Avonhead Park Pavilion

PRK 0206 BLDG 001 EQ2

Detailed Engineering Evaluation

Quantitative Report

Christchurch City Council

Christchurch City Council

Avonhead Park Pavilion

Detailed Engineering Evaluation Quantitative Report

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Avonhead Park Pavilion
PRK 0206 BLDG 001 EQ2

Detailed Engineering Evaluation
Quantitative Report - SUMMARY
Final

146 Hawthornden Road, Christchurch

Background
This is a summary of the quantitative report for the building structure, and is based on the Detailed Engineering Evaluation Procedure document (draft) issued by the Structural Advisory Group on 19 July 2011, visual inspections on 24 May 2012 and calculations.

Damage Observed
Damage observed includes:
- Minor cracking of the bottom northern masonry wall.
- Minor cracking of a lintel beam.

Critical Structural Weaknesses
No potential critical structural weaknesses have been identified.

Indicative Building Strength
Based on the information available, and from undertaking a quantitative assessment, the building's original capacity has been assessed to be 20%NBS across the building and 20%NBS along the building, limited by the out-of-plane bending capacity of the masonry wall, due to the absence of a ceiling diaphragm.

The building has been assessed to have a seismic capacity less than 34% NBS and is therefore classed as earthquake prone.

Recommendations
The following recommendations are made:

1) Carry out an intrusive investigation to determine the actual reinforcement size in the masonry wall.

2) Strengthen the building to at least 67%NBS.

Contents

1 Introduction

Opus International Consultants Limited has been engaged by Christchurch City Council (CCC) to undertake a detailed seismic assessment of the Avonhead Park Pavilion building, located at 146 Hawthornden Road, Christchurch. This report has been commissioned following the M6.3 Christchurch earthquake on 22 February 2011.

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

The seismic assessment and reporting have been undertaken based on the 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 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 owner's 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.

Any building with a capacity of less than 34%NBS (New Building Standard), including consideration of critical structural weaknesses, will need to be strengthened to a target of 67%NBS, as required by 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).

Section 115 – Change of Use

This section requires that the territorial authority (in this case Christchurch City Council (CCC)) 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 CCC as being 67% of the strength of an equivalent new building. 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.

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:

- 36% increase in the basic seismic design load for Christchurch (Z factor increased from 0.22 to 0.3);
- 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	Improvement of Structural Performance: NZSEE Recommendation
Low Risk Building	A or B	Low	Above 67	Acceptable (improvement may be desirable)	The Building Act sets no required level of structural improvement (unless change in use) This is for each TA to decide. Improvement is not limited to 34%NBS.	100%NBS desirable. Improvement should achieve at least 67%NBS
Moderate Risk Building	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). It is noted that the current seismic risk in Christchurch results in a 6% risk of exceedance 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

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

EPBs. As a result of this, we would expect such a building would be issued with a Section 124 notice by the Territorial Authority, or CERA acting on their behalf, once they are made aware of our assessment. Based on information received from CERA to date, this notice is likely to prohibit occupancy of the building (or parts of it); 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/Christchurch City Council 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 Building Description

4.1 General

The Avonhead Park Pavilion building is a single storey structure with 200mm thick reinforced masonry internal and external walls. The roof is comprised of a timber truss system supporting a corrugated iron roof. The structure has a concrete slab on grade and is assumed to be a 1970s or 1980s construction. The structure is primarily used as a sports changing room with shower and toilet facilities.

The building structure is approximately 20.1m long in the north-south direction and 17.7m wide in the east-west direction, with a veranda at the northern and western side. The height of the masonry walls are approximately 2.6m.

The building has a ceiling diaphragm throughout, except for the toilets and the northern changing room areas.

Refer to Appendix B for the floor plan of the building.

4.2 Gravity Load Resisting System

The roof of the structure is a lightweight corrugated roofing supported on timber trusses. The connection of the trusses to the walls could not be inspected.

The gravity loads are transferred to the foundation via the reinforced masonry walls.

4.3 Seismic Load Resisting System

Lateral support for the roof is provided by the timber trusses and the reinforced masonry walls in the longitudinal direction (north-south) and transverse direction (east-west).

5 Survey

No copies of the original design calculations or drawings have been obtained for this building.

The building structure was inspected and measured. Layout drawings were prepared by Opus International Consultants.

A level 2 Rapid assessment was carried out on the building on 4 July 2011 by Opus International Consultants.

The layout drawings produced by Opus International Consultants have been used to investigate potential critical structural weaknesses (CSW) wherever possible, and to identify details which required particular attention.

A site visit was carried out on 24 May 2012 to identify the structural systems of the building, and to note any critical structural weaknesses and any damage resulting from the February 2011 earthquake.

6 Damage Assessment

The building appears to have suffered only minor damage as a result of the recent earthquake events. The following damage has been noted:

6.1 Cracking

We observed minor cracks on the bottom northern wall and minor cracking of a lintel beam.

7 General Observations

Overall the building has performed well under the recent seismic conditions. The building has sustained little damage and continues to be fully operational.

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

8 Detailed Seismic Assessment

8.1 Critical Structural Weaknesses

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

We have not identified any critical structural weaknesses in the building.

8.2 Seismic Coefficient Parameters

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

- Site soil class D, clause 3.1.3 NZS 1170.5:2004
- Site hazard factor, Z=0.3, B1/VM1 clause 2.2.14B
- Return period factor R_u = 1.0 from Table 3.5, NZS 1170.5:2004, for an Importance Level 2 structure with a 50 year design life.
- Ductility factor μ_{max} = 1.25 for the reinforced masonry building.

8.3 Detailed Seismic Assessment Results

A summary of the structural performance of the building is shown in Table 2. Note that the values given represent the worst performing elements in the building, as these effectively define the building's capacity. Other elements within the building may have significantly greater capacity when compared with the governing element.

Assumptions made

- The reinforcement spacing in the masonry wall was determined using a cover meter. The reinforcement size could not be determined and has been assumed as 9.5mm diameter (⅜ inch rods) bars at 600mm centres for the load bearing walls and 1200mm centres for the non-load bearing walls.

- There were no architectural or structural drawings available and therefore we were not able to assess the connection details between the timber trusses and the masonry walls. We have, however, assumed that these connections are adequate to allow transfer of lateral loads of at least those associated with the assessed %NBS lateral loading for the structure. This assumption is based on site visits carried out and the performance of the building in recent seismic events.

Table 2: Summary of Seismic Performance

Structural Element/System	Failure mode and description of limiting criteria	% NBS based on calculated capacity
External masonry wall	Out-of-plane bending capacity in the north-south direction (where there is no ceiling diaphragm)	30%
Internal masonry wall	Out-of-plane bending capacity in the north-south direction (where there is no ceiling diaphragm)	20%
Internal masonry wall	Out-of-plane bending capacity in the east-west direction (where there is no ceiling diaphragm)	20%
External masonry walls	Out-of-plane bending capacity in the north-south and east-west directions (with ceiling diaphragm)	>100%
Internal masonry walls	Out-of-plane bending capacity in the north-south and east-west directions (with ceiling diaphragm)	>100%
Wall bracings	In plane shear in the north-south and east-west directions	>100%

8.4 Discussion of Results

The building has a calculated capacity of 20%NBS, with the capacity being governed by the out-of-plane bending capacity of the masonry walls due to the absence of a ceiling diaphragm in the toilet area and the adjacent changing room. This is below the threshold limit for buildings classified as 'earthquake prone', which is effectively one third (33%) of the seismic performance specified in the current loading standard for new buildings. The building is therefore defined as earthquake prone in accordance with the Building Act 2004.

