CHRISTCHURCH CITY COUNCIL

PRK_1133_BLDG_002 EQ2
Bradford Park - Toilets
192 Milton Street, Sydenham

QUALITATIVE ASSESSMENT REPORT

FINAL

- Rev B
- 07 December 2012

CHRISTCHURCH CITY COUNCIL
PRK_1133_BLDG_002 EQ2
Bradford Park - Toilets
192 Milton Street, Sydenham

QUATATIVE ASSESSMENT REPORT

FINAL

- Rev B
- 07 December 2012

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

Contents

Document history and status

Revision	Date issued	Reviewed by	Approved by	Date approved	Revision type
A	28/06/2012	TW Robertson	NM Calvert	28/06/2012	Draft for Client Approval
B	07/12/2012	NM Calvert	NM Calvert	07/12/2012	Final Issue

Distribution of copies

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

Printed:	7 December 2012
Last saved:	7 December 2012 09:56 AM
File name:	ZB01276.115_CCC_PRK_1133_BLDG_002_EQ2_Qualitative Assmt_B.docx
Author:	Willow Patterson-Kane
Project manager:	Nick Calvert
Name of organisation:	Christchurch City Council
Name of project:	Christchurch City Council Structures Panel
Name of document:	PRK_1133_BLDG_002 EQ2 Qualitative Assessment Report
Document version:	B
Project number:	ZB01276.115

1. Executive Summary

1.1. Background

A Qualitative Assessment was carried out on PRK_1133_BLDG_002 EQ2 located in Bradford Park at 192 Milton Street, Sydenham. The building is single storey and is currently utilised as a toilet block. It is believed to be constructed from partially reinforced masonry walls and a steel-framed ceiling with a lightweight roof. An aerial photograph illustrating this area is shown below in Figure 1. Detailed descriptions outlining the buildings age and construction type is given in Section 5 of this report.

- **Figure 1 Aerial Photograph of PRK_1133_BLDG_002 EQ2 Bradford Park - Toilets**

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 23 May 2012.

1.2. Key Damage Observed

No external or internal damage was observed during our site inspection.

1.3. Critical Structural Weaknesses

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

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

Based on the information available, and using the NZSEE Initial Evaluation Procedure, the buildings original capacity has been assessed to be in the order of 100%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 greater than 67% NBS and is therefore not potentially earthquake prone. No further assessment is required as the capacity is greater than 67%NBS.

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 PRK_1133_BLDG_002 EQ2 located in Bradford Park at 192 Milton Street 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.

[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 Bradford Park at 192 Milton Street. There is only one building on this site. The building has one storey that is currently utilised as a toilet block. The building is believed to be constructed from partially reinforced masonry walls and lightweight corrugated steel roof sheeting with steel hollow section roof framing. The north and south walls extend and curve on opposing sides to form east and west walls, respectively. There is also an internal masonry wall spanning north-south. The ground floor appears to be supported on a concrete slab foundation. It is assumed the building was designed and constructed in the 1980's.

Our evaluation was based on the visual inspection carried out on 23 May 2012. Drawings were not available to verify the foundation system and the date of construction.

5.2. Gravity Load Resisting system

Gravity loads are taken by the steel roof framing and into the concrete masonry walls, with direct transfer into the concrete slab foundation below.

5.3. Seismic Load Resisting system

Lateral loads acting across and along the building will be resisted by the masonry walls in shear.

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

5.4. Geotechnical Conditions

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

- In accordance with NZS1170.5 the site is likely to be seismic subsoil Class D (deep or soft soil) ground performance and properties.
- Liquefaction risk appears to be low for this site. No evidence of liquefaction near the area was observed during the reconnaissance undertaken shortly after the 22 February earthquake. Likewise, no significant evidence of liquefaction having occurred on site was observed during the site walkover undertaken by a SKM engineer.

If a quantitative assessment is to be performed for the structure, additional investigations are required to confirm the liquefaction assessment and to estimate ground properties. Additional investigations recommended are:

- Two CPT tests on site to refusal. Pre-drilling to a shallow depth may be required if gravel is present in the top soil.
- Two hand augers to a depth of 3m to determine the composition of the shallow soil layers.

6. Damage Summary

SKM undertook an inspection on 23 May 2012. The following areas of damage were observed during the time of inspection:

General

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

Building Damage

1) No earthquake-related damage was observed during our site inspection.
2) Impact damage was noted on the outer west wall and the top of the inner west wall. This is not believed to be earthquake-related damage.
3) Impact damage was noted on the roof cladding above the west toilet entrance. This is not believed to be earthquake-related damage

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

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

7. Initial Seismic Evaluation

7.1. The Initial Evaluation Procedure Process

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

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

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

[3] http://resources.ccc.govt.nz/files/EarthquakeProneDangerousAndInsanitaryBuildingsPolicy2010.pdf
[4] NZSEE 2006, *Assessment and Improvement of the Structural Performance of Buildings in Earthquakes*, p 2-2
[5] http://resources.ccc.govt.nz/files/EarthquakeProneDangerousAndInsanitaryBuildingsPolicy2010.pdf

plans is also likely to identify any critical structural weaknesses. The IEP assumes that the building was properly designed and built according to the relevant codes at the time of construction. The IEP method rates buildings based on the code used at the time of construction and some more subjective parameters associated with how the building is detailed and so it is possible that %NBS derived from different engineers may differ.

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

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

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

7.2. Available Information, Assumptions and Limitations

Following our inspection on 23 May 2012, SKM carried out a preliminary structural review. The structural review was undertaken using the available information which was as follows:

- SKM site measurements and external and internal 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.
  - 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.

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

- 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	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.

8. Further Investigation

Due to the likely seismic rating of this building being greater than 67% and the lack of any structural damage, no further investigation is required at this stage of the assessment.

9. Conclusion

A qualitative assessment was carried out on the building located in Bradford Park at 192 Milton Street, in Sydenham. The building has sustained no earthquake-related damage. The building has been assessed to have a seismic capacity in the order of 100% NBS and is therefore likely to be classified as a 'Low Risk Building'.

Due to the likely seismic rating of this building and the lack of any structural damage, no further investigation is 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: South elevation

Photo 2: West elevation

Photo 3: North elevation

Photo 4: East elevation

	
Photo 5: East wall at east toilet entrance	Photo 6: Impact damage on west wall.
	
