Christchurch City Council
PRK_1338_BLDG_002 EQ2
Edmonds Factory Gardens Toilets
365 Ferry Road, Phillipstown

QUANTITATIVE ASSESSMENT REPORT

FINAL

- Rev B
- 15 July 2013

Christchurch City Council
PRK_1338_BLDG_002 EQ2
Edmonds Factory Gardens Toilets
365 Ferry Road, Phillipstown

QUANTITATIVE ASSESSMENT REPORT

FINAL

- Rev B
- 15 July 2013

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	15/02/2013	G Fletcher	N Calvert	15/02/2013	Draft for Client Approval
B	15/07/2013	G Fletcher	A Martin	15/07/2013	Final Issue

Approval

	Signature	Date	Name	Title
Author	p.p.	15/07/2013	Adam Langsford p.p. Graeme Fletcher	Structural Engineer
Approver		15/07/2013	Alex Martin	Project Manager

Distribution of copies

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

Printed:	15 July 2013
Last saved:	15 July 2013 08:35 AM
File name:	PRK 1338 BLDG 002 Edmonds Factory Gardens Toilets Quantitative Final.docx
Author:	Adam Langsford
Project manager:	Alex Martin
Name of organisation:	Christchurch City Council
Name of project:	Christchurch City Council Structures Panel
Name of document:	PRK_1338_BLDG_002 EQ2 Qualitative Assessment Report
Document version:	B
Project number:	ZB01276.166

1. Executive Summary

1.1. Background

A Quantitative Assessment was carried out on the building located at PRK_1338_BLDG_002 EQ2 located at 365 Ferry Road. The building located on this site comprises of a multi use filled masonry building, the structure contains the public toilets to the west and storage rooms to the east. The building's design period has been assumed to be 1976-1992 based on the approximate purchase of the land by council. An aerial photograph illustrating these areas is shown below in Figure 1 Aerial Photograph of PRK_1338_BLDG_002 EQ2 Edmonds Factory Garden. Detailed descriptions outlining the building's age and construction type are given in Section 5 Building Details of this report.

- **Figure 1 Aerial Photograph of PRK_1338_BLDG_002 EQ2 Edmonds Factory Garden**

This Quantitative report for the building structure is based on the Detailed Engineering Evaluation Procedure document (draft) issued by the Engineering Advisory Group on 19 July 2011, visual inspections 27 June 2012, mark up on 11 January 2013 and calculations.

1.2. Key Damage Observed

Key damage observed includes:

- Spalling to the masonry block units on the north west corner of the building.

1.3. Critical Structural Weaknesses

The building has no critical structural weaknesses.

1.4. Indicative Building Strength

As described in the Engineering Advisory Group's "Guidance on Detailed Engineering Evaluation of Earthquake Affected Non-residential Buildings" (from July 2011) the percentage of new building standard seismic resistance has been assessed using the quantitative method. The assessment included consideration of geotechnical conditions, existing earthquake damage to the building and structural engineering calculations to assess both strength and ductility/resilience.

The assessments were based on the following:

- On-site investigation to assess the extent of existing earthquake damage including limited intrusive investigation.
- Qualitative assessment of critical structural weaknesses (CSWs) based on inspection and mark up where drawings were not available.
- Assessment of the strength of the existing structures taking account of the current condition.

Any building that is found to have a seismic capacity less than 33% of the new building standard is required to be strengthened up to a capacity of at least 67%NBS.

Based on the information available, and using the Quantitative Assessment Procedure, the buildings original capacity has been assessed to be in the order of 11%NBS and post earthquake capacity in the order of 11%NBS. This assessment has been made without structural drawings and is accordingly limited.

The building has been assessed to have a seismic capacity in the order of 11% NBS and is therefore potentially earthquake prone.

Please note that structural strengthening is required by law for buildings that are confirmed to have a seismic capacity of less than 33% NBS.

1.5. Recommendations

It is recommended that:

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

b) We recommend that options be considered to strengthen the building to 67%NBS.

2. Introduction

Sinclair Knight Merz was engaged by Christchurch City Council to carry out a Quantitative Assessment of the seismic performance of the Edmonds Factory Garden Toilets located at 365 Ferry Road.

The scope of this quantitative analysis includes the following:

- Analysis of the seismic load carrying capacity of the building compared with current seismic loading requirements or New Buildings Standard (NBS). It should be noted that this analysis considers the building in its damaged state where appropriate.
- Identify any critical structural weaknesses which may exist in the building and include these in the assessed %NBS of the structure.
- Preparation of a summary report outlining the areas of concern in the building as well as identifying strengthening concepts to 67%NBS for any areas which have insufficient capacity if the building is found to be an earthquake prone building.

The recommendations from the Engineering Advisory Group[1] were followed to assess the likely performance of the structures 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[2].

At the time of this report, no intrusive site investigation had been carried out. Construction drawings were not available, and where necessary assumptions had been made based on the likely construction of the time. The building description below is based on our visual inspections.

---

[1] EAG 2011, *Guidance on Detailed Engineering Evaluation of Earthquake Affected Non-residential Buildings in Canterbury - Draft*, p 10

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

3. Compliance

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

3.1. Canterbury Earthquake Recovery Authority (CERA)

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

Section 38 – Works

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

Section 51 – Requiring Structural Survey

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

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

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

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

- The importance level and occupancy of the building
- The placard status and amount of damage
- The age and structural type of the building

- Consideration of any critical structural weaknesses
- The extent of any earthquake damage

3.2. Building Act

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

3.2.1. Section 112 – Alterations

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

3.2.2. Section 115 – Change of Use

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

3.2.3. Section 121 – Dangerous Buildings

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

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

3.2.4. Section 122 – Earthquake Prone Buildings

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

3.2.5. Section 124 – Powers of Territorial Authorities

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

3.2.6. Section 131 – Earthquake Prone Building Policy

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

3.3. Christchurch City Council Policy

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

The 2010 amendment includes the following:

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

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

We anticipate that any building with a capacity of less than 34%NBS (including consideration of critical structural weaknesses) will need to be strengthened to a target of 67%NBS of new building standard as recommended by the Policy.

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

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

3.4. Building Code

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

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

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

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

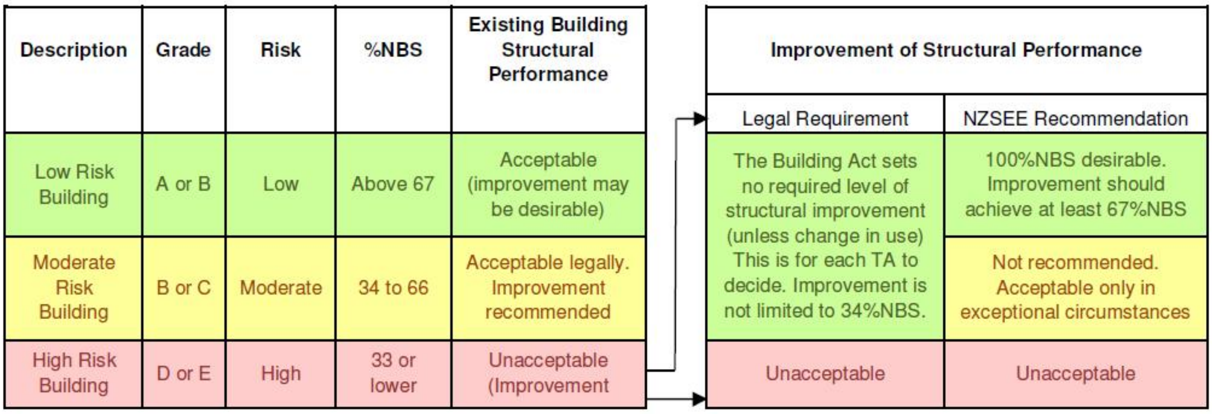
The increase in the above factors has resulted in a reduction in the level of compliance of an existing building relative to a new building despite the capacity of the existing building not changing.

4. Earthquake Resistance Standards

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

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

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



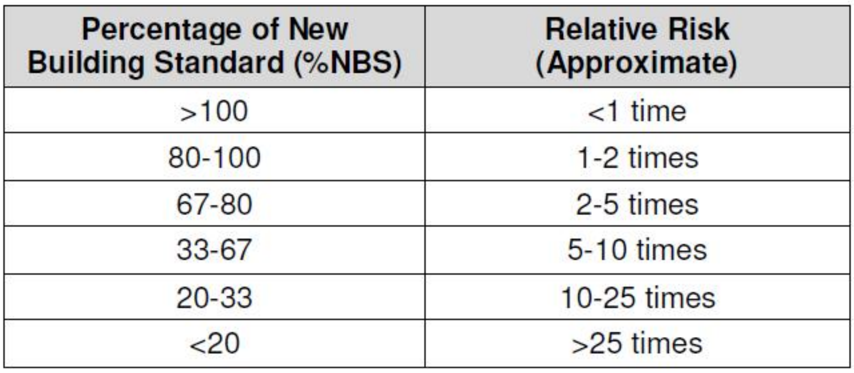
Description	Grade	Risk	%NBS	Existing Building Structural Performance	Improvement of Structural Performance	
					Legal Requirement	NZSEE Recommendation
Low Risk Building	A or B	Low	Above 67	Acceptable (improvement may be desirable)	The Building Act sets no required level of structural improvement (unless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

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

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

.

