning across the building with bearer at mid-span.

	
Photo 13: Concrete piles on east perimeter of building, with joists and 150x50mm nogs shown.	Photo 14: Concrete pile on northwest corner of building with 450mm square concrete footing exposed.
	
Photo 17: Two 130mm square timber piles in concrete footings replacing concrete piles on the west side.	Photo 18: Gaps opening up between timber elements on north soffit.

<table>
<tr><td></td><td></td></tr>
<tr><td>Photo 19: West soffit with timber elements and corrugated metal roof sheeting above.</td><td>Photo 20: Northwest concrete pile and timber pile shown.</td></tr>
<tr><td></td><td></td></tr>
<tr><td>Photo 21: Timber joists on bearer at mid-span.</td><td>Photo 22: Two timber piles with a concrete pile on their right on the west side of the building are shown.</td></tr>
</table>

	
Photo 23: Timber edge beam and joist resting on concrete pile on the west side of the building.	Photo 24: Timber edge beam and joist resting on timber pile on the west side of the building.
	
Photo 25: Existing displaced timber weatherboards on west wall.	Photo 26: Longitudinal crack in timber element on west soffit.

Photo 27: Longitudinal crack along timber element on southwest corner of building.

Photo 28: Longitudinal crack along timber element on southwest corner of building.

Photo 29: West soffit with corrugated metal roof sheeting above 80x50mm timber rafters at 450mm centres.

Photo 30: Metal plate support for timber post on south side of building.

	
Photo 31: Longitudinal crack in timber weatherboard on south wall.	Photo 32: Longitudinal crack in timber weatherboard on south wall.
	
Photo 33: Longitudinal crack in timber element on south wall.	Photo 34: Entrance on south side of building.

	
Photo 35: Longitudinal cracking in timber weatherboards at connections on south wall of building by entrance.	Photo 36: Plasterboard cladding on south wall, east of the entrance.
	
Photo 37: Covered opening on east wall.	Photo 38: East soffit with corrugated metal roof sheeting above 80x50mm timber rafters at 450mm centres.

	
Photo 39: Southeast soffit with corrugated metal roof sheeting above timber rafters.	Photo 40: Timber edge beam and joist resting on concrete pile on east side of building.
	
Photo 41: Timber joists and nogs on the east side of the building.	Photo 42: Northeast soffit with corrugated metal roof sheeting above timber rafters.

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_1415_BLDG_003 EQ2 Old School Reserve - Shed**
Location: 172 Major Hornbrook Road, Mt Pleasant

Ref. **ZB01276.175**
By WPK
Date 26/06/2012

Step 1 - General Information

1.1 Photos (attach sufficient to describe building)

1.2 Sketch of building plan

1.3 List relevant features

The building in Old School Reserve at 172 Major Hornbrook Road is one storey and is currently utilised for storage. The building consists of timber framed walls, roof and floor. The main lateral load-resisting system appear to be the walls. These are assumed to be braced in the north-south and east-west direction. Internal inspection was not able to be performed as the entrance was locked. The floor is supported by concrete piles in a concrete footing with an unknown embedment depth. The building is assumed to have been constructed in the 1950's.

1.4 Note information sources

Tick as appropriate

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

Table IEP-2 Initial Evaluation Procedure – Step 2

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

Building Name:	**PRK_1415_BLDG_003 EQ2 Old School Reserve - Shed**	Ref.	**ZB01276.175**
Location:	172 Major Hornbrook Road, Mt Pleasant	By	WPK
Direction Considered:	**Longitudinal & Transverse**	Date	26/06/2012

(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 =	**3.1**	meters

	Longitudinal	Transverse	
Ac =	15	11	m2

Can use following:

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

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

Longitudinal	Transverse	
0.1	**0.1**	Seconds

d) (%NBS)nom determined from Figure 3.3

Longitudinal	3.6	$(\%NBS)_{nom}$
Transverse	3.6	$(\%NBS)_{nom}$

			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	3.6	$(\%NBS)_{nom}$
Transverse	3.6	$(\%NBS)_{nom}$

Continued over page

Table IEP-2 Initial Evaluation Procedure – Step 2 continued

Building Name:	**PRK_1415_BLDG_003 EQ2 Old School Reserve - Shed**	Ref.	**ZB01276.175**
Location:	172 Major Hornbrook Road, Mt Pleasant	By	WPK
Direction Considered:	**Longitudinal & Transverse**	Date	26/06/2012

(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
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	3.33

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	2.00

2.5 Ductility Scaling Factor, D

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

Longitudinal	**1.25**	μ Maximum = 2
Transverse	**1.25**	μ Maximum = 2

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**	1.14
Transverse	**Factor D**	1.14

