



CLIENTS | PEOPLE | PERFORMANCE

House
Sumnervale Reserve
PRK 0528 BLDG 001

Detailed Engineering Evaluation
Qualitative Report
Version FINAL

45 Sumnervale Drive, Sumner,
Christchurch



**House - Sumnervale Reserve
PRK 0528 BLDG 001**

Detailed Engineering Evaluation
Qualitative Report
Version FINAL

45 Sumnervale Drive, Sumner,
Christchurch

Christchurch City Council

Prepared By
Simon Barker

Reviewed By
Stephen Lee

Date
13/02/14



Contents

Qualitative Report Summary	i
1. Background	1
2. Compliance	2
2.0 Canterbury Earthquake Recovery Authority (CERA)	2
2.1 Building Act	3
2.2 Christchurch City Council Policy	4
2.3 Building Code	4
3. Earthquake Resistance Standards	5
4. Building Description	7
4.0 General	7
4.1 Gravity Load Resisting System	8
4.2 Lateral Load Resisting System	8
5. Assessment	10
6. Damage Assessment	11
6.0 Surrounding Buildings	11
6.1 Residual Displacements and General Observations	11
6.2 Ground Damage	11
7. Critical Structural Weakness	12
7.1 Short Columns	12
7.2 Lift Shaft	12
7.3 Roof	12
7.4 Staircases	12
7.5 Plan Irregularity	12
7.6 Liquefaction and Lateral Spreading	12
7.7 Pounding	13
8. Geotechnical Consideration	14
8.0 Site Description	14
8.1 Published Information on Ground Conditions	14
8.2 Seismicity	16



8.3	Slope Failure and/or Rockfall Potential	16
8.4	Liquefaction Potential	17
8.5	Recommendations	17
8.6	Conclusions & Summary	17
9.	Survey	18
10.	Initial Capacity Assessment	19
10.1	% NBS Assessment	19
10.2	Seismic Parameters	19
10.3	Expected Structural Ductility Factor	19
10.4	Discussion of Results	20
11.	Initial Conclusions	21
12.	Recommendations	22
13.	Limitations	23
13.1	General	23
13.2	Geotechnical Limitations	23

Table Index

Table 1	%NBS compared to relative risk of failure	6
Table 2	ECan Borehole Summary	14
Table 3	Summary of Known Active Faults	16

Figure Index

Figure 1	NZSEE Risk Classifications Extracted from table 2.2 of the NZSEE 2006 AISPBE	5
Figure 2	Plan Sketch Showing Key Structural Elements	8
Figure 3	Post February 2011 Earthquake Aerial Photography	15

Appendices

- A Photographs
- B Existing Drawings
- C CERA Building Evaluation Form



Qualitative Report Summary

House - Sumnervale Reserve

PRK 0528 BLDG 001

Detailed Engineering Evaluation

Qualitative Report - SUMMARY

Version Final

45 Sumnervale Drive, Sumner, Christchurch

Background

This is a summary of the Qualitative report for the building structure, and is based in general on the Detailed Engineering Evaluation Procedure document (draft) issued by the Structural Advisory Group on 19 July 2011 and visual inspections on 17 April 2012.

Building Description

The House at Sumnervale Reserve is assumed to have been constructed in the late 1950s, with additions at later dates. No plans for the House were available, so construction details have been observed on site. The buildings are used as general offices and storage facilities for an equestrian club. The site is located in a largely rural area on flat land at Sumnervale Reserve in Sumner near Christchurch. The site slopes gently to the east to Sumnervale Drive, and lies at the bottom of the Port hills.

The house consists of two single-storey timber structures separated by a narrow gap. The original house has a duo-pitch roof constructed of timber trusses, and the additions feature mono-pitch roof sections constructed with timber rafters. All roof sections feature timber purlins or sarking and corrugated steel cladding. There was no cross-bracing observed in the roof. The internal and external walls are timber-framed. Roughly half the walls are lined internally with plasterboard, and half are unlined internally. Some of the bare internal walls exhibit timber cross-bracing. The exterior walls are clad in timber weatherboard and corrugated steel. The floors are constructed of timber and are elevated off the ground on short concrete and timber piles, and the two entry doors feature short timber stairs to the ground. The two house sections are roughly 7.7m long by 7.3m wide and 3.0m in height, and 8.1m long by 3.8m wide and 2.4m in height, respectively. Both sections feature small additions to these rectangular footprints.

Key Damage Observed

No significant damage was observed on-site.



Critical Structural Weaknesses

The building exhibits the following critical structural weakness:

- Plan Irregularity (weak roof structure) 30% reduction

Indicative Building Strength (from IEP and CSW assessment)

Based on the information available, and using the NZSEE Initial Evaluation Procedure, the building's seismic capacity has been assessed to be in the order of 19% NBS. The building's capacity excluding critical structural weaknesses is in the order of 27% NBS. Therefore the building is potentially Earthquake Prone. No significant damage was observed on-site.

Recommendations

The building has been assessed as being potentially Earthquake Prone. As a result, it is recommended that further detailed assessment be completed and strengthening undertaken if required.



1. Background

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

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

A qualitative assessment involves inspections of the building and a desktop review of existing structural and geotechnical information, including existing drawings and calculations, if available.

The purpose of the assessment is to determine the likely building performance and damage patterns, to identify any potential critical structural weaknesses or collapse hazards, and to make an initial assessment of the likely building strength in terms of percentage of new building standard (%NBS).

At the time of this report, no intrusive site investigation, detailed analysis, or modelling of the building structure had been carried out. The building description is based on the visual inspection carried out on site.



2. Compliance

This section contains a brief summary of the requirements of the various statutes and authorities that control activities in relation to buildings in Christchurch at present.

