Christchurch City Council

Innes Courts
PRO 0643

Detailed Engineering Evaluation

Quantitative Assessment Report

Christchurch City Council

Innes Courts

Quantitative Assessment Report

403 & 407 Innes Road, Mairehau, Christchurch

Prepared By

Andres Benavides
Structural Engineer

Reviewed By

Anthony Chin
Senior Structural Engineer

MHalliday

Approved By

Mary Ann Halliday
Senior Structural Engineer

Opus International Consultants Ltd
Christchurch Office
20 Moorhouse Avenue
PO Box 1482, Christchurch Mail
Centre, Christchurch 8140
New Zealand

Telephone: +64 3 363 5400
Facsimile: +64 3 365 7858

Date: June 2013
Reference: 6-QUCC2.16
Status: Final

Summary

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Detailed Engineering Evaluation
Quantitative Report - Summary
Final

403 & 407 Innes Road, Mairehau, Christchurch

Background

This is a summary of the Quantitative report for the Innes Courts Complex and it is based on the Detailed Engineering Evaluation Procedure document (draft) issued by the Structural Advisory Group on 19 July 2011, visual inspections on 14 December 2012, the available drawings and calculations.

Key Damage Observed

Minor non-structural damage was observed around all blocks. The damage consisted of mostly minor cracking and minor step cracking of the block masonry veneer. Minor cracking to plasterboard linings and shifting of the brick veneers was also observed at Block F.

Critical Structural Weaknesses

No critical structural weaknesses have been identified for the buildings.

Indicative Building Strength

Based on the available information, Blocks A, B, D and E have seismic capacities of 34%NBS and Block C has a seismic capacity of 35%NBS. The garage at Block F has a seismic capacity of 42%NBS. These buildings are therefore classed as moderate risk in accordance with the Building Act 2004.

The buildings have 10 times the risk of an equivalent 100%NBS building in a design level seismic event according to NZSEE guidelines. Based on the form of construction and the seismic load resistant systems present, we do not believe that the building has a moderate risk of collapse. We consider there may be a fall hazard risk from the brick veneer if it is not tied to the structure.

The house at Block F has a seismic capacity of 85%NBS and is therefore classed as low risk in accordance with the Building Act.

Recommendations

It is recommended that:

(a) Strengthening options be developed to increase the seismic capacities of Blocks A –E and the garage at Block F to at least 67% NBS.

(b) Connections of the non-structural masonry block veneer and the roof diaphragm to the timber walls to be checked on site and strengthened if necessary. This could be achieved by providing brick ties between these structural and non-structural elements.

Contents

1 Introduction

Opus International Consultants Limited has been engaged by the Christchurch City Council (CCC) to undertake a detailed seismic assessment of the Innes Courts buildings, located at 403 Innes Road, Mairehau, Christchurch, including the residential house (and garage) located at 407 Innes Road. This assessment has been deemed necessary following the M6.3 Christchurch earthquake on 22 February 2011.

The seismic assessment and reporting have been undertaken based on the qualitative and quantitative procedures detailed in the Detailed Engineering Evaluation Procedure (DEEP) document (draft) issued by the Structural Engineering Society (SESOC) on 19 July 2011.

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

We understand that CERA 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). CERA have adopted the Detailed Engineering Evaluation Procedure (DEEP) document (draft) issued by the Structural Engineering Society (SESOC) on 19 July 2011. This document sets out a methodology for both initial qualitative and detailed quantitative assessments.

It is anticipated that a number of factors, including the following, will determine the extent of evaluation and strengthening level required:

1. The importance level and occupancy of the building.
2. The placard status and amount of damage.
3. The age and structural type of the building.
4. Consideration of any critical structural weaknesses.

Christchurch City Council requires any building with a capacity of less than 34% of New Building Standard (including consideration of critical structural weaknesses) to be strengthened to a target of 67% as required under the CCC Earthquake Prone Building Policy.

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

The Earthquake Prone Building policy for the territorial authority shall apply as outlined in Section 2.3 of this report.

Section 115 – Change of Use

This section requires that the territorial authority is satisfied that the building with a new use complies with the relevant sections of the Building Code 'as near as is reasonably practicable'.

This is typically interpreted by territorial authorities as being 67% of the strength of an equivalent new building or as near as practicable. This is also the minimum level recommended by the New Zealand Society for Earthquake Engineering (NZSEE).

Section 121 – Dangerous Buildings

This section was extended by the Canterbury Earthquake (Building Act) Order 2010, and defines a building as dangerous if:

1. 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
2. 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

3. 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
4. There is a risk that other property could collapse or otherwise cause injury or death; or
5. 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 (EPB) 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 loads 33% of those 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 on 4 September 2010.

The 2010 amendment includes the following:

1. A process for identifying, categorising and prioritising Earthquake Prone Buildings, commencing on 1 July 2012;
2. A strengthening target level of 67% of a new building for buildings that are Earthquake Prone;
3. A timeframe of 15-30 years for Earthquake Prone Buildings to be strengthened; and,
4. 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.

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.

Where an application for a change of use of a building is made to Council, the building will be required to be strengthened to 67% of New Building Standard or as near as is reasonably practicable.

2.4 Building Code

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

On 19 May 2011, Compliance Document B1: Structure was amended to include increased seismic design requirements for Canterbury as follows:

- increase in the basic seismic design load for the Canterbury earthquake region (Z factor increased to 0.3 equating to an increase of 36 – 47% depending on location within the region);
- Increased serviceability requirements.

2.5 Institution of Professional Engineers New Zealand (IPENZ) Code of Ethics

One of the core ethical values of professional engineers in New Zealand is the protection of life and safeguarding of people. The IPENZ Code of Ethics requires that:

Members shall recognise the need to protect life and to safeguard people, and in their engineering activities shall act to address this need.

1.1 Giving Priority to the safety and well-being of the community and having regard to this principle in assessing obligations to clients, employers and colleagues.

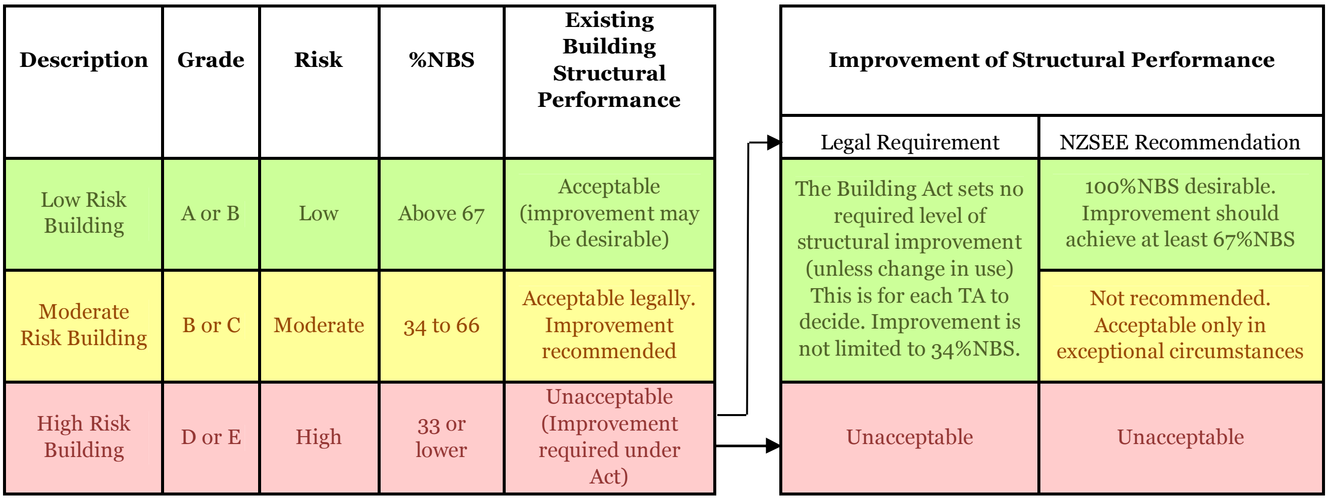
1.2 Ensuring that responsible steps are taken to minimise the risk of loss of life, injury or suffering which may result from your engineering activities, either directly or indirectly.

