Christchurch City Council

Lyttelton Information Centre
PRK 3505 BLDG 003/006

Detailed Engineering Evaluation

Quantitative Assessment Report

Christchurch City Council

Lyttelton Information Centre Quantitative Assessment Report

20 Oxford St

Prepared By

Simon Biggs
Senior Structural Engineer, MIEAust

Reviewed By

Drew Gordon
Senior Structural Engineer, MIEAust

Approved By

Dave Dekker
Senior Structural Engineer, CPEng

Opus International Consultants Ltd
Christchurch Office
20 Moorhouse Avenue
PO Box 1482, Christchurch Mail Centre, Christchurch 8140
New Zealand

Telephone: +64 3 363 5400
Facsimile: +64 3 365 7858

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Status: Final

Summary

Lyttelton Information Centre
PRK 3050 BLDG 003/006

Detailed Engineering Evaluation
Quantitative Report - Summary
Final

Background
This is a summary of the quantitative report for the Lyttelton Information Centre building, and is based on the Detailed Engineering Evaluation Procedure document (draft) issued by the Structural Advisory Group on 19 July 2011, visual inspections on 21 March 2012, measured-up sketch drawings and calculations.

Key Damage Observed
No major damage was identified. There are minor wall lining cracks at internal door openings, a crack in the front window frame and broken glass, and cracked floor tiles in the public toilets area.

Some bulging of the rear wall was noted due to the shed pushing into the building from movement of the retaining wall at the rear.

Critical Structural Weaknesses
No critical structural weaknesses have been identified.

It is noted that there is a lack of connection between the bearers and the foundation to provide effective lateral load transfer. Although failure at this connection is unlikely, any failure would not result in collapse. This deficiency is not compliant with the Building Act and should be remedied as soon as possible.

Indicative Building Strength
Based on the information available, and from undertaking a quantitative assessment, the building's seismic capacity has been assessed to be 78%NBS across and greater than 100%NBS along the building, as limited by the wall bracing. It is therefore not classed as an earthquake prone building under the NZSEE classification system.

Recommendations
We recommend that the following repairs and remedial works be undertaken:

(a) Remove the rear shed or provide a structural gap of at least 200mm between the shed and the dry stone retaining wall,

(b) The dry stone retaining wall should be reinspected by a Geotechnical Engineer to confirm the wall's integrity,

(c) Install hold-down connections between the timber bearers and rock piers, or new anchor piles at isolated locations at the building perimeter,

(d) If required to improve capacity to 100%NBS or more, investigate options for strengthening taking into account the bracing across the front of the building,

(e) Repair cracked wall linings and front window frame and glazing,

(f) Replace cracked verandah column,

(g) Investigate strengthening or replacement of spliced verandah rafters.

Contents

1 Introduction

Opus International Consultants Limited has been engaged by Christchurch City Council (CCC) to undertake a detailed seismic assessment of the Lyttelton Information Centre, located in Lyttelton, 20 Oxford St, following the M6.3 Christchurch earthquake on 22 February 2011.

The purpose of the assessment is to determine if the building is classed as being earthquake prone in accordance with the Building Act 2004.

The seismic assessment and reporting have been undertaken based on the quantitative procedures detailed in the Detailed Engineering Evaluation Procedure (DEEP) document (draft) issued by the Structural Engineering Society (SESOC) on 19 July 2011.

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 to carry out a full structural survey before the building is re-occupied.

We understand that CERA 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). CERA have adopted the Detailed Engineering Evaluation Procedure (DEEP) document (draft) issued by the Structural Engineering Society (SESOC) on 19 July 2011. This document sets out a methodology for both initial qualitative and detailed quantitative assessments.

It is anticipated that a number of factors, including the following, will determine the extent of evaluation and strengthening level required:

1. The importance level and occupancy of the building.

2. The placard status and amount of damage.
3. The age and structural type of the building.
4. Consideration of any critical structural weaknesses.

Christchurch City Council requires any building with a capacity of less than 34% of New Building Standard (including consideration of critical structural weaknesses) to be strengthened to a target of 67% as required under the CCC Earthquake Prone Building Policy.

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 the alteration. This effectively means that a building cannot be weakened as a result of an alteration (including partial demolition).

The Earthquake Prone Building policy for the territorial authority shall apply as outlined in Section 2.3 of this report.

Section 115 – Change of Use

This section requires that the territorial authority is satisfied that the building with a new use complies with the relevant sections of the Building Code 'as near as is reasonably practicable'.

This is typically interpreted by territorial authorities as being 67% of the strength of an equivalent new building or as near as practicable. This is also the minimum level recommended by the New Zealand Society for Earthquake Engineering (NZSEE).

Section 121 – Dangerous Buildings

This section was extended by the Canterbury Earthquake (Building Act) Order 2010, and defines a building as dangerous if:

1. 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
2. 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
3. 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
4. There is a risk that other property could collapse or otherwise cause injury or death; or

5. 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 (EPB) 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 loads 33% of those 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 on 4 September 2010.

The 2010 amendment includes the following:

1. A process for identifying, categorising and prioritising Earthquake Prone Buildings, commencing on 1 July 2012;
2. A strengthening target level of 67% of a new building for buildings that are Earthquake Prone;
3. A timeframe of 15-30 years for Earthquake Prone Buildings to be strengthened; and,
4. 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.

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.

Where an application for a change of use of a building is made to Council, the building will be required to be strengthened to 67% of New Building Standard or as near as is reasonably practicable.

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.

On 19 May 2011, Compliance Document B1: Structure was amended to include increased seismic design requirements for Canterbury as follows:

- increase in the basic seismic design load for the Canterbury earthquake region (Z factor increased to 0.3 equating to an increase of 36 – 47% depending on location within the region);
- Increased serviceability requirements.

2.5 Institution of Professional Engineers New Zealand (IPENZ) Code of Ethics

One of the core ethical values of professional engineers in New Zealand is the protection of life and safeguarding of people. The IPENZ Code of Ethics requires that:

Members shall recognise the need to protect life and to safeguard people, and in their engineering activities shall act to address this need.

1.1 Giving Priority to the safety and well-being of the community and having regard to this principle in assessing obligations to clients, employers and colleagues.

1.2 Ensuring that responsible steps are taken to minimise the risk of loss of life, injury or suffering which may result from your engineering activities, either directly or indirectly.

All recommendations on building occupancy and access must be made with these fundamental obligations in mind.

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 loadings are in accordance with the current earthquake loading standard NZS1170.5 [1].

A generally accepted classification of earthquake risk for existing buildings in terms of %NBS that has been proposed by the NZSEE 2006 [2] is presented in Figure 1 below.

Description	Grade	Risk	%NBS	Existing Building Structural Performance
Low Risk Building	A or B	Low	Above 67	Acceptable (improvement may be desirable)
Moderate Risk Building	B or C	Moderate	34 to 66	Acceptable legally. Improvement recommended
High Risk Building	D or E	High	33 or lower	Unacceptable (Improvement required under Act)

Improvement of Structural Performance	
Legal Requirement	NZSEE Recommendation
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
	Not recommended. Acceptable only in exceptional circumstances
Unacceptable	Unacceptable

Figure 1: NZSEE Risk Classifications Extracted from table 2.2 of the NZSEE 2006 AISPBE Guidelines

Table 1 below 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).

