

CHRISTCHURCH CITY COUNCIL
PRK_2347_BLDG_004 EQ2
Travis Wetland Toilets
280 Beach Road, Burwood



QUALITATIVE ASSESSMENT REPORT
FINAL

- Rev B
- 23 May 2013



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1. Executive Summary

1.1. Background

A qualitative assessment was carried out on the building located in Travis Wetland at 280 Beach Road, Burwood. The building is single storey and is currently utilised as public toilets. It is constructed from timber framed walls and 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 toilet block in Travis Wetland

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 18 September 2012.



1.2. Damage Observed

Damage observed includes:-

- Hairline cracking of concrete ground slab

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 in the order of 82%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 greater than 67% NBS and is therefore not a potential earthquake risk.

1.5. Recommendations

It is recommended that:

- a) There is no damage to the building that would cause it to be unsafe to occupy.
- 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 Travis Wetland at 280 Beach Road 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 0.3¹.

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.

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 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 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 Travis Wetland at 280 Beach Road. The building has one storey that is currently utilised as a public toilet. The building has a lightweight corrugated steel roof with timber-framing. There are 150mmx50mm rafters at 800mm centres with a 150mmx50mm ridge beam, supported on lightweight timber-frame walls. The structure is supported on a concrete ground slab. It is assumed the building was designed and constructed in the 1970's.

Our evaluation was based on the visual inspection carried out on 18 September 2012. Drawings were not available to verify the date of construction.

5.2. Gravity Load Resisting system

It appears that the gravity loads are taken by the timber framing in the walls with direct transfer into the concrete slab foundation below.

5.3. Seismic Load Resisting system

Lateral loads acting across and along the building will be transferred through the timber framing in the walls.

Note that for this building the 'along direction' has been taken as north-south and the 'across 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 is expected to be moderate for this site.
- There is future risk of lateral spreading on site.

If ground properties are required for a quantitative assessment, additional investigations would be required to estimate shallow ground properties. The additional investigations recommended are:

- Two hand augers near the structure to a depth of 3m to assess the composition of the shallow soil layer.

Deeper intrusive investigations would be required if a more detailed liquefaction assessment for the structures on site if required.

6. Damage Summary

SKM undertook an inspection on 18 September 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, therefore a level survey is not required at this stage of assessment.

Building Damage

- 1) Hairline cracks in concrete ground slab in male toilet (see Photos 11 & 12), however it is not clear whether this is a result of earthquake damage.
- 2) Slightly dislodged weatherboard on east wall (see Photo 5). This is very minor non-structural damage therefore a repair solution will not be recommended.
- 3) Plant material was observed growing inside the male toilets at gutter level (see Photo 10). This is not earthquake damage, but indicates weather-tightness is not achieved.

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



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 buildings².

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% NBS³. 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 prone⁴.

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

² <http://resources.ccc.govt.nz/files/EarthquakeProneDangerousAndInsanitaryBuildingsPolicy2010.pdf>

³ NZSEE 2006, *Assessment and Improvement of the Structural Performance of Buildings in Earthquakes*, p 2-2

⁴ <http://resources.ccc.govt.nz/files/EarthquakeProneDangerousAndInsanitaryBuildingsPolicy2010.pdf>

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 building⁵. 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

7.2. Available Information, Assumptions and Limitations

Following our inspection on 18 September 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 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 1. This level of importance is described as 'low' with small or moderate consequence of failure.
 - Ductility level of 1.25 in both directions, based on our assessment and code requirements at the time of design.

⁵ NZSEE 2006, *Assessment and Improvement of the Structural Performance of Buildings in Earthquakes*, p2-9



- Site hazard factor, $Z = 0.3$, NZBC, Clause B1 Structure, Amendment 11 effective from 1 August 2011

This IEP was based on our 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

<u>Item</u>	<u>%NBS</u>
Likely Seismic Capacity of Building	82

Our qualitative assessment found that the building is not likely to be classed as a potential earthquake risk and probably a 'Low Risk Building' (capacity greater than 67% of NBS). The full IEP assessment form is detailed in Appendix 2 – IEP Reports.



8. Further Investigation

No further investigation is required at this stage as the likely seismic capacity of the building is greater than 67% NBS and no structural damage was observed.



9. Conclusion

A qualitative assessment was carried out on the building located in Travis Wetland at 280 Beach Road, Burwood. The building has sustained minor damage to the concrete ground slab with hairline cracking, however it is not clear whether this is a result of earthquake damage. The building has been assessed to have a seismic capacity in the order of 82% NBS and is therefore not a potential earthquake risk and is likely to be classified as a 'Low Risk Building' (capacity greater than 67% of NBS).

No further investigation is recommended at this stage.

It is recommended that:

- a) There is no damage to the building that would cause it to be unsafe to occupy.
- 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: North elevation



Photo 2: East elevation



Photo 3: South elevation



Photo 4: West elevation



Photo 5: Dislodged weathboard on east wall



Photo 6: Water damage to underside of gutter (typical)



Photo 7: Internal view of female toilet



Photo 8: Internal view of male toilet

	
<p>Photo 9: Timber framing in the roof</p>	<p>Photo 10: Plant growth at gutter level inside male toilet</p>
	
<p>Photo 11: Hairline crack in concrete ground slab in male toilet</p>	<p>Photo 12: Hairline crack in concrete ground slab in male toilet</p>

Christchurch City Council
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12. Appendix 2 – IEP Reports

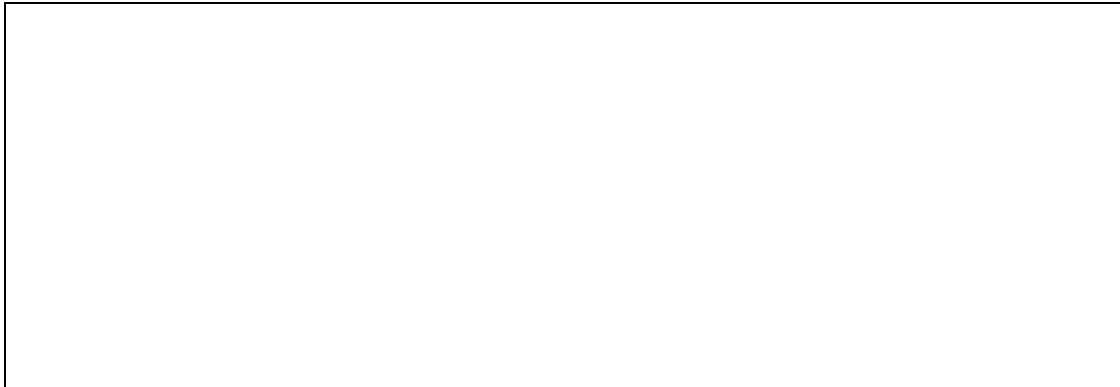
Building Name:	Travis Wetland Toilets	Ref.	ZB01276.195
Location:	280 Beach Road, Burwood	By	WPK
		Date	20/09/2012

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 Travis Wetland at 280 Beach Road is one storey and is currently used as a public toilet. The building has timber-framed walls and a concrete floor slab. The main lateral load-resisting system appear to be the timber framing in the walls. The roof is timber-framed with metal sheeting as cladding. The building is assumed to have been constructed in the 1970's.