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



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

5. Building Details

5.1. Building description

The building is located at 365 Ferry Road. There is only one building on this site. The building has one storey consisting of public toilets and storage rooms. The building is constructed from light metal cladding on light timber framed roofing and load bearing filled masonry walls. The internal walls are constructed of filled masonry walls as for the external walls. The building is supported on perimeter strip foundation and concrete slab on grade throughout.

Our evaluation was based on visual inspection of the building on the 27th of June 2012 as no structural drawings were available.

The building is estimated to have been constructed around 1990 based on the purchase of the land by council at that time.

5.2. Gravity Load Resisting system

The gravity load resisting structure of the building is made up of load bearing filled concrete masonry block units on strip foundations. A reinforced concrete slab on grade creates the ground floor area.

5.3. Seismic Load Resisting system

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

In both the longitudinal and transverse directions lateral loads to the roof are carried through the purlins and rafters through axial compression and bending into the concrete bond beams at the top of the masonry walls. Load from the masonry walls in face loading is transferred to the bond beams through out of plane bending to the foundations and bond beam. The bond beam transfers load to the end walls through shear of the bond beam and bending. The end walls resist these loads through shear and transfer loads to the foundation strip footings. These loads are resisted by the bearing capacity of the soil. There is no roof diaphragm assumed for seismic load transfer in the assessment.

5.4. Building Damage

1) North West corner, minor spalling to the concrete bond beam.

6. Available Information and Assumptions

6.1. Available Information

Following our inspections on the 11 January 2013, SKM carried out a seismic review on the structure. This review was undertaken using the available information which was as follows:

- SKM site measurements, cover meter survey and inspection findings for the building.

6.2. Survey

A level survey was not deemed necessary on the building

6.3. Design Criteria and Assumptions

The following design criteria and assumptions made in undertaking the assessment include:

- The building was built according to the drawings and according to good practice at the time. We have reviewed the building and from our visual inspection the structure appears to be built in accordance with the drawings.
- The soil on site is class D as described in AS/NZS1170.5:2004, Clause 3.1.3, Soft Soil. This is a conservative assumption based on our experience of soils around Christchurch. The ultimate bearing capacity on site is 300kPa, we believe that this assumption is reasonable. Liquefaction does not need to be accounted for in the foundation design. The latter two assumptions assume that the ground conditions classify as “good ground”.
- Standard design criteria 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 2. This level of importance is described as ‘normal’ with medium or considerable consequence for loss of human life, or considerable economic, social or environmental consequence of failure.
- The building has a short period less than 0.4 seconds.
- Site hazard factor, Z = 0.3, NZBC, Clause B1 Structure, Amendment 11 effective from 1 August 2011
- The following ductility criteria used in the building:
- **Table 2: Assumed Building Ductility**

Building	Ductility of Building in Current State	Ductility of Building in Strengthened State
Toilets	1.25	1.25

The ductility factor of 1.25 has been chosen based on the timber roof system and reinforced concrete masonry block walls.

- The following material properties were used in the analyses:
- **Table 3: Material Properties**

Material	Nominal Strength	Structural Performance
Structural reinforcing steel	f_y = 300MPa	S_p = 0.9
Masonry (reinforced vertically at 800mm crs)	f_m = 4MPa	S_p = 1.0
Concrete	f_c' = 30MPa	S_p = 1.0
Timber - Assumed No.1 Framing	f_b = 10MPa & f_c = 15MPa	S_p = 1.0

The detailed engineering analysis is a post construction evaluation therefore it has the following limitations:

- It is not likely to pick up on any concealed construction errors (if they exist)
- Other possible issues that could affect the performance of the building such as corrosion and modifications to the structure will not be identified unless they are visible and have been specifically mentioned in this report.
- The detailed engineering evaluation deals only with the structural aspects of the structure. Other aspects such as building services are not covered.
- It has been assumed that a building consent will be required to repair the damage to the building. The likely requirements for a building consent would be repairs costing in excess of $ 50,000, or structural alteration.

6.4. The Detailed Engineering Evaluation (DEE) process

The DEE is a procedure written by the Department of Building and Housing's Engineering Advisory Group and 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 procedure of the DEE is as follows:

1) Qualitative assessment procedure

---

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

   a. Determine the building's status following any rapid assessment that have been done
   b. Review any existing documentation that is available. This will give the engineer an understanding of how the building is expected to behave. If no documentation is available, site measurements may be required
   c. Review the foundations and any geotechnical information available. This will include determining the zoning of the land and the likely soil behaviour, a site investigation may be required
   d. Investigate possible Critical Structural Weaknesses (CSW) or collapse hazards
   e. Assess the original and post earthquake strength of the building (this assessment is subsequently superseded by the quantitative assessment)

2) Quantitative procedure
   a. Carry out a geotechnical investigation if required by the qualitative assessment
   b. Analyse the building according to current building codes and standards. Analysis accounts for damage to the building.

The DEE assessment 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 4. 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 34 %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 strengthened within 30 years of the owner being notified that the building is potentially earthquake prone[5].

---

[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

Table 4: DEE 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 DEE method rates buildings based on the plans (if available) and other information known about the building 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 DEE does also consider Serviceability Limit State (SLS) performance of the building and or the level of earthquake that would start to cause damage to the building but this result is secondary to the ULS performance.

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

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

7. Results and Discussions

7.1. Critical Structural Weaknesses

The building has no critical structural weaknesses:

7.2. Analysis Results

The equivalent static force method was used to analyse the seismic capacity of the building. The results of the analysis are reported in the following table as %NBS. The results below are calculated for the building in its damaged state. The building results have been broken down into their seismic resisting elements. As the building has elements that are less than 34%NBS any item with a capacity less than 67%NBS will need to be strengthened so that the overall building capacity is greater than 67%NBS.

(%NBS = probable strength / new building standards)

- **Table 5: DEE Results**

Seismic Resisting Element	Action	Seismic Rating %NBS
Concrete Bond Beam	Bending	11%
Masonry Wall Strip Foundations in plane	Bearing due to overturning	74%.
Masonry Wall in plane	Bending	96%
Masonry Wall Strip Foundations out of plane	Bearing due to overturning	100%
Purlins	Compression and bending	>100%
Rafters	Compression and bending	>100%
Masonry Walls out of Plane	Bending	>100%
Masonry Walls in plane	Shear	>100%

7.3. Recommendations

The quantitative assessment carried out on the Edmonds Factory Garden Toilets indicates that the building has a seismic capacity less than 34% of NBS and is therefore classed as being in the category of ‘High Risk Buildings’. Strengthening of the building is required to bring it up to a minimum of 67% of NBS.

It should be noted that the 11%NBS indicated corresponds to the capacity of the concrete bond beams in transferring seismic loads, where no roof diaphragm is assumed in the assessment. The rest of the structure appears to be over 67%NBS. We recommend that roof bracings or ceiling boards are added so that the roof could act as a diaphragm to transfer seismic loads, and thus reducing the lateral loads on the concrete bond beams.

Notwithstanding the above, the building occupier may wish to evacuate the building until it is strengthened or propped on the basis of the limiting building capacity summarised above in Table 5, the building occupier should ensure that they are meeting their requirements under the health and safety in employment act.

If it is determined that the building should be repaired and a building consent is required there are a number of issues which will need to be investigated and associated documents prepared in order to submit a building consent application. These issues will need to be considered during the initial phase of strengthening works. Listed below are the likely items the council may require to be explored:

- A geotechnical investigation may be required and associated factual and interpretive geotechnical reports prepared – the geotechnical reports may be required to enable completion of the strengthening design.
- A fire report may be required and all necessary upgrades to egress routes, emergency lighting and specified systems may need to be undertaken.
- An emergency lighting design may be required to meet the provisions noted in the fire report.
- A disabled access summary may be required including provision for disabled facilities.
- The site amenities (toilets and the like) may need to be reviewed to ensure that there are sufficient facilities for the expected number of people on site.
- Landscaping may need to be considered although we do not anticipate that any modifications will be required since you will not be adjusting the footprint area of buildings on site and will likely only be required for a new build option.

8. Conclusion

SKM carried out a quantitative assessment on the Edmonds Factory Gardens Toilets located at 365 Ferry Road. This assessment concluded that the building is classified as Earthquake Prone.

- **Table 6: Quantitative assessment summary**

Description	Grade	Risk	%NBS	Structural Performance
Maintenance shed and Toilets	E	High	11	Unacceptable. Improvement required.

Strengthening is required on the building to bring the seismic capacity up to at a minimum of 67% of NBS.

It is recommended that:

a) We consider that barriers around the building are not necessary.
b) We recommend that options are considered to strengthen the building to at least 67%NBS.

9. 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.

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.

