Christchurch City Council

Stoddart Cottage
BU 3555-006 EQ2

Detailed Engineering Evaluation

Quantitative Assessment Report

OPUS

Christchurch City Council

Stoddart Cottage

Quantitative Assessment Report

Purau Avenue, Diamond Harbour

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Stoddart Cottage
BU 3555-006 EQ2

Detailed Engineering Evaluation
Quantitative Report – SUMMARY
FINAL

Purau Avenue, Diamond Harbour

Background

This is a summary of the quantitative assessment report for Stoddart Cottage located at Purau Avenue, Diamond Harbour, and is based on the Detailed Engineering Evaluation Procedure document (draft) issued by the Structural Advisory Group on 19 July 2011, visual inspection on 24 September 2012 and available drawings.

Heritage Status

Stoddart Cottage is classified as Protected under the Banks Peninsula District Plan and registered as a Category I historic place, under the provisions of the Historic Places Act, 1993.

Key Damage Observed

- Severe damage to all three brick chimneys.

Other Observations

- It is not conclusive if the building is fixed to the foundation or not. However, considering that the floor boards are well nailed to the joists which are bearing directly on the pile foundation, the floor system is likely to remain stable in a design level earthquake.
- Numerous restoration works were observed during the intrusive site investigation where the original rotted structural timber members had been replaced. Additional areas of rotted timber were also observed at the front gable rafters.

Critical Structural Weaknesses

No critical structural weaknesses were identified for this building.

Indicative Building Strength (from quantitative assessment)

Based on the information available, and from undertaking a quantitative assessment, the building's seismic capacity has been assessed to be 34% NBS. The building is not considered to be earthquake prone in accordance with the Building Act 2004.

Recommendations

a. Strengthening options be developed to increase the building's seismic capacity to as near as practicable to 100%NBS, and at least 67%NBS.
b. During the strengthening works as recommended above, conduct an intrusive investigation to check if the building is connected to the foundation. Carry out remedial works if it is not connected.
c. Proceed with the non-structural remedial works as recommended in the Building Condition Report, including the replacement of the rotted timber as highlighted in this report.
d. In the interim, the building may be occupied. Although the risk exposure is moderate, the failure modes of the critical elements identified are non-brittle.

Contents

1 Introduction

Opus International Consultants Limited (Opus) has been engaged by Christchurch City Council (CCC) to undertake a detailed seismic assessment of the Stoddart Cottage located at Purau Avenue, Diamond Harbour following the M6.3 Christchurch earthquake on 22 February 2011.

This report is a Stage Two quantitative assessment of the building structure, and is based on the qualitative and quantitative procedures detailed in the Detailed Engineering Evaluation Procedure (DEEP) document (draft) issued by the Structural Engineering Society (SESOC) on 19 July 2011 [2]. In order to expedite the detailed evaluation procedure, the qualitative assessment was not undertaken. However this report incorporates the key aspects of a qualitative assessment.

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

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

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.

4 Background Information

4.1 Building Description

The Stoddart Cottage, located at Purau Avenue, Diamond Harbour, was constructed in 1861. The building is currently managed by the Friends of Stoddart Cottage Trust and was used as a local attraction prior to the Canterbury earthquakes. It is classified as Protected under the Banks Peninsula District Plan and registered as a Category I historic place, under the provisions of the Historic Places Act, 1993.

The north facing single storey timber building has a double gable roof constructed predominantly of slate shingles on timber framing, with the exception that the north face of the rear gable is cladded in corrugated steel. There is a small attic located at the eastern half of the rear gable. The two lean-to structures to the west and south elevations appear to be later additions. Both have corrugated steel roofing. The external walls are clad in timber weatherboard except for the rear lean-to which is mostly clad in corrugated steel. The interior wall and ceiling finishes are timber matchlining, with the front room walls being further overlaid with either hardboard or softboard. The walls within the main double gable structure have a rare wall construction, where earth is packed within the wall timber framing. This appears to be loose soil that was put in for insulation purpose rather than for structural reasons. The flooring is tongue and groove timber on a timber foundation. The overall building is approximately 9m wide by 13.5m long. The height of the roof apex and the eaves are 5.2m and 2.4m respectively.

The cottage's three original brick chimneys were damaged during the Canterbury earthquakes. Two of the chimneys have been deconstructed down to the ceiling level, while the entire chimney and fireplace in the front room has been deconstructed.

For the purpose of this report, we refer to the direction parallel to Purau Avenue as east-west (longitudinal) and the perpendicular direction as north-south (transverse).

Figure 2: Diamond Harbour Stoddart Cottage Site Location

4.2 Gravity Load Resisting System

The main building roof gravity loads are supported by transverse 90 x 70mm timber rafters at 500mm centres supported on perimeter timber framed earth infilled walls. Although hidden between the floor and ceiling boards, the attic floor load is also likely to be resisted by transverse timber members similar to the rafters.

4.3 Lateral Load Resisting System

The lateral load resisting systems in both principal directions are the perimeter timber bracing walls. An overview of the key lateral resisting elements is as shown is Figure 3 below.