2.0 Canterbury Earthquake Recovery Authority (CERA)

CERA was established on 28 March 2011 to take control of the recovery of Christchurch using powers established by the Canterbury Earthquake Recovery Act enacted on 18 April 2011. This act gives the Chief Executive Officer of CERA wide powers in relation to building safety, demolition and repair. Two relevant sections are:

Section 38 – Works

This section outlines a process in which the chief executive can give notice that a building is to be demolished and if the owner does not carry out the demolition, the chief executive can commission the demolition and recover the costs from the owner or by placing a charge on the owners' land.

Section 51 – Requiring Structural Survey

This section enables the chief executive to require a building owner, insurer or mortgagee carry out a full structural survey before the building is re-occupied.

We understand that CERA will require a detailed engineering evaluation to be carried out for all buildings (other than those exempt from the Earthquake Prone Building definition in the Building Act). It is anticipated that CERA will adopt the Detailed Engineering Evaluation Procedure document (draft) issued by the Structural Advisory Group on 19 July 2011. This document sets out a methodology for both qualitative and quantitative assessments.

The qualitative assessment is a desk-top and site inspection assessment. It is based on a thorough visual inspection of the building coupled with a review of available documentation such as drawings and specifications. The quantitative assessment involves analytical calculation of the buildings strength and may require non-destructive or destructive material testing, geotechnical testing and intrusive investigation.

It is anticipated that factors determining the extent of evaluation and strengthening level required will include:

- ▶ The importance level and occupancy of the building
- ▶ The placard status and amount of damage
- ▶ The age and structural type of the building
- ▶ Consideration of any critical structural weaknesses
- ▶ The extent of any earthquake damage



2.1 Building Act

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

Section 112 – Alterations

This section requires that an existing building complies with the relevant sections of the Building Code to at least the extent that it did prior to any alteration. This effectively means that a building cannot be weakened as a result of an alteration (including partial demolition).

Section 115 – Change of Use

This section requires that the territorial authority (in this case Christchurch City Council (CCC)) be satisfied that the building with a new use complies with the relevant sections of the Building Code 'as near as is reasonably practicable'. Regarding seismic capacity 'as near as reasonably practicable' has previously been interpreted by CCC as achieving a minimum of 67% NBS however where practical achieving 100% NBS is desirable. The New Zealand Society for Earthquake Engineering (NZSEE) recommend a minimum of 67% NBS.

2.1.1 Section 121 – Dangerous Buildings

The definition of dangerous building in the Act was extended by the Canterbury Earthquake (Building Act) Order 2010, and it now defines a building as dangerous if:

- ▶ In the ordinary course of events (excluding the occurrence of an earthquake), the building is likely to cause injury or death or damage to other property; or
- ▶ In the event of fire, injury or death to any persons in the building or on other property is likely because of fire hazard or the occupancy of the building; or
- ▶ There is a risk that the building could collapse or otherwise cause injury or death as a result of earthquake shaking that is less than a 'moderate earthquake' (refer to Section 122 below); or
- ▶ There is a risk that that other property could collapse or otherwise cause injury or death; or
- ▶ A territorial authority has not been able to undertake an inspection to determine whether the building is dangerous.

Section 122 – Earthquake Prone Buildings

This section defines a building as earthquake prone if its ultimate capacity would be exceeded in a 'moderate earthquake' and it would be likely to collapse causing injury or death, or damage to other property. A moderate earthquake is defined by the building regulations as one that would generate ground shaking 33% of the shaking used to design an equivalent new building.

Section 124 – Powers of Territorial Authorities

This section gives the territorial authority the power to require strengthening work within specified timeframes or to close and prevent occupancy to any building defined as dangerous or earthquake prone.

Section 131 – Earthquake Prone Building Policy

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



2.2 Christchurch City Council Policy

Christchurch City Council adopted their Earthquake Prone, Dangerous and Insanitary Building Policy in 2006. This policy was amended immediately following the Darfield Earthquake of the 4th September 2010.

The 2010 amendment includes the following:

- ▶ A process for identifying, categorising and prioritising Earthquake Prone Buildings, commencing on 1 July 2012;
- ▶ A strengthening target level of 67% of a new building for buildings that are Earthquake Prone;
- ▶ A timeframe of 15-30 years for Earthquake Prone Buildings to be strengthened; and,
- ▶ Repair works for buildings damaged by earthquakes will be required to comply with the above.

The council has stated their willingness to consider retrofit proposals on a case by case basis, considering the economic impact of such a retrofit.

We anticipate that any building with a capacity of less than 33% NBS (including consideration of critical structural weaknesses) will need to be strengthened to a target of 67% NBS of new building standard as recommended by the Policy.

If strengthening works are undertaken, a building consent will be required. A requirement of the consent will require upgrade of the building to comply 'as near as is reasonably practicable' with:

- ▶ The accessibility requirements of the Building Code.
- ▶ The fire requirements of the Building Code. This is likely to require a fire report to be submitted with the building consent application.

2.3 Building Code

The building code outlines performance standards for buildings and the Building Act requires that all new buildings comply with this code. Compliance Documents published by The Department of Building and Housing can be used to demonstrate compliance with the Building Code.

After the February Earthquake, on 19 May 2011, Compliance Document B1: Structure was amended to include increased seismic design requirements for Canterbury as follows:

- ▶ Hazard Factor increased from 0.22 to 0.3 (36% increase in the basic seismic design load)
- ▶ Serviceability Return Period Factor increased from 0.25 to 0.33 (80% increase in the serviceability design loads when combined with the Hazard Factor increase)

The increase in the above factors has resulted in a reduction in the level of compliance of an existing building relative to a new building despite the capacity of the existing building not changing.

