Norman Kirk Memorial Pool - Lean-to Shelter Detailed Engineering Evaluation

BU 3513-006 EQ2

Qualitative Report

Prepared for Christchurch City Council (CCC)

By Beca Carter Hollings & Ferner Ltd (Beca)

12 July 2013

Revision History

Revision Nº	Prepared By	Description	Date
A	Andrew Franklin	Draft for CCC review	11 October 2012
B	Andrew Franklin	Final	12 July 2013

Document Acceptance

Action	Name	Signed	Date
Prepared by	Andrew Franklin		12 July 2013
Reviewed by	Nicholas Charman		12 July 2013
Approved by	David Whittaker		12 July 2013
on behalf of	Beca Carter Hollings & Ferner Ltd		

Norman Kirk Memorial Pool
Lean-to Shelter
BU 3513-006 EQ2

Detailed Engineering Evaluation
Qualitative Report – SUMMARY
Version 1

Address
54 Oxford St
Lyttelton

Background

This is a summary of the Qualitative report for the building structure, and is based on the document 'Guidance on Detailed Engineering Evaluation of Earthquake Affected Non-residential Buildings in Canterbury – Part 2 Evaluation Procedure' (draft) issued by the Engineering Advisory Group (EAG) on 19 July 2011.

The Lean-to Shelter is located at the Norman Kirk Memorial Pool at 54 Oxford St, Lyttelton. It was built in 1973 and has an approximate floor area of 39m^2. The main structural system is a timber frame, with the roof consisting of steel joists, timber beams and purlins and lightweight metal sheeting. No architectural or structural drawings were available and no calculations were carried out.

The Norman Kirk Memorial Pool site has a number of concrete masonry block walls/fences and retaining walls of varying construction type.

Key Damage Observed

Visual inspections on 7 August 2012 indicate the Lean-to Shelter building has suffered minor earthquake damage. The key damage observed includes:

- Cracking and differential settlement of concrete pavement.
- Cracking to concrete retaining wall beneath south wall of building.
- Cracking to concrete bond beam.
- Bowing of timber columns.

Our inspections also noted the following earthquake damage:

- Extensive cracking to mortar and block work of adjacent concrete masonry block wall/fence that extends along the southern boundary, between the Main Plant Room and the Lean-to Shelter.

Critical Structural Weaknesses (CSW)

The following potential Critical Structural Weaknesses have been identified for the Lean-to Shelter during our inspection:

- Plan irregularity (torsion).
- Plan irregularity (long, narrow structure).

Indicative Building Strength (from Initial Evaluation Procedure and CSW assessment)

The building has been assessed to have a seismic capacity of 10%NBS using the NZSEE Initial Evaluation Procedure (IEP) and is therefore classified as potentially Earthquake Prone and Seismic Grade E.

Recommendations

In order that the owner can make an informed decision about the ongoing use and occupancy of their building the following information is presented in line with the Department of Building and Housing document *‘Guidance for engineers assessing the seismic performance of non-residential and multi-unit residential buildings in greater Christchurch*’, June 2012.

The building is considered to be potentially earthquake prone, having an assessed capacity less than 33%NBS. The risk of collapse of an earthquake prone building is considered to be 10 to 25 times greater than that of an equivalent new building.

For greater Christchurch the definition of a “dangerous” building in the Building Act has been extended (by the Canterbury Earthquake (Building Act) Order 2011) to include buildings at risk of collapsing in a moderate earthquake, that is earthquake prone buildings with a capacity at or below 33%NBS. Where council requires a dangerous building or an earthquake prone building to be upgraded, it may prohibit the use of the building until the works are carried out.

The building has suffered damage to the seismic or gravity load resisting system that is sufficient to impair or significantly reduce the ability to resist further loads, it is in a condition under which further deterioration may be expected in future aftershocks.

With consideration to the earthquake damage and the existing hazards observed, in its current state the building is not capable of resisting a moderate earthquake without collapse (its assessed capacity is less than 33%NBS) and it should not be used until it is repaired. Access should be limited to restricted occupancy for damage assessment or removal of essential items only.

It is recommended that:

- Barricades be installed to cordon off access to damaged structures on the western portion of the Norman Kirk Memorial Pool site including walls/fences and buildings. No occupancy restrictions exist for the Main Plant Room or the Nursery Building and we understand the Nursery is currently occupied. Access to these two building should be restricted to routes that do not require entering cordoned areas of the site.
- Repairs that would bring the building back to an “as new” condition are typically entitled under typical replacement insurance policies. We suggest you consult with your insurance advisor as

to how you wish to proceed. Note that a number of recommendations below are dependent on the outcome of this consultation and your agreed remediation strategy for the building. We believe the structure may not be reasonably repairable based on our observations and damage to adjoining structures (Ladies' Change Room to the west and block fence to the east), and further investigations may not be warranted.

- Further efforts are made to obtain structural drawings.
- A verticality and level survey could be carried out to determine the extent of settlement of the building, and differential settlement across the site, for insurance purposes.
- A quantitative %NBS analysis of the building should be completed.
- An investigation is undertaken to determine the structural integrity of the retaining wall along the driveway at the south of the site (and supporting the south wall of the building).

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1 Background

Beca Carter Hollings & Ferner Ltd (Beca) has been engaged by Christchurch City Council (CCC) to undertake a qualitative Detailed Engineering Evaluation (DEE) of the Lean-to Shelter located at the Norman Kirk Memorial Pool at 54 Oxford St, Lyttelton.