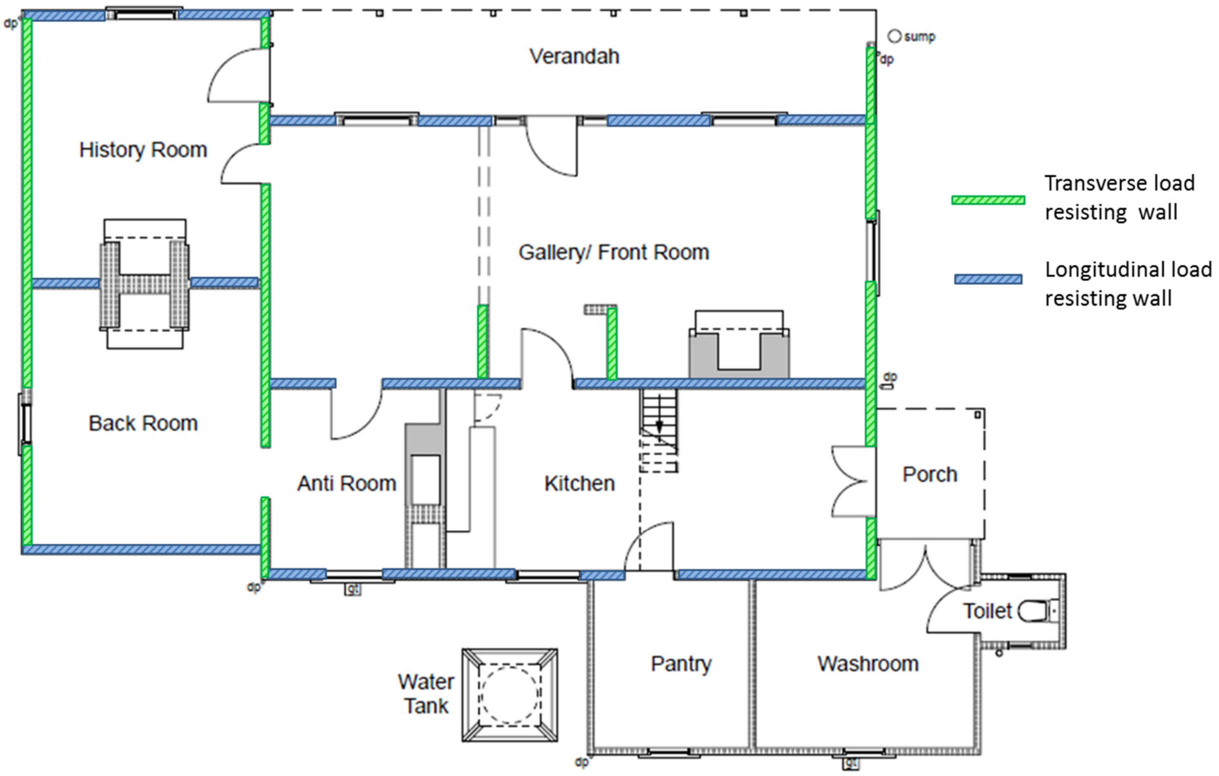


Figure 3: Building Layout and Location of Timber Bracing Wall

4.4 Foundation

The building is founded at ground level and does not facilitate a definitive investigation of the foundation system. The east elevation has a concrete skirt at the base of the external wall while in other areas the weatherboards are installed down to ground level. Based on historical records [7 & 8], amongst other restoration works, the building's timber piles were replaced in 1986.

4.5 Original Documentation

Copies of the following drawings were provided by CCC:

- Stoddart Cottage basic floor plan and elevation drawings sheet no. 5413/SK 1.0 and 1.1 by Fulton Ross dated September 2009. See Appendix 3 - Drawing.

4.6 Post 22 February 2011 Rapid Assessment

An engineer from Opus International Consultants undertook a Level 1 assessment of the building on 14 March 2011. This was followed by a Level 2 assessment by an engineer from Structex on 23 June 2011. On both assessments, the site was posted with a Red (R1) placard indicating that the building was unsafe. This was due to the collapsed brick chimneys. Further collapse risk has been mitigated as discussed in Section 5.1 below.

4.7 Further Inspections

A detailed inspection was undertaken by an Opus engineer on 12 May 2012 for the purpose of this detailed engineering evaluation. An intrusive site investigation was subsequently requested and carried out on 26 September 2012. The purpose of the intrusive site investigation was to ascertain the condition of the timber framing due to the earth infill, and the presence of any diagonal bracing to restrain lateral loading. Refer to Appendix 2 for observations from the intrusive site investigation.

5 Damage Assessment

The following damage has been noted:

5.1 Roofing & Chimney

All three brick chimneys were severely damaged during the Canterbury earthquakes and have been reduced down to ceiling level except for the east chimney where the entire chimney including fireplace has been deconstructed. See Photo 2 in Appendix 1. Any future reinstatement of these chimneys would need to consider structural strengthening down to the ground level.

5.2 Load Bearing Wall

No observed earthquake related damage. However, refer to Section 6 on general observations of the timber wall construction.

5.3 Flooring

No observed earthquake related damage.

5.4 Foundation

As mentioned in section 4.4 above, visual inspection of the foundation was not possible. Based on the observation of the timber flooring and its surrounding, the foundation appears to have performed satisfactory with no observed earthquake damage.

5.5 Non Structural

No observed earthquake related damage.

6 General Observations

Apart from the collapsed chimneys, the building has sustained minimal earthquake related damage. Overall, the building has performed well under seismic conditions, which is consistent for a single storey timber framed structure.

As expected for a 150 year old building, the timber members that are subjected to moisture are likely to degrade over time. There had been a couple of major restoration works undertaken in 1977 and 1986 as noted in the Conservation Plan Report [7]. Some of these works were noted during the intrusive site investigation. See Photo 3 in Appendix 1. Numerous remedial actions were also recommended in the Building Condition Report [8]. Additional areas of rotted timber at the front gable were also observed during the recent site investigations. See Photo 4 in Appendix 1.

7 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.

7.1 Critical Structural Weaknesses

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 a building.

No critical structural weaknesses were identified for this building.

