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Waimakariri Road Soil Store

PRO 0360-001

Detailed Engineering Evaluation

Qualitative Report

FINAL Version

22 Waimakariri Road, Harewood, Christchurch

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

Waimakariri Road Soil Store
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Detailed Engineering Evaluation
Qualitative Report
FINAL Version

22 Waimakariri Road, Harewood,
Christchurch

Christchurch City Council

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Date
24/05/2013

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Waimakariri Road Soil Store
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Detailed Engineering Evaluation

Qualitative Report - SUMMARY

DRAFT Version

22 Waimakariri Road, Harewood, Christchurch

Background

This is a summary of the Qualitative report for the building structure, and is based in general on the Detailed Engineering Evaluation Procedure document (draft) issued by the Structural Advisory Group on 19 July 2011 and visual inspections on 16 April 2012.

Building Description

The Soil Store at 22 Waimakariri Road is a covered storage area constructed in 1980. The site is generally flat with some variation in the topography due to dumping of soils and other materials. There is a small hill that abuts the eastern side of the soil store, such that the eastern wall retains an estimated 2m of soil height. The original construction drawings for the Soil Store consist of general soil shed drawings which have been modified. Some of the modifications are not shown in the available drawing set and must therefore be inferred from observations on-site.

The general structure is a covered storage area with two sides enclosed. The roof consists of corrugated steel cladding on (3) deep timber rafters and timber purlins, with flat strap cross-bracing. The roof system is supported at the western end by a transverse steel/timber frame, which sits on concrete column bases, and on the eastern side by a cross-braced timber-framed wall which sits atop a 200 series masonry wall. The southern side of the building features a timber-framed wall which is not cross-braced. Both walls are clad in corrugated steel. The foundations on the western side are assumed to be concrete piles, and a concrete strip footing supports the eastern wall. There are large concrete blocks stacked against the base of the southern wall, against the exterior cladding.

The dimensions of the building are approximately 11 m long, 10 m wide, and 6m in height.

Key Damage Observed

Key damage observed includes:

- Separation of wall cladding from supports along the southern wall.
- Failure of chain-link fencing (non-structural).

Critical Structural Weaknesses

The building exhibits the following critical structural weaknesses:

- Plan Irregularity — 30% reduction
- Site Characteristics (liquefaction potential) — 30% reduction

Indicative Building Strength (from IEP and CSW assessment)

Based on the information available, and using the NZSEE Initial Evaluation Procedure, the building's original capacity has been assessed to be in the order of 77% NBS. The building's capacity excluding critical structural weaknesses is >100% NBS. Therefore the building is neither potentially Earthquake Prone nor a potential Earthquake Risk.

Recommendations

No quantitative assessment is required as the building is not a potential Earthquake Risk.

1. Background

GHD has been engaged by the Christchurch City Council (CCC) to undertake a detailed engineering evaluation of the Soil Store structure at 22 Waimakariri Road.

This report is a Qualitative Assessment of the building structure, and is based in general 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. The building description is based on the visual inspection carried out on site and the building drawings made available.

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.

2.0 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

2.1 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.

2.1.1 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.

2.2 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.

2.3 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	Improvement of Structural Performance: 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	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.	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

4.0 General

The Soil Store at 22 Waimakariri Road was constructed in 1980. The site is located at the dump at 22 Waimakariri Road. The surrounding area consists of open space where soils and other materials have been dumped. There are two small huts adjacent to the soil store to the north, with no other buildings or obstructions nearby. Waimakariri Road is located roughly 50m to the east of the soil store.

The site is generally flat with some variation in the topography due to dumping of soils and other materials. There is a small hill that abuts the eastern side of the soil store, such that the eastern wall retains some soil (2m estimated height).

The original construction drawings for the Soil Store consist of general soil shed drawings which have been modified. Some of the modifications are not shown in the available drawing set and must therefore be inferred from observations on-site.