3. Earthquake Resistance Standards

For this assessment, the building's earthquake resistance is compared with the current New Zealand Building Code requirements for a new building constructed on the site. This is expressed as a percentage of new building standard (%NBS). The new building standard load requirements have been determined in accordance with the current earthquake loading standard (NZS 1170.5:2004 Structural design actions - Earthquake actions - New Zealand).

The likely capacity of this building has been derived in accordance with the New Zealand Society for Earthquake Engineering (NZSEE) guidelines 'Assessment and Improvement of the Structural Performance of Buildings in Earthquakes' (AISPBE), 2006. These guidelines provide an Initial Evaluation Procedure that assesses a buildings capacity based on a comparison of loading codes from when the building was designed and currently. It is a quick high-level procedure that can be used when undertaking a Qualitative analysis of a building. The guidelines also provide guidance on calculating a modified Ultimate Limit State capacity of the building which is much more accurate and can be used when undertaking a Quantitative analysis.

The New Zealand Society for Earthquake Engineering has proposed a way for classifying earthquake risk for existing buildings in terms of %NBS and this is shown in Figure 1 below.

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

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

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



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

Table 1 %NBS compared to relative risk of failure



4. Building Description

4.0 General

The House at Sumnervale Reserve is assumed to have been constructed in the late 1950s, with additions at later dates. No plans for the House were available, so construction details have been observed on site. The buildings are used as general offices and storage facilities for an equestrian club. The site is located in a largely rural area on flat land at Sumnervale Reserve in Sumner near Christchurch. The site slopes gently to the east to Sumnervale Drive, and lies at the bottom of the Port hills. There are some large boulders scattered around the nearby area, and a residential neighbourhood roughly 100m to the east.

The house consists of two single-storey timber structures separated by a narrow gap. The original house has a duo-pitch roof constructed of timber trusses, and the additions feature mono-pitch roof sections constructed with timber rafters. All sections feature timber purlins or sarking and corrugated steel cladding. There was no cross-bracing observed in any of the roof sections. The internal and external walls are timber-framed. Roughly half the walls are lined internally with plasterboard, and half are unlined internally. Some of the bare internal walls exhibit timber cross-bracing. The exterior walls are clad in timber weatherboard and corrugated steel, and timber lintels span over doors and window openings. Some external doorways in the timber additions have been filled in since their original construction. The floors are constructed of timber and are elevated off the ground on short concrete and timber piles, and the two entry doors feature short timber stairs to the ground. The two house sections are roughly 7.7m long by 7.3m wide and 3.0m in height, and 8.1m long by 3.8m wide and 2.4m in height, respectively. Both sections feature small additions to these rectangular footprints.

A plan sketch is provided in the following Figure 2 to illustrate the main structural members of the building.