7.2 Quantitative Assessment Methodology

The equivalent static load method was used to analyse the forces in the key components of the building's lateral load resisting system. The parameters used for the detailed analyses are as follows:

7.2.1 Seismic coefficient parameters

The seismic design parameters based on current design requirements from NZS1170.5:2004 [1] and the NZBC clause B1 for this building are:

- Site soil class C, clause 3.1.3 NZS 1170:2002
- 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 [1] with a 50 year design life and based on an Importance Level 2).

7.2.2 Expected ductility factor

Based on our assessment of the building structure and using guidance from the timber structures standard NZS 3603:1993, our estimate for the expected structural ductility factor is 1.25 for the structure in both orthogonal directions.

7.3 Limitations and Assumptions in Results

Our analysis and assessment incorporates the reduced seismic mass of the chimneys. This is consistent with the recommendation in Section 5.1 that any future reinstatement of the chimneys would need to consider structural strengthening down to the ground level.

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.

7.4 Quantitative Analysis Methodology

The seismic force arising from the roof mass is assumed to be distributed to the perimeter timber framed walls based on their respective tributary area. This is a reasonable assumption considering the flexible horizontal diaphragm created by the ceiling timber framing.

7.5 Quantitative Assessment Results

Based on the criteria as listed above, the estimated structural performance of the respective primary structural load resisting elements are as follows.

Structural Element / System	Failure mode or description of limiting criteria based on elastic capacity of critical element	% NBS (based on calculated capacity)
North-South Direction		
Perimeter timber bracing wall along the west elevation	Timber bracing wall resisting lateral load in north-south direction. The failure mode is likely to be ductile failure of the nail connection.	100%
Internal timber bracing wall between the west lean-to rooms and the main building	Timber bracing wall resisting lateral load in north-south direction. The failure mode is likely to be ductile failure of the nail connection.	34%
Perimeter timber bracing wall along the east elevation	Timber bracing wall resisting lateral load in north-south direction. The failure mode is likely to be ductile failure of the nail connection.	36%
East - West Direction		
Perimeter timber bracing wall along the north elevation	Timber bracing wall resisting lateral load in east-west direction. The failure mode is likely to be ductile failure of the nail connection.	55%
Internal timber bracing wall between the front room and the back area	Timber bracing wall resisting lateral load in east-west direction. The failure mode is likely to be ductile failure of the nail connection.	44%

Structural Element / System	Failure mode or description of limiting criteria based on elastic capacity of critical element	% NBS (based on calculated capacity)
Perimeter timber bracing wall along the south elevation	Timber bracing wall resisting lateral load in east-west direction. The failure mode is likely to be ductile failure of the nail connection.	93%

8 Discussion of Results

Despite the minimal earthquake damage sustained, apart from the fallen chimneys, the building is assessed to have a minimum seismic capacity of approximately 34% NBS. This is primarily due to the high seismic weight arising from the heavy slate shingles roof and the earth infilled timber wall.

The reason for the minimal earthquake damage is likely due to the redundancies within the structural system, but do not form the principal lateral load resisting system. For example, the bracing capacity of the earth infill within the timber framing is not considered in this instance. In a typical mud & stud wall construction where earth is packed within the timber framing, the shear resistance capacity of the earth infill may be considered. However, in this case, the infill is found to be relatively loose and would have limited shear resistance capacity. Therefore, it cannot be reliably considered in the lateral load resistance capacity assessment.

The lean-to structure at the south east corner is a relatively lightweight structure and has well distributed timber bracing walls. This structure is likely to resist any lateral loading independently.

It is not known if the floor joists are fixed to the foundation or not. However, considering that the floor boards are well nailed to the joists which are at ground level, the floor system is likely to remain intact in a design level earthquake. It would be unlikely that the substructure would collapse even if the building is not connected to the foundation.

This building is not considered to be earthquake prone in accordance with the Building Act 2004.

9 Summary of Geotechnical Appraisal

9.1 Regional Geology

The published geological map of the area, (Geology of the Christchurch Urban Area 1:25,000, Brown and Weeber, 1992) indicates the site is underlain by The Stoddart Basalt. This consists of a series of basanite, olivine basalt and olivine hawaiite flows sourced from a number of monogenetic cones scattered around the flanks of Lyttelton Volcano as well as from within the crater. The thick basalt flow at Diamond Harbour forms a prominent 5km long dip slope, dipping into Lyttelton Harbour.

9.2 Expected Ground Conditions

A review of the Environmental Canterbury (ECan) Wells database showed one well located approximately 230m NNW of the property (M36/1253, Godley House) and one shallow (<1m) investigation bore approximately 225m SSE of the site (M36/10496). No data on groundwater levels was recorded in either bore log. No springs of other wet areas were observed during the site inspection.

The terraced nature of the site indicates the house is likely to be on a cut platform, with the excavated material placed below (north) of the cottage to form low terraces. It is likely that loess covers the site to variable depth over the Stoddart Basalt.

9.3 Liquefaction Hazard

No evidence of liquefaction was observed at the site, or noted on the CERA maps

The Christchurch Earthquake Recovery Authority (CERA) last updated 18 May 2012 has classified this site and the surrounding residential properties as Green Zone, indicating repair and rebuilding process can begin.

9.4 Geotechnical Discussion

No obvious evidence of slope movement due to the recent earthquakes was observed on the property or adjoining properties. It appears the existing foundations have performed adequately in recent earthquakes.

Based on the land performance in and around the cottage in recent earthquakes, the land is not likely to be susceptible to slope failure, liquefaction or settlement. No further geotechnical investigations or geotechnical assessments are therefore considered necessary.

10 Conclusions

The building has seismic capacity of 34% NBS and is therefore not considered to be earthquake prone in accordance to the Building Act 2004.