For areas which have a celling diaphragm the seismic capacity is above 100%NBS. This is due to the behaviour of the wall acting as simply supported between the diaphragm and the floor.

It must be noted that the assessment was based on the assumption that the vertical reinforcement bars in the walls are 9.5mm diameter. Reinforcement bars larger than 9.5mm diameter will produce a higher %NBS. Limited breakout of the masonry wall is recommended to accurately determine the size of the reinforcement.

8.5 Limitations and Assumptions in Results

Our analysis and assessment is based on an assessment of the building in its undamaged state. However, we haven't observed any significant structural damage to the building.

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 the unavailability of drawings, and site inspections;
- The normal variation in material properties which change from batch to batch;
- Approximations made in the assessment of the capacity of each element, especially when considering the post-yield behaviour.

9 Geotechnical Assessment

A summary of the Geotechnical Desktop Study for the site is shown in this section.

A full Geotechnical Desktop Study for the Avonhead Park Pavilion Building, dated 29 June 2012 is attached in Appendix C.

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 on dominantly alluvial and silt overbank deposits belonging to the Yaldhurst Member of the Springston Formation.

9.2 Expected Ground Conditions

A review of the Environment Canterbury (ECan) wells database showed three wells located within approximately 430m of the property.

Material logs available from ECan have been used to infer the ground conditions at the site, as shown in Table 3 below.

Table 3: Inferred Ground Conditions

Stratigraphy	Thickness (m)	Depth Encountered (m)
SILT	2.0	Surface
SAND	1.4	2
GRAVEL	-	3.0-3.4

A groundwater depth of approximately 5.5m to 6.5m below ground level has been interpreted from groundwater depth contour maps (Environment Canterbury (2003) and Elder et al. (1991)).

9.3 Liquefaction Hazard Study

A liquefaction hazard study was conducted by the Canterbury Regional Council (ECan) in 2004 to identify areas of Christchurch susceptible to liquefaction during an earthquake. The Avonhead Park Toilet Block is located in an area identified as having 'low liquefaction ground damage potential'. According to this study, based on a low groundwater table, ground damage from liquefaction is expected to be minor and is likely to be affected by less than 100mm of ground subsidence.

Tonkin and Taylor Ltd (T&T Ltd), the Earthquake Commission's (EQC) geotechnical consultants, have prepared maps showing areas of liquefaction interpreted from high resolution aerial photos for the September 2010 earthquake and the aftershocks of February 2011, June 2011 and December 2011. There has been no evidence of liquefaction in the vicinity.

The land at Avonhead Park has been zoned as N/A-Urban Non-residential. However, the neighbouring properties 70m south have been zoned as Green-TC1 'grey zone', which indicates negligible land deformation is expected in future small- to medium-sized earthquakes and up to minor land deformation in a future moderate to large earthquake.

9.4 Discussion and Recommendation of Geotechnical Assessment

ECan well logs indicate the building is founded on a layer of silt and sand overlying a thick densely packed gravel layer. Liquefaction typically occurs in recent (i.e. less than 10,000 years old), normally consolidated silts and sands beneath groundwater and is dependent on material density, grain size and soil composition. We would expect that liquefaction is unlikely at the Avonhead Park, due to the underlying compact dense gravels and deep groundwater level. The lack of ground damage reported at the site during the recent earthquakes of 2010 and 2011 confirm that the site is not at risk of liquefaction.

Based on the past performance in recent earthquakes, the existing foundations should be acceptable in terms of future ultimate limit state (ULS) and serviceability limit state (SLS) loadings, although CCC may have to accept the risk for potential differential settlement in the order of 0 to 50mm in a future seismic event.

10 Conclusions

(a) The building has a seismic capacity of 20%NBS and is therefore considered earthquake prone in accordance with the Building Act 2004.

(b) Due to the calculated capacity the building is classed as grade D, high risk and has a relative risk of failure of approximately 10-25 times that of a building complying with current codes.

(c) The seismic capacity is governed by the out-of-plane bending capacity of the masonry walls, due to the absence of ceiling diaphragm in two areas of the building.

(d) The diameter of the vertical reinforcement is unknown, but for the purposes of this assessment was taken to be 9.5mm diameter. A larger bar diameter will result in a higher seismic capacity. Limited breakout of the walls is recommended to accurately establish the bar diameter.

(e) It is recommended that the building be strengthened to at least 67%NBS to reduce the seismic risk.

11 Recommendations

(a) Carry out an intrusive investigation on the masonry wall to determine the actual reinforcement size.

(b) Strengthen the building to at least 67%NBS.

12 Limitations

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

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

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

(d) In the absence of structural drawings the seismic capacity is based on an assumed reinforcement bar diameter. In order to accurately establish the seismic capacity it is recommended that limited breakout of the walls is undertaken.

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

Appendix A – Photographs

Photo 1: Northern wall.

Photo 2: Western wall.

Photo 3: Southern wall.

Photo 4: Typical view of roof truss. Note no ceiling diaphragm.

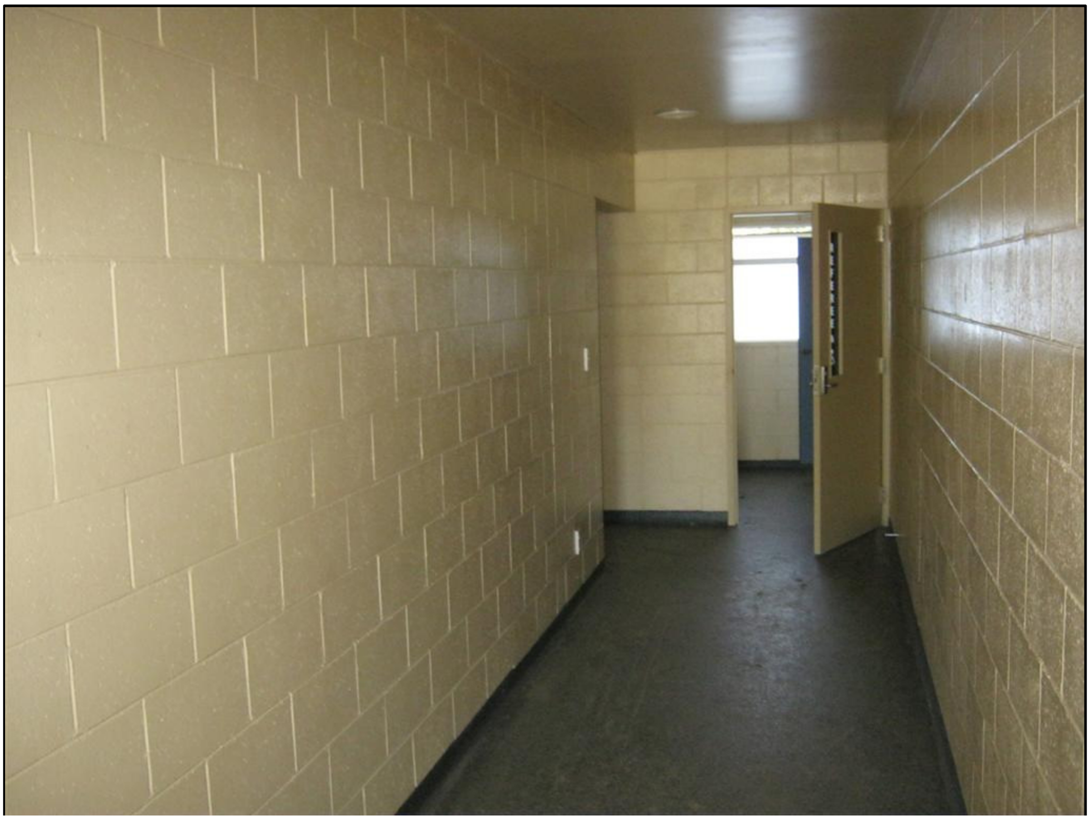


Photo 5: Typical view of internal walls.