1.4 Note information sources

Tick as appropriate

- Visual Inspection of Exterior
- Visual Inspection of Interior
- Drawings (note type)
- Specifications
- Geotechnical Reports
- Other (list)

<input checked="" type="checkbox"/>
<input checked="" type="checkbox"/>
<input type="checkbox"/>
<input type="checkbox"/>
<input type="checkbox"/>
<input type="checkbox"/>

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:	Travis Wetland Toilets	Ref.	ZB01276.195
Location:	280 Beach Road, Burwood	By	WPK
Direction Considered:	Longitudinal & Transverse	Date	20/09/2012
(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		<input type="radio"/>	See also notes 1, 3
1935-1965		<input type="radio"/>	
1965-1976	Seismic Zone; A	<input type="radio"/>	
	B	<input checked="" type="radio"/>	
	C	<input type="radio"/>	See also note 2
1976-1992	Seismic Zone; A	<input type="radio"/>	
	B	<input type="radio"/>	
	C	<input type="radio"/>	
1992-2004		<input type="radio"/>	

b) Soil Type

From NZS1170.5:2004, Cl 3.1.3	A or B Rock	<input type="radio"/>
	C Shallow Soil	<input type="radio"/>
	D Soft Soil	<input checked="" type="radio"/>
	E Very Soft Soil	<input type="radio"/>
From NZS4203:1992, Cl 4.6.2.2 (for 1992 to 2004 only and only if known)	a) Rigid	<input checked="" type="radio"/> N-A
	b) Intermediate	<input type="radio"/>

c) Estimate Period, T

building Ht = 3.4 meters

Can use following:

- $T = 0.09h_n^{0.75}$ for moment-resisting concrete frames
- $T = 0.14h_n^{0.75}$ for moment-resisting steel frames
- $T = 0.08h_n^{0.75}$ for eccentrically braced steel frames
- $T = 0.06h_n^{0.75}$ for all other frame structures
- $T = 0.09h_n^{0.75}/A_c^{0.5}$ for concrete shear walls
- $T \leq 0.4\text{sec}$ for masonry shear walls

Where h_n = height in m from the base of the structure to the uppermost seismic weight or mass.
 $A_c = \sum A_i(0.2 + L_{wi}/h_n)^2$
 A_i = cross-sectional shear area of shear wall i in the first storey of the building, in m^2
 L_{wi} = length of shear wall i in the first storey in the direction parallel to the applied forces, in m
 with the restriction that L_{wi}/h_n shall not exceed 0.9

	Longitudinal	Transverse	
$A_c =$	N/A	N/A	m ²
<input type="radio"/>	MRCF	<input type="radio"/>	MRCF
<input type="radio"/>	MRSF	<input type="radio"/>	MRSF
<input type="radio"/>	EBSF	<input type="radio"/>	EBSF
<input checked="" type="radio"/>	Others	<input checked="" type="radio"/>	Others
<input type="radio"/>	CSW	<input type="radio"/>	CSW
<input type="radio"/>	MSW	<input type="radio"/>	MSW

Longitudinal	Transverse	
0.2	0.2	Seconds

d) (%NBS)nom determined from Figure 3.3

- 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. Factor 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. Factor 1
- Note 2:** For reinforced concrete buildings designed between 1976 -1984 (%NBS)nom by 1.2. Factor 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. Factor 1

Longitudinal	5	(%NBS)nom
Transverse	5	(%NBS)nom

Longitudinal	5.0	(%NBS)nom
Transverse	5.0	(%NBS)nom

Continued over page

Building Name:	Travis Wetland Toilets	Ref.	ZB01276.195
Location:	280 Beach Road, Burwood	By	WPK
Direction Considered:	Longitudinal & Transverse	Date	20/09/2012
(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

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 0.6

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
(from NZS1170.0:2004, Table 3.1 and 3.2)

b) Return Period Scaling Factor from accompanying Table 3.1

Factor C	2.00
----------	------

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_{μ}
For 1976 onwards = 1
(where k_{μ} 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
Transverse

a) Structural Performance Factor, S_p
from accompanying Figure 3.4

Longitudinal S_p 0.93
Transverse S_p 0.93

b) Structural Performance Scaling Factor

Longitudinal $1/S_p$ Factor E 1.08
Transverse $1/S_p$ Factor E 1.08

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

Longitudinal	41.2	(%NBS) _b
Transverse	41.2	(%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: <u>Travis Wetland Toilets</u>	Ref. <u>ZB01276.195</u>
Location: <u>280 Beach Road, Burwood</u>	By <u>WPK</u>
Direction Considered: a) Longitudinal	Date <u>20/09/2012</u>
(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

Score

3.1 Plan Irregularity

Effect on Structural Performance

Comment

Severe	Significant	Insignificant
<input type="radio"/>	<input type="radio"/>	<input checked="" type="radio"/>

Factor A

3.2 Vertical Irregularity

Effect on Structural Performance

Comment

Severe	Significant	Insignificant
<input type="radio"/>	<input type="radio"/>	<input checked="" type="radio"/>

Factor B

3.3 Short Columns

Effect on Structural Performance

Comment

Severe	Significant	Insignificant
<input type="radio"/>	<input type="radio"/>	<input checked="" type="radio"/>

Factor C

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

Table for Selection of Factor D1

Separation	Factor D1		
	Severe 0<Sep<.005H	Significant .005<Sep<.01H	Insignificant Sep>.01H
Alignment of Floors within 20% of Storey Height	<input type="radio"/> 0.7	<input type="radio"/> 0.8	<input checked="" type="radio"/> 1
Alignment of Floors not within 20% of Storey Height	<input type="radio"/> 0.4	<input type="radio"/> 0.7	<input type="radio"/> 0.8

b) Factor D2: - Height Difference Effect

Select appropriate value from Table

Factor D2

Table for Selection of Factor D2

Separation	Factor D2		
	Severe 0<Sep<.005H	Significant .005<Sep<.01H	Insignificant Sep>.01H
Height Difference > 4 Storeys	<input type="radio"/> 0.4	<input type="radio"/> 0.7	<input type="radio"/> 1
Height Difference 2 to 4 Storeys	<input type="radio"/> 0.7	<input type="radio"/> 0.9	<input type="radio"/> 1
Height Difference < 2 Storeys	<input type="radio"/> 1	<input type="radio"/> 1	<input checked="" type="radio"/> 1

Factor D

(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)

Effect on Structural Performance

Severe	Significant	Insignificant
<input type="radio"/> 0.5	<input type="radio"/> 0.7	<input checked="" type="radio"/> 1

Factor E

3.6 Other Factors

For < 3 storeys - Maximum value 2.5,

otherwise - Maximum value 1.5. No minimum.

Factor F

Record rationale for choice of Factor F:

Small, lightweight structure with low consequence of failure. No earthquake damage noted.

3.7 Performance Achievement Ratio (PAR)

(equals A x B x C x D x E x F)

PAR

Building Name:	Travis Wetland Toilets	Ref.	ZB01276.195
Location:	280 Beach Road, Burwood	By	WPK
Direction Considered:	b) Transverse	Date	20/09/2012
(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

Effect on Structural Performance

Comment

Severe	Significant	Insignificant
<input type="radio"/>	<input type="radio"/>	<input checked="" type="radio"/>

Factor A

3.2 Vertical Irregularity

Effect on Structural Performance

Comment

Severe	Significant	Insignificant
<input type="radio"/>	<input type="radio"/>	<input checked="" type="radio"/>

Factor B

3.3 Short Columns

Effect on Structural Performance

Comment

Severe	Significant	Insignificant
<input type="radio"/>	<input type="radio"/>	<input checked="" type="radio"/>

Factor C

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

Table for Selection of Factor D1

Separation	Factor D1		
	Severe	Significant	Insignificant
Alignment of Floors within 20% of Storey Height	<input type="radio"/> 0.7	<input type="radio"/> 0.8	<input checked="" type="radio"/> 1
Alignment of Floors not within 20% of Storey Height	<input type="radio"/> 0.4	<input type="radio"/> 0.7	<input type="radio"/> 0.8

b) Factor D2: - Height Difference Effect

Select appropriate value from Table

Factor D2

Table for Selection of Factor D2

Separation	Factor D2		
	Severe	Significant	Insignificant
Height Difference > 4 Storeys	<input type="radio"/> 0.4	<input type="radio"/> 0.7	<input type="radio"/> 1
Height Difference 2 to 4 Storeys	<input type="radio"/> 0.7	<input type="radio"/> 0.9	<input type="radio"/> 1
Height Difference < 2 Storeys	<input type="radio"/> 1	<input type="radio"/> 1	<input checked="" type="radio"/> 1

Factor D

(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)

Effect on Structural Performance

Severe	Significant	Insignificant
<input type="radio"/> 0.5	<input type="radio"/> 0.7	<input checked="" type="radio"/> 1

Factor E

3.6 Other Factors

For < 3 storeys - Maximum value 2.5,

otherwise - Maximum value 1.5. No minimum.

Factor F

Record rationale for choice of Factor F:

Small, lightweight structure with low consequence of failure. No earthquake damage noted.

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

PAR

Building Name:	Travis Wetland Toilets	Ref.	ZB01276.195
Location:	280 Beach Road, Burwood	By	WPK
Direction Considered:	Longitudinal & Transverse		Date
(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)	41	41
4.2 Performance Achievement Ratio (PAR) (from Table IEP - 2)	2.00	2.00
4.3 PAR x Baseline (%NBS)_b	82	82
4.4 Percentage New Building Standard (%NBS) (Use lower of two values from Step 4.3)		82

Step 5 - Potentially Earthquake Prone?
(Mark as appropriate)

%NBS ≤ 33

Step 6 - Potentially Earthquake Risk?

