CLIENTS | PEOPLE | PERFORMANCE

Memorial Park Cemetery Shed
PRK 0880-BLDG-002 EQ2

Detailed Engineering Evaluation
Qualitative Report
Version FINAL

31 Ruru Road
Bromley

INFRASTRUCTURE | MINING & INDUSTRY | DEFENCE | PROPERTY & BUILDINGS | ENVIRONMENT

Memorial Park Cemetery Shed
PRK 0880-BLDG-002 EQ2

Detailed Engineering Evaluation
Qualitative Report
Version FINAL

31 Ruru Road
Bromley

Christchurch City Council

Prepared By
Chris Wells

Reviewed By
Razel Ramilo

Date
14 March 2013

Contents

Qualitative Report Summary 1

1. Background 3

2. Compliance 4

2.1 Canterbury Earthquake Recovery Authority (CERA) 4
2.2 Building Act 5
2.3 Christchurch City Council Policy 6
2.4 Building Code 6

3. Earthquake Resistance Standards 7

4. Building Description 9

4.1 General 9
4.2 Gravity Load Resisting System 10
4.3 Lateral Load Resisting System 10

5. Assessment 11

6. Damage Assessment 12

6.1 Surrounding Buildings 12
6.2 Residual Displacements and General Observations 12
6.3 Ground Damage 12

7. Critical Structural Weakness 13

7.1 Short Columns 13
7.2 Lift Shaft 13
7.3 Roof 13
7.4 Staircases 13
7.5 Site Characteristics 13
7.6 Plan Irregularity 13
7.7 Vertical irregularity 13
7.8 Pounding effect 13

8. Geotechnical Consideration 14

8.1.1 Site Description 14
8.1.2 Published Information on Ground Conditions 14

8.1.3 Seismicity 16
8.1.4 Slope Failure and/or Rockfall Potential 17
8.1.5 Liquefaction Potential 17
8.1.6 Conclusions & Recommendations 17

9. Survey 18

10. Initial Capacity Assessment 19
10.1 % NBS Assessment 19
10.2 Seismic Parameters 19
10.3 Expected Structural Ductility Factor 19
10.4 Discussion of Results 19
10.5 Occupancy 20

11. Initial Conclusions 21

12. Recommendations 22

13. Limitations 23
13.1 General 23
13.2 Geotechnical Limitations 23

Table Index

Table 1 %NBS compared to relative risk of failure 8
Table 2 ECan Borehole Summary 14
Table 3 EQC Geotechnical Investigation Summary Table 15
Table 4 Summary of Known Active Faults' 16

Figure Index

Figure 1 NZSEE Risk Classifications Extracted from table 2.2 of the NZSEE 2006 AISPBE 7
Figure 2 Plan Sketch Showing Key Structural Elements 9
Figure 3 Post February 2011 Earthquake Aerial Photography 15

Appendices

A Photographs

B CERA Building Evaluation Form

Qualitative Report Summary

Memorial Park Cemetery Shed

PRK 0880 BLDG 002 EQ2

Detailed Engineering Evaluation

Qualitative Report - SUMMARY

Version FINAL

31 Ruru Road, Bromley, Christchurch

Background

This is a summary of the Qualitative report for the building structure, and is based in part on the Detailed Engineering Evaluation Procedure document (draft) issued by the Structural Advisory Group on 19 July 2011, visual inspections on 19^{th} July 2012.

Building Description

The Building is located within Memorial Park Cemetery at 31 Ruru Road. It is isolated with the nearest residential properties 25 meters to the West. The building is a single story unmanned pump shed used for pump shelter and valve operations. It is estimated to have been constructed in 1970, given the building materials used and construction date of neighbouring buildings. It appears that no alterations have been made to the building since construction.

The roof structure is built from timber joists spanning in the transverse direction with approximately 5° mono-pitch roof that provides the link between the roof and walls. The roof is clad with corrugated metal sheeting.

