OPUS

Christchurch City Council

Linwood Community Crèche Storage Shed BU 0836-003 EQ2

Detailed Engineering Evaluation

Quantitative Assessment Report

Christchurch City Council

Linwood Community Crèche Storage Shed Quantitative Assessment Report

136 Aldwins Ave, Christchurch

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Status: Final

Summary

Linwood Community Crèche Storage Shed
BU 0836 003 EQ2

Detailed Engineering Evaluation
Quantitative Report - Summary
Final

Background
This is a summary of the quantitative report for the Linwood Community Crèche storage shed, and is based on the Detailed Engineering Evaluation Procedure document (draft) issued by the Structural Advisory Group on 19 July 2011 and a visual inspection carried out on 12 July 2012.

Key Damage Observed
The building does not appear to have suffered any damage as a result of the recent earthquake events.

Critical Structural Weaknesses
No critical structural weaknesses have been identified for this building.

Indicative Building Strength
The structure has been found to have a structural capacity greater than 100%NBS and therefore is not earthquake prone.

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1 Introduction

Opus International Consultants Limited has been engaged by Christchurch City Council to undertake a detailed seismic assessment of Linwood Community Crèche storage shed, located at 136 Aldwins Ave, Christchurch following the Canterbury Earthquake Sequence since September 2010.

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) [3] [4].

2 Compliance

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

2.1 Canterbury Earthquake Recovery Authority (CERA)

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

Section 38 – Works

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

Section 51 – Requiring Structural Survey

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

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

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

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

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

2.2 Building Act

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

Section 112 - Alterations

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

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

Section 115 – Change of Use

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

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

Section 121 – Dangerous Buildings

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

1. In the ordinary course of events (excluding the occurrence of an earthquake), the building is likely to cause injury or death or damage to other property; or
2. In the event of fire, injury or death to any persons in the building or on other property is likely because of fire hazard or the occupancy of the building; or
3. There is a risk that the building could collapse or otherwise cause injury or death as a result of earthquake shaking that is less than a 'moderate earthquake' (refer to Section 122 below); or

4. There is a risk that other property could collapse or otherwise cause injury or death; or
5. A territorial authority has not been able to undertake an inspection to determine whether the building is dangerous.

Section 122 – Earthquake Prone Buildings

This section defines a building as earthquake prone (EPB) if its ultimate capacity would be exceeded in a 'moderate earthquake' and it would be likely to collapse causing injury or death, or damage to other property.

A moderate earthquake is defined by the building regulations as one that would generate loads 33% of those used to design an equivalent new building.

Section 124 – Powers of Territorial Authorities

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

Section 131 – Earthquake Prone Building Policy

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

2.3 Christchurch City Council Policy

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

The 2010 amendment includes the following:

1. A process for identifying, categorising and prioritising Earthquake Prone Buildings, commencing on 1 July 2012;

2. A strengthening target level of 67% of a new building for buildings that are Earthquake Prone;

3. A timeframe of 15-30 years for Earthquake Prone Buildings to be strengthened; and,

4. Repair works for buildings damaged by earthquakes will be required to comply with the above.

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

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

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

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

2.4 Building Code

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

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

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

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

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

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

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

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

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

3 Earthquake Resistance Standards

For this assessment, the building's earthquake resistance is compared with the current New Zealand Building Code requirements for a new building constructed on the site. This is expressed as a percentage of new building standard (%NBS). The loadings are in accordance with the current earthquake loading standard NZS1170.5 [1].

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

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

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

Table 1 below compares the percentage NBS to the relative risk of the building failing in a seismic event with a 10% risk of exceedance in 50 years (i.e. 0.2% in the next year).

Table 1: %NBS compared to relative risk of failure

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

3.1 Minimum and Recommended Standards

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

3.1.1 Occupancy

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

3.1.2 Cordoning

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

3.1.3 Strengthening

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

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

3.1.4 Our Ethical Obligation

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

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

4 Background Information

4.1 Building Description

The Linwood Community Crèche storage shed building is a small, single storey timber framed structure with lightweight metal wall cladding, a timber truss roof with lightweight metal cladding, and sits on a concrete slab foundation.

The storage shed is situated on a flat section adjacent to the main crèche building on the southern boundary of the section. The building is approximately 6m long in the east-west direction and 3m wide in the north-south direction. The apex of the roof is approximately 3m from the ground with a stud height of approximately 2.4m. The building consists of a single main storage room at the eastern end, and a small storage room at the western end of the building. The ceiling is unlined as are the walls in the lengthwise direction. The walls in the widthwise direction are lined with plywood.

Lateral restraint of the building is provided by the plywood lining in the widthwise direction, steel strap bracing in the lengthwise direction, and timber dragon ties in the ceiling plane. Other components of lateral load resistance will be provided from frame action from the timber frame and also from the external cladding.

The exact building age is unknown, but is thought to have been built in the 1990's.

4.2 Survey

4.2.1 Post 22 February 2011 Rapid Assessment

A rapid assessment of the storage shed was undertaken on July 12 2012 by Opus International Consultants.

4.3 Original Documentation

Copies of structural drawings, details, and calculations were not provided.

5 Structural Damage

The building does not appear to have suffered any damage as a result of the recent earthquake events, however minor damage was observed in the adjacent building and surrounding property as summarised below.

5.1 Surrounding Buildings

Minor settlement and wall lining damage has been observed in the adjacent main crèche building and some liquefaction was observed in the back yard of the property.

6 General Observations

Overall the building has performed well under seismic conditions which would be expected for a timber framed single storey structure. The building has sustained no visible seismic damage and continues to be fully operational.

7 Detailed Seismic Assessment

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

7.1 Critical Structural Weaknesses

The term Critical Structural Weakness (CSW) refers to a component of a building that could contribute to increased levels of damage or cause premature collapse of a building. During the initial qualitative stage of the assessment the following potential CSW's were identified for each of the buildings and have been considered in the quantitative analysis.

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

7.2 Quantitative Assessment Methodology

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.
- μ_{max} = 2.0 for timber framed building, modern fixings, plywood linings and steel angle braces.

7.3 Limitations and Assumptions in Results

Onsite observations did not identify any damage deemed severe enough to affect the capacity of the building. Consequently, the analysis and assessment is based on an assessment of the building in its undamaged state. There may have been damage to the building that was unable to be observed during the assessment that could cause the capacity of the building to be reduced; therefore the current capacity of the building maybe lower than that stated.

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

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

7.4 Assessment

A summary of the structural performance of the building is shown in the following table. 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 elements. This will be considered further when developing the strengthening options.

Table 2: Summary of Seismic Performance

Structural Element/System	Failure Mode, or description of limiting criteria based on displacement capacity of critical element.	% NBS based on calculated capacity
Wall capacity along the building	Capacity of the steel angle braces along the building	>100%
Wall capacity across the building	Capacity of the plywood lining across the building	>100%

The storage shed has a calculated seismic capacity of more than 100%NBS and is therefore classed as a low risk building in accordance with NZSEE guidelines.

It is worth noting that a light weight structure of this type is likely to be governed by applied wind loads rather than seismic loadings. While this assessment focuses on seismic loads and no specific wind based analysis has been carried out, it is our opinion that the storage shed seems adequately detailed for resisting wind loads.