10. Appendix 1 – CERA Standardised Report Form

Detailed Engineering Evaluation Summary Data

V1.11

Location

Building Name: Edmonds Factory Garden

	No:	Street
Building Address:	365	Ferry Road, Christchurch

Legal Description:

	Degrees	Min	Sec
GPS south:	45	32	28.00
GPS east:	172	39	55.00

Building Unique Identifier (CCC): PRK_1338_BLDG_002

Reviewer: **N Calvert**
CPEng No: **242062**
Company: Sinclair Knight Merz
Company project number: **ZB01276.166**
Company phone number: 03 940 4900

Date of submission: 15-Jul
Inspection Date: 27/06/2012
Revision: B
Is there a full report with this summary? yes

Site

Site slope: flat
Soil type:
Site Class (to NZS1170.5): D
Proximity to waterway (m, if <100m):
Proximity to clifftop (m, if < 100m):
Proximity to cliff base (m,if <100m):

Max retaining height (m):
Soil Profile (if available):
If Ground improvement on site, describe:
Approx site elevation (m): 4.00

Building

No. of storeys above ground: 1 single storey = 1
Ground floor split? no
Storeys below ground 0
Foundation type: mat slab
Building height (m): 2.40
Floor footprint area (approx): 37
Age of Building (years): 22

Ground floor elevation (Absolute) (m): 4.00
Ground floor elevation above ground (m): 0.20
if Foundation type is other, describe: Slab on grade throughout
height from ground to level of uppermost seismic mass (for IEP only) (m): 2.2
Date of design:

Strengthening present? no

If so, when (year)?
And what load level (%g)?
Brief strengthening description:

Use (ground floor): public
Use (upper floors):
Use notes (if required):
Importance level (to NZS1170.5): IL2

Gravity Structure

Gravity System: load bearing walls
Roof: timber framed
Floors: concrete flat slab
Beams:
Columns:
Walls: fully filled concrete masonry

rafter type, purlin type and cladding: 150x50mm Rafters, 75x50mm Purlins corrugated steel cladding + corrugated plastic skylight
slab thickness (mm): ~200mm
No Beams
No Columns
#N/A

Lateral load resisting structure

Lateral system along: fully filled CMU
Ductility assumed, μ: 1.25
Period along: 0.02
Total deflection (ULS) (mm): 20
maximum interstorey deflection (ULS) (mm): 20

Note: Define along and across in detailed report!
0.02 from parameters in sheet

note total length of wall at ground (m): 10
wall thickness (m): 0.19
estimate or calculation? calculated
estimate or calculation? estimated
estimate or calculation? estimated

Lateral system across: fully filled CMU
Ductility assumed, μ: 1.25
Period across: 0.10
Total deflection (ULS) (mm): 20
maximum interstorey deflection (ULS) (mm): 20

0.10 from parameters in sheet

note total length of wall at ground (m): 3.7
wall thickness (m): 0.19
estimate or calculation? calculated
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:
Roof Cladding: Metal
Glazing: timber frames
Ceilings: fibrous plaster, fixed
Services(list):

describe
No claddings to masonry
Corrugated iron with skylights
skylights only no glazing

Available documentation

Architectural none
Structural none
Mechanical none
Electrical none
Geotech report none

original designer name/date Unknown
original designer name/date Unknown
original designer name/date Unknown
original designer name/date Unknown
original designer name/date Unknown

Damage

Site:
(refer DEE Table 4-2)

Site performance: Good
Describe damage: Minor concrete seperation at foundation to surround concrete paths

Settlement: none observed
notes (if applicable):
Differential settlement: none observed
notes (if applicable):
Liquefaction: 0-2 m²/100m³
notes (if applicable): Signs of potentially ejected silt on footpath
Lateral Spread: none apparent
notes (if applicable):
Differential lateral spread: none apparent
notes (if applicable):
Ground cracks: none apparent
notes (if applicable):
Damage to area: slight
notes (if applicable): Building closures in surrounding area

Building:

Current Placard Status: green

Along
Damage ratio: 0%
Describe (summary): Non stuctural seperation from paths
Describe how damage ratio arrived at: No Structural damage

Across
Damage ratio: 0%
Describe (summary): Minor spalling to NW corner but unlikely EQ damage and no structural

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

Diaphragms Damage?: no
Describe:

CSWs: Damage?: no
Describe: None identified

Pounding: Damage?: no
Describe:

Non-structural: Damage?: yes
Describe: Spalling of NW corner and seperation from surrounding concret paths

Recommendations

Level of repair/strengthening required: minor structural
Describe: Increase bond beam capacity through bolting plates through the beam face internally and externally or install roof bracing. Patch NW corner for durability
Building Consent required: no
Describe: Very minor repair
Interim occupancy recommendations: full occupancy
Describe: Low risk of collapse

Along
Assessed %NBS before: 11%
Assessed %NBS after: 11%
%NBS from IEP below
If IEP not used, please detail assessment methodology: SKM/NZSEE IEP

Across
Assessed %NBS before: 11%
Assessed %NBS after: 11%
%NBS from IEP below

11. Appendix 2 – Geotech desk study

Christchurch City Council - Structural Engineering Service

Geotechnical Desk Study

SKM project number	ZB01276
SKM project site number	166
Address	Toilets – Edmonds Factory Garden, Phillipstown
Report date	19 July 2012
Author	Dominic Hollands
Reviewer	Leah Bateman
Approved for issue	Yes

1. Introduction

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

2. Scope

This geotechnical desk top study incorporates information sourced from:

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

3. Limitations

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

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

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

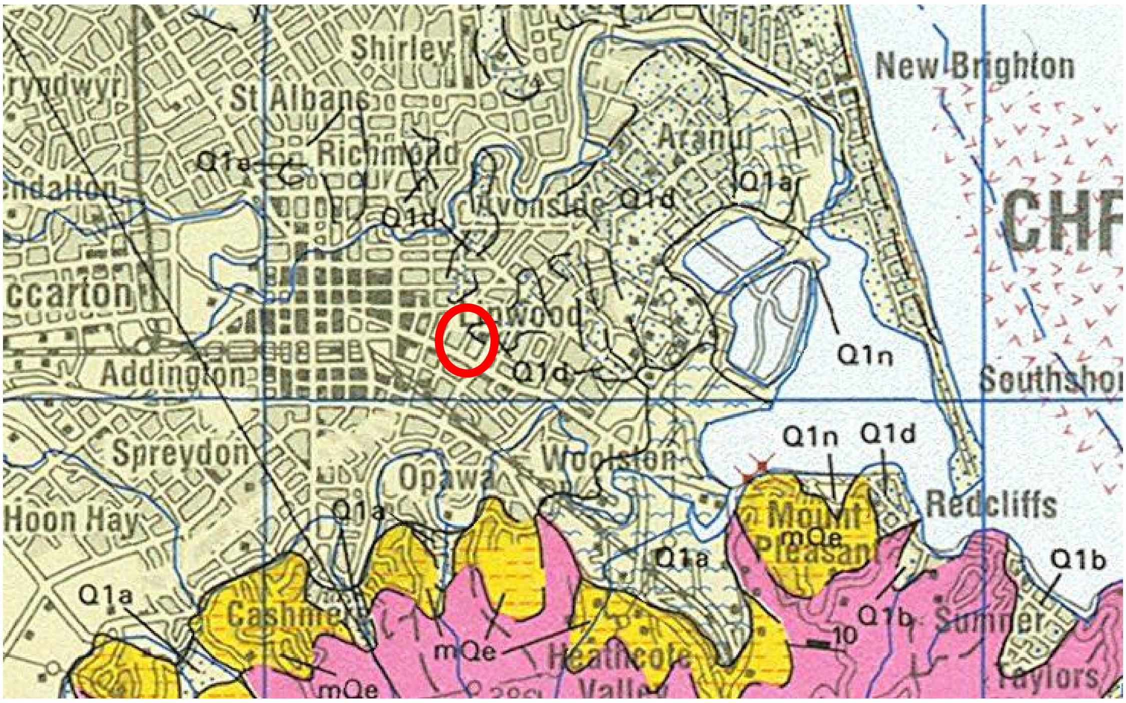
4. Site location

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

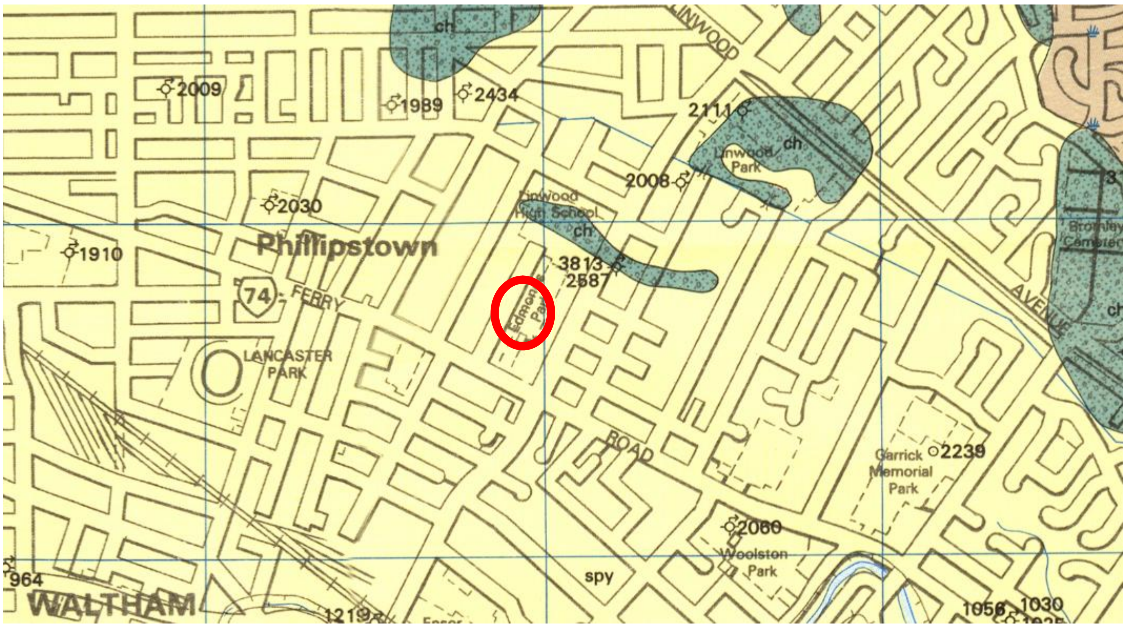
The structure is located at Edmonds Factory garden at 365 Ferry Road at grid reference 1572935 E, 5178989 N (NZTM).