The general structure is a covered storage area with two sides enclosed. The roof consists of corrugated steel cladding on 600mm deep timber rafters (3 total) and 200x50 timber purlins, with flat strap steel cross-bracing. The timber roof rafters span in the longitudinal direction. The rafters sit atop a transverse steel frame at the western end, with a bolted connection to the steel posts (which extend above the steel beam), and each rafter is supported at the eastern end by a matching 600mm deep timber column. Original drawings show these rafters and their support columns at the eastern end to be made of steel and form a portal frame with a diagonal strut at each connection along the eastern wall, but this has been modified to use timber rafters and columns without any diagonal struts. The timber columns at the eastern end are connected via steel plate connections to 200 series reinforced concrete masonry column bases, with a 200 series reinforced concrete masonry wall spanning between each column base. The concrete masonry column bases are 800mm deep, 200mm wide and 2.4m tall. The concrete masonry wall which spans between the column bases is also 200mm wide and 2.4m tall. The column bases and masonry wall sit atop a 200mm deep reinforced concrete footing, which has an additional 200mm deep thickened edge which runs under the free ends of the column bases in the transverse direction. Original construction drawings show an additional 2.4m tall unispan slab above the masonry walls, but it is assumed that this has been eliminated in the Soil Store construction.

The transverse steel/timber frame at the western end consists of (2) 100mm square steel posts and a 100mm square beam under a deep timber beam, with steel cleat connections between the beams and posts. The timber beam is flush with the roof framing that runs along the top of the steel beam, and the steel posts extend up past the steel beam to terminate flush with the top of the timber beam. The square steel posts terminate in a welded end plate, which is bolted atop 250mm square concrete column bases, which reach from concrete pads below ground level to roughly 1500mm above ground level. Original drawings show these foundations to be 300 diameter concrete posts, but it is assumed that the soil store foundations are 250 square reinforced concrete piles which continue from the above-ground column bases. The timber columns on the eastern elevation which support the roof rafters are braced with corrugated steel-clad, cross-braced timber framing, with girts spanning horizontally between the columns at 1200mm on-centre and vertical timber purlins at 2.5m on-centre between the columns. The southern (longitudinal) wall is also timber framed, with the horizontal timber joists attached to the steel post at the western end of the wall with steel cleats welded to the post. The southern wall has no cross-bracing. There are large concrete blocks stacked against part of the base of the southern wall, against the exterior cladding. The northern and western sides are open, with a chain-link fence running along the northern side.

The dimensions of the building are approximately 11 m long, 10 m wide, and 6m in height.

Figure 2 below shows the plan view from the original construction drawings, with modifications in red.