8 Summary of Geotechnical Appraisal

8.1 General

A geotechnical assessment was carried out in February 2012 for the main crèche building adjacent to the shed. This report can be found in Appendix 2. A summary of the report follows:

8.2 Discussion

Minor damage has occurred to the building at 136 Aldwins Road due to the Canterbury Earthquake Sequence following the 4 September 2010 earthquake.
No obvious evidence of surface rupture or lateral spreading due to the recent earthquakes was observed on the property or adjoining properties. While liquefaction has occurred in close proximity to the site, it appears the existing shallow foundations have performed adequately in recent earthquakes.
The existing building is supported on a reinforced concrete slab on grade, connected into a shallow reinforced concrete perimeter strip footing. The existing foundations have performed satisfactorily and do not appear to have sustained damage from cracking from differential settlement. The existing foundations are considered appropriate for the building with CCC acceptance of potential differential subsidence damage.
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[2] indicates there is an 18% probability of another Magnitude 6 or greater earthquake occurring in the next 12 months in the Canterbury region. This event may cause liquefaction induced land damage at the site similar to that experienced, however it is dependent on the location of the earthquakes epicentre. This confirms that there is currently a significant risk of liquefaction and differential settlements occurring. It is expected that the probability of occurrence is likely to decrease with time following periods of reduced seismic activity.

8.3 Recommendations

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

b) If the CCC wish to further evaluate and quantify the liquefaction potential at this specific site, additional site testing comprising two CPT's and associated analysis would be required. Allowance should be made for predrilling of shallow gravels, if encountered, to complete CPT testing.

[2] GNS Science reporting on Geonet Website: http://www.geonet.org.nz/canterbury-quakes/aftershocks/ updated on 3 February 2012.

9 Conclusions

a) The building has a seismic capacity of greater than 100%NBS and therefore is not classed as an earthquake risk.

b) Due to the compliant seismic capacity and lack of observed damage, no further action is deemed necessary.

10 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.

11 References

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

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

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

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

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

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

Appendix 1 - Photographs

Site Name		
No.	Item description	Photo
General		
1.	View of the south west corner of the shed and door to the smaller filing room.	
2.	View of the interior northern wall in the main storage room. Plywood lining can be seen at the western end and a steel angle brace can be seen on the north wall	
3.	View of the ply lining adjacent to the entrance in the interior south west corner of the small filing room.	

Appendix 2 - Geotechnical Appraisal

17 February 2012

Lindsay Fleming
Christchurch City Council
PO Box 237
CHRISTCHURCH 8140

6-QUCCC.60/005SC

Dear Lindsay

Geotechnical Desktop Study – Linwood Community Crèche (New Beginnings Pre-School Inc.)

1. Introduction

This report summarises the findings of a geotechnical desktop study and site walkover completed by Opus International Consultants (Opus) for the Christchurch City Council at the above property on 26 January 2012. The Geotechnical desk study follows the Canterbury Earthquake Sequence initiated by the 4 September 2010 earthquake.

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

It is our understanding this is the first inspection by a Geotechnical Engineer of this property following the Canterbury Earthquake Sequence. Rapid structural inspections have been undertaken by Opus on 9 March 2011 and 17 June 2011.

2. Desktop Study

2.1 Site Description

The Linwood Community Crèche is located east of the Christchurch Central Business District, approximately 250m southwest of the Linwood Avenue/Aldwins Road intersection. The site is relatively flat.

The original building was constructed in 1997 while alterations completed in 1999, 2003 and 2007 have been undertaken. The building is a single storey structure with timber framed walls clad in various light materials.

2.2 Structural Drawings

We have received extracts from building consent drawings prepared by C W Hadlee Architects dated 1999 and Royal Associates Limited dated May 4 2004 (refer Appendix A) which detail the foundations to the existing building and subsequent additions.

The drawings indicate the existing foundations comprise a 100mm thick 17.5 MPa concrete slab on grade reinforced with 665 or 668 mesh, connected into a 450mm deep by 165mm wide concrete perimeter strip footing with 2 D12 lateral reinforcement rods tied into the concrete slab by R10 ties at 600 centres.

No geotechnical report or record of a ground conditions assessment associated with the construction of the original building or additions have been provided by the Christchurch City Council.

2.4 Regional Geology

The published geological map of the area, (Geology of the Christchurch Urban Area 1:25,000, Brown and Weeber, 1992) indicates the site is located at the boundary between two surficial geological soil types, one being dominantly sand of fixed and semi-fixed dunes and beaches and the other dominantly alluvial sand and silt overbank deposits belonging to the Yaldhurst member of the Springston Formation.

A groundwater table depth of approximately 1m has been shown on the published map by Brown and Weeber (1992).

2.5 Expected Ground Conditions

A review of the Environmental Canterbury (Ecan) Wells database showed three wells located within approximately 190 m of the property (refer to Site Location Plan and Appendix B). Material logs available from two of these wells have been used to infer the ground conditions at the site as shown in table 1 below.

Stratigraphy	Thickness	Depth Encountered from bgl
TOPSOIL	0.5m	0
SILT	0.5m	0.5m
SAND with interbedded SILT layers	1.0-8.1m	1.0m
sandy GRAVEL	10.7m	9.1m
clayey SAND	7.0m	19.8m
Sandy GRAVEL (Riccarton Formation)	-	32.3m

Table 1 Inferred Ground Conditions

Borehole log M35/16559 recorded a ground water level of 1.1m below the ground.

Subsurface investigations have been completed by Tonkin and Taylor on behalf of the Earthquake Commission around Christchurch. CPT-LWD-28 (refer Appendix C), completed in Linwood Park, approximately 90m southeast of the site, indicated the presence of a suspected dense sand, shallow gravel layer or an obstruction at approximately 4.2m below ground level.

2.6 Liquefaction Hazard

Examination of post-earthquake aerial photos did not identify any evidence of significant quantities of liquefied soils ejected at the ground surface after the Magnitude 7.1 September 2010, Magnitude 6.3 February 2011 event or recent aftershocks. It appears soils ejected resultant from liquefaction occurred in Aldwins Road, but little to no material was ejected at the property.

The 2004 Environment Canterbury Solid Facts Liquefaction Study indicates the site is in an area designated as 'moderate liquefaction ground damage potential'. According to this study, based on a low groundwater table, ground damage is expected to be moderate and may be affected by 100-300mm of ground subsidence.

The Christchurch Earthquake Recovery Authority (CERA) last updated 11 December, 2011 has classified 136 Aldwins Road and surrounding residential properties as Green Zone, indicating repair and rebuilding process can begin. The maps that were released by the Department of Building and Housing (DBH) on 9 February 2012 indicate that the area surrounding the site is classified as Technical Category 2 (yellow), which indicates that minor to moderate land damage from liquefaction is possible in future significant earthquakes.

3. Site Walkover Inspection

A walkover inspection of the interior of the building and surrounding land was carried out by Mark Broughton, Opus Geotechnical Engineer on 26 January 2012. The following observations were made (refer to the Walkover Inspection Plan and Site Photographs attached to this report):

- 50mm undulations in the asphalt footpath due to liquefaction, observed 20m northeast of property on Aldwins Road near fire hydrant (refer Photograph 2);
- Evidence of ejected sand material due to liquefaction at the kerb on Aldwins Road;
- 10mm depression in asphalt carpark surface;
- hairline cracks in concrete encasement to slotted drain around the perimeter of the building. Possibly due to seismic shaking (Refer Photograph 3);
- settlement of concrete tile/paver in rear of section by up to 20mm;
- 3mm crack in concrete path;
- numerous cracks in gib and gib linings in interior of the dwelling, predominantly confined to the northern part of the building;
- a number of windows and doors had been realigned to open and close properly. Largely confined to the northern part of the building;

4. Discussion

Minor damage has occurred to the building at 136 Aldwins Road due to the Canterbury Earthquake Sequence following the 4 September 2010 earthquake.

No obvious evidence of surface rupture or lateral spreading due to the recent earthquakes was observed on the property or adjoining properties.

While liquefaction has occurred in close proximity to the site, it appears the existing shallow foundations have performed adequately in recent earthquakes.

The existing building is supported on a reinforced concrete slab on grade, connected into a shallow reinforced concrete perimeter strip footing. The existing foundations have performed satisfactorily and do not appear to have sustained damage from cracking from differential settlement. The existing foundations are considered appropriate for the building with CCC acceptance of potential differential subsidence damage.