This report is a Qualitative Assessment of the building structure, and is based on the document 'Guidance on Detailed Engineering Evaluation of Earthquake Affected Non-residential Buildings in Canterbury – Part 2 Evaluation Procedure' (draft) issued by the Engineering Advisory Group (EAG) on 19 July 2011.

A qualitative assessment involves inspections of the building, a desktop review of existing structural and geotechnical information, including existing drawings and calculations, if available and an assessment of the level of seismic capacity against current code using the Initial Evaluation Procedure (IEP).

The purpose of the assessment is to determine the likely building performance and damage patterns, to identify any potential Critical Structural Weaknesses or collapse hazards, and to make an initial assessment of the likely building strength in terms of percentage of New Building Standard (%NBS).

At the time of this report, no intrusive site investigation, detailed analysis, or modelling of the building structure has been carried out. The building description below is based only on our visual inspection as drawings were not available.

The format and content of this report follows a template provided by CCC, which is based on the EAG document.

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

We understand that CERA will require a detailed engineering evaluation to be carried out for all buildings (other than those exempt from the Earthquake Prone Building definition in the Building

Act). It is understood that CERA is adopting the Detailed Engineering Evaluation Procedure document (draft) issued by the Engineering Advisory Group on 19 July 2011, which sets out a methodology for both qualitative and quantitative assessments. We understand this report will be used in response to CERA Section 51.

The qualitative assessment includes a thorough visual inspection of the building coupled with a desktop review of available documentation such as drawings, specifications and IEP's. The quantitative assessment involves analytical calculation of the building's strength and may require non-destructive or destructive material testing, geotechnical testing and intrusive investigation.

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

- The importance level and occupancy of the building
- The placard status that was assigned during the state of emergency following the 22 February 2011 earthquake
- The age and structural type of the building
- Consideration of any Critical Structural Weaknesses
- The extent of any earthquake damage

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

Section 115 – Change of Use

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

Section 121 – Dangerous Buildings

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

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

Section 122 – Earthquake Prone Buildings

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

Section 124 – Powers of Territorial Authorities

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

Section 131 – Earthquake Prone Building Policy

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

2.3 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 of the 4th September 2010.

The 2010 amendment includes the following:

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

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

It is understood that any building with a capacity of less than 33%NBS (including consideration of Critical Structural Weaknesses) will need to be strengthened to a target of 67%NBS of new building standard as recommended by the Policy.

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

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

2.4 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:

a. Hazard Factor increased from 0.22 to 0.3 (36% increase in the basic seismic design load)

b. Serviceability Return Period Factor increased from 0.25 to 0.33 (80% increase in the serviceability design loads when combined with the Hazard Factor increase)

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

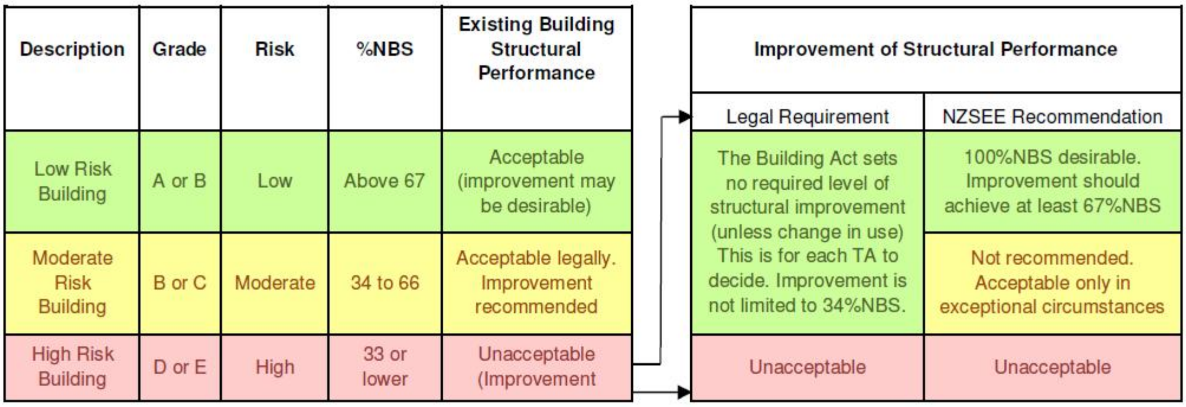
3 Earthquake Resistance Standards

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

No consideration has been given at this stage to checking the level of compliance against the increased Serviceability Limit State requirements.

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

The New Zealand Society for Earthquake Engineering has proposed a way for classifying earthquake risk for existing buildings in terms of %NBS and this is shown in Figure 3.1 below.



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

Improvement of Structural Performance	
Legal Requirement	NZSEE Recommendation
The Building Act sets no required level of structural improvement (unless change in use) This is for each TA to decide. Improvement is not limited to 34%NBS.	100%NBS desirable. Improvement should achieve at least 67%NBS
	Not recommended. Acceptable only in exceptional circumstances
Unacceptable	Unacceptable

Figure 3.1: NZSEE Risk Classifications Extracted from table 2.2 of the NZSEE 2006 AISPBE Guidelines

Table 3.1 compares the percentage NBS to the relative risk of the building failing in a seismic event with a 10% risk of exceedance in 50 years (i.e. on average 0.2% in any year). It is noted that the current seismic risk in Christchurch results in a 6% risk of exceedance in the next year.

Table 3.1: %NBS compared to relative risk of failure

Building Grade	Percentage of New Building Standard (*%NBS*)	Approx. Risk Relative to a New Building
A+	>100	<1
A	80-100	1-2 times
B	67-80	2-5 times
C	33-67	5-10 times
D	20-33	10-25 times
E	<20	>25 times

4 Building Description

4.1 General

Summary information about the building is given in the following table.

