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Thorrington Reserve – Pump Shed
PRK 1762 BLDG 001

Detailed Engineering Evaluation
Qualitative Report
Version FINAL

Thorrington Road, Cashmere

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

Thorrington Reserve – Pump Shed
PRK 1762 BLDG 001

Detailed Engineering Evaluation
Qualitative Report
Version FINAL

Thorrington Road, Cashmere

Christchurch City Council

Prepared By
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Reviewed By
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Date
21 May 2013

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Qualitative Report Summary

Thorrington Reserve – Pump Shed

PRK 1762 BLDG 001

Detailed Engineering Evaluation

Qualitative Report - SUMMARY

Version FINAL

Thorrington Road, Cashmere

Background

This is a summary of the Qualitative report for the Thorrington Reserve Pump Shed, and is based in part on the Detailed Engineering Evaluation Procedure document (draft) issued by the Structural Advisory Group on 19 July 2011 and visual inspections on 31st August 2012.

Building Description

The building is located at 22 Thorrington Road, Cashmere, Christchurch. The exact date of construction is unknown but it is believed to be between 1976 and 1992. The building is used as a pumping station. There have been no alterations to the building since construction.

The roof of the building is a timber framed flat roof with corrugated metal cladding. Cladding to the underside of the rafters is provided by 5mm thick fibreboard lining. The rafters span between the south-east and north-west walls. The walls supporting the roof are of concrete masonry construction. The north-east and south-west walls are of timber frame construction lined internally by 5m thick fibreboard and externally by timber weatherboard. The floor is on grade concrete slab with perimeter thickenings for foundations.

Key Damage Observed

No damage was observed to the building.

Critical Structural Weaknesses

The following potential critical structural weaknesses have been identified in the structure.

- Site Characteristics (30% reduction) 83% NBS

Indicative Building Strength (from IEP and CSW assessment)

Based on the information available, and using the NZSEE Initial Evaluation Procedure, the original capacity of the building has been assessed to be in the order of 83% NBS and post-earthquake capacity also in the order of 83% NBS. The buildings post-earthquake capacity excluding critical structural weaknesses is in the order of >100% NBS.

The building has been assessed to have a seismic capacity in the order of 83% NBS and is therefore neither an Earthquake Risk nor Earthquake Prone building.

Recommendations

It is recommended that the current placard status of the building of green remains as is.

The recent seismic activity in Christchurch has caused no visible damage to the building. As the building has achieved greater than 67% NBS following a qualitative Detailed Engineering Evaluation, no further assessment and geotechnical investigation is necessary.

As the building has been assessed as being neither Earthquake Prone nor Earthquake Risk, and no immediate collapse hazards have been identified, general access to the building is permitted.

1. Background

GHD has been engaged by the Christchurch City Council (CCC) to undertake a detailed engineering evaluation of the pump shed at Thorrington Reserve.

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. Drawings were not made available. The building description is based on our visual inspections.

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 at 22 Thorrington Road, Cashmere, Christchurch. The exact date of construction is unknown but it is believed to be between 1976 and 1992. The building is used as a pumping station. There have been no alterations to the building since construction.

The roof of the building is a timber framed flat roof with corrugated metal cladding. Ceiling linings are provided by 5mm thick fibreboard lining fixed to the underside of the rafters. The rafters span between the south-east and north-west walls. The walls supporting the roof are of concrete masonry construction. The north-east and south-west walls are of timber frame construction lined internally by 5m thick fibreboard and externally by timber weatherboard. The floor is on grade concrete slab with perimeter thickenings for foundations.