Photo 7: Corrugated metal roof sheeting.	Photo 8: West toilet entrance.

	
Photo 9: Internal masonry wall between the east and west toilets. Steel roof framing also shown.	Photo 10: West toilet entrance wall layout.
	
Photo 11: Impact damage to top of masonry wall above west toilet entrance.	Photo 12: West toilet interior layout.

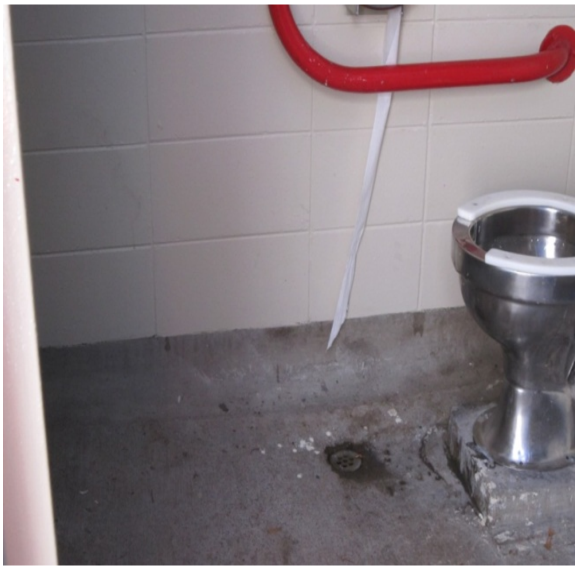


Photo 13: Concrete ground slab with concrete strip footings directly under the masonry wall.

Photo 14: Impact damage on roof cladding above west toilet entrance.

Photo 15: West toilet door connection to masonry wall.

Photo 16: West toilet door connection to masonry wall.

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_1133_BLDG_002 EQ2 Bradford Park - Toilets**	Ref.	ZB01276.115
Location:	192 Milton Street, Sydenham	By	WPK
		Date	24/05/2012

Step 1 - General Information

1.1 Photos (attach sufficient to describe building)

1.2 Sketch of building plan

1.3 List relevant features

The building in Bradford Park at 192 Milford Street is one storey and is currently in use as a toilet block. The building consists of concrete masonry block walls and a lightweight roof with steel framing. The main lateral load-resisting system appear to be the walls. These act as shear walls in the north-south and east-west direction. The north and south walls extend and curve past the toilet entrances to form west and east walls. There is also an internal wall spanning north-south. The block walls appear to be founded on a concrete slab footing. The building is assumed to have been constructed in the 1980's due to its architecture.

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_1133_BLDG_002 EQ2 Bradford Park - Toilets**	Ref.	ZB01276.115
Location:	192 Milton Street, Sydenham	By	WPK
Direction Considered:	**Longitudinal & Transverse**	Date	24/05/2012

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

Step 2 - Determination of (%NBS)b

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

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

b) Soil Type

From NZS1170.5:2004, Cl 3.1.3

A or B Rock	○
C Shallow Soil	○
D Soft Soil	◉
E Very Soft Soil	○

From NZS4203:1992, Cl 4.6.2.2
(for 1992 to 2004 only and only if known)

a) Rigid	◉	N-A
b) Intermediate	○	

c) Estimate Period, T

building Ht =	3.1	meters

	Longitudinal	Transverse	
Ac =	20	12	m2

Can use following:

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

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

Longitudinal	Transverse	
0.4	**0.4**	Seconds

d) (%NBS)nom determined from Figure 3.3

Longitudinal	16.5	$(\%NBS)_{nom}$
Transverse	16.5	$(\%NBS)_{nom}$

			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	16.5	$(\%NBS)_{nom}$
Transverse	16.5	$(\%NBS)_{nom}$

Continued over page

Building Name:	**PRK_1133_BLDG_002 EQ2 Bradford Park - Toilets**	Ref.	ZB01276.115
Location:	192 Milton Street, Sydenham	By	WPK
Direction Considered:	**Longitudinal & Transverse**	Date	24/05/2012

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

2.2 Near Fault Scaling Factor, Factor A

If T < 1.5sec, Factor A = 1

a) Near Fault Factor, N(T,D) 1

(from NZS1170.5:2004, Cl 3.1.6)

b) Near Fault Scaling Factor = 1/N(T,D) — **Factor A** 1.00

2.3 Hazard Scaling Factor, Factor B

Select Location: Christchurch

a) Hazard Factor, Z, for site

(from NZS1170.5:2004, Table 3.3)

Z = 0.3

Z 1992 = 0.8

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

b) Hazard Scaling Factor

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

b) Ductility Scaling Factor

For pre 1976 = k_μ

For 1976 onwards = 1

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

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

2.6 Structural Performance Scaling Factor, Factor E

Select Material of Lateral Load Resisting System

Longitudinal Masonry Block

Transverse Masonry Block

a) Structural Performance Factor, S_p

from accompanying Figure 3.4

Longitudinal	Sp	0.90
Transverse	Sp	0.90

b) Structural Performance Scaling Factor

Longitudinal	$1/S_p$	**Factor E**	1.11
Transverse	$1/S_p$	**Factor E**	1.11

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

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

Longitudinal	122.2	(%NBS)b
Transverse	122.2	(%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_1133_BLDG_002 EQ2 Bradford Park - Toilets**	Ref.	ZB01276.115
Location:	192 Milton Street, Sydenham	By	WPK
Direction Considered:	**a) Longitudinal**	Date	24/05/2012

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

Step 3 - Assessment of Performance Achievement Ratio (PAR)

(Refer Appendix B - Section B3.2)

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

3.4 Pounding Potential

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

a) Factor D1: - Pounding Effect

Select appropriate value from Table

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

Factor D1 1

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

b) Factor D2: - Height Difference Effect

Select appropriate value from Table

Factor D2 1

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

Factor D 1

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

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

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

3.6 Other Factors

For < 3 storeys - Maximum value 2.5,

otherwise - Maximum value 1.5. No minimum. **Factor F** 1

Record rationale for choice of Factor F:

3.7 Performance Achievement Ratio (PAR)

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

PAR 1

(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_1133_BLDG_002 EQ2 Bradford Park - Toilets	Ref.	ZB01276.115
Location:	192 Milton Street, Sydenham	By	WPK
Direction Considered:	b) Transverse	Date	24/05/2012

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

Step 3 - Assessment of Performance Achievement Ratio (PAR)

(Refer Appendix B - Section B3.2)

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

3.4 Pounding Potential

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

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

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

Factor D1 1

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

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

Factor D2 1

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

Factor D 1

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

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

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

3.6 Other Factors

For < 3 storeys - Maximum value 2.5,
otherwise - Maximum value 1.5. No minimum.