2.6 Structural Performance Scaling Factor, Factor E

Select Material of Lateral Load Resisting System

Longitudinal	Timber
Transverse	Timber

a) Structural Performance Factor, S_p
from accompanying Figure 3.4

Longitudinal	Sp	0.93
Transverse	Sp	0.93

b) Structural Performance Scaling Factor

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

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

Longitudinal	29.7	(%NBS)b
Transverse	29.7	(%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_1415_BLDG_003 EQ2 Old School Reserve - Shed**	Ref.	**ZB01276.175**
Location:	172 Major Hornbrook Road, Mt Pleasant	By	WPK
Direction Considered:	**a) Longitudinal**	Date	26/06/2012

(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** 2

Record rationale for choice of Factor F:

Small scale building that is lightweight. Likely to be governed by wind instead of earthquake loading.

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

PAR 2

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_1415_BLDG_003 EQ2 Old School Reserve**	Ref.	**ZB01276.175**
Location:	Location:	By	WPK
Direction Considered:	**b) Transverse**	Date	26/06/2012

(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 2

Record rationale for choice of Factor F:

Small scale building that is lightweight. Likely to be governed by wind instead of earthquake loading.

3.7 Performance Achievement Ratio (PAR)

(equals A x B x C x D x E x F)

PAR 2

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_1415_BLDG_003 EQ2 Old School Reserve - Shed**	Ref.	**ZB01276.175**
Location:	172 Major Hornbrook Road, Mt Pleasant	By	WPK
Direction Considered:	**Longitudinal & Transverse**	Date	26/06/2012

(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)	29	29
4.2 Performance Achievement Ratio (PAR) (from Table IEP - 2)	2.00	2.00
4.3 PAR x Baseline $(\%NBS)_b$	58	58
4.4 Percentage New Building Standard (%NBS) (Use lower of two values from Step 4.3)		58

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

%NBS ≤ 33 NO

Step 6 - Potentially Earthquake Risk?

%NBS < 67 YES

Step 7 - Provisional Grading for Seismic Risk based on IEP

Seismic Grade C

Evaluation Confirmed by

Signature

JAMES CARTER Name

1017618 CPEng. No

Relationship between Seismic Grade and % NBS :

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

13. Appendix 3 – CERA Standardised Report Form

Detailed Engineering Evaluation Summary Data

V1.11

Location

Building Name: PRK_1415_BLDG_003 EQ2

Unit No: Street

Building Address: Old School Reserve - Shed 172 Major Hornbrook Road, Mt Pleasant

Legal Description:

Degrees Min Sec

GPS south:

GPS east:

Building Unique Identifier (CCC):

Reviewer: **JAMES CARTER**

CPEng No: **1017618**

Company: SKM

Company project number: ZB01276.175

Company phone number: 09 928 5500

Date of submission: 7-Mar

Inspection Date: 19/06/2012

Revision: B

Is there a full report with this summary? yes

Site

Site slope: flat

Soil type:

Site Class (to NZS1170.5): C

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

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

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

Max retaining height (m):

Soil Profile (if available):

If Ground improvement on site, describe:

Approx site elevation (m):

Building

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

Ground floor split? no

Storeys below ground 0

Foundation type: other (describe)

Building height (m): 3.10

Floor footprint area (approx): 16

Age of Building (years): 65

Ground floor elevation (Absolute) (m): 3.10

Ground floor elevation above ground (m): 3.10

if Foundation type is other, describe: 150mm diameter concrete piles with 450mm square concrete footings. Depth unknown.

height from ground to level of uppermost seismic mass (for IEP only) (m): 3.1

Date of design: 1935-1965

Strengthening present? no

If so, when (year)?

And what load level (%g)?

Brief strengthening description:

Use (ground floor): recreational

Use (upper floors):

Use notes (if required):

Importance level (to NZS1170.5): IL1

Gravity Structure

Gravity System: frame system

Roof: timber framed

Floors: timber

Beams: timber

Columns: timber

Walls: non-load bearing

rafter type, purlin type and cladding 80x50mm rafters at 450mm centres

joist depth and spacing (mm) 150x50 joists at 475 centres

type Unknown

typical dimensions (mm x mm) Unknown

0

Lateral load resisting structure

Lateral system along: lightweight timber framed walls

Ductility assumed, μ: 1.25

Period along: 0.10 0.00

Total deflection (ULS) (mm): 10

maximum interstorey deflection (ULS) (mm):

Note: Define along and across in detailed report!

note typical wall length (m) 4.8

estimate or calculation? estimated

estimate or calculation? estimated

estimate or calculation? estimated

Lateral system across: lightweight timber framed walls

Ductility assumed, μ: 1.25

Period across: 0.10 0.00

Total deflection (ULS) (mm): 10

maximum interstorey deflection (ULS) (mm):

note typical wall length (m) 3.3

estimate or calculation? estimated

estimate or calculation? estimated

estimate or calculation? estimated

Separations:

north (mm):

east (mm):

south (mm):

west (mm):

leave blank if not relevant

Non-structural elements

Stairs:

Wall cladding: other light

Roof Cladding: Metal

Glazing:

Ceilings:

Services(list): Unknown

describe Weatherboards

describe Corrugated sheeting

Available documentation

Architectural none

Structural none

Mechanical none

Electrical none

Geotech report partial

original designer name/date

original designer name/date

original designer name/date

original designer name/date

original designer name/date

Damage

Site:

(refer DEE Table 4-2)

Site performance:

Settlement: none observed

Differential settlement: none observed

Liquefaction: none apparent

Lateral Spread: none apparent

Differential lateral spread: none apparent

Ground cracks: none apparent

Damage to area: none apparent

Describe damage:

notes (if applicable):

notes (if applicable):

notes (if applicable):

notes (if applicable):

notes (if applicable):

notes (if applicable):

notes (if applicable):

Building:

Current Placard Status: green

Along Damage ratio: 0%

Describe (summary): No damage observed

Describe how damage ratio arrived at: No damage observed during the site inspection.

Across Damage ratio: 0%

Describe (summary): No damage observed

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

Diaphragms Damage?: no Describe:

CSWs: Damage?: no Describe:

Pounding: Damage?: no Describe:

Non-structural: Damage?: no Describe:

Recommendations

Level of repair/strengthening required: minor non-structural Describe:

Building Consent required: no Describe:

Interim occupancy recommendations: full occupancy Describe: Not an immediate collapse hazard.

Along Assessed %NBS before: 58% %NBS from IEP below

Assessed %NBS after: 58%

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

Across Assessed %NBS before: 58% %NBS from IEP below

Assessed %NBS after: 58%

14. Appendix 4 – Geotechnical Desktop Study

Christchurch City Council - Structural Engineering Service

Geotechnical Desk Study

SKM project number	ZB01276
SKM project site number	123
Address	Toilet block, Old School Reserve, Mt Pleasant
Report date	20 June 2012
Author	Dominic Hollands
Reviewer	Ross Roberts
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:

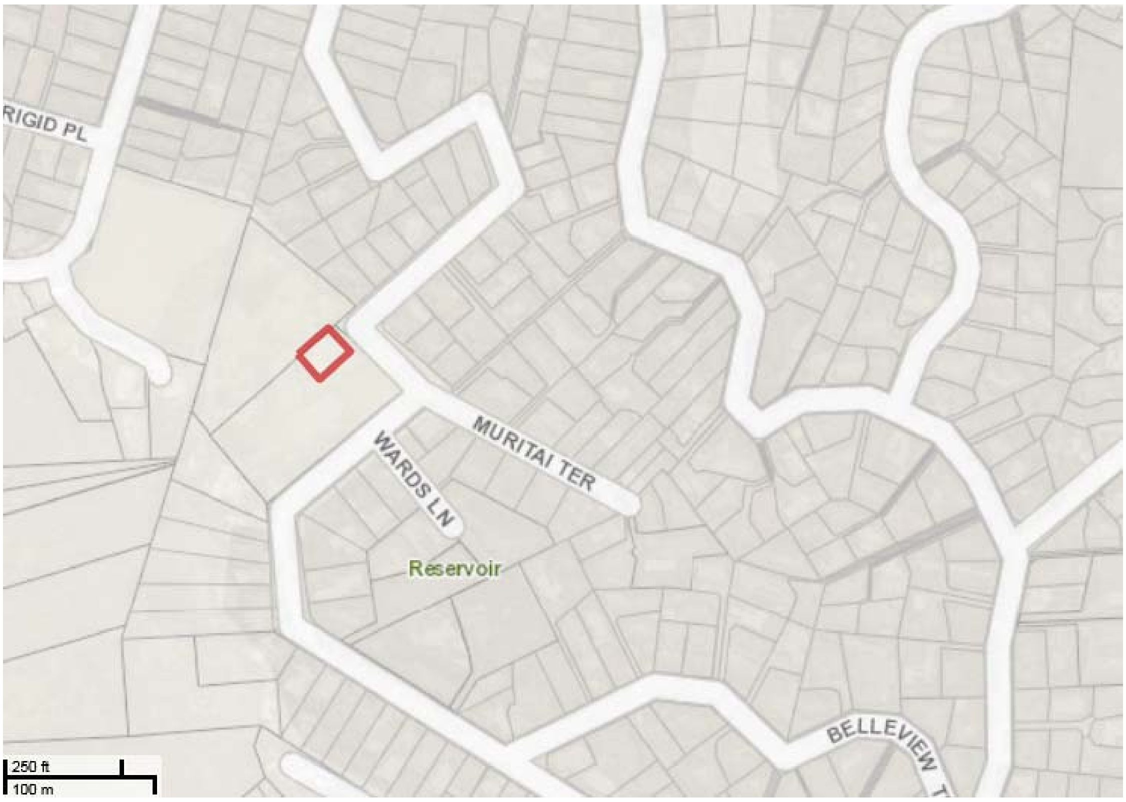
- Published geology
- Publically available borehole records
- Liquefaction records
- Aerial photography
- A preliminary site walkover