Table 4.1: Building Summary Information

Item	Details	Comment
Building name	Norman Kirk Memorial Pool - Lean-to Shelter.	
Street Address	54 Oxford St, Lyttelton.	
Age	39 years. Constructed in 1973.	Advised by CCC.
Description	Single story timber framed shade shelter.	
Building Footprint / Floor Area	Approximately 39m^2. Approximately 15.5m x 2.5m.	Dimensions based on photos and site observations. No drawings available.
No. of storeys / basements	1 storey / no basement.	
Occupancy / use	Shade shelter.	Importance Level 2.
Construction	Timber framed.	No drawings available. Based on visual inspection.
Gravity load resisting system	Lightweight metal roof sheeting on timber purlins that are supported by steel joists, timber beams and timber columns. Columns are connected to concrete plinths on the north side, and to the part-height concrete masonry block wall on the south side.	No drawings available.
Seismic load resisting system	The seismic load resisting systems in the Lean-to Shelter are unclear, particularly in the transverse direction. However the structure is of only lightweight construction and is likely to be	No drawings available. The timber columns are connected to the concrete plinth and concrete masonry wall with U-brackets however it is unclear how the U-

Item	Details	Comment
	reasonably flexible in the transverse direction, hence the seismic loads would therefore be small. The Lean-to Shelter is tied to the adjacent Ladies' Change Room at its western end, and at the eastern end the Lean-to Shelter's south-eastern column is tied to the southern, partial-height, cantilevered concrete masonry wall. Seismic loads in the longitudinal direction appear likely to be transferred through the roof structure to the end columns which connect to the Ladies' Change Room structure. Given the lightweight nature of the structure and resulting small seismic loads, loads in the transverse direction may possibly also transfer through the roof structure and sheeting to the Ladies' Change Room structure. Based on the observed connection details only limited frame action appears achievable, although the south-east column has additional connections and would have some cantilever capacity.	brackets are fixed into the concrete substrates. It is assumed that this connection is pinned. The connections between the Lean-to Shelter and the Ladies' Change Room concrete masonry wall and southern partial-height concrete masonry wall consists of a metal bracket with one bolt either side of the column. The north-western column is connected to the Ladies' Change Room at both the top and bottom. The eaves beam of the Lean-to Shelter is bolted to the Ladies' Change Room. The column at the eastern end of the Lean-to Shelter is bolted to the top of the partial height masonry wall and also has additional connections to the face of this wall.
Foundation system	Unknown but assumed to be shallow foundations with a concrete slab on grade surrounding pavement.	The southern concrete masonry wall sits on top of a concrete retaining wall that runs along the driveway at the south of the site. The driveway below the retaining wall slopes from east to west, with the western end approximately 2m below the Lean-to Shelter's floor level.
Stair system	No stairs.	
Other notable features	Severe Plan Irregularity: § Inadequate torsion resistance. § Length to width ratio greater than 4.	
External works	Pavement to the north and east, Retaining wall (below) to the south. In ground concrete swimming pool located in the centre of the site.	

Item	Details	Comment
Construction information	Visual inspection only.	No drawings available.
Likely design standard	NZS 1900 Chapter 8: 1965.	Inferred from age of building.
Heritage status	No heritage status.	
Other		

4.2 Structural 'Hot-spots'

- Ill-defined lateral load resisting structure.
- Connections between timber columns, foundations and roof.
- Structural integrity of concrete retaining wall on southern side.
- Connection between timber beam/columns and concrete masonry wall of the Ladies' Change Room.
- Concrete masonry wall to the east (along the driveway and which continues to the Main Plant Room) where differential settlement is evident.

5 Site Investigations

5.1 Previous Assessments

The building had a level 2 rapid assessment undertaken following the February 2011 and June 2011 earthquake events (refer to Appendix C).

5.2 Level 4 Damage Inspection

Visual inspections as part of the level 4 damage assessment were undertaken on 7 August 2012.

6 Damage Assessment

6.1 Damage Summary

The table below provides a summary of damage observed during our inspection. Refer to Appendix A for photographs of the observed damage.

Table 6.1: Damage Summary

Damage type	Unknown	Minor	Moderate	Major	Comment
settlement of foundations	ü				None observed during visual inspection. Level survey may be required to confirm.
tilt of building		ü			Minor tilt to structure observed during visual inspection.
liquefaction					None observed during visual inspection.
settlement of external ground			ü		Some differential settlement noted. Pavement slopes from the pool to the south.

Damage type	Unknown	Minor	Moderate	Major	Comment
lateral spread / ground cracks		ü			Ground cracks observed throughout area, especially between pavement and pool edge.
frame					Timber columns slightly bowed.
concrete and masonry walls		ü			Cracking to concrete bond beam on top of partial-height masonry block wall on south side.
cracking to concrete floors					Not applicable.
bracing					Not applicable. No bracing observed during visual inspection.
precast flooring seating					Not applicable.
stairs					Not applicable.
cladding /envelope					Glazing on south wall shattered.
internal fit out					Not applicable.
building services	ü				No inspection of services was carried out.
other			ü		Cracking in blocks and mortar in concrete masonry wall to the east of the Lean-to Shelter (along the driveway and which continues to the Main Plant Room). Cracking in retaining wall beneath south wall of building.