Table 1: %NBS compared to relative risk of failure

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

3.1 Minimum and Recommended Standards

Based on governing policy and recent observations, Opus makes the following general recommendations:

3.1.1 Occupancy

The Canterbury Earthquake Order[1] in Council 16 September 2010, modified the meaning of "dangerous building" to include buildings that were identified as being EPB's. As a result of this, we would expect such a building would be issued with a Section 124 notice, by the Territorial Authority, or CERA acting on their behalf, once they are made aware of our assessment. Based on information received from CERA to date and from the DBH guidance document dated 12 June 2012 [6], this notice is likely to prohibit occupancy of the building (or parts thereof), until its seismic capacity is improved to the point that it is no longer considered an EPB.

3.1.2 Cordoning

Where there is an overhead falling hazard, or potential collapse hazard of the building, the areas of concern should be cordoned off in accordance with current CERA/territorial authority guidelines.

3.1.3 Strengthening

Industry guidelines (NZSEE 2006 [2]) strongly recommend that every effort be made to achieve improvement to at least 67%NBS. A strengthening solution to anything less than 67%NBS would not provide an adequate reduction to the level of risk.

It should be noted that full compliance with the current building code requires building strength of 100%NBS.

3.1.4 Our Ethical Obligation

In accordance with the IPENZ code of ethics, we have a duty of care to the public. This obligation requires us to identify and inform CERA of potentially dangerous buildings; this would include earthquake prone buildings.

[1] This Order only applies to buildings within the Christchurch City, Selwyn District and Waimakariri District Councils authority

4 Building Description

4.1 General

The Lyttelton Information Centre building is a single storey timber framed structure with corrugated iron sheet wall cladding and a corrugated iron roof. The floor bearers sit on rock upstand piers.

The building is approximately 13.5m long in the east-west direction and 9.2m wide in the north-south direction. The apex of the roof is approximately 6.5m from the ground and the stud height is approximately 3.6m. The building consists of a front office/reception area, office in the middle and the kitchen and toilet are in the rear. A separate, but attached, public amenities area is on the right – possibly a lean-to addition.

The building has a plasterboard or fibrous plaster lined ceiling at 3.6m height except within the central skylight area. The lining in an area of the kitchen wall was investigated and it showed an internal lining of plasterboard over either ply or tongue and groove lining.

The building age is unknown, but it is expected to have been built before the 1960s.

4.2 Gravity Load Resisting System

The roof is a timber framed roof clad in corrugated iron sheet, with the ceiling lined with either fibrous plaster or possibly plasterboard.

The subfloor consists of timber flooring on timber joists and timber bearers sitting on short stone piers.

4.3 Seismic Load Resisting System

Seismic loads in both principal directions are resisted by sheet lined bracing walls. The ceiling is assumed to provide an adequate flexible diaphragm to distribute the seismic induced lateral loads to the wall bracing elements.

There was no sign of any hold-down connection between the rock piers and the timber bearers to transfer the lateral loads directly to the foundation.

5 Survey

The building was previously issued with a red placard (not issued as part of this inspection and now expired), the reason noted as being due to the falling danger of the neighbouring building. This building has since been demolished and no longer represents a hazard.

Copies of the following drawings were referred to as part of the assessment:

- Measured-up sketches of the building completed by Opus Architecture, titled "Lyttelton Information Centre, Existing Plan and Section".

No copies of the design calculations nor structural drawings have been obtained for this building.

The sketch drawings and survey photos have been used to confirm the structural systems, investigate potential critical structural weaknesses (CSW) wherever possible, and identify details which required particular attention.

6 Damage Assessment

The building structure does not appear to have suffered major damage as a result of the recent earthquake events.

There are minor cracks at door openings in the wall linings. There are broken glass windows at the front and a crack in the window frame of the external wall, and cracked floor tiles in the public toilets area.

Some bulging of the rear wall was noted due to the shed pushing into the building from movement of the retaining wall at the rear.

It was also noted that a verandah post was cracked, though this is more likely due to vehicle impact than earthquake forces. The splice in the verandah rafters were noted to be pulling apart, but again, this may not be earthquake damage.

7 General Observations

Overall the building has performed well under seismic conditions which would be expected for a single-storey timber framed structure. The building has sustained little damage. However the shed at the rear of the building should be removed to prevent further damage to the building due to further rotation of the retaining wall.

Due to the non-intrusive nature of the original survey, many connection details could not be ascertained.

8 Detailed Seismic Assessment

The detailed seismic assessment has been based on the NZSEE 2006 [2] guidelines for the “Assessment and Improvement of the Structural Performance of Buildings in Earthquakes” together with the “Guidance on Detailed Engineering Evaluation of Earthquake Affected Non-residential Buildings in Canterbury, Part 2 Evaluation Procedure” [3] draft document prepared by the Engineering Advisory Group on 19 July 2011, and the SESOC guidelines “Practice Note – Design of Conventional Structural Systems Following Canterbury Earthquakes” [5] issued on 21 December 2011.

8.1 Critical Structural Weaknesses

As outlined in the Critical Structural Weakness and Collapse Hazards draft briefing document, issued by the Structural Engineering Society (SESOC) on 7 May 2011, the term ‘Critical Structural Weakness’ (CSW) refers to a component of a building that could contribute to increased levels of damage or cause premature collapse of the building.

We have not identified any critical structural weaknesses with this building.

8.2 Seismic Coefficient Parameters

The seismic design parameters based on current design requirements from NZS1170.5:2004 and the NZBC clause B1 for this building are:

- Site soil class C, clause 3.1.3 NZS 1170.5:2004;
- Site hazard factor, Z=0.3, B1/VM1 clause 2.2.14B;
- Return period factor R_u = 1.0 from Table 3.5, NZS 1170.5:2004, for an Importance Level 2 structure with a 50 year design life;
- μ_{max} = 2.0 for wall bracing elements

8.3 Detailed Seismic Assessment Results

A summary of the structural performance of the building is shown in the following table.

Table 2: Summary of Seismic Performance

Structural Element/System	Failure mode and description of limiting criteria	% NBS based on calculated capacity
Walls in the north-south direction i.e. across the building	Bracing capacity of wall across the building-Grid 3	87%
Walls in the north-south direction i.e. across the building	Bracing capacity of wall across the building-Grid 4	78%
Walls in the east-west direction i.e. along the building	Bracing capacity of wall along the building-Grid B	>100%

8.4 Discussion of Results

The building has a calculated capacity of 78%NBS, as limited by the bracing capacity of the walls in the north-south directions (across).

It has been assumed that the ceiling lining acts as an adequate flexible diaphragm.