All recommendations on building occupancy and access must be made with these fundamental obligations in mind.

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 loadings are in accordance with the current earthquake loading standard NZS1170.5 [1].

A generally accepted classification of earthquake risk for existing buildings in terms of %NBS that has been proposed by the NZSEE 2006 [2] is presented in Figure 1 below.



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

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

Figure 1: NZSEE Risk Classifications Extracted from table 2.2 of the NZSEE 2006 AISPBE Guidelines

Table 1 below compares the percentage NBS to the relative risk of the building failing in a seismic event with a 10% risk of exceedance in 50 years (i.e. 0.2% in the next year).

Table 1: %NBS compared to relative risk of failure

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

3.1 Minimum and Recommended Standards

Based on governing policy and recent observations, Opus makes the following general recommendations:

3.1.1 Occupancy

The Canterbury Earthquake Order[1] in Council 16 September 2010, modified the meaning of "dangerous building" to include buildings that were identified as being EPB's. As a result of this, we would expect such a building would be issued with a Section 124 notice, by the Territorial Authority, or CERA acting on their behalf, once they are made aware of our assessment. Based on information received from CERA to date and from the DBH guidance document dated 12 June 2012 [6], this notice is likely to prohibit occupancy of the building (or parts thereof), until its seismic capacity is improved to the point that it is no longer considered an EPB.

3.1.2 Cordoning

Where there is an overhead falling hazard, or potential collapse hazard of the building, the areas of concern should be cordoned off in accordance with current CERA/territorial authority guidelines.

3.1.3 Strengthening

Industry guidelines (NZSEE 2006 [2]) strongly recommend that every effort be made to achieve improvement to at least 67%NBS. A strengthening solution to anything less than 67%NBS would not provide an adequate reduction to the level of risk.

It should be noted that full compliance with the current building code requires building strength of 100%NBS.

3.1.4 Our Ethical Obligation

In accordance with the IPENZ code of ethics, we have a duty of care to the public. This obligation requires us to identify and inform CERA of potentially dangerous buildings; this would include earthquake prone buildings.

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[1] This Order only applies to buildings within the Christchurch City, Selwyn District and Waimakariri District Councils authority

4 Building Description

4.1 General

The Innes Courts complex consists of 30 units and one residential house and garage (located at 407 Innes Road). As Figure 2 below shows, there are three types of buildings on the site:

- ***Type 1***: Two storey stand-alone building containing two units: Block A units 1/2 and 3/4; Block B units 5/6 and 11/12; Block D units 15/16 and 21/22 and Block E units 23/24 and 29/30.
- ***Type 2***: Two storey building attached with a common internal wall containing four units: Block B units 7/ 8 and 9/10; Block D units 17/18 and 19/20 and Block E units 25/26 and 27/28.
- ***Type 3:*** Single storey building: Block C units 13/14.

One case of each type was analysed. The building types are marked in the site plan below.

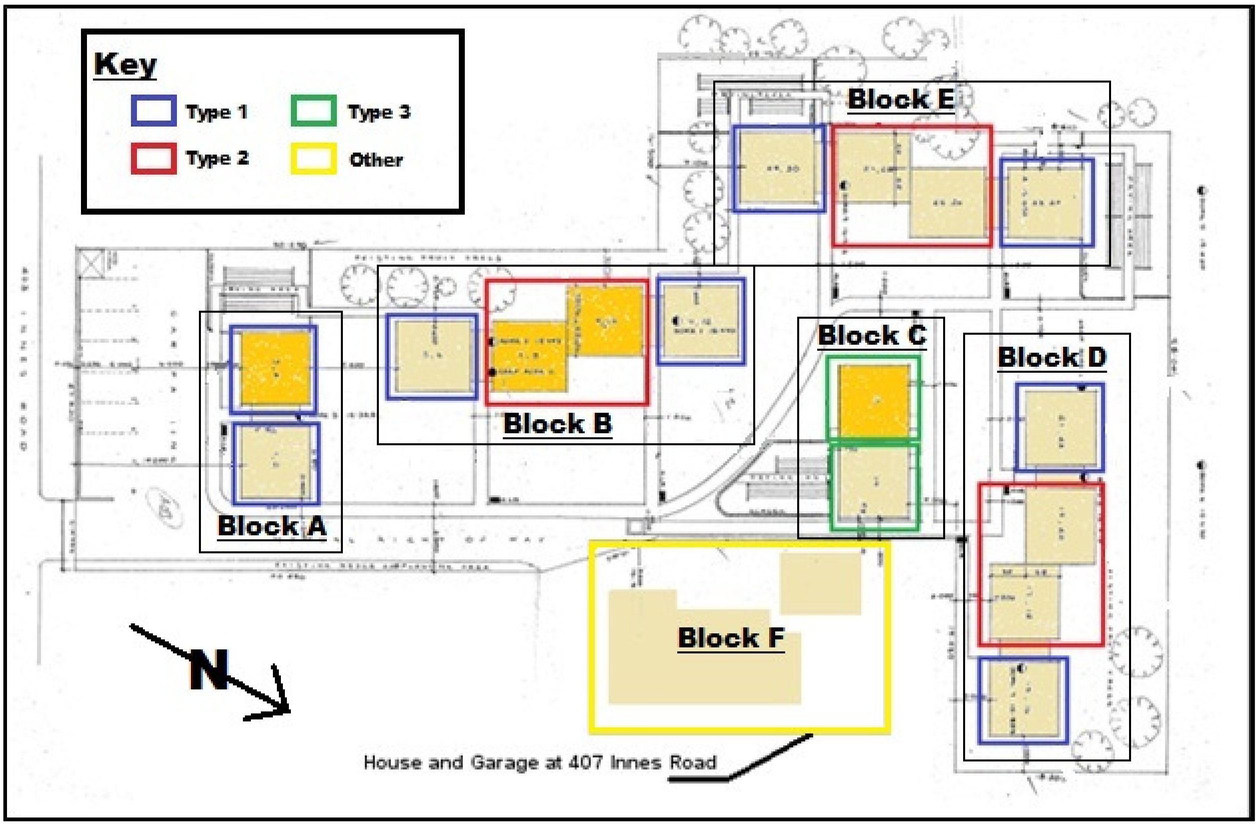


Figure 2: Innes Courts Layout

The Type 1 buildings are approximately 6.6m long by 6.4m wide. The Type 2 buildings are approximately 12.9m long by 9.5m wide. In both Types 1 and 2 the height to the top of the first floor slab is 2.6m and to the roof apex is approximately 6m from the ground level with a ceiling height of approximately 4.7m height from the ground. All internal walls in the ground level are fully filled concrete masonry walls 140mm thick with an external block veneer 90mm thick. In the first level, the walls are timber framed, lined with plasterboard on one side with an external block veneer. The level one slab consists of 75mm unispan precast units with 65mm topping. The foundations consist of strip footings and a slab on grade. The roof consists of timber trusses with timber stringers. The configuration of the Type 2 buildings consist of four units of the same Type 1 units attached with an internal masonry wall from the ground to the ceiling level.