6.2 Surrounding Buildings

To the east of the Lean-to Shelter (along the driveway to the south of the site) is a partially filled and lightly reinforced concrete masonry block wall that sustained damage to both the blocks and mortar. The cracking is vertical in nature and the damage observed suggests local differential settlement. It was identified that the likely cause for the differential settlement is the founding of the concrete masonry wall on two concrete retaining walls (refer Photo 6 in Appendix A). The differential settlement on the western side of the cracking coincides with the differential settlement and sloping pavement in the Lean-to Shelter proximity.

The Lean-to Shelter also adjoins the Ladies' Change Room (BU 3513-002 EQ2) to the west. It is assumed that the majority of the Lean-to Shelter's seismic load is transferred to, and resisted by, the Ladies' Change Room concrete masonry block walls.

To the north side of the pool is a concrete retaining wall approximately 2m high with a 2m high concrete masonry block fence on top that is significantly damaged (refer Photo 13 and Photo 14 in Appendix A). The block fence section appears to be very lightly reinforced and has minimal fill. It appears likely that the block fence will need to be demolished and reconstructed with an appropriately engineered replacement.

6.3 Residual Displacements and General Observations

Some evidence of permanent settlement and displacements to the external ground surrounding the Lean-to Shelter, and other areas of the site, was observed during our visual inspection. A global settlement survey may reveal movement that could be described as damage under insurance entitlement.

6.4 Implication of Damage

The Lean-to Shelter main structure has suffered only minor structural damage and we believe its structural capacity has not been affected.

7 Generic Issues

None of the generic issues referred to in Appendix A of the EAG guideline document are applicable to the Lean-to Shelter.

8 Critical Structural Weaknesses

8.1 Plan Irregularity

8.1.1 Insufficient Torsional Resistance

The western end of the Lean-to Shelter is connected to the Ladies' Change Room. It is assumed this connection transfers seismic forces, which are then resisted by the Ladies' Change Room's concrete masonry block walls. Some additional resistance to seismic loads may be provided from the Lean-to Shelter's connection to the partial height concrete masonry wall at its eastern end. As a result, the Lean-to Shelter has an uneven distribution of seismic loads particularly for transverse seismic loading, resulting in torsional forces in the structure. This has been accounted for by including a 'Plan Irregularity' factor of 0.4 in the IEP.

8.1.2 Long Narrow Building

In accordance with Table 3.4 of the NZSEE guidelines, the Lean-to Shelter is considered a long narrow building where spacing of lateral load resisting elements is greater than four times the building width. As a result the Lean-to Shelter is considered to have severe plan irregularity. This is usually accounted for in the IEP by the inclusion of a 'Plan Irregularity' factor of 0.4, however this factor has already been included due to insufficient torsional resistance.

9 Geotechnical Consideration

No geotechnical information was available for this site. During the inspection, any damage to the surrounding pavement was noted and any affect to the structure was considered.

10 Survey

There was some evidence of settlement and lateral spread across the site that was observed during our inspection however no level or vertical surveys were carried out. CCC may wish to undertake level and verticality surveys as part of insurance entitlement considerations.

11 Initial Capacity Assessment

11.1 %NBS Assessment

The building has had its seismic capacity assessed using the Initial Evaluation Procedure based on the information available. The building's capacity is expressed as a percentage of New Building Standard (%NBS) and is in the order of that shown in Table 11.1. These capacities are subject to confirmation by a quantitative analysis which is more detailed. The post-damage capacity is considered to be the same as the original capacity.

The seismic capacity of the masonry block wall between the Lean-to Shelter and the Main Plant Room has not been assessed.

Table 11.1: Indicative Building Capacities

System	Direction	Seismic Performance in *%NBS*	Notes
Support assumed to be provided by adjacent partially filled Concrete Masonry Walls.	Longitudinal	10%	NZSEE Initial Evaluation Procedure. IL 2, Z=0.3.
Support assumed to be provided by adjacent partially filled Concrete Masonry Walls, with some resistance provided by frame action.	Transverse	10%	NZSEE Initial Evaluation Procedure. IL 2, Z=0.3.

11.2 Seismic Parameters

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

- Site soil class: C – NZS 1170.5:2004, Clause 3.1.3.
- Site hazard factor, Z = 0.3 – NZBC, Clause B1 Structure, Amendment 11 effective from 19 May 2011.
- Return period factor Ru = 1 – NZS 1170.5:2004, Table 3.5, Importance level 2 structure with a 50 year design life.
- Near fault factor N(T,D) = 1 – NZS 1170.5:2004, Clause 3.1.6, Distance more than 20 km from fault line.

11.3 Expected Structural Ductility Factor

A structural ductility factor of 1.25 has been assumed for the IEP assessment.

11.4 Discussion of results

Based on the IEP results, the Lean-to Shelter is considered potentially Earthquake Prone and seismic grade E as the IEP result is less than 33%NBS. This assessment is qualitative and based on the NZSEE IEP only. The dimensions have been approximated by visual inspection and it is assumed that the connection between the columns and foundations are typically pinned and do not provide lateral support.

12 Initial Conclusions

- Minor earthquake damage observed.
- The building has been assessed to have a seismic capacity of 10% NBS and is therefore potentially Earthquake Prone.
- Critical Structural Weaknesses have been identified.
- Collapse hazards have been identified at the Norman Kirk Memorial Pool site and these require cordoning off.

13 Recommendations

13.1 Occupancy

In order that the owner can make an informed decision about the ongoing use and occupancy of their building the following information is presented in line with the Department of Building and Housing document *'Guidance for engineers assessing the seismic performance of non-residential and multi-unit residential buildings in greater Christchurch*', June 2012.