11 Recommendations

a. Strengthening options be developed to increase the building's seismic capacity to as near as practicable to 100%NBS, and at least 67%NBS.
b. During the strengthening works, conduct an intrusive investigation to check if the building is connected to the foundation. Carry out remedial works if it is not found to be connected.
c. Proceed with the non-structural remedial works as recommended in the Building Condition Report, including the replacement of the rotted timber as highlighted in this report.
d. In the interim, the building may be occupied. Although the risk exposure is moderate, the failure modes of the critical elements identified are non-brittle.

12 Limitations

a. This report is based on an inspection of the structure of the building and focuses on the structural damage resulting from the Canterbury Earthquakes and aftershocks only.
b. Apart from the limited intrusive investigations as mentioned in this report, our inspections have been visual and non-intrusive, and no linings or finishes were removed to expose structural elements.
c. 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 this time.
d. This report is prepared for CCC to assist with assessing the remedial works required for their buildings and facilities. It is not intended for any other party or purpose.

13 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 (2011), *Practice Note – Design of Conventional Structural Systems Following Canterbury Earthquakes*, Structural Engineering Society of New Zealand, 21 December 2011.

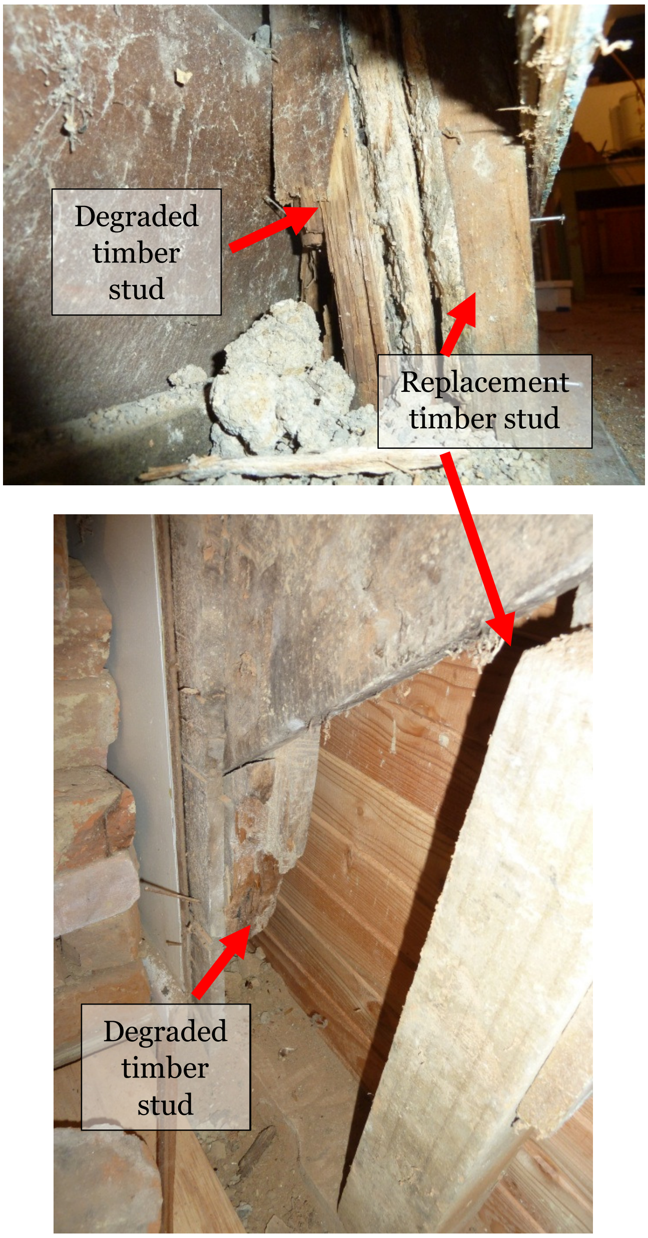
[6] DBH (2012), *Guidance for engineers assessing the seismic performance of non-residential and multi-unit residential buildings in greater Christchurch*, Department of Building and Housing, June 2012

[7] Stoddart Cottage Conservation Plan, Ian Bowman, December 2004.

[8] Stoddart Cottage Building Condition Report, Fulton Ross, October 2009.

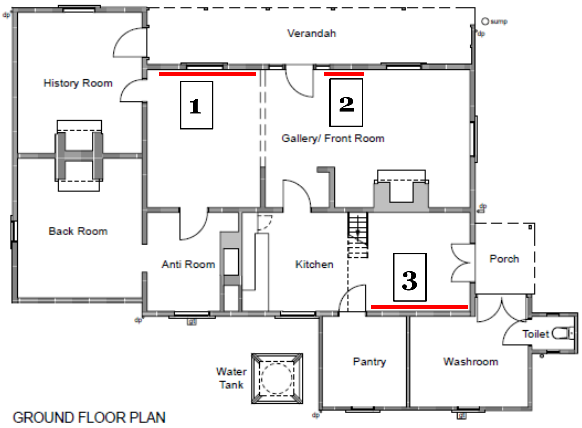
Appendix 1 - Photographs

No.	Item description	Photo
1.	General building elevations North east elevation South west elevation East elevation	  

2.	East chimney showing removed fireplace	
3.	Previous restoration works Back area rear wall Wall between Front room and Back area	

