Christchurch City Council
BU 3555-007 & BU 3555-008
Diamond Harbour Hall/Library/Toilets
Waipapa Avenue 1 J

QUANTITATIVE REPORT
FINAL

- Rev B
- 05 April 2013

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QUANTITATIVE ASSESSMENT REPORT

FINAL

- Rev B
- 05 April 2013

Sinclair Knight Merz
142 Sherborne Street
Saint Albans
PO Box 21011, Edgeware
Christchurch, New Zealand
Tel: +64 3 940 4900
Fax: +64 3 940 4901
Web: www.skmconsulting.com

Contents

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	Signature	Date	Name	Title
Author		28/03/2013	Maria Angela Astorga Mendizabal	Structural Engineer
Approver		28/03/2013	Alex Martin	Project Manager

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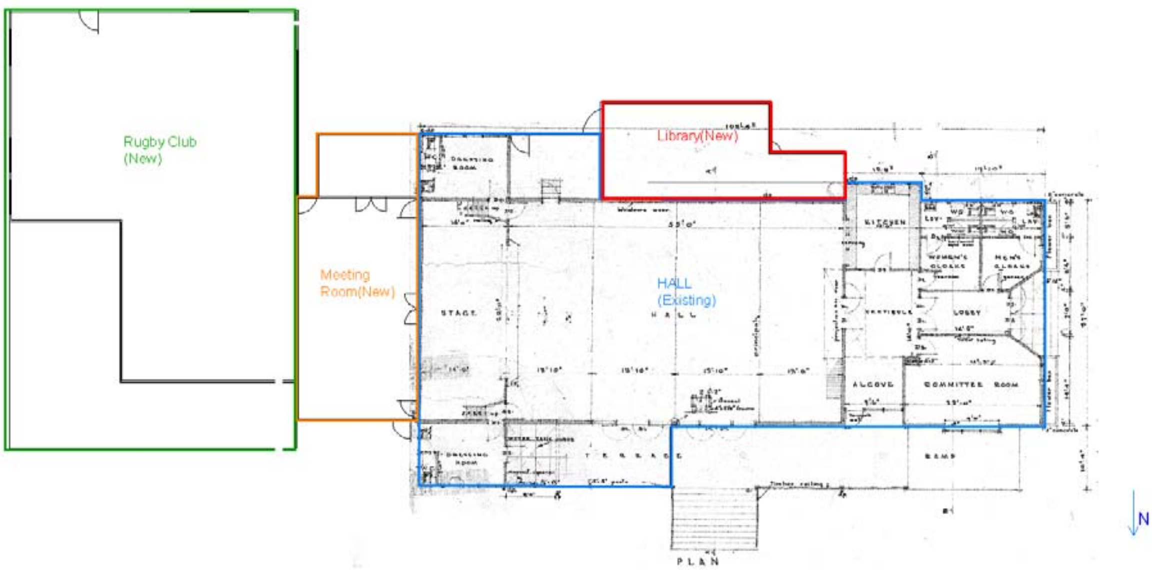
1. Executive Summary

1.1. Background

A QUANTITATIVE Assessment was carried out on the buildings owned by Christchurch City Council located at 1J Waipapa Avenue containing the Diamond Harbour Hall, Library and Toilets. The structure located on this site comprises three buildings: the original Diamond Harbour Hall, the Library (an addition to the original structure) and the Diamond Harbour Rugby Club (which is not owned by the Christchurch City Council).

The library is located to the south of the hall and shares a structural wall with it. A new meeting room has been also added to the original structure at its eastern extent. The rugby club is located to the east of the meeting room and has not been considered within this assessment apart from a load allowance on the shared wall of the meeting room. The overall structure of the adjacent Rugby Club has not been assessed.

A Plan sketch illustrating these areas is shown below in Figure1. Detailed descriptions outlining the buildings load resisting systems are given in Section 5 of this report.



- **Figure 1 Plan sketch of 1J Waipapa Avenue, Diamond Harbour**

This Quantitative report for the building structure is based on the Engineering Advisory Group's "Guidance on Detailed Engineering Evaluation of Earthquake Affected Non-residential Buildings" (draft) July 2011, visual inspections on 12th April 2012 and 11th September 2012, available drawings of the original structure and calculations.

1.2. Key Damage Observed

Key damage observed includes:-

- Minor damage to wall and roof linings throughout the original hall and more recent library addition.

A more detailed account of the damage can be found in section 5.

1.3. Critical Structural Weaknesses

No potential critical structural weaknesses have been identified.

1.4. Indicative Building Strength

As described in the Engineering Advisory Group's "Guidance on Detailed Engineering Evaluation of Earthquake Affected Non-residential Buildings" (draft) July 2011, we have assessed the capacity of the building as a percentage new building standard seismic resistance using the quantitative method. Our assessment included consideration of geotechnical conditions, existing earthquake damage to the building and structural engineering calculations to assess both strength and ductility/resilience.

The assessments were based on the following:

- On-site investigation to assess the extent of existing earthquake damage including limited intrusive investigation.
- Qualitative assessment of critical structural weaknesses (CSWs) based on review of available structural drawings and inspection where drawings were not available.
- A geotechnical desktop study of the site
- Assessment of the strength of the existing structures taking account of the current condition.

Any building that is found to have a seismic capacity less than 33% of the new building standard (NBS) is required to be strengthened up to a capacity of at least 67%NBS in order to comply with Christchurch City Council (CCC) policy - Earthquake-prone dangerous & insanitary buildings policy 2010.