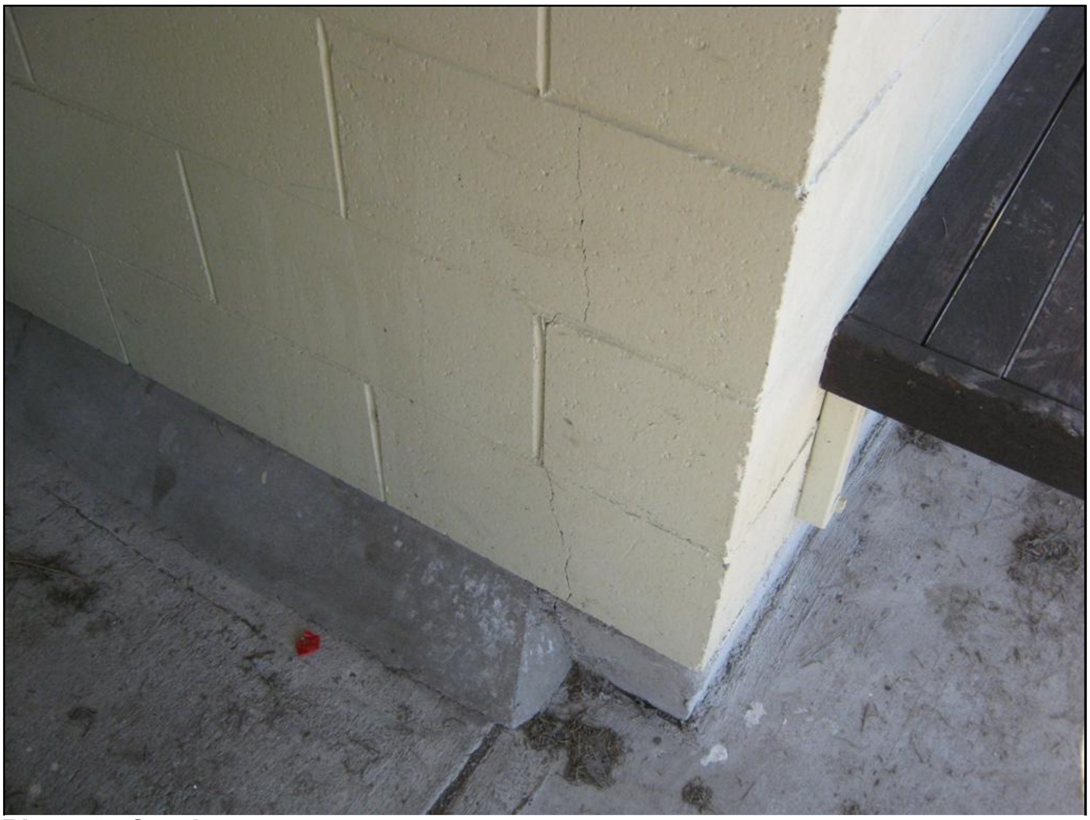


Photo 6: Crack on masonry wall.

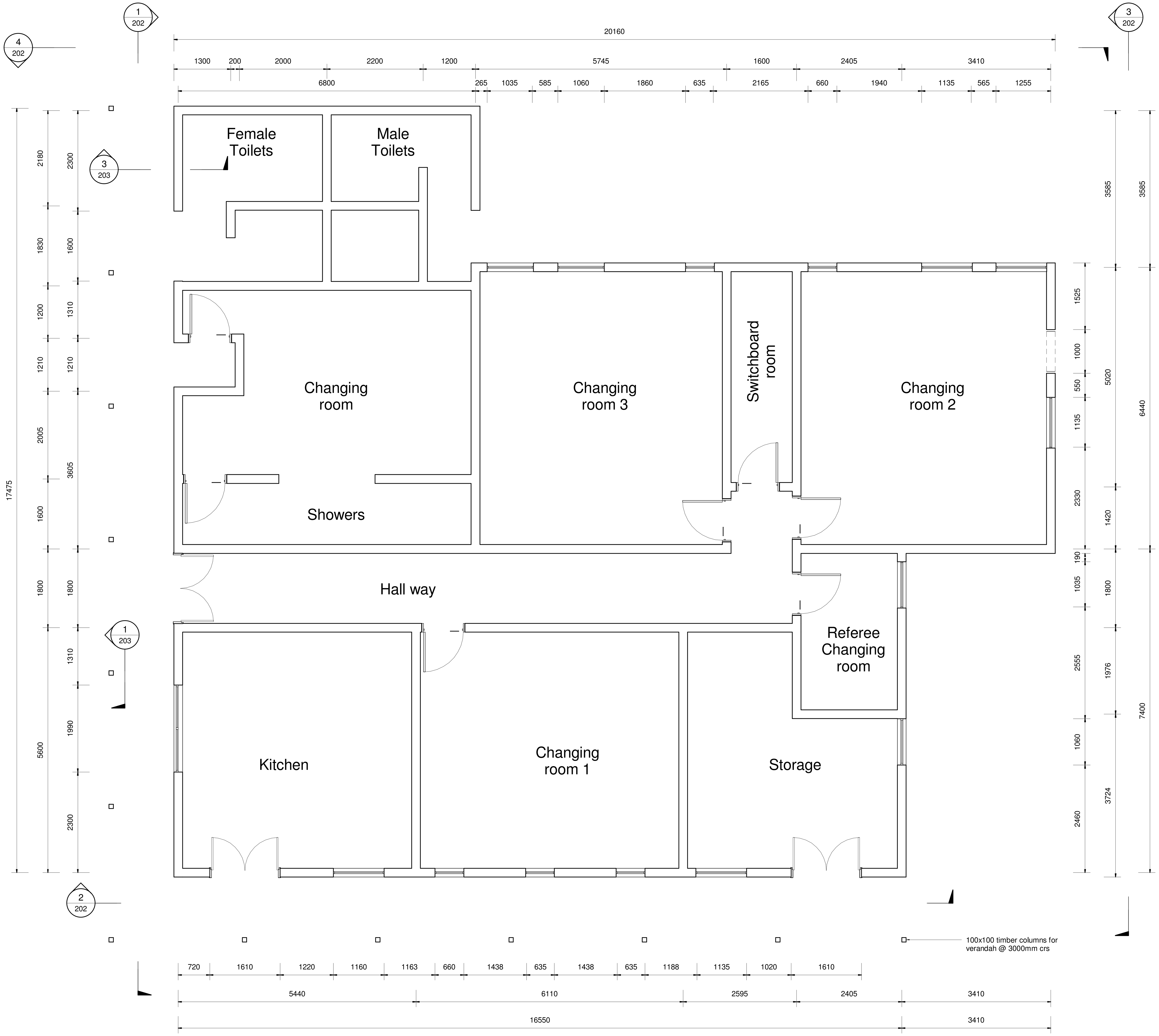
Appendix B – Floor Plans

DRAWING LIST	
Sheet Number	Sheet Name
201	Layout
202	Elevations
203	Details

3D Structural
SCALE

Notes:

Blockwork:	20-Series Masonry Blocks. Blockwork appears to be filled.
Reinforcement:	Non-load bearing walls reinforcement is placed @ 200mm crs
	Load bearing walls reinforcement is placed @ 600mm crs
Ceiling height:	2465mm
Rafter Spacing:	Rafters are 100 x 50mm spaced @ 1200mm crs. Connected by nail pates.



Plan
SCALE 1 : 50

CONSTRUCTION DETAILS

Revision	Amendment	Approved	Revision Date

CHRISTCHURCH
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Project
Christchurch City Council
Hawthornden Road
Avonhead Park Pavilion

Title
Layout

Drawn	Designed	Approved	Revision Date
J.R.W			03.07.2012

Project No.	Scale	Drawing No.	Sheet No.	Revision
6-QUCC1.19	1 : 50	6/1366/276/ 8602	201	R0

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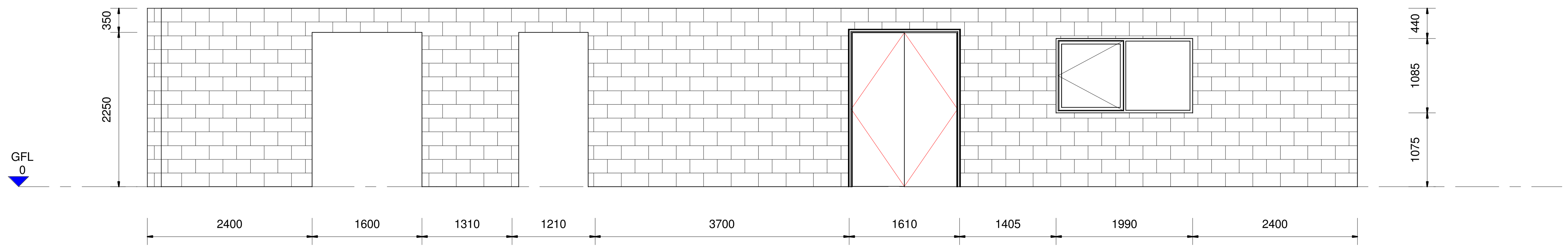

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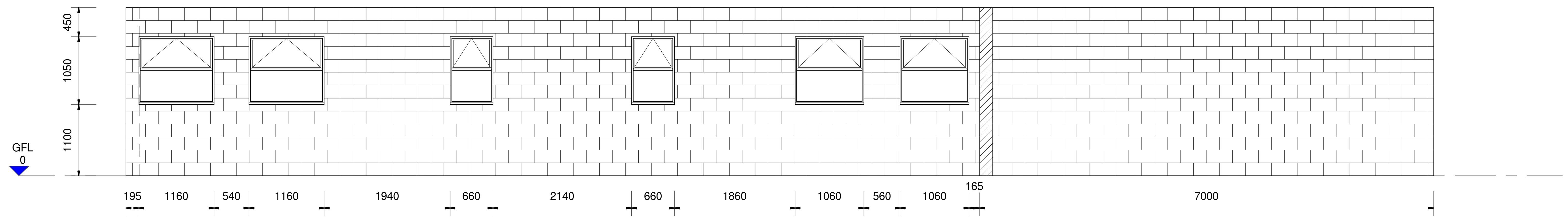

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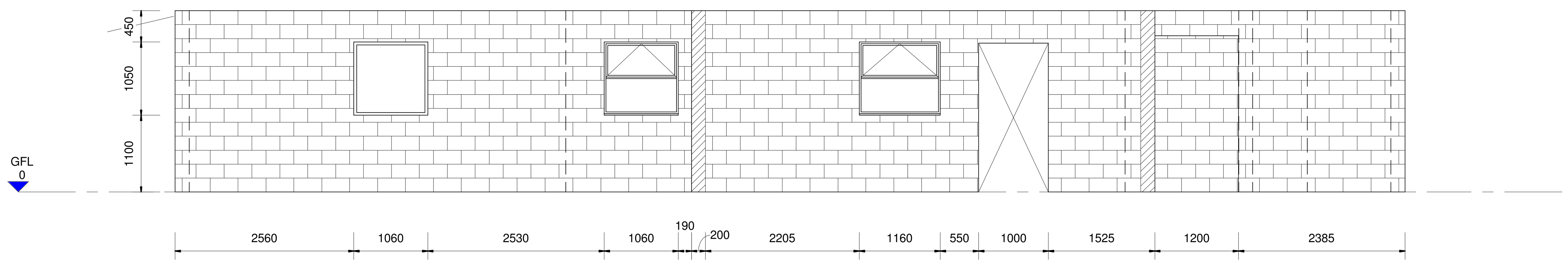

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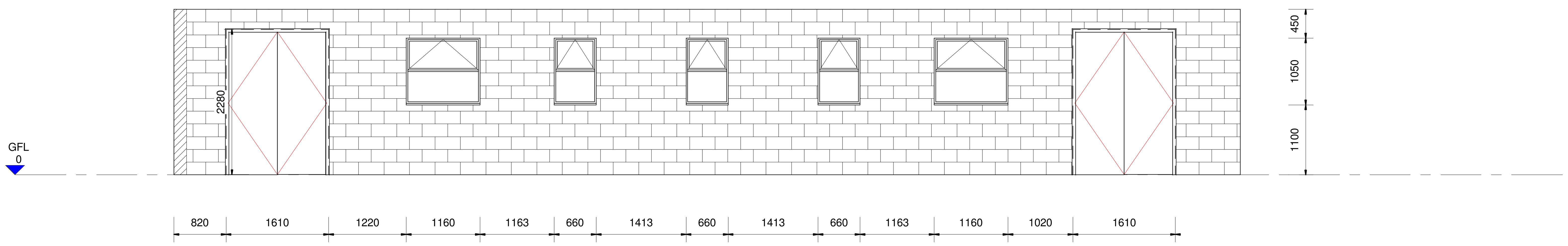