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[1] indicates there is an 18% probability of another Magnitude 6 or greater earthquake occurring in the next 12 months in the Canterbury region. This event may cause liquefaction induced land damage at the site similar to that experienced, however it is dependent on the location of the earthquakes epicentre. This confirms that there is currently a significant risk of liquefaction and differential settlements occurring. It is expected that the probability of occurrence is likely to decrease with time following periods of reduced seismic activity

5. Recommendations

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

- If Christchurch City Council wish to further evaluate and quantify the liquefaction potential at this specific site, additional site testing comprising x2 CPT's and associated analysis would be required. Allowance should be made for predrilling of shallow gravels, if encountered, to complete CPT testing.

6. Limitation

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

Prepared By:	Reviewed By:
pp	
Mark Broughton Geotechnical Engineer	Graham Brown Senior Geotechnical Engineer

<u>Figures:</u>
Site Photographs
Site Location Plan
Walkover Inspection Plans

<u>Appendices:</u>
Appendix A: Building Consent Drawings
Appendix B: Environment Canterbury Borehole Logs
Appendix C: CPT-LWD-28 Report

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[1] GNS Science reporting on Geonet Website: http://www.geonet.org.nz/canterbury-quakes/aftershocks/ updated on 3 February 2012.

Photograph 1. Northern Elevation (Main entrance to building)


Photograph 2. 50mm undulations in asphalt footpath adjacent site on Aldwins Road

Photograph 3. Hairline crack in concrete encasement to slotted perimeter drain

Photograph 4. Typical cracking in Gib above door frame in northern part of building

SOURCE: canterburyrecovery.projectorbit.com (Accessed on 26/01/12)

BH ref	Ecan ref
1	M35/2111
2	M35/16559
3	M35/14475

Ref	CPT Ref
4	CPT-LWD-28

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Project: Linwood Community Creche
Geotechnical Desktop Study

Project No.: 6-QUCCC.60

Client: Christchurch City Council

Site Location Plan

Drawn: Mark Broughton
Geotechnical Engineer

Date: 26/01/2012

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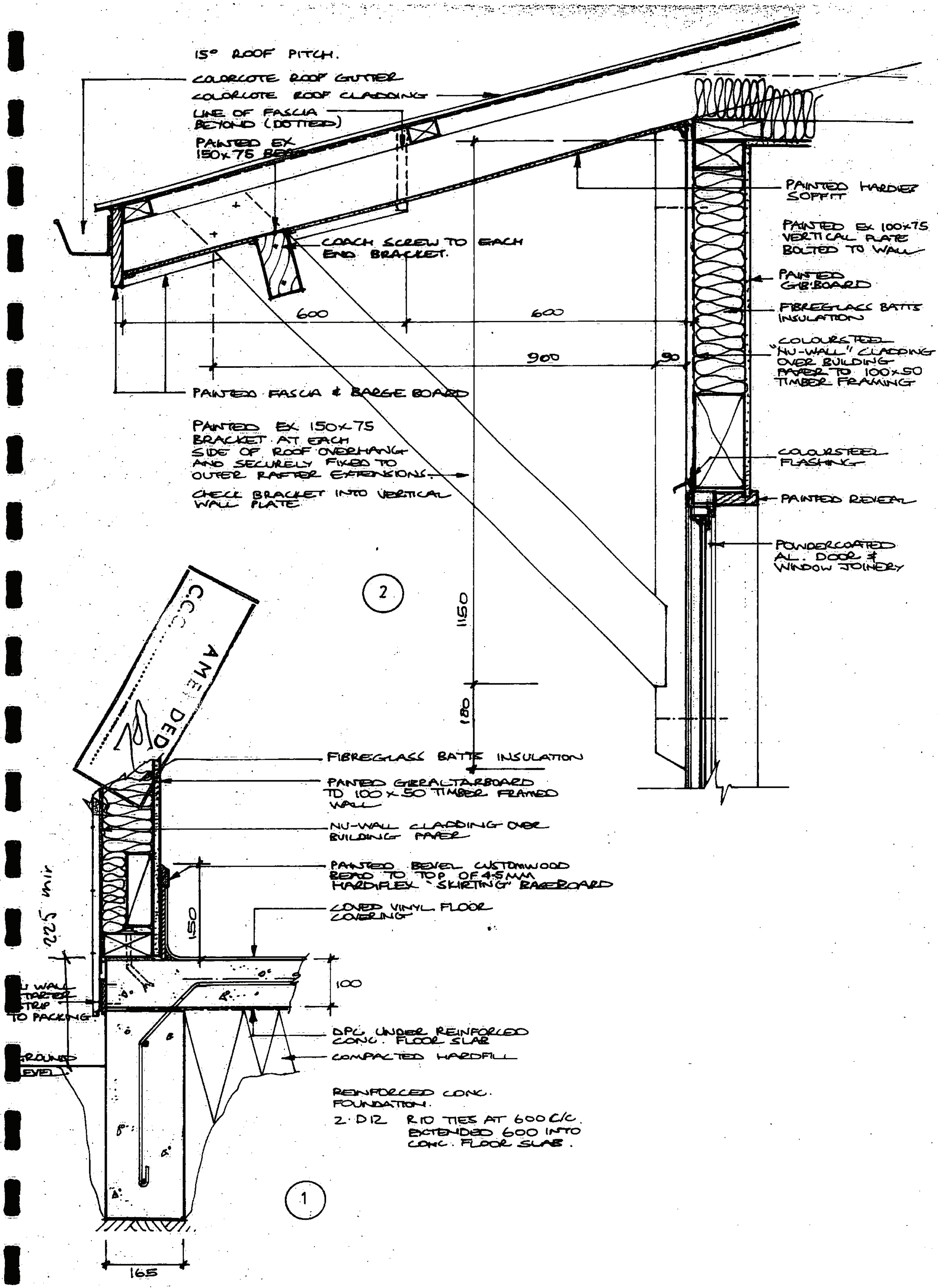
Project:	Linwood Community Creche Geotechnical Desktop Study
Project No.:	6-QUCCC.60
Client:	Christchurch City Council

Walkover Inspection Plan

Completed by:	Mark Broughton on 26/01/2012 Geotechnical Engineer
Date Drawn:	30/01/2012

