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Berwick Courts
BE 0630 EQ2
Detailed Engineering Evaluation
Quantitative Report
Version FINAL

31 Berwick Street, St Albans

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Berwick Courts
BE 0630 EQ2
Detailed Engineering Evaluation
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31 Berwick Street, St Albans

Christchurch City Council

Prepared By
Alex Baylis

Reviewed By
Stephen Lee

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Contents

Table Index

Figure Index

Appendices

Quantitative Report Summary

Berwick Courts

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Detailed Engineering Evaluation

Quantitative Report - SUMMARY

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31 Berwick Street, St Albans

Background

This is a summary of the Quantitative report for the building structure, and is based in general on the Detailed Engineering Evaluation Procedure document (draft) issued by the Structural Advisory Group on 19 July 2011 and visual inspections on 8 November 2012.

Building Descriptions

The Berwick Courts Residential Housing Complex consists of single storey multi residential buildings and is located at 31 Berwick Street in St Albans. The original buildings are assumed to have been constructed during the early 1970s based on the type of construction observed. The complex consists of 6 blocks (Blocks A to F) comprising a total of 12 one bedroom residential units. The buildings are solely used as residential housing. The layout and orientation of the housing blocks are shown below. All blocks have a similar layout and are constructed from similar materials.

Key Damage Observed

Cracking in the plaster lining of the timber framed walls was observed in all units in Blocks A to F. Cracking was also observed in all of the units in the plasterboard linings at the corners of windows and door frames where stresses are likely to have been concentrated during an earthquake. The most significant cracking to the plasterboard linings has occurred where a timber lintel beam perpendicular to the wall is supported above a door or window opening.

Cracking was observed in the reinforced concrete perimeter footing in Blocks A, D, E and F.

Building Capacity Assessment

Blocks A to F have been assessed to have a seismic capacity in the order of 94% NBS and are therefore not Earthquake Prone or Earthquake Risk.

Recommendations

Blocks A to F have been assessed to have a %NBS greater than 67% NBS and are neither Earthquake Prone nor Earthquake Risk. No further action is required by Christchurch City Council to comply with the Building Code.

The plasterboard linings on the interior faces of the timber framed walls in each block have suffered damage during the recent seismic activity. In several locations, the plasterboard lining has fractured. It is recommended that where a plasterboard panel has fractured, it is replaced to ensure the full bracing capacity of the structure is achieved.

1. Background

GHD has been engaged by Christchurch City Council (CCC) to undertake a detailed engineering evaluation of Berwick Courts in St Albans.

This report is a Quantitative Assessment of the building structure, and is based in general on the Detailed Engineering Evaluation Procedure document (draft) issued by the Structural Advisory Group on 19 July 2011.

A quantitative assessment involves a full site measure of the building which is used to determine the buildings bracing capacity in accordance with manufacturers' guidelines where available. When the manufacturers' guidelines are not available, values for material strengths are taken from Table 11.1 of the NZSEE guidelines for the Assessment and Improvement of the Structural Performance of Buildings in Earthquakes. The demand for the building is determined in accordance with NZS 3604: 2011 and the percentage of New Building Standard (%NBS) is assessed.

At the time of this report, no intrusive site structural investigation or modelling of the building structure had been carried out. The detailed analysis consisted of a bracing calculation for each orthogonal direction of the structure. No further analysis or calculations were carried out.

2. Compliance

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

2.1 Canterbury Earthquake Recovery Authority (CERA)

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

Section 38 – Works

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

Section 51 – Requiring Structural Survey

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

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

2.2 Building Act

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

Section 112 – Alterations

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

Section 115 – Change of Use

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

2.2.1 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 other property could collapse or otherwise cause injury or death; or
- A territorial authority has not been able to undertake an inspection to determine whether the building is dangerous.

Section 122 – Earthquake Prone Buildings

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

Section 124 – Powers of Territorial Authorities

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

Section 131 – Earthquake Prone Building Policy

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

2.3 Christchurch City Council Policy

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

The 2010 amendment includes the following:

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

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

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.

2.4 Building Code

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

After the February Earthquake, on 19 May 2011, Compliance Document B1: Structure was amended to include increased seismic design requirements for Canterbury as follows:

- Hazard Factor increased from 0.22 to 0.3 (36% increase in the basic seismic design load)
- Serviceability Return Period Factor increased from 0.25 to 0.33 (80% increase in the serviceability design loads when combined with the Hazard Factor increase)

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

3. Earthquake Resistance Standards

For this assessment, the building's 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 3.1 below.

Description	Grade	Risk	%NBS	Existing Building Structural Performance	Improvement of Structural Performance: Legal Requirement	Improvement of Structural Performance: 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 3.1 NZSEE Risk Classifications Extracted from table 2.2 of the NZSEE 2006 AISPBE

Figure 3.2 compares the percentage NBS to the relative risk of the building failing in a seismic event with a 10% risk of exceedance in 50 years (i.e. 0.2% in the next year). It is noted that the current seismic risk in Christchurch results in a 6% risk of exceedance in the next year.

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

Figure 3.2 %NBS compared to relative risk of failure

4. Building Descriptions

4.1 General

The Berwick Courts Residential Housing Complex consists of single storey multi residential buildings and is located at 31 Berwick Street in St Albans. The original buildings are assumed to have been constructed during the early 1970s based on the type of construction observed. The complex consists of 6 blocks (Blocks A to F) comprising a total of 12 one bedroom residential units. The buildings are solely used as residential housing. The layout and orientation of the housing blocks are shown below. All blocks have a similar layout and are constructed from similar materials.

Figure 4.1 Layout of housing blocks

Blocks A to F are similar in construction and consist of 2 one bedroom units. The blocks are approximately 12m long, 6.5m wide and 4.0m in height. The overall footprint of these blocks is approximately $80m^2$.

The structure of these buildings consists of internal and external timber framed walls lined internally with plasterboard and clad externally with fibre-cement boards. The roof structure consists of timber purlins and rafters clad with corrugated sheet metal. The underside of the timber rafters in each residential unit are lined with plasterboard. The foundations of the buildings consist of timber joists and bearers supported by reinforced concrete piles (see Photograph 11). There is a reinforced concrete foundation wall around the perimeter of each building.

Figures 4.2 and 4.3 show sketches of the construction details typical to all blocks.

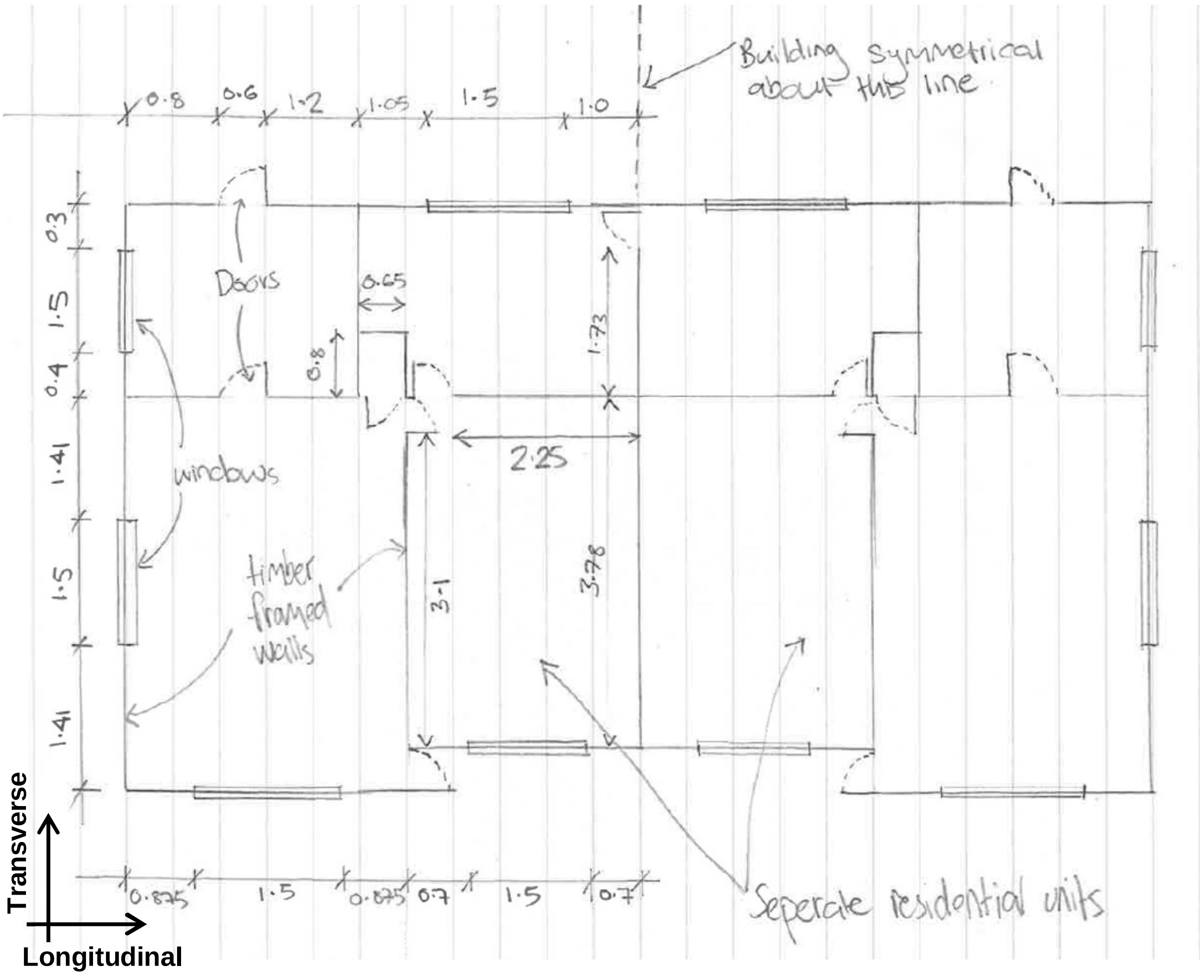


Figure 4.2 Typical Plan of Blocks A & B

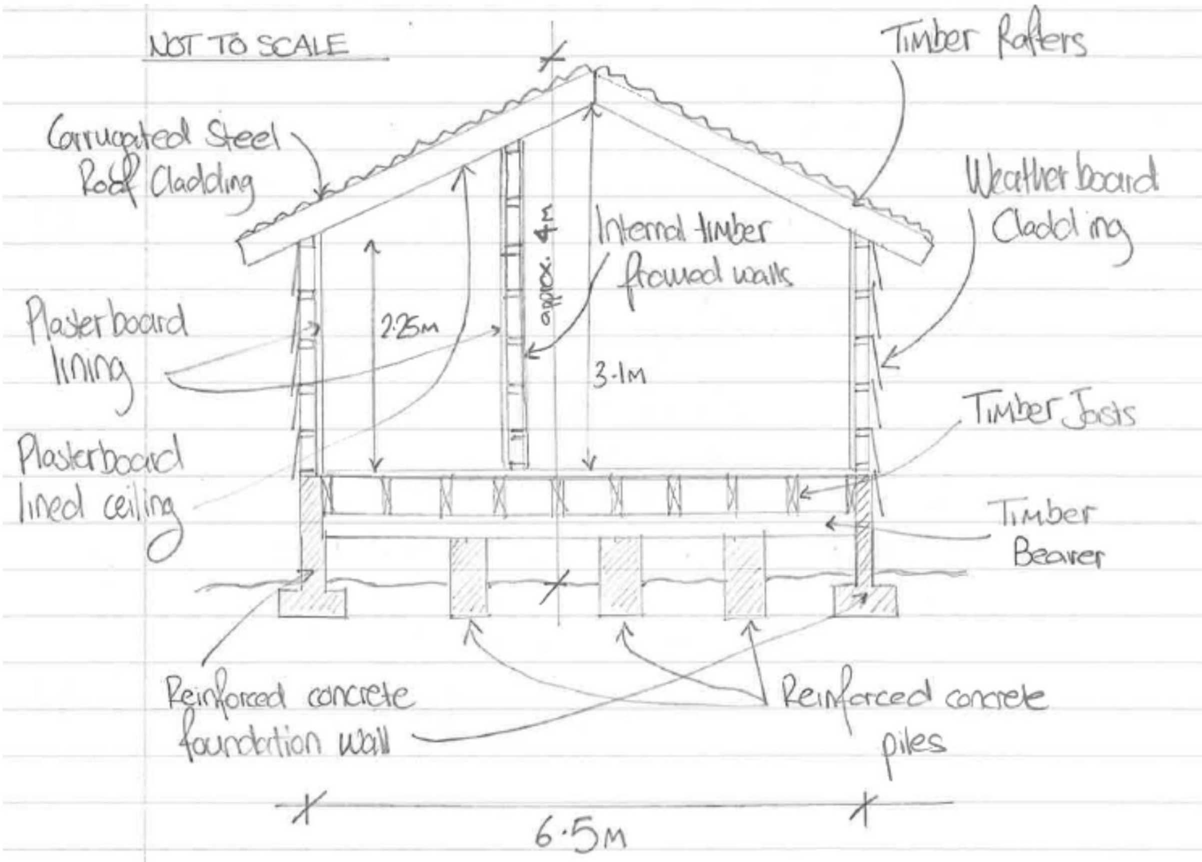


Figure 4.3 Typical Section of a Housing Unit

4.2 Gravity Load Resisting Systems

Gravity loads acting on the buildings are resisted by load bearing timber framed walls. Gravity loads from the corrugated sheet metal roof are transferred via the timber purlins and rafters to the timber framed walls. The gravity loads are transferred through the timber framed walls to the timber floor joists and bearers and to the reinforced concrete piles and foundation walls where they are distributed into the ground.

4.3 Lateral Load Resisting Systems

The plasterboard lined ceiling to the underside of the timber rafters in each residential unit provides a diaphragm to transfer seismic forces in the roof structure to the lateral load resisting walls supporting the diaphragm. The lateral seismic loads in both the longitudinal and transverse directions are resisted by the plasterboard lined timber framed walls which act as in-plane shear bracing panels.

In each direction of the buildings, subfloor bracing is provided by the perimeter concrete foundation walls. The timber floor joists and timber bearers supported by reinforced concrete piles provide a diaphragm to allow the lateral seismic forces to be distributed to the reinforced concrete foundation walls.

5. Assessment

5.1 Site Inspection

An inspection of the buildings was undertaken on the 8th of November 2012. Both the interior and exterior of each unit was inspected. Most of the main structural components of the building were internally and externally lined and were unable to be viewed. Limited inspections of the foundations of Block F were undertaken.

The inspection consisted of observing the building to determine the structural systems and likely behaviours of the building during earthquake. The site was assessed for damage, including observing the ground condition, checking for damage areas where damage would be expected for the structure type observed and noting general damage observed throughout the building in both structural and non-structural elements.

5.2 Available Drawings

No drawings of the existing structures are available.

Sketches of key structural elements are included in Appendix B.

5.3 Damage Assessment

5.3.1 Surrounding Buildings

No significant damage to the surrounding buildings was observed during inspections.

5.3.2 General Observations

Cracking in the plaster lining of the timber framed walls (see Photograph 3) was observed in all units in Blocks A to F. Cracking was also observed in all of the units in the plasterboard linings at the corners of windows and door frames where stresses are likely to have been concentrated during an earthquake. The most significant cracking to the plasterboard linings has occurred where a timber lintel beam perpendicular to the wall is supported above a door or window opening (see Photographs 5 and 7).

Cracking was observed in the reinforced concrete perimeter footing in Blocks A, D, E and F (see Photograph 2).

5.3.3 Ground Damage

Evidence of liquefaction was observed near the front entrance to Unit 6 in Block C.

5.3.4 Level Survey

A level survey of all units within the blocks was undertaken during the inspection of the site on 8 November 2012. The survey was carried out with a zip level, using the entrance to each unit as the datum point. Levels were taken at the corners of each room in the units where accessible.

All units had a recorded differential settlement in the range of 30mm to 60mm across the building. The largest relative settlement of up to 60mm was recorded in Unit 2 of Block A. Unit 1 in Block A also has a recorded differential settlement of 58mm. The remaining blocks have differential settlement in the range of 30mm to 50mm. These settlements are not likely to affect the seismic performance of the buildings.

The values obtained from the level survey suggest that sections of the buildings foundations have settled. The differential settlement is attributable to localised minor liquefaction of the ground. The observed settlements are consistent with estimated settlements for the ground conditions observed.

6. Geotechnical Consideration

The site, known as Berwick Courts is situated at 31 Berwick Street, in the suburb of Saint Albans, north of Christchurch City centre. It is relatively flat at approximately 4.9 m above mean sea level. It is approximately 1.8 km northwest of Avon River, and 7.3 km west of the coast (Pegasus Bay).

6.1 Published Information on Ground Conditions

6.1.1 Local Geology

The geological map[1] of the area indicates that the site is underlain by:

- Dominantly alluvial sand and silt overbank deposits, being alluvial soils of the Yaldhurst Member, sub-group of the Springston Formation, Holocene in age;
- The Riccarton gravels are located approximately 20 m bgl; and
- Groundwater is likely within 1 m of ground level.

6.1.2 Environment Canterbury Records

Information from Environment Canterbury (Can) indicates that there are ten boreholes located within 100 m of the site. The bore logs are shown in Table 6.1. These indicate the area is underlain by sand and silt layers overlying sandy gravels, with some layers of sand overlying deeper gravel. Varying amounts of clay and peat are also indicated to be present.

Table 6.1 ECan Borehole Summary

Bore Name	Log Depth	Groundwater	From Site	Log Summary
M35/2562	15.5 m	Not indicated	100 m SE	0 – 0.6 m Silty fine SAND
				0.6 – 1.2 m Clayey SILT
				1.2 – 1.6 m SILT with peat and roots
				1.6 – 2.5 m Sandy SILT
				2.5 – 6.8 m SAND with peat
				6.8 – 7.6 m SAND and GRAVEL
				7.6 – 10.3 m Sandy GRAVEL
				10.3 – 10.9 m Gravelly SAND
				10.9 – 12.1 m Fine to medium SAND

[1] Brown, L. J. and Weeber, J.H. 1992: Geology of the Christchurch Urban Area. Institute of Geological and Nuclear Sciences 1:25,000 Geological Map 1. Lower Hutt. Institute of Geological and Nuclear Sciences Limited.