As the building has a capacity of greater than 67%NBS it is defined as a low earthquake risk building under the NZSEE classification system. Strengthening work would need to be investigated if deemed necessary to increase the building capacity to 100%NBS or more, taking into account the wall bracing along the street-front.

As highlighted in Section **Error! Reference source not found.**, there is lack of connection between the bearers and the foundation to provide effective lateral load transfer. Although failure at this connection is unlikely, any failure would not result in collapse. This deficiency is not compliant with the Building Act and should be remedied as soon as possible.

8.5 Limitations and Assumptions in Results

Our analysis and assessment is based on an assessment of the building in its undamaged state. Therefore the current capacity of the building will be lower than that stated.

The results have been reported as a %NBS and the stated value is that obtained from our analysis and assessment. Despite the use of best national and international practice in this analysis and assessment, this value contains uncertainty due to the many assumptions and simplifications which are made during the assessment. These include:

- Simplifications made in the analysis, including boundary conditions such as foundation fixity,
- Assessments of material strengths based on limited drawings, specifications and site inspections,
- The normal variation in material properties which change from batch to batch,
- Approximations made in the assessment of the capacity of each element, especially when considering the post-yield behaviour.

9 Summary of Geotechnical Appraisal

The geotechnical appraisal for the building is contained in Appendix C of this report. A summary of the geotechnical appraisal is as follows:

9.1 General

A search of CCC property files has not located any construction drawings for this building.

No geotechnical reports or records of a ground condition assessment associated with the construction of the original building or additions have been identified.

The site has a slight slope of approximately 1% towards the south. The height of the footing is 100mm on the northern side and increased to 250mm at the southern end.

The 1:25,000 Geological Map of Christchurch Urban Area (GNS 2008) indicates the site is underlain by windblown loess deposits over basalt to trachytic lava flows of the Lyttelton Volcanic Group. The loess typically comprises yellow brown silt deposits, locally fine sand or clay, up to 3.0m in thickness.

9.2 Liquefaction Potential

The Christchurch Earthquake Recovery Authority (CERA) has classified the site and surrounding residential properties as Green Zone, indicating the repair and rebuilding process can begin.

The maps that were released by the Department of Building and Housing (DBH) indicate that the surrounding areas of the site are classified as 'N/A – Port Hills & Banks Peninsula'. We anticipate the site to be the equivalent of Foundation Technical Category 1 (TC1). Future land damage from liquefaction is unlikely, and ground settlements are expected to be within normally acceptable tolerances.

9.3 Discussion

The Visitor Information Centre foundations appear to have performed adequately during the seismic events. Based on visual observations, differential settlement up to 20mm has occurred. No level survey has been undertaken.

A small shed has been built as an annex to the building. The retaining wall has moved laterally approximately 30mm pushing the shed and thus damaging the main unit. Also, because of the horizontal accelerations during the earthquakes, minor cracking has appeared at the mortar joints within the retaining wall with crack widths of up to 10mm.

GNS Science indicates an elevated risk of seismic activity is expected in the Canterbury region as a result of the earthquake sequence following the 4th September 2010 earthquake. Recent advice indicates there is a 14% probability of another Magnitude 6 or greater earthquake occurring in the next 12 months in the Canterbury region. This event may cause shaking damage at the site, dependent on the location of the earthquakes epicentre. It is expected that the probability of occurrence is likely to decrease with time following periods of reduced seismic activity

9.4 Recommendations

Based on the building performance in recent earthquakes, the existing foundations should be acceptable in terms of future ultimate limit state (ULS) and serviceability limit state (SLS) loadings, although CCC will have to accept the risk for potential differential settlement in the order of 0 to 30mm in a future seismic event.

Minor cracking at the mortar joints in the dry stone retaining wall has occurred. We recommend that once the shed is demolished or a 200mm structural gap is installed, the dry stone retaining wall is reinspected by a Geotechnical Engineer to confirm the integrity.

10 Remedial Options

The bulging rear wall should be relieved of stress by demolishing the rear shed that lies between the building and the rear retaining wall or by providing a 200mm structural gap between the shed and retaining wall.

The bearers should be fixed to the rock pier foundations or an alternative system installed, for example, new anchor piles at isolated locations at the building perimeter.

If deemed necessary to strengthen the building to 100%NBS further structural investigations should be undertaken taking into account the bracing across the front of the building.

11 Conclusions

The building was previously issued with a red placard (not issued as part of this inspection and now expired), the reason noted as being due to the falling danger of the neighbouring building. This building has since been demolished and no longer represents a hazard.

The building has a seismic capacity of greater than 33%NBS and is therefore not classified as earthquake prone in accordance with the Building Act 2004. The capacity is greater than 67% NBS and is therefore classed as a low earthquake risk building under the NZSEE classification system. Minor structural repairs are required.

12 Recommendations

We recommend that the following repairs and remedial works be undertaken:

(a) Remove the rear shed or provide a structural gap of at least 200mm between the shed and the dry stone retaining wall,

(b) The dry stone retaining wall should be reinspected by a Geotechnical Engineer to confirm the wall's integrity,

(c) Install hold-down connections between the timber bearers and rock piers, or new anchor piles at isolated locations at the building perimeter,

(d) If required to improve capacity to 100%NBS or more, investigate options for strengthening taking into account the bracing across the front of the building,

(e) Repair cracked wall linings and front window frame and glazing,

(f) Replace cracked verandah column,

(g) Investigate strengthening or replacement of spliced verandah rafters.

13 Limitations

(a) This report is based on an inspection of the structure with a focus on the damage sustained from the 22 February 2011 Canterbury Earthquake and aftershocks only. Some non-structural damage is mentioned but this is not intended to be a comprehensive list of non-structural items.

(b) Our professional services are performed using a degree of care and skill normally exercised, under similar circumstances, by reputable consultants practicing in this field at the time.

(c) This report is prepared for the CCC to assist with assessing remedial works required for council buildings and facilities. It is not intended for any other party or purpose.

14 References

[1] NZS 1170.5: 2004, *Structural design actions, Part 5 Earthquake actions,* Standards New Zealand.

[2] NZSEE: 2006, *Assessment and improvement of the structural performance of buildings in earthquakes,* New Zealand Society for Earthquake Engineering.

[3] Engineering Advisory Group, *Guidance on Detailed Engineering Evaluation of Earthquake Affected Non-residential Buildings in Canterbury, Part 2 Evaluation Procedure*, Draft Prepared by the Engineering Advisory Group, Revision 5, 19 July 2011.

[4] Engineering Advisory Group, *Guidance on Detailed Engineering Evaluation of Non-residential buildings, Part 3 Technical Guidance*, Draft Prepared by the Engineering Advisory Group, 13 December 2011.

[5] SESOC, *Practice Note – Design of Conventional Structural Systems Following Canterbury Earthquakes*, Structural Engineering Society of New Zealand, 21 December 2011.