5. Review of available information

5.1 Geological maps



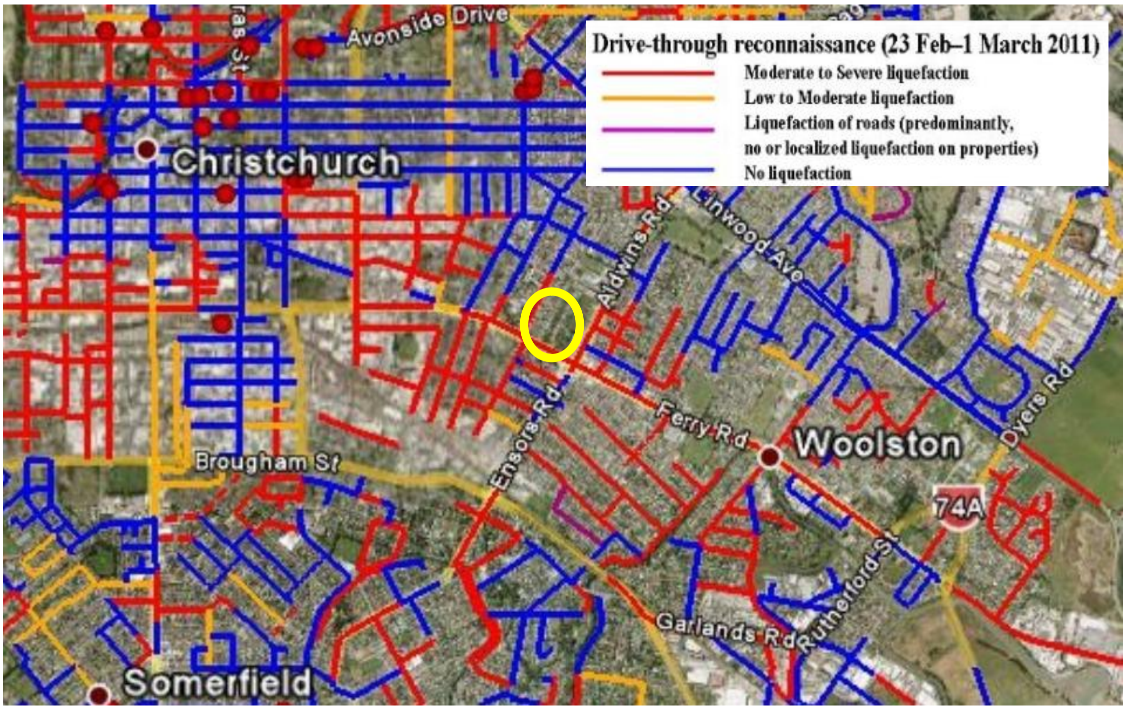
- **Figure 2 – Regional geological map (Forsyth et al, 2008). Site marked in red.**



- **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 yellow.**

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 findings show moderate to severe liquefaction along Ferry Road to the south, Aldwins Road to the east and Ryan Street to the west of Edmonds Factory Garden

5.3 Aerial photography

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

Aerial photography shows definite evidence of liquefaction in the local area after the 22 February 2011 event. Sand and silt ejecta was widespread in the area with Edmonds Factory Park, most roads and properties in the local area affected.

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: Urban Non-residential (adjacent residential properties to the west are classified as TC3)

5.5 Historical land use

Reference to historical documents (e.g. Appendix A) indicates that no swamp, marshland or waterways existed or traversed the site as of 1856.

5.6 Existing ground investigation data

- **Figure 6 – Local boreholes from Project Orbit and SKM files (https://canterburygeotechnicaldatabase.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

Only one drawing showing the proposed conversion of the garden shed to a public toilet at Edmond Factory Garden was available at the time of writing this report.

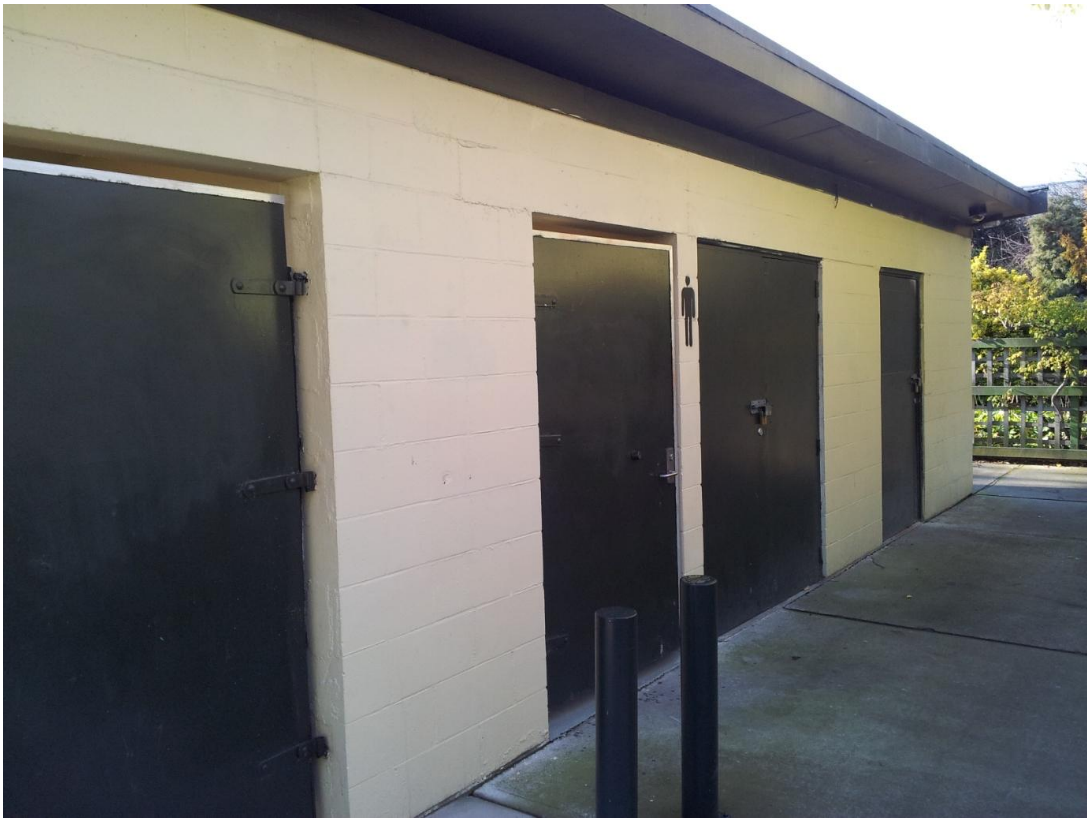
From the available drawing, the foundation appears to be a partially embedded floor slab with plaster covering to the perimeter of the toilet block. However, additional foundation details, such as the depth of embedment or whether any reinforcement was used for the construction of the floor slab, were not available in the council file drawing. No relevant ground condition information was found in the available council property file for the site.

5.8 Site walkover

A site walkover was conducted by an SKM engineer on 17 July 2012.

The building was noted to be a masonry block construction with a sheet metal roof and slab on grade foundation. Some hairline cracks in the masonry walls and minor spalling of the block to the north west corner of the building were observed. There was a minor separation between the building and external ground slab on the southern elevation.

There was evidence of liquefaction having occurred at the site with significant amounts of sand ejecta still present 18 months after the 22 February 2011 event. The nearby car park appeared to have been resurfaced most likely due to the earthquake damage. No visual evidence of lateral spreading or settlement of the structure was observed during the site walkover.



- **Figure 7 Front view of the building (southern elevation)**

- **Figure 8 Minor gap between the building and external ground slab**

- **Figure 8 Sand and silt ejecta close to the toilet block**

6. Conclusions and recommendations

6.1 Site geology

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

Approximate Depth range (m BGL)	Soil type
0 – 3	Clay (Springston Formation)
3 – 20	Silts and sands (Springston Formation)
20+	Clays and sands (Christchurch Formation)

Borehole and CPT data indicate both shallow and deep variable ground conditions. The borehole and CPT data indicates that there is predominantly a surface layer of clay, however this is commonly absent from shallow borehole records in the area and where sand and silt ground dominates.

At depth borehole and CPT logs indicate highly variable ground conditions with thick clay sequences and thick sand and silt sequences separated by short distances.

The prevalence of silt and sand ejecta in the local area suggests that the shallow clay deposits, indicated by some of the available investigation data, are unlikely to be present at this site.

6.2 Seismic site subsoil class

The site has been assessed as NZS1170.5 Class D (deep or soft soil) from 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 least preferred method. It is therefore possible that site specific investigation could revise the site class.

6.3 Building Performance

No survey information on whether the building had settled due to the level of liquefaction noted on site was available at the time of writing this report. However, there does not appear to be significant settlement of the building from visual inspection.

Therefore, the present foundation is likely to be adequate for its current purpose.

6.4 Ground performance and properties

Liquefaction risk is medium to high at this site. Aerial photographs after the February 2011 earthquake show extensive sand and silts ejecta in the local area including at the Edmonds Factory Garden site. There is a common presence of silt and sand within shallow and deep boreholes in the local area.

No groundwater data was available close to the site.

Ground properties have not been provided in this desk study as available data is located 150 m from the siteand ground conditions are highly variable. . Therefore an investigation at or close to the site location would be required to perform a full quantitative DEE.