4.	Degraded timber rafters at front gable	 

Appendix 2 – Intrusive Investigation Observations

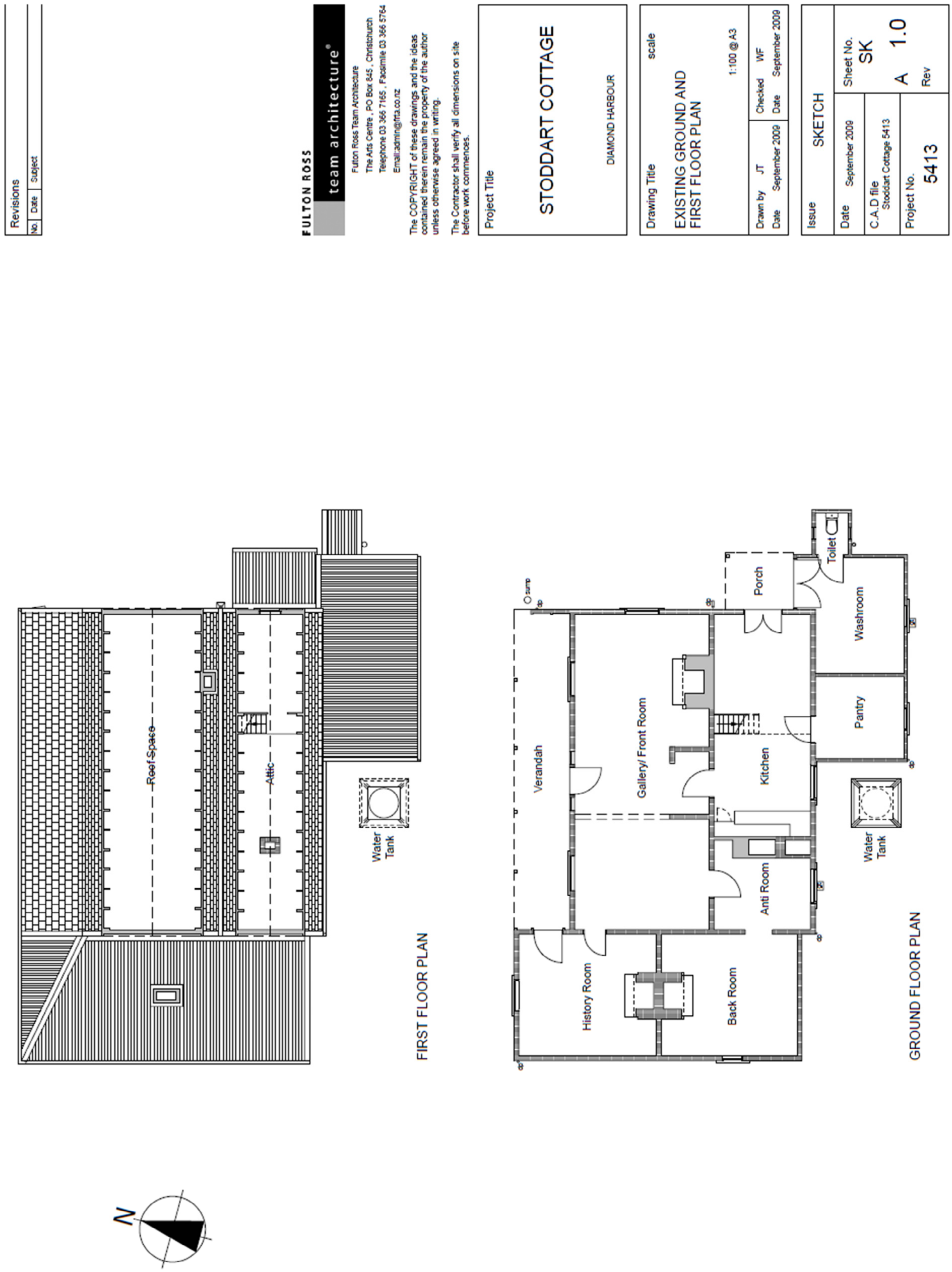


Locations of Intrusive Site Investigations

Location	Photos	Key Observations
1	 	• Earth infill is not damp indicating that there is no evidence of moisture seepage from the ground below. Furthermore, the veranda on the exterior would provide limited weather protection. • No sign of rotting to the timber studs. • No diagonal bracing member was observed at the exposed location, however, it could be hidden by the infill earth. Based on evidence of diagonal bracing members within the wall construction in other locations, it is assumed that the typical wall construction within the building would include diagonal bracings. No attempt is made to hollow out the earth infill to expose any diagonal brace because this may destroy the heritage value of the wall construction.
2		• Similar to location 1, there were no signs of timber stud rotting or diagonal bracing. • Even though location 2 is within the front area as location 1, the intrusive investigation was carried out because this portion of the building was constructed during a different period.

3	  	• Earth infill has been partially hollowed out during restoration so that new timber stud could be installed. • Evidence of diagonal timber bracing member. • Original timber stud had degraded and replaced with new stud.