The building is considered to be potentially earthquake prone, having an assessed capacity less than 33%NBS. The risk of collapse of an earthquake prone building is considered to be 10 to 25 times greater than that of an equivalent new building.

For greater Christchurch the definition of a “dangerous” building in the Building Act has been extended (by the Canterbury Earthquake (Building Act) Order 2011) to include buildings at risk of collapsing in a moderate earthquake, that is earthquake prone buildings with a capacity at or below 33%NBS. Where council requires a dangerous building or an earthquake prone building to be upgraded, it may prohibit the use of the building until the works are carried out.

The building has suffered damage to the seismic or gravity load resisting system that is sufficient to impair or significantly reduce the ability to resist further loads, it is in a condition under which further deterioration may be expected in future aftershocks.

With consideration to the earthquake damage and the existing hazards observed, in its current state the building is not capable of resisting a moderate earthquake without collapse (its assessed capacity is less than 33%NBS) and it should not be used until it is repaired. Access should be limited to restricted occupancy for damage assessment or removal of essential items only.

13.2 Further Investigations, Survey or Geotechnical Work

It is recommended that:

- Barricades be installed to cordon off access to damaged structures on the western portion of the Norman Kirk Memorial Pool site including walls/fences and buildings. No occupancy restrictions exist for the Main Plant Room or the Nursery Building and we understand the Nursery is currently occupied. Access to these two building should be restricted to routes that do not require entering cordoned areas of the site.
- Further efforts are made to obtain structural drawings.
- A verticality and level survey could be carried out to determine the extent of settlement of the building, and differential settlement across the site, for insurance purposes.
- A quantitative %NBS analysis of the building should be completed.
- An investigation is undertaken to determine the structural integrity of the retaining wall along the driveway at the south of the site (and supporting the south wall of the building).

13.3 Damage Reinstatement

Repairs that would bring the building back to an “as new” condition are typically entitled under typical replacement insurance policies. We suggest you consult with your insurance advisor as to how you wish to proceed.

Note that a number of recommendations in 13.2 above are dependent on the outcome of this consultation and your agreed remediation strategy for the building. We believe the structure may not be reasonably repairable based on our observations and damage to adjoining structures (Ladies’ Change Room to the west and block fence to the east), and further investigations may not be warranted.

14 Design Features Report

Repairs will be required to reinstate the existing structural system. No additional load paths are expected. A repair methodology has not been prepared at this stage.

15 Limitations

The following limitations apply to this engagement:

- Beca and its employees and agents are not able to give any warranty or guarantee that all defects, damage, conditions or qualities have been identified.
- Inspections are primarily limited to visible structural components. Appropriate locations for invasive inspection, if required, will be based on damage patterns observed in visible elements, and review of the construction drawings and structural system. As such, there will be concealed structural elements that will not be directly inspected.
- The inspections are limited to building structural components only.
- Inspection of building services, pipework, pavement, and fire safety systems is excluded from the scope of this report.
- Inspection of the glazing system, linings, carpets, claddings, finishes, suspended ceilings, partitions, tenant fit-out, or the general water tightness envelope is excluded from the scope of this report.
- The preliminary assessment of the lateral load capacity of the building is limited by the completeness and accuracy of the drawings provided. Assumptions have been made in respect of the geotechnical conditions at the site and any aspects or material properties not clear on the drawings. Where these assumptions are considered material to the outcome further investigations may be recommended. It is noted the assessment has not been exhaustive, our analysis and calculations have focused on representative areas only to determine the level of provision made. At this stage we have not undertaken any checks of the gravity system, wind load capacity, or foundations.
- The information in this report provides a snapshot of building damage at the time the detailed inspection was carried out. Additional inspections required as a result of significant aftershocks are outside the scope of this work.

This report is of defined scope and is for reliance by CCC only, and only for this commission. Beca should be consulted where any question regarding the interpretation or completeness of our inspection or reporting arises.

Appendix A

Photographs

Figure 1: Site Layout.

Photo 1: External view of Lean-to Shelter (view from north-east). Temporary plywood cladding has been installed to replace the broken glazing.

Photo 2: External view of Lean-to Shelter and retaining wall (view from south-west).

Photo 3: Connections to adjacent Ladies' Change Room eastern masonry wall.

Photo 4: Connection to concrete masonry wall extending to the east.


Photo 5: U-bracket connections between columns and concrete plinth (on the right) and concrete masonry wall (on the left).


Photo 6: Concrete bond beam on top of the partial-height masonry block wall (view from south).

Damage Description: Cracking to concrete band beam.

Photo 7: Lean-to Shelter structure (view from east).

Damage Description: Bowing of timber columns.

Photo 8: Adjacent concrete masonry block wall along driveway between Main Plant Room and Lean-to Shelter. The Lean-to Shelter is to the left of this photo (view from south).

Damage Description: Cracking and differential settlement of concrete masonry block wall.

Photo 9: Adjacent concrete masonry block wall along driveway between Main Plant Room and Lean-to Shelter. The Lean-to Shelter is to the right of this photo (view from north).

Damage Description: Cracking and differential settlement of concrete masonry block wall.