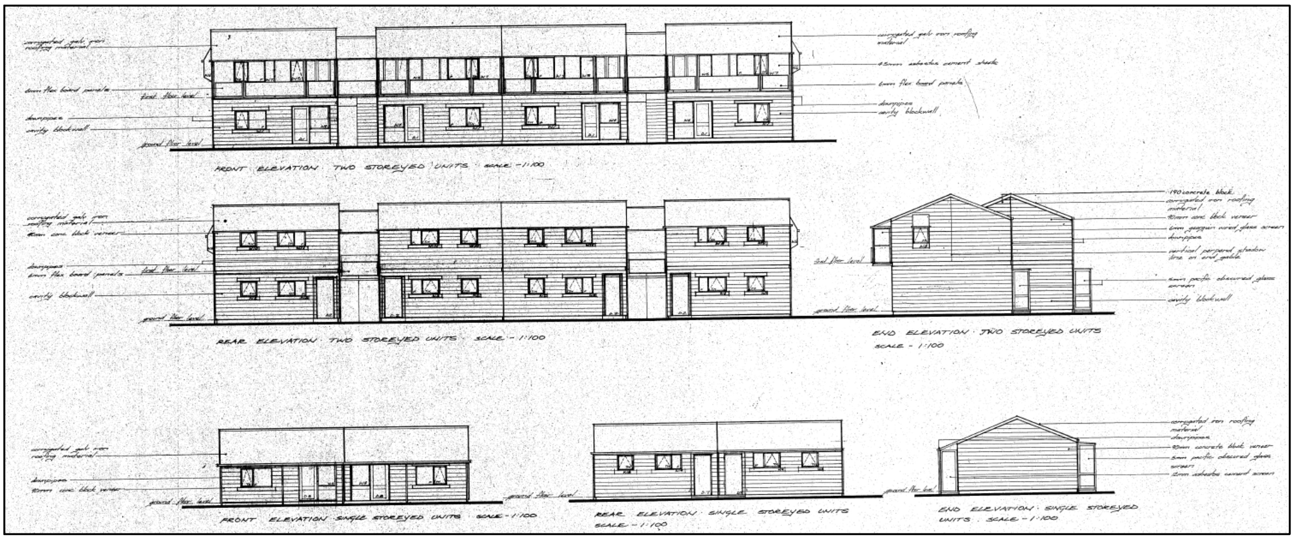


Figure 3: Innes Courts Building Elevations

The Type 3 building is approximately 6.6m long by 6.4m wide. The height of the roof apex is approximately 3.4m from the ground level with a ceiling height of approximately 2.6m. All internal walls are timber stud walls lined with plasterboard on one side with an external block veneer. The foundations consist of strip footings. The roof consists of timber trusses with timber stringers.

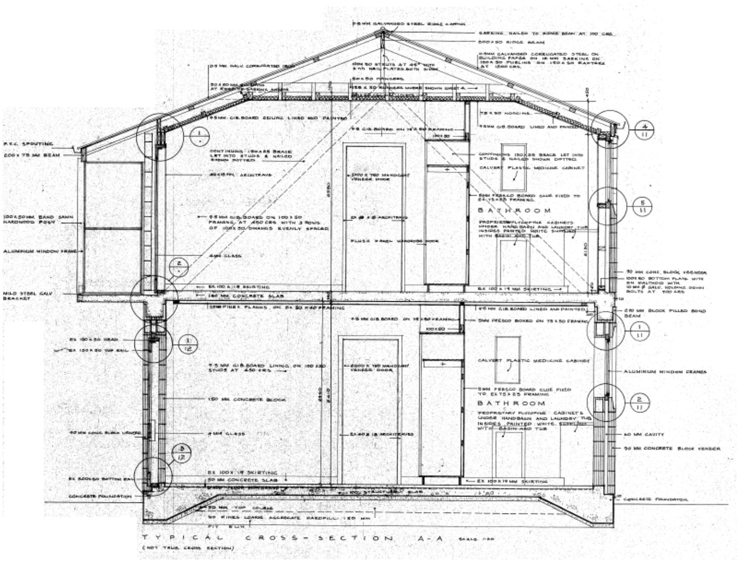


Figure 4: Innes Courts Typical Two Storey Building Section

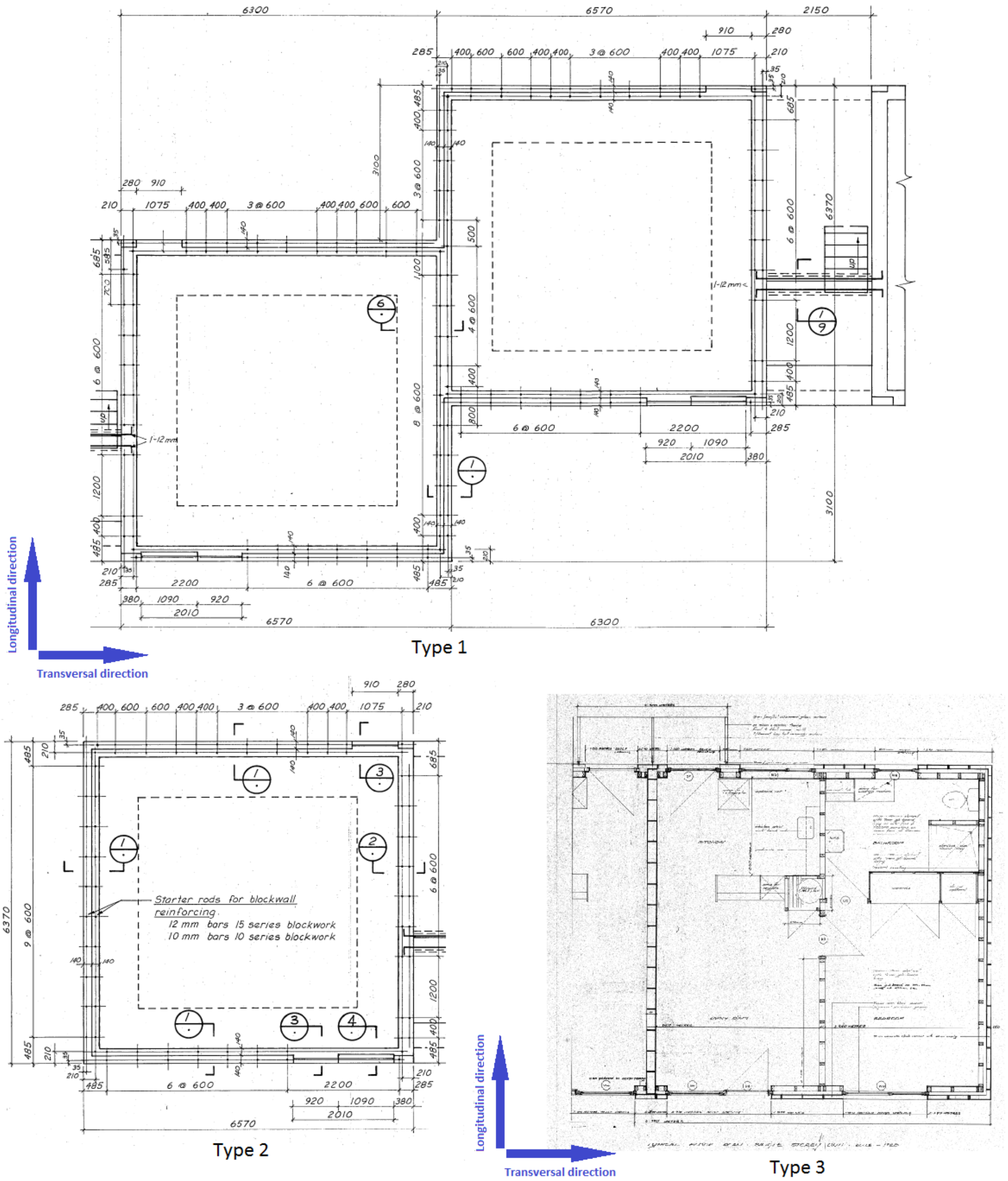


Figure 5: Innes Courts Ground Floor Plans

The date of construction of the development is 1976.

4.2 Gravity Load Resisting System

The roof structure consists of timber trusses and is clad externally with a light weight steel corrugated roof. The roof trusses are supported by timber stud walls in the North-South direction, which are 2.1m in height.