Factor F 1

Record rationale for choice of Factor F:

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

PAR 1

Table IEP-4

Initial Evaluation Procedure – Steps 4, 5 and 6

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

Building Name:	**PRK_1133_BLDG_002 EQ2 Bradford Park - Toilets**	Ref.	ZB01276.115
Location:	192 Milton Street, Sydenham	By	WPK
Direction Considered:	**Longitudinal & Transverse**	Date	24/05/2012
	(Choose worse case if clear at start. Complete IEP-2 and IEP-3 for each if in doubt)		

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

	Longitudinal	Transverse
4.1 Assessed Baseline $(\%NBS)_b$ (from Table IEP - 1)	122	122
4.2 Performance Achievement Ratio (PAR) (from Table IEP - 2)	1.00	1.00
4.3 PAR x Baseline $(\%NBS)_b$	122	122

4.4 Percentage New Building Standard (%NBS) (Use lower of two values from Step 4.3) — **122**

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

TREVOR ROBERTSON Name

28892 CPEng. No

Relationship between Seismic Grade and % NBS :

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

13. Appendix 3 – CERA Standardised Report Form

Detailed Engineering Evaluation Summary Data V1.11

Location

Building Name:	PRK_1133_BLDG_002 EQ2	Reviewer:	**Trevor Robertson**
	Unit / No: / Street	CPEng No:	**28892**
Building Address:	192 Milton Street, Sydenham	Company:	SKM
Legal Description:		Company project number:	ZB01276.115
		Company phone number:	09 928 5500
	Degrees / Min / Sec		
GPS south:		Date of submission:	
GPS east:		Inspection Date:	23/05/2012
		Revision:	A
Building Unique Identifier (CCC):		Is there a full report with this summary?	yes

Site

Site slope:	flat	Max retaining height (m):	
Soil type:		Soil Profile (if available):	
Site Class (to NZS1170.5):	D		
Proximity to waterway (m, if <100m):		If Ground improvement on site, describe:	
Proximity to clifftop (m, if < 100m):			
Proximity to cliff base (m,if <100m):		Approx site elevation (m):	

Building

No. of storeys above ground:	1	single storey = 1	Ground floor elevation (Absolute) (m):	
Ground floor split?	no		Ground floor elevation above ground (m):	
Storeys below ground	0			
Foundation type:	strip footings		if Foundation type is other, describe:	
Building height (m):	2.70		height from ground to level of uppermost seismic mass (for IEP only) (m):	2.7
Floor footprint area (approx):	26			
Age of Building (years):	30		Date of design:	1976-1992
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:	steel truss	truss depth, purlin type and cladding	Corrugated steel cladding on steel hollow section members forming semicircular trusses. Trusses are 0.8m high at the apex.
Floors:	concrete flat slab	slab thickness (mm)	Unknown
Beams:	steel non-composite	beam and connector type	Assumed 75 SHS
Columns:	none	typical dimensions (mm x mm)	None
Walls:	partially filled concrete masonry	thickness (mm)	200

Lateral load resisting structure

Lateral system along:	partially filled CMU	**Note: Define along and across in detailed report!**	note total length of wall at ground (m):	6
Ductility assumed, μ:	1.25		wall thickness (m):	200
Period along:	0.40	0.40 from parameters in sheet	estimate or calculation?	estimated
Total deflection (ULS) (mm):	10		estimate or calculation?	estimated
maximum interstorey deflection (ULS) (mm):			estimate or calculation?	estimated
Lateral system across:	partially filled CMU		note total length of wall at ground (m):	4.5
Ductility assumed, μ:	1.25		wall thickness (m):	200
Period across:	0.40	0.40 from parameters in sheet	estimate or calculation?	estimated
Total deflection (ULS) (mm):	10		estimate or calculation?	estimated
maximum interstorey deflection (ULS) (mm):			estimate or calculation?	estimated

Separations:

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

Non-structural elements

Stairs:			
Wall cladding:	exposed structure	describe	Masonry walls
Roof Cladding:	Metal	describe	Lightweight corrugated steel sheeting
Glazing:			
Ceilings:	none		Assumed
Services(list):	Water, sewerage		

Available documentation

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

Damage

Site: (refer DEE Table 4-2)

Site performance:		Describe damage:	No damage observed
Settlement:	none observed	notes (if applicable):	
Differential settlement:	none observed	notes (if applicable):	
Liquefaction:	none apparent	notes (if applicable):	
Lateral Spread:	none apparent	notes (if applicable):	
Differential lateral spread:	none apparent	notes (if applicable):	
Ground cracks:	none apparent	notes (if applicable):	
Damage to area:	none apparent	notes (if applicable):	

Building:

	Current Placard Status:	green		
Along	Damage ratio:	0%	Describe how damage ratio arrived at:	No damage observed during our site inspection.
	Describe (summary):	No damage observed		
Across	Damage ratio:	0%		
	Describe (summary):	No damage observed		
Diaphragms	Damage?:	no	Describe:	
CSWs:	Damage?:	no	Describe:	
Pounding:	Damage?:	no	Describe:	
Non-structural:	Damage?:	no	Describe:	

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

Recommendations

	Level of repair/strengthening required:	none	Describe:	
	Building Consent required:	no	Describe:	
	Interim occupancy recommendations:	full occupancy	Describe:	
Along	Assessed %NBS before:	100%	%NBS from IEP below	If IEP not used, please detail assessment methodology: Qualitative Assessment carried out includes NZSEE IEP (refer to SKM report).
	Assessed %NBS after:	100%		
Across	Assessed %NBS before:	100%	%NBS from IEP below	
	Assessed %NBS after:	100%		