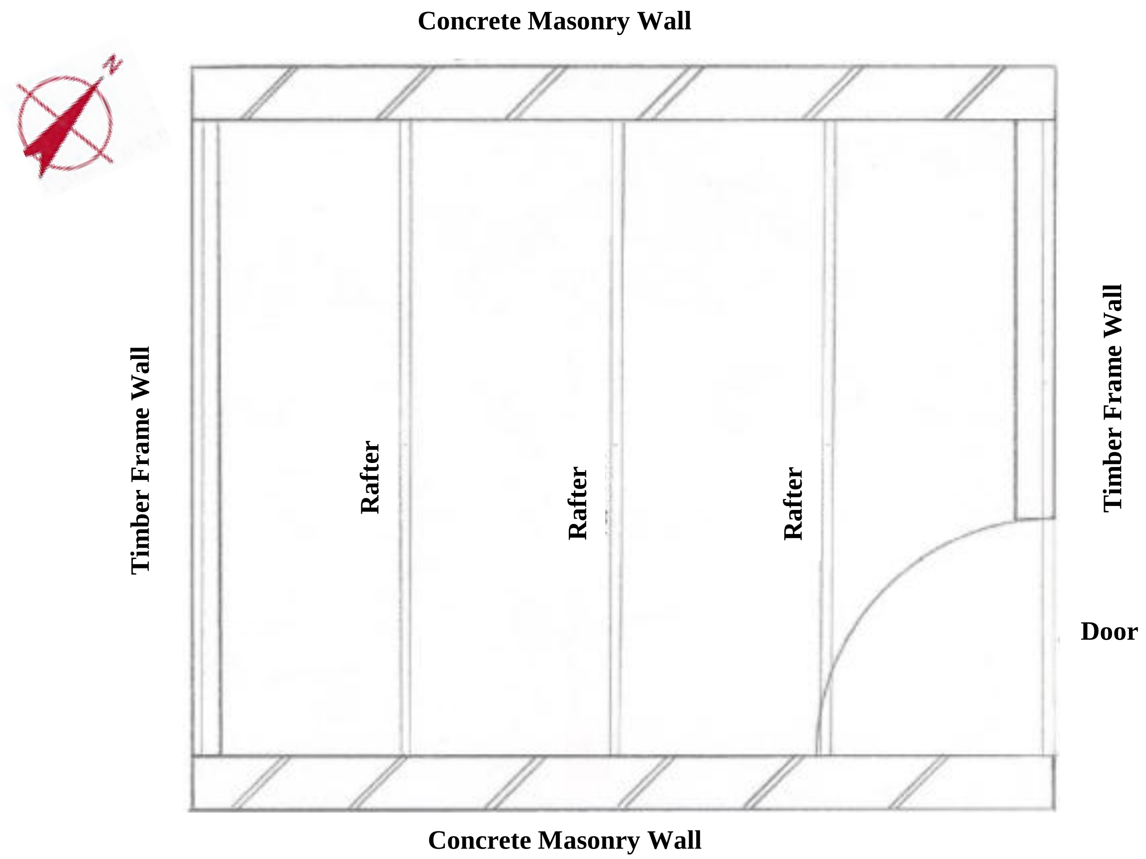

Figure 2 Plan Sketch Showing Key Structural Elements

The building is approximately 3m wide by 3m in length. The height of the building is 2.3m and the approximate area of the building is 9m^2. The nearest waterway is the Heathcote River approximately 20m to the north-west. The site is relatively flat but slopes gently from south-east to north-west.

No plans were made available for this building.

4.2 Gravity Load Resisting System

Gravity loads are transferred from the roof cladding to the timber rafters. The rafters transfer loads to the supporting concrete masonry walls. Loads are transferred down through the masonry walls to the floor slab thickenings and through to the ground below. Internal gravity loads are transferred directly down through the floor slab to the ground below.

4.3 Lateral Load Resisting System

Lateral loads in the along direction are resisted primarily by the concrete masonry walls with secondary lateral load resistance provided by the roof structure. Lateral loads acting in the across direction are resisted by the timber framed external walls.

5. Assessment

An inspection of the building was undertaken on the 31st August 2012. Both the interior and exterior of the building were inspected. The main structural components of the roof of the building were not able to be viewed due to the presence of ceiling linings.

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 observation of the building.

6. Damage Assessment

6.1 Surrounding Buildings

The pump shed is located on a recreational reserve with residential buildings to the south and north-east. No structural damage was noted to the surrounding buildings during our inspection.

6.2 Residual Displacements and General Observations

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

No damage was noted to the building.

6.3 Ground Damage

There was no evidence of ground damage on the property or surrounding neighbours land.

7. Critical Structural Weakness

7.1 Short Columns

No short columns are present in the structure.

7.2 Lift Shaft

The building does not contain a lift shaft.

7.3 Roof

Roof bracing was not seen.

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 potential for liquefaction. If liquefaction or lateral spreading was to occur on site, it is possible that it would have an effect on the structural capacity of the building. For the purposes of the IEP assessment of the building and the determination of the %NBS score, the effects of soil liquefaction on the performance of the building has been assessed as a ‘significant’ site characteristic in accordance with the NZSEE guidelines.