Appendix 1 - Photographs

Photo 1: View of the building from the street. Broken window glass in the front

Photo 2: View of the building from the street

Photo 3: View of Front canopy – splice at curve of rafter

Photo 4: Cracked verandah post

Photo 5: Subfloor bearers on rock piers

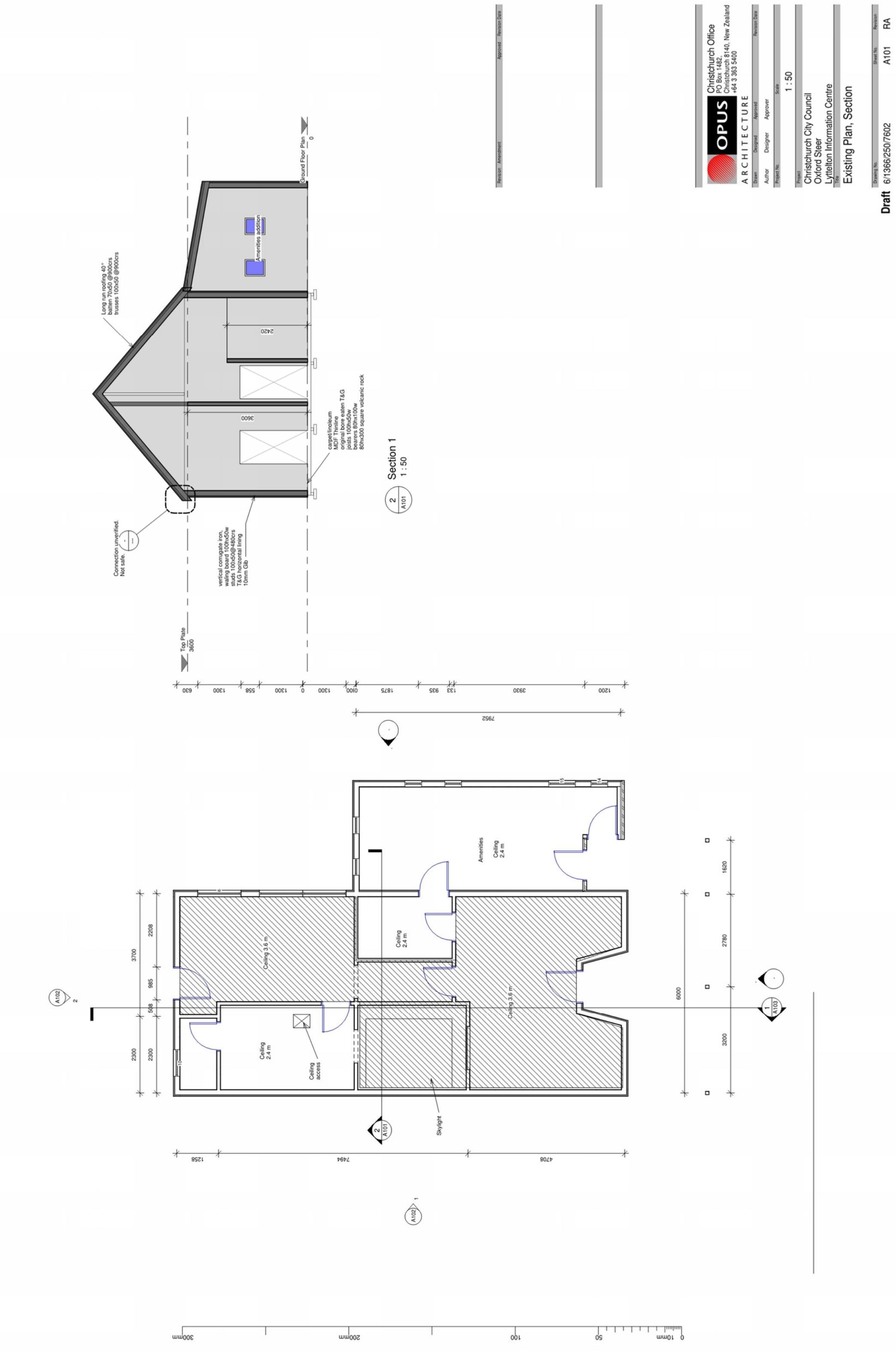
Photo 6: Crack in the window frame above the front door