14. Appendix 4 – Geotechnical Desktop Study

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.globalskm.com

ZChristchurch City Council - Structural Engineering Service

Geotechnical Desk Study

SKM project number	ZB01276
SKM project site number	097 and 115
Address	Bradford Park Pavilion and Toilets, 192 and 196 Milton Street
Report date	12 June 2012
Author	Ananth Balachandra
Reviewer	Leah Bateman
Approved for issue	Yes

1. Introduction

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

2. Scope

This geotechnical desk top study incorporates information sourced from:

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

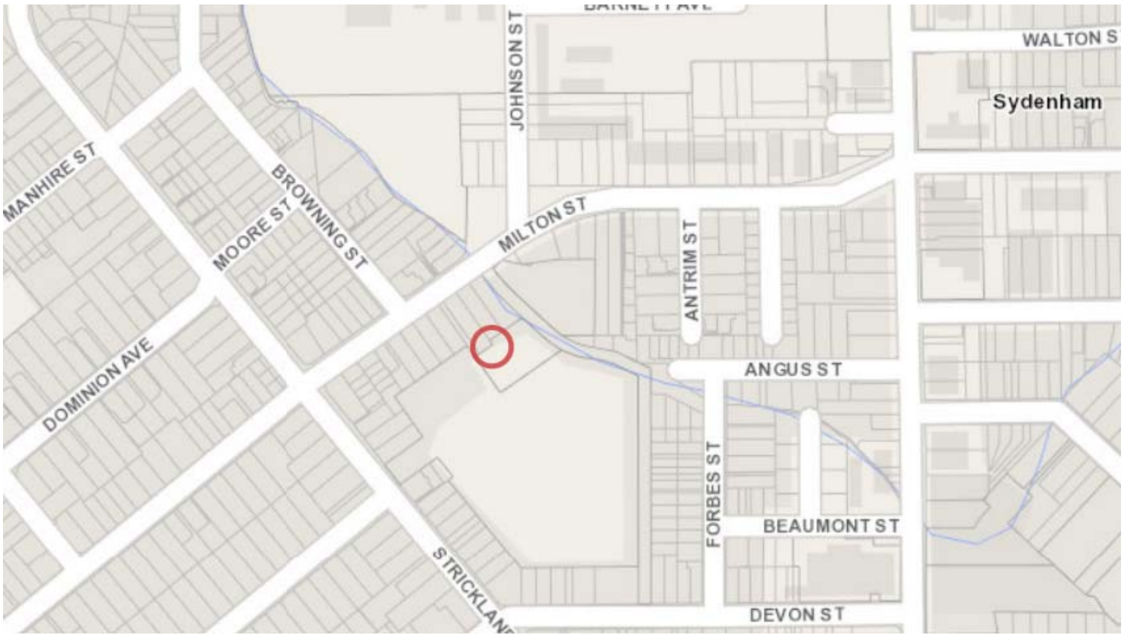
3. Limitations

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

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

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

4. Site location

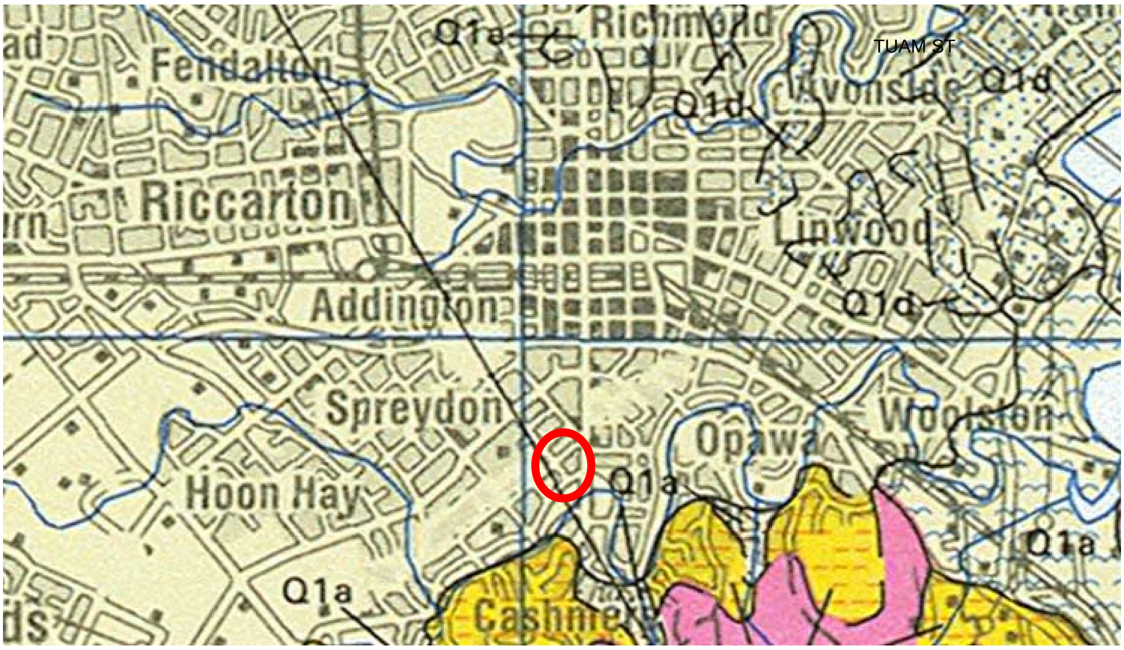


- **Figure 1 – Site location (courtesy of LINZ http://viewers.geospatial.govt.nz)**