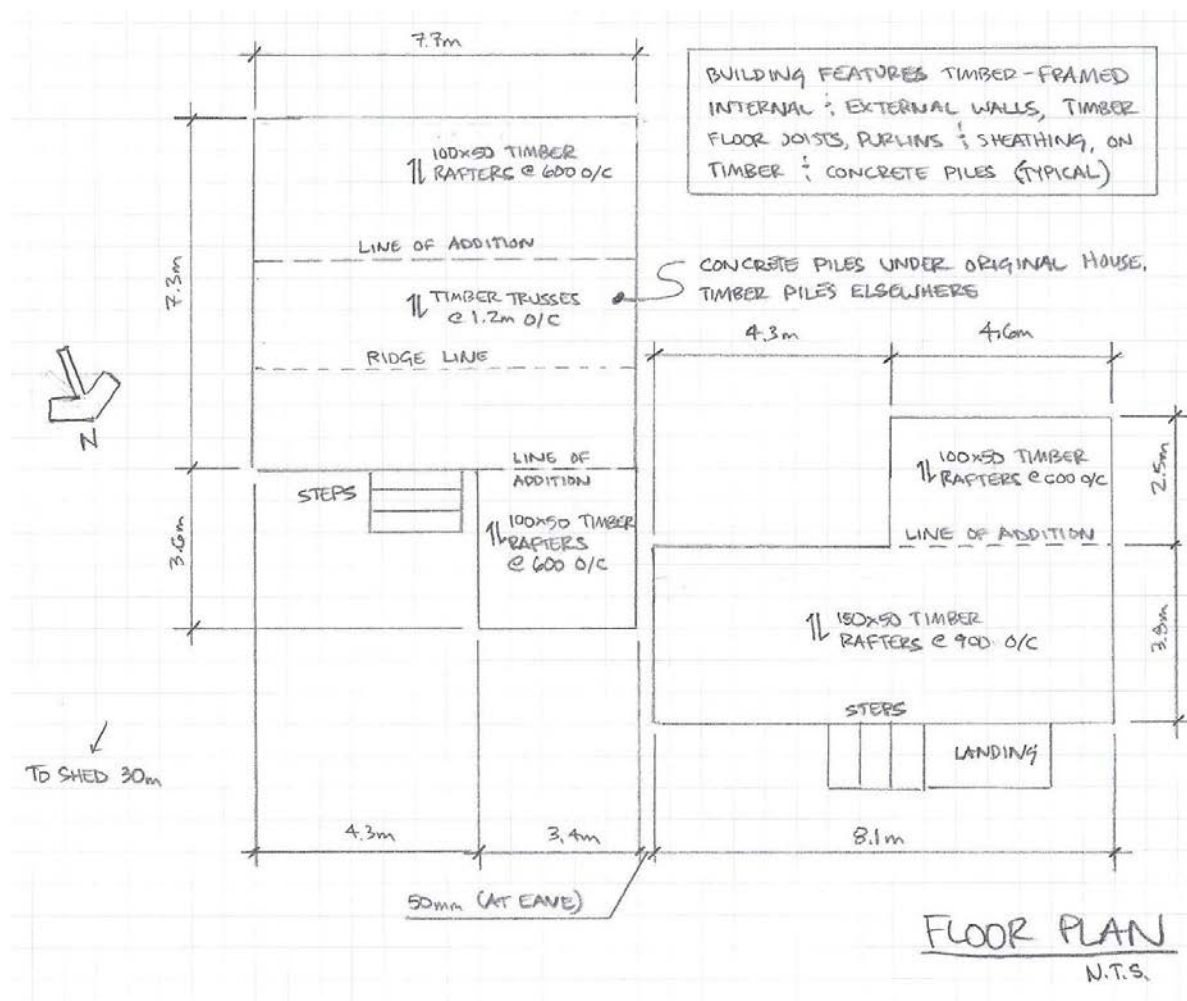


Figure 2 Plan Sketch Showing Key Structural Elements

4.1 Gravity Load Resisting System

The gravity loads at roof level are carried through the steel roof cladding to the timber roof purlins, down through the timber trusses and rafters, out to the timber walls, down through the walls to the concrete and timber piles and into the ground via friction and direct bearing on the founding soils. Gravity loads at floor level are carried through the floor cladding to the timber joists and beams, into the concrete and timber piles and into the ground via friction and direct bearing on the founding soils. At the entrance of the building and the windows, gravity loads from the roof structure are carried across the openings by timber purlins.

4.2 Lateral Load Resisting System

In both the longitudinal and transverse directions, the roof cladding, purlins or sarking and trusses or rafters combine to form nominal diaphragm action that will carry lateral loads in the roof to the in plane shear walls. Some portions of the roof structure at the additions to the house have not been properly attached to the external walls, leaving clear openings between the two. It is expected that the diaphragm action provided by the roof will not be sufficient for the lateral loads imposed on the structure, and the



roof could therefore be damaged; possibly detaching portions from the house. Lateral loads will be transferred into the external walls via shear in the roof-to-wall connections. Next they loads will be passed in-plane through the timber-framed external walls and floor structure, and into the concrete and timber piles via shear in the connections. At floor level, the floor cladding, joists and beams will combine to form adequate diaphragm action to transfer lateral loads across the floor and into the concrete and timber piles via shear in the connections. Though the piles are short, they are not connected with cross-bracing, and it is therefore expected that the foundations may shift or be damaged under seismic loading.



5. Assessment

A visual inspection of the building was undertaken on 17 April 2012. Both the interior and exterior of the building were inspected. There was no placard observed in place at the building. Most of the main structural components of the building were able to be viewed due to the exposed nature of the structure. No detailed inspection of the foundation of the structure was able to be undertaken, though the top of the piles were visible.

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

The %NBS score is determined using the IEP procedure described by the NZSEE which is based on the information obtained from visual observation of the building. Critical structural weaknesses in the form of significant Site Characteristics and Plan Irregularity were identified during the assessment.



6. Damage Assessment

6.0 Surrounding Buildings

The House at Sumnervale Reserve is located in a rural area with open lands adjacent to the site. There is a small shed on the property and a residential neighbourhood roughly 100m to the east. No significant seismic damage to the shed was observed, and there was no significant damage to the nearest houses.

6.1 Residual Displacements and General Observations

The house structures did not exhibit any signs of significant seismic damage, though they did show signs of poor maintenance. The roof structure at some sections of the house additions were never properly attached to external walls and clear openings exist between the roof and walls.

6.2 Ground Damage

No ground damage was observed during the inspection of the site.



7. Critical Structural Weakness

7.1 Short Columns

The building does not contain any significant short columns.

7.2 Lift Shaft

The building does not contain a lift shaft.

7.3 Roof

The roof structure features simple timber trusses and rafters, with timber purlins running and corrugated steel cladding, with no apparent cross-bracing. In addition, portions of the mono-pitch roof structure were never properly attached to the external walls. Limited diaphragm action can be expected from the properly-constructed roof structure, but the lack of proper attachment at some locations means the roof structure is limited in its capacity to transfer loads to the external walls and could easily detach from the rest of the house, leading to a premature collapse of the structure. The roof structure therefore contributes to a critical structural weakness in the form of plan irregularity for the building.

7.4 Staircases

The small timber staircases at the two entrances to the house do not add significantly to the stiffness of the building in these areas and are therefore not expected to contribute to any critical structural weakness in the building.

7.5 Plan Irregularity

The building comprises two structures which are rectangular in plan, with small timber additions to each which are also rectangular in plan. The dimensions of each addition are not sufficient to induce significant torsional effects on the structure. However, the roof structure contributes to a critical structural weakness which may lead to a premature collapse of the building, as detailed above. The building has therefore been assigned a significant critical structural weakness in the form of plan irregularity.

7.6 Liquefaction, Lateral Spreading and Rockfall

No liquefaction was observed at the site, and the geotechnical investigation has identified a low liquefaction and lateral spreading potential for the site. However, the site is situated at the base of hills that have exhibited previous rockfall; these hills put the site under moderate rockfall potential in the future.



7.7 Pounding

The two buildings which comprise the house are separated by a narrow gap. The gap is at its narrowest point at eave level, where there is a roughly 50mm distance between the two buildings. Accordingly, the gap is not narrow enough to assign a critical structural weakness to the building in the form of pounding potential.



8. Geotechnical Consideration

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

This report is only specific to the dwelling and associated structures at Detailed Engineering Evaluations. The property is owned and maintained by the Christchurch City Council.

8.0 Site Description

The site is situated within a recreational reserve, within the suburb of Sumner in southeast Christchurch. It is relatively flat at approximately 15m above mean sea level, and approximately 1.8km southwest of the coast (Pegasus Bay) at Sumner.