3. Limitations

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

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

4. Site location

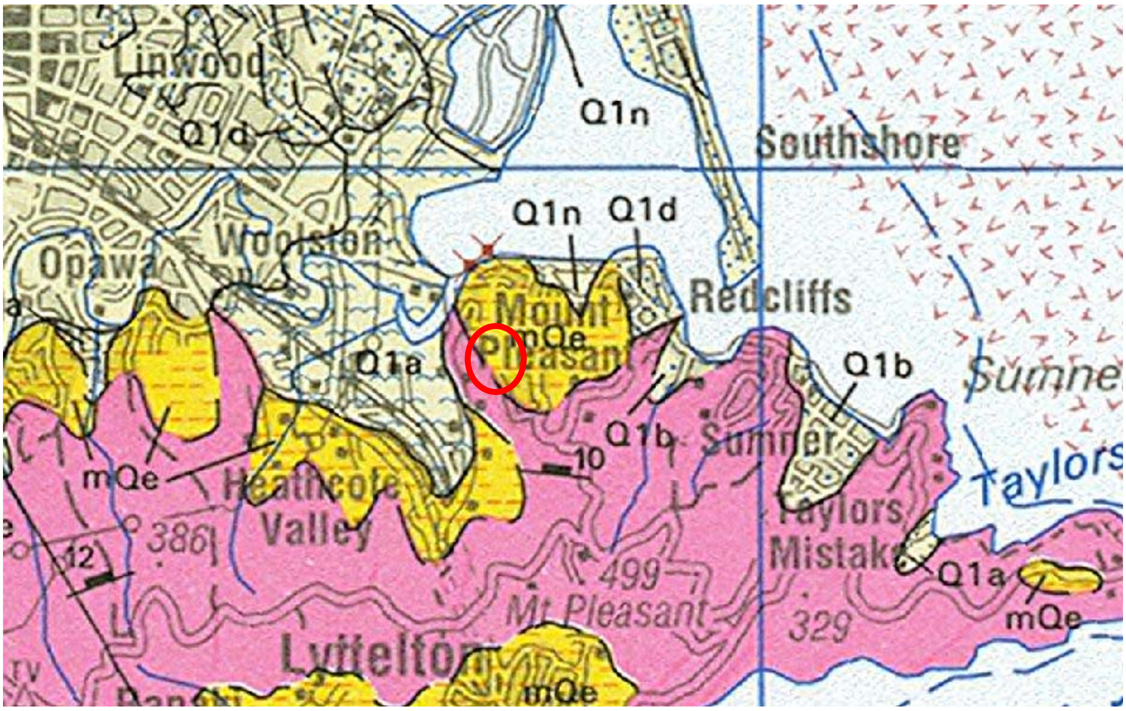


- **Figure 1 – Site location (courtesy of LINZ http://viewers.geospatial.govt.nz)**