7.6 Plan Irregularity

The walls of the building in the north-west and south-east are both of concrete masonry construction and are considered to have a much greater stiffness than the perpendicular timber framed walls. For the purposes of the IEP assessment of the building and the determination of the %NBS score, the influence of stiff elements on the performance of the building has been assessed as an ‘insignificant’ plan irregularity in accordance with the NZSEE guidelines.

8. Geotechnical Consideration

Introduction

This desktop geotechnical study outlines the ground conditions, as indicated from sources quoted within, for inclusion in the subject structure's DEE Qualitative Assessment. This is a desktop study report and no site visit has been undertaken by GHD Geotechnical personnel.

This report is specific to the Pump Shed in Thorrington Reserve. The reserve is situated on the southern bank of the Heathcote River which is surrounded by residential properties, and is owned by the Christchurch City Council.

8.1 Site Description

The site is situated in the suburb of Cashmere, in southern Christchurch. It is relatively flat at approximately 9m above mean sea level. It is approximately 20m south of the Heathcote River, and 10km west of the coast (Pegasus Bay).

8.2 Published Information on Ground Conditions

8.2.1 Published Geology

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

- Dominantly sand and silt overbank deposits, being alluvial soils of the Yaldhurst Member, sub-group of the Springston Formation, Holocene in age.

Figure 72 from Brown & Weeber indicates that groundwater is likely within 1m. Figure 70 indicates that the surface of the Riccarton Gravels is 10 m bgl and is overlain by post glacial gravels.

8.2.2 Environment Canterbury Logs

Information from Environment Canterbury (ECan) indicates that one borehole with an adequate lithographic log is located within 200m of the site (see Table 2).

This indicates the area is underlain by topsoil and silt to 3.0m, overlying sandy gravels to 19.5m with a silt lense from, 10.0 -12.0 m.Groundwater was encountered at 0.7 m bgl.

Table 2 ECan Borehole Summary

Bore Name	Log Depth	Groundwater	Distance & Direction from Site
M36/2195	19.5m	0.7m bgl	0m

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

[1]Brown, L. J. & Weeber, J.H. (1992): Geology of the Christchurch Urban Area. Institute of Geological and Nuclear Sciences 1:25,000 Geological Map 1. IGNS Limited: Lower Hutt.

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.

8.2.3 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 Cashmere[2]. Two investigation points were undertaken within 200m of the site. However they refused at very shallow depths, indicating a dense granular soil is present at approximately 1.5m bgl.

8.2.4 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. These categories describe how the land in expected to perform in future earthquakes.

The site has been categorised as “N/A – Non-Residential”. However, neighbouring residential properties are indicated as being within the TC3 (blue) zone[3]. This means that moderate to significant land damage from liquefaction is possible in future significant earthquakes.

8.2.5 Post February Aerial Photography

Aerial photography taken following the 22 February 2011 earthquake shows no signs of liquefaction outside the building footprint or adjacent to the site, as shown in Figure 3.

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

[3] CERA Landcheck website, http://cera.govt.nz/my-property

Figure 3 Post February 2011 Earthquake Aerial Photography [4]

8.2.6 Summary of Ground Conditions

From the information presented above, the ground conditions underlying the site are anticipated to comprise strata of gravel with occasional silt lenses, with groundwater expected with 1m depth.

8.3 Seismicity

8.3.1 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.

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

Table 3 Summary of Known Active Faults[5][6]

Known Active Fault	Distance from Site	Direction from Site	Max Likely Magnitude	Avg Recurrence Interval
Alpine Fault	130 km	NW	~8.3	~300 years
Greendale (2010) Fault	20 km	W	7.1	~15,000 years
Hope Fault	110 km	N	7.2~7.5	120~200 years
Kelly Fault	110 km	NW	7.2	~150 years
Porters 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.

8.3.2 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.

8.4 Slope Failure and/or Rockfall Potential

The topography surrounding the site suggests that rockfall is not a potential hazard. However, given its proximity to the Heathcote River, and evidence from the recent earthquakes, the site may be susceptible to lateral spreading. In addition, any retaining structures or embankments nearby should be further investigated to determine the site-specific local slope instability potential.

8.5 Liquefaction Potential

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

- No observations of liquefactions from the Septmber post-earthquake aerial;
- The neighbouring properties are classified as TC3;
- The site is located on the southern bank of the Heathcote River; and,
- Presence of predominantly saturated gravels and silts beneath the site.