Bore Name	Log Depth	Groundwater	From Site	Log Summary
				12.1 – 13.4 m SAND and GRAVEL 13.4 – 15.5 m Fine to medium SAND
M35/14863	15.7 m	Not indicated	80 m S	0 – 0.6 m Silty fine SAND 0.6 – 1.2 m Peat and Clayey SILT 1.2 – 1.4 m Sandy and clayey SILT 1.4 – 1.7 m Clayey SILT 1.7 – 2.6 m Sandy SILT 2.6 – 6.8 m Silty SAND 6.8 – 15.7 m GRAVEL and SAND
M35/16199	1.4 m	Not indicated	25 m W	0 – 0.3 m Topsoil 0.3 – 0.6 m SAND 0.6 – 1.4 m Sandy SILT
M35/16984	1.4 m	Not indicated	75 m E	0 – 0.35 m SILT 0.35 – 0.9 m Silty SAND 0.9 – 1.1 m SILT 1.1 – 1.4 m Clayey SILT with some peat

It should be noted that the logs have been written by the well driller and not a geotechnical professional or to a standard. In addition strength data is not recorded.

6.1.3 EQC Geotechnical Investigations

The Earthquake Commission has undertaken geotechnical testing in the area of the site. Information pertaining to this investigation is included in the Tonkin & Taylor Report for St Albans[2]. Two investigation points were undertaken within 100 m of the site, as summarised below in Table 6.2.

Table 6.2 EQC Geotechnical Investigation Summary Table

Bore Name	**Orientation from Site**	**Depth (m bgl)**	**Log Summary[3]**
CPT-STA-50	72 m E	0 – 1.2	Pre-drilled
		1.2 – 1.7	Stiff CLAY
		1.7 – 2	Very loose SAND
		2 – 2.8	Very loose SAND and firm SILT
		2.8 – 4.9	Medium dense SAND
			(WT at 1.2 m bgl)
BH STA 05	88 m S	0 – 1.0	Fill
		1.0 – 2.0	Firm SILT
		2.0 – 3.8	Silty fine SAND, loose
		3.8 – 5.0	Fine to medium SAND with minor silt, loose
		5.0 – 5.9	Gravelly SAND with silt, medium dense
		5.9 – 7.3	Fine to coarse GRAVEL, dense
		7.3 – 11.0	GRAVEL, medium dense to dense
		11.0 – 13.8	SAND with minor silt, medium dense
		13.8 – 14.0	Coarse GRAVEL, dense
		14.0 – 15.0	SAND, medium dense to dense
		15.0 – 20	SAND with silt, medium dense to dense
			(WT at 3.8 m bgl)

The CPT results indicate the soils are generally granular with silt overlaying sand and then sand and gravel.

[2] Tonkin & Taylor Ltd., 2011: Christchurch Earthquake Recovery, *Geotechnical Factual Report, St Albans.*

[3] Log Summary for CPT's interpreted from Soil Behavior Type Robertson *et al*. 2010

6.1.4 CERA Land Zoning

Canterbury Earthquake Recovery Authority (CERA) has indicated the site is situated within the Green Zone, indicating that repair and rebuild may take place.

Land in the CERA green zone has been divided into three technical categories (TC). These categories describe how the land is expected to perform in future earthquakes.

The site has been categorised as TC3. This means that moderate to significant land damage from liquefaction is possible in future significant earthquakes.

6.2 Historical Aerial Photography

No fill is indicated from the CCC Landfill Map[4]. Aerial Photos taken in 1946[5] and 1955[6] show no signs of filling, and instead show residential property.

6.3 Post-Earthquake Land Observations

6.3.1 Aerial Photographs

Aerial photography taken following the 4 September 2010 earthquake shows minor signs of liquefaction at the site.

Aerial photography taken following the 22 February 2011 earthquake shows moderate signs of liquefaction at the site, as shown in Figure 6.1. The wider area shows signs of liquefaction in all the surrounding streets.

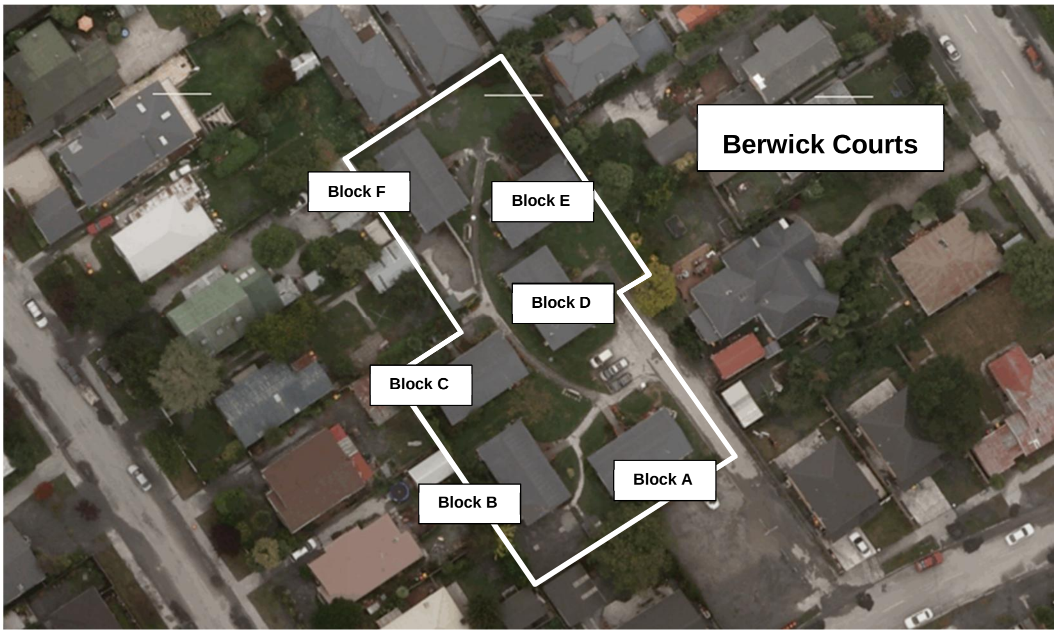
Aerial photography taken following the June 2011 and December 2011 earthquakes show no further signs of liquefaction.

[4] Map of the "Christchurch Landfill Sites", Christchurch City Council, 29 September 1995

[5] Aerial Photography of, Burwood, Greater Christchurch, taken 30/05/1946, provided by Christchurch City Council

[6] Aerial Photography of Burwood, Greater Christchurch, 2nd Edition, taken 10/05/1955, provided by Christchurch City Council

Figure 6.1 Post February 2011 Earthquake Aerial Photography[7]



6.3.2 Field Observations

A number of cracks were observed in the concrete perimeter footing. There was little evidence of liquefaction on the site; however, any evidence is likely to have been remediated.

[7] Aerial Photography Supplied by Koordinates sourced from http://koordinates.com/layer/3185-christchurch-post-earthquake-aerial-photos-24-feb-2011/

6.4 Seismicity

6.4.1 Nearby Faults

There are many faults in the Canterbury region, however only those considered most likely to have an adverse effect on the site are detailed below.

Table 6.3 Summary of Known Active Faults[8,9]

Known Active Fault	Distance from Site	Direction from Site	Max Likely Magnitude	Avg Recurrence Interval
Alpine Fault	120 km	NW	~8.3	~300 years
Greendale Fault (2010)	23 km	W	7.1	~15,000 years
Hope Fault	100 km	N	7.2~7.5	120~200 years
Kelly Fault	110 km	NW	7.2	150 years
Port Hills Fault (2011)	9 km	S	6.3	*Not estimated*

The recent earthquakes since 4 September 2010 have identified the presence of a previously unmapped active fault system underneath the Canterbury Plains; these include the Greendale Fault and Port Hills Fault listed in Table 6.3. Research and published information on this system is in development and the average recurrence interval is yet to be established for the Port Hills Fault.

6.4.2 Ground Shaking

New Zealand Standard NZS 1170.5:2004 quantifies the Seismic Hazard factor for Christchurch as 0.30, being in a moderate to high earthquake zone. This value has recently been provisionally upgraded (from 0.22) to reflect the seismicity hazard observed in the earthquakes since 4 September 2010.

The recent seismic activity has produced earthquakes of Magnitude 6.3 with peak ground accelerations (PGA) up to twice the acceleration due to gravity (2g) in some parts of the city and has resulted in widespread liquefaction throughout Christchurch.

Conditional PGA's from the Canterbury Geotechnical Database (CGD)[10] indicate the PGA at the site to be 0.21g during the 4 September 2010 earthquake, 0.35g on 22 February 2011, and 0.20g on 13 June 2011.

6.5 Global Land Issues

St Albans is a relatively flat lying suburb of Christchurch. There have been no recorded ground issues relating to global lateral movement in this suburb.

[8] Stirling, M.W, McVerry, G.H, and Berryman K.R. (2002) A New Seismic Hazard Model for New Zealand, Bulletin of the Seismological Society of America, Vol. 92 No. 5, pp 1878-1903, June 2002.

[9] GNS Active Faults Database

[10] Canterbury Geotechnical Database (2012): "Conditional PGA for Liquefaction Assessment", Map Layer CGD5110 - 27 Sept 2012, retrieved 31/10/2012 from https://canterburygeotechnicaldatabase.projectorbit.com/

6.6 Field Investigations

The geotechnical field investigation comprised a site walkover, two hand augers (HA01, HA02) with Scala penetrometer tests, and two cone penetrometer tests (CPT01 and CPT02) located around the building. The investigation layout is shown in Figure 6.2 and the GPS (NZMG) locations of the tests are tabulated in Table 6.4 below.

Table 6.4 Investigation Locations

Borehole Number	Depth (m bgl)	Northing	Easting
CPT01	9.8	5744390	2480924
CPT02	10.0	5744351	2480924
HA01	3.8	5744318	2480931
HA02	3.6	5744410	2480890

Two CPTs were undertaken by McMillan Specialist Drilling Services on 2 November, 2012.

Figure 6.2 Investigation Location Plan

6.7 Ground Conditions Encountered

The ground conditions encountered are summarised in this section. Our investigations show that the top layers of silt and sand varied slightly in thickness across the site but were generally 3.5 m thick.
A summary of the ground conditions encountered for each testing methodology are shown in Table 6.5 and Table 6.6.

6.7.1 Hand Auger and Scala Penetrometer Tests

Clay layers were not encountered at all depths in all locations. The hand augers generally show the site to be underlain by interbedded with layers of silt and sand. A general summary is outlined in Table 6.5.

Table 6.5 Summary of Hand Auger and Scala

Depth (m)	Lithology	Scala blows per 100 mm
0 – 0.45	Organic SILT	-
0.45 – 0.7	SILT	-
0.7 – 1.3	Silty SAND	-
1.3 – 2.2	SILT with organics	0 – 7
2.2 – 3.1	Silty SAND to sandy SILT	7 – 19
3.1 – 3.6	Sandy SILT	15 – 24
3.6 – 3.8	Silty SAND	> 20

Groundwater was recorded at 2.1 m and 2.6 m bgl.

Detailed engineering bore logs can be found in Appendix D.

6.7.2 Cone Penetrometer Tests

A summary of the inferred lithology from the soil behaviour type encountered by the CPT investigations is summarised in Table 6.6 below.

Table 6.6 Summary of CPT-Inferred Lithology

Depth (m)	Lithology
0 – 3.3	SILT mix, stiff
3.3 – 5.6	SANDS, loose to medium dense
5.6 – 6.5	Sandy GRAVEL, dense to very dense
6.5 – 8.5	Gravelly SAND, medium dense to dense
8.5 – 10	Sandy GRAVEL, very dense

Groundwater was recorded at 1.7 m bgl.

Detailed engineering bore logs can be found in Appendix D.

6.7.3 Summary of Ground Conditions Encountered

As outlined in Table 6.5 and Table 6.6, the ground conditions below topsoil predominantly consisted of silts with sand horizons to 3.3 m underlain by layers of sand and gravel and sandy gravel.

The sand horizon starts at ~3.5 m depth and varies from loose to medium dense to medium dense. Below typically 5.5 m the sand changes to dense gravelly sand and below 8.5 m to very dense sandy gravel. The EQC CPT refused at the sand layer at a depth of 4.9 m bgl, and the CPT conducted by McMillan Drilling on behalf of GHD refused at the gravel layer at a depth of 10 m bgl.

The deeper EQC and ECan bores indicate below 10 m the ground conditions continues as interbedded gravelly sand and sandy gravel to 20 m

Groundwater levels on site were recorded as being between 1.7 m and 2.6 m bgl.

6.8 Liquefaction Assessment

Due to the anticipated presence of loose/soft alluvial soils a comprehensive liquefaction analysis has been undertaken.

6.8.1 Parameters used in Analysis

Assumptions made for the analysis process are as follows:

- Importance Level 2, 50-year design life, giving peak ground accelerations (PGA's) of:
  - → 0.35 g for Ultimate Limit State (ULS), and
  - → 0.13 g for Serviceability Limit State (SLS);
- Earthquake Magnitude 7.5; and
- Groundwater levels at 1.7 m bgl.

Soil unit weights have been approximated using the tip resistance and sleeve friction from the CPT investigation data using formulae from Robertson & Cabal.

The liquefaction analysis process has been conducted using the methodology from Robertson & Wride, and from the NZGS Guidelines. Settlements were estimated using the methodology outlined in Zhang et al (2002).

6.8.2 Results of Liquefaction Analysis

The results of the liquefaction analysis, as outlined in Table 6.7, indicate that where the sand is loose to medium dense, it is moderately susceptible to liquefaction. The presence of dense gravelly sand at depth inhibits liquefaction.

Please refer to Appendix D for further detail.

Table 6.7 Summary of Liquefaction Susceptibility

Depth (m)	Soil Behaviour Type	Liquefaction Susceptibility [11]
0.0 – 1.7	SILT, stiff	Not liquefiable – above water table
1.7 – 3.3	SILT mix, stiff	Moderate
3.3 – 5.6	SAND, loose to medium dense	Moderate
5.6 – 6.5	Sandy GRAVEL, very dense	Insignificant

[11] Table 6.1, NZGS Guidelines Module 1 (2010)

6.5 – 8.5	Gravelly SAND, medium dense	Low
8.5 – 10.0	Sandy GRAVEL, very dense	Insignificant

Settlement estimates for the CPT locations are listed in Table 6.8.

Table 6.8 Estimated Liquefaction Induced Vertical Settlements

CPT Number	ULS, Total	SLS, Total	SLS Index Value
CPT01	27 mm	6 mm	6 mm
CPT02	62 mm	15 mm	15 mm

The SLS index value reflects the vertical settlement of the shallow soils (<10m) for an SLS event.

The estimated vertical settlements at ULS and SLS are more typical of TC2 type ground behaviour.

Please refer to Appendix D for further details.

6.8.3 Liquefaction Summary

The site is considered to have a moderate susceptibility to liquefaction based of the following:

- Observations of moderate to severe liquefaction in the surrounding area from post-earthquake aerial photography;
- The site and surrounding properties are classified TC3;
- Estimated ULS and SLS settlements are consistent with TC2 ground behaviour.
- Presence of several liquefiable layers identified in liquefaction assessments.

6.9 Interpretation

Since the PGA for 22 February exceeds 170% of the magnitude-corrected SLS value, the site can be considered "sufficiently tested at SLS" [12]. As a result, the ground damage during a future moderate earthquake (SLS) is likely to be similar or less than that observed in the 22 February 2011 earthquake.

The site is considered to be of minor to moderate susceptibility to liquefaction. This is based on there being no significant signs of liquefaction directly outside the unit footprints. However, moderate to significant liquefaction was observed in the car park and neighbouring driveways.

Differential settlement across the units and cracking damage to the foundations of the buildings was observed. This damage is attributable to localised minor liquefaction of the ground. The observed settlements are consistent with estimated settlements which are more typical for TC2 type ground behaviour.

[12] MBIE (2012): "Appendix A: Liquefaction Calculation Methodology", *Guidelines for the investigation and assessment of subdivisions on the flat in Canterbury*, http://www.dbh.govt.nz/subdivisions-assessment-guide#aid10

The liquefaction analysis indicates moderate liquefaction susceptibility of the shallow soil from 1.7 m to 5.6 m bgl and pockets of soil susceptible to liquefaction from 6.5 to 8.5 m bgl.

6.9.1 Summary and Recommendations

The subject structure has remained operational throughout the Canterbury earthquake sequence and has suffered some settlement.

Based on the information presented above, we recommend the following for the subject site:

- A soil class of **D** (in accordance with NZS 1170.5:2004) should be adopted for this site;
- The site has a moderate susceptibility to liquefaction.
- The site is classified as a TC2 property which indicates that minor to moderate land damage may occur from future earthquakes.

7. Structural Analysis

7.1 Seismic Loading Demand

Equivalent Static forces were calculated in accordance with NZS 1170.5:2004. The values obtained from these calculations were compared to the seismic bracing demand obtained from the NZS 3604:2011 requirements. Following comparison between the calculated values, the seismic bracing demand from NZS 3604:2011 calculations were found to be higher. As a result, the seismic bracing demand from NZS 3604:2011 has been used as the basis for %NBS calculations.

The distribution of lateral forces in both the longitudinal and transverse directions of the buildings follows the bracing design procedure discussed in Section 5 of NZS 3604:2011. The seismic bracing demand in each direction was resolved into bracing units (BUs) and compared to the bracing capacity of the timber walls.

In both the longitudinal and transverse direction, a ductility factor of 3.0 has been assumed based on the relatively flexible, lightweight timber framed walls resisting lateral seismic loads.

7.1.1 Equivalent Static Method

Seismic loading parameters from New Zealand Standard 1170.5:2004.

- Site Classification — D
- Seismic Zone factor (Z)
  (Table 3.3, NZS 1170.5:2004 and NZBC Clause B1 Structure) — 0.30 (Christchurch)
- Annual Probability of Exceedance
  (Table 3.3, NZS 1170.0:2002, Importance Level 2) — 1/500 (ULS)
- Return Period Factor (R_u)
  (Table 3.5, NZS 1170.5:2004) — 1.0 (ULS)

Longitudinal Direction

- Ductility Factor (μ) — 3.0
- Ductility Scaling Factor (k_μ) — 2.14
- Performance Factor (S_p) — 0.7

Transverse Direction

- Ductility Factor (μ) — 3.0
- Ductility Scaling Factor (k_μ) — 2.14
- Performance Factor (S_p) — 0.7

An increased Z factor of 0.3 for Christchurch has been used in line with recommendations from the Department of Building and Housing.