6.5 Further investigations

If a quantitative DEE is to be undertaken for the structure on site additional investigations are required to perform a more detailed liquefaction assessment and estimate likely shallow ground properties. In which case additional investigations recommended are:

- One CPT on site to refusal. From available investigation data the site is inferred to be underlain by clay, silts and sand up to a depth of 20 m. However, if the CPT reaches refusal at a depth less than 10 m BGL, one borehole to a depth of 20 m with SPT at intervals of 1.0 m in the upper 10 m and 1.5 m below this depth may be required

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.

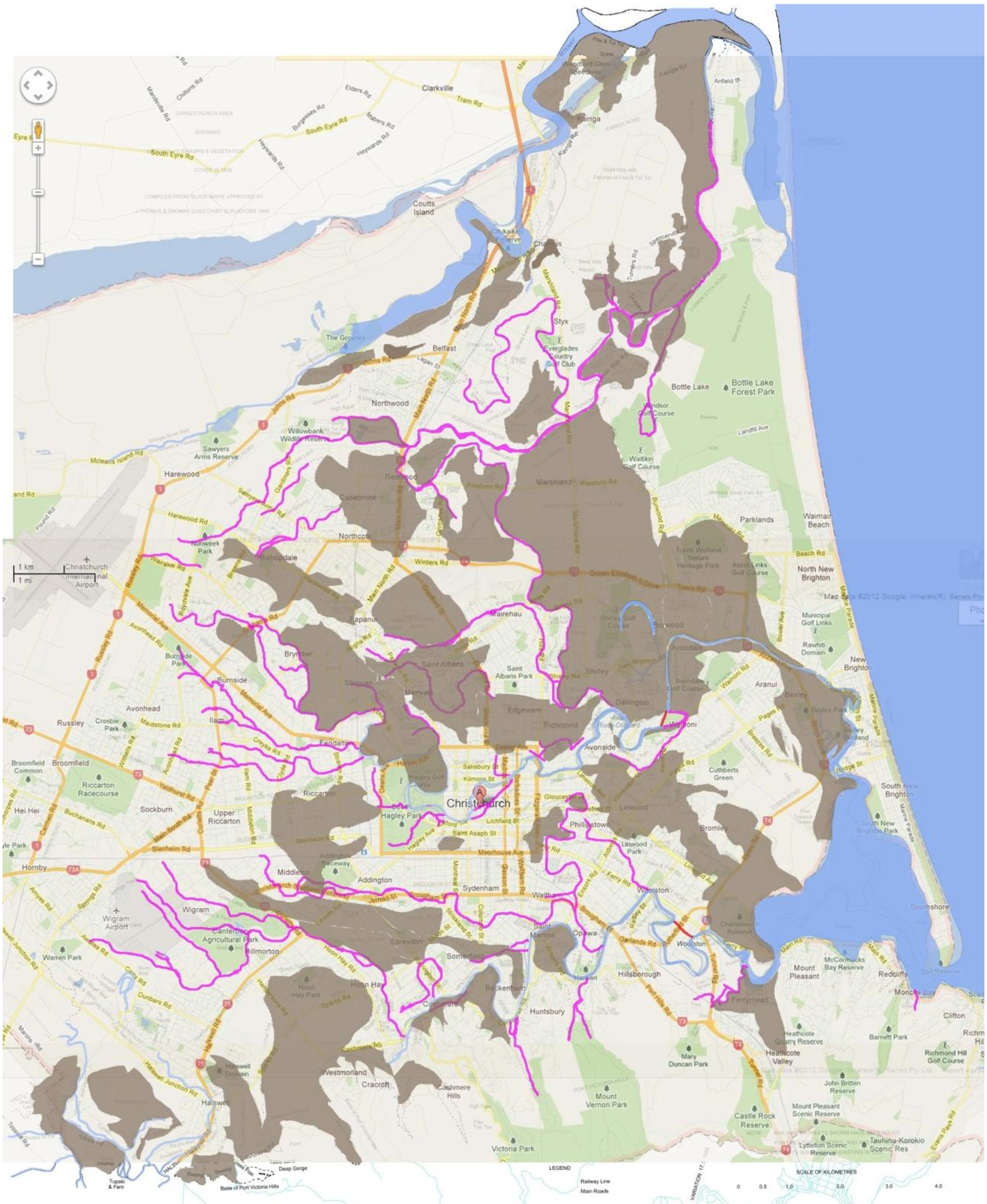
Cubrinovski & Taylor, 2011. Liquefaction map summarising preliminary assessment of liquefaction in urban areas following the 2010 Darfield Earthquake.