20 series concrete masonry form the external perimeter walls. The building's foundation was unable to be determined however, it is assumed that the foundation consists of concrete strip footings to the external perimeter with a concrete slab founded on hardfill.

The building is approximately 3.8m long, 2.4m wide and 2.6m in height. The overall footprint of the building is approximately $9.12m^2$.

Key Damage Observed

No damage was observed to the structure.

Critical Structural Weaknesses

No potential critical structural weaknesses were observed.

Indicative Building Strength (from IEP and CSW assessment)

Based on the information available, and using the NZSEE Initial Evaluation Procedure, the baseline capacity (excluding critical structural weaknesses and earthquake damage) of the building has been assessed to be in the order of 41% NBS.

There was no damage nor critical structural weaknesses identified in our visual inspection; consequently have not reduced the baseline %NBS.

The building has therefore been assessed to have a seismic capacity in the order of 41% NBS and is potentially of Earthquake Risk.

Recommendations

The building has not been assessed as being Earthquake Prone. As a result, the building can remain occupied, as per CCC’s policy. However, GHD recommends a quantitative assessment of the building be undertaken to confirm the seismic capacity.

1. Background

GHD has been engaged by the Christchurch City Council (CCC) to undertake a detailed engineering evaluation of the Memorial Park Cemetery Shed.

This report is a Qualitative Assessment of the building structure, and is based in part on the Detailed Engineering Evaluation Procedure document (draft) issued by the Structural Advisory Group on 19 July 2011.

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).

At the time of this report, no intrusive site investigation, detailed analysis, or modelling of the building structure had been carried out. As there are no available drawings, the building's evaluation is based on the visual inspection carried out on site. The date of construction of the building is estimated based on the building materials used and age of other buildings in the vicinity. The results of the evaluation, however, may change should the exact construction date is made known.

2. 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.

2.1 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

2.2 Building Act

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

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).

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.

2.2.1 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.

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.

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.

Section 131 – Earthquake Prone Building Policy

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

2.3 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;
- 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.

2.4 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:

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

3. 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 1 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 1 NZSEE Risk Classifications Extracted from table 2.2 of the NZSEE 2006 AISPBE

Table 1 compares the percentage NBS to the relative risk of the building failing in a seismic event with a 10% risk of exceedance in 50 years (i.e. 0.2% in the next year). It is noted that the current seismic risk in Christchurch results in a 6% risk of exceedance in the next year.

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

Table 1 %NBS compared to relative risk of failure

4. Building Description

4.1 General

The Building is located within Memorial Park Cemetery at 31 Ruru Road. It is isolated with the nearest residential properties 25 meters to the West. The building is a single story unmanned pump shed used for pump shelter and valve operations. It is estimated to have been constructed in 1970, given the building materials used and construction date of neighbouring buildings. It appears that no alterations have been made to the building since construction.

The roof structure is built from timber joists spanning in the transverse direction with approximately 5° mono-pitch roof that provides the link between the roof and walls. The roof is clad with corrugated metal sheeting.

20 series concrete masonry units form the external perimeter walls. The building's foundation was unable to be determined however, it is assumed that the foundation consists of concrete strip footings to the external perimeter with a concrete slab founded on hardfill.

The building is approximately 3.8m long, 2.4m wide and 2.6m in height. The overall footprint of the building is approximately 9.12m². A sketch of the key structural elements are shown in Figure 2.