The seismic weight coefficient was then calculated in accordance with Clause 5.2.1.1 NZS 1170.5: 2011. For the purposes of calculating the seismic weight coefficient a period, T_1, of 0.4 was assumed for both the longitudinal and transverse directions of the building. The coefficient was then calculated using Equation 5.2(1);

$$C_d(T_1) = \frac{C(T_1)S_P}{k_\mu}$$

Where

$$k_\mu = \frac{(\mu - 1)T_1}{0.7} + 1$$

Calculations - Longitudinal and Transverse Direction

$C(T_1) = C_h \cdot Z \cdot R \cdot N(T,D)$

$C_h = 3.0$ – Value from Table 3.1 ($T \leq 0.4s$)

$Z = 0.3$ – Hazard factor determined from Table 3.3 (NZS 1170.5:2004)

$R = 1.0$ – Return period factor determined from Table 3.5 (NZS 1170.5:2004)

$N(T,D) = 1.0$ – Near fault factor from Clause 3.1.6 (NZS 1170.5:2004)

$C(T_1) = 3.0 \cdot 0.3 \cdot 1.0 \cdot 1.0 = 0.9$

The horizontal design action coefficient:

$$C_d(T_1) = \frac{C(T_1) \cdot S_p}{k_\mu} = \frac{0.9 \cdot 0.7}{2.143} = 0.294$$

The seismic weight of each building, W_t, was calculated as 59.9 kN. Therefore, the horizontal seismic design action for the lined timber framed walls is:

$$\mathbf{C_d W_t = 0.294 \times 59.9\ kN = 17.6\ kN = 352\ BUs}$$

7.1.2 NZS 3604:2011 Seismic Bracing Demand

Seismic loading parameters from New Zealand Standard 3604:2011.

- Earthquake Zone: 2 (Christchurch)
- Soil Type: D
- Multiplication Factor: 0.8 (Table 5.8 NZS 3604:2011)

- Building Construction: Single storey building with sub-floor framing
- Floor Loading: 2 kPa
- Roof Cladding: Light
- Single Storey Cladding: Light

- Sub-floor Cladding: Heavy
- Roof Pitch: Less than 25°
- Building Area: 80 m^2

Calculations - Longitudinal and Transverse Direction

Bracing Demand (from Table 5.8 NZS 3604:2011):

$$\mathbf{BU_{demand,sub} = 17\ BU/m^2}$$

$$\mathbf{BU_{demand,wall} = 11\ BU/m^2}$$

Total Bracing Demand:

$$\mathbf{BU_{demand,sub} = 17\ BU/m^2 \times 0.8 \times 80m^2 = 1,088\ BUs}$$

$$\mathbf{BU_{demand,wall} = 11\ BU/m^2 \times 0.8 \times 80m^2 = 704\ BUs}$$

7.2 Capacity of Structural Elements

7.2.1 Timber Framed Wall Bracing Capacity

The bracing capacity of the timber framed walls in both the longitudinal and transverse directions was calculated in accordance with NZS 3604:2011 and the NZSEE guidelines. The demand for each building was calculated in accordance with NZS 3604:2011 and resolved into Bracing Units (BUs) for comparison.

There is no reliable information available regarding the bracing capacities of the plasterboard lining to the timber framed walls based on the assumption that the building was constructed in the early 1970s. Assumptions regarding the likely bracing capacity of the plasterboard lined timber walls have been made in accordance with Table 11.1 of the in NZSEE guidelines. A bracing capacity value of 3 kN/m (60 BU/m) and a strength reduction factor of 0.7 have been used in calculations.

Section 11.4 of the NZSEE guidelines suggests that shear panels may utilise their full bracing capacity for aspect ratios (height-to-width) up to 2:1. For aspect ratios greater than 2:1 and up to 3.5:1 a limiting factor may be applied in accordance with the NEHRP Recommended Provisions (BSSC, 2000) as follows;

$$\text{Aspect Ratio Factor} = \frac{2 \times \text{Width}}{\text{Height}}$$

Any sections of wall with an aspect ratio greater than 3.5:1 were not included in the bracing calculations.

The buildings were also checked against the current requirements in NZS 3604:2011 for spacing of bracing lines, minimum bracing line values, diaphragm spans and the bracing capacities of walls supporting diaphragms.

7.2.2 Subfloor Bracing Capacity

The bracing capacity of the subfloor framing and foundations in both the longitudinal and transverse direction was calculated in accordance with NZS 3604:2011 and the NZSEE guidelines. The demand for each building was calculated in accordance with NZS 3604:2011 in terms of Bracing Units (BUs).

In each direction of the buildings, subfloor bracing is provided by the perimeter concrete foundation walls. In each direction the subfloor bracing lines run around the perimeter of each building. A bracing value of 100 BU per m of reinforced concrete foundations wall has been assumed in the calculations. This value is a third of the bracing value stated in Table 5.11 NZS 3604:2011. The value of a third has been used due to the age of the building, uncertainty of the quality of materials used in construction, uncertainty of the reinforcing content in the concrete foundation walls and the cracking damage observed in some of the foundation walls.

7.2.3 %NBS

The bracing capacities of the lined timber framed walls in both the longitudinal and transverse directions were compared to their respective demands to determine the overall %NBS for each building.

$$\%NBS = \frac{BU_{provided}}{BU_{demand}} \times 100$$

8. Results

The New Zealand Society for Earthquake Engineering (NZSEE) publication “Assessment & Improvement of Structural Performance of Buildings” (2006, Ref. b) and the relevant New Zealand material standards were used to provide a framework and method for the analysis. Our analysis applied live loads, imposed dead loads and seismic loads to the structure. The elements were then assessed against their respective load capacities.

Our calculations show that the seismic load resisting systems of Blocks A to F achieve **94% NBS** and are therefore **not Earthquake Prone.**

The structural analysis results are discussed in the following sections.

8.1 Blocks A to F

Blocks A to F have identical layouts and construction. As a result, all buildings have the same level of assessed seismic performance. The structural analysis results for all buildings are presented together in Section 8.1.

8.1.1 Timber Framed Walls

The bracing demand was determined by evaluating the bracing demand per square metre from NZS 3604:2011 and multiplying the value obtained by the total floor area of each building. The demand in bracing units (BUs) was then compared with bracing capacities of the timber framed walls.

$$\mathbf{BU_{demand,wall} = 704\ BUs}$$

The total bracing capacity of the buildings in each direction was evaluated by determining the lengths of plasterboard lined timber framed walls available that satisfy the aspect ratio limit of 3.5:1 suggested in the NZSEE guidelines.

The bracing capacity for the lined timber framed walls in both the longitudinal and transverse directions has been reduced by 10% to account for the damage to the plasterboard linings. The fractures observed in the plasterboard panels are likely to reduce the bracing capacity of the individual panels and therefore the overall structure.

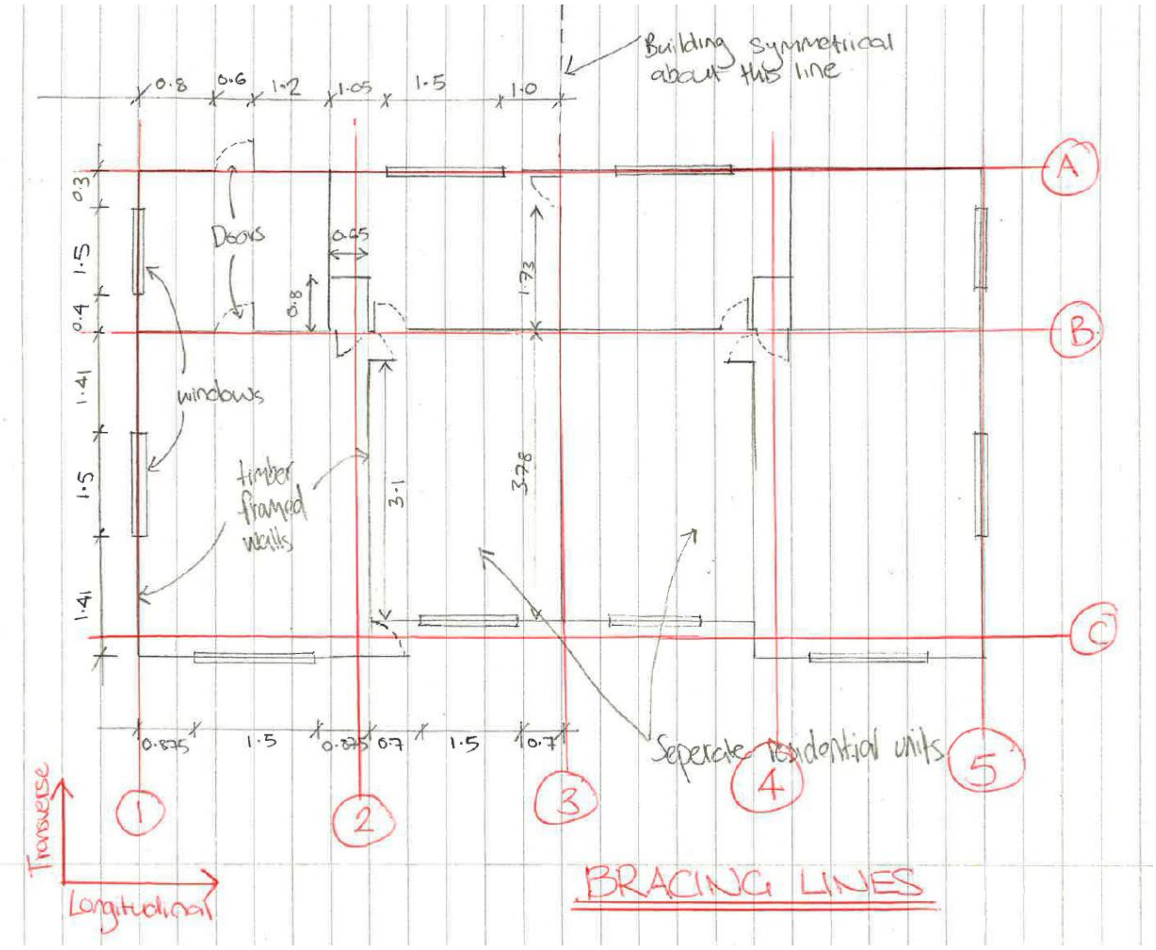


Figure 8.1 Longitudinal and transverse wall bracing lines for Blocks A to F

Bracing Line	Bracing Capacity (BUs)	10% Damage Reduction
Longitudinal Direction		
A	292	263
B	270	243
C	176	158
Total Bracing Capacity	738	664
Transverse Direction		
1	118	106
2	222	200
3	232	209
4	222	200
5	118	106
Total Bracing Capacity	912	821

Table 8.1 Bracing line capacities for walls in Blocks A to F

$$\%NBS_{long} = \frac{664\ BUs}{704\ BUs} = 94\%\ NBS$$

$$\%NBS_{trans} = \frac{821\ BUs}{704\ BUs} = 100\%\ NBS$$

8.1.2 Subfloor Bracing

The bracing demand was determined by evaluating the bracing demand per square metre from NZS 3604:2011 and multiplying the value obtained by the total floor area of each building. The demand in bracing units (BUs) was then compared with bracing capacities of the reinforced concrete foundation walls.

$$\mathbf{BU_{demand,sub} = 1,088\ BUs}$$

The total bracing capacity of the buildings in each direction was evaluated by determining available lengths of reinforced concrete foundation walls available.

Bracing Line	Bracing Capacity (BUs)
Longitudinal Direction	
A	1230
B	1230
Total Bracing Capacity	2460
Transverse Direction	
1	650
2	650
Total Bracing Capacity	1300

Table 8.2 Bracing line capacities for subfloor bracing in Block A to F

$$\%NBS_{long} = \frac{2{,}460\ BUs}{1{,}088\ BUs} = 100\%\ NBS$$

$$\%NBS_{trans} = \frac{1{,}300\ BUs}{1{,}088\ BUs} = 100\%\ NBS$$

8.2 Summary

Bracing Element	Direction	Block A %NBS	Block B %NBS	Block C %NBS	Block D %NBS	Block E %NBS	Block F %NBS
Timber Framed Walls	Longitudinal	94	94	94	94	94	94
	Transverse	100	100	100	100	100	100
Subfloor	Longitudinal	100	100	100	100	100	100
	Transverse	100	100	100	100	100	100

Table 8.3 Summary of %NBS scores

8.3 Discussion of Results

The results obtained from the analysis are generally consistent with those expected for a building of this age and construction type.

Berwick Courts is assumed to have been designed in the early 1970s and as a result the buildings were likely designed in accordance with the loading standard, NZS 1900:1965. The design loads used are likely to have been less than those required by the current loading standard.

The buildings perform well in both the longitudinal and transverse directions with the timber framed walls achieving 94% NBS. There is a regular distribution of lengths of lined timber walls bracing the building against lateral load in both directions.

The layout of the timber framed walls satisfies current NZS 3604:2011 requirements for minimum bracing line values and minimum bracing line values for walls supporting a diaphragm. Based on the lightweight flexible nature of the buildings and the regular layout of lined timber framed walls, it is reasonable to expect the buildings to achieve 94% NBS.

9. Conclusions and Recommendations

Blocks A to F have been assessed to have a seismic capacity in the order of 94% NBS and are therefore not Earthquake Prone. As a result, no strengthening works to the buildings are required.

General Comment

The plasterboard linings on the interior faces of the timber framed walls in each block have suffered damage during the recent seismic activity. In several locations, the plasterboard lining has fractured. It is recommended that where a plasterboard panel has fractured, it is replaced to ensure the full bracing capacity of the structure is achieved.

10. Limitations

10.1 General

This report has been prepared subject to the following limitations:

- No drawings of the building were available.
- The foundations of the building were unable to be inspected beyond those exposed above ground level externally.
- No material testing has been undertaken.

It is noted that this report has been prepared at the request of Christchurch City Council and is intended to be used for their purposes only. GHD accepts no responsibility for any other party or person who relies on the information contained in this report.

10.2 Geotechnical Limitations

The data and advice provided herein relate only to the project and structures described herein and must be reviewed by a competent geotechnical engineer before being used for any other purpose. GHD Limited (GHD) accepts no responsibility for other use of the data by third parties.

Where drill hole or test pit logs, cone tests, laboratory tests, geophysical tests and similar work have been performed and recorded by others under a separate commission, the data is included and used in the form provided by others. The responsibility for the accuracy of such data remains with the issuing authority, not with GHD.

The advice tendered in this report is based on information obtained from the desk study investigation location test points and sample points. It is not warranted in respect to the conditions that may be encountered across the site other than at these locations. It is emphasised that the actual characteristics of the subsurface materials may vary significantly between adjacent test points, sample intervals and at locations other than where observations, explorations and investigations have been made. Subsurface conditions, including groundwater levels and contaminant concentrations can change in a limited time. This should be borne in mind when assessing the data.

It should be noted that because of the inherent uncertainties in subsurface evaluations, changed or unanticipated subsurface conditions may occur that could affect total project cost and/or execution. GHD does not accept responsibility for the consequences of significant variances in the conditions and the requirements for execution of the work.

The subsurface and surface earthworks, excavations and foundations should be examined by a suitably qualified and experienced Engineer who shall judge whether the revealed conditions accord with both the assumptions in this report and/or the design of the works. If they do not accord, the Engineer shall modify advice in this report and/or design of the works to accord with the circumstances that are revealed.

An understanding of the geotechnical site conditions depends on the integration of many pieces of information, some regional, some site specific, some structure specific and some experienced based. Hence this report should not be altered, amended or abbreviated, issued in part and issued incomplete in any way without prior checking and approval by GHD. GHD accepts no responsibility for any circumstances which arise from the issue of the report which have been modified in any way as outlined above.

Appendix A

Photographs

Photograph 1 View of Block A

Photograph 2 Cracking to corner of concrete foundation wall in Block A

Photograph 3 Cracking at corner of window in Block A

Photograph 4 View of Block B

Photograph 5 **Cracking between timber lintel and corner of window in Block B**

Photograph 6 **View of Block C**

Photograph 7 Cracking between timber lintel and corner of window in Block C

Photograph 8 View of Block D

Photograph 9 View of Block E

Photograph 10 View of Block F

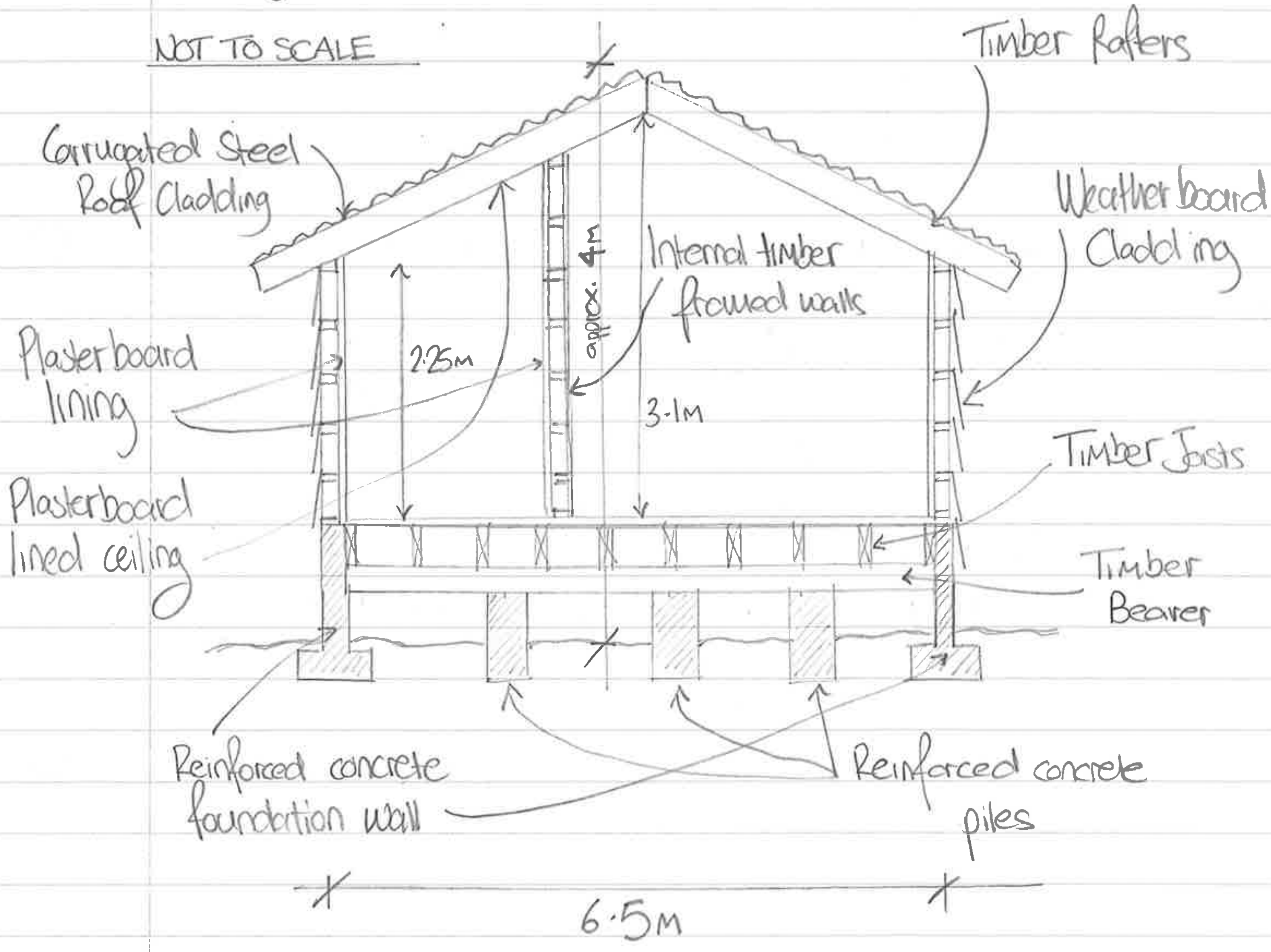
Photograph 11 View of foundations of Block F

