# CHRISTCHURCH CITY COUNCIL
# BU 1316-017 EQ2
# Former Radio Bldg-Rawhiti Golf Course
# 104 Shaw Ave, New Brighton

QUALITATIVE ASSESSMENT REPORT
FINAL

- Rev B
- 19 September 2012

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# Former Radio Bldg - Rawhiti Golf Course
# 104 Shaw Ave, New Brighton

## QUALITATIVE ASSESSMENT REPORT

FINAL

- Rev B
- 19 September 2012

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# 1. Executive Summary

## 1.1. Background

A Qualitative Assessment was carried out on the former Radio building in Rawhiti Golfcourse at 104 Shaw Ave, New Brighton. The building is single storey and is currently unoccupied. It appears to be constructed from concrete walls and a timber-framed ceiling with a lightweight roof. An aerial photograph illustrating this area is shown below in Figure 1. Detailed descriptions outlining the buildings age and construction type is given in Section 5 of this report.


- **Figure 1 Aerial Photograph of the former Radio Building at 104 Shaw Ave**

The qualitative assessment includes a summary of the building damage as well as an initial assessment of the current seismic capacity compared with current seismic code loads using the Initial Evaluation Procedure (IEP).

This Qualitative report for the building structure is based on the Detailed Engineering Evaluation Procedure document (draft) issued by the Structural Advisory Group on 19 July 2011 and a visual inspection on 21 May 2012.

## 1.2. Key Damage Observed

No external or internal damage was observed during our site inspection.

### 1.3. Critical Structural Weaknesses

No potential critical structural weaknesses have been identified for this building.

### 1.4. Indicative Building Strength (from IEP and CSW assessment)

Based on the information available, and using the NZSEE Initial Evaluation Procedure, the buildings original capacity has been assessed to be less than 20%NBS. The damage observed during the site investigation was not significant, therefore the post earthquake capacity will not change as a result of earthquake damage.

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

Please note that structural strengthening is required by law for buildings that are confirmed to have a seismic capacity of less than 34% NBS.

### 1.5. Recommendations

It is recommended that:

a) A quantitative assessment of the building, supported by intrusive investigations if required, be undertaken to determine the seismic capacity and to develop potential strengthening concepts.
b) We consider that barriers around the building are not necessary.

# 2. Introduction

Sinclair Knight Merz was engaged by Christchurch City Council to prepare a qualitative assessment report for the building located in Rawhiti Golfcourse at 104 Shaw Ave following the magnitude 6.3 earthquake which occurred in the afternoon of the 22nd of February 2011 and the subsequent aftershocks.

The Qualitative Assessment uses the methodology recommended in the Engineering Advisory Group draft document "Guidance on Detailed Engineering Evaluation of Earthquake affected Non-residential Buildings in Canterbury", issued 19 July 2011. The qualitative assessment includes a summary of the building damage as well as an initial assessment of the likely current Seismic Capacity compared with current seismic code requirements.

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

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

This report describes the structural damage observed during our inspection and indicates suggested remediation measures. The inspection was undertaken from floor levels and was a visual inspection only. Our report reflects the situation at the time of the inspection and does not take account of changes caused by any events following our inspection. A full description of the basis on which we have undertaken our visual inspection is set out in Section 7.

The NZ Society for Earthquake Engineering (NZSEE) Initial Evaluation Procedure (IEP) was used to assess the likely performance of the building 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[1].

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

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[1] 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 4$^{th}$ 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 provides an indication of the risk of failure for an existing building with a given percentage NBS, relative to the risk of failure for a new building that has been designed to meet current Building Code criteria (the annual probability of exceedance specified by current earthquake design standards for a building of 'normal' importance is 1/500, or 0.2% in the next year, which is equivalent to 10% probability of exceedance in the next 50 years).

- **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 building is located in Rawhiti Golfcourse at 104 Shaw Ave. There are several buildings on this site, but they are outside the scope of this assessment. The building has one storey that is currently unoccupied. The building appears to be constructed from concrete walls with plaster and a lightweight roof with corrugated sheeting. The ground floor appears to be timber, supported on timber joists and bearers, which rest on concrete blocks. No connection was observed between the timber bearers and concrete supports. It is assumed the building was designed and constructed in the late 1930's.

Our evaluation was based on the external visual inspection carried out on 21 May 2012. Internal inspection was not able to be carried out as the entrance to the building was boarded up with corrugated sheeting screwed to the timber doorframe. Drawings were not available to verify the foundation system and the date of construction.

## 5.2. Gravity Load Resisting system

It appears that the gravity loads from the roof are taken by the concrete walls, into the concrete strip footing directly beneath, and into the ground. The floor load is taken by timber joists and bearers, with direct transfer into the concrete elements below.

## 5.3. Seismic Load Resisting system

Lateral loads acting across and along the building will be resisted by the concrete walls in shear.

Note that for this building the 'across direction' has been taken as north-south and the 'along direction' has been taken as east-west.

## 5.4. Geotechnical Conditions

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

- In accordance with NZS1170.5 the site is likely to be seismic subsoil Class D (deep or soft soil) ground performance and properties.
- Liquefaction risk appears to be low for this site. The reconnaissance performed following the 22 February 2011 earthquake and the conclusions from the site walkover conducted by a SKM engineer suggests that no significant liquefaction occurred on site.

If Building Consent is required, additional investigations will be needed to confirm the recommended ground properties and to perform a full liquefaction assessment. Recommended investigations are:

- One cone penetration test to refusal.

# 6. Damage Summary and Remediation

SKM undertook an inspection on 21 May 2012. The following areas of damage were observed during the time of inspection:

**General**

1) No visual evidence of settlement was noted at this site and the neighbouring sites are classified as TC2 land[2]. Therefore a level survey is not required at this stage of assessment.

**Building Damage**

1) Cracking of the plaster on the walls throughout the building was noted. They appear to have been painted over, therefore this is not believed to be earthquake-related damage.

Photos of the above damage can be found in Appendix 1 – Photos.

We note that the building is generally in a state of disrepair. The reinstatement of these areas are not covered in this report and only damage thought to be the cause of the earthquakes have been considered for reinstatement.

[2] http://cera.govt.nz/maps/technical-categories

# 7. Initial Seismic Evaluation

## 7.1. The Initial Evaluation Procedure Process

This section covers the initial seismic evaluation of the building as detailed in the NZSEE 'Assessment and Improvement of the Structural Performance of Buildings in Earthquakes'. The IEP 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 IEP is a coarse screening process designed to identify buildings that are likely to be earthquake prone. The IEP process 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 2. 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 followed up with a detailed assessment and strengthening work within 30 years of the owner being notified that the building is potentially earthquake prone[5].

[3] http://resources.ccc.govt.nz/files/EarthquakeProneDangerousAndInsanitaryBuildingsPolicy2010.pdf
[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 2: IEP 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 IEP is a simple desktop study that is useful for risk management. No detailed calculations are done and so it relies on an inspection of the building and its plans to identify the structural members and describe the likely performance of the building in a seismic event. A review of the plans is also likely to identify any critical structural weaknesses. The IEP assumes that the building was properly designed and built according to the relevant codes at the time of construction. The IEP method rates buildings based on the code used at the time of construction 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 IEP does not attempt to estimate Serviceability Limit State (SLS) performance of the building, or the level of earthquake that would start to cause damage to the building[6]. This assessment concentrates on matters relating to life safety as damage to the building is a secondary consideration. SLS performance of the building can be estimated by scaling the current code levels if required.

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

- AS/NZS 1170 Structural Design Actions
- NZS 3101:2006 Concrete Structures Standard
- NZS 3404:1997 Steel Structures Standard

[6] NZSEE 2006, *Assessment and Improvement of the Structural Performance of Buildings in Earthquakes*, p2-9

## 7.2. Available Information, Assumptions and Limitations

Following our inspection on 21 May 2012, SKM carried out a preliminary structural review. The structural review was undertaken using the available information which was as follows:

- SKM site measurements, and external and inspection findings of the building. Please note no intrusive investigations were undertaken.
- There were no drawings available to carry out our review.

The following assumptions and design criteria were used in this assessment:

- 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 of failure.
  - Ductility level of 1.25 in both directions, based on our assessment and code requirements at the time of design.
  - Site hazard factor, Z = 0.3, NZBC, Clause B1 Structure, Amendment 11 effective from 1 August 2011

This IEP was based on our external visual inspection of the building. Since it is not a full design and construction review, it has the following limitations:

- It is not likely to pick up on any original design or construction errors (if they exist)
- Other possible issues that could affect the performance of the building such as corrosion and modifications to the building will not be identified
- The IEP deals only with the structural aspects of the building. Other aspects such as building services are not covered.

## 7.3. Critical Structural Weaknesses

No critical structural weaknesses have been identified in this building.

## 7.4. Qualitative Assessment Results

The building has had its capacity assessed using the Initial Evaluation Procedure based on the information available. The buildings capacity is expressed as a percentage of new building standard (%NBS) and are in the order of that shown below in Table 3. This capacity is subject to confirmation by a quantitative analysis.

**Table 3: Qualitative Assessment Summary**

| Item | %NBS |
|---|---|
| Likely Seismic Capacity of Building | 11 |

Our qualitative assessment found that the building is likely to be classed as potentially earthquake prone and probably a 'High Risk Building' (capacity less than 34% of NBS). The full IEP assessment form is detailed in Appendix 2 – IEP Reports.