[5] 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, pp 1878-1903, June 2002.

[6] GNS Active Faults Database

8.6 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 stratified alluvial deposits, comprising silt lenses and sandy gravels to 19.5m. Associated with this the site also has a moderate liquefaction potential, in particular where sands and/or silts are present.

Due to the sites liquefaction potential and proximity to the Heatcote River there is a potential for lateral spreading.

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 has had its capacity assessed using the Initial Evaluation Procedure based on the information available. The buildings capacity excluding critical structural weaknesses and the capacity of any identified weaknesses are expressed as a percentage of new building standard (%NBS) and are in the order of that shown below in Table 4.

Item	%NBS
Building excluding CSW's	>100
Site Characteristics (30% reduction)	83

Table 4 Indicative Building and Critical Structural Weaknesses Capacities based on the NZSEE Initial Evaluation Procedure

Following an IEP assessment, the building has been assessed as achieving 83% New Building Standard (NBS). Under the New Zealand Society for Earthquake Engineering (NZSEE) guidelines the building is considered neither Earthquake Risk nor Earthquake Prone as it achieves greater than 67% NBS. This score has not been adjusted when considering damage to the structure as no damage was noted.

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 2.0 acting in the across direction has been assumed for the timber framed wall system observed and the date of construction.

A structural ductility factor of 1.25 acting in the along direction has been assumed for the masonry wall system observed and the date of construction.

10.4 Discussion of Results

The results obtained from the initial IEP assessment are consistent with those expected for a building of this age and construction type. The exact date of construction is unknown but it is believed to have been constructed between 1976 and 1992 and was likely designed to the loading standard current at the time, NZS 4203:1976 or 1984. The design loads used in these standards 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. Due to the age of the building and the chosen importance level it is reasonable to expect the building to be classified as neither an Earthquake Prone nor Earthquake Risk building.

10.5 Occupancy

The building does not pose an immediate risk to users and occupants as no critical structural weaknesses have been identified. As the building has been assessed to have a %NBS greater than 67% NBS, it is deemed to be potentially low risk. As the building has been assessed as being neither Earthquake Prone nor Earthquake Risk, occupancy of the building is permitted.

11. Initial Conclusions

The building has been assessed to have a seismic capacity in the order of 83% NBS and is therefore neither Earthquake Prone nor Earthquake Risk in accordance with the NZSEE guidelines. The building can remain occupied as there are no immediate collapse hazzards.

12. Recommendations

It is recommended that the current placard status of the building of green remains as is.

The recent seismic activity in Christchurch has caused no visible damage to the building. As the building has achieved greater than 67% NBS following a qualitative Detailed Engineering Evaluation of the building, no further assessment and geotechnical investigation is necessary.

As the building has been assessed as being neither Earthquake Prone nor Earthquake Risk, and no immediate collapse hazards have been identified, general access to the building is permitted.

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 report.

13.2 Geotechnical Limitations

This report presents the results of a geotechnical appraisal prepared for the purpose of this commission, and for 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 North elevation.

Photograph 2 View of the pump shed from the south.

Photograph 3 View of the pump shed from the east.

Photograph 4 Internal view of timber frames wall showing fibreboard ceiling and wall lining.

Appendix B

Existing Drawings

No drawings were made available for this building.

Appendix C

CERA Building Evaluation Form

Detailed Engineering Evaluation Summary Data V1.11

Location

Building Name:	Thorrington Reserve Pump Shed			Reviewer:	David Lee
	Unit	No:	Street	CPEng No:	112052
Building Address:			Thorrington Road	Company:	GHD Limited
Legal Description:	Lot 1 DP 78225			Company project number:	513090261
				Company phone number:	03 3780900
	Degrees	Min	Sec		
GPS south:	43	33	51.53	Date of submission:	22/05/2013
GPS east:	172	37	58.70	Inspection Date:	31/08/2012
				Revision:	Final
Building Unique Identifier (CCC):	PRK 1762 BLDG 001			Is there a full report with this summary?	yes

Site

Site slope:	slope < 1in 10	Max retaining height (m):	0
Soil type:	mixed	Soil Profile (if available):	
Site Class (to NZS1170.5):	D		
Proximity to waterway (m, if <100m):	20	If Ground improvement on site, describe:	
Proximity to clifftop (m, if < 100m):			
Proximity to cliff base (m,if <100m):		Approx site elevation (m):	9.00