Based on the information available, and using the Quantitative Assessment Procedure, the buildings original capacity has been assessed to be in the order of 45%NBS and post earthquake capacity in the order of 45%NBS. The buildings post earthquake capacity excluding critical structural weaknesses is in the order of 45%NBS.

The building has been assessed to have a seismic capacity in the order of 45% NBS and is therefore not potentially earthquake prone.

1.5. Recommendations

Based on the findings of this assessment indicating the building is in the order of 45 %NBS, no strengthening is required since it is legally acceptable although its improvement may be desirable.

a) There is no damage to the structure that would cause it to be unsafe to occupy.

b) Options to bring the building to a target of 67% are investigated.

c) We consider that barriers around the building are not necessary.

2. Introduction

Sinclair Knight Merz were engaged by Christchurch City Council to carry out a Quantitative Assessment of the seismic performance of Diamond Harbour Hall/Library/Toilets located at Waipapa Avenue 1 J. Building numbering is defined in Figure 1.

The scope of this quantitative analysis includes the following:

- Analysis of the seismic load carrying capacity of the building compared with current seismic loading requirements or New Buildings Standard (NBS). It should be noted that this analysis considers the building in its damaged state where appropriate.
- Identify any critical structural weaknesses which may exist in the building and include these in the assessed %NBS of the structure.

The recommendations from the Engineering Advisory Group[1] were followed to assess the likely performance of the structures in a seismic event relative to the new building standard (NBS). 100% NBS is equivalent to the strength of a building that fully complies with current codes. This includes a recent increase of the Christchurch seismic hazard factor from 0.22 to 0.3[2].

This assessment identified that the seismic capacity of the building was likely to be less than 33% of the new building standard (NBS). A quantitative assessment was recommended to confirm the initial assessment findings and to determine a more accurate seismic rating of the building.

Constructions drawings of the original structure were made available, and these have been considered in our evaluation of the building. The building description below is based on a review of the drawings and our visual inspections.

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[1] EAG 2011, *Guidance on Detailed Engineering Evaluation of Earthquake Affected Non-residential Buildings in Canterbury - Draft*, p 10
[2] http://www.dbh.govt.nz/seismicity-info

3. 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.

3.1. 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 anticipated that CERA will adopt the Detailed Engineering Evaluation Procedure document (draft) issued by the Structural Advisory Group on 19 July 2011. This document sets out a methodology for both qualitative and quantitative assessments.

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

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

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

- The extent of any earthquake damage

3.2. Building Act

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

3.2.1. 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).

3.2.2. 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.

3.2.3. 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.

3.2.4. 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.

3.2.5. 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.

3.2.6. Section 131 – Earthquake Prone Building Policy

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

3.3. 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. Council recognises that it may not be practicable for some repairs to meet that target. The council will work closely with building owners to achieve sensible, safe outcomes;
- A timeframe of 15-30 years for Earthquake Prone Buildings to be strengthened; and,
- Repair works for buildings damaged by earthquakes will be required to comply with the above.

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

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

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

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

3.4. 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.

After the February Earthquake, 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.

4. Earthquake Resistance Standards

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

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

The New Zealand Society for Earthquake Engineering has proposed a way for classifying earthquake risk for existing buildings in terms of %NBS and this is shown in Figure 2 below.

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

- **Figure 2: NZSEE Risk Classifications Extracted from table 2.2 of the NZSEE 2006 AISPBE Guidelines**

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

- **Table 1: %NBS compared to relative risk of failure**

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

5. Building Details

5.1. Building description

The structure located at 1J Waipapa Avenue comprises three buildings: the original Diamond Harbour Hall, the Library (an addition to the original structure) and the Diamond Harbour Rugby Club (which is not owned by the Christchurch City Council).

The library is located to the south of the hall and shares a structural wall with it. A new meeting room has been also added to the original structure at its eastern extent. The rugby club is located to the east of the meeting room and the two parts of the structure share a common wall. At the west part of the hall there are the committee room, the kitchen and bathrooms. A Plan sketch illustrating these areas is shown in Figure 1. As assessment of the rugby club has not been completed however a load allowance has been made on the shared wall to support a portion of the rugby clubrooms.

The floors of meeting room and rugby club are approximately 1.10m above the level of the Diamond hall floor. This difference in floor levels and the sloping of the site allowed for the introduction of toilets and storage rooms of approximately 2.75m height, below the meeting room and rugby club. The walls of these rooms are formed from blockwork masonry.

Structural drawings of the original structure were available in which it is indicated 1953 as the year of construction of the hall (Attached in Appendix 3). The library and meeting room appears to be constructed in 2002.

5.2. Gravity Load Resisting system

The hall is approximately 6.5m tall with trusses spanning around11m supporting the roof loads. The rooms at the west part of the hall are approximately 4.5m tall and have trusses of smaller dimensions than those of the hall. In both cases, truss loads are transferred to timber framed walls that in turn transfer the loads to the foundations formed by concrete piles and perimeter concrete walls.

The library and meeting room consists of modern timber framed structures formed by timber trusses that transfer the loads to timber framed walls. The timber walls are supported on masonry walls or concrete piles foundations.

5.3. Seismic Load Resisting system

For the lateral analysis of this building the ‘across direction’ has been taken as north-south and the ‘along direction’ has been taken as east-west.