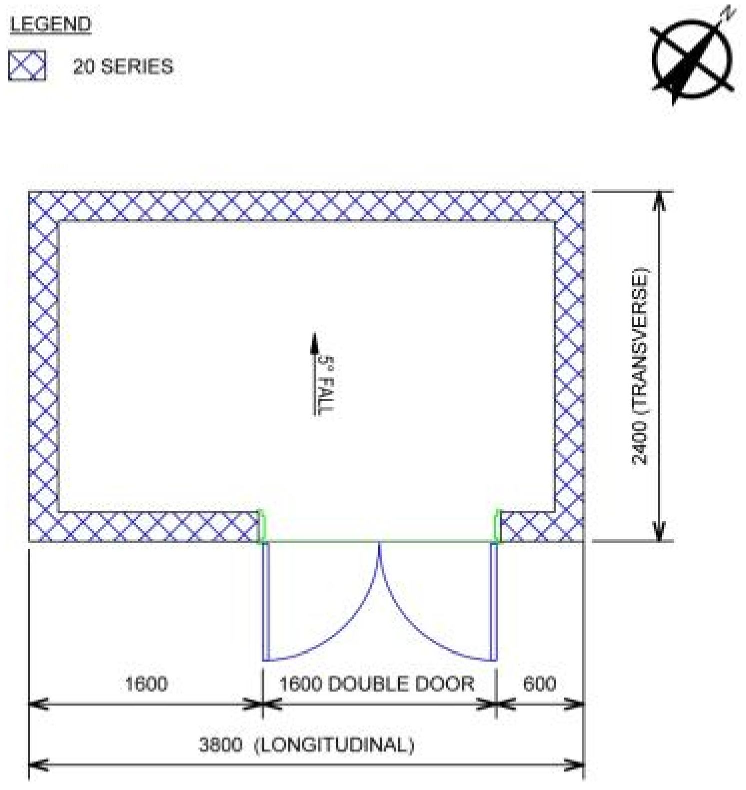

Figure 2 Plan Sketch Showing Key Structural Elements

4.2 Gravity Load Resisting System

Gravity roof loads are carried by timber joists spanning in the transverse direction. These loads are then transferred to the concrete masonry walls down to the strip footings and finally into the ground.

4.3 Lateral Load Resisting System

The seismic demand of the building is resisted by the concrete masonry walls in both the transverse and longitudinal directions.

Nominal diaphragm action produced by the roof allows the lateral roof loads to be transferred from the roof joists, via the top plate into the concrete masonry walls. The panel action produced in these walls transfers the seismic loads into the foundation. The loads then pass through the foundation and into the ground.

5. Assessment

An inspection of the building was undertaken on the 19th July 2012. Both the interior and exterior of the building were inspected. The main structural components of the roof of the building were all able to be viewed. No inspection of the foundation of the structure was able to be undertaken.

The inspection consisted of scrutinising the building to determine the structural systems and likely behaviour of the building during an earthquake. The site was assessed for damage, including examination of the ground conditions, checking for damage in areas where damage would be expected for the type of structure and noting general damage observed throughout the building in both structural and non-structural elements.

The %NBS score determined for this building has been based on the IEP procedure described by the NZSEE and based on the information obtained from visual inspection of the building. As there are no available drawings, the year of construction of the building was estimated based on the building materials used and age of the neighbouring buildings.

6. Damage Assessment

6.1 Surrounding Buildings

No damage to surrounding buildings was observed during the site inspection.

6.2 Residual Displacements and General Observations

No residual displacements of the structure were noticed during the inspection of the building.

6.3 Ground Damage

During the site inspection undertaken on 19th of July, there was no evidence of ground damage on the property or surrounding neighbour's land.

7. Critical Structural Weakness

7.1 Short Columns

The building does not contain short columns.

7.2 Lift Shaft

The building does not contain a lift shaft.

7.3 Roof

As the structure is relatively small only nominal diaphragm action is required from the roof.

7.4 Staircases

The building does not contain a staircase.

7.5 Site Characteristics

Following the geotechnical appraisal, it was found that the site has a minor to moderate liquefaction potential. For the purposes of the IEP assessment and determination of the %NBS score of the building, the effects of soil liquefaction on the performance of the building is considered 'insignificant' in accordance with the NZSEE guidelines.

7.6 Plan Irregularity

In the longitudinal direction, the lateral loads are resisted by the concrete masonry walls located at the front and rear of the building. The door opening in the south eastern wall results in a difference in stiffness between the opposing sides. Under strong lateral loading this may produce some torsional effects; however, due to the close spacing of the walls and size of the building this is not regarded as a critical structural weakness.