%NBS < 67

Step 7 - Provisional Grading for Seismic Risk based on IEP

Seismic Grade

Evaluation Confirmed by

Signature

N 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: <input type="text" value="Travis Wetland Toilets"/>	Unit No: <input type="text" value="Street"/>	Reviewer: <input type="text" value="N Calvert"/>
Building Address: <input type="text" value="280 Beach Road, Burwood"/>	Legal Description: <input type="text"/>	Company: <input type="text" value="SKM"/>		CPEng No: <input type="text" value="242062"/>
GPS south: <input type="text"/>		Company project number: <input type="text" value="ZB01276.195"/>		Company phone number: <input type="text" value="09 928 5500"/>
GPS east: <input type="text"/>		Date of submission: <input type="text" value="24-May"/>		Inspection Date: <input type="text" value="18/09/2012"/>
Building Unique Identifier (CCC): <input type="text" value="PRK_2347_BLDG_004"/>		Revision: <input type="text" value="B"/>		Is there a full report with this summary?: <input type="text" value="yes"/>

Site	Site slope: <input type="text" value="flat"/>	Max retaining height (m): <input type="text"/>
Soil type: <input type="text"/>	Soil Profile (if available): <input type="text"/>	
Site Class (to NZS1170.5): <input type="text" value="D"/>	If Ground improvement on site, describe: <input type="text"/>	
Proximity to waterway (m, if <100m): <input type="text"/>	Approx site elevation (m): <input type="text"/>	
Proximity to cliff top (m, if < 100m): <input type="text"/>		
Proximity to cliff base (m, if <100m): <input type="text"/>		

Building	No. of storeys above ground: <input type="text" value="1"/>	single storey = 1	Ground floor elevation (Absolute) (m): <input type="text"/>
Ground floor split?: <input type="text" value="no"/>	Storeys below ground: <input type="text" value="0"/>		Ground floor elevation above ground (m): <input type="text"/>
Foundation type: <input type="text" value="mat slab"/>	Building height (m): <input type="text" value="3.40"/>		if Foundation type is other, describe: <input type="text"/>
Floor footprint area (approx): <input type="text" value="22"/>	Age of Building (years): <input type="text" value="40"/>		height from ground to level of uppermost seismic mass (for IEP only) (m): <input type="text" value="3.4"/>
Age of Building (years): <input type="text" value="40"/>			Date of design: <input type="text" value="1965-1976"/>
Strengthening present?: <input type="text" value="no"/>			If so, when (year)? <input type="text"/>
Use (ground floor): <input type="text" value="recreational"/>			And what load level (%g)? <input type="text"/>
Use (upper floors): <input type="text"/>			Brief strengthening description: <input type="text"/>
Use notes (if required): <input type="text"/>			
Importance level (to NZS1170.5): <input type="text" value="IL1"/>			

Gravity Structure	Gravity System: <input type="text" value="frame system"/>	rafter type, purlin type and cladding: <input type="text" value="150x50 rafters @ 800 c/c with 150x50 ridge beam"/>
Roof: <input type="text" value="timber framed"/>	Floors: <input type="text" value="concrete flat slab"/>	slab thickness (mm): <input type="text" value="Unknown"/>
Beams: <input type="text" value="timber"/>	Columns: <input type="text" value="timber"/>	type: <input type="text" value="Unknown"/>
Walls: <input type="text" value="non-load bearing"/>		typical dimensions (mm x mm): <input type="text" value="0"/>

Lateral load resisting structure	Lateral system along: <input type="text" value="lightweight timber framed walls"/>	Note: Define along and across in detailed report!	note typical wall length (m): <input type="text" value="5.5"/>
Ductility assumed, μ: <input type="text" value="1.25"/>	Period along: <input type="text" value="0.20"/>		estimate or calculation? <input type="text" value="estimated"/>
Total deflection (ULS) (mm): <input type="text" value="10"/>	maximum interstorey deflection (ULS) (mm): <input type="text"/>		estimate or calculation? <input type="text" value="estimated"/>
Lateral system across: <input type="text" value="lightweight timber framed walls"/>	Ductility assumed, μ: <input type="text" value="1.25"/>		note typical wall length (m): <input type="text" value="4"/>
Period across: <input type="text" value="0.20"/>	Total deflection (ULS) (mm): <input type="text" value="10"/>		estimate or calculation? <input type="text" value="estimated"/>
maximum interstorey deflection (ULS) (mm): <input type="text"/>			estimate or calculation? <input type="text" value="estimated"/>

Separations:	north (mm): <input type="text"/>	leave blank if not relevant
east (mm): <input type="text"/>		
south (mm): <input type="text"/>		
west (mm): <input type="text"/>		

Non-structural elements	Stairs: <input type="text"/>	describe: <input type="text" value="Plasterboard"/>
Wall cladding: <input type="text" value="plaster system"/>		describe: <input type="text" value="Lightweight corrugated sheeting"/>
Roof Cladding: <input type="text" value="Metal"/>		
Glazing: <input type="text"/>		
Ceilings: <input type="text"/>		
Services(list): <input type="text"/>		

Available documentation	Architectural: <input type="text" value="none"/>	original designer name/date: <input type="text"/>
Structural: <input type="text" value="none"/>		original designer name/date: <input type="text"/>
Mechanical: <input type="text" value="none"/>		original designer name/date: <input type="text"/>
Electrical: <input type="text" value="none"/>		original designer name/date: <input type="text"/>
Geotech report: <input type="text" value="partial"/>		original designer name/date: <input type="text"/>

Damage	Site performance: <input type="text"/>	Describe damage: <input type="text" value="Hairline cracks in concrete ground slab"/>
Site: (refer DEE Table 4-2)	Settlement: <input type="text" value="none observed"/>	notes (if applicable): <input type="text"/>
Differential settlement: <input type="text" value="none observed"/>	Liquefaction: <input type="text" value="none apparent"/>	notes (if applicable): <input type="text"/>
Lateral Spread: <input type="text" value="none apparent"/>	Differential lateral spread: <input type="text" value="none apparent"/>	notes (if applicable): <input type="text"/>
Ground cracks: <input type="text" value="none apparent"/>	Damage to area: <input type="text" value="none apparent"/>	notes (if applicable): <input type="text"/>

Building:	Current Placard Status: <input type="text" value="green"/>	
Along	Damage ratio: <input type="text" value="0%"/>	Describe how damage ratio arrived at: <input type="text" value="No structural damage observed during our site inspection."/>
	Describe (summary): <input type="text" value="No structural damage observed"/>	
Across	Damage ratio: <input type="text" value="0%"/>	$Damage_Ratio = \frac{(\% NBS (before) - \% NBS (after))}{\% NBS (before)}$
	Describe (summary): <input type="text" value="No structural damage observed"/>	
Diaphragms	Damage?: <input type="text" value="no"/>	Describe: <input type="text"/>
CSWs:	Damage?: <input type="text" value="no"/>	Describe: <input type="text"/>
Pounding:	Damage?: <input type="text" value="no"/>	Describe: <input type="text"/>
Non-structural:	Damage?: <input type="text" value="yes"/>	Describe: <input type="text" value="Hairline cracks in concrete ground slab"/>

Recommendations	Level of repair/strengthening required: <input type="text" value="none"/>	Describe: <input type="text"/>
Building Consent required: <input type="text" value="no"/>		Describe: <input type="text"/>
Interim occupancy recommendations: <input type="text" value="full occupancy"/>		Describe: <input type="text"/>
Along	Assessed %NBS before: <input type="text" value="82%"/>	%NBS from IEP below
	Assessed %NBS after: <input type="text" value="82%"/>	If IEP not used, please detail assessment methodology: <input type="text" value="Qualitative Assessment carried out includes NZSEE IEP (refer to SKM report)."/>
Across	Assessed %NBS before: <input type="text" value="82%"/>	%NBS from IEP below
	Assessed %NBS after: <input type="text" value="82%"/>	



14. Appendix 4 – Geotechnical Desktop Study



Christchurch City Council - Structural Engineering Service Geotechnical Desk Study

SKM project number	ZB01276
SKM project site number	195 - 197
Address	Travis Wetland
Report date	20 September 2012
Author	Ananth Balachandra
Reviewer	Leah Bateman
Approved for issue	No