In the along and across directions, the structure of the hall resists lateral loading through diagonal timber blocking within the walls. The lateral loads acting at the rooms at west part of the hall are resisted by plywood linings over the timber framing.

The bearers of the floor are not connected to the concrete piles, hence they don't work as cantilever piles. As such, the lateral loads resisted by the timber framed walls are transferred to the concrete perimeter walls.

The structures of the library and new meeting room resist lateral loads through the action of the linings over the timber framing that then are transferred to their foundations. The shared wall between the rugby clubrooms and the meeting room carries in plane load from the rugby club.

5.4. Geotechnical Conditions

A geotechnical desktop study was carried out for this site. The main conclusions from this report are:

- The site has been assessed as being either Class B (rock) or Class C (shallow soil) as described in NZS1170.5. Further, investigation would be needed to confirm the depth of the surface soil. Until such investigations have been undertaken, Class C should be used as a conservative parameter.
- Liquefaction risk appears to be low for this site. The basaltic lava flows underlying the site inferred from the regional geological map is not susceptible to liquefaction. However, further investigation is needed to determine the composition and depth of the surface material and to confirm the liquefaction assessment.

Unless a change of use is intended for the site we do not believe that any further geotechnical investigations are required. Specific ground investigation should be undertaken if significant alterations or new structures are proposed. If any excavations are required on the site further investigation of the potential for contamination should be undertaken. The full geotechnical desktop study can be found in Appendix 3 – Geotechnical Desktop Study.

5.5. Building Damage

SKM undertook inspections on the 12/04/2012 and 11/09/2012. The following areas of damage were observed during the time of inspection:

1) The only structural damage observed was to internal linings where minor separation has occurred between panels

Photos of the above damage can be found in Appendix 1 Photos 13 to 24.

6. Available Information and Assumptions

6.1. Available Information

Following our inspections on the on 12th April 2012, 11th September 2012 and 19th March 2013 SKM carried out a seismic review on the structure. This review was undertaken using the available information which was as follows:

- Structural drawings of the original building dated June 1953.
- SKM site measurements and inspection findings of the existing building and additions.

6.2. Survey

There was no visible settlement of the structure, nor was there any significant ground movement issue around the building. The combination of these factors means that we do not recommend that any survey be undertaken at this point.

6.3. Assumptions

The assumptions made in undertaking the assessment include:

- The building was built according to the drawings and according to good practice at the time. We have reviewed the building and from our visual inspection the structure appears to be built in accordance with the drawings.
- Standard design assumptions for typical office and factory buildings as described in AS/NZS1170.0:2002:
  - 50 year design life, which is the default NZ Building Code design life.
  - Structure importance level 2. This level of importance is described as ‘normal’ with medium or considerable consequence for loss of human life, or considerable economic, social or environmental consequence of failure.
- The building has a short period less than 0.4 seconds.
- Site hazard factor, Z = 0.3, NZBC, Clause B1 Structure, Amendment 11 effective from 1 August 2011
- The following ductility criteria used in the building:
- **Table 2: Assumed Building Ductility**

Building	Ductility of Building in Current State	Ductility of Building in Strengthened State
Diamond Harbour Hall/Library/Toilets	2	2
Subfloor perimeter concrete walls	1.25	1.25

The ductility of 2 above has been considered as inherent to timber buildings with sheets linings or diagonal braces at the walls that provide a bracing capacity to the structure. In the same way, a ductility of 1.25 is considered reasonable for concrete walls of the age and detailing as those evaluated.

- The following material properties were used in the analyses:
- **Table 3: Material Properties**

Material	Nominal Strength	Structural Performance
Timber - Unknown	f_b = 10MPa & f_c = 15MPa	S_p = 0.7
Concrete	f_c' = 20MPa	S_p = 0.93

- It is assumed that a suitable connection between the timber structure and the concrete foundations exists.

The detailed engineering analysis is a post construction evaluation. Since it is not a full design and construction monitoring, it has the following limitations:

- It is not likely to pick up on any concealed construction errors (if they exist)
- Other possible issues that could affect the performance of the building such as corrosion and modifications to the structure will not be identified unless they are visible and have been specifically mentioned in this report.
- The detailed engineering evaluation deals only with the structural aspects of the structure. Other aspects such as building services are not covered.

6.4. The Detailed Engineering Evaluation (DEE) process

The DEE is a procedure written by the Department of Building and Housing's Engineering Advisory Group and grades buildings according to their likely performance in a seismic event. The procedure is not yet recognised by the NZ Building Code but is widely used and recognised by the Christchurch City Council as the preferred method for preliminary seismic investigations of buildings[3].

The procedure of the DEE is as follows:

1) Qualitative assessment procedure
    a. Determine the building's status following any rapid assessment that have been done

[3] http://resources.ccc.govt.nz/files/EarthquakeProneDangerousAndInsanitaryBuildingsPolicy2010.pdf

b. Review any existing documentation that is available. This will give the engineer an understanding of how the building is expected to behave. If no documentation is available, site measurements may be required

c. Review the foundations and any geotechnical information available. This will include determining the zoning of the land and the likely soil behaviour, a site investigation may be required

d. Investigate possible Critical Structural Weaknesses (CSW) or collapse hazards

e. Assess the original and post earthquake strength of the building (this assessment is subsequently superseded by the quantitative assessment)

2) Quantitative procedure

a. Carry out a geotechnical investigation if required by the qualitative assessment

b. Analyse the building according to current building codes and standards. Analysis accounts for damage to the building.