7.7 Vertical irregularity

This building does not qualify as vertically irregular according to the NZSEE guidelines.

7.8 Pounding effect

This building has no potential for pounding.

8. Geotechnical Consideration

8.1.1 Site Description

The site is situated in the suburb of Bromley, eastern Christchurch. The site is relatively flat at approximately 10m above mean sea level. It is approximately 2.5km west of Avon River, 2.5km north of the Heathcote River, and 4km west of the coast (Pegasus Bay).

8.1.2 Published Information on Ground Conditions

8.1.2.1 Published Geology

The geological map of the area[1] indicates that the site is underlain by:

- Christchurch Formation, dominantly sand of fixed and semi-fixed dunes and beaches, Holocene in age.

Due to the low-lying location of the site, shallow ground water table is anticipated.

8.1.2.2 Environment Canterbury Logs

Information from Environment Canterbury (ECan) indicates that there are thirteen boreholes located within 200m of the site. There are three boreholes with significant information summarised in the table below (see Table 2).

These indicate that the area is underlain by layers of sand and clay with intermediate layers of shingle.

Table 2 ECan Borehole Summary

Bore Name	Log Depth	Groundwater	Distance & Direction from Site
M35-16044-WC	2.9 m	Not indicated	170m NE
M35-1869-WC	60.29 m	0.28 m bgl	150m W
M35-1898-WC	90.5 m	0.6m bgl	170m SW

It should be noted that the boreholes were sunk for groundwater extraction and not for geotechnical purposes. Therefore, the amount of material recovered and available for interpretation and recording will have been variable at best and may not be representative. The logs have been written by the well driller and not a geotechnical professional or to a standard. In addition strength data is not recorded.

8.1.2.3 EQC Geotechnical Investigations

The Earthquake Commission has undertaken geotechnical testing in the area of the site. Information pertaining to this investigation is included in the Tonkin & Taylor Report for Bromley[2]. One investigation points were undertaken within 300m of the site, as summarised below in Table 3.

[1] Forsyth, P. J., Barrell, D. J. A., & Jongens, R. (2008): *Geology of the Christchurch Urban Area*. Institute of Geological and Nuclear Sciences 1:250,000 Geological Map 16. IGNS Limited: Lower Hutt.

[2] Tonkin & Taylor Ltd., 2011: Christchurch Earthquake Recovery, *Geotechnical Factual Report, Bromley.*

Table 3 EQC Geotechnical Investigation Summary Table

Bore Name	Orientation from Site	Depth (m bgl)	Log Summary	
CPT-BRY-21	50m SW	0-9.56	Sand to Silty Sand	(GWL 2m bgl)

Initial observations of the CPT result indicate the site is underlain by sand to Silty sand.

8.1.2.4 CERA Land Zoning

Canterbury Earthquake Recovery Authority (CERA) has indicated the site is situated within the Green Zone, indicating that repair and rebuild may take place.

Land in the CERA Green Zone has been divided into three technical categories (TC). These categories describe how the land in expected to perform in future earthquakes.

The site is within an area classified as “Not Applicable” as it is a non-residential property. However, adjacent properties are classified as Green Zone TC2 (yellow) indicating that minor to moderate land damage from liquefaction is possible in future significant earthquakes.

8.1.2.5 Post February Aerial Photography

Aerial photography taken following the 22 February 2011 earthquake shows signs of liquefaction close to the site, as shown in Figure 3**.**

Figure 3 Post February 2011 Earthquake Aerial Photography[3]

[3] Aerial Photography Supplied by Koordinates sourced from http://koordinates.com/layer/3185-christchurch-post-earthquake-aerial-photos-24-feb-2011/

8.1.2.6 Summary of Ground Conditions

From the information presented above, the ground conditions underlying the site are anticipated to comprise multiple strata of sand and silty sand.

8.1.3 Seismicity

8.1.3.1 Nearby Faults

There are many faults in the Canterbury region, however only those considered most likely to have an adverse effect on the site are detailed below.