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
- A preliminary site walkover

3. Limitations

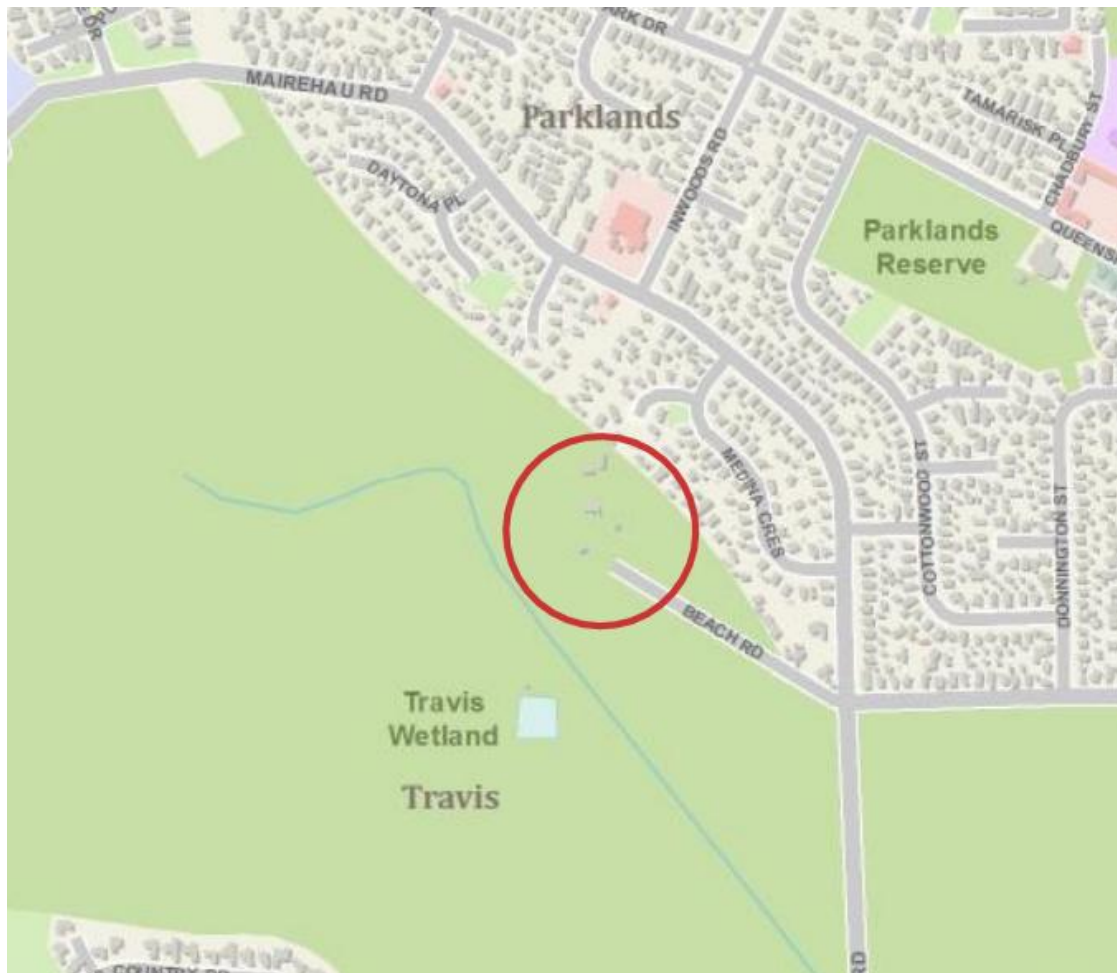
This report was prepared to address geotechnical issues relating to the specific site in accordance with the scope of works as defined in the contract between SKM and our Client. This report has been prepared on behalf of, and for the exclusive use of, our Client, and is subject to, and issued in accordance 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**
(http://apps.geocirrus.co.nz/cera/public/?Viewer=CERA_Public)

These structures are located on 280 Beach Road at grid reference 1575607 E, 5185294 N (NZTM).

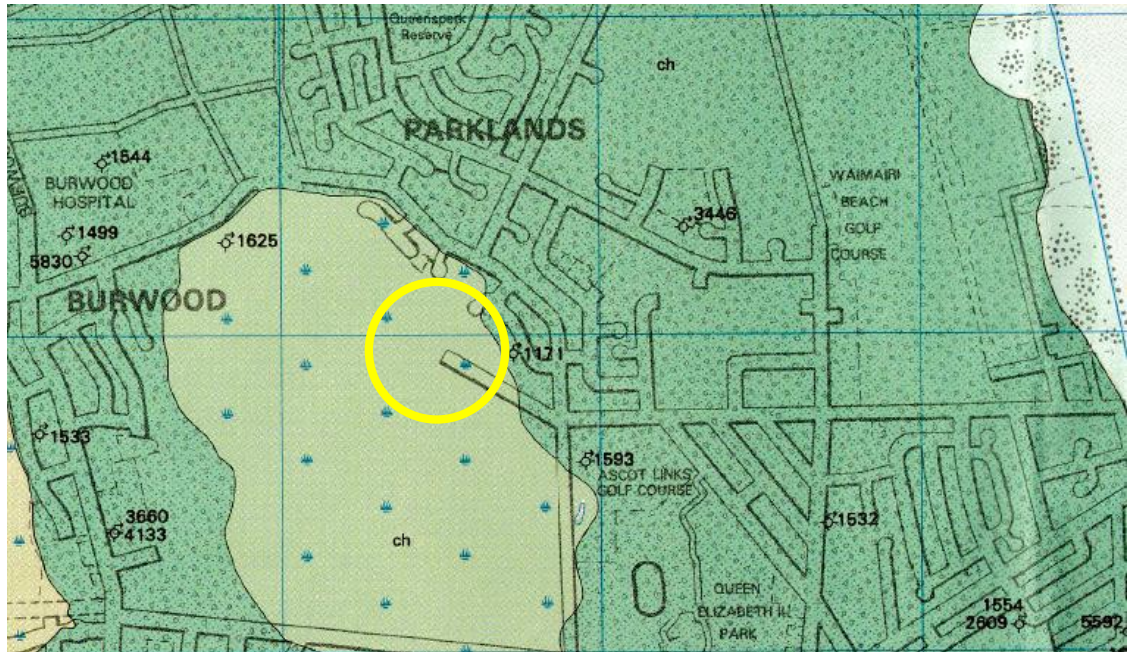


5. Review of available information

5.1 Geological maps



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

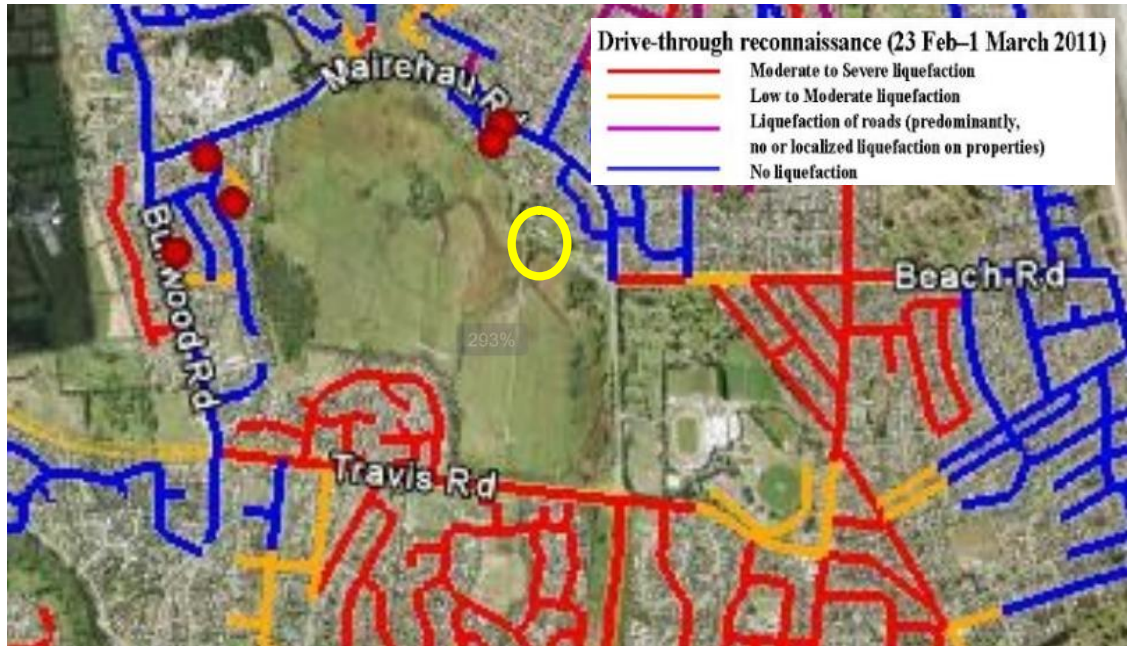


■ **Figure 3 – Local geological map (Brown et al, 1992). Site marked in yellow.**

The local geological map shows the area to be underlain by sand, silt and peat of drained lagoons and estuaries. However, it should be noted that a lake is currently present near the site. Immediately east of the site the area is shown to be underlain by sand of fixed and semi-fixed dunes and beached from the Christchurch formation.