Appendix 3 - Drawings


Revisions
No.
Date
Subject
FULTON ROSS
team architecture
Fulton Ross Team Architecture
The Arts Centre , PO Box 845 , Christchurch
Telephone 03 366 7165 , Facsimile 03 366 5764
Email:admin@frta.co.nz
The COPYRIGHT of these drawings and the ideas contained therein remain the property of the author unless otherwise agreed in writing.
The Contractor shall verify all dimensions on site before work commences.
Project Title
STODDART COTTAGE
DIAMOND HARBOUR
Drawing Title
EXISTING GROUND AND FIRST FLOOR PLAN
scale
1:100 @ A3
Drawn by JT
Date September 2009
Checked WF
Date September 2009
Issue
SKETCH
Date September 2009
C.A.D file
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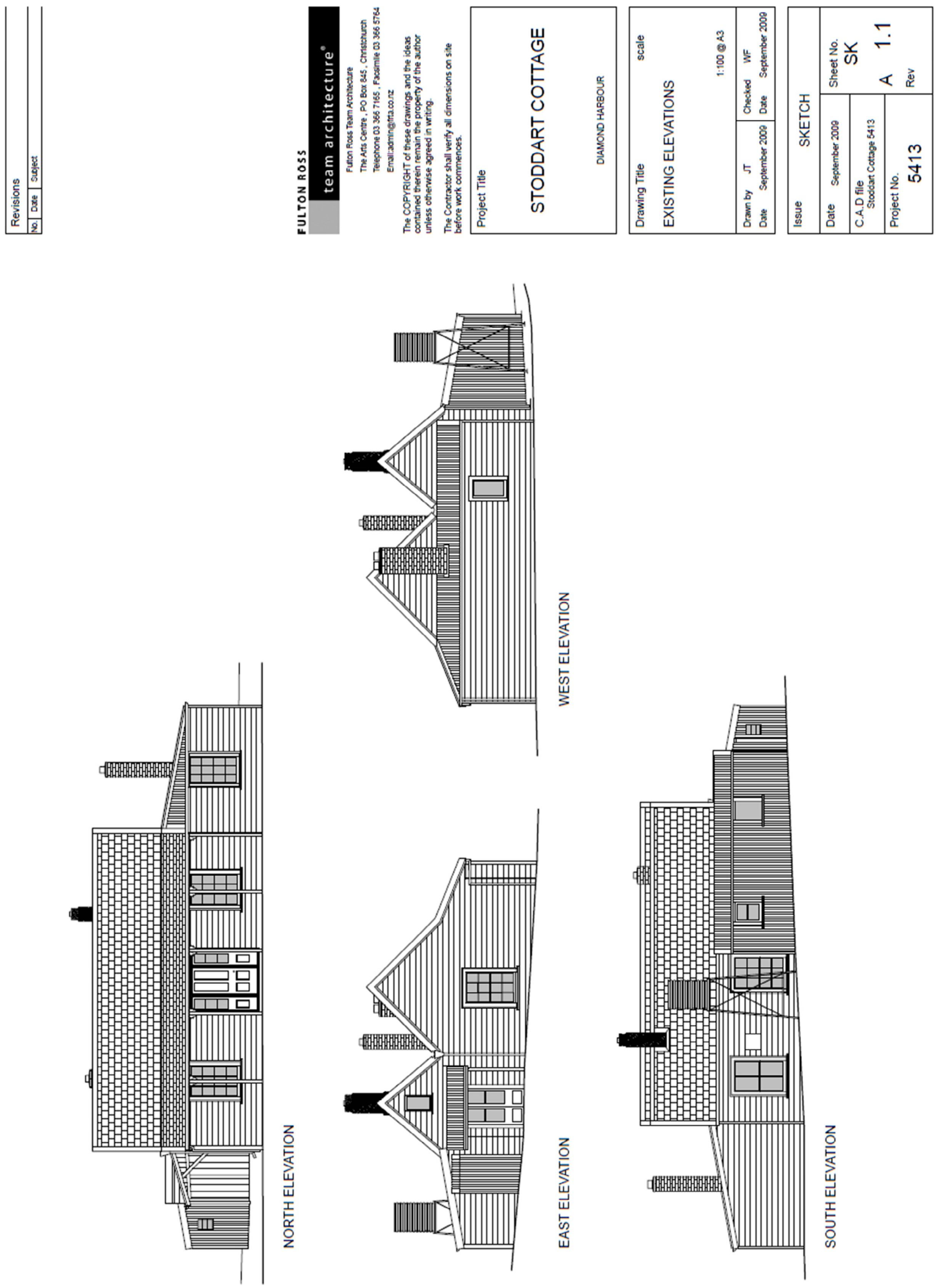
Project No.
5413
Sheet No.
SK
A
1.0
Rev
Roof Space
Attic
Water Tank
FIRST FLOOR PLAN
Verandah
Gallery/ Front Room
Kitchen
Porch
Toilet
Washroom
Pantry
Anti Room
History Room
Back Room
GROUND FLOOR PLAN
N


Revisions
No.
Date
Subject
FULTON ROSS
team architecture®
Fulton Ross Team Architecture
The Arts Centre , PO Box 845 , Christchurch
Telephone 03 366 7165 , Facsimile 03 366 5764
Email:admin@frta.co.nz
The COPYRIGHT of these drawings and the ideas contained therein remain the property of the author unless otherwise agreed in writing.
The Contractor shall verify all dimensions on site before work commences.
Project Title
STODDART COTTAGE
DIAMOND HARBOUR
Drawing Title
EXISTING ELEVATIONS
scale
1:100 @ A3
Drawn by JT
Date September 2009
Checked WF
Date September 2009
Issue
SKETCH
Date September 2009
C.A.D file
Stoddart Cottage 5413
Project No.
5413
Sheet No.
SK
A 1.1
Rev
NORTH ELEVATION
WEST ELEVATION
EAST ELEVATION
SOUTH ELEVATION

Appendix 4 – Geotechnical Desktop Study

30 May 2012

Tony Joseph
Joseph & Associates Limited
47 Main Road
Redcliffs
Christchurch 8081

6-QUCCC.82/015SC

Dear Tony

Geotechnical Desktop Study – Stoddart's Cottage, Diamond Harbour

1. Introduction

This report summarises the findings of a geotechnical desktop study and site walkover completed by Opus International Consultants (Opus) for Joseph & Associates at the above property on 2 May 2012. The Geotechnical desk study follows the Canterbury Earthquake Sequence initiated by the 4 September 2010 earthquake.

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. This Geotechnical Desk Study has been undertaken without the benefit of any site specific investigations and is therefore preliminary in its nature.