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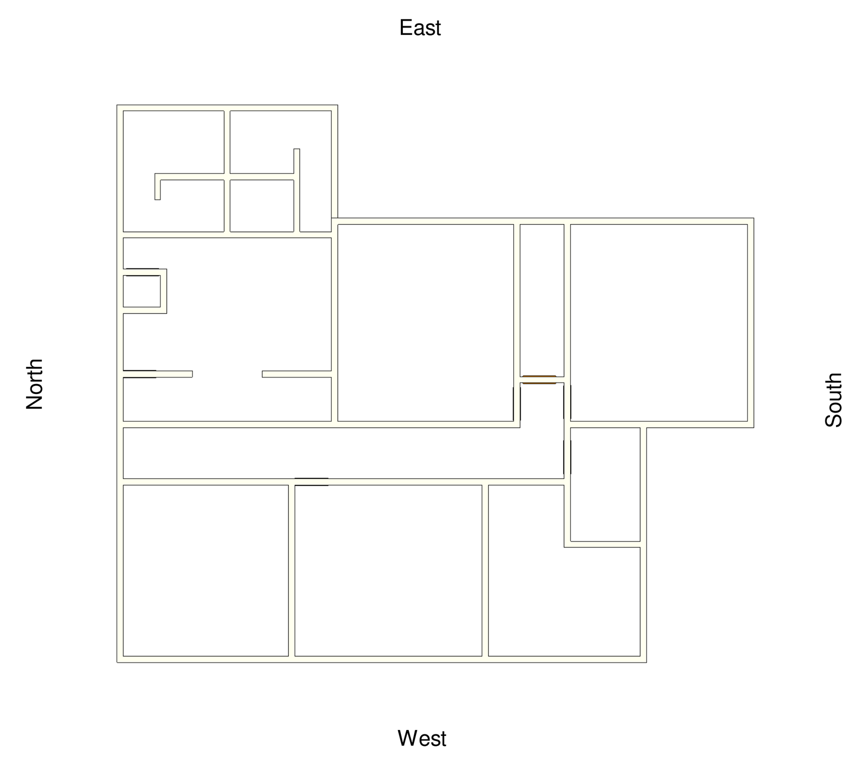

Layout
SCALE 1 : 200

CONSTRUCTION DETAILS

Revision	Amendment	Approved	Revision Date

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Drawn	Designed	Approved	Revision Date
J.R.W			03.07.2012

Project
Christchurch City Council
Hawthornden Road
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Title
Elevations

Project No.	Scale	Drawing No.	Sheet No.	Revision
6-QUCC1.19	As indicated	6/1366/276/ 8602	202	R0

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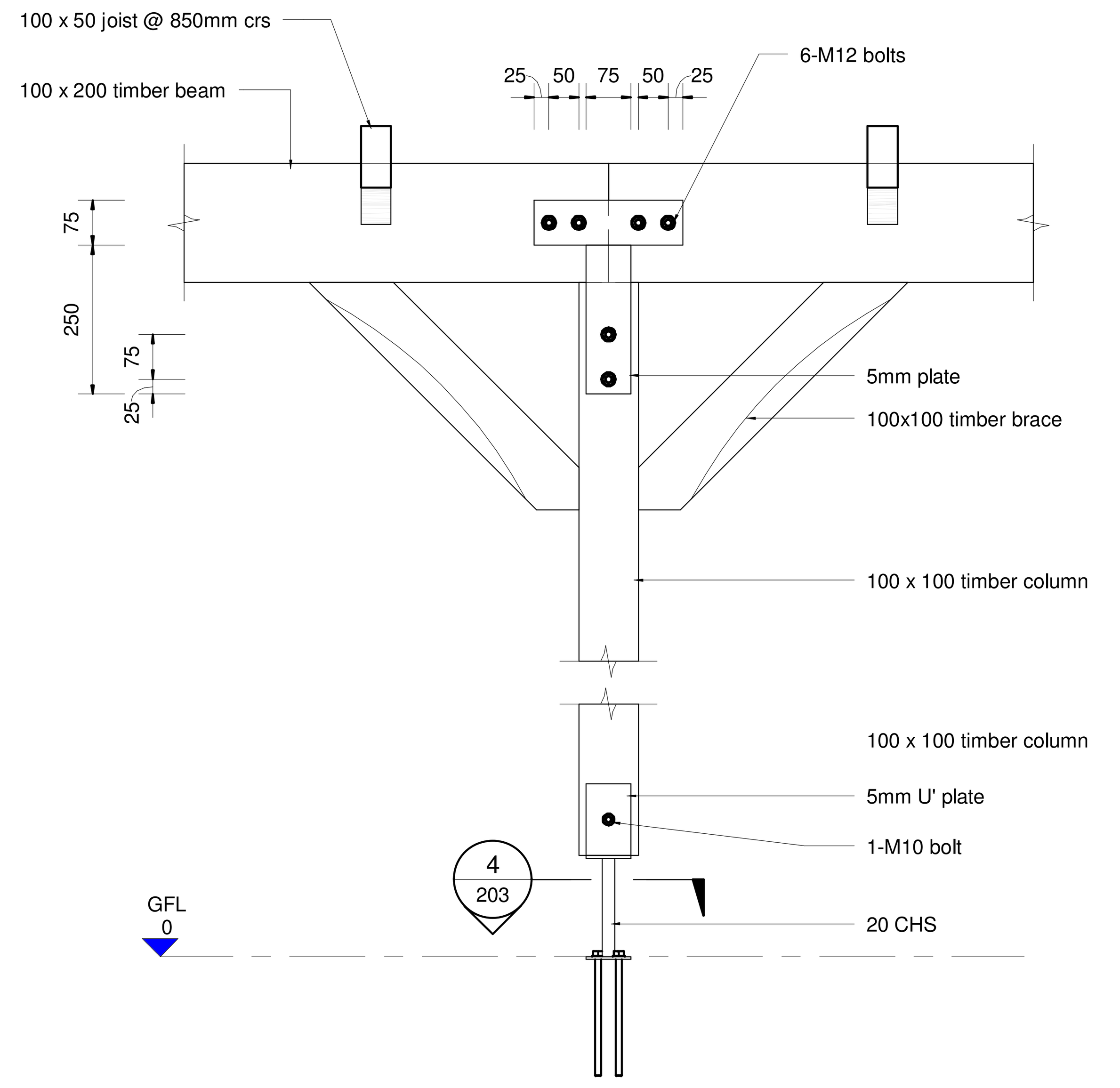