8.1 Published Information on Ground Conditions

8.1.1 Published Geology

The geological map of the area¹ indicates that the site is close to the boundary of the following two units:

- Valley fill and slope wash of loess-volcanic derived colluvium; and,
- Loess overlying volcanic rock.

8.1.2 Environment Canterbury Logs

Information from Environment Canterbury (ECan) indicates that two boreholes are located within a 200m radius of the site (see Table 2). These boreholes only extend to 1.3m and 2.2m bgl and indicate the area is underlain by loess (wind-blown silt) at shallow depth.

Table 2 ECan Borehole Summary

Bore Name	Log Depth	Groundwater	Distance & Direction from Site
M36/10454	1.3m	-	90m SE
M36/10455	2.2m	-	90m SE

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

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

8.1.3 EQC Geotechnical Investigations

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

8.1.4 CERA Land Zoning

Canterbury Earthquake Recovery Authority (CERA) has indicated the site is situated within the Green Zone², indicating that repair and rebuild may take place. CERA have not assigned a technical category to the site.

8.1.5 Post February Aerial Photography

Aerial photography taken following the 22 February 2011 earthquake shows no obvious signs of liquefaction in the vicinity of the site (see Figure 3).

Figure 3 Post February 2011 Earthquake Aerial Photography³



8.1.6 Summary of Ground Conditions

From the information presented above, the ground conditions underlying the site are anticipated to comprise loess (wind-blown silt) overlying volcanic bedrock. However, little information is available on the actual ground conditions at the site.

² CERA, http://cera.govt.nz/my-property?address=45+SUMNERVALE+DRIVE+LOWER%2C+SUMNER&address_id=7690889

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



8.2 Seismicity

8.2.1 Nearby Faults

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

Table 3 Summary of Known Active Faults^{4,5}

Known Active Fault	Distance from Site	Direction from Site	Max Likely Magnitude	Avg Recurrence Interval
Alpine Fault	135 km	NW	~8.3	~300 years
Greendale (2010) Fault	31 km	W	7.1	~15,000 years
Hope Fault	110 km	N	7.2~7.5	120~200 years
Kelly Fault	120 km	NW	7.2	~150 years
Porters Pass Fault	70 km	NW	7.0	~1100 years

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

8.2.2 Ground Shaking Hazard

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

Post February 2011 seismic activity has produced earthquakes of Magnitude 6.3 with peak ground accelerations (PGA) up to twice the acceleration due to gravity (2g) in some parts of the city. This has resulted in widespread liquefaction throughout Christchurch.

In addition, anticipation of loess overlying volcanic bedrock anticipated to be within 30m, a 475-year PGA (peak ground acceleration) of ~0.4 (Stirling et al, 2002⁴), ground shaking is likely to be moderate to high.

8.3 Slope Failure and/or Rockfall Potential

The site is situated at the base of the Port Hills. As a result, the site is considered to be at moderate risk from rockfall. The Port Hills are undergoing geotechnical investigations and assessments to quantify the risk posed by rockfall.

In addition, any localised retaining structures or embankments should be further investigated to determine the site-specific slope instability potential.

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

⁵ GNS Active Faults Database, <http://maps.gns.cri.nz/website/af/viewer.htm>



8.4 Liquefaction Potential

Evidence of liquefaction was not noted on the aerial photography. However, if saturated, loess has the potential to liquefy, which can result in settlement of the structure. The groundwater level at the site, along with the thickness of loess is also unknown. Therefore the site liquefaction potential is currently considered to be moderate. However, further investigation is recommended to better determine subsoil conditions. From this, a more comprehensive liquefaction assessment could be undertaken.

8.5 Recommendations

Given the lack of site specific ground investigation data, and unknown depth to bedrock, we recommend that further investigation is undertaken. This will allow a more comprehensive ground condition and liquefaction assessment to be carried out.

8.6 Conclusions & Summary

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

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

The site appears to be situated on loess, which is likely to be overlying volcanic bedrock. However the thickness of the loess is not known, and if saturated loess can be susceptible to liquefaction. Further investigation is recommended.



9. Survey

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



10. Initial Capacity Assessment

10.1 % NBS Assessment

The building's capacity was assessed using the Initial Evaluation Procedure based on the information available. The building's capacity excluding and including Critical Structural Weaknesses (CSWs) are expressed as a percentage of new building standard (%NBS) and are in the order of that shown below in Table 4. These capacities are subject to confirmation by a more detailed quantitative analysis.

<u>Item</u>	<u>%NBS</u>
Building Capacity excluding CSWs	27%
Building Capacity including:	
Plan Irregularity (significant; 30% reduction)	19%

Table 4 Indicative Capacities based on the NZSEE Initial Evaluation Procedure

Following an IEP assessment, the building has been assessed as achieving 19% New Building Standard (NBS). Under the New Zealand Society for Earthquake Engineering (NZSEE) guidelines the building is considered potentially Earthquake Prone as it achieves less than 34% NBS. The building's capacity excluding critical structural weaknesses is in the order of 27% NBS. The overall %NBS has been reduced by 30% to account for significant Plan Irregularity.

10.2 Seismic Parameters

The seismic design parameters based on current design requirements from NZS1170:2002 and the NZBC clause B1 for this building are:

- ▶ Site soil class: C, NZS 1170.5:2004, Clause 3.1.3, Shallow Soil
- ▶ Site hazard factor, $Z = 0.3$, NZBC, Clause B1 Structure, Amendment 11 effective from 1 August 2011
- ▶ Return period factor $R_u = 1.0$, NZS 1170.5:2004, Table 3.5, Importance Level 2 structure with a 50-year design life.

Some key seismic parameters have influenced the %NBS score obtained from the IEP assessment. The building has been assessed as an Importance Level 2 building. An increased Z factor of 0.3 for Christchurch has been used in line with recommendations from the Department of Building and Housing recommendations.