Appendix B

Sketches

Seismic Weight of a Typical Block, W_t (kN)

Seismic weight will be the same for Block A – F as layout and construction are the same



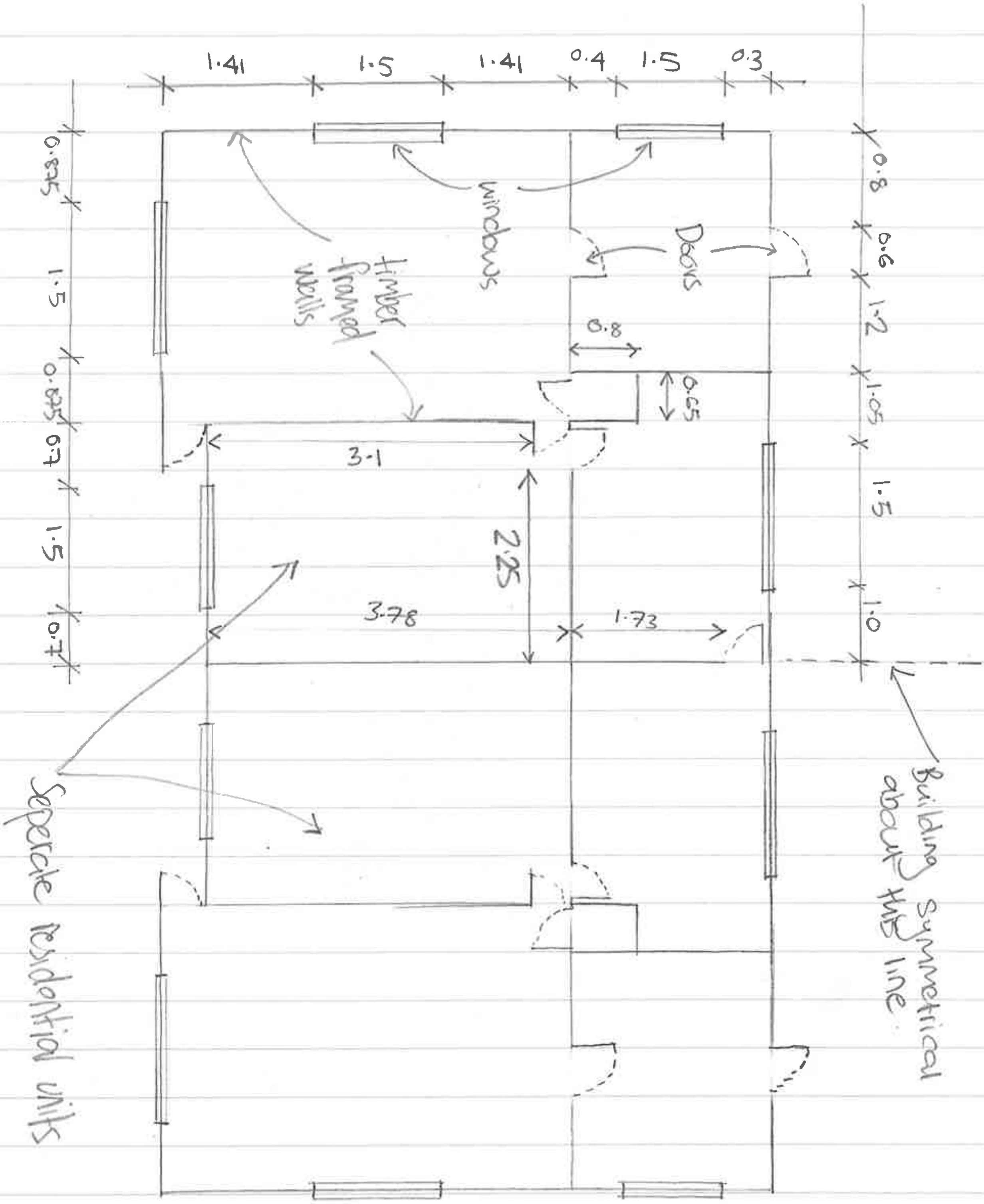
Building Dimensions: Longitudinal — 12.3m

Transverse — 6.5m

Footprint — 80 m^2

Plan Sketch of Typical Block – Wall Layout

Not to Scale



Plan Sketch of Typical Block – Wall Layout

Not to Scale

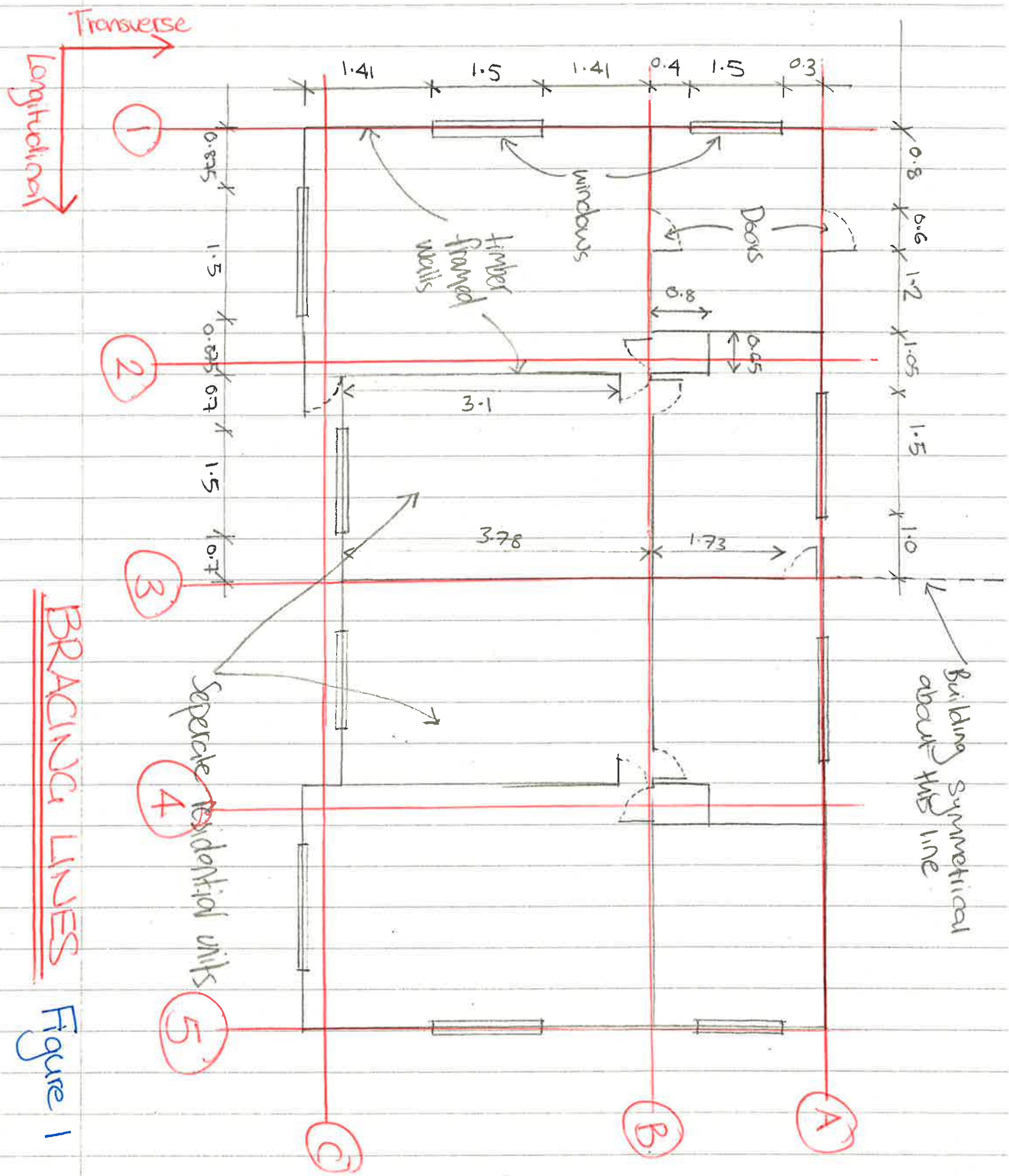


Figure 1

Plan Sketch of Typical Block – Wall Layout

Not to Scale

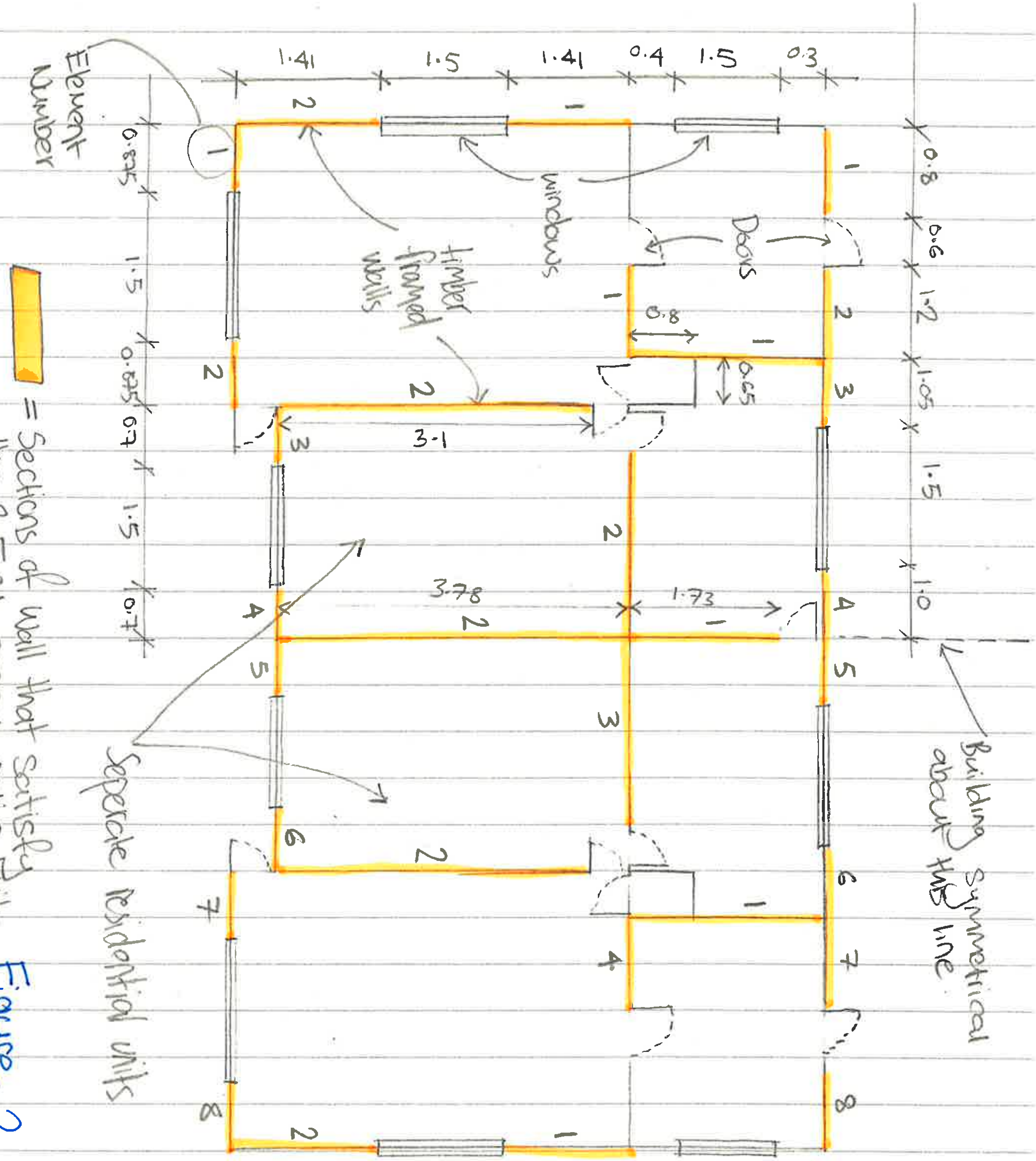


Figure 2

Appendix C

CERA Forms

Detailed Engineering Evaluation Summary Data V1.11

Location

Building Name:	Berwick Courts Block A	Reviewer:	Stephen Lee
Building Address:	Unit: No: 31 Street: Berwick Street	CPEng No:	1006840
Legal Description:		Company:	GHD
		Company project number:	513090279
	Degrees / Min / Sec	Company phone number:	04 472 0799
GPS south:		Date of submission:	25/01/2013
GPS east:		Inspection Date:	8/11/2012
		Revision:	final
Building Unique Identifier (CCC):	BE 0630 EQ2	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):	
Ground floor split?	no		Ground floor elevation above ground (m):	0.50
Storeys below ground	0			
Foundation type:	driven precast piles		if Foundation type is other, describe:	
Building height (m):	4.00		height from ground to level of uppermost seismic mass (for IEP only) (m):	
Floor footprint area (approx):	80			
Age of Building (years):	40		Date of design:	1965-1976
Strengthening present?	no		If so, when (year)?	
			And what load level (%g)?	
Use (ground floor):	multi-unit residential		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	
Floors:	timber	joist depth and spacing (mm)	
Beams:	timber	type	
Columns:			
Walls:			

Lateral load resisting structure

Lateral system along:	lightweight timber framed walls	**Note: Define along and across in detailed report!**		
Ductility assumed, μ:	3.00		note typical wall length (m)	
Period along:	0.40	0.00	estimate or calculation?	estimated
Total deflection (ULS) (mm):			estimate or calculation?	
maximum interstorey deflection (ULS) (mm):			estimate or calculation?	
Lateral system across:	lightweight timber framed walls			
Ductility assumed, μ:	3.00		note typical wall length (m)	
Period across:	0.40	0.00	estimate or calculation?	estimated
Total deflection (ULS) (mm):			estimate or calculation?	
maximum interstorey deflection (ULS) (mm):			estimate or calculation?	

Separations:

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

Non-structural elements

Stairs:			
Wall cladding:	other light	describe	Fibre-cement boards.
Roof Cladding:	Metal	describe	Corrugated sheet metal
Glazing:	aluminium frames		
Ceilings:	fibrous plaster, fixed		
Services(list):			

Available documentation

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

Damage

Site: (refer DEE Table 4-2)

Site performance:	Good	Describe damage:	
Settlement:	none observed	notes (if applicable):	
Differential settlement:	0-1:350	notes (if applicable):	Minor foundation settlement.
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:	6%	Describe how damage ratio arrived at:	
	Describe (summary):	Damage to plasterboard linings.		
Across	Damage ratio:	0%		
	Describe (summary):	Damage to plasterboard linings.		
Diaphragms	Damage?:	no	Describe:	
CSWs:	Damage?:	no	Describe:	
Pounding:	Damage?:	no	Describe:	
Non-structural:	Damage?:	yes	Describe:	Damaged linings.

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

Recommendations

	Level of repair/strengthening required:		Describe:	
	Building Consent required:		Describe:	
	Interim occupancy recommendations:		Describe:	
Along	Assessed %NBS before e'quakes:	100% ##### %NBS from IEP below	If IEP not used, please detail assessment methodology:	Quantitative analysis.
	Assessed %NBS after e'quakes:	94%		
Across	Assessed %NBS before e'quakes:	100% ##### %NBS from IEP below		
	Assessed %NBS after e'quakes:	100%		

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

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

h_n from above: m

Seismic Zone, if designed between 1965 and 1992:

not required for this age of building
not required for this age of building

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

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

	along	across
Final $(\%NBS)_{nom}$:	**0%**	**0%**

2.2 Near Fault Scaling Factor

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

	along	across
Near Fault scaling factor (1/N(T,D), **Factor A**:	#DIV/0!	#DIV/0!

2.3 Hazard Scaling Factor

Hazard factor Z for site from AS1170.5, Table 3.3:
Z_{1992}, from NZS4203:1992
Hazard scaling factor, **Factor B:** #DIV/0!

2.4 Return Period Scaling Factor

Building Importance level (from above): 2
Return Period Scaling factor from Table 3.1, **Factor C**:

2.5 Ductility Scaling Factor

	along	across
Assessed ductility (less than max in Table 3.2)		
Ductility scaling factor: =1 from 1976 onwards; or =kμ, if pre-1976, fromTable 3.3:		
Ductiity Scaling Factor, **Factor D**:	0.00	0.00

2.6 Structural Performance Scaling Factor:

	along	across
Sp:		
Structural Performance Scaling Factor **Factor E**:	#DIV/0!	#DIV/0!

	along	across
2.7 Baseline %NBS, $(NBS\%)_b = (\%NBS)_{nom}$ x A x B x C x D x E — **$\%NBS_b$:**	**#DIV/0!**	**#DIV/0!**

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

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

3.4. Pounding potential
Pounding effect D1, from Table to right
Height Difference effect D2, from Table to right
Therefore, Factor D: 0

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

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

3.5. Site Characteristics insignificant 1

3.6. Other factors, Factor F

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

Detail Critical Structural Weaknesses: (refer to DEE Procedure section 6)
List any: Refer also section 6.3.1 of DEE for discussion of F factor modification for other critical structural weaknesses

	Along	Across
3.7. Overall Performance Achievement ratio (PAR)	**0.00**	**0.00**
4.3 PAR x (%NBS)b: — PAR x Baselline %NBS:	**#DIV/0!**	**#DIV/0!**
4.4 Percentage New Building Standard (%NBS), (before)		**#DIV/0!**

Detailed Engineering Evaluation Summary Data V1.11

Location

Building Name:	Berwick Courts Block B	Reviewer:	Stephen Lee
Unit / No: / Street	31 Berwick Street	CPEng No:	1006840
Building Address:	31 Berwick Street	Company:	GHD
Legal Description:		Company project number:	513090279
		Company phone number:	04 472 0799
GPS south (Degrees / Min / Sec):		Date of submission:	25/01/2013
GPS east:		Inspection Date:	8/11/2012
		Revision:	final
Building Unique Identifier (CCC):	BE 0630 EQ2	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):	
Ground floor split?	no	Ground floor elevation above ground (m):	0.50
Storeys below ground	0		
Foundation type:	driven precast piles	if Foundation type is other, describe:	
Building height (m):	4.00	height from ground to level of uppermost seismic mass (for IEP only) (m):	
Floor footprint area (approx):	80		
Age of Building (years):	40	Date of design:	1965-1976
Strengthening present?	no	If so, when (year)?	
		And what load level (%g)?	
Use (ground floor):	multi-unit residential	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	
Floors:	timber	joist depth and spacing (mm)	
Beams:	timber	type	
Columns:			
Walls:			

Lateral load resisting structure

Note: Define along and across in detailed report!