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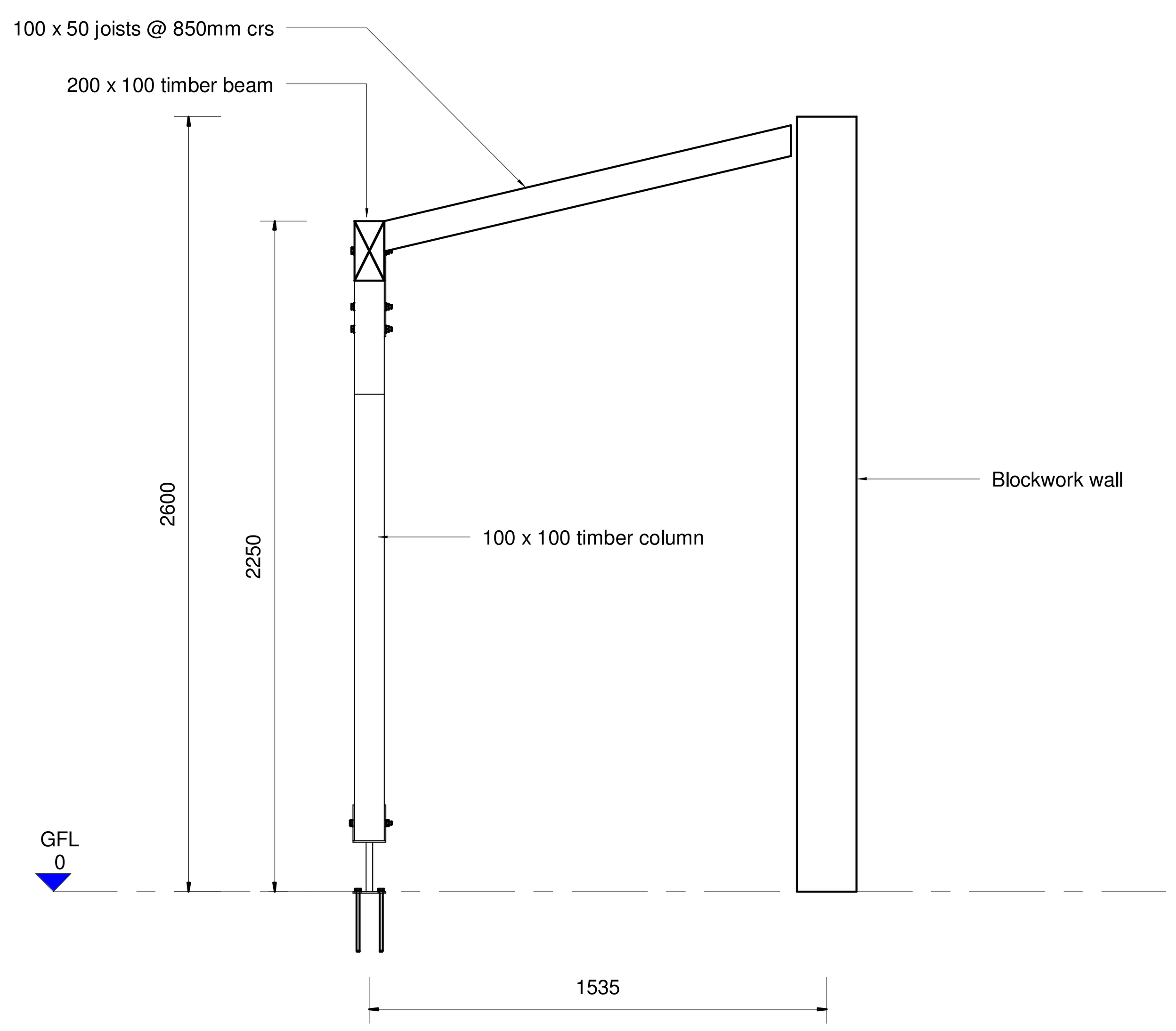

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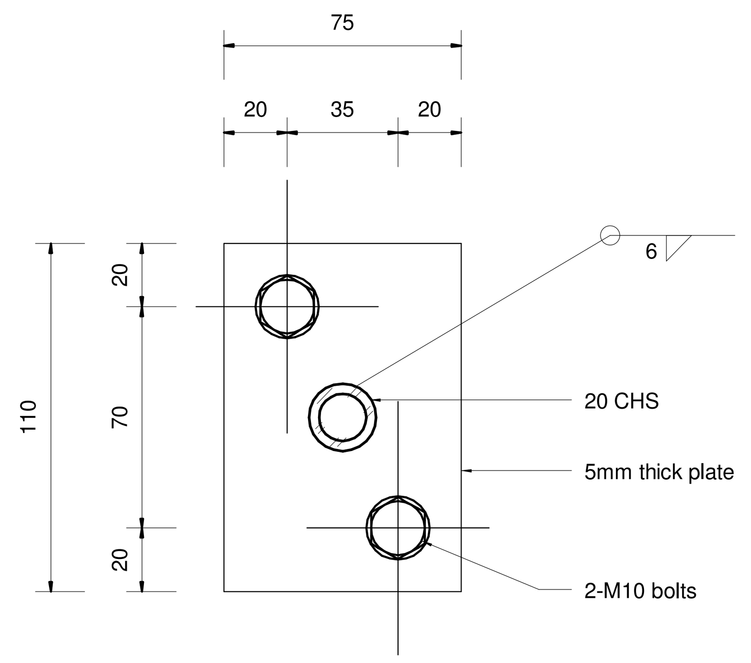

Detail 1.A
SCALE 1 : 2

CONSTRUCTION DETAILS

Revision	Amendment	Approved	Revision Date

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Drawn	Designed	Approved	Revision Date
J.R.W			03.07.2012

Project
Christchurch City Council
Hawthornden Road
Avonhead Park Pavilion

Title
Details

Project No.	Scale	Drawing No.	Sheet No.	Revision
6-QUCC1.19	As indicated	6/1366/276/ 8602	203	R0

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Appendix C – Geotechnical Appraisal

20 November 2012

Michael Sheffield
Christchurch City Council
PO Box 2522
Addington
CHRISTCHURCH 8140

6-QUCC1.19

Dear Michael

Geotechnical Desk Study – Avonhead Park Pavilion

1. Introduction

Christchurch City Council (CCC) has commissioned Opus International Consultants (Opus) to undertake a brief Geotechnical Desk Study of the Avonhead Park Pavilion, Avonhead, Christchurch. The purpose of this study is to collate existing subsoil information, undertake an appraisal of the potential geotechnical hazards at this site and determine whether further investigations are required.

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

This geotechnical desk study has been undertaken without the benefit of any site specific investigations and is therefore preliminary in nature.

2. Desktop Study

2.1 Site Description

The Avonhead Park Pavilion is located at 146 Hawthornden Road on the eastern boundary of Avonhead Park. The Pavilion occupies an approximate footprint of 400m^2.

The Avonhead Park Pavilion building is bounded by a carpark to the south, tennis court to the east, and grassed areas of Avonhead Park to the north and west.

The ground profile is relatively flat, low lying and is typically level with the surrounding car park and grassed areas. The grounds surrounding the site are generally grassed with planted areas and with a small portion surfaced with concrete pavers.

2.2 Structural Drawings

Structural Drawings of the Pavilion have not been available for review. Based upon the photographs, the superstructure appears predominantly constructed from concrete masonry blocks. It is assumed that the building is founded on perimeter strip footings and concrete floor slab on grade.

No geotechnical investigations or geotechnical reports associated with the building were available on the CCC property file.

2.3 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 on dominantly alluvial and silt overbank deposits belonging to the Yaldhurst Member of the Springston Formation.

2.4 Expected Ground Conditions

A review of the Environmental Canterbury (ECan) wells database showed three wells located within approximately 430 m of the property (refer to Site Location Plan in Appendix B).

Material logs available from ECan have been used to infer the ground conditions at the site, as shown in Table 1 below.

Table 1: Inferred Ground Conditions

Stratigraphy	Thickness (m)	Depth Encountered (m)
SILT	2.0	Surface
SAND	1.4	2
GRAVEL	-	3.0-3.4

A groundwater depth of approximately 5.5m to 6.5m below ground level has been interpreted from groundwater depth contour maps (Environment Canterbury (2003) and Elder et al. (1991)).

2.5 Liquefaction Hazard

A liquefaction hazard study was conducted by the Canterbury Regional Council (ECan) in 2004 to identify areas of Christchurch susceptible to liquefaction during an earthquake. The Avonhead Park Pavilion is located in an area identified as having ‘low liquefaction ground damage potential’. According to this study, based on a low groundwater table, ground damage from liquefaction is expected to be minor and is likely to be affected by less than 100mm of ground subsidence.