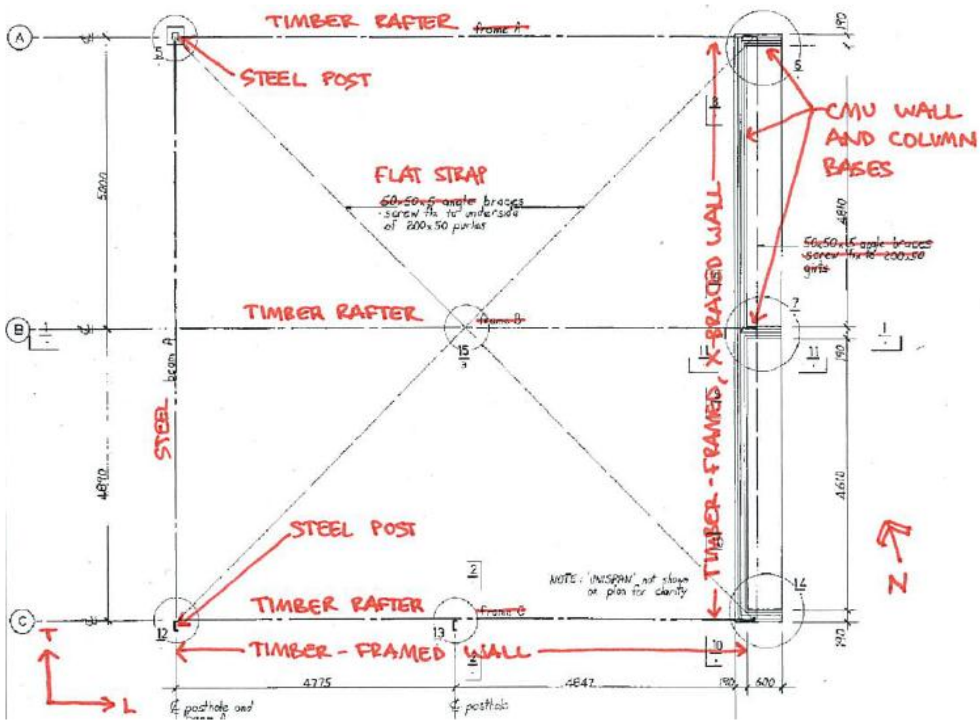


Figure 2 Plan Sketch Showing Key Structural Elements

4.1 Gravity Load Resisting System

The gravity loads in the structure are carried by the steel cladding to the timber roof members, which span to the steel frame on the western end and the timber columns at the eastern end, down through these posts into the foundations and into the ground. The wall cladding on the eastern and southern sides of the structure and the chain-link fencing on the northern side of the structure do not have the capacity to carry gravity loads.

4.2 Lateral Load Resisting System

The cross-braced roof structure carries lateral loads out to the edges of the roof.

In the transverse direction, lateral loads from the cross-braced roof are translated on the western side through the steel/timber frame into the concrete supports, through the concrete foundations and into the ground. Transverse lateral loads are translated on the eastern side through the cross-braced timber wall, into the concrete masonry column bases, through the concrete foundations and into the ground. The concrete masonry wall between the column bases provides further bracing to the lower elevation of this wall.

In the longitudinal direction, lateral loads from the cross-braced roof are transferred to the two perimeter portal frames and the central portal frame, through these frames via bending into the concrete supports, through the concrete foundations and into the ground. The timber wall on the southern side should exhibit some capacity to translate lateral loads also.

5. Assessment

A visual inspection of the building was undertaken on 16 April 2012. Both the interior and exterior of the building were inspected. There was no placard observed in place at the building. The main structural components of the building were all able to be viewed due to the exposed nature of the structure. No inspection of the foundations of the structure was able to be undertaken.

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

The %NBS score is determined using the IEP procedure described by the NZSEE which is based on the information obtained from visual observation of the building and drawings made available. Some critical structural weaknesses were observed, which reduced the overall %NBS.

6. Damage Assessment

6.0 Surrounding Buildings

The Soil Store at 22 Waimakariri Road is located in a rural area with open land adjacent to the site. There are a few small huts near the Soil Store on the same property. During the inspection there was no apparent damage to the surrounding buildings or adjoining properties.

6.1 Residual Displacements and General Observations

Residual displacement of the southern wall cladding was observed. This is due to soil pressure against the wall, which may or may not have been exacerbated during recent seismic activity. The chain link fence on the northern side of the structure showed similar residual displacement.

No damage was evident to the frames, beams and columns supporting the roof structure, nor to the other structural members in place. It was not possible to inspect the concrete column bases and wall on the eastern side of the building, nor the concrete foundations.

6.2 Ground Damage

No ground damage was observed during the inspection of the site. The site regularly accommodates large dump trucks and other industrial vehicles, and signs of ground damage may have been obscured due to regular use of the site by these vehicles.

7. Critical Structural Weakness

The building exhibits a critical structural weakness in plan irregularity and site characteristics. No other critical structural weaknesses were identified.

7.1 Short Columns

The building does not contain any significant short columns.

7.2 Lift Shaft

The building does not contain a lift shaft.

7.3 Roof

No critical structural weaknesses were observed in the roof structure. Diagonal flat steel strap cross-bracing was evident in the timber-framed roof structure during the inspection. Adequate diaphragm action can be expected from the roof structure.

7.4 Staircases

The building does not contain a staircase.

7.5 Plan Irregularity

The building contains plan irregularity in that the eastern side of the building is much stiffer than the western side. Accordingly, the building exhibits a “significant” critical structural weakness in the form of plan irregularity.

7.6 Vertical Irregularity

The building does not exhibit any significant vertical irregularity as defined by NZSEE guidelines.

7.7 Liquefaction

No liquefaction was observed at the site. Geotechnical information suggests a low to moderate risk of liquefaction for the site, which has been accounted for in the Site Characteristics section of the IEP procedure as a “significant” factor. The potential for liquefaction constitutes a critical structural weakness because, should liquefaction occur, the isolated concrete pads could lose their bearing and cause a premature collapse of the structure.