Further investigation is required to confirm our initial findings and establish possible strengthening concepts.

The Council regulations state that if the %NBS of the building is less than 34%, this building is considered earthquake prone and is required to be strengthened.

The Engineering Advisory Group notes:

> *"For buildings with insignificant damage, but that have %NBS<33%, and buildings with significant damage, a quantitative assessment is required. Note that according to the extent of damage, it may be possible to complete a quantitative assessment for part only of the structure, with a qualitative analysis for the structure as a whole. This could be sufficient when there is highly localised severe damage but the building has otherwise suffered little or no damage."*

# 8. Further Investigation

Due to the lack of structural drawings and the likely seismic capacity of the building being less than 34% NBS a quantitative assessment will be required. This will allow us to confirm our findings and establish possible strengthening concepts.

If a quantitative assessment is carried out then intrusive investigations will be required to confirm the following structural details:

- Foundation layout and size of elements.
- Structural roof member sizes and layouts.
- Connections sizes and layouts.

It is believed that a building consent is not likely to be required for the repair of the damage noted in Section 6, but a consent will likely be required to strengthen the building. A consent may not be required to demolish it.

# 9. Conclusion

A qualitative assessment was carried out on the former Radio building located in Rawhiti Golfcourse at 104 Shaw Ave, New Brighton. The building has sustained no earthquake-related damage. The building has been assessed to have a seismic capacity less than 20% NBS and is therefore potentially earthquake prone and is likely to be classified as a ‘High Risk Building’ (capacity less than 34% of NBS).

Further investigation is required to confirm our initial findings and to establish possible strengthening concepts. This investigation will require carrying out a quantitative assessment on the building to determine if there is enough capacity in the structural elements to resist the required earthquake demand.

If the building is to be strengthened, building consent will likely be required.

It is recommended that:

a) A quantitative assessment of the building, supported by intrusive investigations if required, be undertaken to determine the seismic capacity and to develop potential strengthening concepts.
b) We consider that barriers around the building are not necessary.

# 10. 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.

There is a risk of further movement and increased cracking due to subsequent aftershocks or settlement.

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.

# 11. Appendix 1 – Photos

| | |
|---|---|
|  |  |
| Photo 1: Southeast elevation | Photo 2: South elevation |
|  |  |
| Photo 3: East elevation | Photo 4: West elevation |

| | |
|---|---|
|  |  |
| Photo 5: Soffit on south side with timber members missing. | Photo 6: Crack in plaster on south concrete wall under timber windowsill has been painted over. |
|  |  |
| Photo 7: Timber floor supported by timber joists and bearers, resting on concrete blocks on ground. | Photo 8: No visible connection between timber bearers and concrete block. |

| | |
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|  |  |
| Photo 9: Boarded up window on south side. | Photo 10: Soffit on south side. |
|  |  |
| Photo 11: Soffit on south side. | Photo 12: Lower section of building on southeast corner. |

| | |
|---|---|
|  |  |
| Photo 13: Timber edge beam on south side. | Photo 14: Concrete ground slab on east side. |
|  |  |
| Photo 15: Rusted steel element on southeast corner of roof. | Photo 16: Crack in plaster on east wall by timber windowsill has been painted over. |

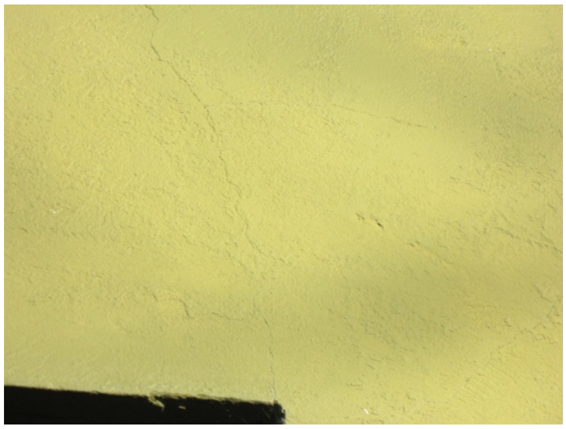
| | |
|---|---|
|  |  |
| Photo 17: Crack in external ground concrete slab on northeast corner of building. | Photo 18: Crack in plaster on north wall has been painted over. |
|  |  |
| Photo 19: Soffit on north side. | Photo 20: Entrance to building boarded up with corrugated metal sheeting. |


Photo 21: Corrugated metal sheeting over entrance secured with screws into timber doorframe.

Photo 22: Crack in plaster on north wall has been painted over.

Photo 23: Crack in plaster on north wall has been painted over.

Photo 24: Existing impact damage to wall on northwest corner.

Photo 25: Crack in plaster on west wall has been painted over.

Photo 26: Crack in plaster on west wall has been painted over.

Photo 27: Existing impact damage to wall on southwest corner.

Photo 28: Existing damage to piping.

# 12. Appendix 2 – IEP Reports

## Table IEP-1 Initial Evaluation Procedure – Step 1

**(Refer Table IEP - 2 for Step 2; Table IEP - 3 for Step 3, Table IEP - 4 for Steps 4, 5 and 6)**

| | | | |
|---|---|---|---|
| Building Name: | Rawhiti Golfcourse Radio Building | Ref. | ZB01276.139 |
| Location: | 104 Shaw Ave, New Brighton | By | WPK |
| | | Date | 25/05/2012 |

### Step 1 - General Information

#### 1.1 Photos (attach sufficient to describe building)

#### 1.2 Sketch of building plan

#### 1.3 List relevant features

The building in the Rawhiti Golfcourse at 204 Shaw Ave is one storey and is currently unoccupied. The entrance was boarded up so internal inspection was not carried out. The building is believed to consist of concrete walls and a timber-framed roof. The main lateral load-resisting system appear to be the walls. These act as shear walls in the north-south and east-west direction. The ground floor is supported timber joists and bearers, which appear to rest on concrete blocks on the ground. The building is believed to have been constructed in the late 1930's.

#### 1.4 Note information sources

| | Tick as appropriate |
|---|---|
| Visual Inspection of Exterior | ✓ |
| Visual Inspection of Interior | |
| Drawings (note type) | |
| Specifications | |
| Geotechical Reports | ✓ |
| Other (list) | |

**Table IEP-2 Initial Evaluation Procedure – Step 2**

**(Refer Table IEP - 1 for Step 1; Table IEP - 3 for Step 3, Table IEP - 4 for Steps 4, 5 and 6)**

| | | | |
|---|---|---|---|
| Building Name: | Rawhiti Golfcourse Radio Building | Ref. | ZB01276.139 |
| Location: | 104 Shaw Ave, New Brighton | By | WPK |
| Direction Considered: | **Longitudinal & Transverse** | Date | 25/05/2012 |

( Choose worse case if clear at start. Complete IEP-2 and IEP-3 for each if in doubt)

## Step 2 - Determination of (%NBS)b

### 2.1 Determine nominal (%NBS) = (%NBS)nom

| | | | |
|---|---|---|---|
| Pre 1935 | | ○ | See also notes 1, 3 |
| 1935-1965 | | ◉ | |
| 1965-1976 | Seismic Zone; A | ○ | |
| | B | ○ | |
| | C | ○ | See also note 2 |
| 1976-1992 | Seismic Zone; A | ○ | |
| | B | ○ | |
| | C | ○ | |
| 1992-2004 | | ○ | |

### b) Soil Type

From NZS1170.5:2004, Cl 3.1.3

| | |
|---|---|
| A or B Rock | ○ |
| C Shallow Soil | ○ |
| D Soft Soil | ◉ |
| E Very Soft Soil | ○ |

From NZS4203:1992, Cl 4.6.2.2

(for 1992 to 2004 only and only if known)

| | | |
|---|---|---|
| a) Rigid | ○ | N-A |
| b) Intermediate | ○ | |

### c) Estimate Period, T

**building Ht =** **5** meters

| | Longitudinal | Transverse | |
|---|---|---|---|
| Ac = | 50 | 36 | m2 |

Can use following:

| | | Longitudinal | Transverse |
|---|---|---|---|
| $T = 0.09h_n^{0.75}$ | for moment-resisting concrete frames | ○ MRCF | ○ MRCF |
| $T = 0.14h_n^{0.75}$ | for moment-resisting steel frames | ○ MRSF | ○ MRSF |
| $T = 0.08h_n^{0.75}$ | for eccentrically braced steel frames | ○ EBSF | ○ EBSF |
| $T = 0.06h_n^{0.75}$ | for all other frame structures | ○ Others | ○ Others |
| $T = 0.09h_n^{0.75}/A_c^{0.5}$ | for concrete shear walls | ○ CSW | ○ CSW |
| $T <= 0.4sec$ | for masonry shear walls | ◉ MSW | ◉ MSW |

Where hn = height in m from the base of the structure to the uppermost seismic weight or mass.