The DEE assessment ranks buildings according to how well they are likely to perform relative to a new building designed to current earthquake standards, as shown in Table 4. The building rank is indicated by the percent of the required new building standard (%NBS) strength that the building is considered to have. Earthquake prone buildings are defined as having less than 33 %NBS strength which correlates to an increased risk of approximately 20 times that of 100% NBS[4]. Buildings that are identified to be earthquake prone are required by law to be strengthened within 30 years of the owner being notified that the building is potentially earthquake prone[5].

[4] NZSEE 2006, *Assessment and Improvement of the Structural Performance of Buildings in Earthquakes,* p 2-2

[5] http://resources.ccc.govt.nz/files/EarthquakeProneDangerousAndInsanitaryBuildingsPolicy2010.pdf

- **Table 4: DEE Risk classifications**

Description	Grade	Risk	%NBS	Structural performance
Low risk building	A+	Low	> 100	Acceptable. Improvement may be desirable.
	A		100 to 80	
	B		80 to 67	
Moderate risk building	C	Moderate	67 to 33	Acceptable legally. Improvement recommended.
High risk building	D	High	33 to 20	Unacceptable. Improvement required.
	E		< 20	

The DEE method rates buildings based on the plans (if available) and other information known about the building and some more subjective parameters associated with how the building is detailed and so it is possible that %NBS derived from different engineers may differ.

This assessment describes only the likely seismic Ultimate Limit State (ULS) performance of the building. The ULS is the level of earthquake that can be resisted by the building without catastrophic failure. The DEE does also consider Serviceability Limit State (SLS) performance of the building and or the level of earthquake that would start to cause damage to the building but this result is secondary to the ULS performance.

The NZ Building Code describes that the relevant codes for NBS are primarily:

- AS/NZS 1170 parts 0, 1 and 5 Structural Design Actions
- NZS 3101:2006 Concrete Structures Standard
- NZS 3404:1997 Steel Structures Standard
- NZS 2606:1993 Timber Structures Standard
- NZS 4230:1990 Design of Reinforced Concrete Masonry Structures

7. Results and Discussions

7.1. Critical Structural Weaknesses

No potential critical structural weaknesses have been identified.

7.2. Analysis Results

The equivalent static force method was used to analyse the seismic capacity of the building. The results of the analysis are reported in the following table as %NBS. The results below are calculated for the building in its damaged state. The building results have been broken down into their seismic resisting elements.

(%NBS = the reliable strength / new building standards)

Table 5: DEE Results

Building	Seismic Resisting Element	Action	Seismic Rating %NBS
Diamond Harbour Hall/Library/Toilets	Timber Framed walls (Across direction)	Shear	45%
	Timber Framed walls (Along direction)	Shear	64%
	Subfloor reinforced concrete walls (Across direction)	Shear	69%
	Subfloor reinforced concrete walls (Along direction)	Shear	100%
	Subfloor reinforced concrete walls (Along and Across direction)	Out of plane bending	100%

7.3. Recommendations

If it is determined that the building should be repaired there are a number of issues which will need to be investigated and associated documents prepared in order to submit a building consent application. These issues will need to be considered during the initial phase of strengthening works. Listed below are the likely items the council may require to be explored:

- A geotechnical investigation will be required and associated factual and interpretive geotechnical reports prepared – the geotechnical reports will be required to enable completion of the strengthening design.

- A fire report will be required and all necessary upgrades to egress routes, emergency lighting and specified systems will need to be undertaken.
- An emergency lighting design will be required to meet the provisions noted in the fire report.
- A disabled access summary will be required including provision for disabled facilities.
- The site amenities (toilets and the like) will need to be reviewed to ensure that there are sufficient facilities for the expected number of people on site.
- Landscaping will need to be considered although we do not anticipate that any modifications will be required since you will not be adjusting the footprint area of buildings on site and will likely only be required for the new build option.

8. Conclusion

SKM carried out a quantitative assessment on BU 3555-008 EQ2 located at Waipapa Avenue 1 J. This assessment concluded that the building is classified Moderate risk building.

- **Table 6: Quantitative assessment summary**

Description	Grade	Risk	%NBS	Structural performance
Diamond Harbour Hall/Library/Toilets	C	Moderate	45%	Acceptable legally. Improvement recommended.

It is recommended that:

a) There is no damage to the structure that would cause it to be unsafe to occupy.

b) Options to bring the building to a target of 67% are investigated.

c) We consider that barriers around the building are not necessary.

9. Limitation Statement

This report has been prepared on behalf of, and for the exclusive use of, SKM’s client, and is subject to, and issued in accordance with, the provisions of the contract between SKM and the Client. It is not possible to make a proper assessment of this report without a clear understanding of the terms of engagement under which it has been prepared, including the scope of the instructions and directions given to, and the assumptions made by, SKM. The report may not address issues which would need to be considered for another party if that party's particular circumstances, requirements and experience were known and, further, may make assumptions about matters of which a third party is not aware. No responsibility or liability to any third party is accepted for any loss or damage whatsoever arising out of the use of or reliance on this report by any third party.

Without limiting any of the above, in the event of any liability, SKM's liability, whether under the law of contract, tort, statute, equity or otherwise, is limited in as set out in the terms of the engagement with the Client.