5.2 Liquefaction map



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

Following the 22 February 2011 event drive through reconnaissance was undertaken from 23 February until 1 March by M Cubrinovski and M Taylor of Canterbury University. Their findings show no liquefaction on Mairehau Road and Medina Crescent to the north east and moderate to severe liquefaction on Beach Road to the east.

However, as the drive through reconnaissance did not continue to the immediate location of the site and as the site is inferred to be underlain by a different geological formation, the level of liquefaction noted above may not be relevant for the site itself.

5.3 Aerial photography



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

A reasonably significant amount of liquefied ejecta could be seen on Beach Road and in land areas around the structures. Due to the presence of the lake to the west, it is expected that ground water level would be shallow beneath the site. This may explain the level of liquefaction noted. From the aerial photograph, no clear evidence of tension cracks or lateral movement towards the lake could be seen.

Additionally, from high level view of the structures there appears to be no catastrophic damage of the surrounding structures as a result of the seismic shaking and land damage caused by the earthquake event.

5.4 CERA classification

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

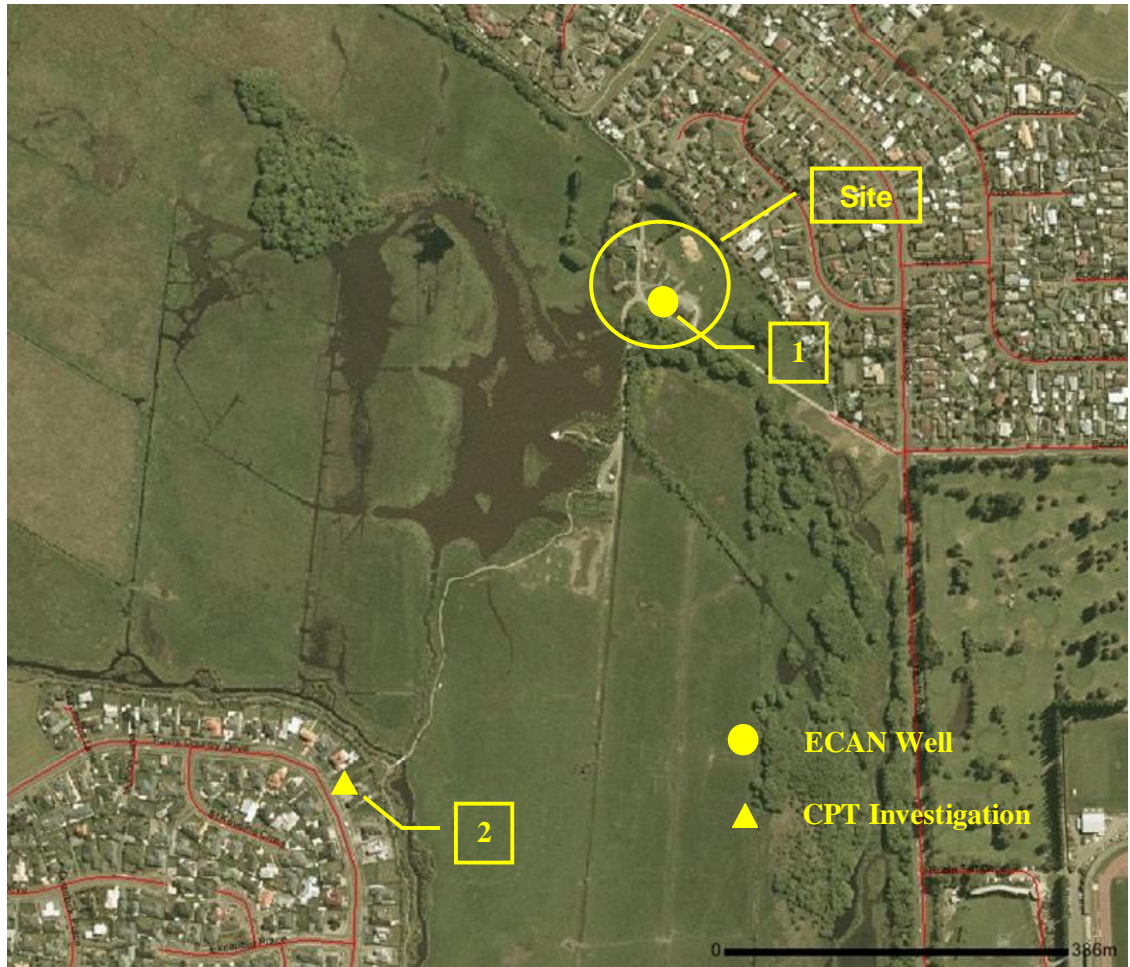
- Zone: Green
- DBH Technical Category – N/A – Urban Non residential - properties immediately east and north east of the site are classified as TC2 while properties further north and south west of the site are classified as TC3



5.5 Historical land use

In reference to historical documents (e.g. Appendix A) it is shown that the site lies within land that was recorded as marshland or swamp in 1856 which is not too dissimilar to what is present today. It is therefore possible that soft or liquefiable ground would be present at the site. Some of the land area however has likely been built up since then including roads and paths on the site.

5.6 Existing ground investigation data



- **Figure 6 - Local Boreholes from project orbit**
(<https://canterburygeotechnicaldatabase.projectorbit.com/>)

Where available logs from these investigation locations are attached to this report (Appendix B), and the results are summarised in Section 6.1 and Appendix C.

Only investigation data located within the geological formation inferred to be present beneath the site were considered for this desktop study. The CPT investigation is located a significant distance away from the site, however it is located within the area inferred to be underlain by estuary and lagoon deposits. Therefore, the CPT investigation was considered to gain some understanding of the geology that may be present beneath the site. As significant changes in surface geology could occur in the area, the CPT investigation is unlikely to be a suitable indicator of geotechnical parameters for more detailed study.



5.7 Council property files

No council property files were available for the structures on site at the time of writing this report.

5.8 Site walkover

An external site walkover was conducted by a SKM engineer on 18 September 2012.

PRK 2347 BLDG 004 EQ2

The building is a timber construction with metal roofing supported on a concrete slab on grade floor. At the time of the site walkover no significant damage to the land surrounding the structure was noted. However, the site walkover was conducted more than 18 months after the earthquake event and any liquefied ejecta may have since been removed from the site. Small amount of silt ejecta was however noted near the perimeter of the structure. Some undulation in the surrounding ground was observed, however this is likely to be a landscaping feature rather than damage caused by the earthquake event.