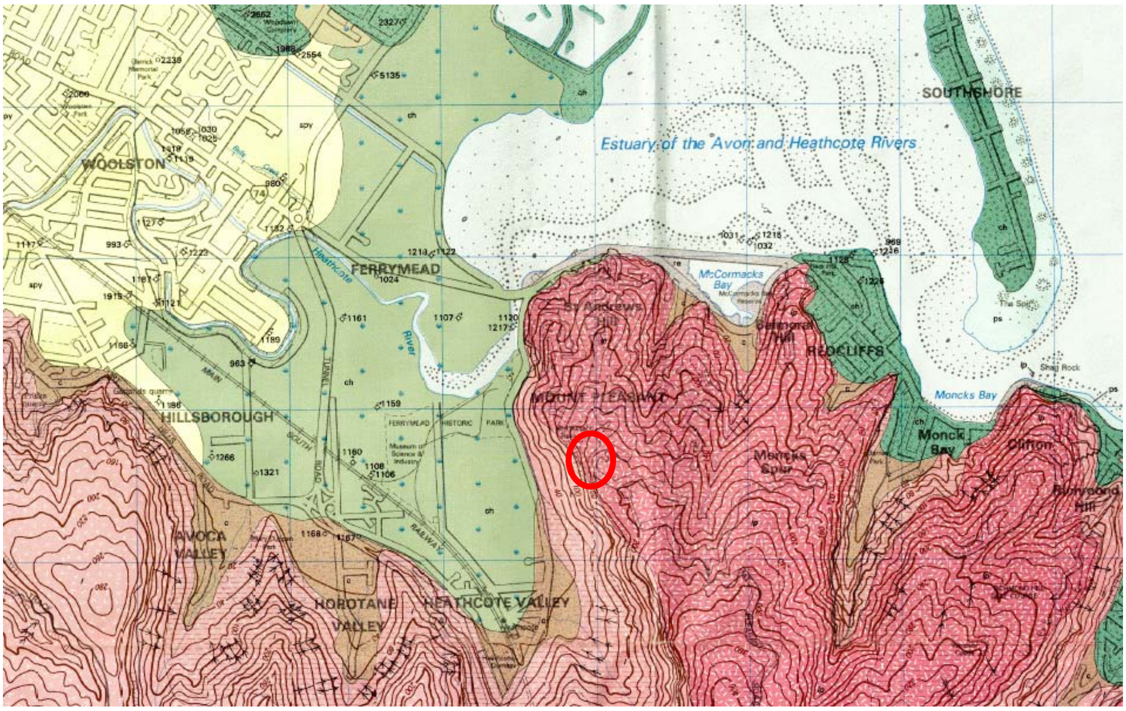
The structure is located on Major Hornbrook Road opposite Wardens Lane in Mount Pleasant at grid reference 1577012 E, 5176170 N (NZTM).

5. Review of available information

5.1 Geological maps



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



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

The site is shown to be underlain by Quaternary yellow blown silt (loess) over Lyttelton Volcanic Group basalt.

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. This survey did not extend to this site; however liquefaction is not associated with volcanic hill terrain that includes Mount Pleasant and the Port Hills.

5.3 Aerial photography

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

Aerial photography does not show any earthquake land damage i.e. rock fall or tension cracks after the 22 Feb 2011 event, however this type of damage may have occurred but not be visible. There has been shaking damage to roofs of some nearby dwellings.

5.4 CERA classification

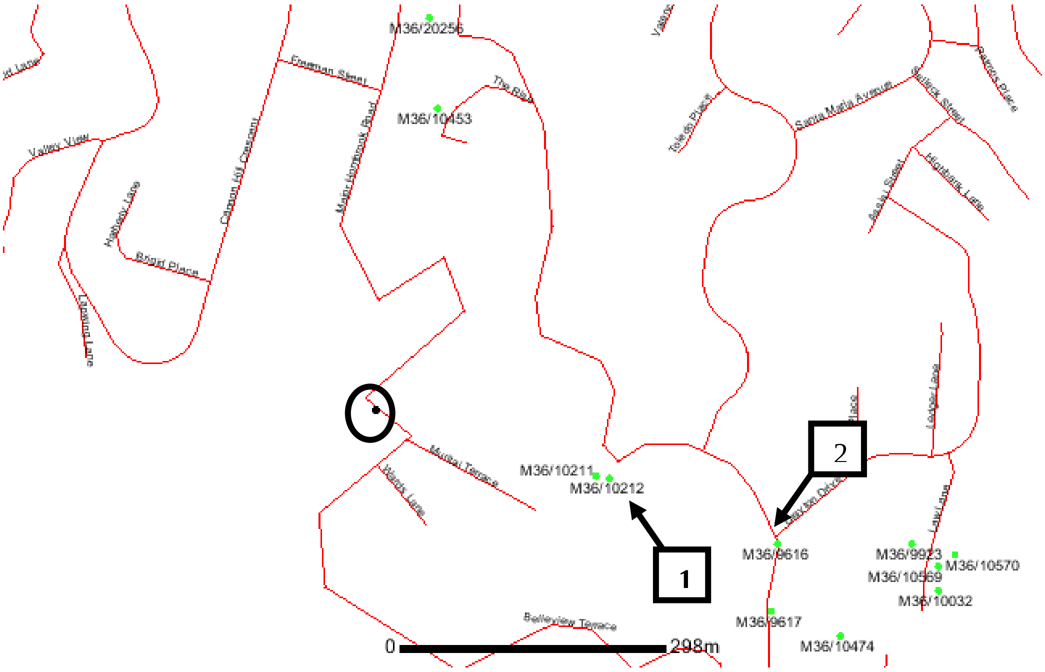
A review of the LINZ website (http://viewers.geospatial.govt.nz/) shows that the site is:

- Zone: Green
- Port Hills and Banks Peninsula

5.5 Historical land use

Historical land use documents (e.g. Appendix A) shows only lowland land use and not applicable for the hilly terrain of Mount Pleasant.