It is not within SKM’s scope or responsibility to identify the presence of asbestos, nor the responsibility of SKM to identify possible sources of asbestos. Therefore for any property pre-dating 1989, the presence of asbestos materials should be considered when costing remedial measures or possible demolition.

Should there be any further significant earthquake event, of a magnitude 5 or greater, it will be necessary to conduct a follow-up investigation, as the observations, conclusions and recommendations of this report may no longer apply Earthquake of a lower magnitude may also cause damage, and SKM should be advised immediately if further damage is visible or suspected.

10. Appendix 1 – Photos

Photo 1: Building constructed approx 1954

Photo 2: View of the hall looking south from the sports field

Photo 3: View looking east at the entrance to the hall

Photo 4: View East along the south side of the building. Library sharing the south wall

	
Photo 5: View looking North at the library add on	Photo 6: View of the library entrance past pre existing structure
	
Photo 7: Community Hall with timber trusses apex approx 7m	Photo 8: Composite truss made up of steel rods and timber with timber/ timber connections created with steel gussets

	
Photo 9: Timber roof cladding	Photo 10: Timber trusses – no apparent damage
	
Photo 11: Meeting room / back stage area	Photo 12: Roof supported by a timber beam
	
Photo 13: Typical damage to the interior linings of the meeting room	Photo 14: Typical separation between internal wall linings

Photo 15: Typical plasterboard damage to the hall

Photo 16: Typical plasterboard damage to the hall

Photo 17: Typical plasterboard damage to the hall

Photo 18: Typical plasterboard damage to the hall entrance

Photo 19: Typical plasterboard damage to the hall entrance

Photo 20: Typical plasterboard damage to the hall entrance

Photo 21: Plasterboard separation in the Library

Photo 22: Plasterboard separation in the Library

Photo 23: Plasterboard separation in the Library

Photo 24: Plasterboard separation in the Library

	
Photo 25: Plasterboard separation in the Library	Photo 26: Plasterboard separation in the Library
	
Photo 27: Back stage area supported by masonry block around the perimeter	Photo 28: Storage rooms on south side of back stage area timber floor on joists on bearers supported by timber piles

Photo 29: Ventilation points around concrete perimeter ring beam for internal ventilation

Photo 30: Venitlation point on buildings NW used to take photos 31 and 32

Photo 31:Floor and foundation system under the hall and foyer. Timber flooring on joists on bearrers supported by concrete piles. View south

Photo 32: View east

11. Appendix 2 – CERA Standardised Report Form

Detailed Engineering Evaluation Summary Data V1.11

Location

Building Name:	Diamond Harbour Hall/Library/Toilets	Reviewer:	N Calvert
	Unit / No: / Street	CPEng No:	242062
Building Address:	1J Waipapa Avenue	Company:	SKM
Legal Description:		Company project number:	ZB01276.07
		Company phone number:	03 940 4900
	Degrees / Min / Sec		
GPS south:		Date of submission:	5-Apr
GPS east:		Inspection Date:	12/04/2012
		Revision:	A
Building Unique Identifier (CCC):	BU 3555-007 EQ2 & BU 3555-008 EQ2	Is there a full report with this summary?	yes

Site

Site slope:	slope < 1in 5	Max retaining height (m):	
Soil type:		Soil Profile (if available):	
Site Class (to NZS1170.5):	C		
Proximity to waterway (m, if <100m):		If Ground improvement on site, describe:	
Proximity to clifftop (m, if < 100m):			
Proximity to cliff base (m,if <100m):		Approx site elevation (m):	50.00

Building

No. of storeys above ground:	1	single storey = 1	Ground floor elevation (Absolute) (m):	50.00
Ground floor split?	no		Ground floor elevation above ground (m):	0.40
Storeys below ground	0			
Foundation type:	strip footings		if Foundation type is other, describe:	
Building height (m):	6.50		height from ground to level of uppermost seismic mass (for IEP only) (m):	
Floor footprint area (approx):	588			
Age of Building (years):	60		Date of design:	1935-1965
Strengthening present?	no		If so, when (year)?	
			And what load level (%g)?	
Use (ground floor):	public		Brief strengthening description:	
Use (upper floors):	other (specify)			
Use notes (if required):				
Importance level (to NZS1170.5):	IL2			

Gravity Structure

Gravity System:	frame system		
Roof:	timber framed	rafter type, purlin type and cladding	Timber trusses: rafters 180x100mm, purlins 150x50, steel sheeting
Floors:	timber	joist depth and spacing (mm)	125x50mm joists@900mm
Beams:	timber	type	
Columns:	timber	typical dimensions (mm x mm)	75x100mm
Walls:			

Lateral load resisting structure

Lateral system along:	lightweight timber framed walls	**Note: Define along and across in detailed report!**	note typical wall length (m)	4
Ductility assumed, μ:	2.00			
Period along:	0.40	0.00	estimate or calculation?	estimated
Total deflection (ULS) (mm):	20		estimate or calculation?	estimated
maximum interstorey deflection (ULS) (mm):	20		estimate or calculation?	estimated
Lateral system across:	lightweight timber framed walls		note typical wall length (m)	4
Ductility assumed, μ:	2.00			
Period across:	0.40	0.00	estimate or calculation?	estimated
Total deflection (ULS) (mm):	20		estimate or calculation?	estimated
maximum interstorey deflection (ULS) (mm):	20		estimate or calculation?	estimated

Separations:

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

Non-structural elements

Stairs:			
Wall cladding:	other light	describe	Softboard int, Weatherboard ext
Roof Cladding:	Metal	describe	Corrugated light steel roofing
Glazing:	timber frames		
Ceilings:	strapped or direct fixed		Light timber panels
Services(list):			

Available documentation

Architectural	partial	original designer name/date	Melville Lawry
Structural	partial	original designer name/date	EGS Powell
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:	slight	notes (if applicable):	

Building:

	Current Placard Status:	green		
Along	Damage ratio:	0%	Describe how damage ratio arrived at:	
	Describe (summary):	No damage		
Across	Damage ratio:	0%		
	Describe (summary):	No damage		
Diaphragms	Damage?:	no	Describe:	
CSWs:	Damage?:	no	Describe:	
Pounding:	Damage?:	no	Describe:	
Non-structural:	Damage?:	no	Describe:	

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

Recommendations

	Level of repair/strengthening required:	minor non-structural	Describe:	Plasterboard separation
	Building Consent required:	yes	Describe:	
	Interim occupancy recommendations:	full occupancy	Describe:	little immediate risk
Along	Assessed %NBS before:	64%	%NBS from IEP below	If IEP not used, please detail assessment methodology: Quantitative calculations
	Assessed %NBS after:	64%		
Across	Assessed %NBS before:	45%	%NBS from IEP below	
	Assessed %NBS after:	45%		

12. Appendix 3 – Geotechnical Desktop Study

Sinclair Knight Merz
142 Sherborne Street
Saint Albans
PO Box 21011, Edgeware
Christchurch, New Zealand

Tel: +64 3 940 4900
Fax: +64 3 940 4901
Web: www.globalskm.com

Christchurch City Council - Structural Engineering Service

Geotechnical Desk Study

SKM project number	ZB01276
SKM project site number	007
Address	Diamond Harbour Community Facilities, 1J Waipapa Avenue
Report date	13 April 2012
Author	Ross Roberts/ Ananth Balachandra
Reviewer	Leah Bateman
Approved for issue	Yes

1. Introduction

This report outlines the geotechnical information that Sinclair Knight Merz (SKM) has been able to source from our database and other sources in relation to the property listed above. We understand that this information will be used as part of an initial qualitative Detailed Engineering Evaluation (DEE), and will be supplemented by more detailed information and investigations to allow detailed scoping of the repair or rebuild of the building.

2. Scope

This geotechnical desk top study incorporates information sourced from:

- Published geology
- Publically available borehole records
- Liquefaction records
- Aerial photography
- Council files
- A preliminary site walkover

3. Limitations

This report was prepared to address geotechnical issues relating to the specific site in accordance with the scope of works as defined in the contract between SKM and our Client. This report has been prepared on behalf of, and for the exclusive use of, our Client, and is subject to, and issued in accordance with, the provisions of the contract between SKM and our Client. The findings presented in this report should not be applied to another site or another development within the same site without consulting SKM.

The assessment undertaken by SKM was limited to a desktop review of the data described in this report. SKM has not undertaken any subsurface investigations, measurement or testing of materials from the site. In preparing this report, SKM has relied upon, and presumed accurate, any information (or confirmation of the absence thereof) provided by our Client, and from other sources as described in the report. Except as otherwise stated in this report, SKM has not attempted to verify the accuracy or completeness of any such information.

This report should be read in full and no excerpts are to be taken as representative of the findings. It must not be copied in parts, have parts removed, redrawn or otherwise altered without the written consent of SKM.