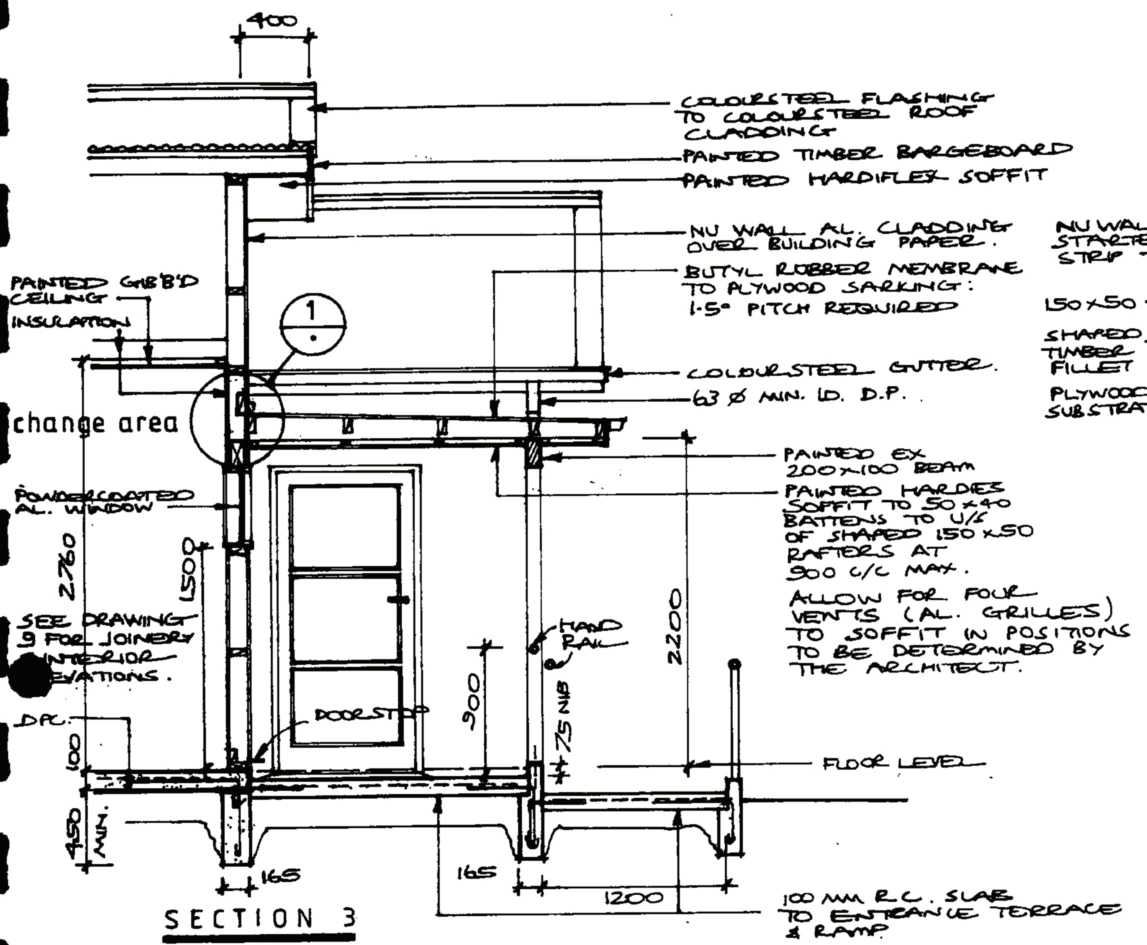
Appendix A:

Building Consent Drawings



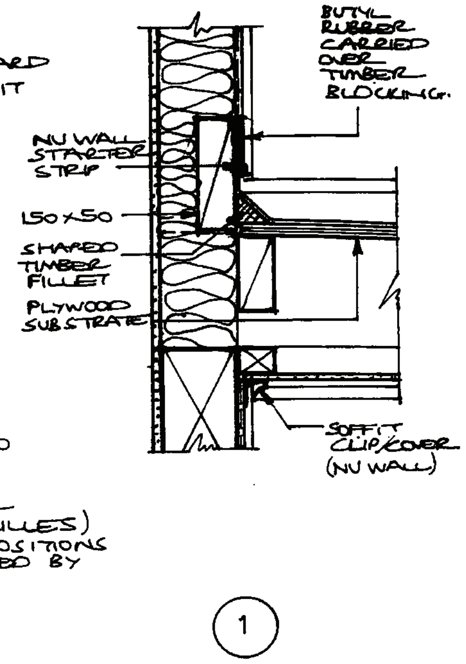
DETAILS 12

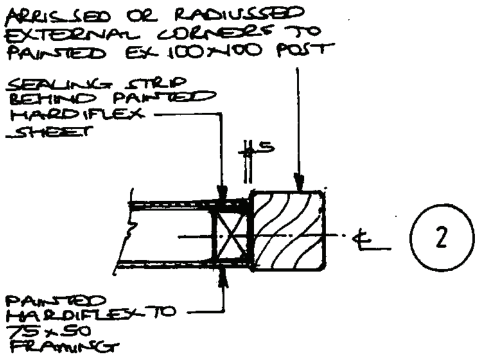
INWOOD CRECHE 7·7·96 1:10 9515

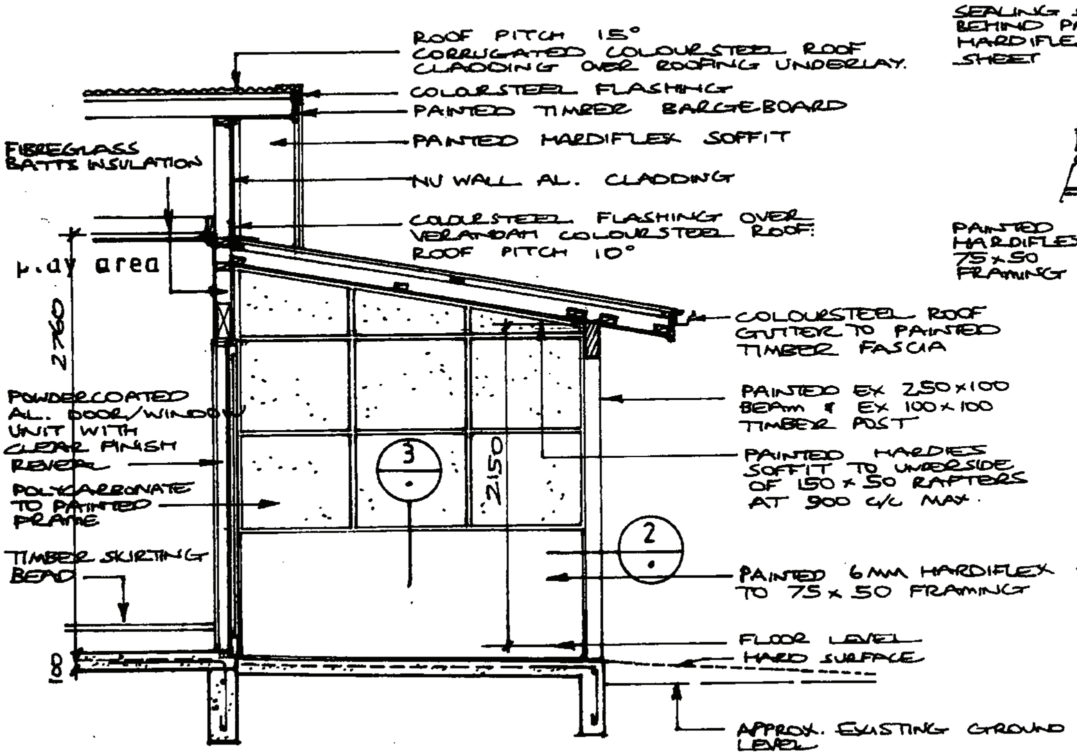


SECTION 3

1:50







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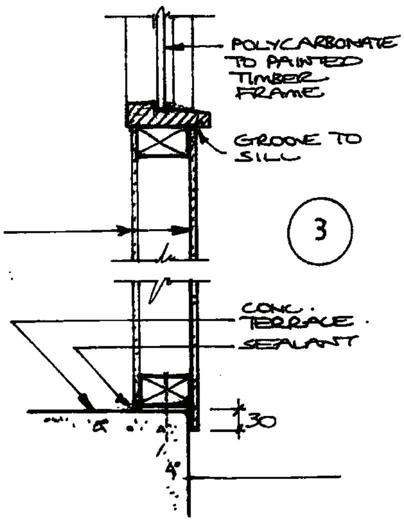
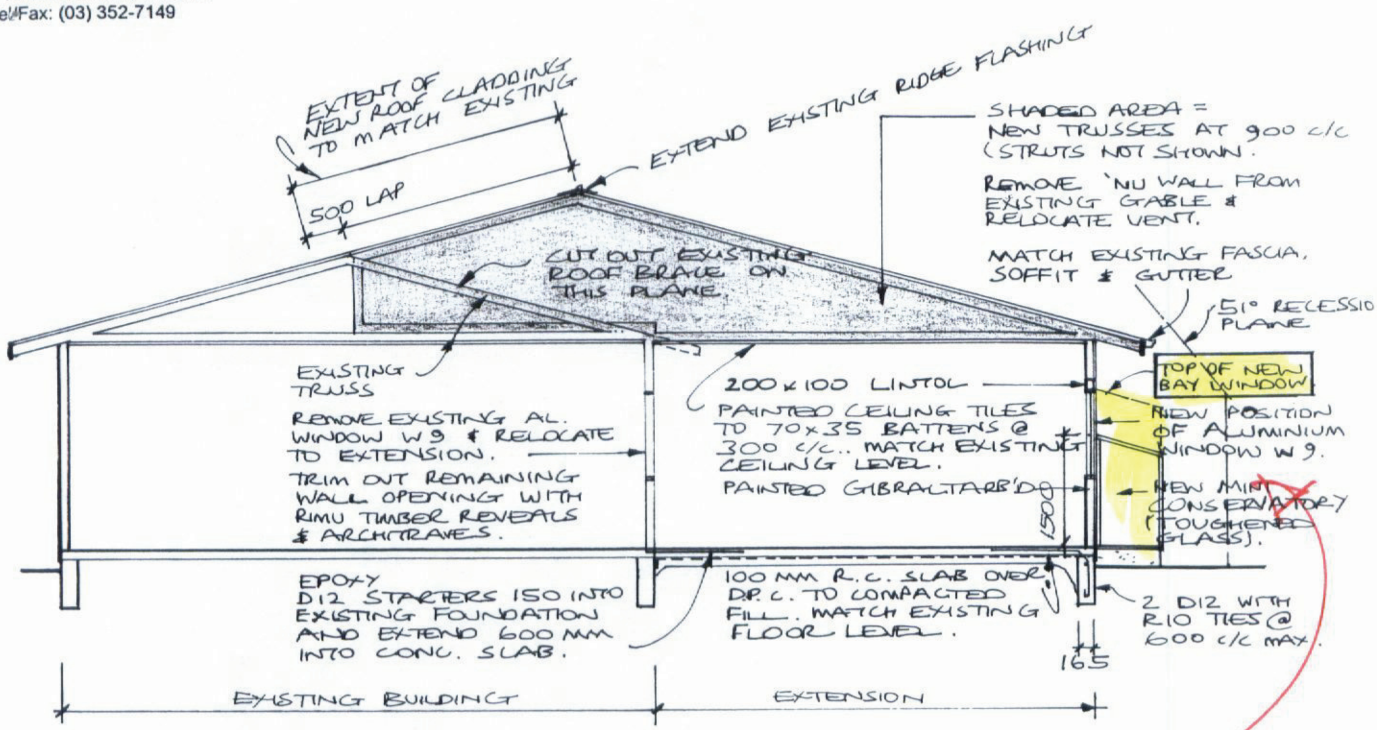


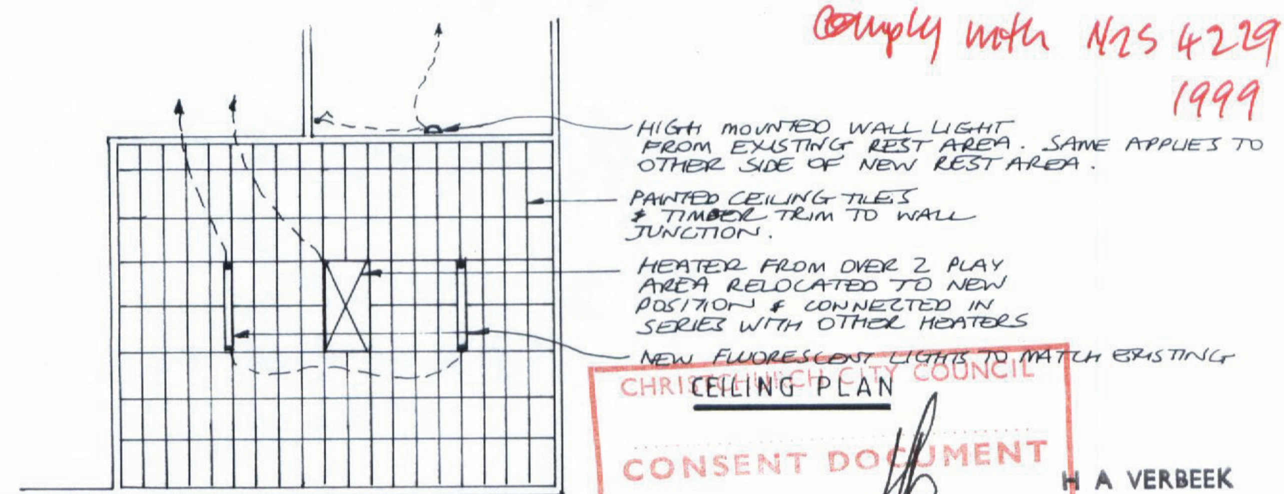
LINWOOD CRECHE 7.'96 1:10 8 9525

C.W. Hadlee, Architect
3 Tillman Avenue, CHCH 5
Tel/Fax: (03) 352-7149



CROSS - SECTION

Comply with NZS 4229 1999



CEILING PLAN

CHRISTCHURCH CITY COUNCIL

CONSENT DOCUMENT

1 8 DEC 1999

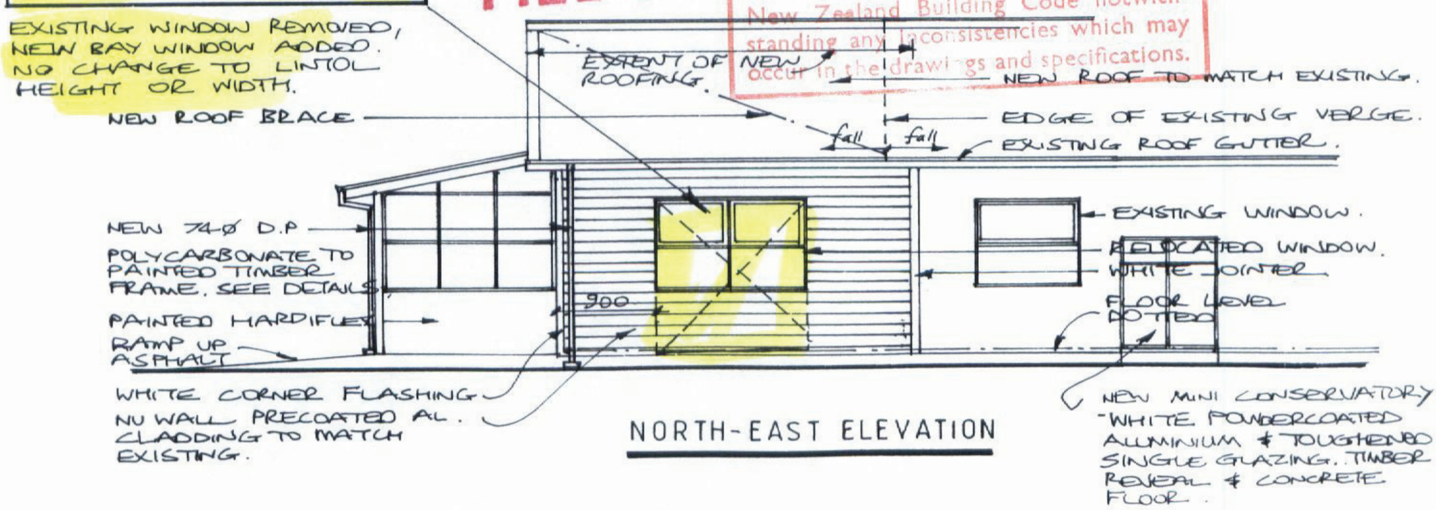
All building work shall comply with the New Zealand Building Code notwithstanding any inconsistencies which may occur in the drawings and specifications.