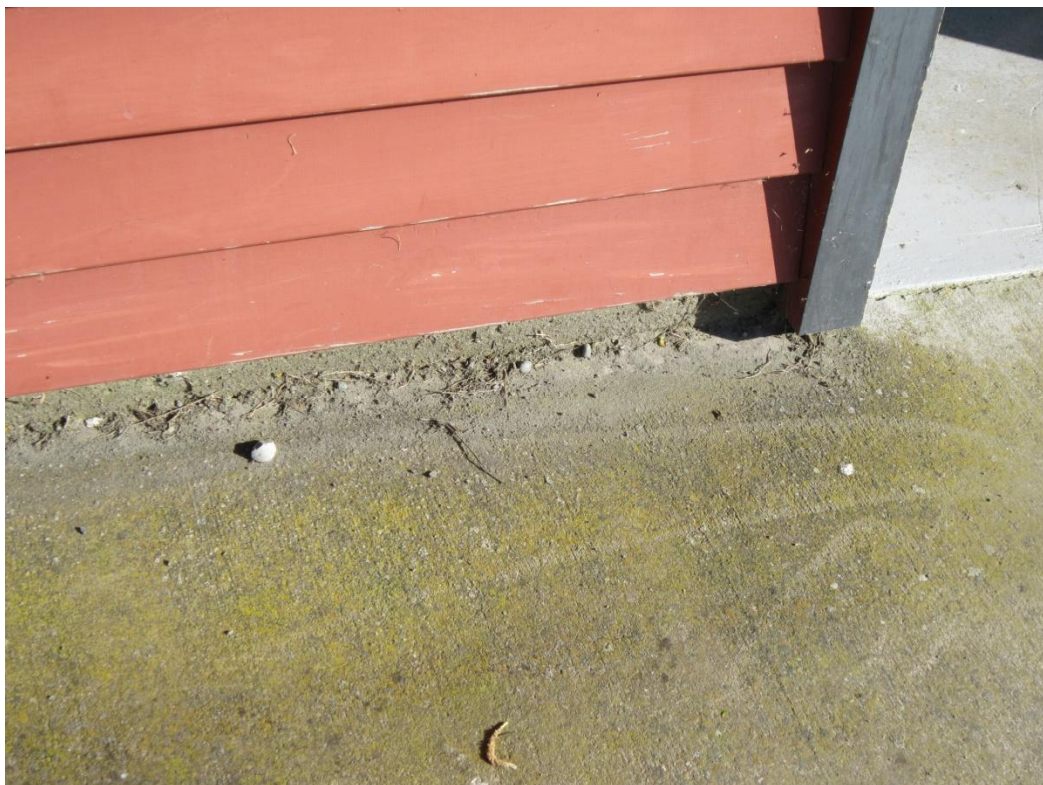
Additionally, hair line cracks were in the floor slab and some separation of the outside pavement slabs was noted. No significant evidence of settlement due to liquefaction was noted. Therefore, the above separation and settlement may have been caused by ground shaking.



■ **Figure 7 - Overview of the toilet block**



■ **Figure 8 - Small separation of the pavement slabs**



■ **Figure 9 - Remaining silt ejecta from the earthquake event**



■ **Figure 10 - Hair line cracks in the floor slab**

PRK 2347 BLDG 006 EQ2

The building is an open structure with timber framing supported on timber poles. The depth the poles are buried to is not known.

Undulating ground was noted around the structure. However, this topography is expected to have existed before the earthquake. Some loose silt and sand material at ground surface was noted, which may be remnant ejecta from the earthquake event. However, other than for this no other significant land damage was noted during the site walkover.



■ **Figure 11 - Overview of the plant nursery**



■ **Figure 12 - Patches of remnant silt ejecta**



PRK 2347 BLDG 007 EQ2

The building is a timber construction, with timber piled foundations, with a metal roof, with the canopy supported on timber posts. The timber piles appear to be encased in a concrete block below ground level. The embedment depth of the piles is not known. The adjacent ground was noted to be slightly sloping toward the toilet structure.

Some separation of the concrete block encasing the piles and adjacent ground was noted. This may indicate some differential settlement between adjacent ground and the respective posts. Significant amount of cracking (up to 10 mm wide) was also observed in the concrete slab west of the structure. However, the level and nature of this damage indicates that it is likely to have been a result of vehicle or other repeated loading on the unreinforced concrete slab rather than damage caused by the earthquake event.

Some patches of loose sand and silt material were noted around the property. This may be remnant liquefied ejecta from the earthquake event. No significant evidence of other land damage was found during the site walkover.



■ **Figure 13 - Overview of building**



■ **Figure 14 - Observed foundation for the building**



■ **Figure 15 - Concrete encased piles some separation between the block and adjacent ground**



■ **Figure 16 - Significant cracking of the slab west of the building**

6. Conclusions and recommendations

6.1 Site geology

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

Depth range (mBGL)	Soil type
0 - 5	No Data
1 - 29	Medium dense to dense sand (Christchurch formation)
29 - 32	Silt and silty sand (Christchurch Formation)
32 - 40	Gravel (Riccarton Gravels)

A shallow water table within 0.5 m to 1 m BGL is expected due to nearby water ways.

6.2 Seismic site subsoil class

The site has been assessed as NZS 1170.5 Class D (soft or deep soil) using nearby borehole investigation data.

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.

The third preferred method has been used in the above assessment of site subsoil class. Even though, the site is inferred to be underlain by lagoon and estuary deposits, the site is not expected to be underlain by Class E soil. This is supported by the fact that even though a moderate level of liquefaction appears to have occurred on site due to the 22 February 2011 event, there is no significant evidence of land movement toward the estuary, which may be expected for a Class E soil. Additionally, below a depth of 5 m available investigation data indicates sand from the Christchurch formation to be present. Therefore, in this case it is very unlikely that 10 m of very soft or very loose soil, as defined in NZS 1170.5 as required for Class E soil, is present beneath the site.

6.3 Building Performance

Two of the structures were noted to be supported on timber piles (likely shallow founding depth), while the third structure appears to be supported on a concrete slab on grade. However, no other detailed information regarding the dimensions of the respective foundation was known at the time of writing this report. From the general performance of the structures, the foundations appear to be adequate for their current purpose.

It should be noted that no evidence of lateral spreading was noted on site as a result of the 22 February 2011 earthquake. The presence of a free face in the form of the nearby waterway and liquefiable soils beneath the site means that in a future event there is still a possibility of lateral spreading occurring on site. In this case a TC3 type foundation may be required for the toilet structure. Additionally, the embedment depth of the timber piles for the plant nursery and cottage respectively is not known. These foundations may not be adequate if lateral spreading due to an earthquake event was to occur on site. This would require further consideration if the foundation for the structure is to be rebuilt or repaired.



6.4 Ground performance and properties

Liquefaction risk is expected to be moderate for this site. Significant surface evidence of liquefaction on site as well as elevated water table could be seen from the aerial photographs. It should be noted that no significant evidence of liquefaction was noted during the site walkover. However, this is most likely due to the significant lapse of time between the seismic event and the external site walkover undertaken. It is expected that swamp deposits would be present at very shallow depths. These layers are likely to be highly susceptible to liquefaction if they are below the ground water table. The CPT investigation undertaken approximately 700 m away from the site indicates medium dense to dense sand beneath the respective location with lenses of loose sand and silty sand. A similar formation may exist beneath the site. In which case, the loose and medium dense sand are likely to be susceptible to liquefaction under an ultimate limit state earthquake event. The inferred dense sand layers are unlikely to be susceptible to liquefaction.

Even though there was no evidence of lateral spreading noted during the site walkover, there is still some risk of lateral spreading on site in the future due to the high potential for liquefaction to occur within the shallow soil layers and the presence of free faces caused by nearby waterways. The level of risk is however expected to be low as the closest structure is 50 m from the free face with the height of free face is expected to be relatively small in comparison to the above distance.

As no information for the first 5 m below ground level is available from the borehole log near the site and the CPT investigation is located a significant distance away from the site, an estimation of ground properties, which can be reliably used in a quantitative DEE to assess the capacity of the foundations, has not been made in this desktop study. If such properties are required for further investigation, a set of shallow investigation on site would be required.

6.5 Further investigations

If ground properties are required for the quantitative DEE, additional investigations would be required. Additional investigations required to estimate shallow ground properties for quantitative DEE purposes are:

- Two hand augers near each structure to a depth of 3m to assess the composition of the shallow soil layer

Deeper intrusive investigations would be required if a more detailed liquefaction assessment for the structures on site is required.