8. Geotechnical Consideration

This desktop geotechnical study outlines the ground conditions, as indicated from sources quoted within. This is a desktop study report and no site visit has been undertaken by Geotechnical personnel.

This report is only specific to the Soil Store at 22 Waimakariri Road, Harewood. Soil Store is located on a large property bounded by Waimakariri Road to the north and Johns Road to the south. The surrounding area is host to commercial, agricultural and residential properties. The property is owned and maintained by the Christchurch City Council.

8.0 Site Description

The site is situated within a large property used for storing various soils, within the suburb of Harewood in north-western Christchurch. It is relatively flat and at approximately 25m above mean sea level. It is approximately 4.5km south of the Waimakariri River, and 13km west of the coast (Pegasus Bay).

8.1 Published Information on Ground Conditions

8.1.1 Published Geology

The geological map of the area[1] indicates that the site is underlain by Holocene alluvial soils of the Yaldhurst Member, sub-group of the Springston Formation, comprising alluvial, gravel, sand, and silt of historic river flood channels.

8.1.2 Environment Canterbury Logs

Information from Environment Canterbury (ECan) indicates that seven boreholes are located within a 200m radius of the site (see Table 1). Of these boreholes, two have lithographic logs. The site geology described in these logs indicate the area is predominantly layers of sandy gravel and gravel to a depth of ~10mbgl. Varying amounts of silt are also indicated to be present.

Table 2 ECan Borehole Summary

Bore Name	Log Depth	Groundwater	Distance & Direction from Site
M35/18067	~10m	N/A	195m NW
M35/10911	~24m	N/A	~90m SE

It should be noted that the purpose of the boreholes the well logs are associated with, 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.

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

8.1.3 EQC Geotechnical Investigations

The Earthquake Commission has not undertaken geotechnical testing in the area of the subject site.

8.1.4 Land Zoning

Canterbury Earthquake Recovery Authority (CERA) has published areas showing the Green Zone Technical Category in relation to the risk of future liquefaction and how these areas are expected to perform in future earthquakes. The site is classified as Technical Category Not Applicable (TC N/A). This means that non-residential properties in urban areas, properties in rural areas or beyond the extent of land damage mapping have not been given a Technical Category.

8.1.5 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.

Figure 3 Post February 2011 Earthquake Aerial Photography [2]

8.1.6 Summary of Ground Conditions

From the information presented above, the ground conditions underlying the site are anticipated to comprise multiple strata of sandy gravel and gravel, with varying amounts of silt.

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

8.2 Seismicity

8.2.1 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 3 Summary of Known Active Faults[3,4]

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	90 km	N	7.2~7.5	120~200 years
Kelly Fault	90 km	NW	7.2	150 years
Porters Pass Fault	35 km	N	7.0	1100 years

Recent earthquakes since 22 February 2011 have identified the presence of a previously unmapped active fault system underneath 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.

8.2.2 Ground Shaking Hazard

This 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.

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.

In addition, due to the anticipation of alluvial deposits in excess of 500m deep, a 475-year PGA (peak ground acceleration) of ~0.4 (Stirling et al, 2002[4]), ground shaking is likely to be moderate to high.

8.3 Slope Failure and/or Rockfall Potential

The topography surrounding the site is typically flat, and hence rockfalls are not considered to be a hazard at this site. However, any unretained stockpiles of soils and other materials may experience instability in a future seismic event.

[3] 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.

[4] GNS Active Faults Database

8.4 Liquefaction Potential

The two borehole logs available for the site, are either side of the site, and indicate potentially moderate to highly liquefiable material in one, and low to negligible liquefiable material in the other. Due to the lack of noted liquefaction occurring at the site it is considered likely that the potential at this structure of interest is low to moderate. However, that cannot be confirmed with this desk study, and it is considered possible and likely that liquefaction will occur where sands and silts are present.

8.5 Recommendations

It is recommended that intrusive investigation comprising one piezocone CPT test to 20m bgl should be undertaken. This will allow a numerical liquefaction analysis to be carried out.