Lateral system along:	lightweight timber framed walls			
Ductility assumed, μ:	3.00		note typical wall length (m)	
Period along:	0.40	0.00	estimate or calculation?	estimated
Total deflection (ULS) (mm):			estimate or calculation?	
maximum interstorey deflection (ULS) (mm):			estimate or calculation?	
Lateral system across:	lightweight timber framed walls			
Ductility assumed, μ:	3.00		note typical wall length (m)	
Period across:	0.40	0.00	estimate or calculation?	estimated
Total deflection (ULS) (mm):			estimate or calculation?	
maximum interstorey deflection (ULS) (mm):			estimate or calculation?	

Separations:

leave blank if not relevant

north (mm):	
east (mm):	
south (mm):	
west (mm):	

Non-structural elements

Stairs:			
Wall cladding:	other light	describe	Fibre-cement boards.
Roof Cladding:	Metal	describe	Corrugated sheet metal
Glazing:	aluminium frames		
Ceilings:	fibrous plaster, fixed		
Services(list):			

Available documentation

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

Damage

Site: (refer DEE Table 4-2)

Site performance:	Good	Describe damage:	
Settlement:	none observed	notes (if applicable):	
Differential settlement:	0-1:350	notes (if applicable):	Minor foundation settlement.
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:	6%	Describe how damage ratio arrived at:	
	Describe (summary):	Damage to plasterboard linings.		
Across	Damage ratio:	0%		
	Describe (summary):	Damage to plasterboard linings.		
Diaphragms	Damage?:	no	Describe:	
CSWs:	Damage?:	no	Describe:	
Pounding:	Damage?:	no	Describe:	
Non-structural:	Damage?:	yes	Describe:	Damaged linings.

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

Recommendations

Level of repair/strengthening required:		Describe:	
Building Consent required:		Describe:	
Interim occupancy recommendations:		Describe:	

Along	Assessed %NBS before e'quakes:	100%	##### %NBS from IEP below	If IEP not used, please detail assessment methodology:	Quantitative analysis.
	Assessed %NBS after e'quakes:	94%			
Across	Assessed %NBS before e'quakes:	100%	##### %NBS from IEP below		
	Assessed %NBS after e'quakes:	100%			

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

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

h_n from above: m

Seismic Zone, if designed between 1965 and 1992:

not required for this age of building
not required for this age of building

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

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

	along	across
Final $(\%NBS)_{nom}$:	**0%**	**0%**

2.2 Near Fault Scaling Factor

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

	along	across
Near Fault scaling factor (1/N(T,D), **Factor A**:	#DIV/0!	#DIV/0!

2.3 Hazard Scaling Factor

Hazard factor Z for site from AS1170.5, Table 3.3:
Z_{1992}, from NZS4203:1992
Hazard scaling factor, **Factor B:** #DIV/0!

2.4 Return Period Scaling Factor

Building Importance level (from above): 2
Return Period Scaling factor from Table 3.1, **Factor C**:

2.5 Ductility Scaling Factor

	along	across
Assessed ductility (less than max in Table 3.2)		
Ductility scaling factor: =1 from 1976 onwards; or =kμ, if pre-1976, fromTable 3.3:		
Ductiity Scaling Factor, **Factor D**:	0.00	0.00

2.6 Structural Performance Scaling Factor:

Sp:		
Structural Performance Scaling Factor **Factor E**:	#DIV/0!	#DIV/0!

2.7 Baseline %NBS, $(NBS\%)_b = (\%NBS)_{nom}$ x A x B x C x D x E **$\%NBS_b$:** **#DIV/0!** **#DIV/0!**

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

3.1. Plan Irregularity, factor A: insignificant 1

3.2. Vertical irregularity, Factor B: insignificant 1

3.3. Short columns, Factor C: insignificant 1

3.4. Pounding potential
Pounding effect D1, from Table to right
Height Difference effect D2, from Table to right

Therefore, Factor D: 0

3.5. Site Characteristics insignificant 1

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

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

3.6. Other factors, Factor F

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

Detail Critical Structural Weaknesses: (refer to DEE Procedure section 6)
List any: Refer also section 6.3.1 of DEE for discussion of F factor modification for other critical structural weaknesses

3.7. Overall Performance Achievement ratio (PAR) **0.00** **0.00**

4.3 PAR x $(\%NBS)_b$: PAR x Baselline %NBS: **#DIV/0!** **#DIV/0!**

4.4 Percentage New Building Standard (%NBS), (before) **#DIV/0!**

Detailed Engineering Evaluation Summary Data V1.11

Location

Building Name:	Berwick Courts Block C	Reviewer:	Stephen Lee
Building Address:	Unit: No: 31 Street: Berwick Street	CPEng No:	1006840
Legal Description:		Company:	GHD
		Company project number:	513090279
		Company phone number:	04 472 0799
GPS south: (Degrees / Min / Sec)		Date of submission:	25/01/2013
GPS east:		Inspection Date:	8/11/2012
		Revision:	final
Building Unique Identifier (CCC):	BE 0630 EQ2	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):	
Ground floor split?	no	Ground floor elevation above ground (m):	0.50
Storeys below ground	0		
Foundation type:	driven precast piles	if Foundation type is other, describe:	
Building height (m):	4.00	height from ground to level of uppermost seismic mass (for IEP only) (m):	
Floor footprint area (approx):	80		
Age of Building (years):	40	Date of design:	1965-1976
Strengthening present?	no	If so, when (year)?	
		And what load level (%g)?	
Use (ground floor):	multi-unit residential	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	
Floors:	timber	joist depth and spacing (mm)	
Beams:	timber	type	
Columns:			
Walls:			

Lateral load resisting structure

Lateral system along:	lightweight timber framed walls	Note: Define along and across in detailed report!	
Ductility assumed, μ:	3.00	note typical wall length (m)	
Period along:	0.40 (0.00)	estimate or calculation?	estimated
Total deflection (ULS) (mm):		estimate or calculation?	
maximum interstorey deflection (ULS) (mm):		estimate or calculation?	
Lateral system across:	lightweight timber framed walls		
Ductility assumed, μ:	3.00	note typical wall length (m)	
Period across:	0.40 (0.00)	estimate or calculation?	estimated
Total deflection (ULS) (mm):		estimate or calculation?	
maximum interstorey deflection (ULS) (mm):		estimate or calculation?	

Separations:

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

Non-structural elements

Stairs:			
Wall cladding:	other light	describe	Fibre-cement boards.
Roof Cladding:	Metal	describe	Corrugated sheet metal
Glazing:	aluminium frames		
Ceilings:	fibrous plaster, fixed		
Services(list):			

Available documentation

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

Damage

Site: (refer DEE Table 4-2)

Site performance:	Good	Describe damage:	
Settlement:	none observed	notes (if applicable):	
Differential settlement:	0-1:350	notes (if applicable):	Minor foundation settlement.
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:	6%	Describe how damage ratio arrived at:	
	Describe (summary):	Damage to plasterboard linings.		
Across	Damage ratio:	0%		
	Describe (summary):	Damage to plasterboard linings.		
Diaphragms	Damage?:	no	Describe:	
CSWs:	Damage?:	no	Describe:	
Pounding:	Damage?:	no	Describe:	
Non-structural:	Damage?:	yes	Describe:	Damaged linings.

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

Recommendations

	Level of repair/strengthening required:		Describe:	
	Building Consent required:		Describe:	
	Interim occupancy recommendations:		Describe:	
Along	Assessed %NBS before e'quakes:	100% (##### %NBS from IEP below)	If IEP not used, please detail assessment methodology:	Quantitative analysis.
	Assessed %NBS after e'quakes:	94%		
Across	Assessed %NBS before e'quakes:	100% (##### %NBS from IEP below)		
	Assessed %NBS after e'quakes:	100%		

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

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

h_n from above: m

Seismic Zone, if designed between 1965 and 1992:

not required for this age of building
not required for this age of building

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

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

	along	across
Final $(\%NBS)_{nom}$:	**0%**	**0%**

2.2 Near Fault Scaling Factor

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

	along	across
Near Fault scaling factor (1/N(T,D), **Factor A**:	#DIV/0!	#DIV/0!

2.3 Hazard Scaling Factor

Hazard factor Z for site from AS1170.5, Table 3.3:
Z_{1992}, from NZS4203:1992
Hazard scaling factor, **Factor B:** #DIV/0!

2.4 Return Period Scaling Factor

Building Importance level (from above): 2
Return Period Scaling factor from Table 3.1, **Factor C**:

2.5 Ductility Scaling Factor

	along	across
Assessed ductility (less than max in Table 3.2)		
Ductility scaling factor: =1 from 1976 onwards; or =kμ, if pre-1976, fromTable 3.3:		
Ductiity Scaling Factor, **Factor D**:	0.00	0.00

2.6 Structural Performance Scaling Factor:

	along	across
Sp:		
Structural Performance Scaling Factor **Factor E**:	#DIV/0!	#DIV/0!

2.7 Baseline %NBS, $(NBS\%)_b = (\%NBS)_{nom}$ x A x B x C x D x E **$\%NBS_b$:** **#DIV/0!** **#DIV/0!**

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

3.1. Plan Irregularity, factor A: insignificant 1

3.2. Vertical irregularity, Factor B: insignificant 1

3.3. Short columns, Factor C: insignificant 1

3.4. Pounding potential
Pounding effect D1, from Table to right
Height Difference effect D2, from Table to right

Therefore, Factor D: 0

3.5. Site Characteristics insignificant 1

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

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

3.6. Other factors, Factor F

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

Detail Critical Structural Weaknesses: (refer to DEE Procedure section 6)
List any: Refer also section 6.3.1 of DEE for discussion of F factor modification for other critical structural weaknesses

3.7. Overall Performance Achievement ratio (PAR) **0.00** **0.00**

4.3 PAR x (%NBS)b: PAR x Baselline %NBS: **#DIV/0!** **#DIV/0!**

4.4 Percentage New Building Standard (%NBS), (before) **#DIV/0!**

Detailed Engineering Evaluation Summary Data V1.11

Location

Building Name:	Berwick Courts Block D	Reviewer:	Stephen Lee
	Unit / No: 31 / Street: Berwick Street	CPEng No:	1006840
Building Address:	31 Berwick Street	Company:	GHD
Legal Description:		Company project number:	513090279
		Company phone number:	04 472 0799
GPS south: (Degrees / Min / Sec)		Date of submission:	25/01/2013
GPS east:		Inspection Date:	8/11/2012
		Revision:	final
Building Unique Identifier (CCC):	BE 0630 EQ2	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):
Ground floor split?	no	Ground floor elevation above ground (m):	0.50
Storeys below ground	0		
Foundation type:	driven precast piles	if Foundation type is other, describe:	
Building height (m):	4.00	height from ground to level of uppermost seismic mass (for IEP only) (m):	
Floor footprint area (approx):	80		
Age of Building (years):	40	Date of design:	1965-1976
Strengthening present?	no	If so, when (year)?	
		And what load level (%g)?	
Use (ground floor):	multi-unit residential	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	
Floors:	timber	joist depth and spacing (mm)	
Beams:	timber	type	
Columns:			
Walls:			

Lateral load resisting structure

Note: Define along and across in detailed report!

Lateral system along:	lightweight timber framed walls			
Ductility assumed, μ:	3.00		note typical wall length (m)	
Period along:	0.40	0.00	estimate or calculation?	estimated
Total deflection (ULS) (mm):			estimate or calculation?	
maximum interstorey deflection (ULS) (mm):			estimate or calculation?	
Lateral system across:	lightweight timber framed walls			
Ductility assumed, μ:	3.00		note typical wall length (m)	
Period across:	0.40	0.00	estimate or calculation?	estimated
Total deflection (ULS) (mm):			estimate or calculation?	
maximum interstorey deflection (ULS) (mm):			estimate or calculation?	

Separations:

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

Non-structural elements

Stairs:			
Wall cladding:	other light	describe	Fibre-cement boards.
Roof Cladding:	Metal	describe	Corrugated sheet metal
Glazing:	aluminium frames		
Ceilings:	fibrous plaster, fixed		
Services(list):			

Available documentation

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

Damage

Site: (refer DEE Table 4-2)

Site performance:	Good	Describe damage:	
Settlement:	none observed	notes (if applicable):	
Differential settlement:	0-1:350	notes (if applicable):	Minor foundation settlement.
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:	6%	Describe how damage ratio arrived at:	
	Describe (summary):	Damage to plasterboard linings.		
Across	Damage ratio:	0%		
	Describe (summary):	Damage to plasterboard linings.		
Diaphragms	Damage?:	no	Describe:	
CSWs:	Damage?:	no	Describe:	
Pounding:	Damage?:	no	Describe:	
Non-structural:	Damage?:	yes	Describe:	Damaged linings.

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

Recommendations

	Level of repair/strengthening required:		Describe:	
	Building Consent required:		Describe:	
	Interim occupancy recommendations:		Describe:	
Along	Assessed %NBS before e'quakes:	100%	##### %NBS from IEP below	If IEP not used, please detail assessment methodology: Quantitative analysis.
	Assessed %NBS after e'quakes:	94%		
Across	Assessed %NBS before e'quakes:	100%	##### %NBS from IEP below	
	Assessed %NBS after e'quakes:	100%		

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

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

h_n from above: m

Seismic Zone, if designed between 1965 and 1992:

not required for this age of building
not required for this age of building

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

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

	along	across
Final $(\%NBS)_{nom}$:	**0%**	**0%**

2.2 Near Fault Scaling Factor

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

	along	across
Near Fault scaling factor (1/N(T,D), **Factor A**:	#DIV/0!	#DIV/0!

2.3 Hazard Scaling Factor

Hazard factor Z for site from AS1170.5, Table 3.3:
Z_{1992}, from NZS4203:1992
Hazard scaling factor, **Factor B:** #DIV/0!

2.4 Return Period Scaling Factor

Building Importance level (from above): 2
Return Period Scaling factor from Table 3.1, **Factor C**:

2.5 Ductility Scaling Factor

	along	across
Assessed ductility (less than max in Table 3.2)		
Ductility scaling factor: =1 from 1976 onwards; or =kμ, if pre-1976, fromTable 3.3:		
Ductiity Scaling Factor, **Factor D**:	0.00	0.00

2.6 Structural Performance Scaling Factor:

	along	across
Sp:		
Structural Performance Scaling Factor **Factor E**:	#DIV/0!	#DIV/0!

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

	along	across
$\%NBS_b$:	**#DIV/0!**	**#DIV/0!**

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

3.1. Plan Irregularity, factor A: insignificant 1

3.2. Vertical irregularity, Factor B: insignificant 1

3.3. Short columns, Factor C: insignificant 1

3.4. Pounding potential

Pounding effect D1, from Table to right
Height Difference effect D2, from Table to right

Therefore, Factor D: 0

3.5. Site Characteristics insignificant 1

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

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

3.6. Other factors, Factor F

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

Detail Critical Structural Weaknesses: (refer to DEE Procedure section 6)
List any: Refer also section 6.3.1 of DEE for discussion of F factor modification for other critical structural weaknesses

3.7. Overall Performance Achievement ratio (PAR) **0.00** **0.00**

4.3 PAR x (%NBS)b:

PAR x Baselline %NBS: **#DIV/0!** **#DIV/0!**

4.4 Percentage New Building Standard (%NBS), (before) **#DIV/0!**

Detailed Engineering Evaluation Summary Data V1.11

Location

Building Name:	Berwick Courts Block E	Reviewer:	Stephen Lee
	Unit / No: 31 / Street: Berwick Street	CPEng No:	1006840
Building Address:	31 Berwick Street	Company:	GHD
Legal Description:		Company project number:	513090279
		Company phone number:	04 472 0799
GPS south (Degrees / Min / Sec):		Date of submission:	25/01/2013
GPS east:		Inspection Date:	8/11/2012
		Revision:	final
Building Unique Identifier (CCC):	BE 0630 EQ2	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):	
Ground floor split?	no	Ground floor elevation above ground (m):	0.50
Storeys below ground	0		
Foundation type:	driven precast piles	if Foundation type is other, describe:	
Building height (m):	4.00	height from ground to level of uppermost seismic mass (for IEP only) (m):	
Floor footprint area (approx):	80		
Age of Building (years):	40	Date of design:	1965-1976
Strengthening present?	no	If so, when (year)?	
		And what load level (%g)?	
Use (ground floor):	multi-unit residential	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	
Floors:	timber	joist depth and spacing (mm)	
Beams:	timber	type	
Columns:			
Walls:			

Lateral load resisting structure

Note: Define along and across in detailed report!

Lateral system along:	lightweight timber framed walls			
Ductility assumed, μ:	3.00		note typical wall length (m)	
Period along:	0.40	0.00	estimate or calculation?	estimated
Total deflection (ULS) (mm):			estimate or calculation?	
maximum interstorey deflection (ULS) (mm):			estimate or calculation?	
Lateral system across:	lightweight timber framed walls			
Ductility assumed, μ:	3.00		note typical wall length (m)	
Period across:	0.40	0.00	estimate or calculation?	estimated
Total deflection (ULS) (mm):			estimate or calculation?	
maximum interstorey deflection (ULS) (mm):			estimate or calculation?	

Separations:

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

Non-structural elements

Stairs:			
Wall cladding:	other light	describe	Fibre-cement boards.
Roof Cladding:	Metal	describe	Corrugated sheet metal
Glazing:	aluminium frames		
Ceilings:	fibrous plaster, fixed		
Services(list):			

Available documentation

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

Damage

Site: (refer DEE Table 4-2)

Site performance:	Good	Describe damage:	
Settlement:	none observed	notes (if applicable):	
Differential settlement:	0-1:350	notes (if applicable):	Minor foundation settlement.
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:	6%	Describe how damage ratio arrived at:	
	Describe (summary):	Damage to plasterboard linings.		
Across	Damage ratio:	0%		
	Describe (summary):	Damage to plasterboard linings.		
Diaphragms	Damage?:	no	Describe:	
CSWs:	Damage?:	no	Describe:	
Pounding:	Damage?:	no	Describe:	
Non-structural:	Damage?:	yes	Describe:	Damaged linings.