H A VERBEEK
Consent Officer

FILE COPY

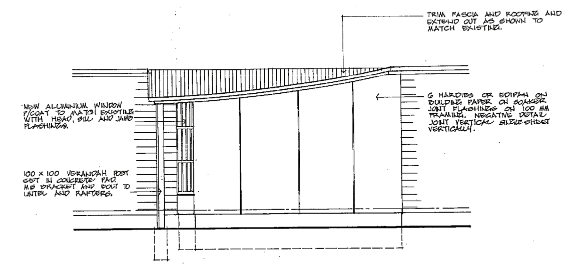
DRAWING MODIFIED 3·12·99

EXISTING WINDOW REMOVED, NEW BAY WINDOW ADDED. NO CHANGE TO LINTOL HEIGHT OR WIDTH.



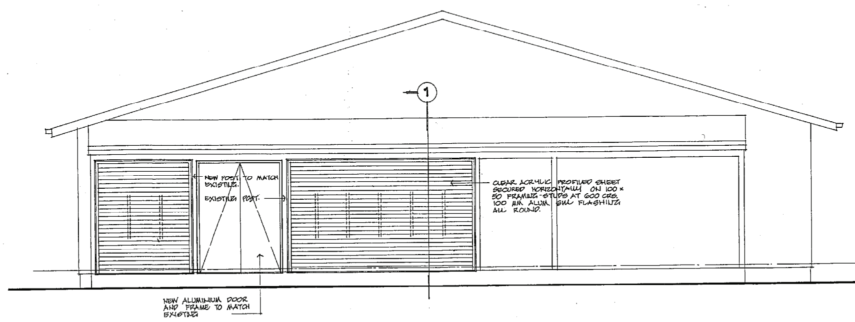
NORTH-EAST ELEVATION

PROPOSED ALTERATIONS TO LINWOOD CRECHE : ALDWINS ROAD 1:100, 23·6·99 9830 4



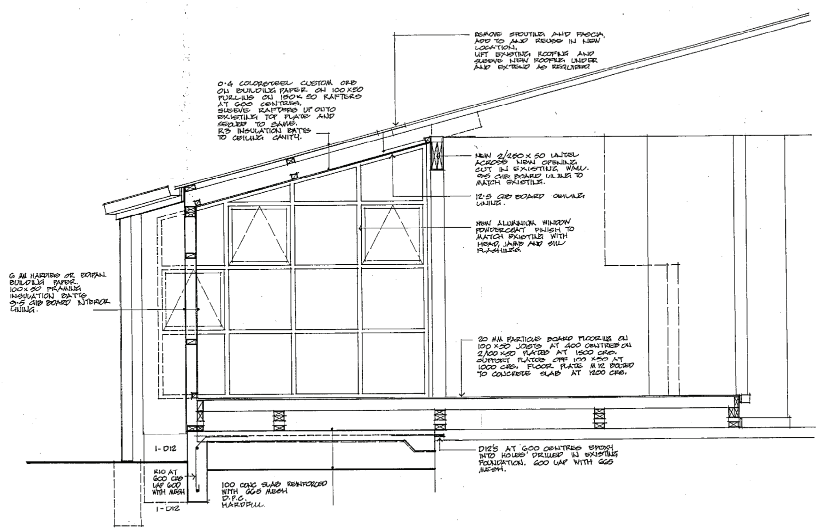
PART WEST ELEVATION
SHOWING PASSIVE PLAY AREA PROJECTION

SCALE : 1 TO 50



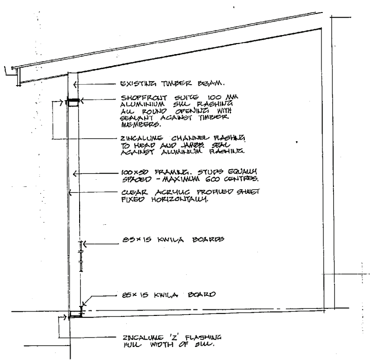
SOUTH ELEVATION
SHOWING PART CLOSING-IN OF VERANDAH

SCALE : 1 TO 50



SECTION THROUGH PASSIVE PLAY AREA

SCALE : 1 TO 25



SECTION AT (1)

SCALE : 1 TO 25

CHRISTCHURCH CITY COUNCIL
P.I.M. APPLICATION
Rec'd 9 - AUG 2004
Linwood Service Centre
PROJECT No. 10048081

LINWOOD COMMUNITY CRECHE
NEW BEGINNINGS
CHRISTCHURCH

TITLE
ELEVATIONS
SECTIONS
DETAILS

Stage 2.

DATE
MARCH 2004

SCALE
A2 1:50 1:25

SHEET No.
A-3.00

ROYAL ASSOCIATES LIMITED
REGISTERED ARCHITECTS

THE CONTRACTOR SHALL VERIFY ALL DIMENSIONS ON THE SITE BEFORE COMMENCING ANY WORK

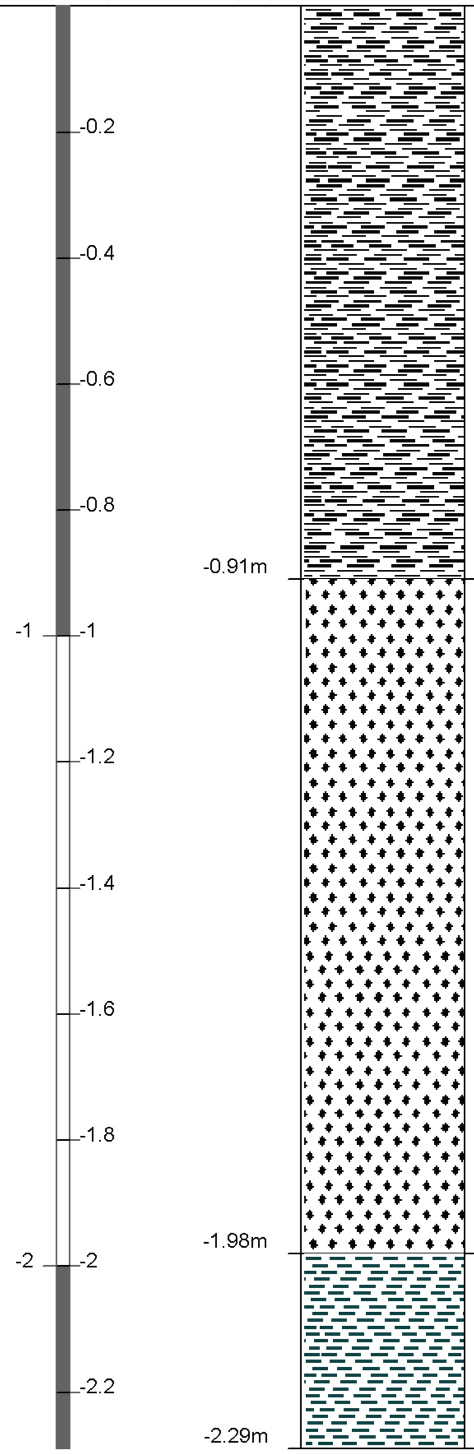
Appendix B:

Environment Canterbury Borehole Logs

Borelog for well M35/14475

Gridref: M35:83416-41281 Accuracy : 3 (1=high, 5=low)
Ground Level Altitude : 4.2 +MSD
Well name : CCC BorelogID 3317
Drill Method : Not Recorded
Drill Depth : -2.29m Drill Date :

Scale(m)	Water Level	Depth(m)	Full Drillers Description	Formation Code
			clay	
		-0.91m	wet sand	
		-1.98m	silt	
		-2.29m		