7. References

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

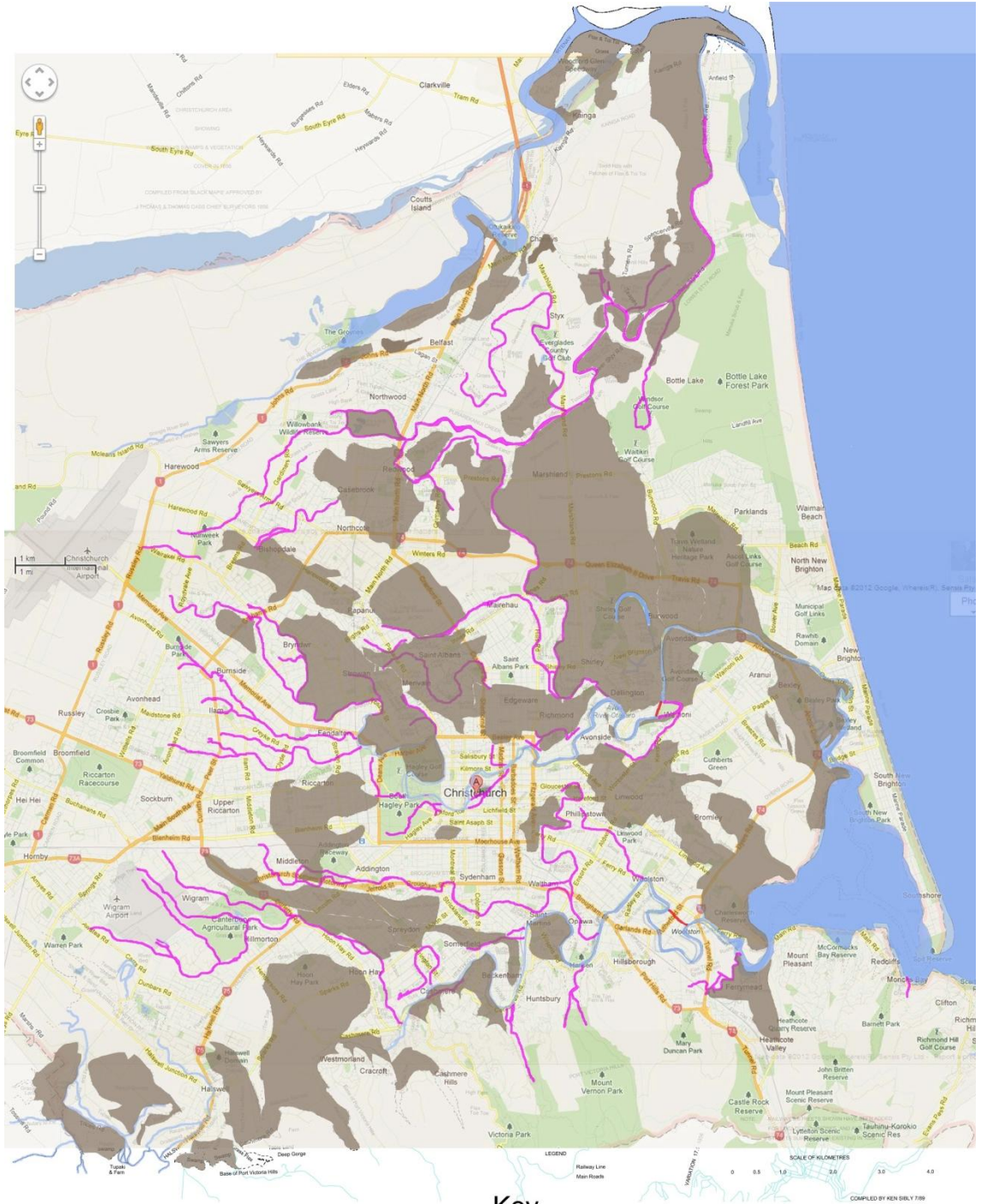
Forsyth PJ, Barrell DJA, Jongens R, 2008. Geology of the Christchurch area. Institute of Geological & Nuclear Sciences geological map 16.

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/riders from 1856 have been overlaid onto a map of Christchurch in 2012

- Key**
- Previous creeks/riders
 - Existing creeks/riders
 - New creeks/riders
 - Swamp/Marshland