5.6 Existing ground investigation data



- **Figure 5 – Local boreholes from Project Orbit and SKM files (https://canterburyrecovery.projectorbit.com/)**

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

5.7 Council property files

Council files were not available at the time of writing this report

5.8 Site walkover

An engineer from SKM undertook a site walkover on 19 May 2012.

The toilet block is a masonry block building with a flat wood roof with beams and a concrete slab on grade foundation.

Very little damage could be seen on the toilet buildings on site, with minor hairline cracks in the foundation. Nearby buildings also exhibit very minor damage.

The adjacent asphalt car park did not appear to have suffered earthquake damage.

The dry stack garden wall approximately 0.6 m high and approximately 1 m from the toilet block appears to have partially collapsed due to the earthquake events.

There was no other evidence in the nearby area of earthquake damage such as landslips and rock fall.

The site appears to be underlain by loess with bed rock at shallow depths. Bedrock outcrops were present in the reserve area.

- **Figure 6** Toilet block at Old School Reserve.

- **Figure 8** Failed dry stack garden wall behind the toilet block

6. Conclusions and recommendations

6.1 Site geology

An interpretation of the most relevant local investigation and geological map detail suggests that the site is underlain by:

Depth range (mBLG)	Soil type
0 – 0.3	Topsoil
0.3 - 3	Silt (loess)
3 +	Basalt

6.2 Seismic site subsoil class

The site has been assessed as NZS1170.5 Class C (Shallow soil site) from the regal geological map and adjacent borehole logs.

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 absence of deep boreholes near the site has resulted in the use of the two least preferred methods. It is therefore possible that site specific investigation could revise the site class. For example, if shallower rock is confirmed at a depth of less than 3m bgl the site may be considered Class A or B.

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

Ground damage caused by earthquake on sloping land with this particular site's ground characteristics would likely be in the form of a slope failure, rock fall damage. However no evidence of slope failure such as surface ruptures or toe bulges were observed during the site walkover or on aerial photographs.

In addition information provided by Christchurch City Council indicates that the site was not affected by evacuation or inundation of rocks during the recent earthquake events.

The site is located on a negligible thickness of loess over significant thicknesses of basalt, and therefore there is minimal liquefaction risk.

For the purposes of carrying out a Quantitative Detailed Engineering Evaluation the engineer can assume this site is 'good ground' (as defined in NZS3604:2011) and therefore the following parameters are recommended for the shallow loess material:

Parameter	Estimated value
Effective angle of friction	28 degrees
Apparent cohesion	5 kPa
Unit weight	20 kPa
Ultimate bearing capacity of a shallow square pad footing	300 kPa

NOTE: These figures are based on geological data from outside the site for the purposes of preliminary structural assessment. These parameters should not be relied upon for any design work. Site specific investigations are required to confirm that these assumed values are correct. Additionally, further geotechnical investigation could potentially increase the ultimate bearing capacity stated above.

6.5 Further investigations

If future significant structure alterations or new structures are proposed which require building consent geotechnical investigations are recommended. For relatively small structures this would include:

- Two hand augers near to the building to a depth of approximately 3m deeper to in part confirm the ground conditions and the depth to the basalt layer.
- Two dynamic cone penetration tests to estimate likely properties of the soil near the surface.

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.