Ac = ΣAi(0.2 + Lwi/hn)2

Ai = cross-sectional shear area of shear wall i in the first storey of the building, in m2

lwi = length of shear wall i in the first storey in the direction parallel to the applied forces, in m

with the restriction that lwi/hn shall not exceed 0.9

| Longitudinal | Transverse | |
|---|---|---|
| **0.4** | **0.4** | Seconds |

### d) (%NBS )nom determined from Figure 3.3

| | | |
|---|---|---|
| **Longitudinal** | 2.8 | $(\%NBS)_{nom}$ |
| **Transverse** | 2.8 | $(\%NBS)_{nom}$ |

| | | | Factor |
|---|---|---|---|
| **Note 1:** | For buildings designed prior to 1965 and known to be designed as public buildings in accordance with the code of the time, multiply (%NBS)nom by 1.25. | No | 1 |
| | For buildings designed 1965 - 1976 and known to be designed as public buildings in accordance with the code of the time, multiply (%NBS)nom by 1.33 - Zone A or 1.2 - Zone B | No | 1 |
| **Note 2:** | For reinforced concrete buildings designed between 1976 -1984 (%NBS )nom by 1.2 | No | 1 |
| **Note 3:** | For buildings designed prior to 1935 multiply (%NBS)nom by 0.8 except for Wellington where the factor may be taken as 1. | No | 1 |

| | | |
|---|---|---|
| **Longitudinal** | 2.8 | $(\%NBS)_{nom}$ |
| **Transverse** | 2.8 | $(\%NBS)_{nom}$ |

Continued over page

| | | | |
|---|---|---|---|
| Building Name: | Rawhiti Golfcourse Radio Building | Ref. | ZB01276.139 |
| Location: | 104 Shaw Ave, New Brighton | By | WPK |
| Direction Considered: | **Longitudinal & Transverse** | Date | 25/05/2012 |

( Choose worse case if clear at start. Complete IEP-2 and IEP-3 for each if in doubt)

## 2.2 Near Fault Scaling Factor, Factor A
**If T < 1.5sec, Factor A = 1**

**a) Near Fault Factor, N(T,D)** 1
(from NZS1170.5:2004, Cl 3.1.6)

**b) Near Fault Scaling Factor** = 1/N(T,D) **Factor A** 1.00

## 2.3 Hazard Scaling Factor, Factor B

Select Location: Christchurch

**a) Hazard Factor, Z, for site**
(from NZS1170.5:2004, Table 3.3)

Z = 0.3
Z 1992 = 0.8

| | | | |
|---|---|---|---|
| Auckland | 0.6 | Palm Nth | 1.2 |
| Wellington | 1.2 | Dunedin | 0.6 |
| Christchurch | 0.8 | Hamilton | 0.67 |

**b) Hazard Scaling Factor**
For pre 1992 = 1/Z
\# For 1992 onwards = Z 1992/Z
(Where Z 1992 is the NZS4203:1992 Zone Factor from accompanying Figure 3.5(b))

**Factor B** 3.33

## 2.4 Return Period Scaling Factor, Factor C

**a) Building Importance Level** 2
(from NZS1170.0:2004, Table 3.1 and 3.2)

**b) Return Period Scaling Factor from accompanying Table 3.1** **Factor C** 1.00

## 2.5 Ductility Scaling Factor, D

**a) Assessed Ductility of Existing Structure, μ**
(shall be less than maximum given in accompanying Table 3.2)

| | | |
|---|---|---|
| **Longitudinal** | **1.25** | μ Maximum = 2 |
| **Transverse** | **1.25** | μ Maximum = 2 |

**b) Ductility Scaling Factor**
For pre 1976 = $k_\mu$
For 1976 onwards = 1
(where $k_\mu$ is NZS1170.5:2005 Ductility Factor, from accompanying Table 3.3)

| | | |
|---|---|---|
| **Longitudinal** | **Factor D** | 1.14 |
| **Transverse** | **Factor D** | 1.14 |

## 2.6 Structural Performance Scaling Factor, Factor E

**Select Material of Lateral Load Resisting System**
**Longitudinal**: Masonry Block
**Transverse**: Masonry Block

**a) Structural Performance Factor, $S_p$**
**from accompanying Figure 3.4**

| | | |
|---|---|---|
| **Longitudinal** | Sp | 0.90 |
| **Transverse** | Sp | 0.90 |

**b) Structural Performance Scaling Factor**

| | | | |
|---|---|---|---|
| **Longitudinal** | $1/S_p$ | **Factor E** | 1.11 |
| **Transverse** | $1/S_p$ | **Factor E** | 1.11 |

## 2.7 Baseline %NBS for Building, $(\%NBS)_b$
**(equals $(\%NSB)_{nom}$ x A x B x C x D x E )**

| | | |
|---|---|---|
| **Longitudinal** | 11.9 | (%NBS)b |
| **Transverse** | 11.9 | (%NBS)b |

**Table IEP-3 Initial Evaluation Procedure – Step 3**

**(Refer Table IEP - 1 for Step 1; Table IEP - 2 for Step 2, Table IEP - 4 for Steps 4, 5 and 6)**

| | | | |
|---|---|---|---|
| Building Name: | Rawhiti Golfcourse Radio Building | Ref. | ZB01276.139 |
| Location: | 104 Shaw Ave, New Brighton | By | WPK |
| Direction Considered: | **a) Longitudinal** | Date | 25/05/2012 |

( Choose worse case if clear at start. Complete IEP-2 and IEP-3 for each if in doubt)

## Step 3 - Assessment of Performance Achievement Ratio (PAR)

(Refer Appendix B - Section B3.2)

| Critical Structural Weakness | Effect on Structural Performance (Choose a value - Do not interpolate) | | | | Building Score |
|---|---|---|---|---|---|
| | Severe | Significant | Insignificant | | |
| **3.1 Plan Irregularity** – Effect on Structural Performance | ○ | ○ | ◉ | **Factor A** | 1 |
| Comment | | | | | |
| **3.2 Vertical Irregularity** – Effect on Structural Performance | ○ | ○ | ◉ | **Factor B** | 1 |
| Comment | | | | | |
| **3.3 Short Columns** – Effect on Structural Performance | ○ | ○ | ◉ | **Factor C** | 1 |
| Comment | | | | | |

**3.4 Pounding Potential**

(Estimate D1 and D2 and set D = the lower of the two, or =1.0 if no potential for pounding)

a) Factor D1: - Pounding Effect
Select appropriate value from Table

Note:
Values given assume the building has a frame structure. For stiff buildings ( eg with shear walls), the effect of pounding may be reduced by taking the co-efficient to the right of the value applicable to frame buildings.

**Factor D1** 1

Table for Selection of Factor D1

| Separation | Severe 0<Sep<.005H | Significant .005<Sep<.01H | Insignificant Sep>.01H |
|---|---|---|---|
| Alignment of Floors within 20% of Storey Height | ○ 0.7 | ○ 0.8 | ◉ 1 |
| Alignment of Floors not within 20% of Storey Height | ○ 0.4 | ○ 0.7 | ○ 0.8 |

b) Factor D2: - Height Difference Effect
Select appropriate value from Table

**Factor D2** 1

Table for Selection of Factor D2

| Separation | Severe 0<Sep<.005H | Significant .005<Sep<.01H | Insignificant 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 |

**Factor D** 1

(Set D = lesser of D1 and D2 or..
set D = 1.0 if no prospect of pounding)

**3.5 Site Characteristics -** (Stability, landslide threat, liquefaction etc)

| | Severe | Significant | Insignificant | | |
|---|---|---|---|---|---|
| Effect on Structural Performance | ○ 0.5 | ○ 0.7 | ◉ 1 | **Factor E** | 1 |

**3.6 Other Factors**

For < 3 storeys - Maximum value 2.5,

otherwise - Maximum value 1.5. No minimum. **Factor F** 1

**Record rationale for choice of Factor F:**

**3.7 Performance Achievement Ratio (PAR)**
**(equals A x B x C x D x E x F )**

**PAR** 1

**(Refer Table IEP - 1 for Step 1; Table IEP - 2 for Step 2, Table IEP - 4 for Steps 4, 5 and 6)**

| | | | |
|---|---|---|---|
| Building Name: | Rawhiti Golfcourse Radio Building | Ref. | ZB01276.139 |
| Location: | 104 Shaw Ave, New Brighton | By | WPK |
| Direction Considered: | **b) Transverse** | Date | 25/05/2012 |

( Choose worse case if clear at start. Complete IEP-2 and IEP-3 for each if in doubt)

## Step 3 - Assessment of Performance Achievement Ratio (PAR)

(Refer Appendix B - Section B3.2)

| **Critical Structural Weakness** | **Effect on Structural Performance** (Choose a value - Do not interpolate) | | | **Building Score** |
|---|---|---|---|---|
| **3.1 Plan Irregularity** | Severe | Significant | Insignificant | |
| Effect on Structural Performance | ○ | ○ | ◉ | **Factor A** 1 |
| Comment | | | | |
| **3.2 Vertical Irregularity** | Severe | Significant | Insignificant | |
| Effect on Structural Performance | ○ | ○ | ◉ | **Factor B** 1 |
| Comment | | | | |
| **3.3 Short Columns** | Severe | Significant | Insignificant | |
| Effect on Structural Performance | ○ | ○ | ◉ | **Factor C** 1 |
| Comment | | | | |

**3.4 Pounding Potential**

(Estimate D1 and D2 and set D = the lower of the two, or =1.0 if no potential for pounding)

a) Factor D1: - Pounding Effect
Select appropriate value from Table

Note:
Values given assume the building has a frame structure. For stiff buildings ( eg with shear walls), the effect of pounding may be reduced by taking the co-efficient to the right of the value applicable to frame buildings.