Table 4 Summary of Known Active Faults[4,5]

Known Active Fault	Distance from Site	Direction from Site	Max Likely Magnitude	Avg Recurrence Interval
Alpine Fault	120 km	NW	~8.3	~300 years
Greendale (2010) Fault	25 km	W	7.1	~15,000 years
Hope Fault	105 km	NW	7.2~7.5	120~200 years
Kelly Fault	105 km	NW	7.2	150 years
Porter Pass Fault	65 km	NW	7.0	1100 years

The recent earthquakes since 4 September 2010 have identified the presence of a previously unmapped active fault system underneath the Canterbury Plains, including Christchurch City, and the Port Hills. Research and published information on this system is in development and not generally available. Average recurrence intervals are yet to be estimated.

8.1.3.2 Ground Shaking Hazard

New Zealand Standard NZS 1170.5:2004 quantifies the Seismic Hazard factor for Christchurch as 0.30, being in a moderate to high earthquake zone. This value has been provisionally upgraded recently (from 0.22) to reflect the seismicity hazard observed in the earthquakes since 4 September 2010.

The recent seismic activity has produced earthquakes of Magnitude-6.3 with peak ground accelerations (PGA) up to twice the acceleration due to gravity (2g) in some parts of the city. This has resulted in widespread liquefaction throughout Christchurch.

In addition, anticipation of the presence of sand and silt deposits beneath the site, a 475-year PGA (peak ground acceleration) of ~0.4 (Stirling et al, 2002[4]), and bedrock anticipated to be in excess of 500m deep, ground shaking is likely to be moderate to high.

[4] Stirling, M.W, McVerry, G.H, and Berryman K.R. (2002): "A New Seismic Hazard Model for New Zealand", *Bulletin of the Seismological Society of America*, Vol. 92 No. 5, June 2002, pp. 1878-1903.

[5] GNS Active Faults Database, http://maps.gns.cri.nz/website/af/viewer

8.1.4 Slope Failure and/or Rockfall Potential

Given the site's location in Bromley, global slope instability is considered negligible. However, any localised retaining structures or embankments should be further investigated to determine the site-specific slope instability potential.

8.1.5 Liquefaction Potential

The site is considered to be minor to moderately susceptible to liquefaction, due to the following reasons:

- Signs of minor to moderate liquefaction close to the site (evidence from the post-earthquake aerial photography);
- Anticipated presence of sand and silt deposits beneath the site; and,
- Anticipated shallow ground water table.

Due to the limited subsoil information, further investigation is recommended to better determine subsoil conditions. From this, a more comprehensive liquefaction assessment could be undertaken.

8.1.6 Conclusions & Recommendations

This assessment is based on a review of the geology and existing ground investigation information, and observations from the Christchurch earthquakes since 4 September 2010.

The site appears to be situated on sand and silt deposits. Associated with this the site also has a minor to moderate liquefaction potential, in particular where sands and/or silts are present.

A soil class of **D** (in accordance with NZS 1170.5:2004) should be adopted for the site.

Should a more comprehensive liquefaction and/or ground condition assessment be required, it is recommended that intrusive investigation be conducted.

9. Survey

No level or verticality surveys have been undertaken for this building at this stage as indicated by Christchurch City Council guidelines.

10. Initial Capacity Assessment

10.1 % NBS Assessment

The building's capacity was assessed using the Initial Evaluation Procedure based on the information available. The building's capacity is expressed as a percentage of New Building Standard (%NBS) as shown below. This capacity is subject to confirmation by a more detailed quantitative analysis.

Item	%NBS
Building's seismic capacity (No CSW observed)	41

Table 5 Indicative Building's Capacity based on the NZSEE Initial Evaluation Procedure

Following an IEP assessment, the building has been assessed as achieving 41% New Building Standard (NBS). Under the New Zealand Society for Earthquake Engineering (NZSEE) guidelines the building is considered Earthquake Risk as it achieves greater than 33% and less than 67% NBS. This score has not been adjusted when considering damage to the structure as none was observed.