8.6 Conclusions & Summary

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 gravel, sand, and silt. The site may have a moderate to low liquefaction potential but this cannot be confirmed by the available information. It is also considered that liquefaction is likely to occur where sands and/or silts are present.

It is recommended that an intrusive investigation comprising at least one piezocone CPT be conducted.

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

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 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. These capacities are subject to confirmation by a more detailed quantitative analysis.

Item	%NBS
Building Capacity excluding CSW's	>100%
Building Capacity including:	
Plan Irregularity (30% Reduction), and	
Site Characteristics (Liquefaction; 30% Reduction)	77%

Table 4 Indicative Building Capacities based on the NZSEE Initial Evaluation Procedure

Following an IEP assessment, the building has been assessed as achieving 77% New Building Standard (NBS). Under the New Zealand Society for Earthquake Engineering (NZSEE) guidelines the building is not considered potentially Earthquake Prone as it achieves greater than 33% NBS, nor is it considered a potential Earthquake Risk as it achieves greater than 67% NBS. The overall %NBS has been reduced to account for Critical Structural Weaknesses in the form of plan irregularity and liquefaction potential. This score has not been adjusted when considering damage to the structure as all damage observed was relatively minor and considered unlikely to adversely affect the load carrying capacity of the structural systems.

10.2 Seismic Parameters

The seismic design parameters based on current design requirements from NZS1170:2002 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.

Several key seismic parameters have influenced the %NBS score obtained from the IEP assessment. The building has been assessed as an Importance Level 1 building. An increased Z factor of 0.3 for Christchurch has been used in line with requirements from the Department of Building and Housing Compliance Document B1/VM1. The site soil class of D has adversely affected the %NBS score.

10.3 Expected Structural Ductility Factor

A structural ductility factor of 3.0 has been assumed based on the timber and steel frame structure, bracing observed and date of construction.

10.4 Discussion of Results

The results obtained from the initial IEP assessment are consistent with those expected for an Importance Level 1 building of this age and construction type, with significant plan irregularity and significant site characteristics founded on Class D soils. This building would have been designed to the standards at the time, namely NZS4203:1976. The design loads used in this standard will have been less than those required by the current loading standard, with lower detailing requirements for ductile seismic behaviour than those that are present in the current standards. Given the above, it is reasonable to expect the building would not be classified as a potential Earthquake Risk.

10.5 Occupancy

As the building is not habitable and has been assessed as an Importance Level 1 structure, it poses a low risk to users. The building does not qualify as potentially Earthquake Prone, as it scores greater than 33% NBS. Normal occupancy of the building should not be restricted.

11. Initial Conclusions

The building has been assessed to have a seismic capacity in the order of 77% NBS and is therefore not potentially Earthquake Prone.

12. Recommendations

The damage to the building during recent seismic activity in Christchurch has only caused minor, if any, damage to the building which does not compromise the load resisting capacity of the existing structural systems. The building has no collapse hazards and has achieved greater than 67% NBS following an initial IEP assessment of the building, and therefore no further assessment is required.

13. Limitations

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.

<u>Scope and Limits of this Assessment</u>

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: Southwest corner elevation.

Photograph 2: Northwest corner elevation.

Photograph 3: North elevation. Portable building on the right obscures view.

Photograph 4: View looking at the eastern wall and roof structure.

Photograph 5: Base of steel frame post, bolted to concrete base.