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



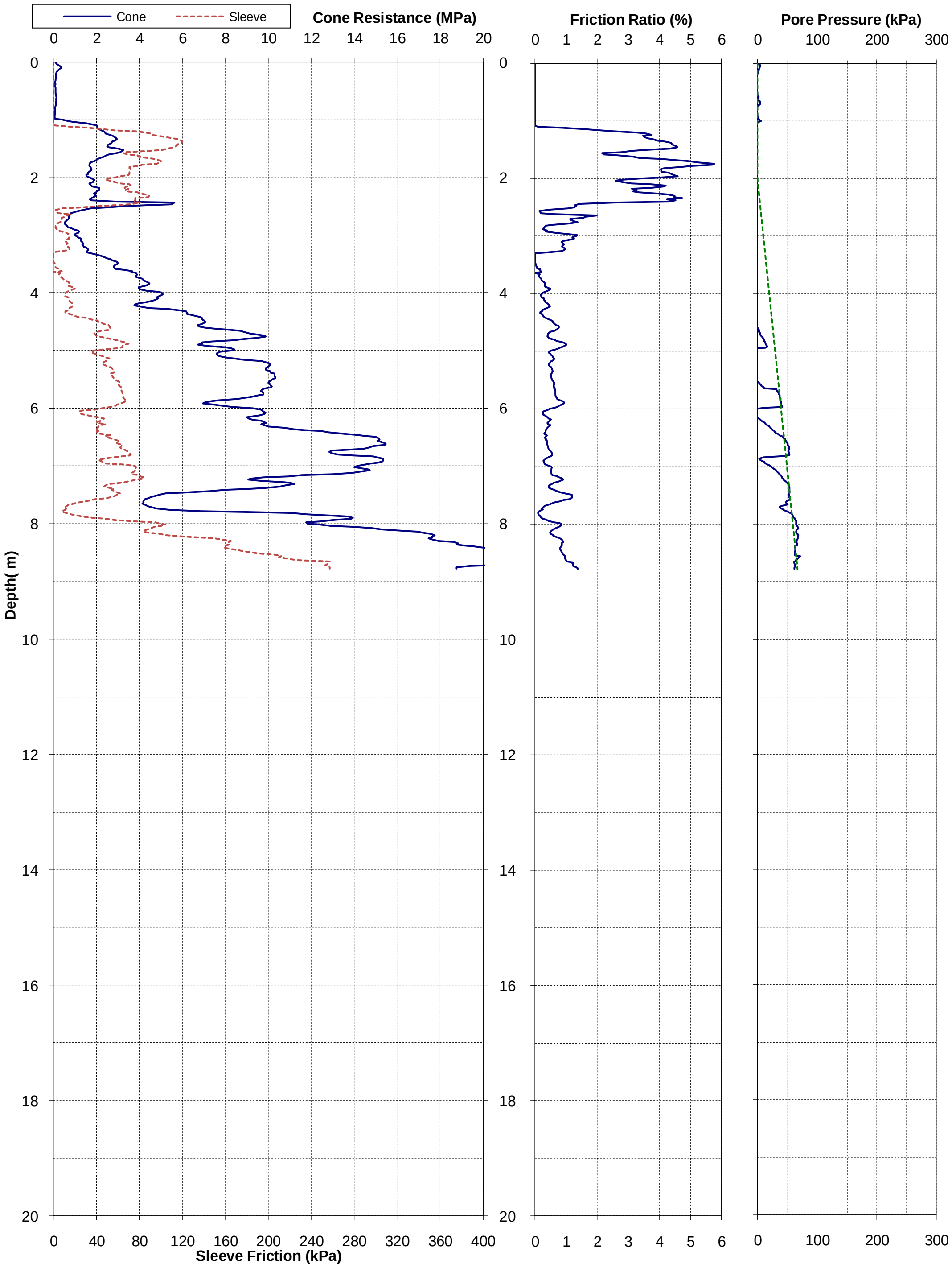
Key

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

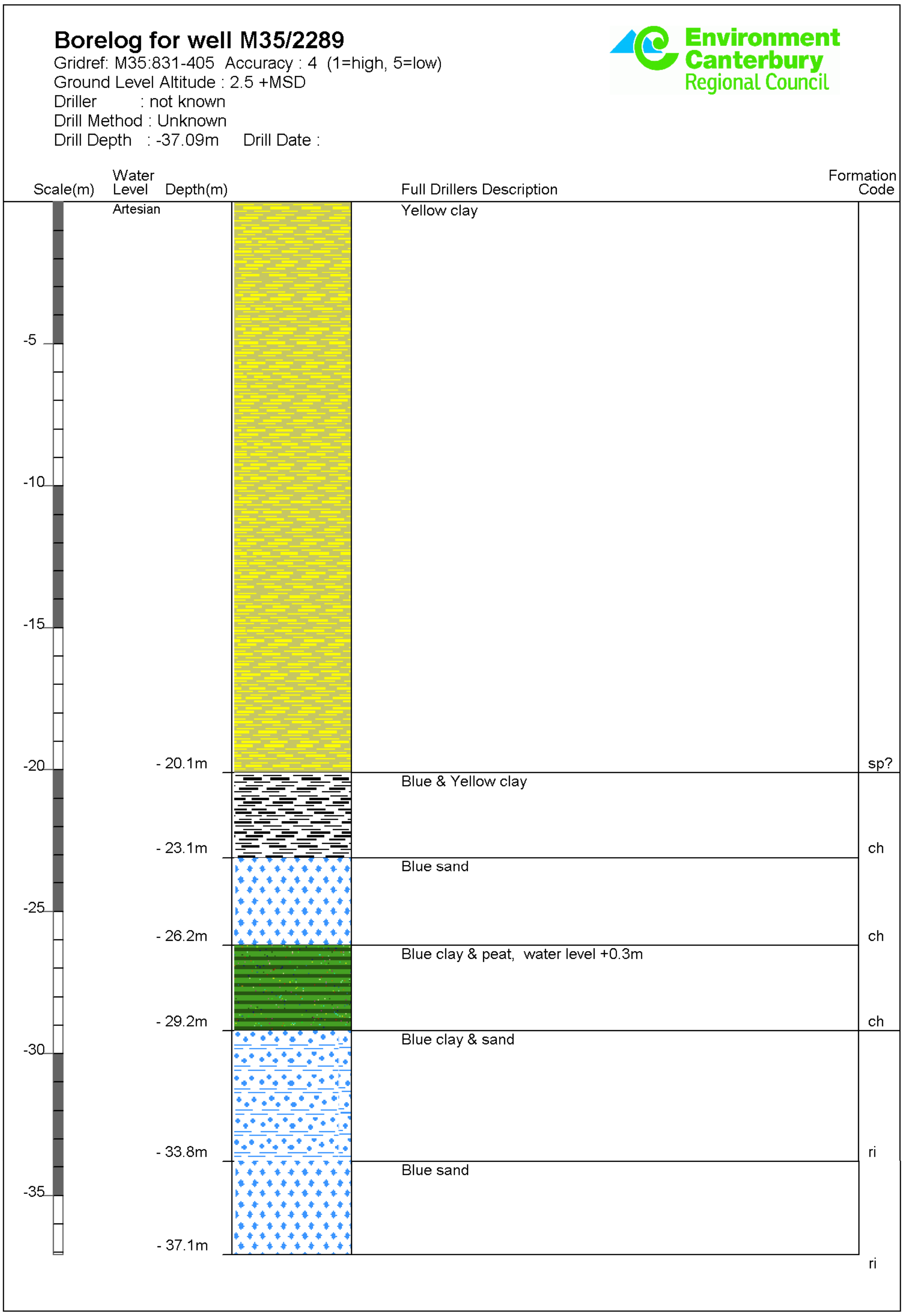
The swamps and previous creeks/rivers from 1856 have been overlayed onto a map of Christchurch in 2012

Appendix B – Existing ground investigation logs

Project:	Christchurch 2011 Earthquake - EQC Ground Investigations			**Page:** 1 of 1	**CPT-WTM-07**
Test Date:	18-May-2011	**Location:**	Waltham	**Operator:**	Geotech
Pre-Drill:	1.2m	**Assumed GWL:**	2mBGL	**Located By:**	Survey GPS
Position:	2482895.9mE	5740463.2mN	2.706mRL	**Coord. System:**	NZMG & MSL
Other Tests:				**Comments:**	



T+T Ref: 52000.3000 Printed: 30/08/2011 10:36 a.m. Template: CPT Graph Template v0.41.xls



Borelog for well M35/2289

Gridref: M35:831-405 Accuracy : 4 (1=high, 5=low)
Ground Level Altitude : 2.5 +MSD
Driller : not known
Drill Method : Unknown
Drill Depth : -37.09m Drill Date :

Environment Canterbury Regional Council

Water Level	Depth(m)	Full Drillers Description	Formation Code
Artesian	- 20.1m	Yellow clay	sp?
	- 23.1m	Blue & Yellow clay	ch
	- 26.2m	Blue sand	ch
	- 29.2m	Blue clay & peat, water level +0.3m	ch
	- 33.8m	Blue clay & sand	ri
	- 37.1m	Blue sand	ri

TONKIN & TAYLOR LTD

BOREHOLE LOG

BOREHOLE No: WTM 03
Hole Location: 13 Frederick St

SHEET 1 OF 5

PROJECT: CHRISTCHURCH 2011 EARTHQUAKE
LOCATION: WALTHAM
JOB No: 52000.3200

CO-ORDINATES 5740460.62 mN
2482738.82 mE
R.L. 3.11 m
DATUM NZMG

DRILL TYPE: Rotary
DRILL METHOD: Triple Tube
DRILL FLUID: N/A

HOLE STARTED: 19/5/11
HOLE FINISHED: 19/5/11
DRILLED BY: McNeill
LOGGED BY: RKH
CHECKED: BMcD

GEOLOGICAL: GEOLOGICAL UNIT, GENERIC NAME, ORIGIN, MINERAL COMPOSITION.

ENGINEERING DESCRIPTION: SOIL DESCRIPTION: Soil type, minor components, plasticity or particle size, colour. ROCK DESCRIPTION: Substance: Rock type, particle size, colour, minor components. Defects: Type, inclination, thickness, roughness, filling.

Columns: FLUID LOSS, WATER, CORE RECOVERY (%), METHOD, CASING, TESTS, SAMPLES, R.L. (m), DEPTH (m), GRAPHIC LOG, CLASSIFICATION SYMBOL, MOISTURE CONDITION / WEATHERING, STRENGTH/DENSITY CLASSIFICATION, SHEAR STRENGTH (kPa) 10 25 50 100 200, COMPRESSIVE STRENGTH (MPa) 1 5 20 50 100 250, DEFECT SPACING (mm) 50 250 1000 2000

DEPTH (m)	GEOLOGICAL	CORE RECOVERY (%)	METHOD	TESTS	SAMPLES	CLASSIFICATION SYMBOL	MOISTURE CONDITION	STRENGTH/DENSITY CLASSIFICATION	SOIL DESCRIPTION
0.0	YALDHURST MEMBER OF THE SPRINGSTON FORMATION (ALLUVIAL)	60	HQTT			MO	M	F	Organic SILT and SAND, brown, firm, moist.
0.2						ML	W	F	SILT, brownish grey. Firm, wet, low plasticity.
0.9									0.9m to 1.5m no recovery
1.5			SPT	1/1/1/1 N=4					
1.95		100	HQTT						
2.5									- becoming grey
3.0			SPT	0/1/0/1 N=2				S	- becoming soft
3.45		73	HQTT						
4.0				*FC	B				
4.1									4.1m to 4.5m no recovery
4.5			SPT	4/5/6/6 N=21		ML	M	F	Sandy SILT, grey. Firm, moist, non plastic.

R.L. (m)	DEPTH (m)
3.0	
	0.5
2.5	
	1.0
2.0	
	1.5
1.5	
	2.0
1.0	
	2.5
0.5	
	3.0
0.0	
	3.5
-0.5	
	4.0
-1.0	
	4.5
-1.5	
	5

T+T DATATEMPLATE.GDT eek

BORELOG 650494.000 BOREHOLE LOGS.GPJ 6/10/11

TONKIN & TAYLOR LTD

BOREHOLE LOG

BOREHOLE No: WTM 03
Hole Location: 13 Frederick St

SHEET 2 OF 5

PROJECT: CHRISTCHURCH 2011 EARTHQUAKE
LOCATION: WALTHAM
JOB No: 52000.3200

CO-ORDINATES 5740460.62 mN
2482738.82 mE
R.L. 3.11 m
DATUM NZMG

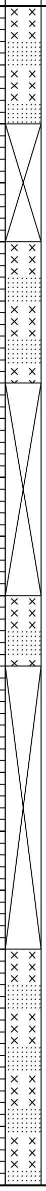
DRILL TYPE: Rotary
DRILL METHOD: Triple Tube
DRILL FLUID: N/A

HOLE STARTED: 19/5/11
HOLE FINISHED: 19/5/11
DRILLED BY: McNeill
LOGGED BY: RKH
CHECKED: BMcD

GEOLOGICAL: GEOLOGICAL UNIT, GENERIC NAME, ORIGIN, MINERAL COMPOSITION.

ENGINEERING DESCRIPTION: SOIL DESCRIPTION — Soil type, minor components, plasticity or particle size, colour. ROCK DESCRIPTION — Substance: Rock type, particle size, colour, minor components. Defects: Type, inclination, thickness, roughness, filling.