10.2 Seismic Parameters

The seismic design parameters based on current design requirements from NZS 1170:2002 and the NZBC clause B1 for this building are:

- Site soil class: D NZS 1170.5:2004, Clause 3.1.3, Soft Soil
- Site hazard factor, Z = 0.3, NZBC, Clause B1 Structure, Amendment 11 effective from 1 August 2011
- Return period factor R_u = 0.5, NZS 1170.5:2004, Table 3.5, Importance level 1 structure with a 50 year design life.

An increased Z factor of 0.3 for Christchurch has been used in line with requirements from the Department of Building and Housing resulting in a reduced % NBS score.

10.3 Expected Structural Ductility Factor

A structural ductility factor of 1.25 has been assumed based on the structural system observed and the date of construction.

10.4 Discussion of Results

Although the shed's construction date is unknown, comparisons were made with similarly constructed buildings and an engineering judgment was made that the building was constructed in or around 1970. The building was likely designed to the loading standard current at the time, NZS 1900:1965. The design loads used in accordance with this standard are likely to have been less than those required by the current loading standard. When combined with the increase in the hazard factor for Christchurch to 0.3, it would be expected that the building would not achieve 100% NBS.

There were no damage and critical structural weaknesses identified in our visual inspection; consequently the %NBS has not reduced the baseline percentage of NBS.

10.5 Occupancy

The building does not pose an immediate risk to users and occupants. The building has been assessed as being potentially Earthquake Risk and as a result, can remain occupied; as per CCC's policy.

11. Initial Conclusions

The building has been assessed to have a seismic capacity in the order of 41% NBS and is therefore potentially Earthquake Risk.

12. Recommendations

The recent seismic activity in Christchurch has caused no visible damage to the building, with no visible damage to any of the buildings elements as a result of significant earthquakes.

As the building is not potentially earthquake prone it can remain occupied as CCC's policy. However, as the building is potentially earthquake risk GHD recommend a quantitative detailed seismic assessment is undertaken.

13. Limitations

13.1 General

This report has been prepared subject to the following limitations:

- No intrusive structural investigations have been undertaken.
- No intrusive geotechnical investigations have been undertaken.
- No level or verticality surveys have been undertaken.
- No material testing has been undertaken.
- No calculations, other than those included as part of the IEP in the CERA Building Evaluation Report, have been undertaken. No modelling of the building for structural analysis purposes has been performed.

It is noted that this report has been prepared at the request of Christchurch City Council and is intended to be used for their purposes only. GHD accepts no responsibility for any other party or person who relies on the information contained in this reportrite a specific limitations section.

13.2 Geotechnical Limitations

This report presents the results of a geotechnical appraisal prepared for the purpose of this commission, and prepared solely for the use of Christchurch City Council and their advisors. The data and advice provided herein relate only to the project and structures described herein and must be reviewed by a competent geotechnical engineer before being used for any other purpose. GHD Limited (GHD) accepts no responsibility for other use of the data.

The advice tendered in this report is based on a visual geotechnical appraisal. No subsurface investigations have been conducted. An assessment of the topographical land features have been made based on this information. It is emphasised that Geotechnical conditions may vary substantially across the site from where observations have been made. Subsurface conditions, including groundwater levels can change in a limited distance or time. In evaluation of this report cognisance should be taken of the limitations of this type of investigation.

An understanding of the geotechnical site conditions depends on the integration of many pieces of information, some regional, some site specific, some structure specific and some experienced based. Hence this report should not be altered, amended or abbreviated, issued in part and issued incomplete in any way without prior checking and approval by GHD. GHD accepts no responsibility for any circumstances, which arise from the issue of the report, which have been modified in any way as outlined above.

Appendix A

Photographs

Photograph 1 Southeast front elevation.

Photograph 2 Northeast side elevation.

Photograph 3 Northwest rear elevation.