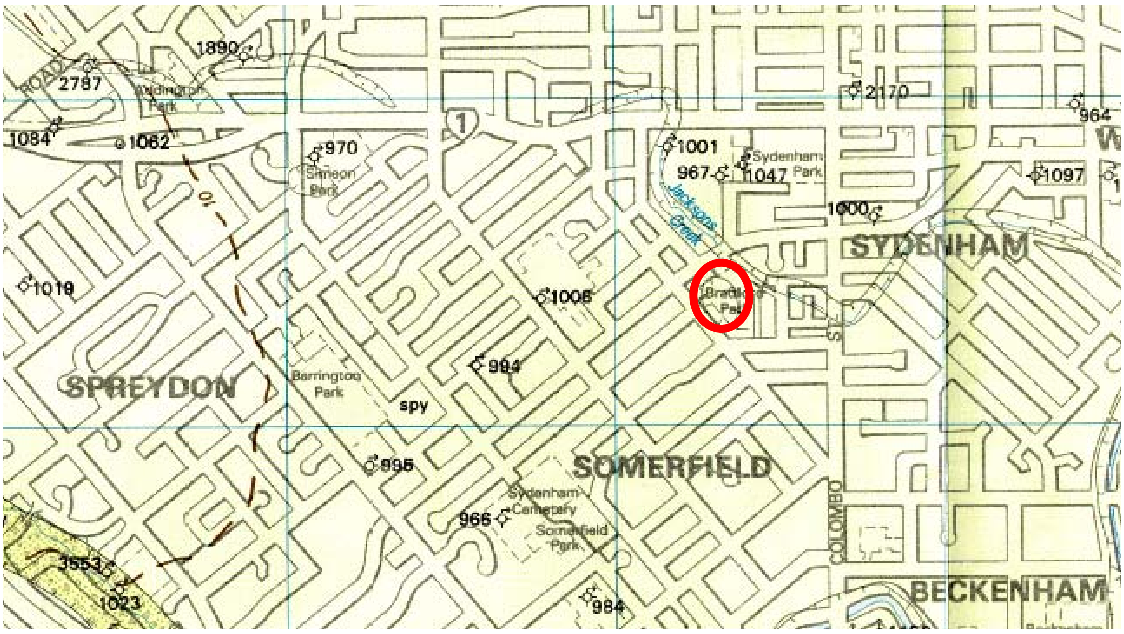
The structures are located on 192 and 196 Milton Street at grid reference 1570326 E, 5177847 N (NZTM).

5. Review of available information

5.1 Geological maps



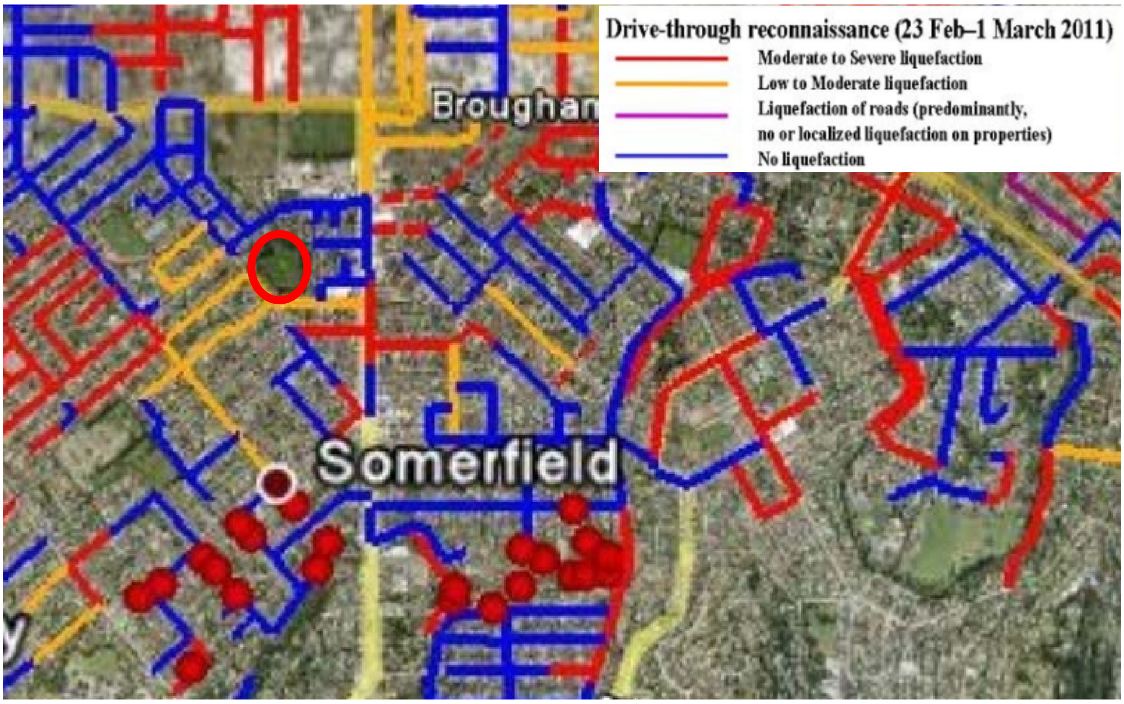
- **Figure 2 – Regional geological map (Forsyth et al, 2008). Site marked in red.**



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

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

5.2 Liquefaction map



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

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

Their finding show low to moderate liquefaction near Strickland Street located south west of the site. No liquefaction in the area near the Milton Street entrance to Bradford Park was identified.

5.3 Aerial photography

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

- **Figure 6 – Aerial photography of wider area from 24 Feb 2011 (http://viewers.geospatial.govt.nz/)**

Some evidence of liquefied material ejected at surface on the drive ways and back yards of adjacent properties could be seen from the aerial photographs. However, no significant liquefied material appears to be present near Milton Road, which is in agreement with the findings from the reconnaissance performed by M Cubrinovsko and M Taylor. The evidence suggests that some or local liquefaction occurred on adjacent properties. However, there appears to be no significant evidence that would indicate significant liquefaction of the underlying soil in the site area.

5.4 CERA classification

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

- Zone: Green
- DBH Technical Category: N/A (Urban Non-residential) – adjacent properties are TC2
-

5.5 Historical land use

Reference to historical documents (eg Appendix A) shows that a river or creek was present near the site in 1856. The historical document shows the area to the west and south of the site were recorded as swamp or marshland. Due to low accuracy of the available historical land use maps, it is possible that the swamp or marshland extended to the location of the site with the site potentially underlain by soft, liquefiable material.

5.6 Existing ground investigation data

- **Figure 7 – Local boreholes from Project Orbit and SKM files (https://canterburyrecovery.projectorbit.com/)**

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

5.7 Council property files

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

5.8 Site walkover

A site walkover was undertaken by a SKM engineer in the week commencing 16 April 2012.

The pavilion and toilets were observed to be a masonry block buildings with sheet metal roof and slab on grade foundations. From the external inspection there was minor step cracking noted in masonry blocks at one location (on the southern side of the pavilion) at the top of the wall.