Geological unit: YALDHURST MEMBER OF THE SPRINGSTON FORMATION (ALLUVIAL)



CORE RECOVERY (%)	METHOD	TESTS	STRENGTH/DENSITY CLASSIFICATION	CLASSIFICATION SYMBOL	MOISTURE CONDITION	SOIL DESCRIPTION
73	HQTT		MD	SP	S	Fine SAND with widely spaced silt laminae, grey. Medium dense, saturated. 5.5m to 6m no recovery
	SPT	2/2/3/3 N=10				
40	HQTT					6.6m to 7.5m no recovery
	SPT	1/1/2/3 N=7	L			- becoming loose 7.8m to 9.0m no recovery
20	HQTT					
	SPT	3/6/8/15 N=32	D			- becoming dense
100	HQTT					

DEPTH (m): 5.5, 6.0, 6.5, 7.0, 7.5, 8.0, 8.5, 9.0, 9.5, 10
R.L. (m): -2.0, -2.5, -3.0, -3.5, -4.0, -4.5, -5.0, -5.5, -6.0, -6.5

T+T DATATEMPLATE.GDT eek

BORELOG 650494.000 BOREHOLE LOGS.GPJ 6/10/11

TONKIN & TAYLOR LTD

BOREHOLE LOG

BOREHOLE No: WTM 03
Hole Location: 13 Frederick St

SHEET 3 OF 5

PROJECT: CHRISTCHURCH 2011 EARTHQUAKE
LOCATION: WALTHAM
JOB No: 52000.3200

CO-ORDINATES 5740460.62 mN
2482738.82 mE
R.L. 3.11 m
DATUM NZMG

DRILL TYPE: Rotary
DRILL METHOD: Triple Tube
DRILL FLUID: N/A

HOLE STARTED: 19/5/11
HOLE FINISHED: 19/5/11
DRILLED BY: McNeill
LOGGED BY: RKH
CHECKED: BMcD

GEOLOGICAL UNIT, GENERIC NAME, ORIGIN, MINERAL COMPOSITION.	CORE RECOVERY (%)	METHOD	TESTS	R.L. (m)	DEPTH (m)	CLASSIFICATION SYMBOL	MOISTURE CONDITION	STRENGTH/DENSITY CLASSIFICATION	SOIL DESCRIPTION
YALDHURST MEMBER OF THE SPRINGSTON FORMATION (ALLUVIAL)				-7.0	10.0	SP	S	D	Fine SAND with widely spaced silt laminae, grey. Medium dense, saturated.
		SPT	6/6/7/9 N=28	-7.5	10.5			MD	- becoming medium dense
	100	HQTT		-8.0 / -8.5	11.0 / 11.5				
		SPT	2/1/2/1/1/2 N=6	-9.0	12.0			L	- becoming loose
	100	HQTT		-9.5 / -10.0	12.5 / 13.0				
	100	HQTT	No SPT reading taken	-10.5 / -11.0 / -11.5	13.5 / 14.0 / 14.5 / 15				

T+T DATATEMPLATE.GDT eek

BORELOG 650494.000 BOREHOLE LOGS.GPJ 6/10/11

TONKIN & TAYLOR LTD

BOREHOLE LOG

BOREHOLE No: WTM 03
Hole Location: 13 Frederick St

SHEET 4 OF 5

PROJECT: CHRISTCHURCH 2011 EARTHQUAKE
LOCATION: WALTHAM
JOB No: 52000.3200

CO-ORDINATES 5740460.62 mN
2482738.82 mE
R.L. 3.11 m
DATUM NZMG

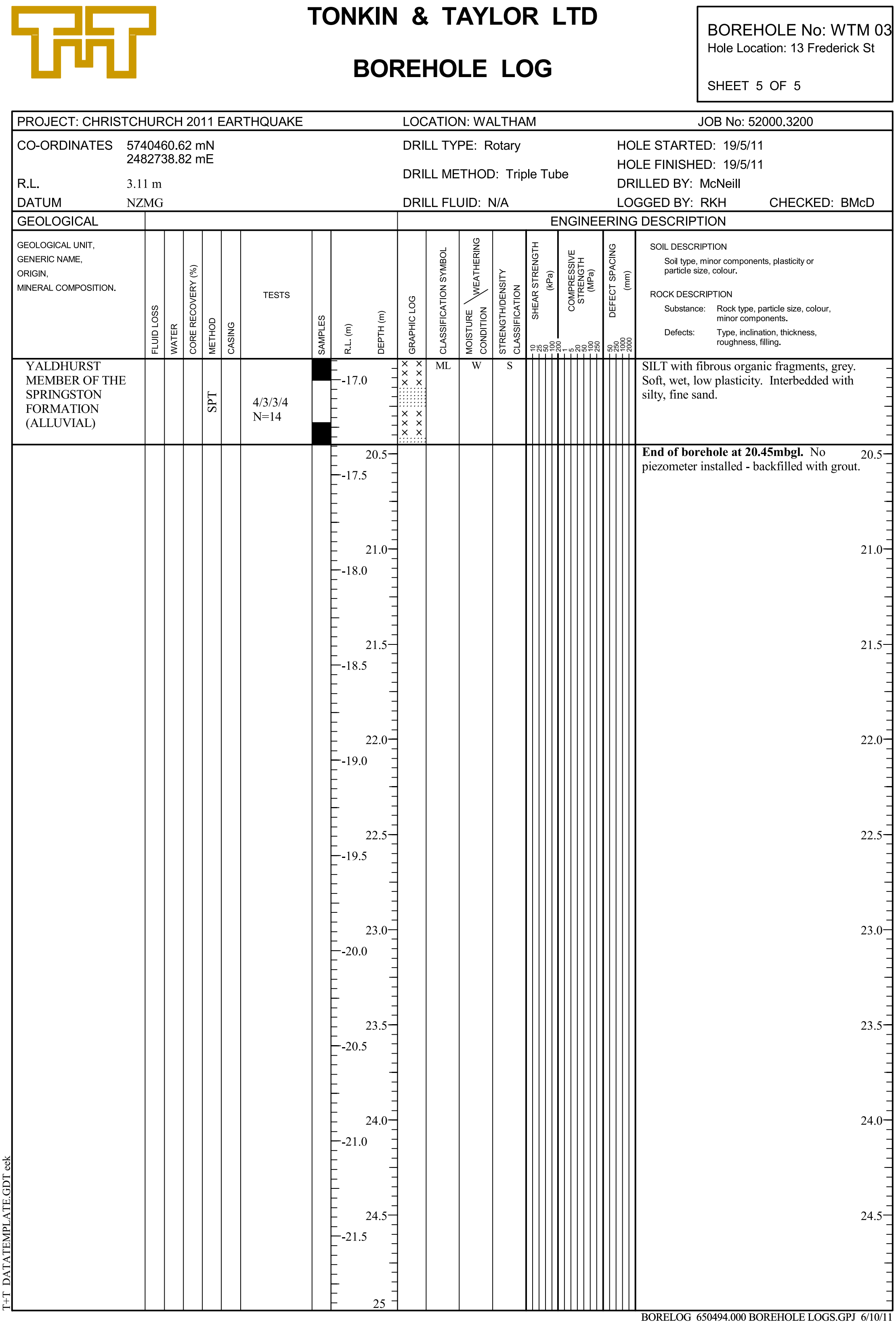
DRILL TYPE: Rotary
DRILL METHOD: Triple Tube
DRILL FLUID: N/A

HOLE STARTED: 19/5/11
HOLE FINISHED: 19/5/11
DRILLED BY: McNeill
LOGGED BY: RKH
CHECKED: BMcD

GEOLOGICAL										ENGINEERING DESCRIPTION							
GEOLOGICAL UNIT, GENERIC NAME, ORIGIN, MINERAL COMPOSITION.	FLUID LOSS	WATER	CORE RECOVERY (%)	METHOD	CASING	TESTS	SAMPLES	R.L. (m)	DEPTH (m)	GRAPHIC LOG	CLASSIFICATION SYMBOL	MOISTURE CONDITION / WEATHERING	STRENGTH/DENSITY CLASSIFICATION	SHEAR STRENGTH (kPa) 10 25 50 100 200	COMPRESSIVE STRENGTH (MPa) 1 5 20 50 100 250	DEFECT SPACING (mm) 50 250 1000 2000	SOIL DESCRIPTION Soil type, minor components, plasticity or particle size, colour. ROCK DESCRIPTION Substance: Rock type, particle size, colour, minor components. Defects: Type, inclination, thickness, roughness, filling.
YALDHURST MEMBER OF THE SPRINGSTON FORMATION (ALLUVIAL)			100	HQTT		No SPT reading taken		-12.0			SP	S	L				Fine SAND with widely spaced silt laminae, grey. Medium dense, saturated.
						✱PSD WS	B	-12.5	15.5								
								-13.0	16.0								
			66			No SPT reading taken		-13.5	16.5								
								-14.0	17.0								
								-14.5	17.5								17.5m to 18.0 no recovery
				SPT		✱FC 2/2/3/3 N=10	B	-15.0	18.0		ML	W	St				SILT with fibrous organic fragments, grey. Stiff, wet, low plasticity. Interbedded with silty, fine sand.
			100	HQTT				-15.5	18.5								
								-16.0	19.0								
								-16.5	19.5								
									20								