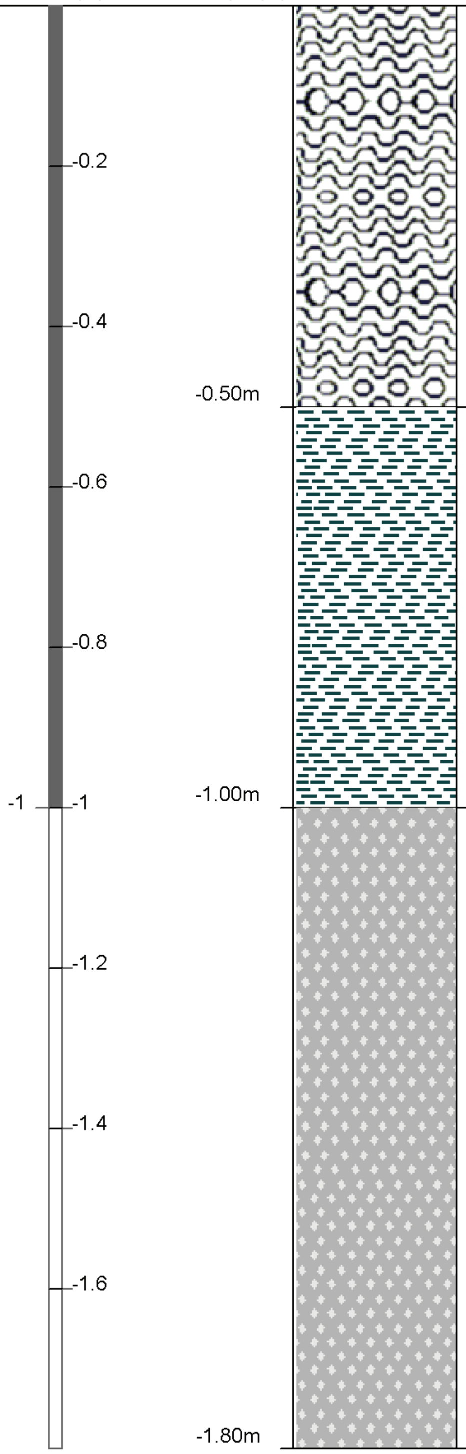


Borelog for well M35/16559

Gridref: M35:83499-41318 Accuracy : 3 (1=high, 5=low)
Ground Level Altitude : 3 +MSD
Well name : CCC BorelogID 6112
Drill Method : Not Recorded
Drill Depth : -1.8m Drill Date : 22/05/2006

Environment Canterbury Regional Council

Scale(m)	Water Level	Depth(m)	Full Drillers Description	Formation Code
		-0.50m	topsoil	
		-1.00m	grey / brown mottled silt	
		-1.80m	grey saturated sand	



Borelog for well M35/2111

Gridref: M35:836-414 Accuracy : 4 (1=high, 5=low)
Ground Level Altitude : 3.1 +MSD
Driller : Job Osborne (& Co/Ltd)
Drill Method : Hydraulic/Percussion
Drill Depth : -66.4m Drill Date : 8/12/1944

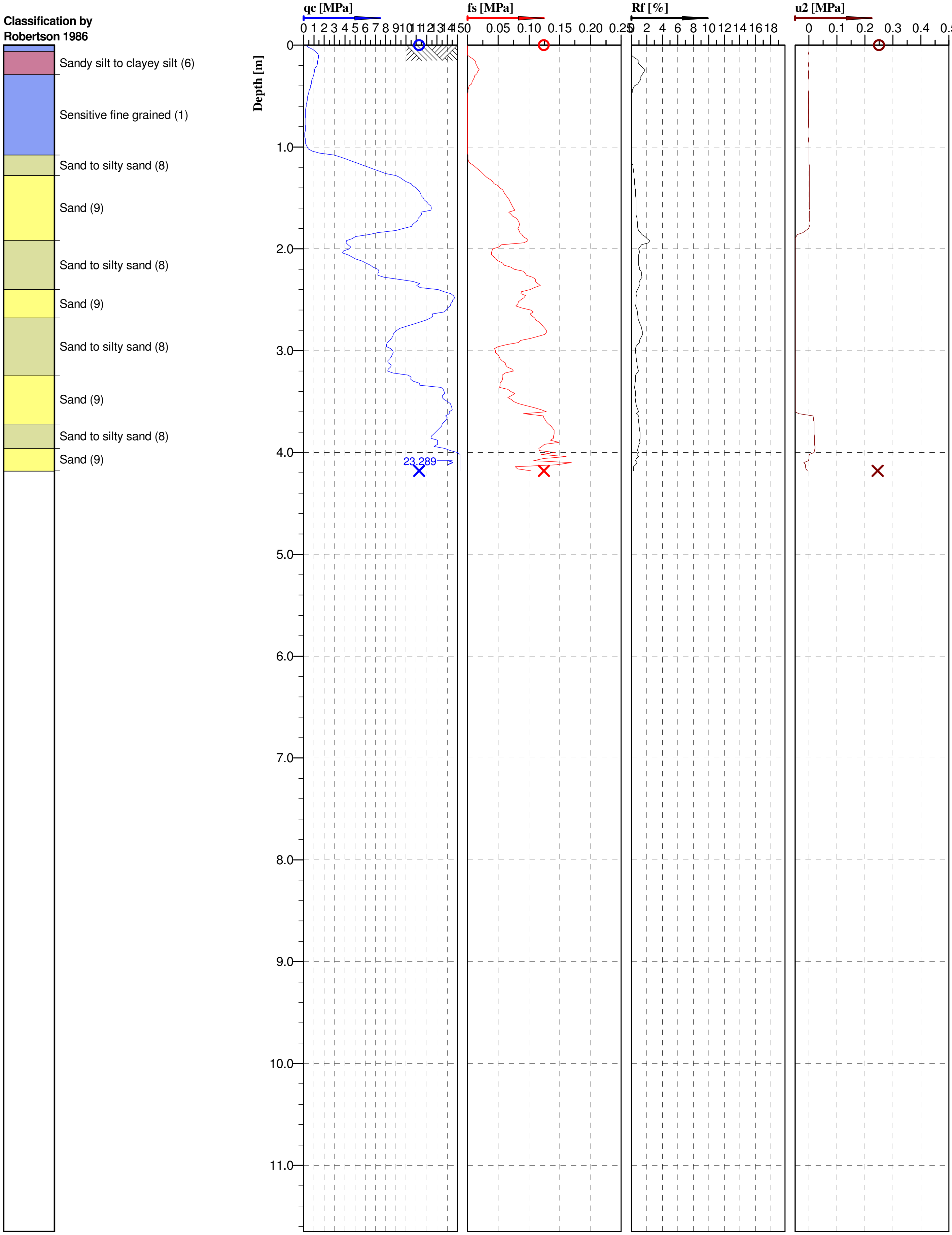
Water Level: Artesian

Depth(m)	Full Drillers Description	Formation Code
-9.10m	Sand & clay	sp?
- 19.8m	Sand & gravel	sp?
- 26.8m	Blue sand & clay	ch
- 32.3m	Blue clay & peat	ch
- 40.5m	Blue shingle	ri
- 53.6m	Brown shingle	ri
- 53.9m	Blue sand	br
- 58.8m	Yellow clay	br
- 63.0m	Brown sand	br
- 66.4m	Brown shingle	li-1

Scale(m): -10, -20, -30, -40, -50, -60

Appendix C:

CPT-LWD-28 Report



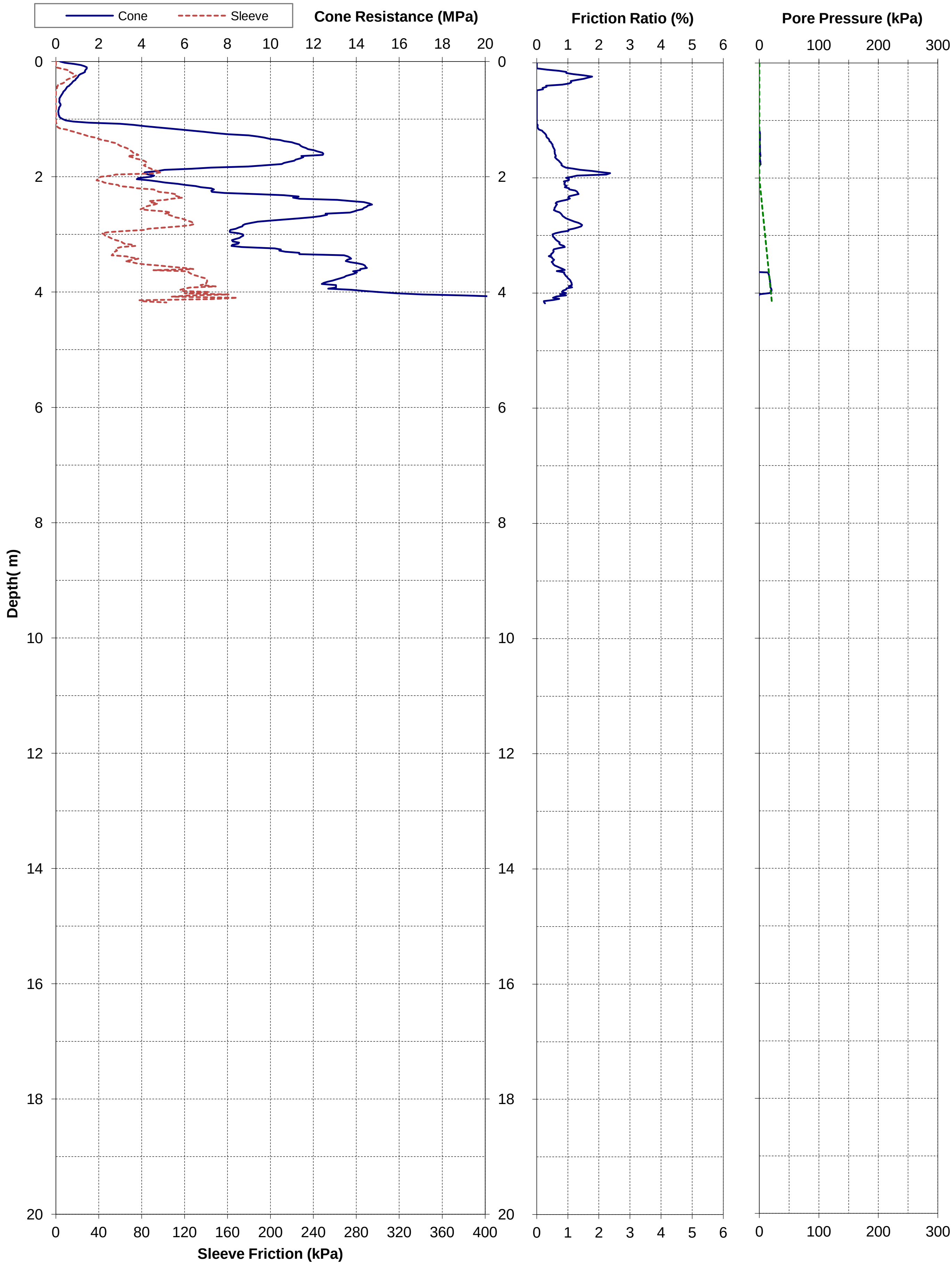
U2

GEOTECH DRILLING

Cone No: 100KN 4341
Tip area [cm2]: 10
Sleeve area [cm2]: 150

Location: LINWOOD	Position: X: 0.00 m, Y: 0.00 m	Ground level: 0.00	Test no: CPT-LWD-28
Project ID:	Client: TONKIN & TAYLOR LTD	Date: 19/05/2011	Scale: 1 : 50
Project: EQC SITES		Page: 1/1	Fig:
		File: CPT-LWD-28.CPT	

Project:	Christchurch 2011 Earthquake - EQC Ground Investigations			**Page:**	1 of 1	**CPT-LWD-28**
Test Date:	19-May-2011	**Location:**	Linwood	**Operator:**	Geotech	
Pre-Drill:	1.2m	**Assumed GWL:**	2mBGL	**Located By:**	Survey GPS	
Position:	2483547.1mE	5741248.6mN	2.73mRL	**Coord. System:**	NZMG & MSL	
Other Tests:				**Comments:**		



Appendix 3 – CERA DEE Spreadsheet

Detailed Engineering Evaluation Summary Data V1.11

Location

Building Name: Linwood Community Creche Storage Shed
Building Address: Unit No: 136, Street: Aldwins Road
Legal Description:
GPS south: (Degrees / Min / Sec)
GPS east:
Building Unique Identifier (CCC): BU 0836-003 EQ2

Reviewer: John Newall
CPEng No: 1018146
Company: Opus International Consultants
Company project number: 6-QUCC1.21
Company phone number: 03 363 5400
Date of submission: 4-Feb-13
Inspection Date: 12/07/2012
Revision: Final
Is there a full report with this summary? yes

Site

Site slope: flat
Soil type: silty sand
Site Class (to NZS1170.5): D
Proximity to waterway (m, if <100m):
Proximity to clifftop (m, if < 100m):
Proximity to cliff base (m,if <100m):

Max retaining height (m): 0
Soil Profile (if available):
If Ground improvement on site, describe:
Approx site elevation (m): 5.00

Building

No. of storeys above ground: 1 — single storey = 1
Ground floor split? no
Storeys below ground: 0
Foundation type: isolated pads, no tie beams
Building height (m): 3.00
Floor footprint area (approx): 16
Age of Building (years): 16

Ground floor elevation (Absolute) (m):
Ground floor elevation above ground (m): 0.10
if Foundation type is other, describe:
height from ground to level of uppermost seismic mass (for IEP only) (m):
Date of design: 1992-2004

Strengthening present? no
If so, when (year)?
And what load level (%g)?
Brief strengthening description:

Use (ground floor): other (specify)
Use (upper floors):
Use notes (if required): Storage shed for creche
Importance level (to NZS1170.5): IL2

Gravity Structure

Gravity System: load bearing walls
Roof: timber truss — truss depth, purlin type and cladding: 1m high timber trusses and lightweight steel roof cladding
Floors: concrete flat slab — slab thickness (mm): 100
Beams: timber — type:
Columns: timber — typical dimensions (mm x mm):
Walls:

Lateral load resisting structure

Lateral system along: lightweight timber framed walls — note typical wall length (m): 2.4
Ductility assumed, μ: 2.00
Period along: 0.40 — 0.00 — estimate or calculation? estimated
Total deflection (ULS) (mm): — estimate or calculation? estimated
maximum interstorey deflection (ULS) (mm): — estimate or calculation? estimated

Note: Define along and across in detailed report!

Lateral system across: lightweight timber framed walls — note typical wall length (m): 3
Ductility assumed, μ: 2.00
Period across: 0.40 — 0.00 — estimate or calculation? estimated
Total deflection (ULS) (mm): — estimate or calculation? estimated
maximum interstorey deflection (ULS) (mm): — estimate or calculation? estimated

Separations:

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

Non-structural elements

Stairs:
Wall cladding: profiled metal — describe: Lightweight
Roof Cladding: Metal — describe: Lightweight
Glazing: aluminium frames
Ceilings: none
Services(list):

Available documentation

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

Damage

Site:
(refer DEE Table 4-2)

Site performance: — Describe damage:
Settlement: 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: 0% — Describe how damage ratio arrived at:
Describe (summary):

Across — Damage ratio: 0%
Describe (summary):

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

Diaphragms — Damage?: no — Describe:
CSWs: — Damage?: no — Describe:
Pounding: — Damage?: no — Describe:
Non-structural: — Damage?: no — Describe:

Recommendations

Level of repair/strengthening required: none — Describe:
Building Consent required: no — Describe:
Interim occupancy recommendations: full occupancy — Describe:

Along — Assessed %NBS before: 100% — ##### %NBS from IEP below
Assessed %NBS after: 100%
If IEP not used, please detail assessment methodology:

Across — Assessed %NBS before: 100% — ##### %NBS from IEP below
Assessed %NBS after: 100%

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Christchurch 8140
New Zealand

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