10.3 Expected Structural Ductility Factor

A structural ductility factor of 2.0 has been assumed based on the timber framed wall structure and date of construction.



10.4 Discussion of Results

The results obtained from the initial IEP assessment are consistent with those expected for a building of this age and construction type founded on Class C soils. This building would have been designed to the standards at the time, namely NZSS 95:1935. The design loads used in this standard would have been significantly less than those required by the current loading standard. When combined with the increase in the hazard factor for Christchurch to 0.3, the potential for rockfall, and the plan irregularity of the building, it is reasonable to expect the building to be classified as potentially Earthquake Prone.



11. Initial Conclusions

The building has been assessed to have a seismic capacity in the order of 19% NBS and is therefore potentially Earthquake Prone.



12. Recommendations

The building has achieved less than 34% NBS capacity according to an initial IEP assessment, which classifies the building as potentially Earthquake Prone. The building is not damaged and does not present any collapse hazard, but does exhibit a critical structural weakness in the form of Plan Irregularity.



13. Limitations

13.1 General

This report has been prepared subject to the following limitations:

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

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

13.2 Geotechnical Limitations

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

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

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



Appendix A

Photographs



Photograph 1: Northeast elevation.



Photograph 2: East Elevation.



Photograph 3: East rear elevation.



Photograph 4: Southeast corner elevation.



Photograph 5: South elevation.



Photograph 6: Southwest elevation.



Photograph 7: Small shed structure on grounds.



Photograph 8: Foundation under small shed structure.



Photograph 9: Timber stair and piles at house entrance.



Photograph 10: Timber piles and floor structure under house.



Photograph 11: Timber piles under entry landing at house.



Photograph 12: Narrow gap between house structures.



Photograph 13: Internal plasterboard linings at office area inside house.



Photograph 14: Roof rafters and purlins at addition. Note lack of attachment to external wall.



Photograph 15: Cross-braced internal wall (once external wall) at house, with addition beyond.



Photograph 16: Roof rafters and sarking at addition.



Appendix B

Existing Drawings

Note: no existing drawings for this building were able to be located.



Appendix C

CERA Building Evaluation Form

Detailed Engineering Evaluation Summary Data

V1.11

Location		Building Name: <input type="text" value="House - Sumnervale Reserve"/>	Unit: <input type="text" value=""/>	No: <input type="text" value=""/>	Street: <input type="text" value=""/>	Reviewer: <input type="text" value="Stephen Lee"/>
Building Address: <input type="text" value="45 Sumnervale Drive, Sumner"/>		CPEng No: <input type="text" value="1006840"/>				Company: <input type="text" value="GHD"/>
Legal Description: <input type="text" value=""/>		Company project number: <input type="text" value="513059696"/>				Company phone number: <input type="text" value="6433780900"/>
GPS south: <input type="text" value=""/>		Degrees		Min	Sec	Date of submission: <input type="text" value="13/02/2014"/>
GPS east: <input type="text" value=""/>						Inspection Date: <input type="text" value="17/4/2012"/>
Building Unique Identifier (CCC): <input type="text" value="PRK 0528 BLDG 001-EQ2"/>		Revision: <input type="text" value="FINAL"/>				Is there a full report with this summary? <input type="text" value="yes"/>

Site	Site slope: <input type="text" value="slope < 1 in 10"/>	Max retaining height (m): <input type="text" value="0"/>
	Soil type: <input type="text" value="sandy silt"/>	Soil Profile (if available): <input type="text" value=""/>
	Site Class (to NZS1170.5): <input type="text" value="C"/>	If Ground improvement on site, describe: <input type="text" value=""/>
	Proximity to waterway (m, if <100m): <input type="text" value=""/>	Approx site elevation (m): <input type="text" value=""/>
	Proximity to cliff top (m, if < 100m): <input type="text" value=""/>	
	Proximity to cliff base (m, if <100m): <input type="text" value=""/>	

Building	No. of storeys above ground: <input type="text" value="1"/>	single storey = 1	Ground floor elevation (Absolute) (m): <input type="text" value=""/>
	Ground floor split? <input type="text" value="no"/>		Ground floor elevation above ground (m): <input type="text" value="0.00"/>
	Storeys below ground: <input type="text" value="0"/>		
	Foundation type: <input type="text" value="timber piles"/>	If Foundation type is other, describe: <input type="text" value=""/>	
	Building height (m): <input type="text" value="2.40"/>	height from ground to level of uppermost seismic mass (for IEP only) (m): <input type="text" value="2.2"/>	
	Floor footprint area (approx): <input type="text" value="24"/>		
	Age of Building (years): <input type="text" value="57"/>	Date of design: <input type="text" value="1935-1965"/>	
	Strengthening present? <input type="text" value="no"/>	If so, when (year)? <input type="text" value=""/>	
	Use (ground floor): <input type="text" value="other (specify)"/>	And what load level (%g)? <input type="text" value=""/>	
	Use (upper floors): <input type="text" value=""/>	Brief strengthening description: <input type="text" value=""/>	
	Use notes (if required): <input type="text" value="Office & equestrian equip. storage"/>		
	Importance level (to NZS1170.5): <input type="text" value="IL2"/>		

Gravity Structure	Gravity System: <input type="text" value="load bearing walls"/>	rafter type, purlin type and cladding: <input type="text" value="Varies"/>
	Roof: <input type="text" value="timber framed"/>	joist depth and spacing (mm): <input type="text" value="Varies"/>
	Floors: <input type="text" value="timber"/>	type: <input type="text" value=""/>
	Beams: <input type="text" value="timber"/>	typical dimensions (mm x mm): <input type="text" value=""/>
	Columns: <input type="text" value="timber"/>	thickness (mm): <input type="text" value=""/>
	Walls: <input type="text" value="timber framed"/>	