There was no evidence of any liquefaction or land damage having occurred at this site

- **Figure 8 Overview of Bradford Park Pavilion**

- **Figure 9 Minor cracking observed**

- **Figure 10 Overview of public toilets**

6. Conclusions and recommendations

6.1 Site geology

There appears to be some variations in the geology indicated by nearby investigation data. However, it should be noted that the investigation data were generally located a significant distance away from the site. A summarised geology from available investigation data is provided below. However, further investigations on site are likely to be needed to confirm this.

Depth range (mBGL)	Soil type
0 – 3	Silt mixtures comprising clayey silt to silt and sandy silt.
3 - 25	Sand and sandy clay

The water table is expected to be shallow. The calculated water table is indicated to be 2.2m from available borehole logs.

6.2 Seismic site subsoil class

The site has been assessed as NZS1170.5 Class D (deep or soft soil including gravel below a depth of 100m).

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

The third preferred method has been used in making this assessment. From the geology indicated by the boreholes and the general geology area it is expected that deep soil are likely to underlay the site. Deep boreholes present approximately 350m of the site indicate soil including clay and gravels to be present below a depth of 100m.

6.3 Building performance

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

6.4 Ground performance and properties

Liquefaction risk appears to be low for this site. No evidence of liquefaction near the area was observed during the reconnaissance undertaken shortly after the 22 February earthquake. Likewise, no significant evidence of liquefaction having occurred on site was observed during the site walkover undertaken by a SKM engineer. Some evidence of liquefied ejecta at surface in the neighbouring properties was seen from the aerial photographs. However, no significant evidence of liquefaction or land damage was visible in the land surrounding the pavilion and toilets.

Even though, liquefaction risk was assessed to be low for the site as there are no ground investigations sufficiently near the site, an estimate of ground properties is not provided in this desk study. Existing investigation data seems to suggest soft or loose material to be present at shallow depths. However, it cannot be said with any certainty whether similar material is present at very shallow depth beneath the site without additional investigations.

6.5 Further investigations

If a quantitative DEE is to be performed for the structures on site, additional investigations are required to confirm the liquefaction assessment and to estimate ground properties. Additional investigations recommended are:

- Two CPTs on site to refusal. Pre-drilling to a shallow depth may be required if gravel is present in the top soil
- Two hand augers to a depth of 3m to determine the composition of the shallow soil layers

7. References

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

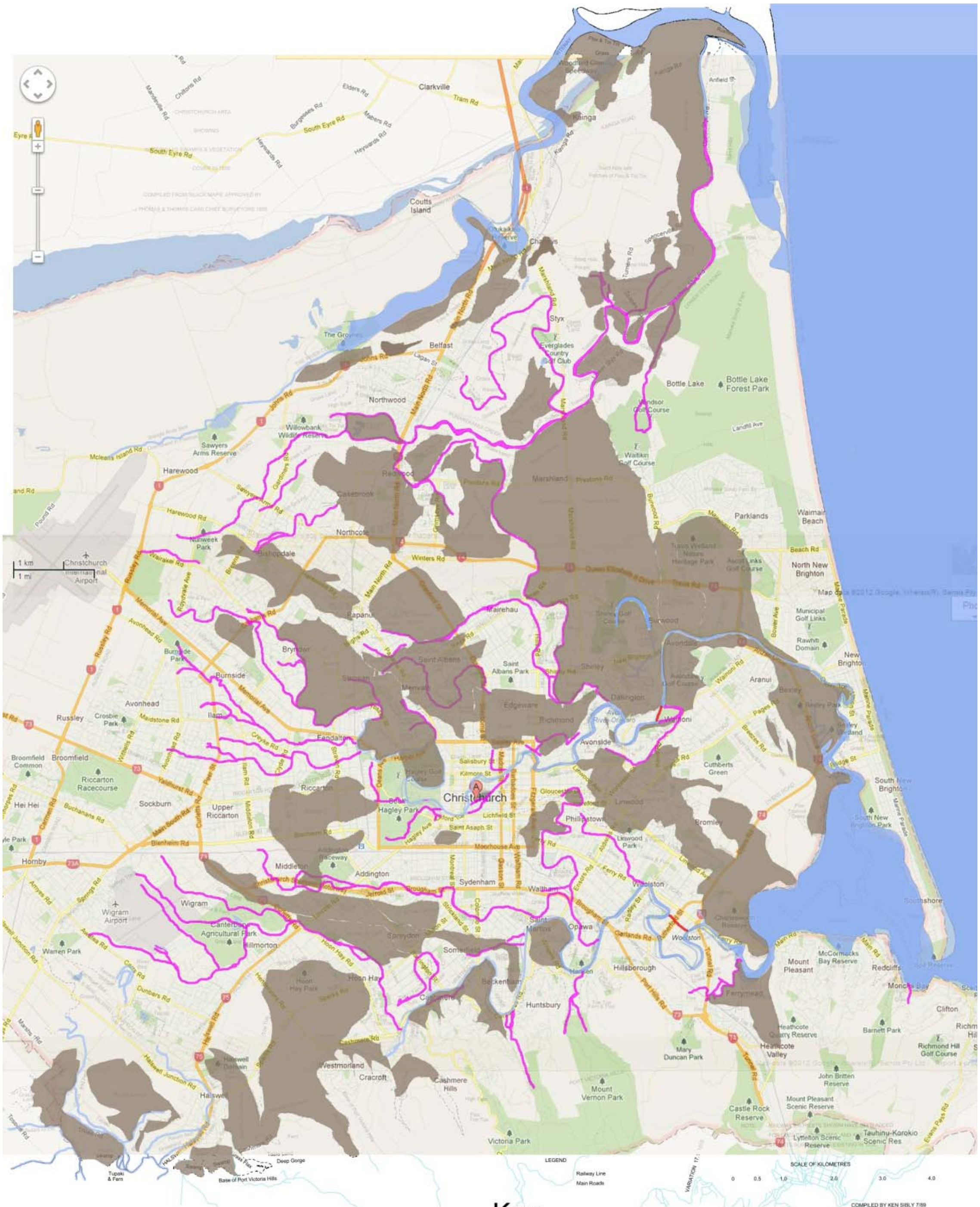
Cubrinovski & Taylor, 2011. Liquefaction map summarising preliminary assessment of liquefaction in urban areas following the 2010 Darfield Earthquake.