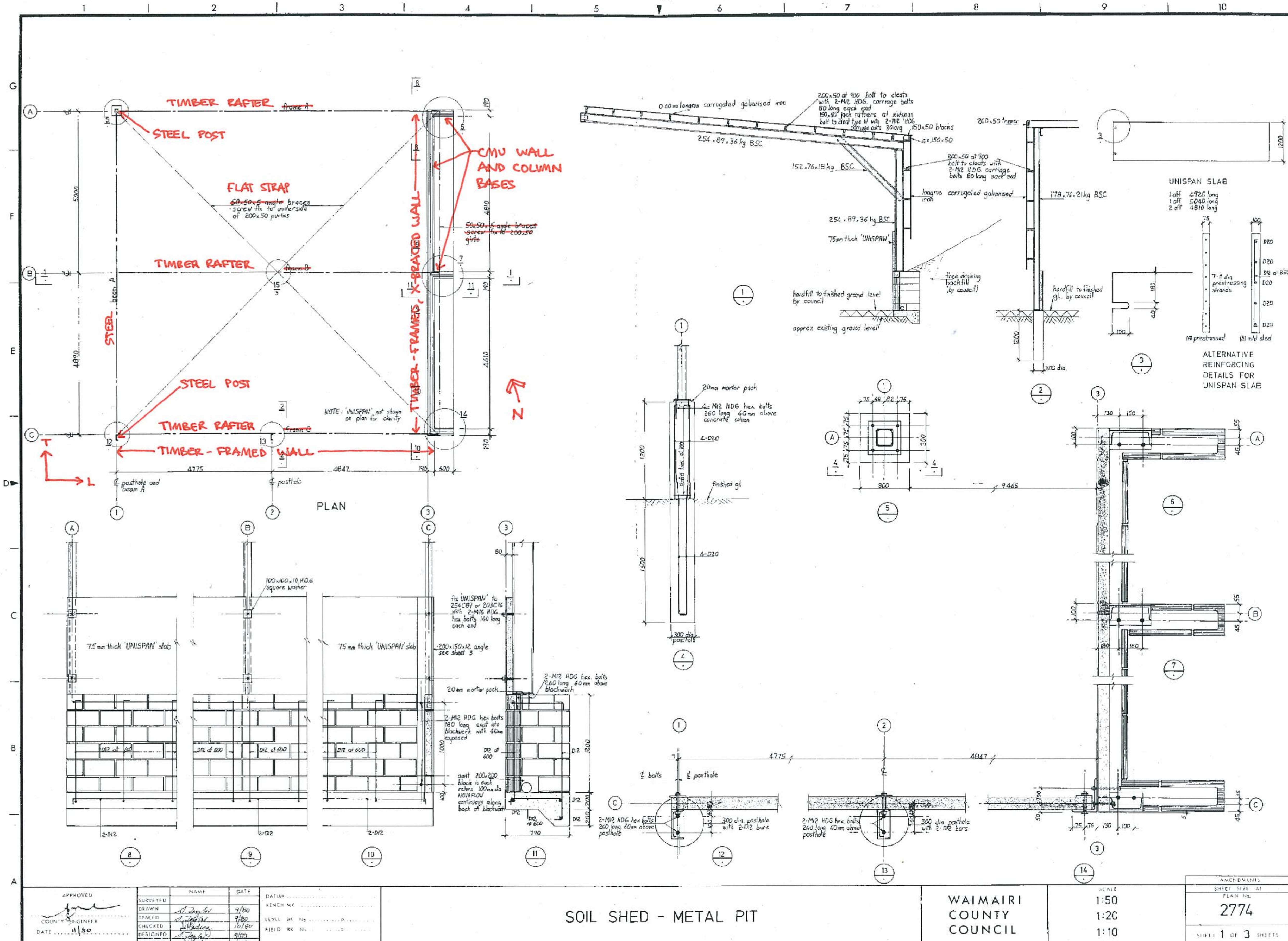
Photograph 6: Top of northern steel frame post at beam connection. Note steel beam (painted blue) underneath deep timber beam.

Photograph 7: Top of southern steel frame post. Note steel beam (painted blue) underneath deep timber beam.

Photograph 8: Southern wall and roof framing.

Appendix B

Existing Drawings



TIMBER RAFTER
STEEL POST
CMU WALL AND COLUMN BASES
FLAT STRAP
TIMBER RAFTER
STEEL
TIMBER-FRAMED, X-BRACED WALL
STEEL POST
TIMBER RAFTER
TIMBER-FRAMED WALL
N
T
L
PLAN
75mm thick 'UNISPAN' slab
75mm thick 'UNISPAN' slab
254 x 89 x 36 kg BSC
152 x 76 x 18 kg BSC
254 x 89 x 36 kg BSC
75mm thick 'UNISPAN'
178 x 76 x 21 kg BSC
UNISPAN SLAB
1 off 4920 long
1 off 5040 long
2 off 4810 long
ALTERNATIVE REINFORCING DETAILS FOR UNISPAN SLAB
4775
4847
APPROVED
COUNTY ENGINEER
SOIL SHED - METAL PIT
WAIMAIRI COUNTY COUNCIL
SCALE
1:50
1:20
1:10
PLAN No.
2774
SHEET 1 OF 3 SHEETS