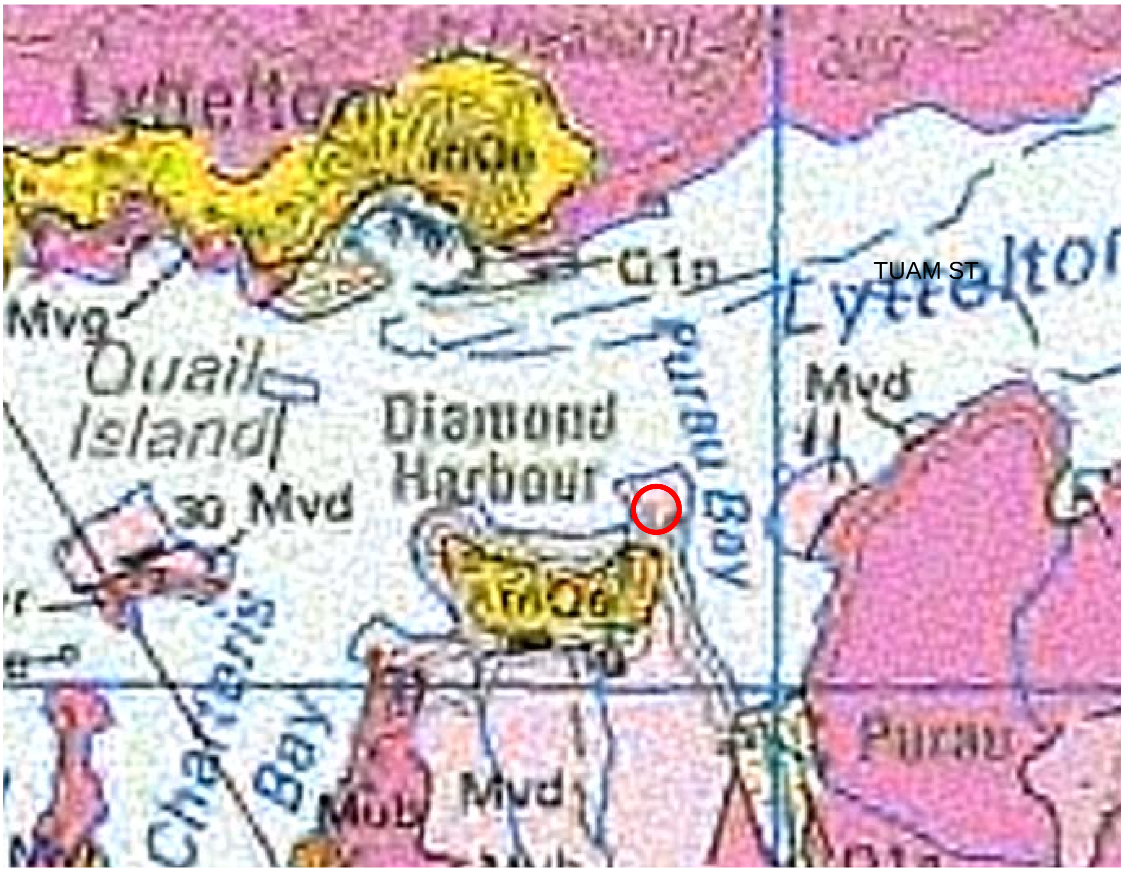
4. Site location

- **Figure 1 – Site location (courtesy of LINZ http://viewers.geospatial.govt.nz)**

The structure is located on 1J Waipapa Avenue, Diamond Harbour at grid reference 1579085 E, 5169590 N (NZTM).

5. Review of available information

5.1 Geological maps



- **Figure 2 – Regional geological map (Forsyth et al, 2008). Site marked in red.**

No local geological map was available at the time for the area.

From the regional geological map, the site is shown to be underlain by basaltic lava flows, dikes, silts, vent plugs and a dome. Additionally, there is minor presence of breccia, conglomerate, sandstone and carbonaceous mudstone.

5.2 Liquefaction map

Following the 22 February 2011 event drive through reconnaissance was undertaken from 23 February until 1 March by M Cubrinovsko and M Taylor of Canterbury University. However, the reconnaissance did not extend to this area.

Due to the presence of mainly basaltic lava flows, the area is unlikely to be susceptible to liquefaction.

5.3 Aerial photography

No aerial photograph of the site was available in the viewers.geospatial.govt.nz website.

5.4 CERA classification

A review of the LINZ website (http://viewers.geospatial.govt.nz/) shows that the site is:

- Zone: Green
- DBH Technical Category: N/A (Port Hills and Banks Peninsula)

5.5 Historical land use

Historical land use for the site is not available.

5.6 Existing ground investigation data

No ground investigation data for the site is available.

5.7 Council property files

The relevant council records for the Diamond Harbour hall and library were the property files for the building located on 2L Waipapa Avenue. The available property files relate to an addition to the eastern end of the Diamond Harbour Community Centre Hall.

The council record files identify a permit was granted for an excavation to a depth of 2.6m to take place. The construction of the building extension is stated as the proposed follow up to the excavation, with no filling of the excavation indicated in the council records. Additionally, no detail on the nature of material excavated is provided.

Available drawings show an unreinforced concrete slab, with a thickness of approximately 100mm, was used as the floor of the structure. Additionally, the foundation detail shows posts from the base of the floor slab embedded in 200mm diameter, 600mm deep reinforced concrete post holes. No further underlying ground condition information was found from the available council records.

5.8 Site walkover

An external inspection of the site was conducted by a SKM engineer in the week commencing 9 April 2012.

The building on site was observed to be a large timber structure on two way timber joist. The structure appears to be supported on a concrete beam around the perimeter of the building and internal concrete piles.

Building is located on a cut to level footprint, with the hill sloping at approximately 2V:3H. Beyond the hall the hill has been benched and there is a level car park. There was no visible sign of liquefied material ejected at surface, and no evidence of any other land damage noted during the external inspection of the site.

6. Conclusions and recommendations

6.1 Site geology

No geotechnical investigation data was available for this site in order to infer the site geology.

6.2 Seismic site subsoil class

The site has been assessed as being either Class B (rock) or Class C (shallow soil) as described in NZS1170.5. Further, investigation would be needed to confirm the depth of the surface soil. Until such investigations have been undertaken, Class C should be used as a conservative parameter.

As described in NZS1170, the preferred site classification method is from site periods based on four times the shear wave travel time through material from the surface to the underlying rock. The next preferred methods are from borelogs including measurement of geotechnical properties or by evaluation of site periods from Nakamura ratios or from recorded earthquake motions. Lacking this information, classification may be based on boreholes with descriptors but no geotechnical measurements. The least preferred method is from surface geology and estimates of the depth to underlying rock.

As no borehole information was available near site, the least preferred method of using surface geology to classify the site was performed. The site was inferred to be underlain by basaltic lava flows using the regional geological maps. However, council records indicate a 2.6m excavation has been undertaken for the construction of the foundation possibly implying the presence of “softer” material near the surface. Further, geotechnical investigation or site specific study could result in a revision to the specified class.

6.3 Building performance

The performance to date suggests that the existing foundations of the structure are adequate for their current purpose.