T+T DATATEMPLATE.GDT eek

BORELOG 650494.000 BOREHOLE LOGS.GPJ 6/10/11



TONKIN & TAYLOR LTD

BOREHOLE LOG

BOREHOLE No: WTM 03
Hole Location: 13 Frederick St

SHEET 5 OF 5

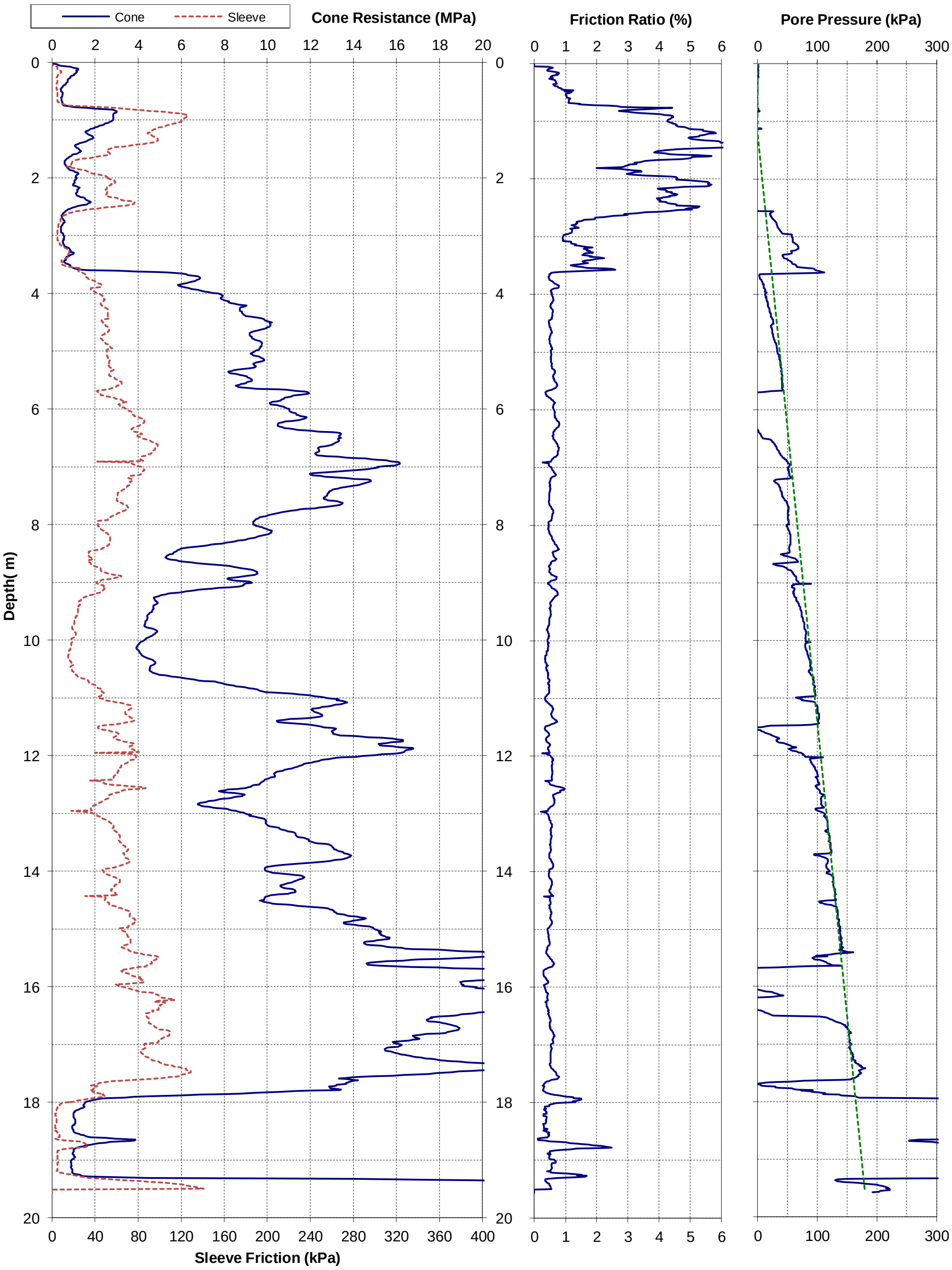
PROJECT: CHRISTCHURCH 2011 EARTHQUAKE
LOCATION: WALTHAM
JOB No: 52000.3200

CO-ORDINATES 5740460.62 mN 2482738.82 mE
R.L. 3.11 m
DATUM NZMG
DRILL TYPE: Rotary
DRILL METHOD: Triple Tube
DRILL FLUID: N/A
HOLE STARTED: 19/5/11
HOLE FINISHED: 19/5/11
DRILLED BY: McNeill
LOGGED BY: RKH
CHECKED: BMcD

GEOLOGICAL UNIT, GENERIC NAME, ORIGIN, MINERAL COMPOSITION.	FLUID LOSS	WATER	CORE RECOVERY (%)	METHOD	CASING	TESTS	SAMPLES	R.L. (m)	DEPTH (m)	GRAPHIC LOG	CLASSIFICATION SYMBOL	MOISTURE CONDITION / WEATHERING	STRENGTH/DENSITY CLASSIFICATION	SHEAR STRENGTH (kPa)	COMPRESSIVE STRENGTH (MPa)	DEFECT SPACING (mm)	SOIL DESCRIPTION Soil type, minor components, plasticity or particle size, colour. ROCK DESCRIPTION Substance: Rock type, particle size, colour, minor components. Defects: Type, inclination, thickness, roughness, filling.
YALDHURST MEMBER OF THE SPRINGSTON FORMATION (ALLUVIAL)				SPT		4/3/3/4 N=14		-17.0			ML	W	S				SILT with fibrous organic fragments, grey. Soft, wet, low plasticity. Interbedded with silty, fine sand.
								-17.5	20.5								**End of borehole at 20.45mbgl.** No piezometer installed - backfilled with grout.

Appendix C – Geotechnical Investigation Summary

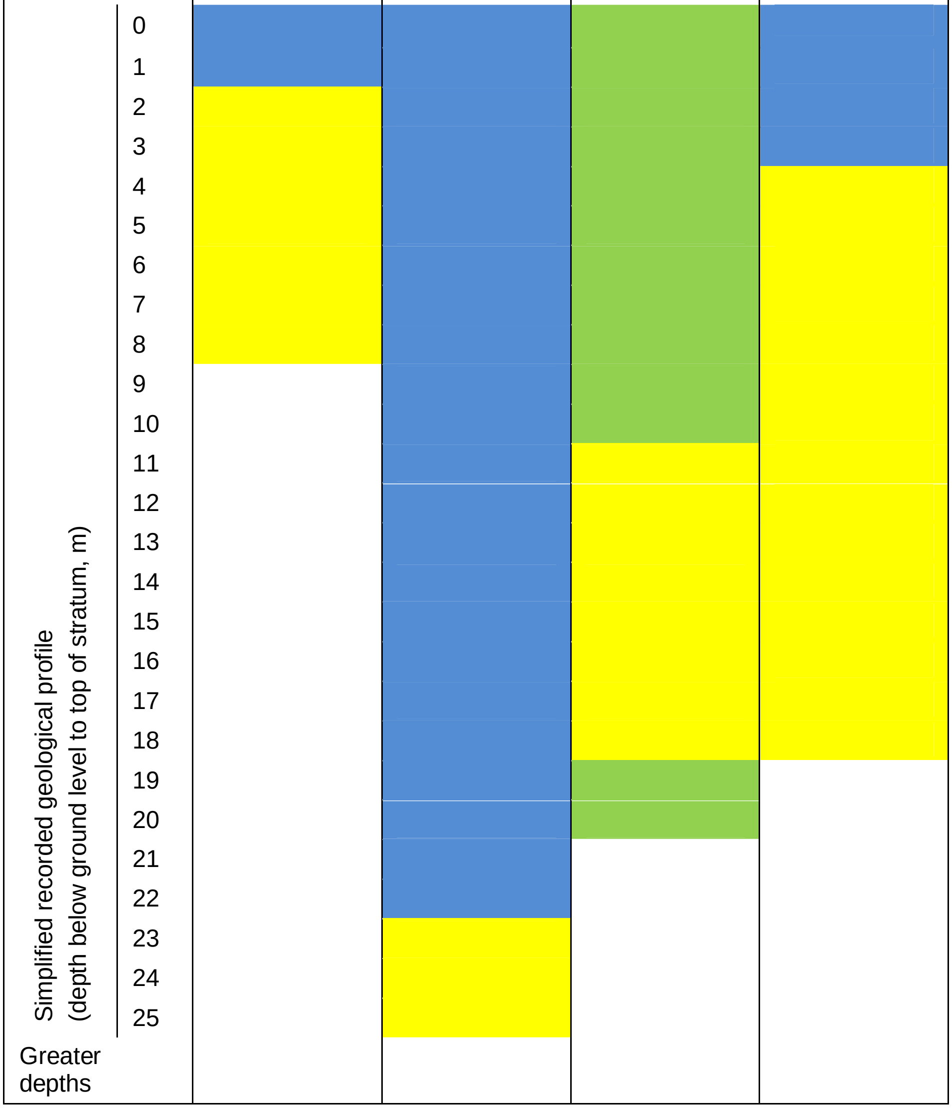
Project:	Christchurch 2011 Earthquake - EQC Ground Investigations			**Page:**	1 of 1	**CPT-LWD-29**
Test Date:	20-May-2011	**Location:**	Linwood	**Operator:**	Opus	
Pre-Drill:	1.2m	**Assumed GWL:**	1.2mBGL	**Located By:**	Survey GPS	
Position:	2483138.2mE	5740801.4mN	2.32mRL	**Coord. System:**	NZMG & MSL	
Other Tests:	Seismic downhole			**Comments:**		



T+T Ref: 52000.3000 Printed: 7/10/2011 10:51 a.m. Template: CPT Graph Template v0.41.xls

▪ Table 1 Summary of most relevant investigation data

ID	**1**	**2**	**3**	**4**
Type *	CPT	BH	BH	CPT
Ref	CPT-WTM-07	M35/2289	T&T WTM03	CPT-LWD-29
Depth (m)	9	37	20.5	19
Distance from site (m)	171	197	265	277
Ground water level (mBGL)	2	N/A	N/A	2



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

🟪	Sensitive or organic clay/silt	🟦	Clay to silty clay	▨	Clayey silt to silt	🟩	Silty sand to silt
▨	Clayey sand	🟨	Sand	🟧	Gravelly sand or gravel		

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