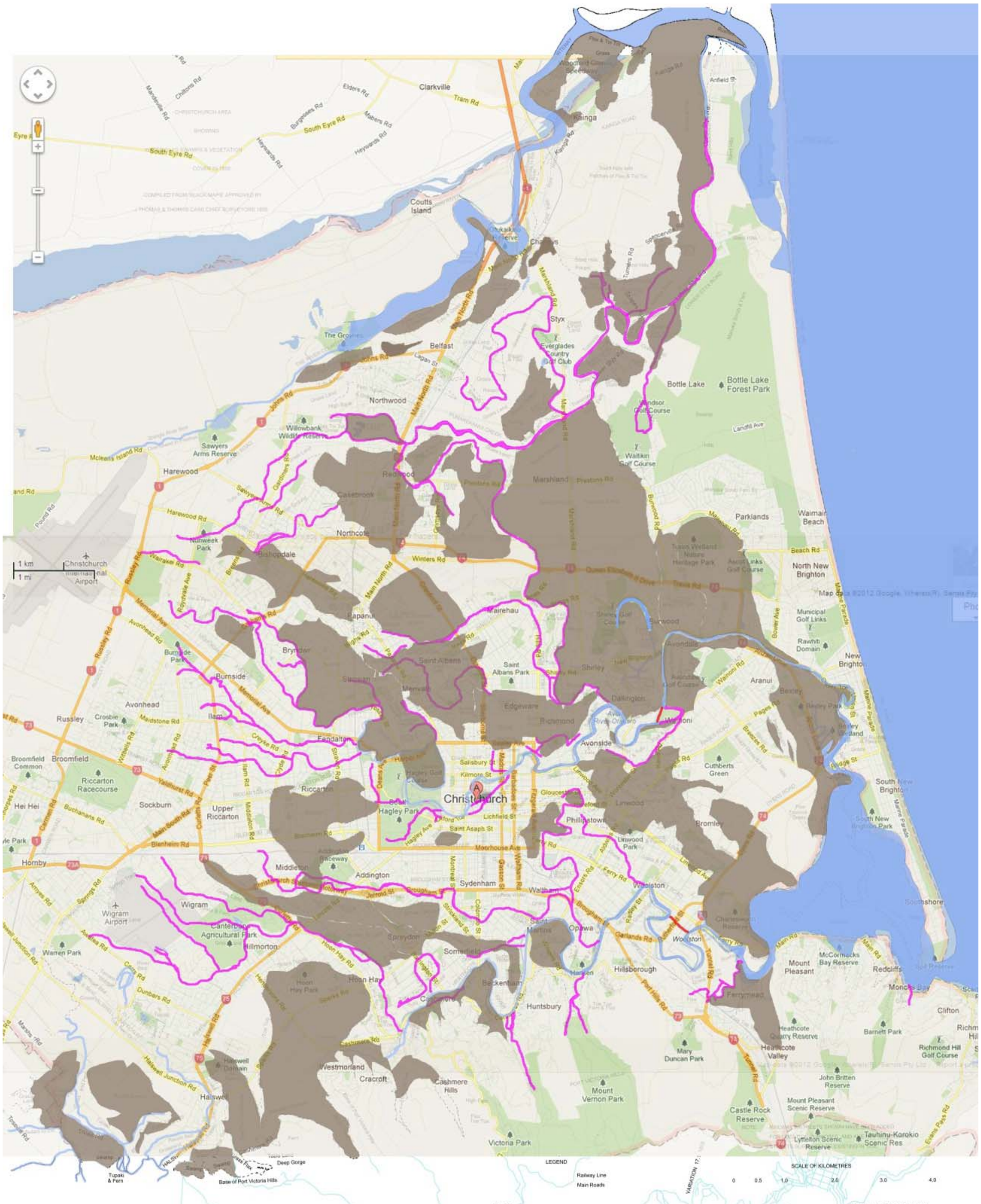
Forsyth PJ, Barrell DJA, Jongens R, 2008. Geology of the Christchurch area. Institute of Geological & Nuclear Sciences geological map 16.

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

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

Christchurch City Council
http://www.ccc.govt.nz/homeliving/civildefence/chchearthquake/earthquakerockfallmaps.aspx

Appendix A – Christchurch 1856 land use



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

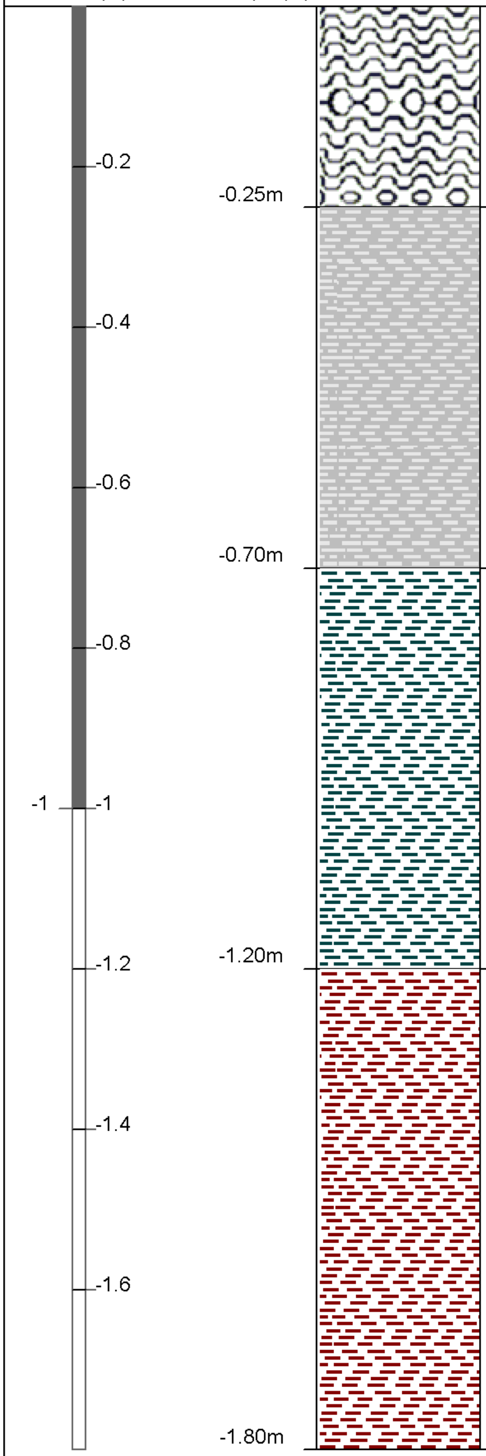
Key

- 🟪 Previous creeks/rivers
- 🟦 Existing creeks/rivers
- 🟥 New creeks/rivers
- 🟫 Swamp/Marshland