Photo 7: Horizontal crack in the internal wall

Photo 8: View of the back of the building and adjacent shed

Photo 9: View of the retaining wall and shed at rear of the building

Appendix 2 – Measure-up Sketches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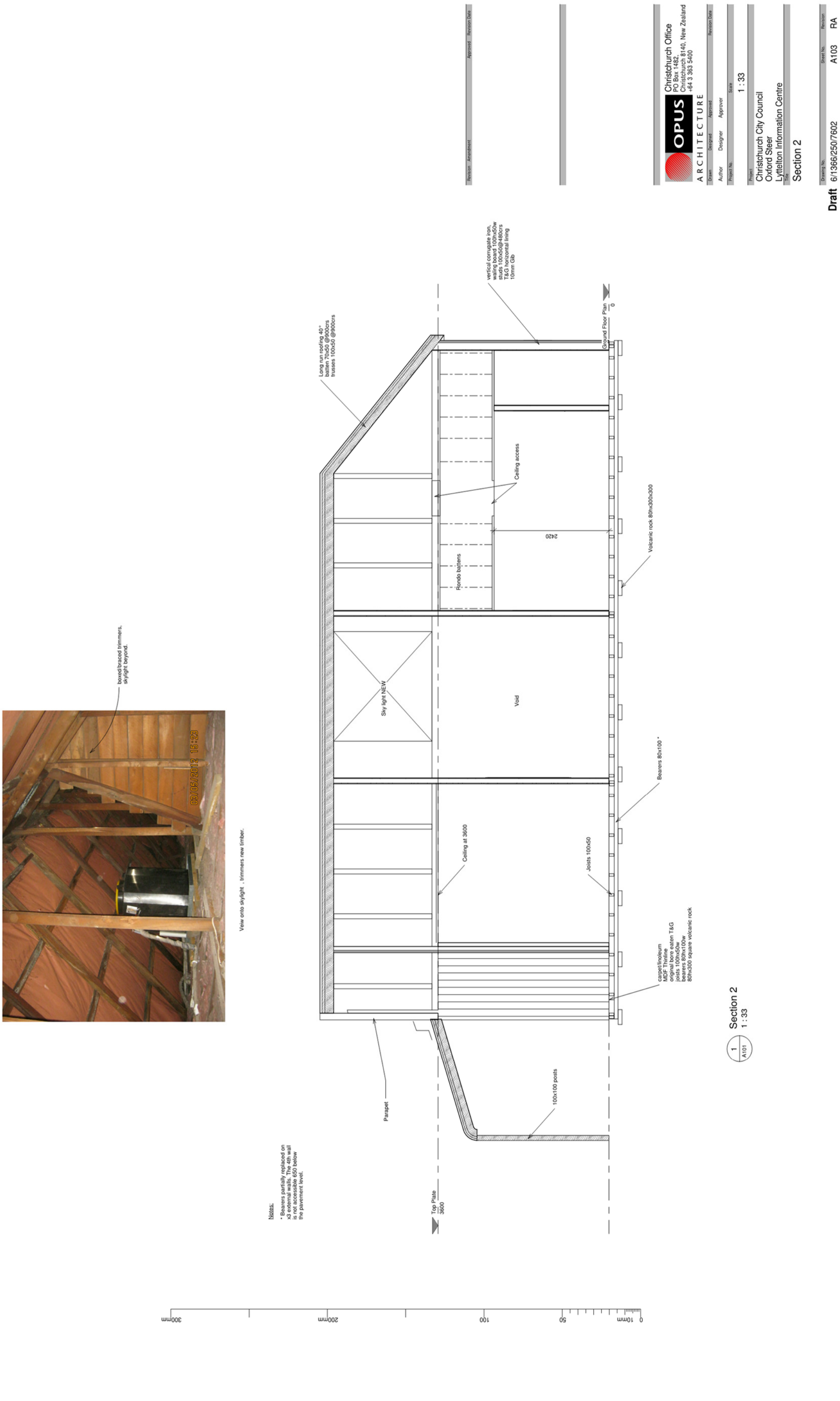
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skylight beyond.
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trusses 100x50 @900crs
vertical corrugate iron,
waling board 100hx50w
studs 100x50@480crs
T&G horizontal lining
10mm Gib
Ground Floor Plan
0
Ceiling access
2420
Rondo battens
Volcanic rock 80hx300x300
Sky light NEW
Void
Bearers 80x100 *
Ceiling at 3600
Joists 100x50
carpet/linoleum
MDF Thinline
original bore eaten T&G
joists 100hx50w
bearers 80hx100w
80hx300 square volcanic rock
Parapet
100x100 posts
Notes:
* Bearers partially replaced on x3 external walls. The 4th wall is not accessible 650 below the pavement level.
Top Plate
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A101
Section 2
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50
100
200mm
300mm
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Revision
Amendment
Approved
Revision Date
OPUS
ARCHITECTURE
Christchurch Office
PO Box 1482,
Christchurch 8140, New Zealand
+64 3 363 5400
Drawn
Designed
Approved
Revision Date
Author
Designer
Approver
Project No.
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Christchurch City Council
Oxford Steer
Lyttelton Information Centre
Title
Section 2
Drawing No.
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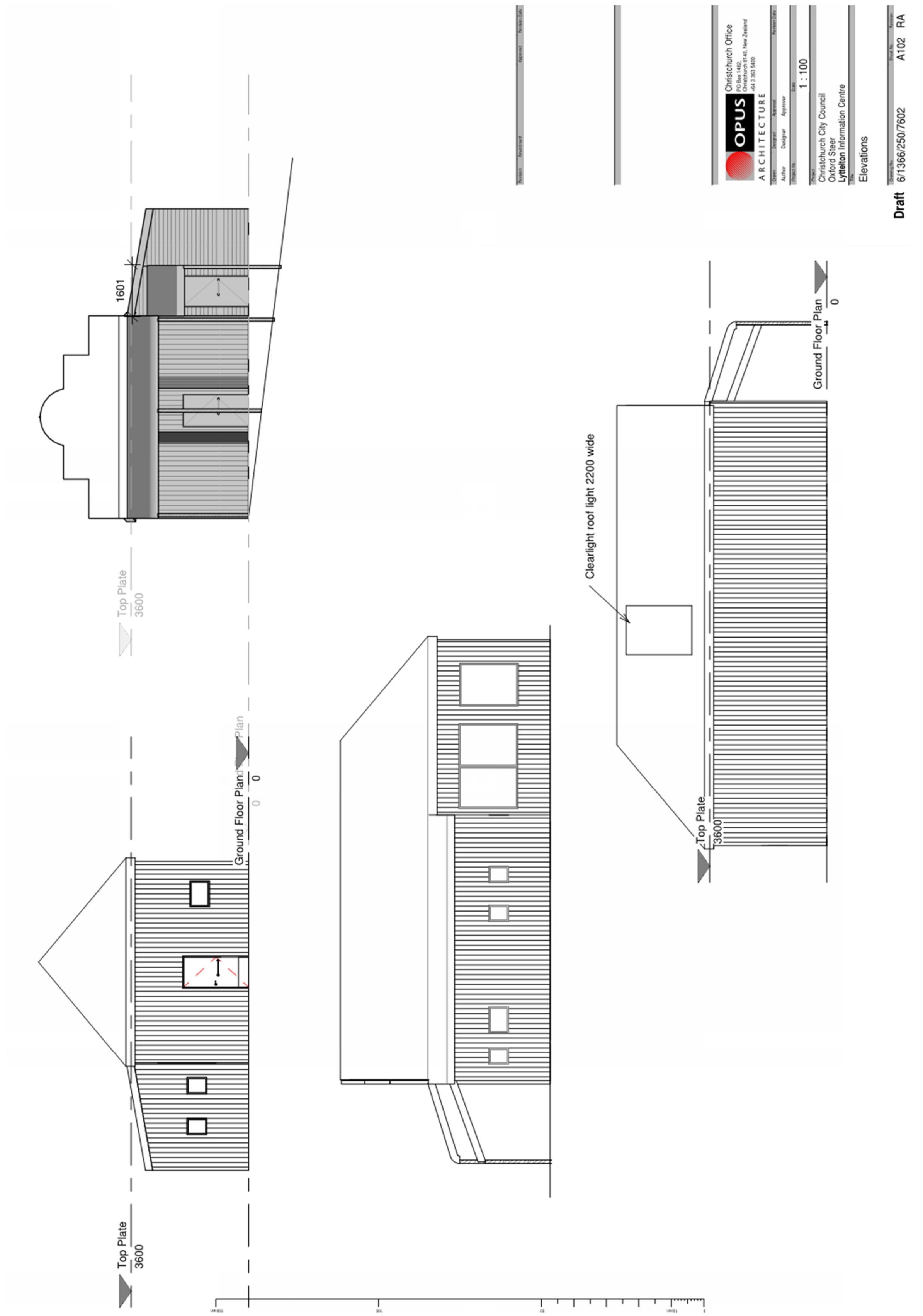
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Christchurch City Council
Oxford Steer
Lyttelton Information Centre
Elevations
Draft
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A102
RA

Appendix 3 – Geotechnical Appraisal

11 July 2012

Michael Sheffield
Christchurch City Council
PO Box 237
CHRISTCHURCH 8140

6-QUCC1.02/005SC

Dear Michael,

Geotechnical Desktop Study – Lyttelton Visitor Information Centre

1. Introduction

This report summarises the findings of a geotechnical desktop study and site walkover completed by Opus International Consultants (Opus) for the Christchurch City Council (CCC) at the above property on 9 May 2012. The Geotechnical Desk Study follows the Canterbury Earthquake Sequence initiated by the 4 September 2010 earthquake.