2. Desktop Study

2.1 Site Description

The historic Stoddart's Cottage was constructed around 1860, and is located near Waipapa Ave, in the Stoddart Point Reserve, Diamond Harbour. A playing field is located to the north of the cottage and Purau Ave forms the southern boundary. The site slopes to the north, with a moderately slope leading down to the cottage from Purau Ave, with a dry stone wall behind the cottage up to 1.2 m high, and a gentle terraced slope leading to the playing field to the north. The area to the south is planted in mature gum trees, while the area to the north comprises a cottage garden sloping down to a playing field.

The building is a single storey structure with an attic, timber walls and a timber frame roof structure. Though no detailed drawings for the foundations have been found, it is assumed that the foundations are likely to be timber pile footings. Roof material comprises slate and corrugated iron. The walls are lined with rammed earth, and the connection between the rammed earth and the ground was not sighted.

2.2 Structural Drawings

A search of CCC property files has not located any extracts from construction drawings. A conservation report describes the properties history and construction[1] and a condition report shows the cottage in plan and elevation[2].

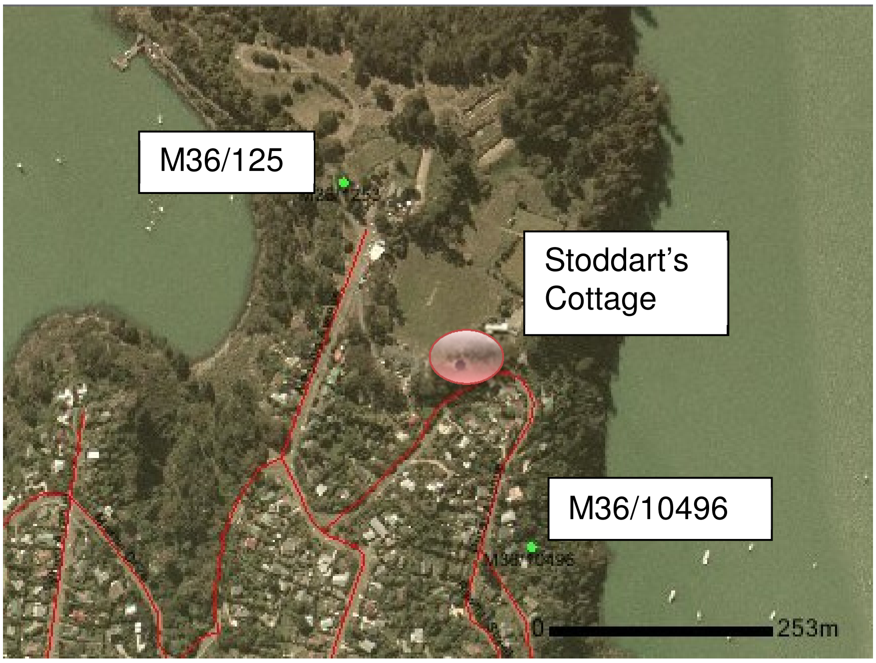
No geotechnical reports or records of a ground condition assessment associated with the construction of the original building or additions have been identified.

2.4 Regional Geology

The published geological map of the area, (Geology of the Christchurch Urban Area 1:25,000, Brown and Weeber, 1992) indicates the site is underlain by The Stoddart Basalt. This consists of a series of basanite, olivine basalt and olivine hawaiite flows sourced from a number of monogenetic cones scattered around the flanks of Lyttelton Volcano as well as from within the crater. The thick basalt flow at Diamond Harbour forms a prominent 5km long dip slope, dipping into Lyttelton Harbour. The ages of these rocks range from 7.0 to 5.8 Ma.

2.5 Expected Ground Conditions

A review of the Environmental Canterbury (ECan) Wells database showed one well located approximately 230 m NNW of the property (M36/1253, Godley House) and one shallow (<1m) investigation bore approximately 225m SSE of the site (M36/10496). No data on groundwater levels was recorded in either bore log. No springs of other wet areas were observed during the site inspection.



Well Data (ECan Database)

The terraced nature of the site indicates the house is likely to be on a cut platform, with the excavated material placed below (north) of the cottage to form low terraces. It is likely that loess covers the site to variable depth over the Stoddart Basalt.

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[1] Stoddart Cottage Diamond Harbour, Conservation Plan. Ian Bowman, December 2004
[2] Stoddart Cottage Condition Assessment. Fulton Ross, 2009

2.6 Liquefaction Hazard

No evidence of liquefaction was observed at the site, or noted on the CERA maps

The Christchurch Earthquake Recovery Authority (CERA) last updated 18 May 2012 has classified this site and the surrounding residential properties as Green Zone, indicating repair and rebuilding process can begin.

3. Site Walkover Inspection

A walkover inspection of the exterior of the building and surrounding land was carried out by an Opus Engineering Geologist on 3rd May 2012. The following observations were made (refer to the Walkover Inspection Plan and Site Photographs attached to this report):

- No sign of slope instability;
- Chimneys have been removed;
- Retaining structures (drystone walls) showing little sign of disturbance
- Veranda roof sagging (support post issue)
- No evidence of tunnel gullying

4. Discussion

Minor damage (chimney removal required) has occurred to Stoddart's Cottage, Waipapa Ave, Diamond Harbour due to the Canterbury Earthquake Sequence following the 4 September 2010 earthquake.

No obvious evidence of slope movement due to the recent earthquakes was observed on the property or adjoining properties.

It appears the existing foundations have performed adequately in recent earthquakes.

Detailed drawings of the foundations have not been located. Based on the walkover it is assumed that the foundations are pile foundations, some of which were replaced during renovation in 1986, as was some of the rammed earth wall infill[1].