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

Recommendations

	Level of repair/strengthening required:		Describe:	
	Building Consent required:		Describe:	
	Interim occupancy recommendations:		Describe:	
Along	Assessed %NBS before e'quakes:	100%	##### %NBS from IEP below	If IEP not used, please detail assessment methodology: Quantitative analysis.
	Assessed %NBS after e'quakes:	94%		
Across	Assessed %NBS before e'quakes:	100%	##### %NBS from IEP below	
	Assessed %NBS after e'quakes:	100%		

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

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

h_n from above: m

Seismic Zone, if designed between 1965 and 1992:

not required for this age of building
not required for this age of building

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

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

	along	across
Final (%NBS)nom:	**0%**	**0%**

2.2 Near Fault Scaling Factor

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

	along	across
Near Fault scaling factor (1/N(T,D), **Factor A**:	#DIV/0!	#DIV/0!

2.3 Hazard Scaling Factor

Hazard factor Z for site from AS1170.5, Table 3.3:
Z_{1992}, from NZS4203:1992
Hazard scaling factor, **Factor B:** #DIV/0!

2.4 Return Period Scaling Factor

Building Importance level (from above): 2
Return Period Scaling factor from Table 3.1, **Factor C**:

2.5 Ductility Scaling Factor

	along	across
Assessed ductility (less than max in Table 3.2)		
Ductility scaling factor: =1 from 1976 onwards; or =kμ, if pre-1976, fromTable 3.3:		
Ductiity Scaling Factor, **Factor D**:	0.00	0.00

2.6 Structural Performance Scaling Factor:

	along	across
Sp:		
Structural Performance Scaling Factor **Factor E**:	#DIV/0!	#DIV/0!

2.7 Baseline %NBS, (NBS%)b = (%NBS)nom x A x B x C x D x E

	along	across
%NBSb:	**#DIV/0!**	**#DIV/0!**

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

3.1. Plan Irregularity, factor A: insignificant 1

3.2. Vertical irregularity, Factor B: insignificant 1

3.3. Short columns, Factor C: insignificant 1

3.4. Pounding potential
Pounding effect D1, from Table to right
Height Difference effect D2, from Table to right

Therefore, Factor D: 0

3.5. Site Characteristics insignificant 1

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

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

3.6. Other factors, Factor F

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

Detail Critical Structural Weaknesses: (refer to DEE Procedure section 6)
List any: Refer also section 6.3.1 of DEE for discussion of F factor modification for other critical structural weaknesses

	Along	Across
3.7. Overall Performance Achievement ratio (PAR)	**0.00**	**0.00**
4.3 PAR x (%NBS)b: PAR x Baselline %NBS:	**#DIV/0!**	**#DIV/0!**
4.4 Percentage New Building Standard (%NBS), (before)		**#DIV/0!**

Detailed Engineering Evaluation Summary Data V1.11

Location

Building Name:	Berwick Courts Block F	Reviewer:	Stephen Lee
	Unit / No: 31 / Street: Berwick Street	CPEng No:	1006840
Building Address:	31 Berwick Street	Company:	GHD
Legal Description:		Company project number:	513090279
	Degrees / Min / Sec	Company phone number:	04 472 0799
GPS south:		Date of submission:	25/01/2013
GPS east:		Inspection Date:	8/11/2012
		Revision:	final
Building Unique Identifier (CCC):	BE 0630 EQ2	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):	
Ground floor split?	no	Ground floor elevation above ground (m):	0.50
Storeys below ground	0		
Foundation type:	driven precast piles	if Foundation type is other, describe:	
Building height (m):	4.00	height from ground to level of uppermost seismic mass (for IEP only) (m):	
Floor footprint area (approx):	80		
Age of Building (years):	40	Date of design:	1965-1976
Strengthening present?	no	If so, when (year)?	
		And what load level (%g)?	
Use (ground floor):	multi-unit residential	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	
Floors:	timber	joist depth and spacing (mm)	
Beams:	timber	type	
Columns:			
Walls:			

Lateral load resisting structure

Note: Define along and across in detailed report!

Lateral system along:	lightweight timber framed walls			
Ductility assumed, μ:	3.00		note typical wall length (m)	
Period along:	0.40	0.00	estimate or calculation?	estimated
Total deflection (ULS) (mm):			estimate or calculation?	
maximum interstorey deflection (ULS) (mm):			estimate or calculation?	
Lateral system across:	lightweight timber framed walls			
Ductility assumed, μ:	3.00		note typical wall length (m)	
Period across:	0.40	0.00	estimate or calculation?	estimated
Total deflection (ULS) (mm):			estimate or calculation?	
maximum interstorey deflection (ULS) (mm):			estimate or calculation?	

Separations:

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

Non-structural elements

Stairs:			
Wall cladding:	other light	describe	Fibre-cement boards.
Roof Cladding:	Metal	describe	Corrugated sheet metal
Glazing:	aluminium frames		
Ceilings:	fibrous plaster, fixed		
Services(list):			

Available documentation

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

Damage

Site: (refer DEE Table 4-2)

Site performance:	Good	Describe damage:	
Settlement:	none observed	notes (if applicable):	
Differential settlement:	0-1:350	notes (if applicable):	Minor foundation settlement.
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:	6%	Describe how damage ratio arrived at:	
	Describe (summary):	Damage to plasterboard linings.		
Across	Damage ratio:	0%		
	Describe (summary):	Damage to plasterboard linings.		
Diaphragms	Damage?:	no	Describe:	
CSWs:	Damage?:	no	Describe:	
Pounding:	Damage?:	no	Describe:	
Non-structural:	Damage?:	yes	Describe:	Damaged linings.

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

Recommendations

	Level of repair/strengthening required:		Describe:	
	Building Consent required:		Describe:	
	Interim occupancy recommendations:		Describe:	
Along	Assessed %NBS before e'quakes:	100%	##### %NBS from IEP below	If IEP not used, please detail assessment methodology: Quantitative analysis.
	Assessed %NBS after e'quakes:	94%		
Across	Assessed %NBS before e'quakes:	100%	##### %NBS from IEP below	
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IEP **Use of this method is not mandatory - more detailed analysis may give a different answer, which would take precedence. Do not fill in fields if not using IEP.**

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

h_n from above: m

Seismic Zone, if designed between 1965 and 1992:

not required for this age of building
not required for this age of building

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

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

	along	across
Final $(\%NBS)_{nom}$:	**0%**	**0%**

2.2 Near Fault Scaling Factor

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

	along	across
Near Fault scaling factor (1/N(T,D), **Factor A**:	#DIV/0!	#DIV/0!

2.3 Hazard Scaling Factor

Hazard factor Z for site from AS1170.5, Table 3.3:
Z_{1992}, from NZS4203:1992
Hazard scaling factor, **Factor B:** #DIV/0!

2.4 Return Period Scaling Factor

Building Importance level (from above): 2
Return Period Scaling factor from Table 3.1, **Factor C**:

2.5 Ductility Scaling Factor

	along	across
Assessed ductility (less than max in Table 3.2)		
Ductility scaling factor: =1 from 1976 onwards; or =kμ, if pre-1976, fromTable 3.3:		
Ductiity Scaling Factor, **Factor D**:	0.00	0.00

2.6 Structural Performance Scaling Factor:

	along	across
Sp:		
Structural Performance Scaling Factor **Factor E**:	#DIV/0!	#DIV/0!

2.7 Baseline %NBS, $(NBS\%)_b = (\%NBS)_{nom}$ x A x B x C x D x E **$\%NBS_b$:** **#DIV/0!** **#DIV/0!**

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

3.1. Plan Irregularity, factor A: insignificant 1

3.2. Vertical irregularity, Factor B: insignificant 1

3.3. Short columns, Factor C: insignificant 1

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Alignment of floors within 20% of H	**0.7**	**0.8**	**1**
Alignment of floors not within 20% of H	**0.4**	**0.7**	**0.8**

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

3.6. Other factors, Factor F

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

Detail Critical Structural Weaknesses: (refer to DEE Procedure section 6)
List any: Refer also section 6.3.1 of DEE for discussion of F factor modification for other critical structural weaknesses

3.7. Overall Performance Achievement ratio (PAR) **0.00** **0.00**

4.3 PAR x (%NBS)b: PAR x Baselline %NBS: **#DIV/0!** **#DIV/0!**

4.4 Percentage New Building Standard (%NBS), (before) **#DIV/0!**

Appendix D

Geotechnical Investigation

HAND AUGER LOG

GHD Limited

PO Box 13468
Christchurch 8141

Site Identification: **HA1**

Sheet 1 of

Project:	Berwick Courts	**Coordinates:** **E** 2480 931, **N** 5744 318	**Datum:** NZMG
Client:	Christchurch City Council	**Surface RL (m):**	**Total Depth:** 3.8m
Site:	-	**Commenced:** 14-Nov-12	**Contractor:**
Job No.:	51-30902-79	**Completed:** 14-Nov-12	

Equipment: 50 mm hand auger

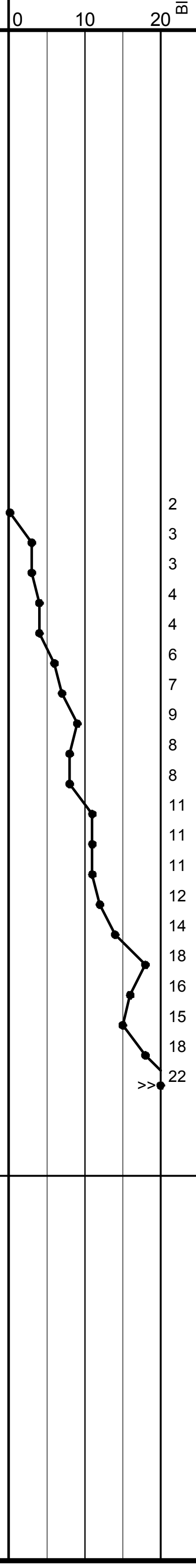
Shear Vane:

Hole Diameter (mm):

Logged:	DW/LW
Processed:	LW
Checked:	SW

Depth (m)	Water	Geological Unit	Classification	SOIL DESCRIPTION: (Soil Code), Soil Name [minor MAJOR], colour, structure [zoning, defects, cementing], plasticity or grain size, secondary components, structure. (Geological Formation)	Moisture Condition	Consistency/ Relative Density	Sample Type & Depth	Sample No.	Sample/ Test Records & Comments
0.45	▽ Groundwater encountered at 2.1 m	Yaldhurst Member	OL	Organic SILT; dark brown. Low plasticity. [Topsoil] .. below 0.1 m contains minor subrounded to subangular gravels	M	St			
0.70			ML	SILT; with trace clay; brown with orange mottling. Low plasticity.	M	St			
0.85			SP	Fine SAND, minor silt; grey with brown mottling. Poorly graded.	M	'L'			
0.95			SP	Fine SAND; red/brown. Poorly graded. [Overbank Deposits]	W	'L'			
1.30			SP	Fine SAND, minor silt; grey. Poorly graded.	W	'L'			
1.50			ML	SILT; grey with black mottling. Low plasticity, contains organics (rootlets). below 1.45 contains rootlets and some clay.	M	F			
2.20			ML	SILT; grey. Low plasticity, dilatant, contains minor wood fragments.	M	F			
3.10			SM	Silty fine SAND; grey. Poorly graded.	S	L			
3.60			ML	Fine sandy SILT; grey. Low plasticity.	S	F-St			
3.80			SM	Silty fine SAND; grey. Poorly graded.	S	MD			
				Termination Depth = 3.8m (Non recovery)					

Test Results (blows per 100mm)



Depth Scale (m): 1, 2, 3, 4, 5

HAND AUGER LOG

GHD Limited
PO Box 13468
Christchurch 8141

Site Identification: **HA2**

Sheet 1 of

Project: Berwick Courts
Client: Christchurch City Council
Site: -
Job No.: 51-30902-79

Coordinates: E 2480 890, N 5744 410
Surface RL (m):
Commenced: 14-Nov-12
Completed: 14-Nov-12
Contractor:

Datum: NZMG
Total Depth: 3.6m

Equipment: 50 mm hand auger
Hole Diameter (mm):
Shear Vane:

Logged:	DW/LW
Processed:	LW
Checked:	SW

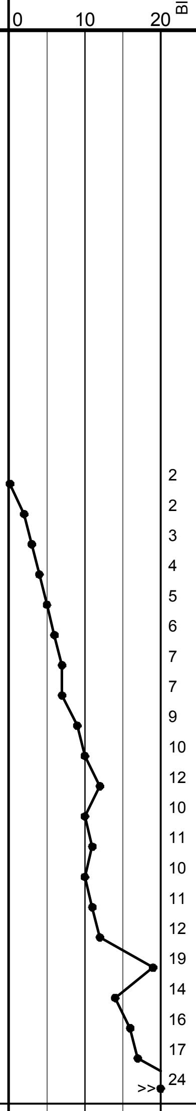
Geological Unit: Yaldhurst Member

Water: Watersrike at 2.6

Depth (m)	Classification	SOIL DESCRIPTION: (Soil Code), Soil Name [minor MAJOR], colour, structure [zoning, defects, cementing], plasticity or grain size, secondary components, structure. (Geological Formation)	Moisture Condition	Consistency/ Relative Density
0.00–0.45	ML	SILT; brown. Low plasticity. [Topsoil]	M	St
0.45–0.55	SM	Silty fine SAND grey mottled brown. Poorly graded	M	'L'
0.55–0.70	ML	SILT; grey mottled brown. Low plasticity.	M	F
0.70–1.10	SM	Silty fine SAND; grey mottled brown. Poorly graded. ... 0.9 m becomes red/brown.	M	'L'
1.10–2.20	ML	SILT; grey mottled brown. Low plasticity. ... at 1.4 m contains trace wood material, and some clay.	M	St
2.20–2.80	ML	Fine sandy SILT; grey. Low plasticity. ... below 2.4 m contains trace rootlets. ... below 2.6 m becomes saturated and dilatant.	M / S	F
2.80–3.10	ML	SILT; minor fine sand; grey. Low plasticity, dilatant	S	S-F
3.10–3.20	SP	Fine to medium SAND, minor silt; grey. Poorly graded.	S	MD
3.20–3.50	ML	SILT, minor sand; grey. Low plasticity, dilatant; sand fine.	S	St
3.50–3.55	SP	Fine to medium SAND; grey. Poorly graded.	S	MD
		Termination Depth = 3.55m (Refusal - Auger grinding, no recovery/)		

Sample/ Test Records & Comments

Test Results (blows per 100mm)



CPT ANALYSIS NOTES

Soil Type

Interpretation using chart of Robertson & Campanella (1983). This is a simple but well proven interpretation using cone tip resistance (q_C) and friction ratio (f_R) only. No normalisation for overburden stress is applied. Cone tip resistance measured with the piezocone is corrected with measured pore pressure (u_C).

- sand (and gravel)
- silt-sand
- silt
- clay-silt
- clay
- peat

Liquefaction Screening

The purpose of the screening is to highlight susceptible soils, that is sand and silt-sand in a relatively loose condition. This is not a full liquefaction risk assessment which requires knowledge of the particular earthquake risk at a site and additional analysis. The screening is based on the chart of Shibata and Teparaksa (1988).

- high susceptibility
- medium susceptibility
- low susceptibility

High susceptibility is here defined as requiring a shear stress ratio of 0.2 to cause liquefaction with D_{50} for sands assumed to be 0.25 mm and for silty sands to be 0.05 mm.

Medium susceptibility is here defined as requiring a shear stress ratio of 0.4 to cause liquefaction with D_{50} for sands assumed to be 0.25 mm and for silty sands to be 0.05 mm.

Low susceptibility is all other cases.

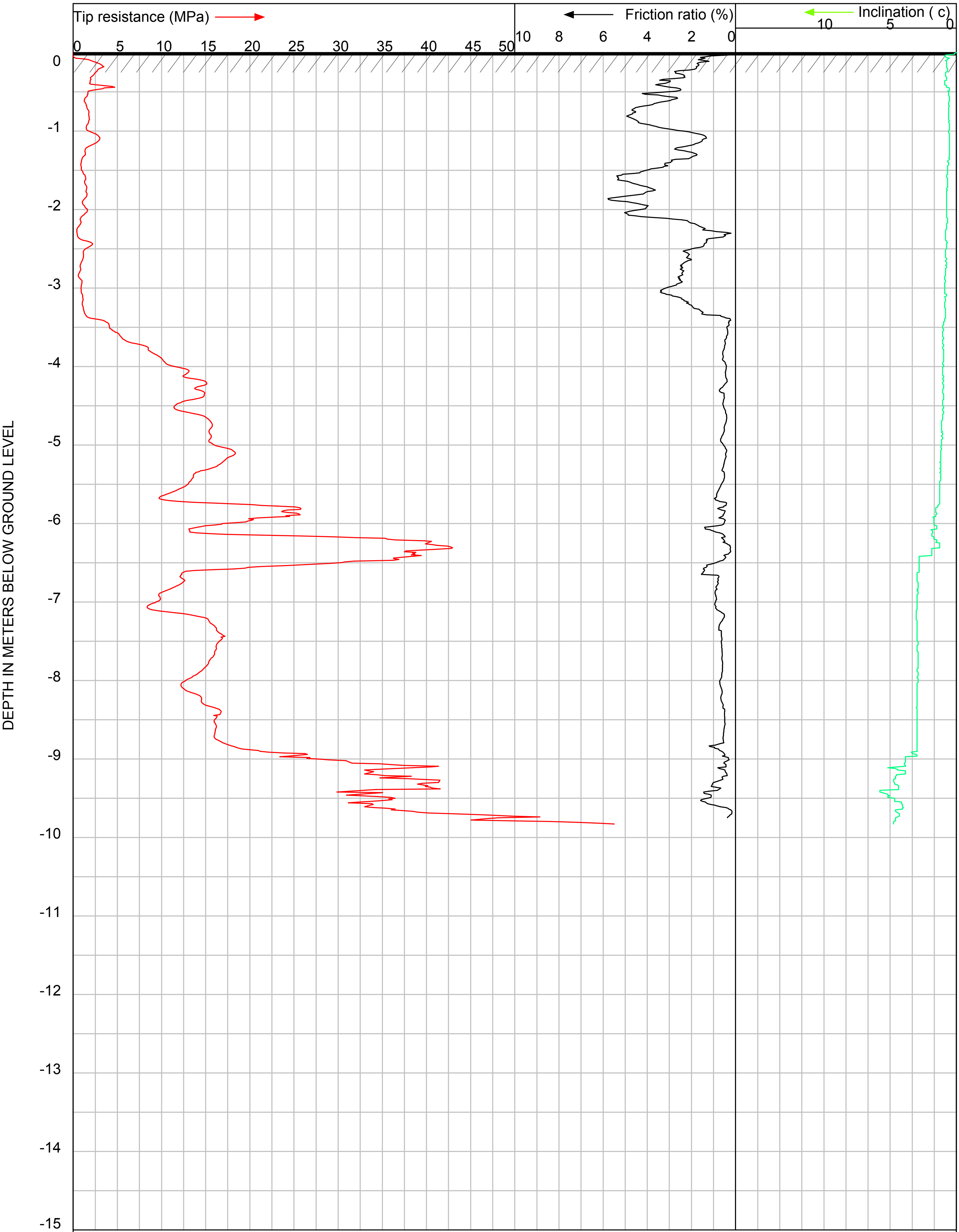
Relative Density (D_R)

Based on the method of Baldi et. al. (1986) from data on normally consolidated sand.