Lateral load resisting structure	Lateral system along: <input type="text" value="lightweight timber framed walls"/>	Note: Define along and across in detailed report!	note typical wall length (m): <input type="text" value="8"/>
	Ductility assumed, μ : <input type="text" value="2.00"/>		estimate or calculation? <input type="text" value="calculated"/>
	Period along: <input type="text" value="0.12"/>		estimate or calculation? <input type="text" value=""/>
	Total deflection (ULS) (mm): <input type="text" value=""/>		estimate or calculation? <input type="text" value=""/>
	maximum interstorey deflection (ULS) (mm): <input type="text" value=""/>		
	Lateral system across: <input type="text" value="lightweight timber framed walls"/>		note typical wall length (m): <input type="text" value="7"/>
	Ductility assumed, μ : <input type="text" value="2.00"/>		estimate or calculation? <input type="text" value="calculated"/>
	Period across: <input type="text" value="0.12"/>		estimate or calculation? <input type="text" value=""/>
	Total deflection (ULS) (mm): <input type="text" value=""/>		estimate or calculation? <input type="text" value=""/>
	maximum interstorey deflection (ULS) (mm): <input type="text" value=""/>		

Separations:	north (mm): <input type="text" value=""/>	leave blank if not relevant
	east (mm): <input type="text" value=""/>	
	south (mm): <input type="text" value=""/>	
	west (mm): <input type="text" value=""/>	

Non-structural elements	Stairs: <input type="text" value="timber"/>	describe supports: <input type="text" value=""/>
	Wall cladding: <input type="text" value="other light"/>	describe: <input type="text" value=""/>
	Roof Cladding: <input type="text" value="Metal"/>	describe: <input type="text" value="Corrugated steel"/>
	Glazing: <input type="text" value="timber frames"/>	
	Ceilings: <input type="text" value="plaster, fixed"/>	
	Services(ist): <input type="text" value=""/>	(at some locations)

Available documentation	Architectural: <input type="text" value="none"/>	original designer name/date: <input type="text" value=""/>
	Structural: <input type="text" value="none"/>	original designer name/date: <input type="text" value=""/>
	Mechanical: <input type="text" value=""/>	original designer name/date: <input type="text" value=""/>
	Electrical: <input type="text" value=""/>	original designer name/date: <input type="text" value=""/>
	Geotech report: <input type="text" value=""/>	original designer name/date: <input type="text" value=""/>

Damage	Site performance: <input type="text" value=""/>	Describe damage: <input type="text" value=""/>
Site: (refer DEE Table 4-2)	Settlement: <input type="text" value="none observed"/>	notes (if applicable): <input type="text" value=""/>
	Differential settlement: <input type="text" value="none observed"/>	notes (if applicable): <input type="text" value=""/>
	Liquefaction: <input type="text" value="none apparent"/>	notes (if applicable): <input type="text" value=""/>
	Lateral Spread: <input type="text" value="none apparent"/>	notes (if applicable): <input type="text" value=""/>
	Differential lateral spread: <input type="text" value="none apparent"/>	notes (if applicable): <input type="text" value=""/>
	Ground cracks: <input type="text" value="none apparent"/>	notes (if applicable): <input type="text" value=""/>
	Damage to area: <input type="text" value="none apparent"/>	notes (if applicable): <input type="text" value=""/>

Building:	Current Placard Status: <input type="text" value=""/>	
Along	Damage ratio: <input type="text" value="0%"/>	Describe how damage ratio arrived at: <input type="text" value=""/>
	Describe (summary): <input type="text" value=""/>	
Across	Damage ratio: <input type="text" value="0%"/>	$Damage_Ratio = \frac{(\%NBS(before) - \%NBS(after))}{\%NBS(before)}$
	Describe (summary): <input type="text" value=""/>	
Diaphragms	Damage?: <input type="text" value="no"/>	Describe: <input type="text" value=""/>
CSWs:	Damage?: <input type="text" value="no"/>	Describe: <input type="text" value=""/>
Pounding:	Damage?: <input type="text" value="no"/>	Describe: <input type="text" value=""/>
Non-structural:	Damage?: <input type="text" value="no"/>	Describe: <input type="text" value=""/>

Recommendations			
	Level of repair/strengthening required:		Describe:
	Building Consent required:		Describe:
	Interim occupancy recommendations:		Describe:
Along	Assessed %NBS before:	19%	19% %NBS from IEP below If IEP not used, please detail assessment methodology:
	Assessed %NBS after:	19%	
Across	Assessed %NBS before:	19%	19% %NBS from IEP below
	Assessed %NBS after:	19%	