Building

No. of storeys above ground:	1	single storey = 1	Ground floor elevation (Absolute) (m):	9.00
Ground floor split?	no		Ground floor elevation above ground (m):	
Storeys below ground	0			
Foundation type:	mat slab		if Foundation type is other, describe:	
Building height (m):	2.30		height from ground to level of uppermost seismic mass (for IEP only) (m):	
Floor footprint area (approx):	9			
Age of Building (years):	24		Date of design:	1976-1992
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 Station			
Importance level (to NZS1170.5):	IL1			

Gravity Structure

Gravity System:	load bearing walls		
Roof:	timber framed	rafter type, purlin type and cladding	
Floors:	concrete flat slab	slab thickness (mm)	
Beams:	none	overall depth x width (mm x mm)	
Columns:			
Walls:	fully filled concrete masonry	#N/A	

Lateral load resisting structure

Lateral system along:	fully filled CMU		**Note: Define along and across in detailed report!**		
Ductility assumed, μ:	1.25			note total length of wall at ground (m):	
Period along:	0.10	#####	enter height above at H31	estimate or calculation?	estimated
Total deflection (ULS) (mm):				estimate or calculation?	
maximum interstorey deflection (ULS) (mm):				estimate or calculation?	
Lateral system across:	lightweight timber framed walls				
Ductility assumed, μ:	2.00			note typical wall length (m)	
Period across:	1.00	0.00		estimate or calculation?	estimated
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:	other light	describe	timber planks
Roof Cladding:	Metal	describe	Corrugated metal
Glazing:			
Ceilings:	none		
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	none	original designer name/date	

Damage

Site: (refer DEE Table 4-2)

Site performance:		Describe damage:	
Settlement:	none observed	notes (if applicable):	
Differential settlement:	none observed	notes (if applicable):	
Liquefaction:	none apparent	notes (if applicable):	
Lateral Spread:	none apparent	notes (if applicable):	
Differential lateral spread:	none apparent	notes (if applicable):	
Ground cracks:	none apparent	notes (if applicable):	
Damage to area:	none apparent	notes (if applicable):	

Building:

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

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

Recommendations

	Level of repair/strengthening required:	none		Describe:
	Building Consent required:	no		Describe:
	Interim occupancy recommendations:	full occupancy		Describe:
Along	Assessed %NBS before e'quakes:	83%	83% %NBS from IEP below	If IEP not used, please detail assessment methodology:
	Assessed %NBS after e'quakes:	83%		
Across	Assessed %NBS before e'quakes:	100%	110% %NBS from IEP below	
	Assessed %NBS after e'quakes:	100%		

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): 1976-1992

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

	along	across
Period (from above):	0.1	1
(%NBS)nom from Fig 3.3:	16.5%	16.5%

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	1.00
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 $(\%NBS)_{nom}$:	**17%**	**17%**

2.2 Near Fault Scaling Factor

	along	across
Near Fault scaling factor, from NZS1170.5, cl 3.1.6:	1.00	
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	
Hazard scaling factor, **Factor B:**	3.333333333

2.4 Return Period Scaling Factor

Building Importance level (from above):	1
Return Period Scaling factor from Table 3.1, **Factor C**:	2.00

2.5 Ductility Scaling Factor

	along	across
Assessed ductility (less than max in Table 3.2)	1.25	2.00
Ductility scaling factor: =1 from 1976 onwards; or =kμ, if pre-1976, fromTable 3.3:	1.00	1.00
Ductiity Scaling Factor, **Factor D**:	1.00	1.00

2.6 Structural Performance Scaling Factor:

	along	across
Sp:	0.925	0.700
Structural Performance Scaling Factor **Factor E**:	1.081081081	1.428571429

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

	along	across
$\%NBS_b$:	**119%**	**157%**

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	significant	0.7

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)	**0.70**	**0.70**
4.3 PAR x (%NBS)b: PAR x Baselline %NBS:	**83%**	**110%**
4.4 Percentage New Building Standard (%NBS), (before)		**83%**

GHD

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Document Status

Rev No.	Author	Reviewer		Approved for Issue		
		Name	Signature	Name	Signature	Date
Final	Peter O'Brien	David Lee	[signature]	Nick Waddington	[signature]	21/05/13