Appendix B – Existing ground investigation logs

Borelog for well M36/10212

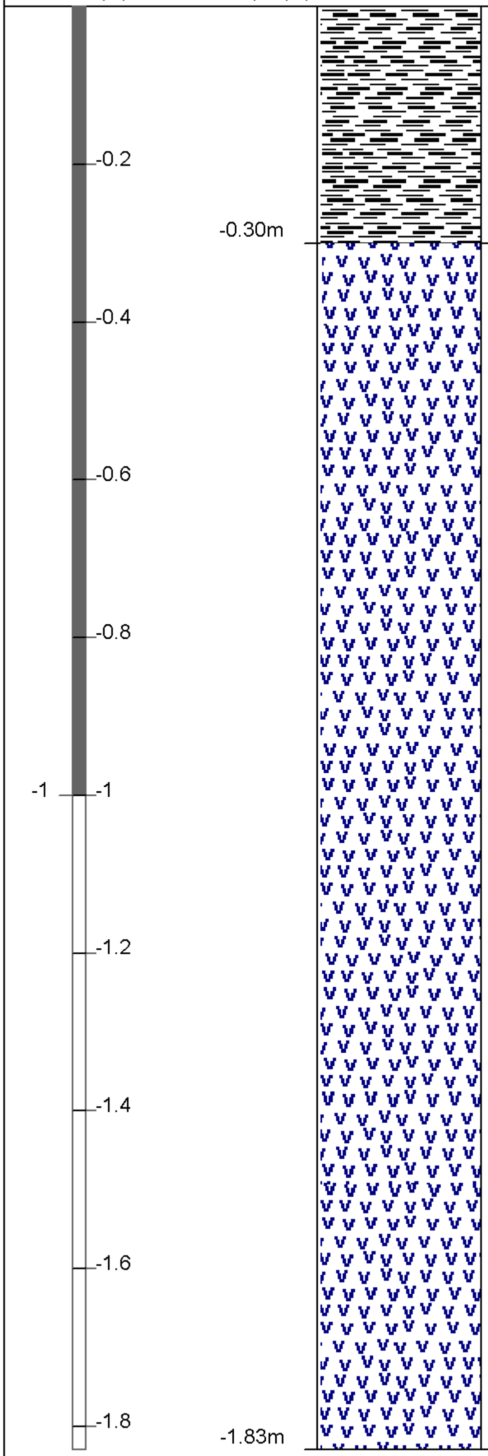
Gridref: M36:87311-37706 Accuracy : 3 (1=high, 5=low)
Ground Level Altitude : 153.01 +MSD
Well name   : CCC BorelogID 6647
Drill Method : Not Recorded
Drill Depth : -1.8m   Drill Date : 3/04/2007



Depth(m)	Full Drillers Description	Formation Code
-0.25m	topsoil	
-0.70m	grey mottled friable dry silt	
-1.20m	grey / brown friable dry silt	
-1.80m	brown friable damp silt	

Borelog for well M36/9616

Gridref: M36:87499-37633 Accuracy : 3 (1=high, 5=low)
Ground Level Altitude : 165.58 +MSD
Well name : CCC BorelogID 4100
Drill Method : Not Recorded
Drill Depth : -1.83m Drill Date : 11/01/1973



Depth(m)	Full Drillers Description	Formation Code
-0.30m	clay	
-1.83m	rock	

Appendix C – Geotechnical Investigation Summary

- **Table 1 Summary of most relevant investigation data**

ID		**1**	**2**
Type *		BH	BH
Ref		M36/10212	M36/9616
Depth (m)		1.8	5.7
Distance from site (m)		270	473
Ground water level (mBGL)		-	-
Simplified recorded geological profile (depth below ground level to top of stratum, m)	0	🟪	🟥
	1	🟪	🟥
	2		
	3		
	4		
	5		
	6		
	7		
	8		
	9		
	10		
	11		
	12		
	13		
	14		
	15		
	16		
	17		
	18		
	19		
	20		
	21		
	22		
	23		
	24		
	25		
Greater depths			

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

🟪	Loess (Silt)	🟦	Clay to silty clay	▧	Clayey silt to silt	🟩	Silty sand to silt
▨	Clayey sand	🟨	Sand	🟧	Gravelly sand or gravel	🟥	Rock

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