Photograph 4 Southwest side elevation.

Photograph 5 Roof detail showing block work with in-situ cement.

Photograph 6 Timber roof structure.

Photograph 7 Timber roof structure.

Photograph 8 Slab on grade.

Appendix B

CERA Building Evaluation Form

Detailed Engineering Evaluation Summary Data V1.11

Location

Building Name:	Memorial Park Cemetery Shed		Reviewer:	Stephen Lee
	No: 31	Street: Ruru Road	CPEng No:	1006840
Building Address:	31	Ruru Road	Company:	GHD
Legal Description:			Company project number:	513090249
			Company phone number:	(04) 472 0799
	Degrees / Min / Sec			
GPS south:			Date of submission:	
GPS east:			Inspection Date:	19/07/2012
			Revision:	
Building Unique Identifier (CCC):	PRK_0880_BLDG_001 EQ2		Is there a full report with this summary?	yes

Site

Site slope:	flat	Max retaining height (m):	
Soil type:	mixed	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):	0.1
Ground floor split?	no	Ground floor elevation above ground (m):	0.1
Storeys below ground	0		
Foundation type:	strip footings	if Foundation type is other, describe:	
Building height (m):	2.60	height from ground to level of uppermost seismic mass (for IEP only) (m):	
Floor footprint area (approx):	10		
Age of Building (years):	42	Date of design:	1965-1976
Strengthening present?	no	If so, when (year)?	
		And what load level (%g)?	
Use (ground floor):	other (specify)	Brief strengthening description:	
Use (upper floors):			
Use notes (if required):	pump shed and valve operations		
Importance level (to NZS1170.5):	IL1		

Gravity Structure

Gravity System:	load bearing walls		
Roof:	timber framed	rafter type, purlin type and cladding	Timber roof joist,metal roof cladding
Floors:	concrete flat slab	slab thickness (mm)	100 slab on grade
Beams:	none	overall depth x width (mm x mm)	NA
Columns:	none	typical dimensions (mm x mm)	NA
Walls:	Concrete masonry unit		20 series concrete block masonry

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):	0.2
Period along:	0.40		estimate or calculation?	
Total deflection (ULS) (mm):			estimate or calculation?	
maximum interstorey deflection (ULS) (mm):			estimate or calculation?	
Lateral system across:	partially filled CMU		note total length of wall at ground (m):	4.8
Ductility assumed, μ:	1.25		wall thickness (m):	0.2
Period across:	0.40		estimate or calculation?	
Total deflection (ULS) (mm):			estimate or calculation?	
maximum interstorey deflection (ULS) (mm):			estimate or calculation?	

Separations:

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

Non-structural elements

Stairs:			
Wall cladding:			
Roof Cladding:	Metal	describe	corrugated metal roofing
Glazing:			
Ceilings:			
Services(list):			

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		original designer name/date	

Damage

Site:
(refer DEE Table 4-2)

Site performance:	Good	Describe damage:	No apparent 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:	No placard in place	
Along	Damage ratio:	0%	Describe how damage ratio arrived at:
	Describe (summary):		
Across	Damage ratio:	0%	
	Describe (summary):		
Diaphragms	Damage?:	no	Describe:
CSWs:	Damage?:	no	Describe:
Pounding:	Damage?:	no	Describe:
Non-structural:	Damage?:	no	Describe: No damage observed

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

Recommendations

	Level of repair/strengthening required:	none		Describe:
	Building Consent required:	no		Describe:
	Interim occupancy recommendations:	full occupancy		Describe:
Along	Assessed %NBS before:	41%	41% %NBS from IEP below	If IEP not used, please detail assessment methodology:
	Assessed %NBS after:	41%		
Across	Assessed %NBS before:	41%	41% %NBS from IEP below	
	Assessed %NBS after:	41%		

IEP **Use of this method is not mandatory - more detailed analysis may give a different answer, which would take precedence. Do not fill in fields if not using IEP.**