**Factor D1** 1

| Table for Selection of Factor D1 | Severe | Significant | Insignificant |
|---|---|---|---|
| Separation | 0<Sep<.005H | .005<Sep<.01H | Sep>.01H |
| Alignment of Floors within 20% of Storey Height | ○ 0.7 | ○ 0.8 | ◉ 1 |
| Alignment of Floors not within 20% of Storey Height | ○ 0.4 | ○ 0.7 | ○ 0.8 |

b) Factor D2: - Height Difference Effect
Select appropriate value from Table

**Factor D2** 1

| Table for Selection of Factor D2 | Severe | Significant | Insignificant |
|---|---|---|---|
| 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 |

**Factor D** 1

(Set D = lesser of D1 and D2 or..
set D = 1.0 if no prospect of pounding)

**3.5 Site Characteristics -** (Stability, landslide threat, liquefaction etc)

| | Severe | Significant | Insignificant | |
|---|---|---|---|---|
| Effect on Structural Performance | ○ 0.5 | ○ 0.7 | ◉ 1 | **Factor E** 1 |

**3.6 Other Factors**

For < 3 storeys - Maximum value 2.5,

otherwise - Maximum value 1.5. No minimum. **Factor F** 1

**Record rationale for choice of Factor F:**

**3.7 Performance Achievement Ratio (PAR)**
**(equals A x B x C x D x E x F )**

**PAR** 1

Table IEP-4

## Initial Evaluation Procedure – Steps 4, 5 and 6

**(Refer Table IEP - 1 for Step 1; Table IEP - 2 for Step 2, Table IEP - 3 for Step 3)**

| | | | |
|---|---|---|---|
| Building Name: | Rawhiti Golfcourse Radio Building | Ref. | ZB01276.139 |
| Location: | 104 Shaw Ave, New Brighton | By | WPK |
| Direction Considered: | **Longitudinal & Transverse** | Date | 25/05/2012 |

( Choose worse case if clear at start. Complete IEP-2 and IEP-3 for each if in doubt)

### Step 4 - Percentage of New Building Standard (%NBS)

| | Longitudinal | Transverse |
|---|---|---|
| **4.1 Assessed Baseline $(\%NBS)_b$** (from Table IEP - 1) | 11 | 11 |
| **4.2 Performance Achievement Ratio (PAR)** (from Table IEP - 2) | 1.00 | 1.00 |
| **4.3 PAR x Baseline $(\%NBS)_b$** | 11 | 11 |
| **4.4 Percentage New Building Standard (%NBS)** ( Use lower of two values from Step 4.3) | | 11 |

### Step 5 - Potentially Earthquake Prone?

(Mark as appropriate)

%NBS ≤ 33 — YES

### Step 6 - Potentially Earthquake Risk?

%NBS < 67 — YES

### Step 7 - Provisional Grading for Seismic Risk based on IEP

**Seismic Grade** — E

**Evaluation Confirmed by**

[signature] Signature

Nick Calvert — Name

242062 — CPEng. No

**Relationship between Seismic Grade and % NBS :**

| Grade: | A+ | A | B | C | D | E |
|---|---|---|---|---|---|---|
| %NBS: | > 100 | 100 to 80 | 80 to 67 | 67 to 33 | 33 to 20 | < 20 |

# 13. Appendix 3 – CERA Standardised Report Form

## Location

| | | | |
|---|---|---|---|
| Building Name: | BU 1316-017 EQ2 | Reviewer: | Nick Calvert |
| | Unit / No: / Street | CPEng No: | 242062 |
| Building Address: | 104 Shaw Ave, New Brighton | Company: | SKM |
| Legal Description: | | Company project number: | ZB01276.139 |
| | | Company phone number: | 09 928 5500 |
| | Degrees / Min / Sec | | |
| GPS south: | | Date of submission: | |
| GPS east: | | Inspection Date: | 21/05/2012 |
| | | Revision: | A |
| Building Unique Identifier (CCC): | | Is there a full report with this summary? | yes |

## Site

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

## Building

| | | | |
|---|---|---|---|
| No. of storeys above ground: | 1 | single storey = 1 | Ground floor elevation (Absolute) (m): 5.00 |
| Ground floor split? | no | | Ground floor elevation above ground (m): 5.00 |
| Storeys below ground | 0 | | |
| Foundation type: | other (describe) | if Foundation type is other, describe: | Timber joists and bearers resting on what appear to be concrete blocks at ground level. |
| Building height (m): | 5.00 | height from ground to level of uppermost seismic mass (for IEP only) (m): | |
| Floor footprint area (approx): | 50 | | |
| Age of Building (years): | 75 | 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): | | | |
| Use notes (if required): | | | |
| Importance level (to NZS1170.5): | IL2 | | |

### Gravity Structure

| | | | |
|---|---|---|---|
| Gravity System: | load bearing walls | | |
| Roof: | timber framed | rafter type, purlin type and cladding | Assumed |
| Floors: | timber | joist depth and spacing (mm) | Assumed |
| Beams: | none | overall depth x width (mm x mm) | None |
| Columns: | none | typical dimensions (mm x mm) | None |
| Walls: | load bearing concrete | #N/A | |

### Lateral load resisting structure

**Note: Define along and across in detailed report!**

| | | | | |
|---|---|---|---|---|
| Lateral system along: | concrete shear wall | | note total length of wall at ground (m): | 9.9 |
| Ductility assumed, μ: | 1.25 | | wall thickness (m): | |
| Period along: | 0.40 | ##### enter height above at H31 | estimate or calculation? | estimated |
| Total deflection (ULS) (mm): | 10 | | estimate or calculation? | estimated |
| maximum interstorey deflection (ULS) (mm): | | | estimate or calculation? | estimated |
| Lateral system across: | concrete shear wall | | note total length of wall at ground (m): | 7.2 |
| Ductility assumed, μ: | 1.25 | | wall thickness (m): | |
| Period across: | 0.40 | ##### enter height above at H31 | estimate or calculation? | estimated |
| Total deflection (ULS) (mm): | 10 | | estimate or calculation? | estimated |
| maximum interstorey deflection (ULS) (mm): | | | estimate or calculation? | estimated |

### Separations:

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

### Non-structural elements

| | | | |
|---|---|---|---|
| Stairs: | | | |
| Wall cladding: | plaster system | describe | |
| Roof Cladding: | Metal | describe | Corrugated sheeting |
| Glazing: | timber frames | | |
| Ceilings: | | | |
| Services(list): | | | |

## Available documentation

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

## Damage

Site:
(refer DEE Table 4-2)

| | | | |
|---|---|---|---|
| Site performance: | | Describe damage: | |
| Settlement: | none observed | notes (if applicable): | |
| Differential settlement: | none observed | notes (if applicable): | |
| Liquefaction: | none apparent | notes (if applicable): | |
| Lateral Spread: | none apparent | notes (if applicable): | |
| Differential lateral spread: | none apparent | notes (if applicable): | |
| Ground cracks: | none apparent | notes (if applicable): | |
| Damage to area: | none apparent | notes (if applicable): | |

Building:

| | | | | |
|---|---|---|---|---|
| | Current Placard Status: | green | | |
| Along | Damage ratio: | 0% | Describe how damage ratio arrived at: | No damage observed during our site inspection. |
| | Describe (summary): | No damage observed | | |
| Across | Damage ratio: | 0% | | |
| | Describe (summary): | No damage observed | | |
| 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: | |
| Building Consent required: | no | Describe: | |
| Interim occupancy recommendations: | full occupancy | Describe: | Not an immediate collapse hazard. |

| | | | | | |
|---|---|---|---|---|---|
| Along | Assessed %NBS before: | 11% | %NBS from IEP below | If IEP not used, please detail assessment methodology: | Qualitative Assessment carried out includes NZSEE IEP (refer to SKM report). |
| | Assessed %NBS after: | 11% | | | |
| Across | Assessed %NBS before: | 11% | %NBS from IEP below | | |
| | Assessed %NBS after: | 11% | | | |

# 14. Appendix 4 – Geotechnical Desktop Study

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# Christchurch City Council - Structural Engineering Service

## Geotechnical Desk Study

| | |
|---|---|
| SKM project number | ZB01276 |
| SKM project site number | 138, 139 |
| Address | Pump House and Former Radio Building<br>100 Shaw Avenue |
| Report date | 22 May 2012 |
| Author | Ain Kim |
| Reviewer | Ross Roberts |
| 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 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:

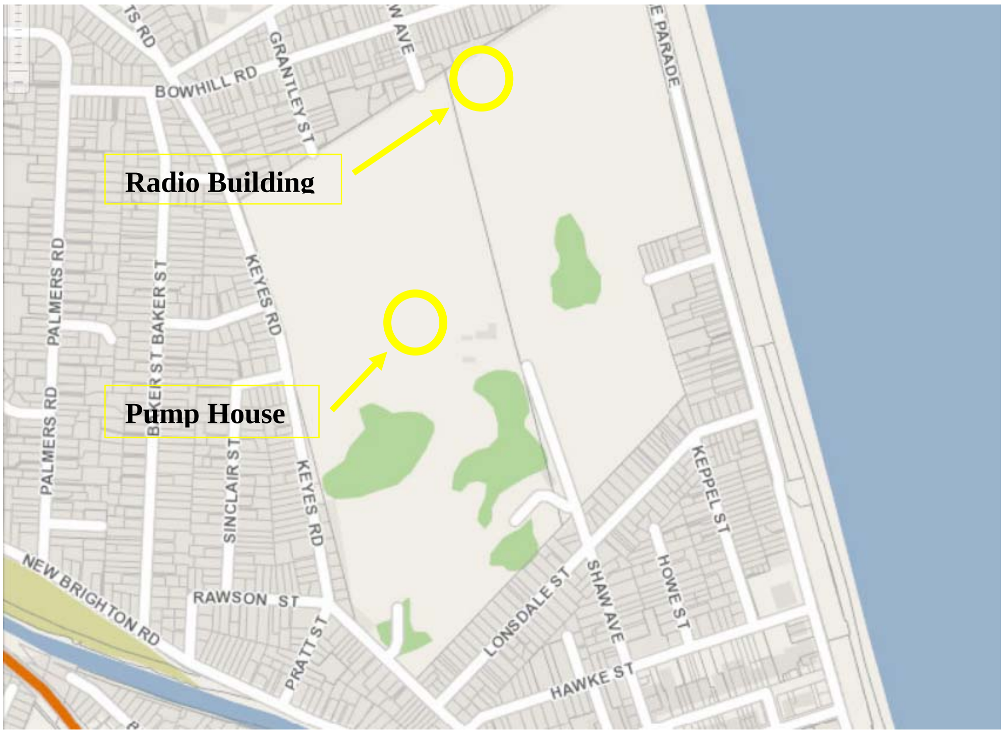
- Published geology
- Publically available borehole records
- Liquefaction records
- Aerial photography
- A preliminary site walkover

## 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.

# 4. Site location



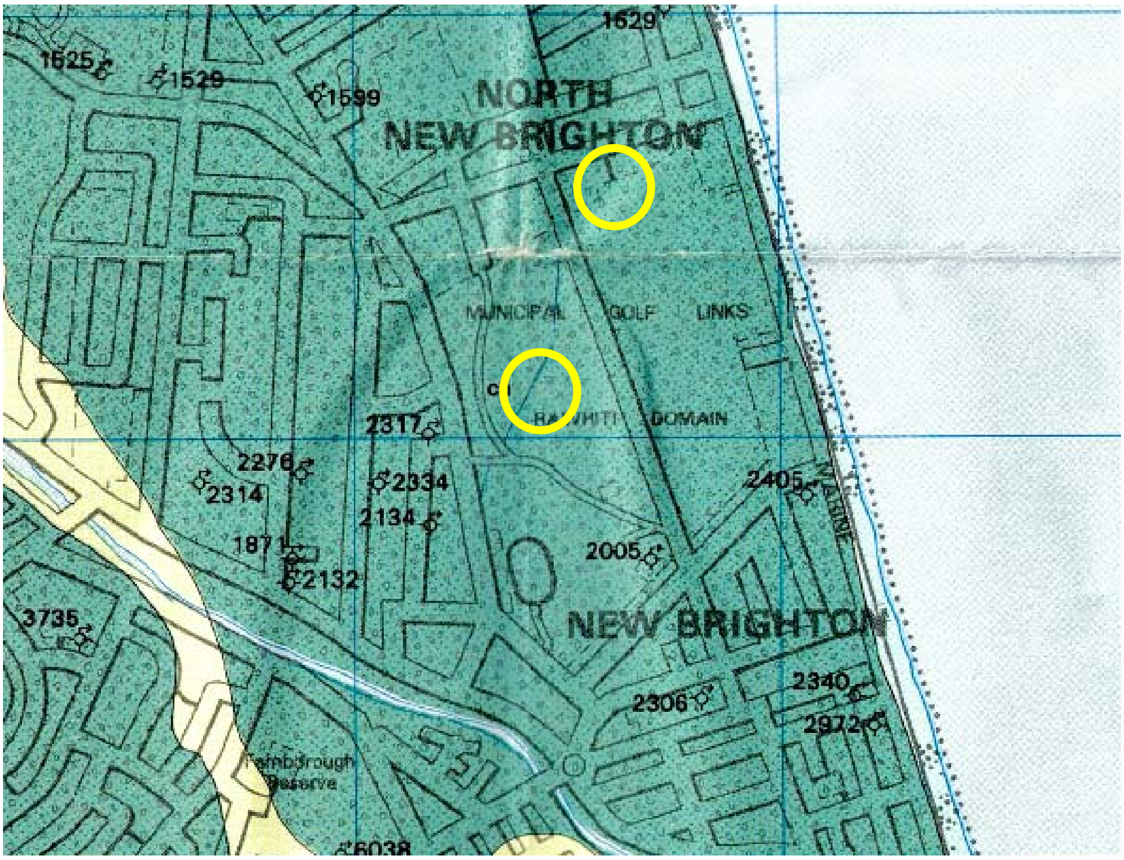

- **Figure 1 – Site location (courtesy of LINZ http://viewers.geospatial.govt.nz)**

The structure is located on 100 Shaw Avenue at grid reference 1577605 E, 5183437 N (NZTM).

# 5. Review of available information

## 5.1 Geological maps

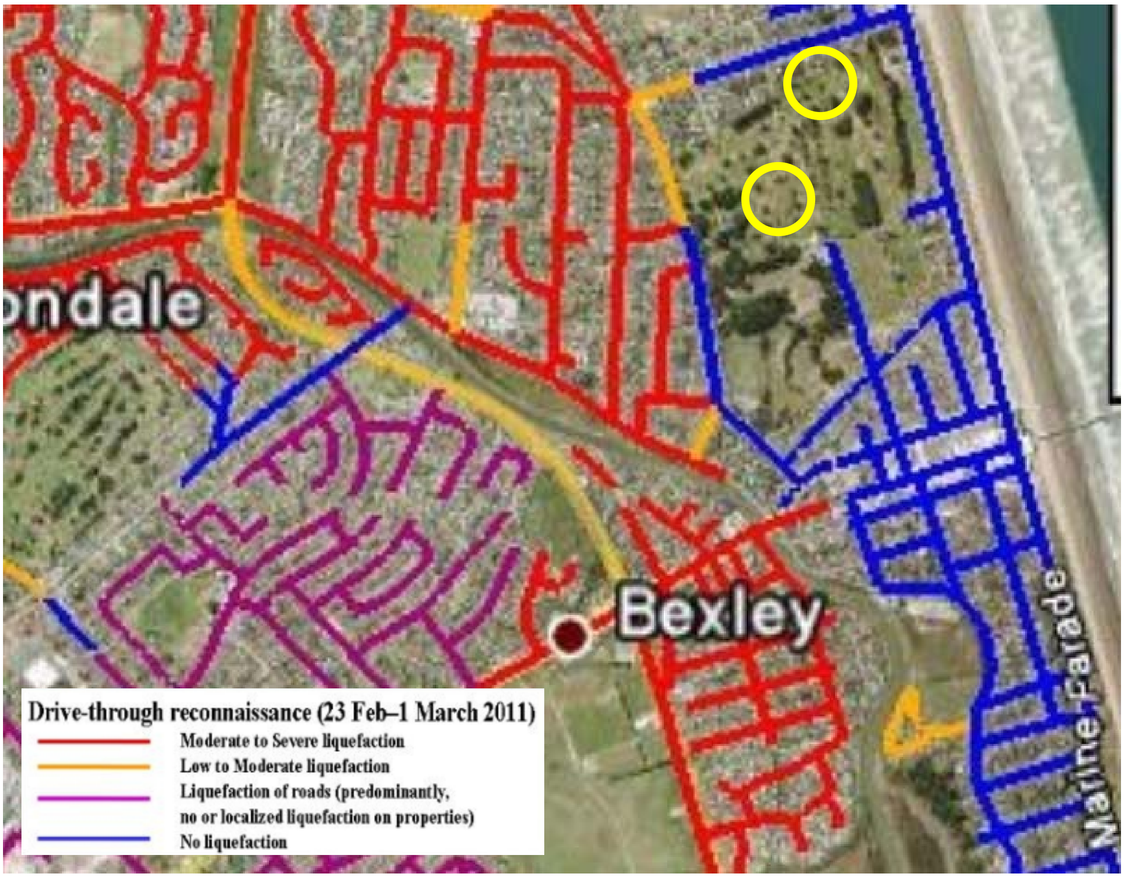

- **Figure 2 – Regional geological map (Forsyth et al, 2008). Site marked in red.**




- **Figure 3 – Local geological map (Brown et al, 1992). Site marked in red.**

The site is shown to be underlain by Holocene deposits comprising sand of fixed and semi-fixed dunes and beaches of the Christchurch formation.

## 5.2 Liquefaction map




- **Figure 4 – Liquefaction map (Cubrinovski & Taylor, 2011). Site marked in red.**

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. Their findings show no liquefaction at this site.

## 5.3 Aerial photography


- **Figure 5 – Aerial photography from 24 Feb 2011 (http://viewers.geospatial.govt.nz/)**

No significant evidence of liquefaction or land damage is visible from the aerial photographs. The site is very close to the beach and the patches are likely to be windblown sand or dune sand exposed by lack of vegetation.