Undrained Shear Strength (S_U)

Derived from the bearing capacity equation using $S_U = (q_C - \sigma_{VO})/15$.

McMILLAN
DRILLING SERVICES

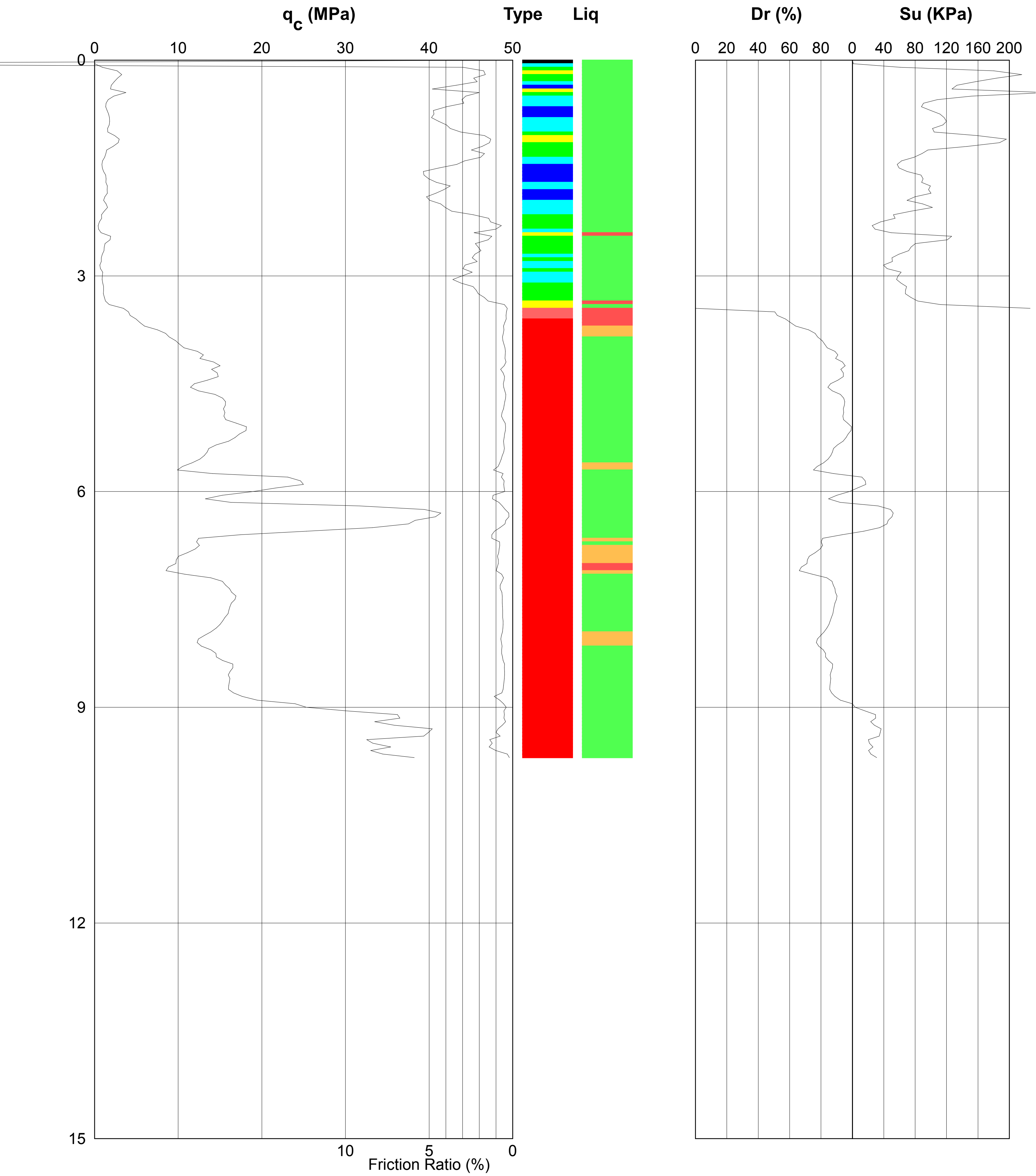


CLIENT : GHD NZ Ltd
LOCATION : 31 Berwick Street, Christchurch
DATE : 2-11-2012
OPERATOR : S.Cardona
REMARK 1 : CPT001
REMARK 2 : Effective Refusal

JOB # : 11258
TEST # : 1
CONE TYPE/SERIAL #: I-CFXY-10 / 080238T

McMILLAN DRILLING SERVICES
120 High St Southbridge CANTERBURY NZ
Ph +64 3 324 2571 Fax +64 3 324 2431
www.drilling.co.nz

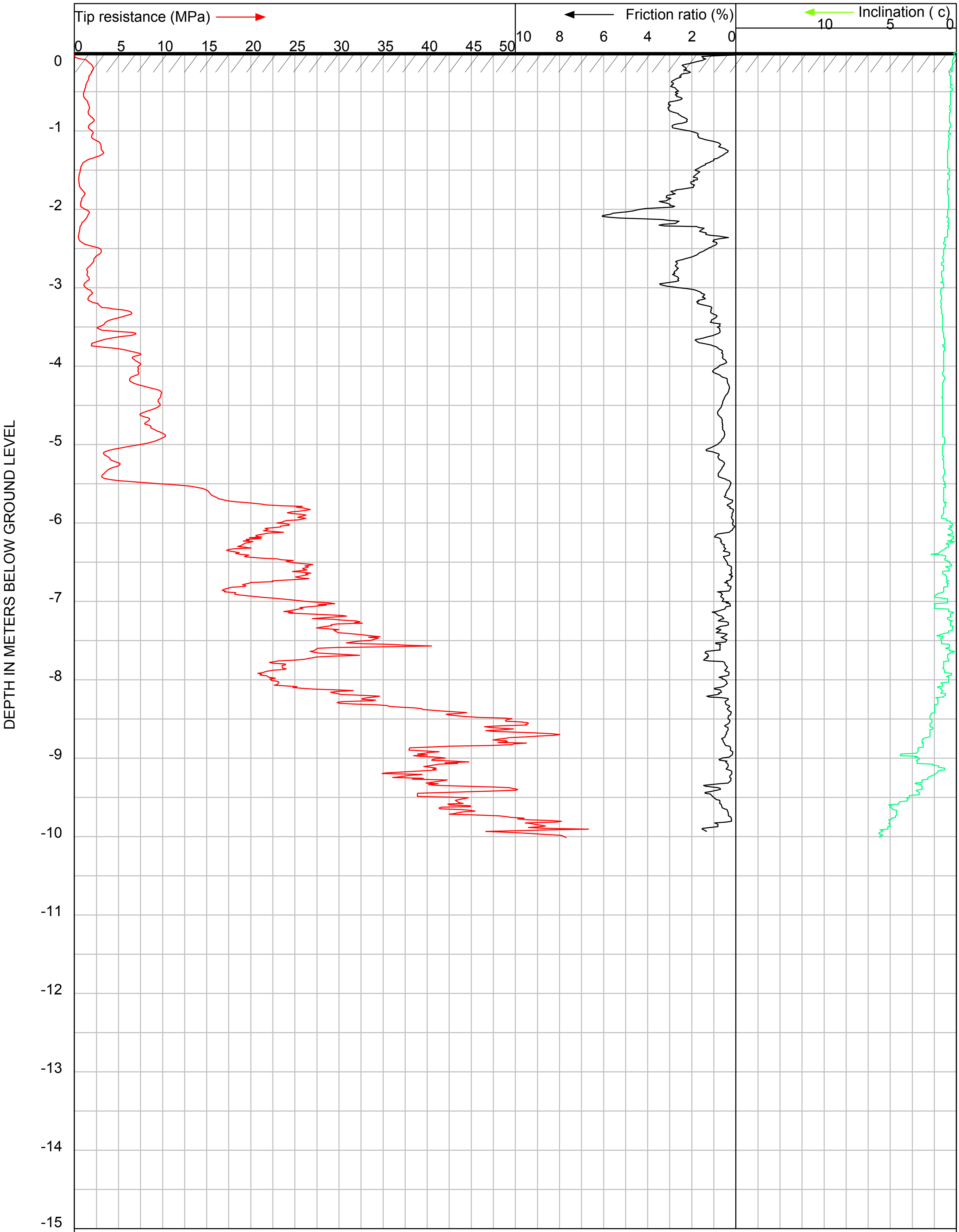
PIEZOCONE PENETROMETER TEST (CPTU) INTERPRETIVE REPORT



Job No: 11258
CPT No: CPT001
Project: GHD NZ Ltd
Location: 31 Berwick Street, Christchurch

Date: 2-11-2012
Operator: S.Cardona
Remark: Effective Refusal

McMILLAN DRILLING SERVICES



CLIENT	:	GHD NZ Ltd
LOCATION	:	31 Berwick Street, Christchurch
DATE	:	2-11-2012
OPERATOR	:	S.Cardona
REMARK 1	:	CPT002
REMARK 2	:	Effective Refusal

JOB # : 11258

TEST # : 2

CONE TYPE/SERIAL #: I-CFXY-10 / 080238T

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120 High St Southbridge CANTERBURY NZ
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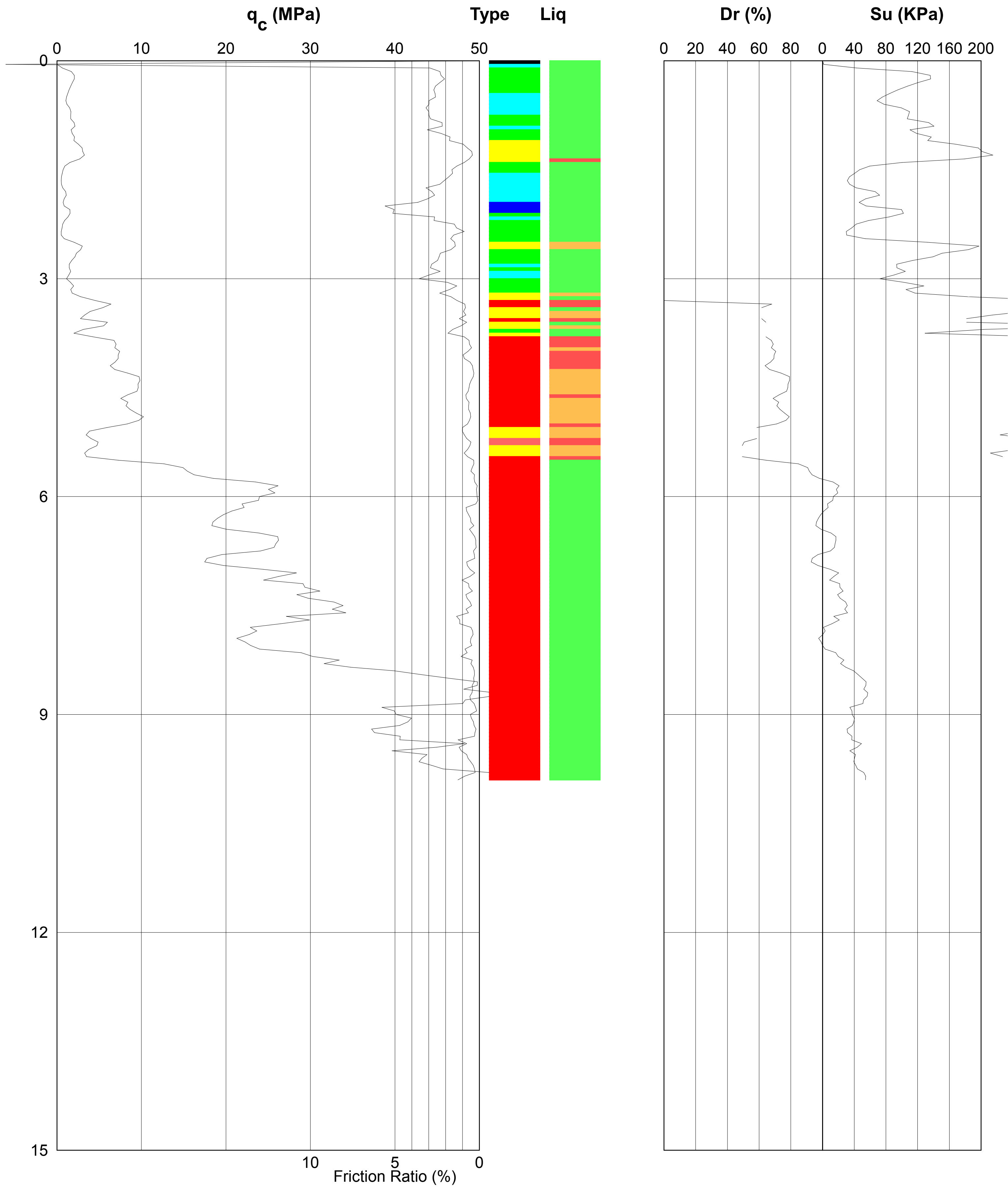
www.drilling.co.nz

PIEZOCONE PENETROMETER TEST (CPTU) INTERPRETIVE REPORT



Job No:	11258	Date:	2-11-2012
CPT No:	CPT002	Operator:	S.Cardona
Project:	GHD NZ Ltd	Remark:	Effective Refusal
Location:	31 Berwick Street, Christchurch		

McMILLAN DRILLING SERVICES

CPT CALIBRATION AND TECHNICAL NOTES

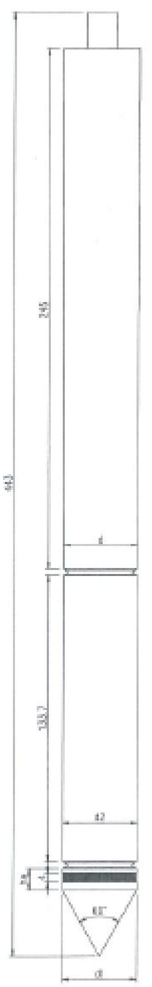
These notes describe the technical specifications and associated calibration references pertaining to the following cone types:

- ELCI-10CFXY measuring cone resistance, sleeve friction and inclination (standard cone);
- ELCI-CFXYP20-10 measuring cone resistance, sleeve friction, inclination and pore pressure (piezo cone).

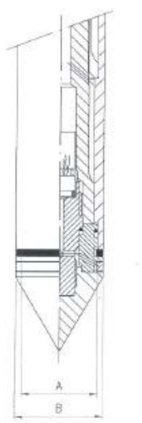
Dimensions

Dimensional specifications for both cone types are detailed below. All tolerances are routinely checked prior to testing and measurements taken are manually recorded on CPT field sheets. All field sheets are kept on file and available on request.

A.P. van den Berg Machinefabriek b.v. tel. :0513-631355 fax. :0513-631212	**DEVIATION of Straightness + MINIMAL Dimensions tip, (friction)jacket, thread adapter**	Standards: EN ISO 22476-1 NEN 5140 APB standard
Type of cone:	10 cm^2	
Diameter of tip: (acc. to EN ISO 22476-1)	$35,3 \le d1 \le 36,0$	
Diameter friction jacket:	$d_1 \le d_2 < d_1 + 0,35$	
Tip: (production dimension)	$d_1 = 35,7\ ^{+0,2}_{0}$	
Jacket (C-cone):	$d_2 = 35,7\ ^{+0,2}_{0}$	
Friction jacket (CF-cone):	$d_2 = 35,9\ ^{+0,1}_{0}$	
Tip for used cone:	$d_1 = 35,5\ ^{+0,1}_{0}$	
Minimal diameter jacket: (C-cone)	$d_2 = 35,2$ (APB std.)	
Minimal diameter of friction jacket: (CF-cone)	$d_2 = 35,3$	
Use "used cone"-tip when friction jacket diameter:	$d_2 \le 35,65$	
Minimal diameter of thread adaptor:	$d = 35,3$	
Height dimension tip edge:	$7 \le h_e \le 10$	
Maximal deviation of straightness:	1 mm on a length of 1000 mm (max. oscillation 1,0 mm.)	



Cone surface ratio



A=0,25x3,14x30,9x30,9=750 MM^2
B=0,25x3,14x35,7x35,7=1000 MM^2

$\alpha = A/B \qquad \beta = 1 - A/B$

$\alpha = 750/1000 = 0,75$
$\beta = 1 - 0,75 = 0,25$

CPT CALIBRATION AND TECHNICAL NOTES (cont.)

Calibration

Each cone has a unique identification number that is electronically recorded and reported for each CPT test. The identification number enables the operator to compare 'zero-load offsets' to manufacturer calibrated zero-load offsets.

The recommended maximum zero-load offset for each sensor is determined as ± 10% of the maximum measuring range although the more conservative trigger point adopted by McMillan Drilling Services is ± 10% of the nominal range.

In addition to maximum zero-load offsets, McMillan Drilling Services also limits the difference in zero load offset before and after the test as ± 1% of the maximum measuring range. See table below:

	Tip (MPa)	Friction (MPa)	Pore Pressure (MPa)
Maximum Measuring Range:	150	1.50	3.00
Nominal Measuring Range:	100	1.00	2.00
Max. 'zero-load offset':	10	0.10	0.20
Max 'before and after test':	1.5	0.015	0.03

Note: The zero offsets are electronically recorded and reported for each test in the same units as that of each sensor.

TEST CERTIFICATE
Icone (all versions)

Supplier:	A.P. v.d. Berg Machinefabriek, Heerenveen The Netherlands
Production-order:	55346.001
Client:	Mc Millan
Cone-type:	ELCI 10 CFXY
Cone-number:	080238

To test / To check item	**Required value**	**Checked value**
Isolation-resistance	>0.5 G-Ohm	O.K. Gohm
Straightness	S=<0,2 mm	O.K. mm
Zero-Value Tip	Good	-2,74 MPa
Zero-Value Local Friction	Good	-0,043 MPa
Zero-Value Pore Pressure	Good	n.v.t. kPa
Zero-Value Inclination X Zero-Value Inclination Y	-2°< X <+2° -2° < Y <+2°	-0,1 ° 0,0 °
Measurements Tip resistance OK?	Yes	0-50 MPa
Influence of Tip on Local Friction? (Tip: 100 kN; Mantle free?)	No influence	O.K.
Measurements Local Friction OK?	Yes	0-0,667 MPa
Measurements Pore Pressure OK?	Yes	n.v.t. kPa
Measurements Inclination OK?	Yes	-24-0-24
Cone recognition on disconnecting and connecting Icone again?	Yes	O.K.
Software version 1.7 installed? Check at opening screen	Yes	O.K.
Thresholds for rapid exit set to maximum	Yes	O.K.