The level one slab consists of 75mm precast concrete floor units with 65mm concrete topping. The floor is supported by the concrete masonry shear walls in the East-West direction. The foundations of the ground floor walls consist of 1m wide strip foundations for the external walls and 1.7m wide strip foundations for the internal walls. All foundations are considered as shallow foundations. The ground floor construction consists of concrete slab-on-grade and the slab is tied to the foundation footings.

4.3 Seismic Load Resisting System

Seismic loads in both principal directions of the two storey units are resisted by fully filled concrete masonry shear walls on the ground floor and timber stud walls lined with plasterboard in the second floor. The roof level loads are transferred to the walls through 12mm sarking under the roof sheeting.

In the single storey units, the seismic loads in both principal directions are resisted by timber stud walls lined with plasterboard and one long fire resistant concrete masonry wall. The roof structure comprises of timber roof trusses, clad with a light weight steel corrugated roof. The roof level loads are transferred to the walls through 12mm ply sarking under the roof sheeting.

4.4 House and Garage at 407 Innes Road

The house at 407 Innes Road is 9m wide and 14.5m long at its largest points. It is constructed using timber frames with a brick veneer. The roof has a 25° pitch and is supported by roof beams and under purlins; it is clad in a heavy concrete tile. The eaves are approximately 2.7m from the ground. The house is founded on ordinary concrete piles with a 400mm high strip concrete perimeter footing. The internal and external walls provide the house with lateral resistance in both directions.

The garage at 407 Innes Road is rectangular, 3.8m wide and 5.2m long. It is constructed using concrete block with horizontal reinforcing bars around the perimeter of the walls and vertical bars at approximately 2.0m spacing. The roof is constructed using timber trusses and is clad in a heavy concrete tile. The external block walls provide lateral resistance in both directions.

5 Survey

This report is based on a site inspections carried out by an Opus Structural Engineer on 14 December 2012 and 24 April 2013 (407 Innes Road only), photographic evidence, and the available structural drawings.

6 Damage Assessment

Generally, the units have suffered minor damage in some non-structural concrete masonry veneer blocks and in timber bracing walls.

The following damage was observed in all units:

- Minor cracking to the block veneers.
- Minor cracking to the plasterboard linings.

The following damage was observed in the house at 407 Innes Road:

- Minor cracking to the brick veneers.
- Brick veneers shifting outwards from timber frames, top brick course separated from rest of brickwork.
- Minor cracking to the plasterboard linings.

The garage at 407 Innes Road had no noticeable damage.

7 General Observations

No major level of damage was observed in the buildings. The timber walls have shown some minor signs of cracking and the concrete masonry shear walls have performed well under seismic conditions.

The concrete masonry walls are stiff structural elements therefore do not allow high deformations in the structure which is favourable for the non-structural elements such as the masonry block veneer. No fallen veneer was observed on site.

Due to the non-intrusive nature of the original survey, apart from the drawing review, many connection details could not be ascertained. In particular, the drawings did not show the connection of the non-structural masonry block veneer to the structure or the connection between the roof diaphragm the timber framed walls. The connections could be present however intrusive investigation will be required to determine this.

No evidence of liquefaction or significant ground damage such as settlements or cracks on the footpaths was observed on site.

8 Detailed Seismic Assessment

8.1 Critical Structural Weaknesses

As outlined in the Critical Structural Weakness and Collapse Hazards draft briefing document, issued by the Structural Engineering Society (SESOC) on 7 May 2011, the term

‘Critical Structural Weakness’ (CSW) refers to a component of a building that could contribute to increased levels of damage or cause premature collapse of the building.

No CSWs have been identified for the buildings.

8.2 Seismic Coefficient Parameters

The seismic design parameters based on current design requirements from NZS1170.5:2004 and the NZBC clause B1 for these buildings are:

- Site soil class D, clause 3.1.3 NZS 1170.5:2004;
- Site hazard factor, Z=0.3, B1/VM1 clause 2.2.14B;
- Importance Level (IL) 2 for all buildings except the Block F garage (IL1);
- Return period factor R_u = 1.0 from Table 3.5, NZS 1170.5:2004, for an Importance Level 1 or 2 structure with a 50 year design life;
- μ = 2.0 for the timber frame with plasterboard wall linings and μ = 1.25 for fully filled blockwork masonry (μ = 1.00 for blockwork on the block F garage).

8.3 Detailed Seismic Assessment Results

A summary of the structural performance of the building is shown in the following tables. Note that the values given represent the worst performing elements in the building, as these effectively define the building's capacity. Other elements within the building may have significantly greater capacity when compared with the governing element.

Table 2: Summary of Seismic Performance by Building Type

Structural Element/System	**Failure mode and description of limiting criteria**	**% NBS based on** **μ = 1.00 (garage walls)** **μ = 1.25 (masonry walls)** **μ = 2.00 (timber frame walls)**
Type 1		
Type 1 Units: Masonry walls in Longitudinal direction	In plane and out-of-plane shear and moment capacity, axial capacity. Stability and border grouted length. Connections to the foundations.	>100%
Type 1 Units: Masonry walls in Transverse direction	In plane and out-of-plane shear and moment capacity, axial capacity. Stability and border grouted length. Connections to the foundations.	47%
Type 1 Units: Timber walls in Longitudinal direction	In plane bracing capacity of the timber stud wall.	42%
Type 1 Units: Timber walls in Transverse direction	In plane bracing capacity of the timber stud wall.	34%
Type 1 Units: Concrete block veneer	In plane and out-of-plane shear and moment capacity, axial capacity. Stability and border grouted length.	44%
Type 1 Units: Concrete slab	Connections in plane shear capacity	>100%
Type 2		
Type 2 Units: Masonry walls in Longitudinal direction	In plane and out-of-plane shear and moment capacity, axial capacity. Stability and border grouted length. Connections to the foundations.	>100%
Type 2 Units: Masonry walls in Transverse direction	In plane and out-of-plane shear and moment capacity, axial capacity. Stability and border grouted length. Connections to the foundations.	47%
Type 2 Units: Timber walls in Longitudinal direction	In plane bracing capacity of the timber stud wall.	42%
Type 2 Units: Timber walls in Transverse direction	In plane bracing capacity of the timber stud wall.	34%

Structural Element/System	Failure mode and description of limiting criteria	% NBS based on µ = 1.00 (garage walls) µ = 1.25 (masonry walls) µ = 2.00 (timber frame walls)
Type 2 Units: Concrete block veneer	In plane and out-of-plane shear and moment capacity, axial capacity. Stability and border grouted length.	44%
Type 2 Units: Concrete slab	Connections in plane shear capacity	>100%
Type 3		
Type 3 Units: Masonry wall in Longitudinal direction	In plane and out-of-plane shear and moment capacity, axial capacity. Stability and border grouted length. Connections to the foundations.	>100%
Type 3 Units: Timber walls in Longitudinal direction	In plane bracing capacity of the timber stud wall.	100%
Type 3 Units: Timber walls in Transverse direction	In plane bracing capacity of the timber stud wall.	35%
Type 3 Units: Concrete block veneer	In plane and out-of-plane shear and moment capacity, axial capacity. Stability and border grouted length.	67%
House at 407 Innes Road		
Walls in Longitudinal direction	In plane bracing capacity of the timber stud walls.	90%
Walls in Transverse direction	In plane bracing capacity of the timber stud walls.	85%
Garage at 407 Innes Road		
Reinforced concrete block walls in Transverse direction	In plane bracing capacity of the block walls.	48%
Reinforced concrete block walls in Longitudinal direction	In plane bracing capacity of the block walls.	100%
Reinforced concrete block walls in both directions	Out of plane capacity of reinforced block walls	42%

Table 3: Summary of Seismic Performance by Block

Structural Element/System	Failure mode and description of limiting criteria	% NBS based on μ = 1.00 (garage walls) μ = 1.25 (masonry walls) μ = 2.00 (timber frame walls)
Block A (Units 1-4)		
Type 1 Units: Timber walls in Transverse direction	In plane bracing capacity of the timber stud wall.	34%
Block B, D and E (Units 5-12,15-22 and 23-30)		
Type 1 Units: Timber walls in Transverse direction	In plane bracing capacity of the timber stud wall.	34%
Type 2 Units: Timber walls in Transverse direction	In plane bracing capacity of the timber stud wall.	34%
Block C (units 13 and 14)		
Type 3 Units: Timber walls in Transverse direction	In plane bracing capacity of the timber stud wall.	35%
Block F: House		
Walls in Transverse direction	In plane bracing capacity of the timber stud walls.	85%
Block F: Garage		
Reinforced concrete block walls in both directions	In plane bracing capacity of the concrete block wall.	42%

8.4 Discussion of Results

The Type 1 and 2 buildings have a calculated capacity of 34% NBS. The Type 3 building has a calculated capacity of 35%NBS.