## 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 (Urban Non-residential). Adjacent properties are TC2.

## 5.5 Historical land use

Reference to historical documents (eg Appendix A) shows that no specific historic land use for the site was recorded in 1856.

## 5.6 Existing ground investigation data


- **Figure 6 – Local boreholes from Project Orbit and SKM files (https://canterburyrecovery.projectorbit.com/)**

Two boreholes are available within 200 m from the former radio building. However, no ground investigation data is available near the pump house.

Where available logs from these investigation locations are attached to this report (Appendix B), and the results are summarised in Appendix C.

## 5.7 Council property files

Council files were not available at the time of writing this report.

## 5.8 Site walkover

A site walkover was conducted by an SKM engineer on 13 June 2012.

### 5.8.1 Rawhiti Golf Course West Pumphouse

The building was noted to be a masonry block construction with sheet metal roof and slab on grade foundations. There was an upward slope of approximately 20-30 degrees from the eastern side of the building. Minor step cracking was noted in masonry blocks from the external inspection. No apparent evidence of liquefaction or land damage was noted in the surrounding vicinity. Any sand present on the surface was likely to be windblown sand from the nearby beach.

- **Figure 7 - Overview of the building (western elevation)**

- **Figure 8 - Overview of the building (northern elevation)**

### 5.8.2 Rawhiti Golf Course Radio Building

The building was noted to be constructed using concrete walls, plaster clad and corrugated sheet metal roof. The foundation was observed to be a concrete perimeter strip footing with intermediate concrete column supports. The structure appeared to be in a state of disrepair with some cracks in the walls of the building and external concrete ground slabs; however, it is not clear how much of the damage is due to the earthquake event. During the external site walkover, no evidence of surface expression of liquefaction or other land damage was noted. Some patches of sand were observed around the site; however, they were likely to be windblown from the nearby beach.

- **Figure 9 - Overview of the building (south elevation)**

- **Figure 10 - Observed cracks in the wall**

- **Figure 11 - Cracking in external concrete ground slab**

- **Figure 12 - Foundation details**

# 6. Conclusions and recommendations

## 6.1 Site geology

An interpretation of the most relevant local investigation suggests that the site is underlain by:

| Depth range (mBLG) | Soil type |
|---|---|
| 0 – 25 + | Clayey sand |

## 6.2 Seismic site subsoil class

The site has been assessed as NZS1170.5 Class D (deep or soft soil) from adjacent borehole logs.

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.

In this case the third preferred method has been used to make the assessment. The available investigations are reasonably close to the site. Site specific investigation is unlikely to revise the assessed site class.

## 6.3 Building performance

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

## 6.4 Ground performance and properties

Liquefaction risk appears to be low for this site. The reconnaissance performed following the 22 February earthquake and the conclusions from the site walkover conducted by a SKM engineer suggests that no significant liquefaction occurred on site.

Using data from the closest borehole located approximately 30 m away from the formal radio building which indicates deep clayey sand, the following parameters are recommended in order to perform a quantitiative DEE. It should be noted that these parameters should not be used for design or consent purposes without confirming the properties through site specific investigation.

| Parameter | Estimated value |
|---|---|
| Effective angle of friction | 35 degrees |
| Apparent cohesion | 0 kPa |
| Unit weight | 18 kPa |
| Ultimate bearing capacity of a shallow square pad footing | *300 kPa |

*likely minimum ultimate bearing capacity which may increase following a site specific geotechnical investigation.

## 6.5 Further investigations

If consent is required additional investigations will be needed to confirm the recommended ground properties and to perform a full liquefaction assessment. Recommended investigations are:

- One cone penetration test to refusal each for the pump house and the radio building

# 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.

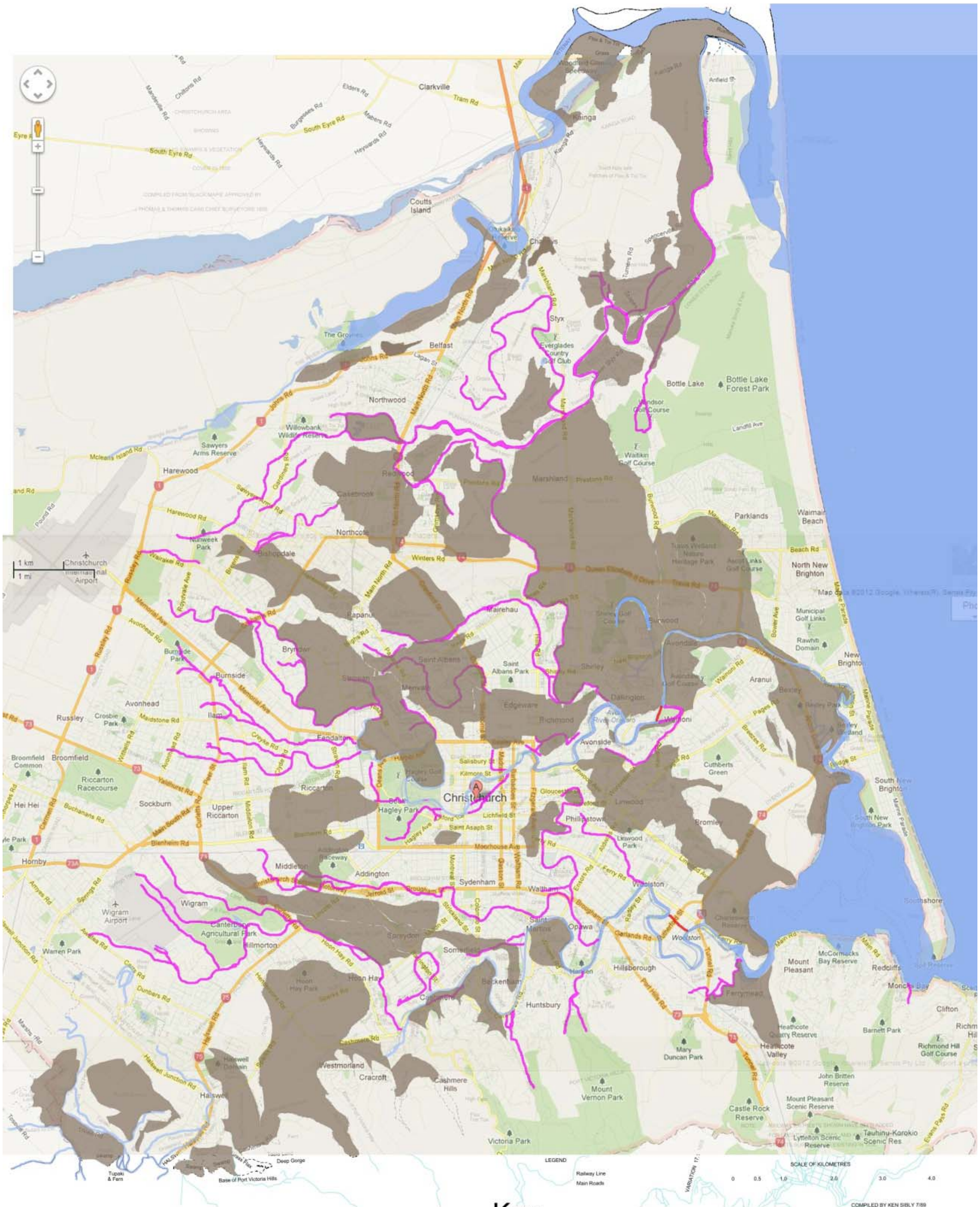
Forsyth PJ, Barrell DJA, Jongens R, 2008. Geology of the Christchurch area. Institute of Geological & Nuclear Sciences geological map 16.

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

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

SINCLAIR KNIGHT MERZ SKM

# 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

# Appendix B – Existing ground investigation logs

| | | | |
|---|---|---|---|
| **Bore or Well No:** | M35/2443 | | |
| **Well Name:** | | | |
| **Owner:** | SEALES, G. | | |

Environment Canterbury
Your regional council

| | | | |
|---|---|---|---|
| **Street of Well:** | MARINE PARADE | **File No:** | |
| **Locality:** | SOUTH NEW BRIGHTON | **Allocation Zone:** | Christchurch/West Melton |
| **NZGM Grid Reference:** | M35:8789-4537 QAR 4 | | |
| **NZGM X-Y:** | 2487890 - 5745370 | | |
| **Location Description:** | | **Uses:** | |
| **ECan Monitoring:** | | | |
| **Well Status:** | Buried / unlikely still exists | | |

| | | | |
|---|---|---|---|
| **Drill Date:** | 05 Feb 1918 | **Water Level Count:** | 0 |
| **Well Depth:** | 104.20m -GL | **Strata Layers:** | 11 |
| **Initial Water Depth:** | 3.66m -MP | **Aquifer Tests:** | 0 |
| **Diameter:** | 51mm | **Isotope Data:** | 0 |
| | | **Yield/Drawdown Tests:** | 0 |
| **Measuring Point Ait:** | 2.50m MSD QAR 4 | **Highest GW Level:** | |
| **GL Around Well:** | 0.00m -MP | **Lowest GW Level:** | |
| **MP Description:** | | **First Reading:** | |
| | | **Last Reading:** | |
| **Driller:** | Job Osborne (& Co/Ltd) | **Calc. Min. GWL:** | 0.60m -MP |
| **Drilling Method:** | Unknown | **Last Updated:** | 04 Dec 1998 |
| **Casing Material:** | | **Last Field Check:** | |
| **Pump Type:** | Unknown | | |
| **Yield:** | | **Screens:** | |
| **Drawdown:** | | **Screen Type:** | |
| **Specific Capacity:** | | **Top GL:** | |
| | | **Bottom GL:** | |
| **Aquifer Type:** | Flowing Artesian | | |
| **Aquifer Name:** | Linwood Gravel | | |

| Date | Comments |
|---|---|
| 04 Dec 1998 | In 1918 G Seales Lived at 135 The Esplande which changed to Marine Parade in 1948. The numbering stayed the same. Currently there is a park where 135 Marine Parade would have been. Field visit could not locate any remains of the well at all. |