GNS Science indicates an elevated risk of seismic activity is expected in the Canterbury region as a result of the earthquake sequence following the 4 September 2010 earthquake. Recent advice[i] 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 is unlikely to cause land damage at the site, dependent on the location of the earthquake's epicentre. It is expected that the probability of occurrence is likely to decrease with time following periods of reduced seismic activity.

The relevant building code performance requirements are set out in the Seismic Loadings Code NZS 1170.5: 2004. The performance requirements for residential buildings are:

- Ultimate Limit State (ULS). Under a seismic event with an annual probability of exceedence of 1 in 500 year return period, people are not to be endangered and collapse of the structure is to be avoided.
- Serviceability Limit State (SLS). Under a seismic event with an annual probability of exceedence of 1 in 25 year return period, damage to the building is to be avoided.

However, these performance requirements are specific to the building structure only and no reference is made to the land performance on which the building is founded. With respect to natural hazards the Building Act 2004 requires that a building be “not likely” to be subject to damage from erosion, subsidence, inundation or slippage.

5. Recommendations

Based on the land performance in and around the cottage in recent earthquakes, the land is not likely to be susceptible to slope failure, liquefaction or settlement. No further geotechnical investigations or geotechnical assessments are therefore considered necessary.

6. Limitation

This report has been prepared solely for the benefit of Joseph & Associates 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

[i] GNS Science reporting on Geonet Website: http://www.geonet.org.nz/canterbury-quakes/aftershocks/ updated on 28th May 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:** Stoddarts Cottage Waipapa Ave, Diamond Harbour Geotechnical Desktop Study **Project No.:** 6-QUCCC.82/015SC **Client:** Joseph & Associates	**Site Location Plan** **Date Drawn:** 9/05/2012

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:** Stoddart's Cottage Geotechnical Desktop Study **Project No.:** 6-QUCCC.82/015SC **Client:** Joseph & Associates	**Walkover Inspection Plan** **Date Drawn:** 28/04/2012

Photograph 1. Main entrance to building (North elevation)

Photograph 2. South western corner the building

Photograph 3. Northern side of cottage, gently sloping to a playing field (from the east)

Photograph 4. Northern Side of Building (from the west).

Photograph 5. Terraced slope to south of cottage, supported by a dry stone wall at the toe of the slope.

Photograph 6. Low drystone wall to south of cottage. Wall up to 1.2 m high behind SE corner of cottage.

Photograph 7. Terrace below cottage, supported by drystone wall.

Appendix 5 – CERA DEE Data Sheet

Detailed Engineering Evaluation Summary Data V1.11

Location

Building Name:	Stoddart Cottage	Reviewer:	Jan Stanway
	Unit / No: / Street	CPEng No:	222291
Building Address:	Purau Avenue, Diamond Harbour	Company:	Opus International Consultants Ltd
Legal Description:		Company project number:	6-QUCCC.82
		Company phone number:	03-3635400
	Degrees / Min / Sec		
GPS south:		Date of submission:	22-Apr-13
GPS east:		Inspection Date:	12-May-12
		Revision:	Final
Building Unique Identifier (CCC):	BU 3555-006 EQ2	Is there a full report with this summary?	yes

Site

Site slope:	flat	Max retaining height (m):	
Soil type:	silt	Soil Profile (if available):	Loess over Stoddart Basalt
Site Class (to NZS1170.5):	C		
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):	57.00

Building

No. of storeys above ground:	1	single storey = 1	Ground floor elevation (Absolute) (m):	2.80
Ground floor split?	no		Ground floor elevation above ground (m):	0.10
Storeys below ground	0			
Foundation type:	timber piles		if Foundation type is other, describe:	
Building height (m):	5.20		height from ground to level of uppermost seismic mass (for IEP only) (m):	4
Floor footprint area (approx):	100			
Age of Building (years):	150		Date of design:	Pre 1935
Strengthening present?	no		If so, when (year)?	
			And what load level (%g)?	
Use (ground floor):	public		Brief strengthening description:	
Use (upper floors):	other (specify)			
Use notes (if required):	attic unoccupied.			
Importance level (to NZS1170.5):	IL2			

Gravity Structure

Gravity System:	load bearing walls		
Roof:	timber framed	rafter type, purlin type and cladding	slate shingles / corr.iron on timber battens on timber rafters
Floors:	timber	joist depth and spacing (mm)	
Beams:	timber	type	
Columns:			
Walls:			

Lateral load resisting structure

Lateral system along:	lightweight timber framed walls	**Note: Define along and across in detailed report!**	note typical wall length (m)	1.5
Ductility assumed, μ:	1.25			
Period along:	0.16	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)	1.5
Ductility assumed, μ:	1.25			
Period across:	0.16	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):	0	
south (mm):	0	
west (mm):		

Non-structural elements

Stairs:			
Wall cladding:	other light	describe	weatherboard
Roof Cladding:	Shingles or shakes	describe	slate shingles / corrugated metal
Glazing:	timber frames		
Ceilings:	strapped or direct fixed		hardboard & timber matchlining
Services(list):			

Available documentation

Architectural	partial	original designer name/date	Fulton Ross / Sept 2009
Structural	none	original designer name/date	
Mechanical	none	original designer name/date	
Electrical	none	original designer name/date	
Geotech report	partial	original designer name/date	Opus / May 12

Damage

Site: (refer DEE Table 4-2)

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

Building:

	Current Placard Status:	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:	Collapsed chimneys (3no.)

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

Recommendations

	Level of repair/strengthening required:		Describe:	
	Building Consent required:		Describe:	
	Interim occupancy recommendations:	do not occupy	Describe:	
Along	Assessed %NBS before:	44%	##### %NBS from IEP below	
	Assessed %NBS after:	44%		
Across	Assessed %NBS before:	34%	##### %NBS from IEP below	
	Assessed %NBS after:	34%		