The buildings are classed as moderate risk in accordance with NZSEE guidelines.

The connection of the veneer blocks is an important structural element. In the analysis of the building, it was assumed that the veneer blocks are self-supported and are able to take the seismic demands generated by their own mass under in-plane loading and out-of-plane loading.

The timber wall bracing elements behaved well after the earthquake events. Due to the limited information given, the existing bracing element capacity was taken as 60 BU/m.

The concrete masonry shear wall capacity in the short walls (length shorter than 1.4m) is 47%NBS governed by the in-plane moment design.

The structural seismic analysis for the stairs for the Type 1 and 2 buildings (two-storey units) have been assessed. According to the structural drawings, the stairs are reinforced concrete but during the site inspection, the stairs were found to be timber stringers and timber steps supported on reinforced concrete landings. The stair landings are confined in the transverse direction by the residential units, and in the longitudinal direction, they are supported by the shear connections to the structural walls According to the analysis, the capacity of the shear connections between the landings and the walls is 100%NBS.

As the buildings have overall capacities of 34% and 35%NBS in accordance with the Building Act 2004, it is recommend that strengthening is undertaken to increase the seismic capacities of the buildings to at least 67%NBS.

The house at 407 Innes Road has an overall capacity of 85%NBS meaning the building is classed as low risk in accordance with NZSEE guidelines. The veneer bricks are assumed to be self-supporting and able to take the seismic demands generated by their own mass under in-plane loading. For out-of-plane loading the veneers rely on the strength of the veneer ties. As the brick veneers suffered some damage the veneer ties may be damaged or inadequate and should be checked.

The garage at 407 Innes Road has been assessed to have a capacity of less than 67%NBS meaning the building is classed as moderate risk in accordance with the NZSEE guidelines. As the garage is an ancillary building it can be assumed to be occupied for brief periods of time, the building can therefore be assumed an IL1 structure. Assessing the building as such results in 48%NBS for in-plane bracing capacity and 42%NBS for out-of-plane capacity of the reinforced concrete block walls.

When categorised into Blocks, Blocks A, B, D and E have seismic capacities of 34%NBS and Block C has a seismic capacity of 35%NBS. The house at Block F has a seismic capacity of 85%NBS while the garage has a seismic capacity of 42%NBS.

8.5 Limitations and Assumptions in Results

There is a possibility that the structures have suffered some level of damage from the recent seismic activity that was not able to be detected or observed during the site inspection. In the absence of further information, the analysis and assessment of the buildings were based on the undamaged state. Therefore the current capacity of the buildings may be lower than that stated.

The results have been reported as a percentage of the building capacity according to the requirements of the actual standard and the stated value is obtained from our analysis and assessment. Despite the use of best national and international practice in this analysis and assessment, this value contains uncertainty due to many assumptions and simplifications which are made during the assessment. These include:

- Simplifications made in the analysis;
- Assessments of material strengths based only on site inspections and engineering judgment;

- The normal variation in material properties which change from batch to batch;
- Approximations made in the assessment of the capacity of each element, especially when considering the post-yield behaviour.
- Construction is consistent with normal practise of the era in which constructed.

9 Geotechnical Assessment

9.1 Liquefaction

According to the Project Orbit file (established by CERA) the buildings are situated in the Technical Category 2 area. They have been exposed to minor settlement due to earthquake liquefaction after the 2010/2011 earthquake events. A preliminary liquefaction assessment confirms that the liquefaction potential is of a minor scale.

9.2 Defects on Buildings

From the desk study information and available drawings, we conclude that the likely reason for the building blocks showing little damage is the low water table and the underlying 2.5 m thick cap of non-liquefiable organic silt clay that resulted in the assumed free field settlement (due to earthquakes) being small and taken place below 6 m depth. Under such condition little differential settlement should manifest itself at the surface.

9.3 Site walkover

The site walk-over found defects in the asphalt pavement of the driveway, car parking, and footpaths that were not apparent in the 2008 maintenance inspection.

9.4 Summary

No signs of significant liquefaction were observed during the geotechnical rapid site assessment.

The buildings have been constructed on shallow strip footings with ground supported floor slabs.

The external inspection found no significant damage to the external of the building units; the risk that future quakes will cause significant damage due to liquefaction is considered to be low. Therefore the buildings will be exposed to a low risk of ground damage during a future earthquake event.

The site walkover found little evidence of ground damage likely to be caused by 2010 / 2011 earthquake and aftershocks. The cosmetic damage to the landscaping is likely largely historic and due to long term consolidation effects from the layer of underlying compressive soils.

10 Remedial Options

Any remedial options for increasing the seismic capacity above 67% NBS would need to address the capacity of the short masonry concrete walls, the capacity of the timber bracing walls, and check on site the connections of the block or brick veneer to the structural system to avoid the fall off and the connection of roof diaphragm to the timber bracing walls.

11 Conclusions

(a) Blocks A, B, D and E have seismic capacities of 34%NBS and Block C has a seismic capacity of 35%NBS. The garage at Block F has a seismic capacity of 42%NBS. These buildings are therefore classed as moderate risk in accordance with the Building Act 2004.

(b) The house at Block F has a seismic capacity of 85%NBS and is therefore classed as low risk in accordance with the Building Act 2004 (note that Blocks C and F are not covered by the Earthquake Prone Building Policies).

(c) The seismic capacities are limited by the capacity of the short (shorter than 1.4m) concrete masonry shear walls and by the capacities of the timber frame walls.

12 Recommendations

(a) Strengthening options should be developed to increase the seismic capacities of Blocks A –E and the garage at Block F to at least 67% NBS.

(b) Connections of the non-structural masonry block or brick (as at the house at 407 Innes Road) veneer and the roof diaphragm to the timber walls to be checked on site and strengthened if necessary. This could be achieved by providing brick ties between these structural and non-structural elements.

13 Limitations

(a) This report is based on an inspection of the structure with a focus on the damage sustained from the Canterbury Earthquake sequence only. Non-structural damage is not included in this report.

(b) Our professional services are performed using a degree of care and skill normally exercised, under similar circumstances, by reputable consultants practicing in this field at the time.

(c) This report is prepared for the CCC to assist with assessing remedial works required for council buildings and facilities. It is not intended for any other party or purpose.

14 References

[1] NZS 1170.5: 2004, *Structural design actions, Part 5 Earthquake actions,* Standards New Zealand.

[2] NZSEE: 2006, *Assessment and improvement of the structural performance of buildings in earthquakes,* New Zealand Society for Earthquake Engineering.

[3] Engineering Advisory Group, *Guidance on Detailed Engineering Evaluation of Earthquake Affected Non-residential Buildings in Canterbury, Part 2 Evaluation Procedure*, Draft Prepared by the Engineering Advisory Group, Revision 5, 19 July 2011.