This Geotechnical Desk Study has been prepared in accordance with the Engineering Advisory Group's Guidance on Detailed Engineering Evaluation of Earthquake Affected Non-residential Building in Cantebury, revision 5, 19 July 2011.

The Geotechnical Desk Study forms part of a Detailed Engineering Evaluation prepared by opus. A level survey has not been undertaken. The Geotechnical Desk Study has been undertaken without the benefit of any site specific investigations and is therefore preliminary in its nature.

The purpose of the geotechnical study is to assess the current ground conditions and the potential geotechnical hazards that may be present at the site, and determine whether further subsurface geotechnical investigations are necessary.

It is our understanding this is the first inspection by a Geotechnical Engineer of this property following the Canterbury Earthquake Sequence.

2. Desktop Study

2.1 Site Description

The Lyttelton Visitor Information Centre is located at 20 Oxford Street in Lyttelton. A vacant section is present on the north side of the site and a driveway leading to a cul-de-sac is on the southern side of the site.

The building is a single storey structure with corrugated steel cladding and a timber frame structure. From the visual inspection, the foundation is formed of perimeter concrete footing and the internal timber beams are supported on rocks.

The site has a slight slope of approximately 1% towards the south. The height of the footing is 100mm on the northern side and increased to 250mm at the southern end.

Opus International Consultants Limited
Christchurch Office

20 Moorhouse Avenue
PO Box 1482, Christchurch Mail Centre,
Christchurch 8140, New Zealand

Telephone: +64 3 363 5400
Facsimile: +64 3 365 7858
Website: www.opus.co.nz

2.2 Structural Drawings

A search of CCC property files has not located any construction drawings for this building.

No geotechnical reports or records of a ground condition assessment associated with the construction of the original building or additions, have been identified.

2.4 Regional Geology

The 1:25,000 Geological Map of Christchurch Urban Area (GNS 2008) indicates the site is underlain by windblown loess deposits over basalt to trachytic lava flows of the Lyttelton Volcanic Group. The loess typically comprises yellow brown silt deposits, locally fine sand or clay, up to 3.0m in thickness.

According to Environment Canterbury Regional Council records, groundwater is anticipated to be lower than 1.5m below ground level.

2.5 Ground Damage

No evidence of liquefaction was observed in aerial photographs taken after the 4th September earthquake, and the aftershocks of 22 February 2011 and 13 June 2011, or the 24 December 2011 earthquake.

2.6 Liquefaction Hazard

Tonkin and Taylor Ltd (T&T Ltd) have been engaged as the Earthquake Commission's (EQC) geotechnical consultants and have prepared maps showing areas of liquefaction interpreted from high resolution aerial photos following the 4th September 2010 and aftershocks. No evidence of liquefaction has been reported in the Lyttelton Area.

The 2004 Environment Canterbury Solid Facts Liquefaction Study indicates the site is in an area designated as 'very low likelihood of liquefaction (Port Hills)'.

The Christchurch Earthquake Recovery Authority (CERA) last updated 11 December, 2011 has classified the site and surrounding residential properties as Green Zone, indicating the repair and rebuilding process can begin.

The maps that were released by the Department of Building and Housing (DBH) indicate that the surrounding areas of the site are classified as 'N/A – Port Hills & Banks Peninsula'. We anticipate the site to be the equivalent of Foundation Technical Category 1 (TC1). Future land damage from liquefaction is unlikely, and ground settlements are expected to be within normally acceptable tolerances.

3. Site Walkover Inspection

A walkover inspection of the building and surrounding land was carried out by an Opus Geotechnical Engineer on 9 May 2012. The following observations were made:

- The building has experienced differential settlement estimated to be up to 20mm;
- The building has suffered damage due to the annexed shed being pushed into the main building. There is no evidence of damage to foundations;

- The 4 metre high dry stone retaining wall behind the Lyttelton Visitor Information Centre has cracks up to 10mm in width and has translated horizontally by approximately 30mm.

The settlements that the building has experienced are estimated to have been below 15mm and no clear signs of differential settlement were noted. The above observations are based on the visual observations, no level survey has been undertaken.

The retaining wall on the eastern boundary is constructed of stone blocks and is approximately 6m high at its highest point and lowers to about 4m height. The top 1.0 metre of the wall is formed of concrete. Due to the earthquake events, cracks have appeared in the wall, at the mortar joints and measure approximately 10mm in width.

The site walkover inspection did not identify any areas that suffered from liquefaction, which is agreement with the desk study.

4. Discussion

The Visitor Information Centre foundations appear to have performed adequately during the seismic events. Based on visual observations, differential settlement up to 20mm has occurred. No level survey has been undertaken.

A small shed has been built as an annex to the building. It is understood that the Structural Engineers have decided that the shed needs to be demolished as its structure is deformed and is pressing onto the main building.

The retaining wall has moved laterally approximately 30mm pushing the shed and thus damaging the main unit. Also, because of the horizontal accelerations during the earthquakes, minor cracking has appeared at the mortar joints within the retaining wall with crack widths of up to 10mm.

The retaining wall has moved less than 50mm however this translational movement was enough to compress the shed's longitudinal beam.

GNS Science indicates an elevated risk of seismic activity is expected in the Canterbury region as a result of the earthquake sequence following the 4th September 2010 earthquake. Recent advice[1] indicates there is a 14% probability of another Magnitude 6 or greater earthquake occurring in the next 12 months in the Canterbury region. This event may cause shaking damage at the site, dependent on the location of the earthquakes epicentre. It is expected that the probability of occurrence is likely to decrease with time following periods of reduced seismic activity

[1] GNS Science reporting on Geonet Website: http://www.geonet.org.nz/canterbury-quakes/aftershocks/ updated on 28 May 2012.

5. Recommendations

- Based on the building performance in recent earthquakes, the existing foundations should be acceptable in terms of future ultimate limit state (ULS) and serviceability limit state (SLS) loadings, although CCC will have to accept the risk for potential differential settlement in the order of 0 to 30mm in a future seismic event;

- Minor cracking at the mortar joints in the dry stone retaining wall has occurred. We recommend that once the shed is demolished, the dry stone retaining wall is re-inspected by an Opus Geotechnical Engineer to confirm the integrity.

6. Limitation

This report has been prepared solely for the benefit of Christchurch City Council as our client with respect to the brief. The reliance by other parties on the information or opinions contained in the report shall, without our prior review and agreement in writing, be at such parties' sole risk.