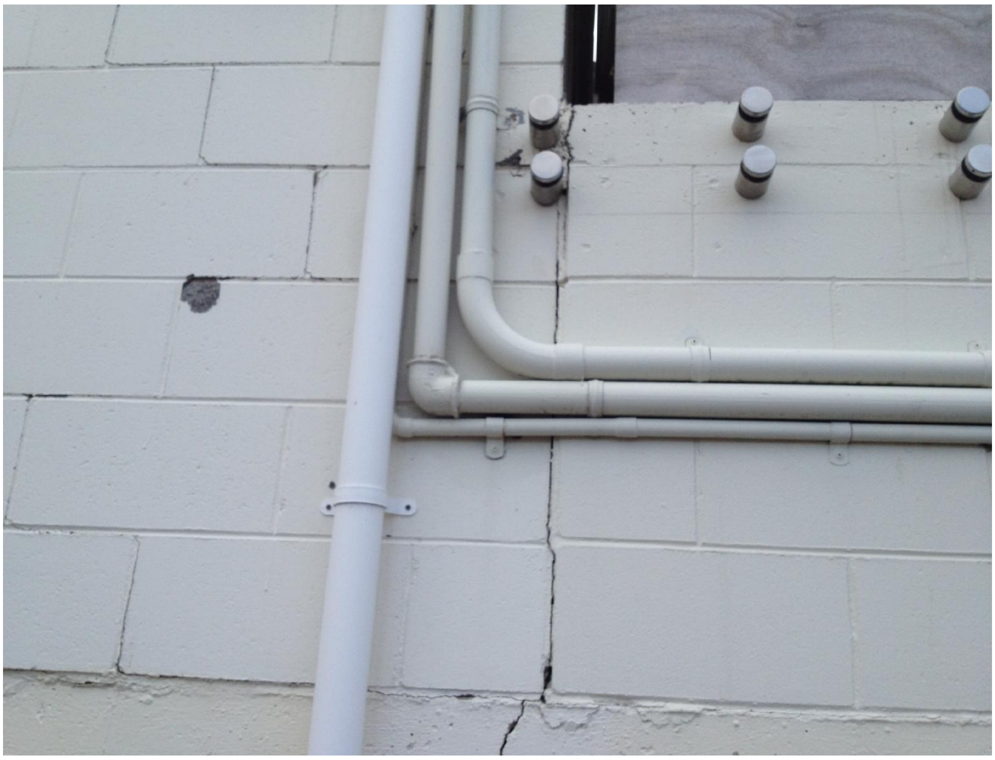


Photo 10: Concrete masonry block wall on southern side of Lean-to Shelter (western end).

Damage Description: Cracking of mortar and concrete masonry block wall.

Photo 11: Concrete retaining wall on southern side of Lean-to Shelter (western end).

Damage Description: Cracking of concrete retaining wall and concrete masonry mortar.

Photo 12: Pavement between pool and Lean-to Shelter.

Damage Description: Cracking/separation between pool and pavement. Differential settlement is evident as the pavement slopes to the right in this photo.

Photo 13: Concrete retaining wall and concrete masonry block fence to the north of the pool (view from south-east).

Damage Description: Cracking and differential settlement of concrete masonry block wall.

Photo 14: Concrete masonry fence to the north of the pool.

Damage Description: Cracked and dislodged concrete masonry units.

Appendix B

CERA DEE Summary Data

Detailed Engineering Evaluation Summary Data

V1.11

Location

Building Name: Lean-to Shelter

	Unit	No:	Street
Building Address:	Norman Kirk Memorial Pool	54	Oxford St, Lyttelton
Legal Description:			

	Degrees	Min	Sec
GPS south:			
GPS east:			

Building Unique Identifier (CCC): BU 3513-006 EO2

Reviewer: David Whittaker
CPEng No: 123089
Company: Beca
Company project number: 5323355
Company phone number: 033663521

Date of submission: 12/07/2013
Inspection Date: 7/08/2012
Revision: 1
Is there a full report with this summary? yes

Site

Site slope: slope < 1in 5
Soil type:
Site Class (to NZS1170.5): C
Proximity to waterway (m, if <100m):
Proximity to clifftop (m, if < 100m):
Proximity to cliff base (m,if <100m): 40

Max retaining height (m): 2
Soil Profile (if available):

If Ground improvement on site, describe:

Approx site elevation (m): 32.00

Building

No. of storeys above ground: 1 single storey = 1
Ground floor split? no
Storeys below ground 0
Foundation type: other (describe)
Building height (m): 3.00
Floor footprint area (approx): 39
Age of Building (years): 39

Ground floor elevation (Absolute) (m): 32.00
Ground floor elevation above ground (m):

if Foundation type is other, describe: Unknown. Shallow foundations assumed.
height from ground to level of uppermost seismic mass (for IEP only) (m): 2

Date of design: 1965-1976

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): Shade shelter
Importance level (to NZS1170.5): IL2

Gravity Structure

Gravity System: frame system
Roof: timber framed
Floors:
Beams:
Columns:
Walls:

rafter type, purlin type and cladding: Timber purlins & bearers, metal joists. Lightweight metal sheeting
No floor, slab on grade surrounds.

Lateral load resisting structure

Note: Define along and across in detailed report!

Lateral system along: other (note)
describe system: Assumed to be provided by partially filled concrete masonry walls of adjacent building
Ductility assumed, μ: 1.25
Period along: 0.40 0.00 estimate or calculation? estimated
Total deflection (ULS) (mm): estimate or calculation?
maximum interstorey deflection (ULS) (mm): estimate or calculation?

Lateral system across: other (note)
describe system: Assumed to mainly be provided by partially filled concrete masonry walls of adjacent building. Some column cantilever action would be generated.
Ductility assumed, μ: 1.25
Period across: 0.40 0.00 estimate or calculation? estimated
Total deflection (ULS) (mm): estimate or calculation?
maximum interstorey deflection (ULS) (mm): estimate or calculation?