Appendix C

CERA Building Evaluation Form

Detailed Engineering Evaluation Summary Data V1.11

Location

Building Name:	22 Waimakariri Rd Soil Store			Reviewer:	Stephen Lee
	Unit	No:	Street	CPEng No:	1006840
Building Address:		22	Waimakariri Road	Company:	GHD
Legal Description:	Sec 1 SO 14256			Company project number:	513059651
				Company phone number:	6433780900
	Degrees	Min	Sec		
GPS south:	43	28	25.00	Date of submission:	24/05/2013
GPS east:	172	34	3.00	Inspection Date:	4/16/2012
				Revision:	FINAL
Building Unique Identifier (CCC):	PRO 0360 001			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):	
Ground floor split?	no		Ground floor elevation above ground (m):	
Storeys below ground	0			
Foundation type:	isolated pads, no tie beams		if Foundation type is other, describe:	
Building height (m):	6.00		height from ground to level of uppermost seismic mass (for IEP only) (m):	
Floor footprint area (approx):	110			
Age of Building (years):	32		Date of design:	1976-1992
Strengthening present?	no		If so, when (year)?	
			And what load level (%g)?	
Use (ground floor):	public		Brief strengthening description:	
Use (upper floors):				
Use notes (if required):				
Importance level (to NZS1170.5):	IL1			

Gravity Structure

Gravity System:	frame system		
Roof:	timber framed	rafter type, purlin type and cladding	rafters 100x50, purlins 75x50, metal cladding
Floors:	other (note)	describe sytem	no floor
Beams:	timber	type	600x100
Columns:	timber	typical dimensions (mm x mm)	600x100; some 100 sq. steel posts
Walls:	non-load bearing	0	

Lateral load resisting structure

Note: Define along and across in detailed report!

Lateral system along:	timber moment frame		note typical bay length (m)	11m - little moment capacity if any
Ductility assumed, μ:	3.00			
Period along:	0.40	0.00	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		note typical wall length (m)	10m, cross-braced, eastern side only
Ductility assumed, μ:	3.00			
Period across:	0.40	0.00	estimate or calculation?	estimated
Total deflection (ULS) (mm):			estimate or calculation?	
maximum interstorey deflection (ULS) (mm):			estimate or calculation?	

Separations:

leave blank if not relevant

north (mm):	
east (mm):	
south (mm):	
west (mm):	

Non-structural elements

Stairs:			none
Wall cladding:	profiled metal	describe	corrugated metal
Roof Cladding:	Metal	describe	corrugated metal
Glazing:	other (specify)		none
Ceilings:	none		
Services(list):			

Available documentation

Architectural	none	original designer name/date	
Structural	partial	original designer name/date	City Architects (CCC)
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):	Low to Mod. Liquefaction Potential
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:		
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?: yes	Describe:	Separation of south wall cladding

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

Recommendations

	Level of repair/strengthening required:	none		Describe:
	Building Consent required:	no		Describe:
	Interim occupancy recommendations:	full occupancy		Describe:
Along	Assessed %NBS before:	77%	77% %NBS from IEP below	If IEP not used, please detail assessment methodology:
	Assessed %NBS after:	77%		
Across	Assessed %NBS before:	77%	77% %NBS from IEP below	
	Assessed %NBS after:	77%		

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: D soft soil

not required for this age of building: b) Intermediate

	along	across
Period (from above):	0.4	0.4
(%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

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:**	3.333333333

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)	3.00	3.00
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:	0.700	0.700
Structural Performance Scaling Factor **Factor E**:	1.428571429	1.428571429

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

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

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

3.1. Plan Irregularity, factor A:	significant	0.7
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)	**0.49**	**0.49**
4.3 PAR x (%NBS)b: PAR x Baselline %NBS:	**77%**	**77%**
4.4 Percentage New Building Standard (%NBS), (before)		**77%**

GHD

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Document Status

Rev No.	Author	Reviewer		Approved for Issue		
		Name	Signature	Name	Signature	Date
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