Figures:
Site Location Plan
Walkover Inspection Plan
Site Photographs

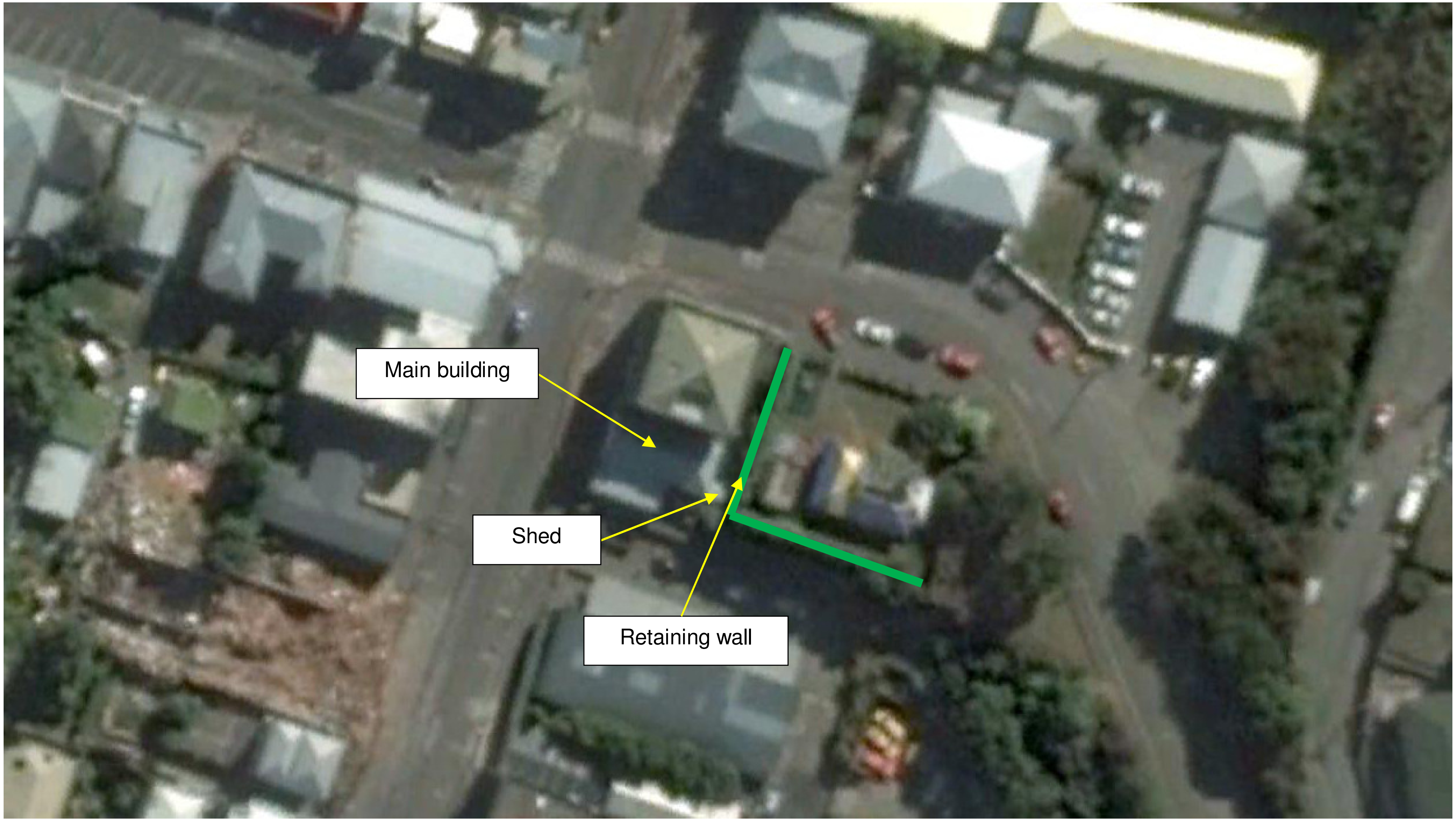
Opus International Consultants Ltd.
Christchurch Office
20 Moorhouse Ave
PO Box 1482
Christchurch, New Zealand
Tel: +64 3 363 5400 Fax: +64 3 365 7857

Project: 20 Oxford Street
Geotechnical Desktop Study
Project No.: 6-QUCC1.02/005SC
Client: Christchurch City Council

Site Location Plan

Completed by: Opus Geotechnical Engineer

Date Drawn: 09/05/2012

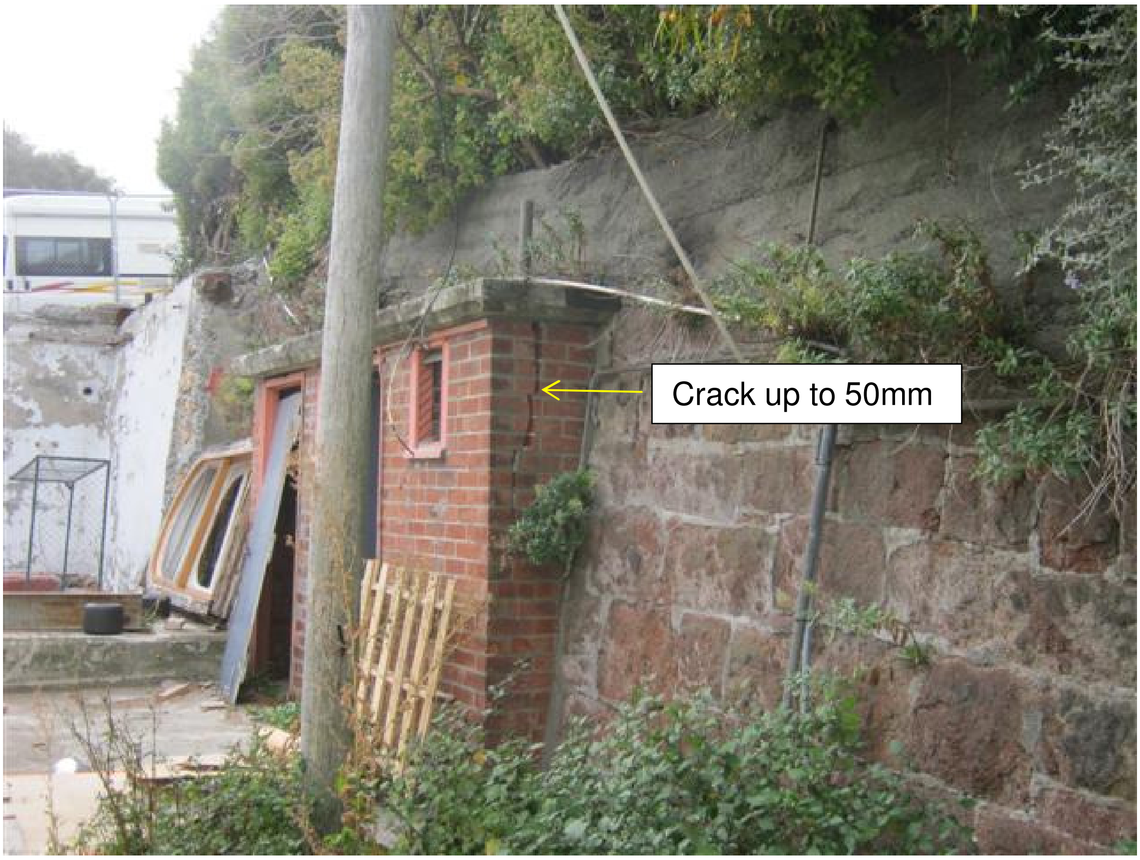


Opus International Consultants Ltd. Christchurch Office 20 Moorhouse Ave PO Box 1482 Christchurch, New Zealand Tel: +64 3 363 5400 Fax: +64 3 365 7857	**Project:** 20 Oxford Street Geotechnical Desktop Study **Project No.:** 6-QUCC1.25/005SC **Client:** Christchurch City Council	**Walkover Inspection Plan** **Completed by:** Opus **Date Drawn:** 09/05/2012