Tonkin and Taylor Ltd (T&T Ltd) the Earthquake Commission’s (EQC) geotechnical consultants have prepared maps showing areas of liquefaction interpreted from high resolution aerial photos for the September 2010 earthquake and the aftershocks of February 2011, June 2011 and December 2011. There has been no evidence of liquefaction in the vicinity.

Following the recent strong earthquakes in Canterbury, the Canterbury Earthquake Recovery Authority (CERA, 2012) has zoned land in the Greater Christchurch area according to its ground performance in future large earthquakes.

The Department of Building and Housing has sub-divided the CERA "Green" residential recovery zone land on the flat in Christchurch into technical categories. The three technical categories are summarised in Table 2 which has been adapted from the Department of Building and Housing guidance document (DBH, 2011).

Table 2: Technical Categories based on Expected Land Performance

Foundation Technical Category	Future land performance expected from liquefaction	Expected SLS land settlement	Expected ULS land settlement
TC 1	Negligible land deformations expected in a future small to medium sized earthquake and up to minor land deformations in a future moderate to large earthquake.	0-15 mm	0-25 mm
TC 2	Minor land deformations possible in a future small to medium sized earthquake and up to moderate land deformations in a future moderate to large earthquake.	0-50 mm	0-100 mm
TC 3	Moderate land deformations possible in a future small to medium sized earthquake and significant land deformations in a future moderate to large earthquake.	>50 mm	>100 mm

The land at Avonhead Park has been zoned as N/A-Urban Non-residential. However, the neighbouring properties 70m south have been zoned as Green-TC1 "grey zone", which indicates negligible land deformation is expected in future small to medium sized earthquakes and up to minor land deformation in a future moderate to large earthquake.

3. Observations

A walkover inspection of the exterior and interior was carried out by an Opus Structural Engineer on 24 May 2012. No evidence of liquefaction, surface rupture or lateral spreading due to the recent earthquakes was observed at the Avonhead Park Pavilion Site.

4. Discussion

ECan well logs indicate the building is founded on a layer of silt and sand overlying a thick densely packed gravel layer. Liquefaction typically occurs in recent (i.e. less than 10,000 years old), normally consolidated silts and sands beneath groundwater and is dependent on material density, grain size and soil composition. We would expect that liquefaction is unlikely at the Avonhead Park due to the underlying dense gravels and relatively deep groundwater level. The lack of ground damage reported at the site during the recent earthquakes of 2010 and 2011 confirms that the site is at low risk of liquefaction.

There are no streams or open water courses within close proximity of the site. Accordingly, the site is evaluated to not be at risk of lateral spreading.

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 (Geonet) indicates there is currently a 12% probability of another Magnitude 6 or greater earthquake occurring in the next 12 months in the Canterbury region. It is expected that the probability of occurrence is likely to decrease with time, following periods of reduced seismic activity.

Based on current evidence, the existing foundations are considered appropriate for the building with the client's acceptance that the potential for minor differential settlement may occur in future seismic events.

5. Recommendations

It is recommended that;

- Based on the past performance in recent earthquakes and the presence of shallow dense gravels, the existing foundations should be acceptable in terms of future ultimate limit state (ULS) and serviceability limit state (SLS) loadings, although CCC may have to accept the risk for potential differential settlement in the order of 0 to 50mm in a future seismic event.

6. Limitation

This report has been prepared solely for the benefit of Christchurch City Council as our client with respect to the particular brief given to us. Data or opinions in this desk study may not be used in other contexts, by any other party or for any other purpose.

It is recognised that the passage of time affects the information and assessment provided in this Document. Opus's opinions are based upon information that existed at the time of the production of this Desk Study. It is understood that the Services provided allowed Opus to form no more than an opinion on the actual conditions of the site at the time the site was visited and cannot be used to assess the effect of any subsequent changes in the quality of the site, or its surroundings or any laws or regulations.

7. References:

Brown, LJ; Webber, JH 1992: Geology of the Christchurch Urban Area. Scale 1:25,000. Institute of Geological and Nuclear Sciences geological map, 1 sheet + 104p.

Environment Canterbury, Canterbury Regional Council (ECan) website:

ECan Well Card
http://ecan.govt.nz/services/online-services/tools-calculators/Pages/well-card.aspx

ECan 2004: The Soild Facts on Christchurch Liquefaction. Canterbury Regional Council, Christchurch, 1 sheet.

Project Orbit, 2011: Interagency/organisation collaboration portal for Christchurch recovery effort. https://canterburyrecovery.projectorbit.com/SitePages/Home.aspx

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

<u>Appendices:</u>
Appendix A: Site Photographs
Appendix B: Site Location Plans
Appendix C: Surrounding Site Investigation Data

Appendix A:
Site Photographs

Figure 1: West elevation of the Avonhead Park Pavilion.

Figure 2: East elevation of the Avonhead Park Pavilion.

Appendix B:
Site Location Plan

0 250m
Approximate Scale: 1:3500 (A3)

ECan Borehole

BH	ECan Ref
1	M35/5649
2	M35/3087
3	M35/10125

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Project: Avonhead Park Pavilion
Geotechnical Desktop Study
Project No: 6-QUCC1.19
Client: Christchurch City Council

Site Location Plan

Drawn: Opus Geotechnical Engineer
Date: 22/06/2012

Appendix C:
Surrounding Site Investigation Data

Borelog for well M35/10125 page 1 of 2

Environment Canterbury Regional Council

Gridref: M35:7361-4406 Accuracy : 4 (1=high, 5=low)
Ground Level Altitude : 23.18 +MSD
Driller : CW Drilling and Investigation
Drill Method : Rotary Rig
Drill Depth : -15.45m Drill Date : 9/03/2004

Scale(m)	Water Level	Depth(m)	Full Drillers Description	Formation Code
-1		-1.50m	Loose light brown silt. Minor fine sand. Dry	sp
-2		-2.00m	Light orange, faintly bedded, thinly laminated sub-horizontal bedding silt. Minor fine sand	sp
-3		-3.00m	Loose dark brown to brown, fine to medium sand, trace silt	sp
		-3.40m	Medium dense dark brown to brown, fine to medium sand, trace silt.	sp
-4		-4.70m	Medium dense light,brown,grey fine to very coarse gravel. Some sand trace silt dry. Gravel well graded,sub-rounded elongate greywacke gravel	sp
-5	-5	-6.20m	Dense light brown,grey fine to very coarse gravel. Some sand trace silt dry. Gravel well graded,sub-rounded elongate greywacke gravel	sp
-6, -7		-7.72m	Medium dense light brown,grey fine to very coarse gravel. Some sand trace silt dry. Gravel well graded,sub-rounded elongate greywacke gravel	sp

Borelog for well M35/10125 page 2 of 2

Gridref: M35:7361-4406 Accuracy : 4 (1=high, 5=low)
Ground Level Altitude : 23.18 +MSD
Driller : CW Drilling and Investigation
Drill Method : Rotary Rig
Drill Depth : -15.45m Drill Date : 9/03/2004