# Borelog for well M35/2443

Gridref: M35:8789-4537 Accuracy : 4 (1=high, 5=low)
Ground Level Altitude : 2.5 +MSD
Driller : Job Osborne (& Co/Ltd)
Drill Method : Unknown
Drill Depth : -104.2m Drill Date : 5/02/1918

Environment Canterbury Regional Council

Water Level: Artesian

| Depth(m) | Full Drillers Description | Formation Code |
|---|---|---|
| - 42.9m | Blue clay, sand & peat | ch |
| - 51.8m | Blue shingle | ri |
| - 59.7m | Blue clay | br |
| - 65.2m | Brown sand | br |
| - 69.5m | Brown shingle | br |
| - 71.0m | Blue clay | br |
| - 78.0m | Brown shingle | li-1 |
| - 85.3m | Clay, peat & sand | li-2 |
| - 87.2m | Brown shingle | li-2 |
| - 94.5m | Brown sand, clay & peat | li-2 |
| - 104.2m | Brown shingle | li-3 |

| | |
|---|---|
| **Bore or Well No:** | M35/2388 |
| **Well Name:** | |
| **Owner:** | GOLF LINKS |

| | | | |
|---|---|---|---|
| **Street of Well:** | SHAW AVE | **File No:** | |
| **Locality:** | NEW BRIGHTON | **Allocation Zone:** | Christchurch/West Melton |
| **NZGM Grid Reference:** | M35:876-450 QAR 4 | | |
| **NZGM X-Y:** | 2487600 - 5745000 | | |
| **Location Description:** | | **Uses:** | |
| **ECan Monitoring:** | | | |
| **Well Status:** | Not Used | | |

| | | | |
|---|---|---|---|
| **Drill Date:** | 19 Mar 1930 | **Water Level Count:** | 0 |
| **Well Depth:** | 84.70m -GL | **Strata Layers:** | 12 |
| **Initial Water Depth:** | 5.20m -MP | **Aquifer Tests:** | 0 |
| **Diameter:** | 51mm | **Isotope Data:** | 0 |
| | | **Yield/Drawdown Tests:** | 0 |
| **Measuring Point Ait:** | 3.80m MSD QAR 3 | **Highest GW Level:** | |
| **GL Around Well:** | 0.00m -MP | **Lowest GW Level:** | |
| **MP Description:** | | **First Reading:** | |
| | | **Last Reading:** | |
| **Driller:** | Job Osborne (& Co/Ltd) | **Calc. Min. GWL:** | 0.50m -MP |
| **Drilling Method:** | Hydraulic/Percussion | **Last Updated:** | 21 Sep 2006 |
| **Casing Material:** | | **Last Field Check:** | |
| **Pump Type:** | Unknown | | |
| **Yield:** | 0 l/s | **Screens:** | |
| **Drawdown:** | 0 m | **Screen Type:** | |
| **Specific Capacity:** | | **Top GL:** | |
| | | **Bottom GL:** | |
| **Aquifer Type:** | Flowing Artesian | | |
| **Aquifer Name:** | Linwood Gravel | | |

# Borelog for well M35/2388

Gridref: M35:876-450 Accuracy : 4 (1=high, 5=low)
Ground Level Altitude : 3.8 +MSD
Driller : Job Osborne (& Co/Ltd)
Drill Method : Hydraulic/Percussion
Drill Depth : -84.69m Drill Date : 19/03/1930

Environment Canterbury Regional Council

| Scale(m) | Water Level | Depth(m) | Full Drillers Description | Formation Code |
|---|---|---|---|---|
| | Artesian | - 15.2m | Sand & clay | ch |
| -10 | | | | |
| -20 | | - 30.4m | Sand & gravel | ch |
| -30 | | - 39.3m | Clay & peat | ch |
| -40 | | - 44.5m | Blue shingle | ri |
| | | - 49.9m | Brown shingle (Water rises +0.9m) | ri |
| -50 | | - 51.8m | Brown sand & gravel | ri |
| | | - 55.7m | Yellow clay | br |
| -60 | | - 67.0m | Yellow sand & gravel | br |
| | | - 69.2m | Yellow clay | br |
| -70 | | - 73.2m | Brown shingle (Water rises 3.05m) | li-1 |
| | | - 80.8m | Clay | li-2 |
| -80 | | - 84.7m | Brown shingle | li-2 |

**Bore or Well No:** M35/2046

**Well Name:**

**Owner:** DRAKE

Environment Canterbury
Your regional council

| | | | |
|---|---|---|---|
| **Street of Well:** | KEYES RD | **File No:** | |
| **Locality:** | NEW BRIGHTON | **Allocation Zone:** | Christchurch/West Melton |
| **NZGM Grid Reference:** | M35:873-451 QAR 4 | | |
| **NZGM X-Y:** | 2487300 - 5745100 | | |
| **Location Description:** | | **Uses:** | |
| **ECan Monitoring:** | | | |
| **Well Status:** | Not Used | | |

| | | | |
|---|---|---|---|
| **Drill Date:** | 05 Dec 1923 | **Water Level Count:** | 0 |
| **Well Depth:** | 89.60m -GL | **Strata Layers:** | 14 |
| **Initial Water Depth:** | | **Aquifer Tests:** | 0 |
| **Diameter:** | 51mm | **Isotope Data:** | 0 |
| | | **Yield/Drawdown Tests:** | 0 |
| **Measuring Point Alt:** | 2.50m MSD QAR 3 | **Highest GW Level:** | |
| **GL Around Well:** | 0.00m -MP | **Lowest GW Level:** | |
| **MP Description:** | | **First Reading:** | |
| | | **Last Reading:** | |
| **Driller:** | Job Osborne (& Co/Ltd) | **Calc. Min. GWL:** | 0.50m -MP |
| **Drilling Method:** | Hydraulic/Percussion | **Last Updated:** | 20 Mar 1995 |
| **Casing Material:** | | **Last Field Check:** | |
| **Pump Type:** | Unknown | | |
| **Yield:** | | **Screens:** | |
| **Drawdown:** | | **Screen Type:** | |
| **Specific Capacity:** | | **Top GL:** | |
| | | **Bottom GL:** | |
| **Aquifer Type:** | Flowing Artesian | | |
| **Aquifer Name:** | Linwood Gravel | | |

# Borelog for well M35/2046

Gridref: M35:873-451 Accuracy : 4 (1=high, 5=low)
Ground Level Altitude : 2.5 +MSD
Driller : Job Osborne (& Co/Ltd)
Drill Method : Hydraulic/Percussion
Drill Depth : -89.59m Drill Date : 5/12/1923

Environment Canterbury Regional Council

Water Level: Artesian

| Depth(m) | Full Drillers Description | Formation Code |
|---|---|---|
| - 33.5m | Sand | ch |
| - 39.6m | Blue clay | ch |
| - 40.8m | Peat & clay | ch |
| - 41.4m | Blue shingle | ri |
| - 50.2m | Brown shingle | ri |
| - 53.3m | Brown sand & gravel | ri |
| - 54.9m | Brown clay | br |
| - 60.4m | Brown sand | br |
| - 68.5m | Sand & clay | br |
| - 70.4m | Clay & peat | br |
| - 79.9m | Brown shingle | li-1 |
| - 84.7m | Blue clay | li-2 |
| - 86.0m | Yellow clay | li-2 |
| - 89.6m | Brown shingle | li-2 |