Separations:

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

Non-structural elements

Stairs:
Wall cladding:
Roof Cladding: Metal describe Lightweight metal sheeting
Glazing:
Ceilings:
Services(list): None observed.

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: Ground cracks and differential settlement
Describe damage: Ground, mortar and blockwork cracking, settlement

Settlement: none observed notes (if applicable):
Differential settlement: 0-1:350 notes (if applicable): ground around pool slopes to the south
Liquefaction: none apparent notes (if applicable):
Lateral Spread: none apparent notes (if applicable):
Differential lateral spread: none apparent notes (if applicable):
Ground cracks: 0-20mm/20m notes (if applicable): pavement cracks throughout site
Damage to area: slight notes (if applicable):

Building:

Current Placard Status: Red

Along Damage ratio: 0%
Describe (summary):
Describe how damage ratio arrived at: No significant structural damage

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: significant structural
Describe: Settlement. Cracked concrete masonry blockwork (adjacent).
Building Consent required: Describe:
Interim occupancy recommendations: do not occupy Describe:

Along Assessed %NBS before: 10% 10% %NBS from IEP below
Assessed %NBS after: 10%

If IEP not used, please detail assessment methodology:

Across Assessed %NBS before: 10% 10% %NBS from IEP below
Assessed %NBS after: 10%

IEP **Use of this method is not mandatory - more detailed analysis may give a different answer, which would take precedence. Do not fill in fields if not using IEP.**

Period of design of building (from above): 1965-1976

h_n from above: 2m

Seismic Zone, if designed between 1965 and 1992: B

not required for this age of building

not required for this age of building

	along	across
Period (from above):	0.4	0.4
(%NBS)nom from Fig 3.3:	6.3%	6.3%

Note:1 for specifically design public buildings, to the code of the day: pre-1965 = 1.25; 1965-1976, Zone A =1.33; 1965-1976, Zone B = 1.2; all else 1.0	1.00
Note 2: for RC buildings designed between 1976-1984, use 1.2	1.0
Note 3: for buildngs designed prior to 1935 use 0.8, except in Wellington (1.0)	1.0

	along	across
Final (%NBS)$_{nom}$:	**6%**	**6%**

2.2 Near Fault Scaling Factor

Near Fault scaling factor, from NZS1170.5, cl 3.1.6: 1.00

	along	across
Near Fault scaling factor (1/N(T,D), **Factor A**:	1	1

2.3 Hazard Scaling Factor

Hazard factor Z for site from AS1170.5, Table 3.3: 0.30

Z_{1992}, from NZS4203:1992 0.7

Hazard scaling factor, **Factor B:** 3.333333333

2.4 Return Period Scaling Factor

Building Importance level (from above): 2

Return Period Scaling factor from Table 3.1, **Factor C**: 1.00

2.5 Ductility Scaling Factor

	along	across
Assessed ductility (less than max in Table 3.2)	1.25	1.25
Ductility scaling factor: =1 from 1976 onwards; or =kμ, if pre-1976, fromTable 3.3:	1.14	1.14
Ductiity Scaling Factor, **Factor D**:	1.14	1.14

2.6 Structural Performance Scaling Factor:

Sp:	0.925	0.925
Structural Performance Scaling Factor **Factor E**:	1.081081081	1.081081081

2.7 Baseline %NBS, (NBS%)$_b$ = (%NBS)$_{nom}$ x A x B x C x D x E

%NBS$_b$:	**26%**	**26%**

Global Critical Structural Weaknesses: (refer to NZSEE IEP Table 3.4)

3.1. Plan Irregularity, factor A:	severe	0.4
3.2. Vertical irregularity, Factor B:	insignificant	1
3.3. Short columns, Factor C:	insignificant	1

3.4. Pounding potential

Pounding effect D1, from Table to right 1.0

Height Difference effect D2, from Table to right 1.0

Therefore, Factor D: 1

3.5. Site Characteristics	insignificant	1

Table for selection of D1	Severe	Significant	Insignificant/none
Separation	0<sep<.005H	.005<sep<.01H	Sep>.01H
Alignment of floors within 20% of H	**0.7**	**0.8**	**1**
Alignment of floors not within 20% of H	**0.4**	**0.7**	**0.8**

Table for Selection of D2	Severe	Significant	Insignificant/none
Separation	0<sep<.005H	.005<sep<.01H	Sep>.01H
Height difference > 4 storeys	0.4	0.7	1
Height difference 2 to 4 storeys	0.7	0.9	1
Height difference < 2 storeys	1	1	1

3.6. Other factors, Factor F

	Along	Across
For ≤ 3 storeys, max value =2.5, otherwise max valule =1.5, no minimum	1.0	1.0
Rationale for choice of F factor, if not 1		

Detail Critical Structural Weaknesses: (refer to DEE Procedure section 6)

List any: Plan Irregularity Refer also section 6.3.1 of DEE for discussion of F factor modification for other critical structural weaknesses

3.7. Overall Performance Achievement ratio (PAR)	**0.40**	**0.40**

4.3 PAR x (%NBS)b: PAR x Baselline %NBS:	**10%**	**10%**

4.4 Percentage New Building Standard (%NBS), (before) **10%**

Official Use only:

Accepted By

Date:

Appendix C

Previous Reports and Assessments

Christchurch Eq RAPID Assessment Form - LEVEL 2

Inspector Initials: M W F
Territorial Authority: Christchurch City
Date: 21-6-11
Time: 11:00
Final Posting (e.g. UNSAFE): UNSafe