[4] Engineering Advisory Group, *Guidance on Detailed Engineering Evaluation of Non-residential buildings, Part 3 Technical Guidance*, Draft Prepared by the Engineering Advisory Group, 13 December 2011.

[5] SESOC, *Practice Note – Design of Conventional Structural Systems Following Canterbury Earthquakes*, Structural Engineering Society of New Zealand, 21 December 2011.

[6] Christchurch City Council Structural Drawings, *Elderly Persons Housing Innes Road,* 1976.

Appendix A – Photographs

Photo 1: General configuration of the two storey buildings

Photo 2: General configuration of the single storey buildings

Photo 3: Connection of the block veneer to the roof structure

Photo 4: Cracking of the block veneer

Photo 5: Cracking of the block veneer

Photo 6: Roof structure without bracings


14/12/2012 12:10

Photo 7: Roof structure without bracings

Photo 8: Roof structure without bracings

Photo 9: General configuration of the house at 407 Innes Road

Photo 10: General configuration of the house at 407 Innes Road

Photo 11: General configuration of the house at 407 Innes Road

Photo 12: General configuration of the garage at 407 Innes Road

Photo 13: General configuration of the garage at 407 Innes Road

Appendix B – Geotechnical Desktop Study

Opus International
Consultants Ltd

Opus International Consultants Ltd
Auckland Office
The Westhaven
100 Beaumont St, Auckland
New Zealand
Tel: +64 9 355 9500
Fax: +64 9 355 9680

3 April 2013

Matt Cummins
Project Manager
Capital Programme Group
Christchurch City Council
PO Box 2522
Christchurch

6-QUCC2.16/55AC

Dear Matt

403 Innes Courts - Geotechnical Desk Study

1 Introduction

Christchurch City Council (CCC) has requested Opus International Consultants (Opus) to provide a geotechnical desk study and walkover inspection of 403 Innes Courts, located at 403 Innes Road, Mairehau in Christchurch.

The purpose of the geotechnical study is to assess the current ground conditions, the potential geotechnical hazards that may be present at the site and determine whether further subsurface geotechnical investigations are necessary. The geotechnical desk study comprises a site walkover and a preliminary liquefaction assessment.

This Geotechnical Desk Study forms part of a Detailed Engineering Evaluation prepared by Opus and has been undertaken without the benefit of any site specific investigations and is, therefore, preliminary in nature.

2 Desktop Study

2.1 Site Description

403 Innes Courts is located at 403 Innes Road in Mairehau, north-east of Christchurch City. The site comprises Block A – E with 30 One Bedroom Units. The units are both single and double storey buildings. The property can be accessed by a mutual right of way and has an asphalt car parking area with eight spaces. A high wall separates Innes Road with this car parking area on the property.

2.2 *Available Structural Drawings*

No geotechnical report or records of ground investigations associated with the construction of the 30 building units are located on Christchurch City Council's (CCC) property file.

Typical plans of the ground floor and first floor of the units that have been made available are No 643, 643 s and 643x owned by Christchurch City Council. No cross sections are available. Copies of CCC drawings are included in Appendix D.

The typical ground floor plan indicates that the buildings are constructed with concrete block or brick veneer walls. It is understood that the units, drive way and car parking facilities were built in 1976 / 1977 as elderly persons housing. The walls of the lower units are built as 60 mm inner / 140 mm outer block wall with a 60 mm block cavity with 100 mm x 50 mm studwall.

It is assumed that the buildings have concrete floor slab with wedge edges to act as a perimeter footing at some 600 mm depth.

2.3 *Regional Geology*

The published geological map of the area, (Geology of the Christchurch Urban Area 1:25,000, Brown and Weeber, Map 1, 1992) shows that 403 Innes Court (Mairehau) is located in the Springton formation with river and fan deposits (see Appendix C). The grey river alluvium deposits comprise gravel, sand and silt. Grey river alluvium can be found beneath plains or low-level terraces. Grey to brown alluvium comprising sub-angular gravel and sand forming alluvial fans.

The Springston Formation includes postglacial fluvial and over-bank sediments accumulated along the inland margin of the Christchurch Formation (deposits ceased circa 3000 years BC). These deposits consists of poorly graded (well sorted) gravel, sand and silt. The Springston formation has a maximum thickness of 20 m.

The Black Map Rural Section cadastral maps of 1856 (modified by Walter Wilson based on a compilation in 1989) shows that the area at Innes Courts was an old swamp covered by flax.

2.4 *Information from ECAN studies*

The following information is made available from Project Orbit (established by CERA):

Table 1 Type of information from project orbit database

	Description
Liquefaction and Lateral Spreading observed:	Aerial photography indicates that liquefaction susceptibility is interpreted as minor. Ground cracking is present in the area but no ejected material.
Observed ground crack locations	There are no observed cracks in the vicinity of the project site
LiDAR and digital elevation models	Elevation is approximately 15.0 m above Christchurch City Datum. The zero point is 9.04m below Mean Sea Level, so the elevation is approximately 6.0 m above sea level.
Vertical ground models	A vertical elevation change (subsidence) of 0.2 – 0.4 m has been observed.
Horizontal ground movement	Minor ground movement has been observed and interpreted by Lidar.
Representative Borehole logs (pre September 2010)	Boreholes 10534-BH-02 ca 300 m west of the units
ECAN borehole logs	ECAN borehole M35_13178 is available ca 200 m north of the units.
Ground water level	2 – 5 m BGL.

CERA Residential zoning maps	Site is located in the green zone.
DBH Residential Foundation Technical	DBH residential Technical Category No 2
Cadastral maps (historical)	The Christchurch and Summer survey district historical map indicates that the properties have been built just outside St Albans Borough, parcel No 345A. The parcel on which the units are now built was once crossed by the 'Dudley's Channel' (considered to be a brook).
MWH Shallow foundation Hazard map 1990	The High Groundwater Liquefaction potential is high. The Low Groundwater Liquefaction potential is low. The Low Groundwater Liquefaction Ground Damage is low.
Groundlevel acceleration (PGA)	0.31 (Feb 2011)

2.5 Risk of seismic activity

A Magnitude 7.1 Darfield Earthquake occurred on 4 September 2010 centred approximately 40 km west of Christchurch. The earthquake caused damage to parts of the Canterbury Region including Christchurch. The earthquake motions were recorded by a number of seismographs around the region installed under the Geonet programme.

The recording station located at Christchurch Shirley Library (2000 m west of the site), reported peak horizontal ground accelerations of 0.18g and peak vertical accelerations of 0.10g (Geonet, 2010) in this event.

Subsequent events have occurred, including a magnitude 6.3 earthquake on 22 February 2011 centred 10km south of Christchurch City and a magnitude 5.6 earthquake on 13 June 2011 centred 10 km east of Christchurch City. The February earthquake resulted in the most damage. According to the ProjectOrbit database, the conditional median Peak Ground Accelerations (PGAs) at the Innes Court site for these events were as follows:

- 4 September 2010: 0.20 g;
- 22 February 2011: 0.31 g;
- 13 June 2011: 0.19 g.

The current design PGA for residential properties: SLS 0.13 and ULS 0.35. (According to the Interim Guidance for repairing and rebuilding foundation in TC3, paragraph C3.5.1.)

2.6 Expected Ground Conditions

A review of the geotechnical investigation data from Project Orbit shows that no previous site investigation results are available at the site location. The ground conditions have therefore been estimated from nearest borehole 10534-BH-02 and M35 / 13178 and nearby CPT 2063. The nearby cone penetrometer tests about 300 metre south of the site locations (see Site Location Plan in Appendix B2). The expected stratigraphy below 403 Innes Road is shown in Table 2 below.