Photograph 1. Shed at the rear of the building

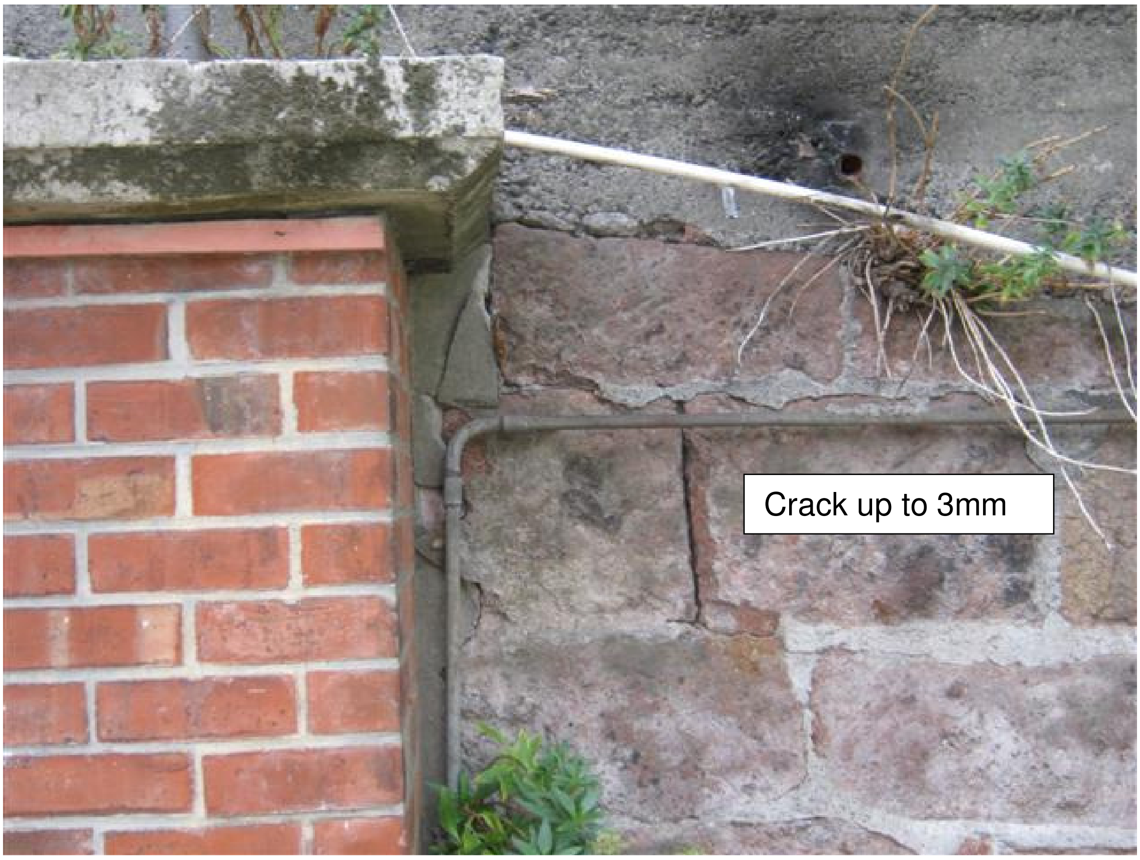

Photograph 2. Deformations along the roof of the shed

Photograph 3. Joint between the shed and building



Photograph 4. Neighbouring structure cracks due to wall movement

Photograph 5. Wall cracks



Photograph 6. Wall cracks

Photograph 7. Wall cracks

Appendix 4 – CERA DEE Data Sheet

Detailed Engineering Evaluation Summary Data V1.11

Location

Building Name:	Lyttelton Information Centre	Reviewer:	Dave Dekker
	Unit / No: / Street	CPEng No:	1003026
Building Address:	20 Oxford St	Company:	Opus International Consultants Ltd
Legal Description:		Company project number:	6-QUCC1.02
		Company phone number:	03 363 5400
	Degrees / Min / Sec		
GPS south:	43 / 36 / 11.70	Date of submission:	26-Oct-12
GPS east:	172 / 43 / 21.80	Inspection Date:	21/03/2012
		Revision:	Final
Building Unique Identifier (CCC):	PRK 3505-BLDG-003_006	Is there a full report with this summary?	yes

Site

Site slope:		Max retaining height (m):	
Soil type:		Soil Profile (if available):	
Site Class (to NZS1170.5):			
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:	other (describe)		if Foundation type is other, describe:	
Building height (m):	3.60		height from ground to level of uppermost seismic mass (for IEP only) (m):	
Floor footprint area (approx):				
Age of Building (years):			Date of design:	
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):	IL2			

Gravity Structure

Gravity System:	load bearing walls		
Roof:	timber framed	rafter type, purlin type and cladding	timber and corrugated iron
Floors:	timber	joist depth and spacing (mm)	
Beams:			
Columns:			
Walls:			

Lateral load resisting structure

Lateral system along:	lightweight timber framed walls	**Note: Define along and across in detailed report!**		
Ductility assumed, μ:	2.00		note typical wall length (m)	
Period along:	0.24	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			
Ductility assumed, μ:	2.00		note typical wall length (m)	
Period across:	0.24	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	metal external, ply or t&g with plaster over
Roof Cladding:	Metal	describe	
Glazing:	timber frames		
Ceilings:	plaster, fixed		plasterboard or fibrous plaster
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:		notes (if applicable):	
Differential settlement:		notes (if applicable):	
Liquefaction:		notes (if applicable):	
Lateral Spread:		notes (if applicable):	
Differential lateral spread:		notes (if applicable):	
Ground cracks:		notes (if applicable):	
Damage to area:		notes (if applicable):	

Building:

	Current Placard Status:	red		
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:	wall lining cracks, cracked window frame

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

Recommendations

	Level of repair/strengthening required:	minor structural	Describe:	strengthen front wall bracing, repair damage
	Building Consent required:	no	Describe:	
	Interim occupancy recommendations:	full occupancy	Describe:	
Along	Assessed %NBS before e'quakes:	100%	##### %NBS from IEP below	If IEP not used, please detail assessment methodology: Quantitative
	Assessed %NBS after e'quakes:	100%		
Across	Assessed %NBS before e'quakes:	78%	##### %NBS from IEP below	
	Assessed %NBS after e'quakes:	78%		

Opus International Consultants Ltd
20 Moorhouse Avenue
PO Box 1482, Christchurch Mail Centre,
Christchurch 8140
New Zealand

t: +64 3 363 5400
f: +64 3 365 7858
w: www.opus.co.nz