Building Name: Norman Kirk Main Pool Ladies, Mens, Nursery & Lean to Bldy
Short Name:
Address: 54 Oxford St
Lyttelton
GPS Co-ordinates S° E°
Contact Name: Bruce Thompson
Contact Phone: 027 449 2937
Storeys at and above ground level: 1
Below ground level: N/A
Total gross floor area (m²):
Year built:
No of residential Units:
Photo Taken: Yes [✓ No]

Type of Construction

- ☐ Timber frame
- ☐ Steel frame
- ☐ Tilt-up concrete
- ☐ Concrete frame
- ☐ RC frame with masonry Infill
- ☐ Concrete shear wall
- ☑ Unreinforced masonry
- ☐ Reinforced masonry
- ☐ Confined masonry
- ☐ Other:

Primary Occupancy

- ☐ Dwelling
- ☐ Other residential
- ☐ Public assembly
- ☐ School
- ☐ Religious
- ☐ Commercial/ Offices
- ☐ Industrial
- ☐ Government
- ☐ Heritage Listed
- ☑ Other Pool Bldgs

Investigate the building for the conditions listed on page 1 and 2, and check the appropriate column. A sketch may be added on page 3

Overall Hazards / Damage	Minor/None	Moderate	Severe
Collapse, partial collapse, off foundation	☐	☐	☑
Building or storey leaning	☑	☐	☐
Wall or other structural damage	☐	☐	☐
Overhead falling hazard	☐	☐	☑
Ground movement, settlement, slips	☐	☑	☐
Neighbouring building hazard	☐	☐	☑
Electrical, gas, sewerage, water, hazmats	☐	☐	☐

Comments

Block walls will require partial complete demolition. Floor sunk. Slab moved 20mm from pool. Significant damage

On to driveway - south side from lean to. This drive gives access to 54a Oxford St

Not known

Record any existing placard on this building:

Existing Placard Type (e.g. UNSAFE): Unsafe

Choose a new posting based on the new evaluation and team judgement. Severe conditions affecting the whole building are grounds for an UNSAFE posting. Localised Severe and overall Moderate conditions may require a RESTRICTED USE. Place INSPECTED placard at main entrance. Post all other placards at every significant entrance. Transfer the chosen posting to the top of this page.

INSPECTED GREEN: G1 G2
RESTRICTED USE YELLOW: Y1 Y2
UNSAFE RED: [✓ R1] R2 R3

Record any restriction on use or entry:

Further Action Recommended:

Tick the boxes below only if further actions are recommended

- ☐ Barricades are needed (state location):
- ☑ Detailed engineering evaluation recommended
  - ☑ Structural
  - ☑ Geotechnical
  - ☐ Other:
- ☐ Other recommendations:

Need to design/detail new walls & investigate foundation conditions

Estimated Overall Building Damage (Exclude Contents)

- None ☐
- 0-1 % ☐
- 2-10 % ☐
- 11-30 % ☑
- 31-60 % ☐
- 61-99 % ☐
- 100 % ☐

Sign here on completion

Date & Time: 26-11 12:00
ID: Murray Frost SKM 021 403 180

PRUPI:

Inspection ID: ________ *(Office Use Only)*

Structural Hazards/ Damage	Minor/None	Moderate	Severe	Comments
Foundations	☐	☑	☐	
Roofs, floors (vertical load)	☑	☐	☐	
Columns, pilasters, corbels	☑	☐	☐	
Diaphragms, horizontal bracing	☐	☐	☐	
Pre-cast connections	☐	☐	☐	
Beam	☐	☐	☐	
Non-structural Hazards / Damage				
Parapets, ornamentation	☐	☐	☐	
Cladding, glazing	☐	☐	☑	
Ceilings, light fixtures	☑	☐	☐	
Interior walls, partitions	☐	☐	☑	
Elevators	☐	☐	☐	N/A
Stairs/ Exits	☑	☐	☐	
Utilities (eg. gas, electricity, water)	☐	☐	☐	Not Known
Other	☐	☐	☐	
Geotechnical Hazards / Damage				
Slope failure, debris	☑	☐	☐	None
Ground movement, fissures	☑	☑	☐	Minor
Soil bulging, liquefaction	☑	☐	☐	None

General Comment ____________________

Usability Category

Damage Intensity	Posting	Usability Category	Remarks
Light damage *Low risk*	Inspected (Green)	G1. Occupiable, no immediate further investigation required	
		G2. Occupiable, repairs required	
Medium damage *Medium risk*	Restricted Use (Yellow)	Y1. Short term entry	
		Y2. No entry to parts until repaired or demolished	
Heavy damage *High risk*	Unsafe (Red)	R1. Significant damage: repairs, strengthening possible	Put danger tape along south wall of Ikon to (along drive to
		R2. Severe damage: demolition likely	54a Oxford st) & across all access to other areas. Block
		R3. At risk from adjacent premises or from ground failure	Walls cracked (5mm) & wing Walls badly damaged.

Sketch (optional)
Provide a sketch of the entire building or damage points. Indicate damage points.

Recommendations for Repair and Reconstruction or Demolition (Optional)

Detailed investigation & inspection required.

This could be a significant claim for CCC to the Insurance Company although danger to public is limited due to the security arrangements around the pool.

Rang Tim Driver - Removed to 45kg gas bottles from cabinet - wall in danger of collapse. City Care to collect. Two cylinders lying flat on ground by childs paddling pool.