Environment Canterbury Regional Council

Water Level: -8.7CalcMin

Scale(m): -8, -9, -10, -11, -12, -13, -14, -15

Depth(m)	Full Drillers Description	Formation Code
-9.00m	Medium dense light brown,grey fine to very coarse gravel. Some sand trace silt dry. Gravel well graded,sub-rounded elongate greywacke gravel	sp
-9.20m	Light brown,grey fine to very coarse gravel. Some sand trace silt moist. Gravel well graded,sub-rounded elongate greywacke gravel	sp
- 10.0m	Dense light brown,grey fine to very coarse gravel. Some sand trace silt dry. Gravel well graded,sub-rounded elongate	sp
- 10.5m	Medium dense light brown,grey fine to very coarse gravel. Some sand trace silt moist. Gravel well graded,sub-rounded elongate greywacke gravel	sp
- 11.5m	Loose light brown,grey fine to very coarse gravel. Some sand trace silt wet. Gravel well graded,sub-rounded elongate greywacke gravel	sp
- 12.0m	Trace medium sand light brown,grey fine to very coarse gravel.Trace silt dry. Gravel well graded,sub-rounded elongate greywacke gravel	sp
- 13.5m	Dense light greyish brown, gravelly fine to medium sand. Wet non plastic. Gravel fine to very coarse well graded sub-rounded elongate greywacke gravel	sp
- 14.3m	Medium dense brownish grey fine to medium sandy fine to very coarse gravel. Trace silt wet non plastic. Gravel well graded sub-rounded elongate greywacke gravel	sp
- 14.9m	Medium dense brownish grey fine to medium sandy fine to very coarse gravel. Trace silt wet non plastic. Gravel well graded sub-rounded elongate greywacke gravel. Dark orange colouration iron oxide staining	sp
- 15.4m	Light brown matrix grey gravel some sand	sp

Borelog for well M35/3087

Gridref: M35:731-442 Accuracy : 4 (1=best, 4=worst)
Ground Level Altitude : 27.3 +MSD
Driller : McMillan Water Wells Ltd
Drill Method : Unknown
Drill Depth : -37.7m Drill Date : 12/01/1983

Water Level: -10.6CalcMin

Depth(m)	Full Drillers Description	Formation Code
-0.30m	Earth	sp?
-3.70m	Clay	sp?
- 19.8m	Free gravel, clay wash	sp-ri
- 37.7m	Free gravel, clay, very sandy	ri

Borelog for well M35/5649

Gridref: M35:728-442 Accuracy : 4 (1=best, 4=worst)
Ground Level Altitude : 28.5 +MSD
Driller : Washingtons Exploration Ltd
Drill Method : Cable Tool
Drill Depth : -27m Drill Date : 10/05/1988

Water Level: -11.8CalcMin

Depth(m)	Full Drillers Description	Formation Code
-0.50m	Topsoil	sp?
-3.00m	Clay and gravels	sp?
-11.8m	Medium to large gravels and sand	sp?
- 15.8m	Brown and Grey small to medium gravels and sand	ri
- 18.7m	Grey gravels and sand with clay layers	ri
- 21.4m	Grey gravels and sand	ri
- 24.0m	Grey gravels and sand, some silty clay	ri
- 27.0m	Grey gravels and sand, bands of claybound gravels	ri

Scale(m): -5, -10, -15, -20, -25

Appendix D – CERA DEE Datasheet

Detailed Engineering Evaluation Summary Data V1.11

Location

Building Name:	Avonhead Park Pavilion	Reviewer:	Alistair Boyce
Unit No: Street		CPEng No:	209860
Building Address:	146 Hawthornden Road, Christchurch	Company:	Opus International Consultants Ltd
Legal Description:		Company project number:	6-QUCC1.19
		Company phone number:	03 3635400
Degrees Min Sec			
GPS south:		Date of submission:	23-Nov-12
GPS east:		Inspection Date:	24-May-12
		Revision:	Final
Building Unique Identifier (CCC):	PRK 0206 BLDG 001 EQ2	Is there a full report with this summary?	yes

Site

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

Building

No. of storeys above ground:	1 single storey = 1	Ground floor elevation (Absolute) (m):	
Ground floor split?	no	Ground floor elevation above ground (m):	
Storeys below ground			
Foundation type:	other (describe)	if Foundation type is other, describe:	assumed to be perimeter strip fnd
Building height (m):	2.60	height from ground to level of uppermost seismic mass (for IEP only) (m):	2.6
Floor footprint area (approx):	335		
Age of Building (years):		Date of design:	
Strengthening present?	no	If so, when (year)?	
		And what load level (%g)?	
Use (ground floor):	public	Brief strengthening description:	
Use (upper floors):			
Use notes (if required):			
Importance level (to NZS1170.5):	IL2		

Gravity Structure

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

Lateral load resisting structure

Lateral system along:	fully filled CMU	**Note: Define along and across in detailed report!**	note total length of wall at ground (m):	
Ductility assumed, μ:	1.00		wall thickness (m):	
Period along:	0.40	##### enter height above at H31	estimate or calculation?	estimated
Total deflection (ULS) (mm):			estimate or calculation?	
maximum interstorey deflection (ULS) (mm):			estimate or calculation?	
Lateral system across:	fully filled CMU		note total length of wall at ground (m):	
Ductility assumed, μ:	1.00		wall thickness (m):	
Period across:	0.40	##### enter height above at H31	estimate or calculation?	estimated
Total deflection (ULS) (mm):			estimate or calculation?	
maximum interstorey deflection (ULS) (mm):			estimate or calculation?	

Separations:

north (mm):		leave blank if not relevant
east (mm):		
south (mm):		
west (mm):		

Non-structural elements

Stairs:		
Wall cladding:		
Roof Cladding:	Metal	describe
Glazing:	aluminium frames	
Ceilings:		
Services(list):		

Available documentation

Architectural	none	original designer name/date	
Structural	none	original designer name/date	
Mechanical	none	original designer name/date	
Electrical	none	original designer name/date	
Geotech report	none	original designer name/date	

Damage

Site: (refer DEE Table 4-2)

Site performance:	good	Describe damage:	minor cracking of wall and lintel beam
Settlement:	none observed	notes (if applicable):	
Differential settlement:	none observed	notes (if applicable):	
Liquefaction:	none apparent	notes (if applicable):	
Lateral Spread:	none apparent	notes (if applicable):	
Differential lateral spread:	none apparent	notes (if applicable):	
Ground cracks:	none apparent	notes (if applicable):	
Damage to area:	none apparent	notes (if applicable):	

Building:

	Current Placard Status:	green		
Along	Damage ratio:	100%	Describe how damage ratio arrived at:	
	Describe (summary):			
Across	Damage ratio:			
	Describe (summary):			
Diaphragms	Damage?:		Describe:	
CSWs:	Damage?:		Describe:	
Pounding:	Damage?:		Describe:	
Non-structural:	Damage?:		Describe:	

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

Recommendations

	Level of repair/strengthening required:	minor structural	Describe:	Install ceiling diaphragm or other restraint to top of wall
	Building Consent required:	yes	Describe:	
	Interim occupancy recommendations:	partial occupancy	Describe:	
Along	Assessed %NBS before:	20% ##### %NBS from IEP below	If IEP not used, please detail assessment methodology:	Quantitative
	Assessed %NBS after:			
Across	Assessed %NBS before:	20% ##### %NBS from IEP below		
	Assessed %NBS after:			

OPUS