Table 2: Indicated Ground Conditions

Stratigraphy	Thickness (m)	Depth encountered from below ground level (m)	Referred SPT-N (from nearest bore hole record)
Topsoil	1.0	0	SPT N = 8
Fine medium SAND	2.5	1.0	SPT N = 5
Very fine PEAT and organic SILT and silty CLAY	2.5 -4.0	3.5	SPT N = 1 – 2
Fine to medium dense SAND embedded with gravel	6.0	6.0	SPTN = 13 – 50
Dense Sand	8.0	12.0	SPT N = 30 – 40
Ricarton Gravel	-	20.0	

NB: The ground water level has been assumed at 2 – 5 m depth based on ECAN study which is relatively low for the Christchurch region.

2.7 Liquefaction assessment

2.7.1 General

Empirical methods are adopted for liquefaction assessment using field testing data (SPT and CPT) which involve the computation of seismic shear stress ratio (CSR) and seismic shear resistance ratio (CRR). The factor of safety against liquefaction is defined as the ratio of CRR to CSR. A soil layer is considered to be liquefiable if CRR is less than CSR (ie FOS < 1).

The analyses have been undertaken using the software application CLiq, a program that uses empirical correlations to estimate geotechnical parameters for basic data interpretation and to analyse the free field settlement taking into account the observed and design earthquake scenarios. An empirical method for calculation of settlements has been used according to Zhang at al. The modified Robertson & Wride method was adopted for fines correction and the calculation of CRR. No calculation is performed for the effect of lateral displacement.

2.7.2 Estimation of liquefaction

For this analysis, the settlement is calculated using a nearby Cone Penetration Test result (CPT2063) and a groundwater table of 2.0 m BGL. Outputs from a preliminary assessment of liquefaction using this CPT test result are added to Appendix F. Magnitude weighted peak ground acceleration ($PGA_{7.5}$) of 0.31 has been used as the conditional PGA of the February 2011 earthquake. The free field settlement is approximately 50 mm from the February 2011 earthquake. As originated from the liquefaction susceptible layer at 6 m depth, the settlements will have a low distortion.

3 Site Walkover Inspection

A walkover inspection of the exterior of the buildings and surroundings at 403 Innes Courts was carried out by an Opus Geotechnical Engineer on 22 November 2012. The purpose of the walkover was to qualify the settlement and defects and find evidence of any liquefaction correlated to the 2010/2011 earthquakes and aftershocks. Internal parts of the buildings have not been inspected during this site walk-over; this part has been reported separately by the Structural Engineer.

Observations (22 November 2012)

Building units of Blocks A-E

Only the external of the buildings have been inspected. No evidence of cracking in the masonry, brick walls and foundations was found.

Grounds

Several signs of ground movement were observed at the driveway, the footpaths, doorsteps and grass lawn of the individual units. A significant number of defects have been observed, mainly major cracks in the asphalt pavement.

Around the corner of Block A, extensive cracking of the footpath and various cracks were observed in the pavement of the footpaths along the units of Block B – E. Ground settlement of approximately 10 cm has been observed near the units.

Comparison pre- and post-earthquake settlements

Digital pre-earthquake photographs were made available from Christchurch City Council archives from a 2008 maintenance assessment and a selection of photographs were taken during the recent site visit (22-11-2012), see Appendix E. From the first comparison (corner at footpath of Block A), we learn that minor cracks are visible on the new photograph but not all of these cracks can be seen on the 2008 photograph. Same for the second comparison. Cracked footpaths can be observed in areas not covered in the CCC 2008 assessment, perhaps indicating that they were not present prior to the earthquake.

We therefore conclude that there is evidence that minor cracks may have developed on the footpaths as a result of the earthquakes. Evidence suggests minor ground damage occurred as a result of the February 2011 event.

4 Discussion and recommendations

From the site walk-over and desk study we conclude that it is unlikely that 403 Innes Courts has been exposed to significant liquefaction induced settlement after the 2010 / 2011 earthquakes and aftershocks. Major defects and ground damage observed is most likely correlated to long term consolidation or other settlement phenomena's.

The following comments can be made:

- *Liquefaction* – According to the Project Orbit file (established by CERA), the building Blocks A-E, situated in Technical Category 2 area, have been exposed to minor settlement due to earthquake liquefaction after the 2010/2011 earthquake events. A preliminary liquefaction assessment confirms that the liquefaction potential is of a minor scale.

- *Site walk over* – The site walk-over found defects in the asphalt pavement of the driveway, car parking, and footpaths traversing the grass lawns of the 403 Innes Road. There were no major cracking observed indicating that most settlement and land damage had already been developed prior to the earthquake 2010 / 2011 sequence.

- *Defects of the building* – From the desk study information and available drawings we conclude that the likely reason for the building blocks showing little damage is the low water table and the underlying 2.5 m thick cap of non-liquefiable organic silt clay that resulted in the assumed free field settlement (due to earthquakes) being small and taken place below 6 m depth. Under such condition little differential settlement should manifest itself at the surface.

- *Comparison* – Not all external areas are made visible on the available photographs predating the earthquake in 2010/2011. A comparison was made based on limited pre- and post-earthquake photographs made available and the observations during the inspection in November 2012. It is unclear whether the ground damage is due to the earthquake in 2010/2011 but because of the timing and the fact that photographs in 2012 show similar cracks it is most likely that the defects (like cracks) have been attributed to settlement of the underlying organic silt / clay soils.

5 Summary

- The external inspection found no evidence of damage to the Masonry, concrete walls and foundations of the buildings caused by the 2010/2011 earthquake; the risk that future quakes will cause significant damage due to liquefaction is considered to be low. Therefore the occupants will be exposed to a low risk of ground damage during a future earthquake event.

- The site walkover found minor evidence of recent ground damage. The overall cosmetic damage to the landscaping is likely largely historic and predominantly due to long term consolidation effects from the layer of underlying compressive soils although it is possible that some damage has been induced by the recent earthquake and aftershocks.

6 Proposed ground investigations

Pending a level survey:

- Based on the desk study and recent site inspection we conclude that the risk of ground damage from future earthquakes is expected to be low at 403 Innes Courts; no specific site investigations are considered necessary.

- However, if there is a requirement to quantify the assumptions made in this report, site investigation will be required to confirm the type of foundation, local strata, soil properties and local ground water table. This can be required on request.

7 Limitation

This report has been prepared solely for the benefit of Christchurch City Council as our client with respect to the particular brief given to us. Data or opinions in this desk study may not be used in other contexts, by any other party or for any other purpose.

It is recognised that the passage of time affects the information and assessment provided in this document. Opus' opinions are based upon information that existed at the time of the production of this Desk Study. It is understood that the Services provided allowed Opus to form no more than an opinion on the actual conditions of the site at the time the site was visited and cannot be used to assess the effect of any subsequent changes in the quality of the site or its surroundings or any laws or regulations.

8 References

- Brown, LJ; Webber, JH 1992: Geology of the Christchurch Urban Area. Scale 1:25,000. Institute of Geological and Nuclear Sciences geological map, 1 sheet + 104p.

  http://ecan.govt.nz/services/online-services/tools-calculators/Pages/well-card.aspx
- Project Orbit, 2011: Interagency/organisation collaboration portal for Christchurch recovery effort. https://canterburyrecovery.projectorbit.com/SitePages/Home.aspx
- GNS Science reporting on Geonet Website: http://www.geonet.org.nz/canterbury-quakes/aftershocks/ updated on 9 September 2012.
- Revised Guidance on repairing and rebuilding houses affected by the Canterbury earthquake sequence. Dept. of Building and Housing November 2011.