Period of design of building (from above): 1965-1976

h_n from above: m

Seismic Zone, if designed between 1965 and 1992: B

not required for this age of building:

not required for this age of building: b) Intermediate

	along	across
Period (from above):	0.4	0.4
(%NBS)nom from Fig 3.3:	5.0%	5.0%

Note:1 for specifically design public buildings, to the code of the day: pre-1965 = 1.25; 1965-1976, Zone A =1.33; 1965-1976, Zone B = 1.2; all else 1.0	1.0
Note 2: for RC buildings designed between 1976-1984, use 1.2	1.0
Note 3: for buildngs designed prior to 1935 use 0.8, except in Wellington (1.0)	1.0

	along	across
Final $(\%NBS)_{nom}$:	**5.0%**	**5.0%**

2.2 Near Fault Scaling Factor

Near Fault scaling factor, from NZS1170.5, cl 3.1.6: 1.00

	along	across
Near Fault scaling factor (1/N(T,D), **Factor A**:	1	1

2.3 Hazard Scaling Factor

Hazard factor Z for site from AS1170.5, Table 3.3:	0.30
Z_{1992}, from NZS4203:1992	0.8
Hazard scaling factor, **Factor B:**	3.33

2.4 Return Period Scaling Factor

Building Importance level (from above):	1
Return Period Scaling factor from Table 3.1, **Factor C**:	2.0

2.5 Ductility Scaling Factor

	along	across
Assessed ductility (less than max in Table 3.2)	1.25	1.25
Ductility scaling factor: =1 from 1976 onwards; or =kμ, if pre-1976, fromTable 3.3:	1.14	1.14
Ductiity Scaling Factor, **Factor D**:	1.14	1.14

2.6 Structural Performance Scaling Factor:

	along	across
Sp:	0.925	0.925
Structural Performance Scaling Factor **Factor E**:	1.08	1.08

2.7 Baseline %NBS, $(NBS\%)_b = (\%NBS)_{nom} \times A \times B \times C \times D \times E$

	along	across
$\%NBS_b$:	**41%**	**41%**

Global Critical Structural Weaknesses: (refer to NZSEE IEP Table 3.4)

3.1. Plan Irregularity, factor A:	insignificant	1
3.2. Vertical irregularity, Factor B:	insignificant	1
3.3. Short columns, Factor C:	insignificant	1

3.4. Pounding potential

Pounding effect D1, from Table to right	1.0
Height Difference effect D2, from Table to right	1.0
Therefore, Factor D:	1

Table for selection of D1	Severe	Significant	Insignificant/none
Separation	0<sep<.005H	.005<sep<.01H	Sep>.01H
Alignment of floors within 20% of H	**0.7**	**0.8**	**1**
Alignment of floors not within 20% of H	**0.4**	**0.7**	**0.8**

Table for Selection of D2	Severe	Significant	Insignificant/none
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

3.5. Site Characteristics	insignificant	1

3.6. Other factors, Factor F

	Along	Across
For ≤ 3 storeys, max value =2.5, otherwise max valule =1.5, no minimum	1.0	1.0
Rationale for choice of F factor, if not 1		

Detail Critical Structural Weaknesses: (refer to DEE Procedure section 6)

List any: Refer also section 6.3.1 of DEE for discussion of F factor modification for other critical structural weaknesses

	along	across
3.7. Overall Performance Achievement ratio (PAR)	**1.00**	**1.00**
4.3 PAR x (%NBS)b: PAR x Baselline %NBS:	**41%**	**41%**
4.4 Percentage New Building Standard (%NBS), (before)		**41%**

Official Use only:

Accepted By

Date:

GHD

Level 11, Guardian Trust House
15 Willeston street, Wellington 6011
T: 64 4 472 0799   F: 64 4 472 0833   E: wgtnmail@ghd.com

Document Status

Rev No.	Author	Reviewer		Approved for Issue		
		Name	Signature	Name	Signature	Date
Final	C. Wells	R.Ramilo	[signature]	S.Lee	[signature]	14.03.13