6.4 Ground performance and properties

Liquefaction risk appears to be low for this site. The basaltic lava flows underlying the site inferred from the regional geological map is not susceptible to liquefaction. However, further investigation is needed to determine the composition and depth of the surface material and to confirm the liquefaction assessment.

Design parameter recommendations have not been made for this site as no historical ground investigation data was available near the site.

6.5 Further investigations

In order to perform a quantitative DEE, further ground investigations are required. Additional investigations recommended are:

- One borehole near the site. To a minimum depth of 20m or into 3m of competent rock
- If the rock layer is found to be shallow (less than 3m below ground level), two hand augers near the site otherwise an additional borehole is required

7. References

Brown LJ, Weeber JH, 1992. Geology of the Christchurch urban area. Scale 1:25,000. Institute of Geological & Nuclear Sciences geological map 1.

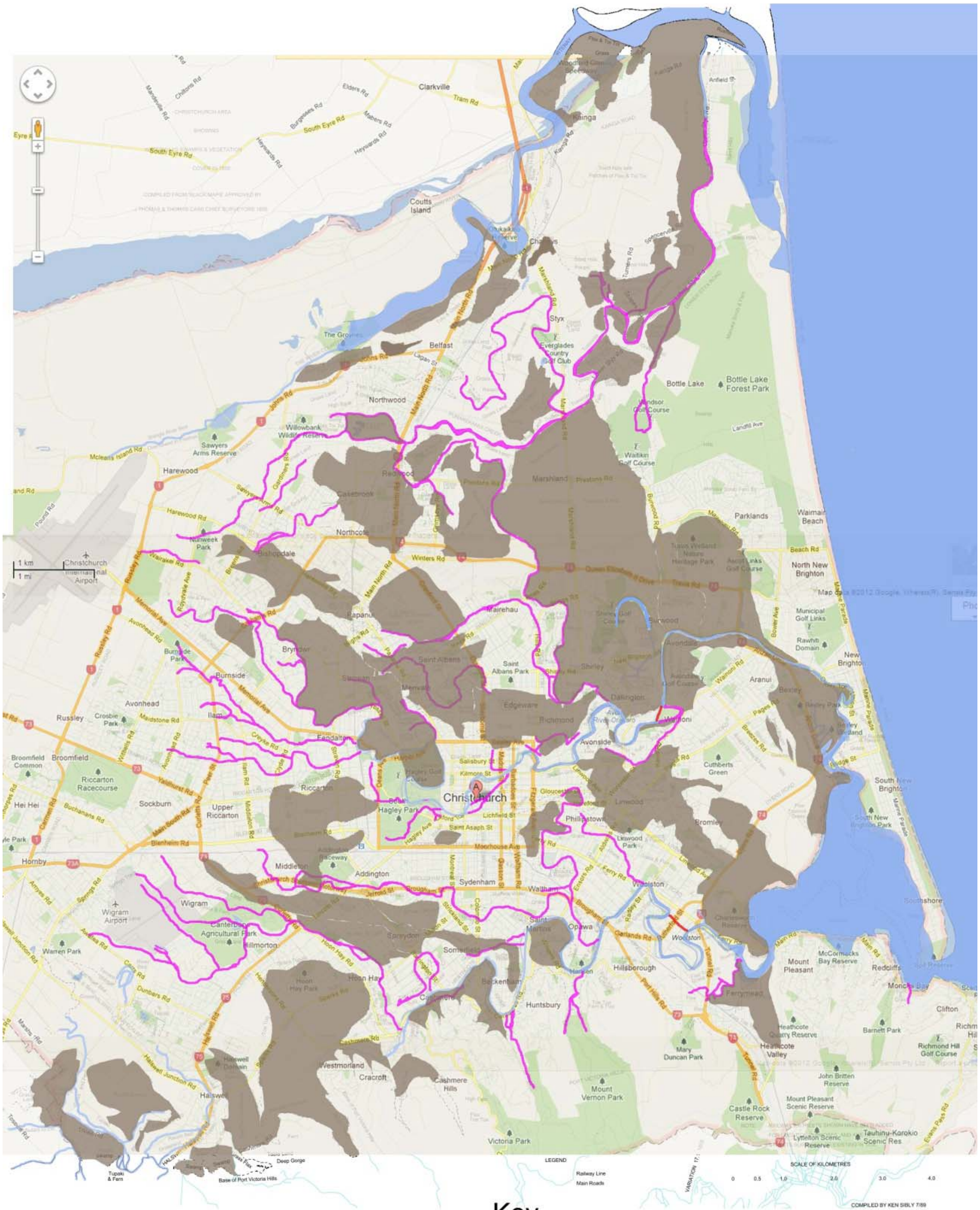
Cubrinovski & Taylor, 2011. Liquefaction map summarising preliminary assessment of liquefaction in urban areas following the 2010 Darfield Earthquake.

Forsyth PJ, Barrell DJA, Jongens R, 2008. Geology of the Christchurch area. Institute of Geological & Nuclear Sciences geological map 16.

Land Information New Zealand (LINZ) geospatial viewer (http://viewers.geospatial.govt.nz/)

EQC Project Orbit geotechnical viewer (https://canterburyrecovery.projectorbit.com/)

Appendix A – Christchurch 1856 land use



The swamps and previous creeks/rivers from 1856 have been overlayed onto a map of Christchurch in 2012

Key

- Previous creeks/rivers
- Existing creeks/rivers
- New creeks/rivers
- Swamp/Marshland