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

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

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

Appendix A – Christchurch 1856 land use



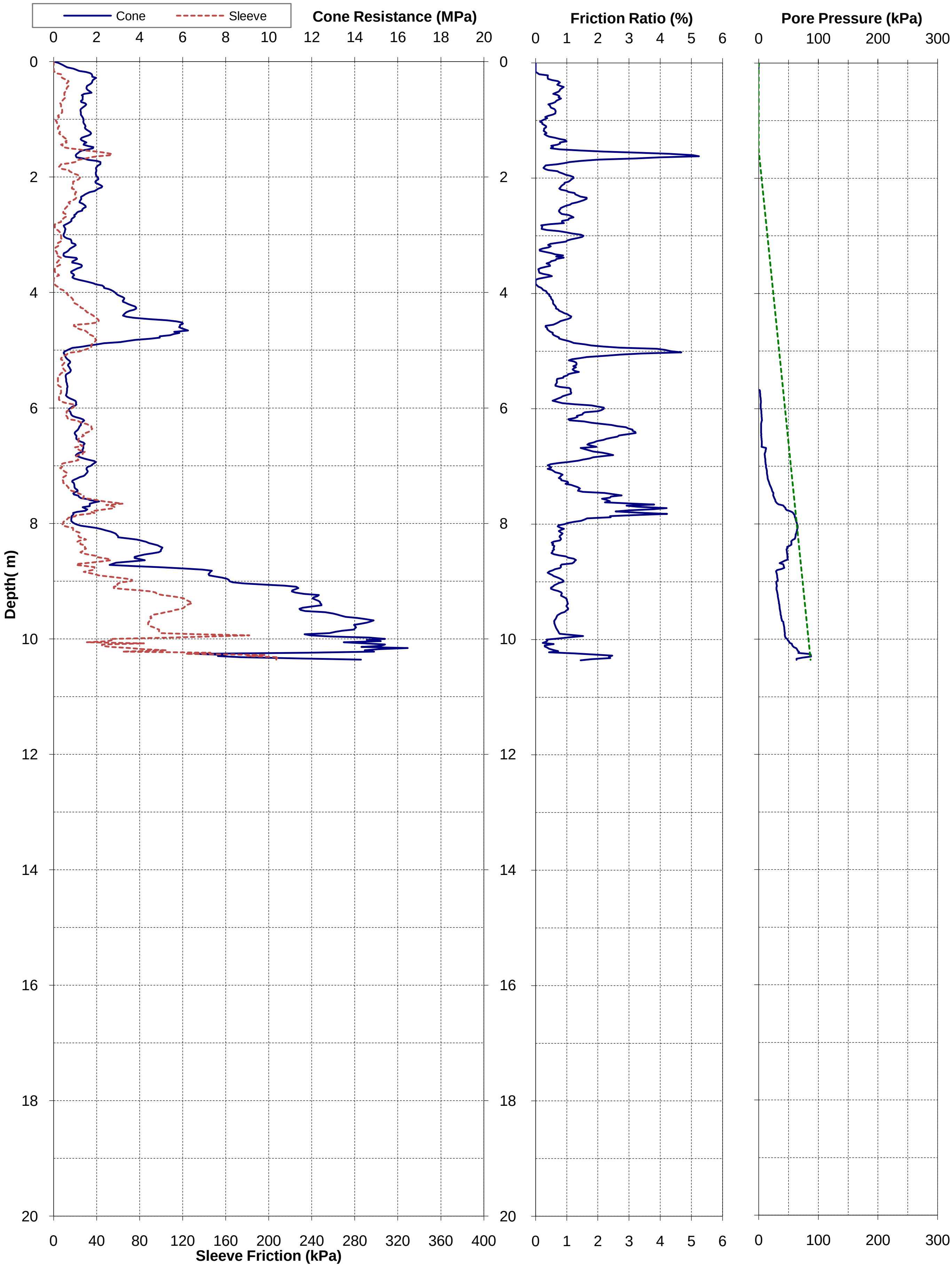
Key

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

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

Appendix B – Existing ground investigation logs

Project:	Christchurch 2011 Earthquake - EQC Ground Investigations			**Page:** 1 of 1		**CPT-SMF-28**
Test Date:	5-May-2011	**Location:**	Somerfield	**Operator:**	Geotech	
Pre-Drill:	1.2m	**Assumed GWL:**	1.5mBGL	**Located By:**	Survey GPS	
Position:	2480315.8mE	5739218.9mN	8.455mRL	**Coord. System:**	NZMG & MSL	
Other Tests:				**Comments:**		



Borelog for well M36/0982

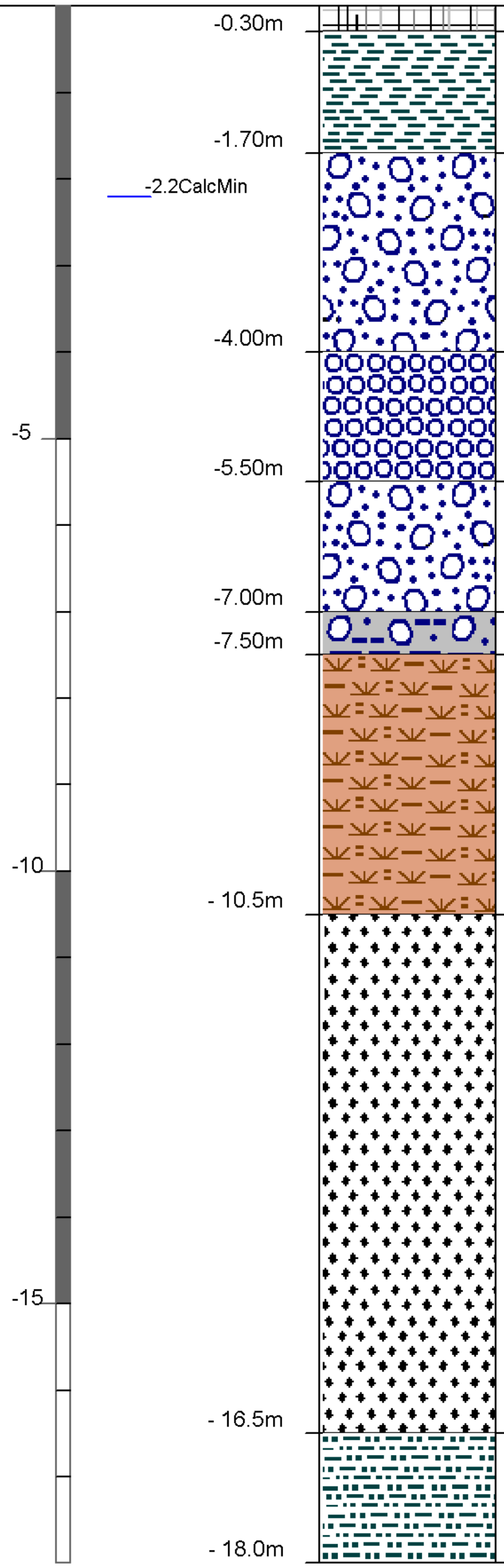
Gridref: M36:804-397 Accuracy : 4 (1=best, 4=worst)
Ground Level Altitude : 9 +MSD
Driller : Owner
Drill Method : Cable Tool
Drill Depth : -44.09m Drill Date : 1/04/1951