Remarks:

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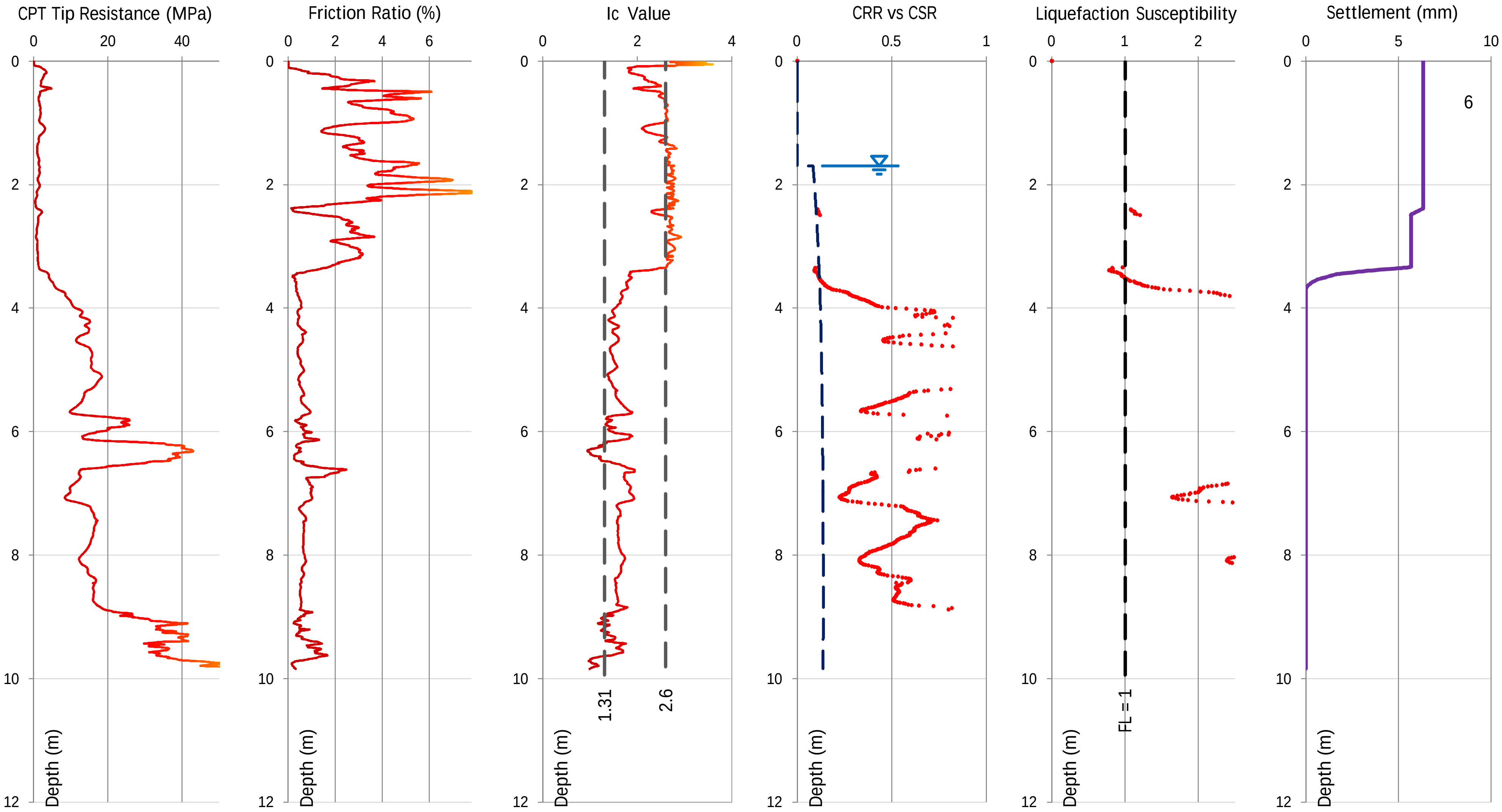
Calibrated by:	C.J. Ouwejan	Date:	22-11-'11	Sign.:	
Final check:	J.E. Tenhage	Date:	22-11-'11	Sign.:	

SOIL LIQUEFACTION SUSCEPTIBILITY ASSESSMENT

LOCATION :	CPT01	SHEET :	SLS
PROJECT :	31 Berwick Street, St Albans	CALCULATED :	JS
JOB NO :	51 30902 79	CHECKED BY :	HN
TEST DATE :	2 Nov 2012	DATE :	7 Nov 2012

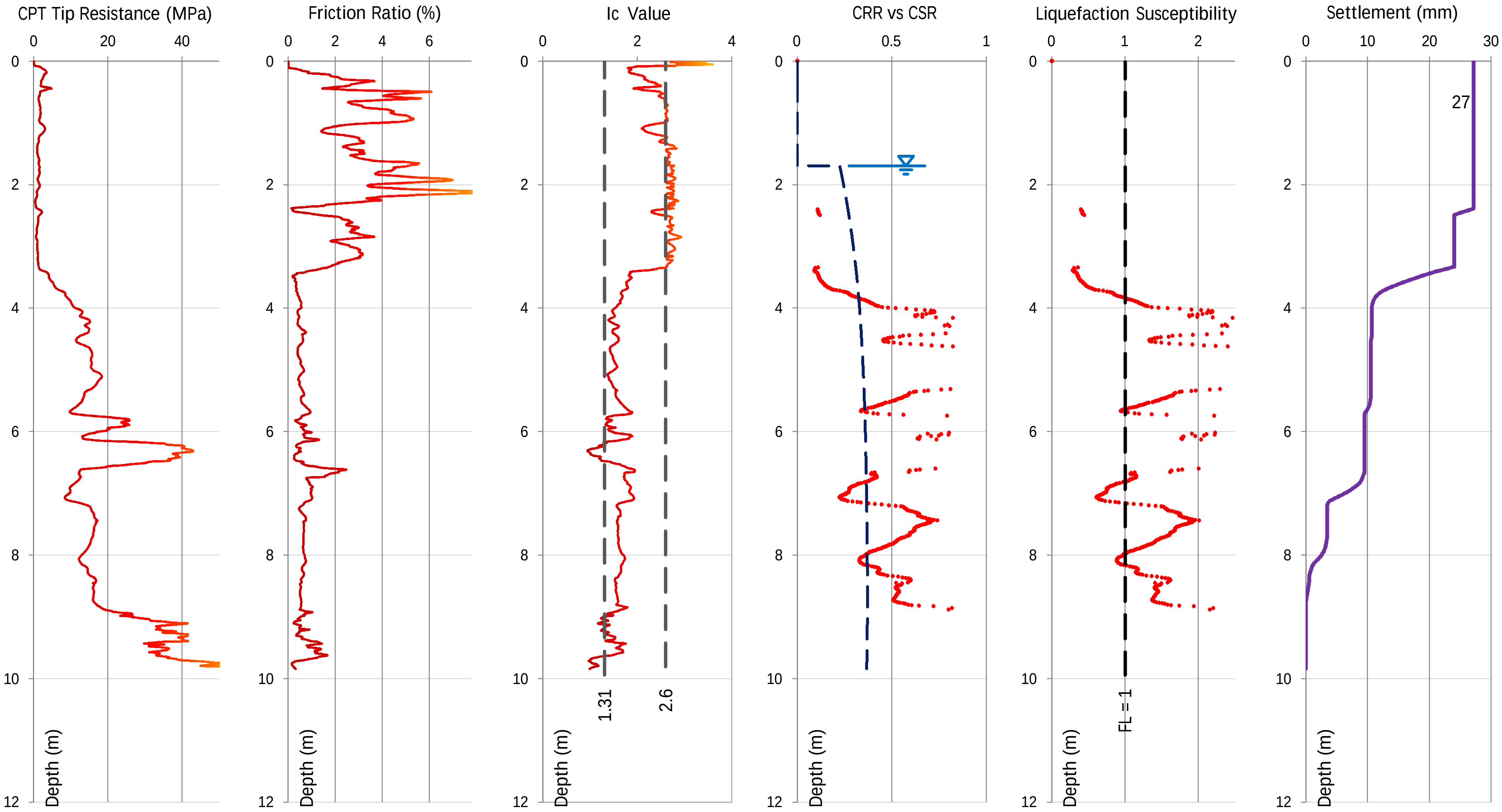
PGA (a_{max}):	0.13 g	Groundwater Level (m bgl):	1.7	Bore depth (m):	9.84	**Total Estimated Settlement (mm)**
EQ Magnitude:	7.5	Atmospheric Pressure (kPa):	101	Test data step (m):	0.01	**6**



SOIL LIQUEFACTION SUSCEPTIBILITY ASSESSMENT

LOCATION :	CPT01	SHEET :	ULS
PROJECT :	31 Berwick Street, St Albans	CALCULATED :	JS
JOB NO :	51 30902 79	CHECKED BY :	HN
TEST DATE :	2 Nov 2012	DATE :	7 Nov 2012

PGA (a_{max}):	0.35 g	Groundwater Level (m bgl):	1.7	Bore depth (m):	9.84	**Total Estimated Settlement (mm)**
EQ Magnitude:	7.5	Atmospheric Pressure (kPa):	101	Test data step (m):	0.01	**27**



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SOIL LIQUEFACTION SUSCEPTIBILITY ASSESSMENT

LOCATION :	CPT02	SHEET :	SLS
PROJECT :	31 Berwick Street, St Albans	CALCULATED :	JS
JOB NO :	51 30902 79	CHECKED BY :	HN
TEST DATE :	2 Nov 2012	DATE :	7 Nov 2012

PGA (a_{max}):	0.13 g	Groundwater Level (m bgl):	1.7	Bore depth (m):	10.02
EQ Magnitude:	7.5	Atmospheric Pressure (kPa):	101	Test data step (m):	0.01

Total Estimated Settlement (mm)

15

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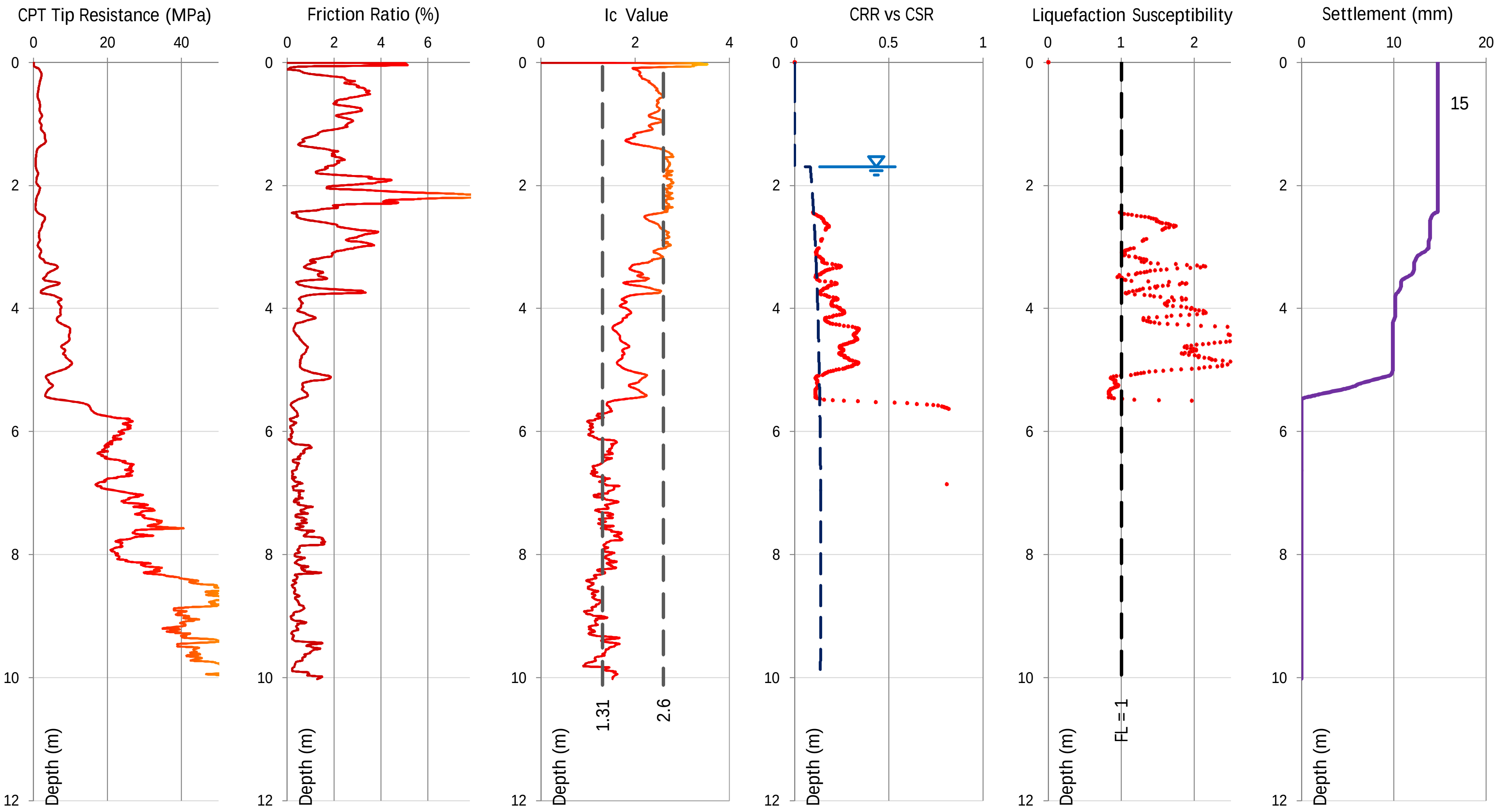

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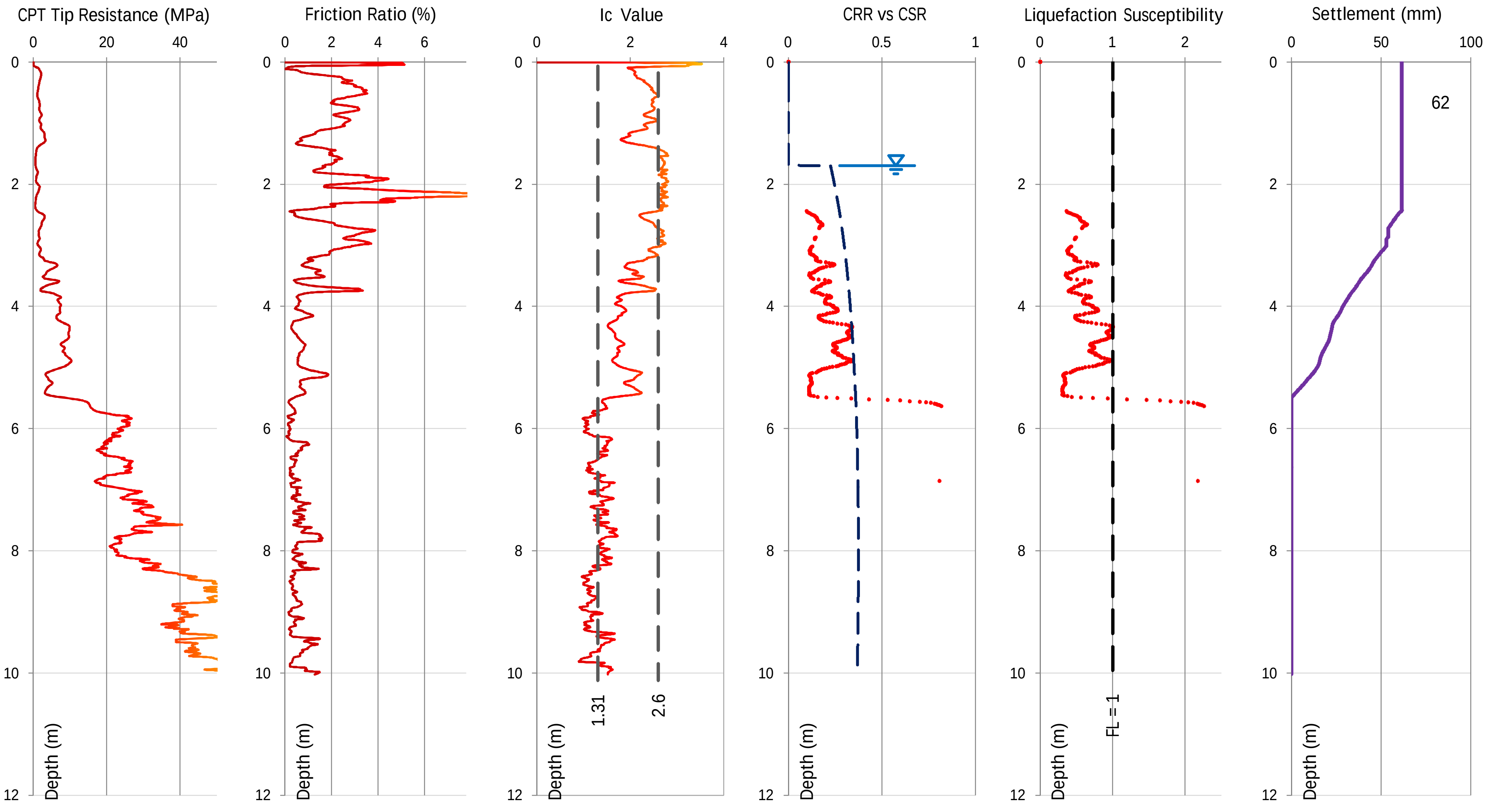
SOIL LIQUEFACTION SUSCEPTIBILITY ASSESSMENT

LOCATION :	CPT02	SHEET :	ULS
PROJECT :	31 Berwick Street, St Albans	CALCULATED :	JS
JOB NO :	51 30902 79	CHECKED BY :	HN
TEST DATE :	2 Nov 2012	DATE :	7 Nov 2012

PGA (a_{max}):	0.35 g	Groundwater Level (m bgl):	1.7	Bore depth (m):	10.02
EQ Magnitude:	7.5	Atmospheric Pressure (kPa):	101	Test data step (m):	0.01

Total Estimated Settlement (mm)

62



GHD

Level 11, Guardian Trust House
15 Willeston street, Wellington 6011
T: 64 4 472 0799 F: 64 4 472 0833 E: wgtnmail@ghd.com

Document Status

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