**Bore or Well No:** M35/2045
**Well Name:**
**Owner:** HINKEY

Environment Canterbury
Your regional council

| | | | |
|---|---|---|---|
| **Street of Well:** | KEYES RD | **File No:** | |
| **Locality:** | NEW BRIGHTON | **Allocation Zone:** | Christchurch/West Melton |
| **NZGM Grid Reference:** | M35:873-451 QAR 4 | | |
| **NZGM X-Y:** | 2487300 - 5745100 | | |
| **Location Description:** | | **Uses:** | |
| **ECan Monitoring:** | | | |
| **Well Status:** | Not Used | | |

| | | | |
|---|---|---|---|
| **Drill Date:** | 21 Nov 1923 | **Water Level Count:** | 0 |
| **Well Depth:** | 86.50m -GL | **Strata Layers:** | 13 |
| **Initial Water Depth:** | | **Aquifer Tests:** | 0 |
| **Diameter:** | 51mm | **Isotope Data:** | 0 |
| | | **Yield/Drawdown Tests:** | 0 |
| **Measuring Point Ait:** | 2.50m MSD QAR 3 | **Highest GW Level:** | |
| **GL Around Well:** | 0.00m -MP | **Lowest GW Level:** | |
| **MP Description:** | | **First Reading:** | |
| | | **Last Reading:** | |
| **Driller:** | Job Osborne (& Co/Ltd) | **Calc. Min. GWL:** | 0.50m -MP |
| **Drilling Method:** | Hydraulic/Percussion | **Last Updated:** | 20 Mar 1995 |
| **Casing Material:** | | **Last Field Check:** | |
| **Pump Type:** | Unknown | | |
| **Yield:** | | **Screens:** | |
| **Drawdown:** | | **Screen Type:** | |
| **Specific Capacity:** | | **Top GL:** | |
| | | **Bottom GL:** | |
| **Aquifer Type:** | Flowing Artesian | | |
| **Aquifer Name:** | Linwood Gravel | | |

# Borelog for well M35/2045

Gridref: M35:873-451 Accuracy : 4 (1=high, 5=low)
Ground Level Altitude : 2.5 +MSD
Driller : Job Osborne (& Co/Ltd)
Drill Method : Hydraulic/Percussion
Drill Depth : -86.5m Drill Date : 21/11/1923

Water Level: Artesian

| Depth(m) | Full Drillers Description | Formation Code |
|---|---|---|
| - 37.7m | Sand & clay | ch |
| - 40.5m | Blue clay & peat | ch |
| - 43.5m | Blue shingle | ri |
| - 44.5m | Brown shingle | ri |
| - 49.3m | Blue shingle | ri |
| - 50.5m | Brown sand & clay | br |
| - 51.8m | Blue sand & clay | br |
| - 67.0m | Brown sand | br |
| - 69.2m | Blue sand & clay | br |
| - 69.5m | Blue shingle | li-1 |
| - 79.6m | Brown shingle | li-1 |
| - 84.1m | Blue sand & clay | li-2 |
| - 86.5m | Brown shingle | li-2 |

Scale(m): -10, -20, -30, -40, -50, -60, -70, -80

**Bore or Well No:** M35/2017
**Well Name:**
**Owner:** WYLIE BROS

Environment Canterbury
Your regional council

**Street of Well:** KEYES RD
**File No:**
**Locality:** NEW BRIGHTON
**Allocation Zone:** Christchurch/West Melton
**NZGM Grid Reference:** M35:873-451 QAR 4
**NZGM X-Y:** 2487300 - 5745100
**Location Description:**
**Uses:**
**ECan Monitoring:**
**Well Status:** Not Used

**Drill Date:** 01 Oct 1910
**Water Level Count:** 0
**Well Depth:** 85.90m -GL
**Strata Layers:** 9
**Initial Water Depth:**
**Aquifer Tests:** 0
**Diameter:** 51mm
**Isotope Data:** 0
**Yield/Drawdown Tests:** 0

**Measuring Point Ait:** 2.50m MSD QAR 3
**Highest GW Level:**
**GL Around Well:** 0.00m -MP
**Lowest GW Level:**
**MP Description:**
**First Reading:**
**Last Reading:**
**Driller:** Job Osborne (& Co/Ltd)
**Calc. Min. GWL:** 0.50m -MP
**Drilling Method:** Unknown
**Last Updated:** 23 Aug 1994
**Casing Material:**
**Last Field Check:**
**Pump Type:** Unknown
**Yield:** 0 l/s
**Screens:**
**Drawdown:** 0 m
**Screen Type:**
**Specific Capacity:**
**Top GL:**
**Bottom GL:**
**Aquifer Type:** Unknown
**Aquifer Name:**

# Borelog for well M35/2017

Gridref: M35:873-451 Accuracy : 4 (1=high, 5=low)
Ground Level Altitude : 2.5 +MSD
Driller : Job Osborne (& Co/Ltd)
Drill Method : Unknown
Drill Depth : -85.9m Drill Date : 1/10/1910

Environment Canterbury Regional Council

Water Level: Artesian

| Depth(m) | Full Drillers Description | Formation Code |
|---|---|---|
| - 10.6m | Sand & clay | ch |
| - 12.1m | Blue shingle | ch |
| - 28.0m | Blue sand & clay | ch |
| - 53.3m | Brown shingle | ri |
| - 67.9m | Blue sand & shingle | br |
| - 80.8m | Blue sand & clay | li |
| - 82.3m | Blue shingle | li |
| - 84.4m | Sand & clay | li |
| - 86.7m | Brown shingle | li |

Scale(m): -10, -20, -30, -40, -50, -60, -70, -80

| | | | |
|---|---|---|---|
| **Bore or Well No:** | M35/2005 | | |
| **Well Name:** | | | |
| **Owner:** | GOLF LINKS | | |

Environment Canterbury
Your regional council

| | | | |
|---|---|---|---|
| **Street of Well:** | SHAW AVE | **File No:** | |
| **Locality:** | NEW BRIGHTON | **Allocation Zone:** | Christchurch/West Melton |
| **NZGM Grid Reference:** | M35:877-447 QAR 4 | | |
| **NZGM X-Y:** | 2487700 - 5744700 | | |
| **Location Description:** | | **Uses:** | |
| **ECan Monitoring:** | | | |
| **Well Status:** | Not Used | | |

| | | | |
|---|---|---|---|
| **Drill Date:** | 02 Oct 1936 | **Water Level Count:** | 0 |
| **Well Depth:** | 87.10m -GL | **Strata Layers:** | 12 |
| **Initial Water Depth:** | 5.30m -MP | **Aquifer Tests:** | 0 |
| **Diameter:** | 51mm | **Isotope Data:** | 0 |
| | | **Yield/Drawdown Tests:** | 0 |
| **Measuring Point Ait:** | 2.20m MSD QAR 3 | **Highest GW Level:** | |
| **GL Around Well:** | 0.00m -MP | **Lowest GW Level:** | |
| **MP Description:** | | **First Reading:** | |
| | | **Last Reading:** | |
| **Driller:** | J W Horne (& Co) | **Calc. Min. GWL:** | 0.90m -MP |
| **Drilling Method:** | Unknown | **Last Updated:** | 18 Nov 1994 |
| **Casing Material:** | | **Last Field Check:** | |
| **Pump Type:** | Unknown | | |
| **Yield:** | | **Screens:** | |
| **Drawdown:** | | **Screen Type:** | |
| **Specific Capacity:** | | **Top GL:** | |
| | | **Bottom GL:** | |
| **Aquifer Type:** | Flowing Artesian | | |
| **Aquifer Name:** | Linwood Gravel | | |

# Borelog for well M35/2005

Gridref: M35:877-447 Accuracy : 4 (1=high, 5=low)
Ground Level Altitude : 2.2 +MSD
Driller : J W Horne (& Co)
Drill Method : Unknown
Drill Depth : -87.09m Drill Date : 2/10/1936

Water Level: Artesian

| Depth(m) | Full Drillers Description | Formation Code |
|---|---|---|
| - 21.3m | Black sand | ch |
| - 24.3m | Black sand | ch |
| - 27.4m | Black sand | ch |
| - 39.0m | Black sand | ch |
| - 49.3m | Black shingle, flow at 42.6 - 45.7m & best flow at 48.7m, rose 0.9m | ri |
| - 50.2m | Brown sand | br |
| - 51.8m | Black sand | br |
| - 69.4m | Black sand | br |
| - 77.7m | Brown shingle, flow at 73.1m rises 2.1m | li-1 |
| - 81.6m | Black clay & sand | li-2 |
| - 83.5m | Yellow clay | li-2 |
| - 87.1m | Brown shingle, flow at 84.1m to 85.9m & 87.1m | li-2 |

Scale(m): -10, -20, -30, -40, -50, -60, -70, -80

# Appendix C – Geotechnical Investigation Summary

## ▪ Table 1 Summary of most relevant investigation data

| **ID** | | **1** | **2** |
|---|---|---|---|
| Type * | | BH | BH |
| Ref | | M35/1540 | M35/1535 |
| Depth (m) | | 84 | 85 |
| Distance from site (m) | | 30 | 200 |
| Ground water level (mBGL) | | Artesian | Artesian |
| Simplified recorded geological profile (depth below ground level to top of stratum, m) | 0 | | |
| | 1 | | |
| | 2 | | |
| | 3 | | |
| | 4 | | |
| | 5 | | |
| | 6 | | |
| | 7 | | |
| | 8 | | |
| | 9 | | |
| | 10 | | |
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| | 12 | | |
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| | 16 | | |
| | 17 | | |
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| | 19 | | |
| | 20 | | |
| | 21 | | |
| | 22 | | |
| | 23 | | |
| | 24 | | |
| | 25 | | |
| Greater depths | | | |

*BH: Borehole, HA: Hand Auger, WW: Water Well, CPT: Cone Penetration Test

Sensitive or organic clay/silt | Clay to silty clay | Clayey silt to silt | Silty sand to silt

Clayey sand | Sand | Gravelly sand or gravel

VL = very loose, L = loose, MD = medium dense, D = dense, VD = very dense
VS = very soft, So = soft, F = firm, St = stiff, VS = very stiff, H = hard