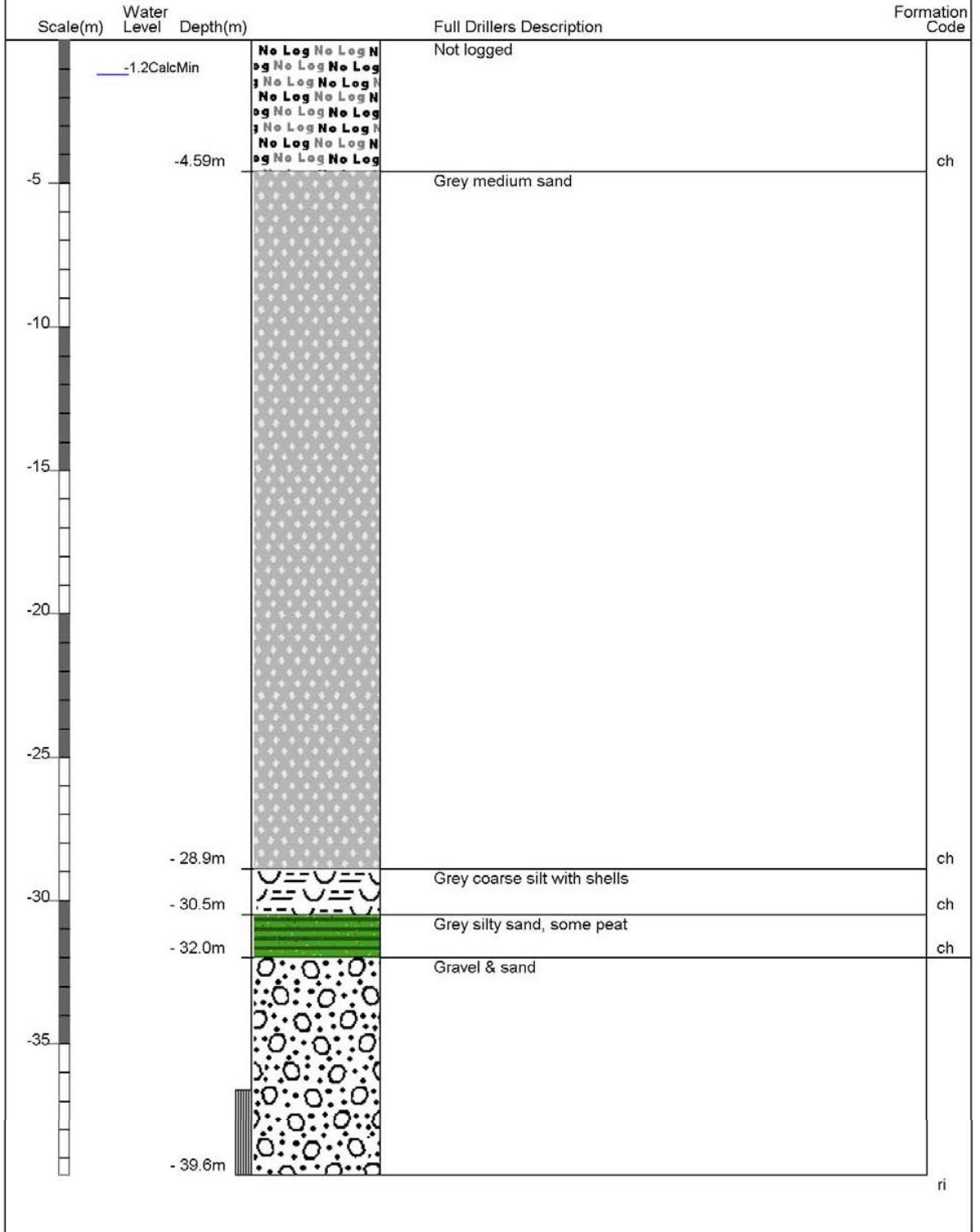


Appendix B – Existing ground investigation logs





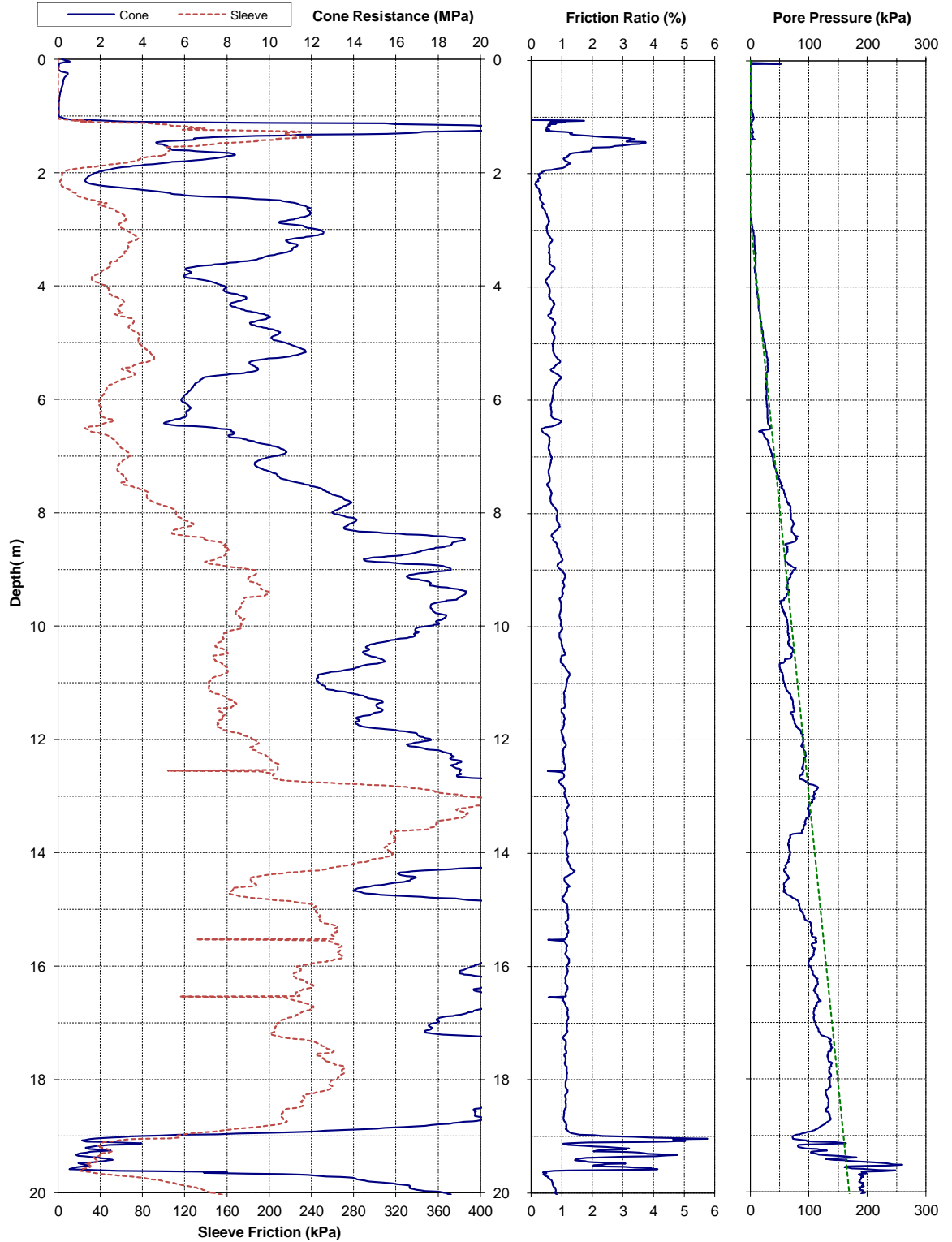
Borelog for well M35/1171

Gridref: M35:8560-4690 Accuracy : 4 (1=high, 5=low)
 Ground Level Altitude : 5.6 +MSD
 Driller : McMillan Water Wells Ltd
 Drill Method : Cable Tool
 Drill Depth : -39.59m Drill Date : 1/09/1976





Project: Christchurch 2011 Earthquake - EQC Ground Investigations			Page: 1 of 2	CPT-BUR-92	
Test Date: 19-Oct-2011	Location: Burwood	Operator: Perry		 EARTHQUAKE.COMMISSION	
Pre-Drill: 1.2m	Assumed GWL: 2.8mBGL	Located By: Survey GPS			
Position: 2485239.1mE	5746323.9mN	1.76mRL	Coord. System: NZMG & MSL		
Other Tests:			Comments:		





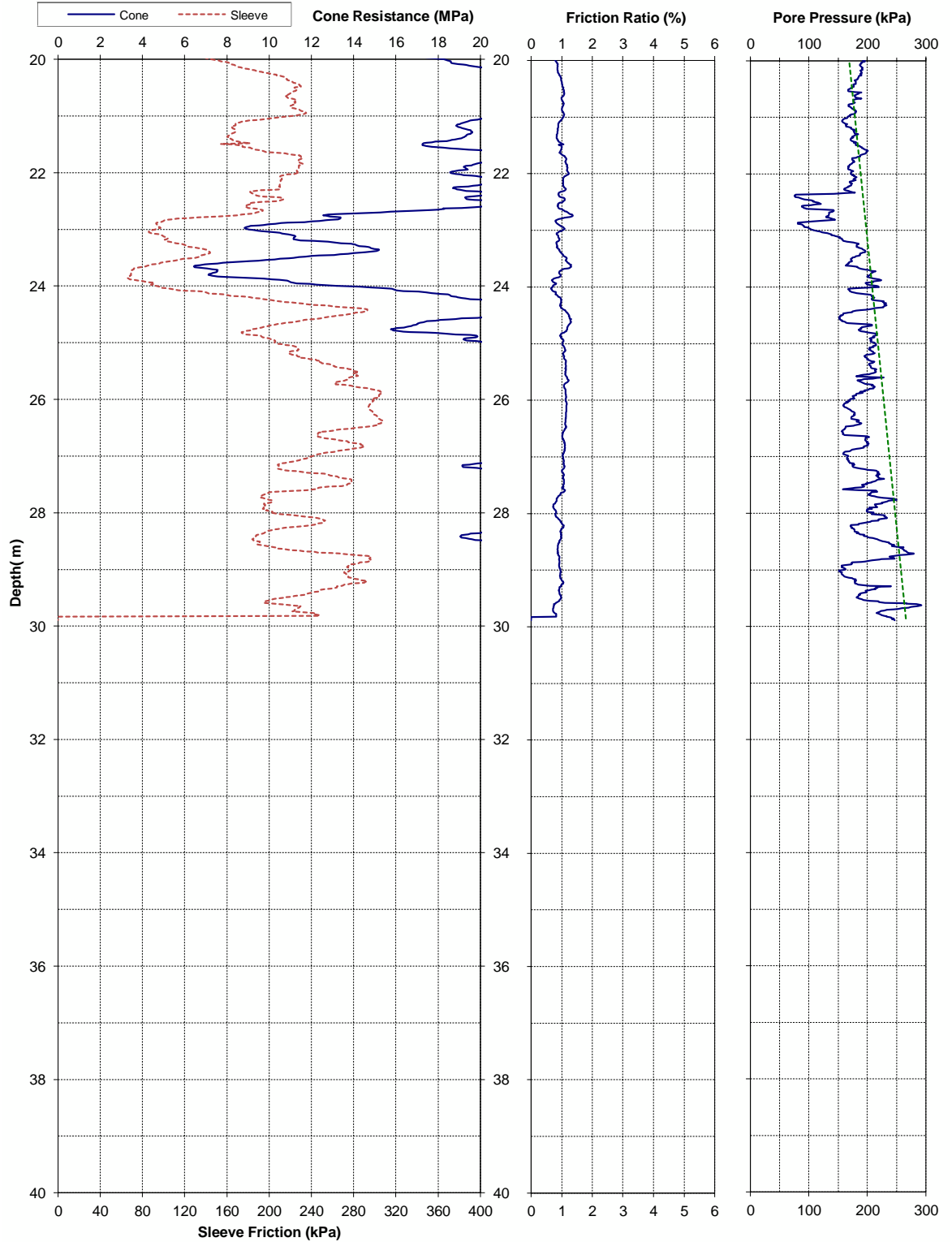
T+T Ref: 52000.3000

Printed: 25/10/2011 10:49 a.m.

Template: CPT Graph Template v0.41.xls



Project: Christchurch 2011 Earthquake - EQC Ground Investigations			Page: 2 of 2	CPT-BUR-92	
Test Date: 19-Oct-2011	Location: Burwood	Operator: Perry	 		
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Other Tests:			Comments:		



T+T Ref: 52000.3000

Printed: 25/10/2011 10:49 a.m.

Template: CPT Graph Template v0.41.xls



Appendix C – Geotechnical Investigation Summary



■ **Table 1 Summary of most relevant investigation data**

ID	1	2
Type *	BH**	CPT
Ref	M35 - 1171	BUR - 92
Depth (m)	40	30
Distance from site (m)	0	700
Ground water level (mBGL)	1.2	2.8
	0	N/A
	1	MD
	2	MD
	3	MD
	4	MD
	5	MD
	6	MD
	7	D
	8	D
	9	D
	10	D
	11	D
	12	D
	13	VD
	14	D
	15	D
	16	D
	17	D
	18	D
	19	D
	20	St
	21	D
	22	D
	23	D
	24	D
	25	D
Greater depths		

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

** 0-5m not logged

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