Environment Canterbury
Your regional council

Water Level	Depth(m)	Full Drillers Description	Formation Code
Artesian	-1.20m	Surface fillings, soil and silty clay	fi
	-3.59m	Sandy Yellow clay	sp
	- 19.8m	Sandy Blue clay with some timber & shells	ch
	- 21.0m	Sandy Blue clay & some gravel	ch
	- 25.6m	Sandy Blue clay & some timber	ch
	- 26.5m	Gravel & clay mixture (Tight)	ri
	- 30.4m	Grey gravel & sand (Water)	ri
	- 37.7m	Brown gravel& sand with some clay	ri
	- 38.3m	Blue gravel mixed with sand & timber	ri
	- 42.0m	Brown gravel (Water)	ri
	- 42.9m	Blue gravel & clay	ri
	- 44.1m	Blue sand clay	br

Borelog for well M36/7145

Gridref: M36:8055-3962 Accuracy : 3 (1=best, 4=worst)
Ground Level Altitude : 8.4 +MSD
Driller : Texco Drilling Ltd
Drill Method : Auger Rig
Drill Depth : -18m Drill Date : 5/10/2001

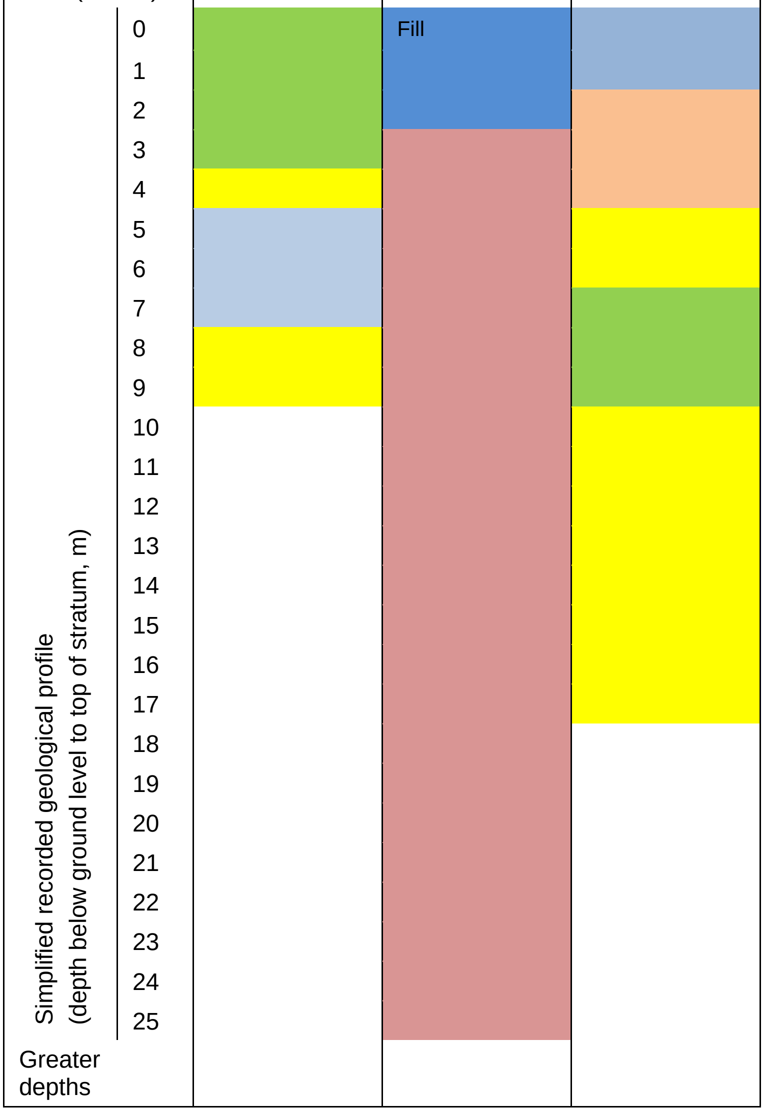


Scale(m)	Water Level	Depth(m)	Full Drillers Description	Formation Code
		-0.30m	Gravel fill	fi
		-1.70m	Brown and grey silt	sp
	-2.2CalcMin	-4.00m	Round medium sandy gravels	sp
-5		-5.50m	Larger gravels	sp
		-7.00m	More sand than gravel	sp
		-7.50m	Silty sand, gravel, vegetation	sp
-10		- 10.5m	Silty sand, vegetation	sp
-15		- 16.5m	Blue sand	ch
		- 18.0m	Blue sand - small amount of silt - heaving sand	ch

Appendix C – Geotechnical Investigation Summary

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

ID	1	2	3
Type *	CPT	BH	BH
Ref	SMF-28	M36-0982	M36-7145
Depth (m)	10.4	44.1	18
Distance from site (m)	240	260	280
Ground water level (mBGL)	*1.5 (assumed)*	Artesian	2.2 (calc min)



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

Sensitive or organic clay/silt — Clay to silty clay — Clayey silt to silt — Silty sand to silt

Clayey sand — Sandy clay — Sand — Sandy gravel

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