IEP Use of this method is not mandatory - more detailed analysis may give a different answer, which would take precedence. Do not fill in fields if not using IEP.																												
Period of design of building (from above): 1935-1965		h _n from above: 2.2m																										
Seismic Zone, if designed between 1965 and 1992: B		not required for this age of building not required for this age of building C shallow soil																										
Period (from above):		along	across																									
(%NBS) _{nom} from Fig 3.3:		0.12	0.12																									
		3.6%	3.6%																									
Note: 1 for specifically design public buildings, to the code of the day: pre-1965 = 1.25; 1965-1976, Zone A = 1.33; 1965-1976, Zone B = 1.2; all else 1.0		1.00																										
Note 2: for RC buildings designed between 1976-1984, use 1.2		1.0																										
Note 3: for buildings designed prior to 1935 use 0.8, except in Wellington (1.0)		1.0																										
Final (%NBS) _{nom} :		along	across																									
		4%	4%																									
2.2 Near Fault Scaling Factor		Near Fault scaling factor, from NZS1170.5, cl 3.1.6: 1.00																										
Near Fault scaling factor (1/N(T,D), Factor A:		along	across																									
		1	1																									
2.3 Hazard Scaling Factor		Hazard factor Z for site from AS1170.5, Table 3.3: 0.30																										
		Z _{res} , from NZS4203:1992																										
Hazard scaling factor, Factor B:		3.333333333																										
2.4 Return Period Scaling Factor		Building Importance level (from above): 2																										
Return Period Scaling factor from Table 3.1, Factor C:		1.00																										
2.5 Ductility Scaling Factor		Assessed ductility (less than max in Table 3.2): 2.00																										
Ductility scaling factor: =1 from 1976 onwards; or = μ , if pre-1976, from Table 3.3:		along	across																									
		1.57	2.00																									
Ductility Scaling Factor, Factor D:		1.57	1.57																									
2.6 Structural Performance Scaling Factor:		Sp: 0.700																										
Structural Performance Scaling Factor Factor E:		1.428571429	1.428571429																									
2.7 Baseline %NBS, (NBS%) _b = (%NBS) _{nom} x A x B x C x D x E		%NBS _b : 27%																										
Global Critical Structural Weaknesses: (refer to NZSEE IEP Table 3.4)																												
3.1. Plan Irregularity, factor A:	significant	0.7																										
3.2. Vertical irregularity, Factor B:	insignificant	1																										
3.3. Short columns, Factor C:	insignificant	1																										
3.4. Pounding potential	Pounding effect D1, from Table to right: 1.0																											
	Height Difference effect D2, from Table to right: 1.0																											
	Therefore, Factor D:	1																										
3.5. Site Characteristics	insignificant	1																										
<table border="1"> <thead> <tr> <th colspan="2">Table for selection of D1</th> <th>Severe</th> <th>Significant</th> <th>Insignificant/none</th> </tr> <tr> <th colspan="2">Separation</th> <th>0<sep<.005H</th> <th>.005<sep<.01H</th> <th>Sep>.01H</th> </tr> </thead> <tbody> <tr> <td>Alignment of floors within 20% of H</td> <td></td> <td>0.7</td> <td>0.8</td> <td>1</td> </tr> <tr> <td>Alignment of floors not within 20% of H</td> <td></td> <td>0.4</td> <td>0.7</td> <td>0.8</td> </tr> </tbody> </table>				Table for selection of D1		Severe	Significant	Insignificant/none	Separation		0<sep<.005H	.005<sep<.01H	Sep>.01H	Alignment of floors within 20% of H		0.7	0.8	1	Alignment of floors not within 20% of H		0.4	0.7	0.8					
Table for selection of D1		Severe	Significant	Insignificant/none																								
Separation		0<sep<.005H	.005<sep<.01H	Sep>.01H																								
Alignment of floors within 20% of H		0.7	0.8	1																								
Alignment of floors not within 20% of H		0.4	0.7	0.8																								
<table border="1"> <thead> <tr> <th colspan="2">Table for Selection of D2</th> <th>Severe</th> <th>Significant</th> <th>Insignificant/none</th> </tr> <tr> <th colspan="2">Separation</th> <th>0<sep<.005H</th> <th>.005<sep<.01H</th> <th>Sep>.01H</th> </tr> </thead> <tbody> <tr> <td>Height difference > 4 storeys</td> <td></td> <td>0.4</td> <td>0.7</td> <td>1</td> </tr> <tr> <td>Height difference 2 to 4 storeys</td> <td></td> <td>0.7</td> <td>0.9</td> <td>1</td> </tr> <tr> <td>Height difference < 2 storeys</td> <td></td> <td>1</td> <td>1</td> <td>1</td> </tr> </tbody> </table>				Table for Selection of D2		Severe	Significant	Insignificant/none	Separation		0<sep<.005H	.005<sep<.01H	Sep>.01H	Height difference > 4 storeys		0.4	0.7	1	Height difference 2 to 4 storeys		0.7	0.9	1	Height difference < 2 storeys		1	1	1
Table for Selection of D2		Severe	Significant	Insignificant/none																								
Separation		0<sep<.005H	.005<sep<.01H	Sep>.01H																								
Height difference > 4 storeys		0.4	0.7	1																								
Height difference 2 to 4 storeys		0.7	0.9	1																								
Height difference < 2 storeys		1	1	1																								
3.6. Other factors, Factor F	For ≤ 3 storeys, max value =2.5, otherwise max value =1.5, no minimum																											
	Rationale for choice of F factor, if not 1																											
Detail Critical Structural Weaknesses: (refer to DEE Procedure section 6)																												
List any: Refer also section 6.3.1 of DEE for discussion of F factor modification for other critical structural weaknesses																												
3.7. Overall Performance Achievement ratio (PAR)	0.70																											
4.3 PAR x (%NBS) _b :	PAR x Baseline %NBS: 19%																											
4.4 Percentage New Building Standard (%NBS), (before)	19%																											



GHD


226 Antigua Street, Christchurch 8011

T: 64 3 378 0900 F: 64 3 377 8575 E: chcmail@ghd.com

© GHD Limited 2014

This document is and shall remain the property of GHD Limited. The document may only be used for the purpose for which it was commissioned and in accordance with the Terms of Engagement for the commission. Unauthorised use of this document in any form whatsoever is prohibited.

Document Status

Rev No.	Author	Reviewer		Approved for Issue		
		Name	Signature	Name	Signature	Date
DRAFT	Nate Oakes	Stephen Lee		Nick Waddington		20.07.12
DRAFT 2	Simon Barker	Stephen Lee		Nick Waddington		24.09.12
Final	Simon Barker	Hamish Mackinven		Donna Bridgeman		13/02/14