Appendices:

Appendix A1: Site Location Plan

Appendix B1: Historical borehole and CPT information
Appendix B2: Location plan of available ground investigation

Appendix C: Geology

Appendix D: Available drawings

Appendix E: Site inspection photographs

Appendix F: Results of liquefaction analysis

Site Inspection and Report by P Cohen

Yours sincerely

Glyn East | Principal Geotechnical Engineering | Opus International Consultants Ltd
Phone +64 9 355 9560 | Mobile +64 27 472 3700 | Fax +64 9 355 9585 | Email Glyn.East@opus.co.nz
The Westhaven, 100 Beaumont St, Auckland, New Zealand
PO Box 5848, Auckland 1141, New Zealand

Visit us online: www.opus.co.nz

Appendix A:

Appendix A1: Site Location Plan

INNES COURTS

SOURCE: Christchurch City Council

Opus International Consultants Ltd
Auckland Office
The Westhaven
100 Beaumont St, Auckland
New Zealand

Tel: +64 9 355 9500 Fax: +64 9 355 9680

Project: 403 Innes Courts
Geotechnical Desktop Study

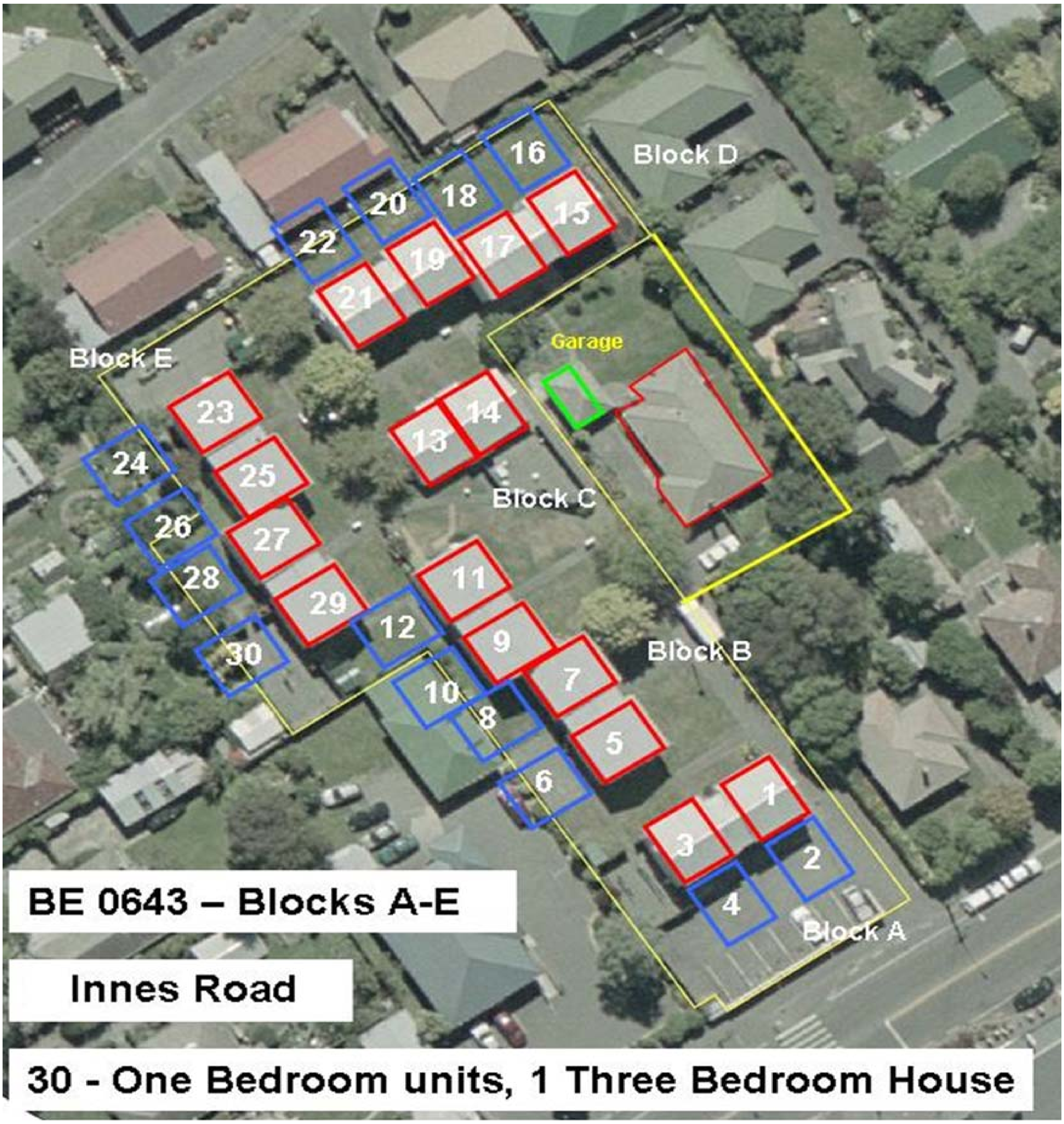
Project No.: 6-QUCC2.16/55AC

Client: Christchurch City Council

Figure A.1 Site Location Plan

Drawn: Opus Geotechnical Engineer

Date: 12/12/2012



SOURCE: Christchurch City Council

Opus International Consultants Ltd
Auckland Office
The Westhaven
100 Beaumont St, Auckland
New Zealand

Tel: +64 9 355 9500 Fax: +64 9 355 9680

Project:	403 Innes Courts Geotechnical Desktop Study
Project No.:	6-QUCC2.16/55AC
Client:	Christchurch City Council

Figure A.2 Site Location Plan

Drawn: Opus Geotechnical Engineer

Date: 12/12/2012

Appendix B:

Appendix B1: Historical borehole information and CPT
Appendix B2: Location plan of available ground investigation

Stronger Christchurch
Infrastructure Rebuild Team

BOREHOLE LOG

Site Identification **10534-BH-02**

Sheet 1 of 4

Project: Innes & Knowles Catchment Pump Stations
Client: SCIRT
Site: Innes and Knowles catchment
Job No.: 10534

Coordinates: **E** 392679.79, **N** 810243.77
Surface RL (m): +15.1m
Commenced: 24-Apr-12
Completed: 27-Apr-12

Datum:
Total Depth: 30.5m
Contractor: McNeill Drilling
Driller: McNeill Drilling

Equipment: Truck Rotary Universal 600
Shear Vane:
Bore Diameter (mm): 114
Inclination: -90
Comments: SPT N values are uncorrected

Logged:	E Petaia
Processed:	E Petaia
Checked:	

Depth (m)/ [Elev.]	Drilling Method	Support / Casing (m)	Water	Geological Fm	Classification	SOIL DESCRIPTION: (Soil Code), Soil Name [minor MAJOR], colour, structure [zoning, defects, cementing], plasticity or grain size, secondary components, structure. (Geological Formation) / ROCK DESCRIPTION: Weathering, colour, fabric, ROCK NAME (Formation Name)	Moisture Condition	Consistency/ Relative Density	Weathering	Estimated Rock Strength EW VW W MS S VS ES	RQD (%)	Defect Spacing (mm) 20 60 200 600 2000
0.1 [+15.0]	Rotary Coring	114mm (HQ)				SILT; brown. Abundant grass roots (TOPSOIL)	M					
						Fine to medium GRAVEL; grey. Gravel is subangular to angular, moderately to highly weathered greywacke with some brick fragments. (FILL)	M	L				
1.5 [+13.6]						Fine sandy SILT; brown. Soft to firm, wet, non plastic. (NATURAL GROUND STARTS)	M					
1.9 [+13.2]						Becomes grey, firm and wet below 1.9m. Shows quick behaviour in hand sample (moderate to highly susceptible).	W	L				
3.3 [+11.8]						Organic SILT with minor clay; dark brown. Soft, moist, non plastic.	M	VL				
4.8 [+10.3]						Organic clayey SILT; dark brown. Soft, moist, medium plasticity.	M	VL				
5.5 [+9.6]						Clayey SILT; grey, stained brown. Firm, wet, high plasticity.	W					
6.1 [+9.0]						SILT with trace clay; grey. Firm, wet, quick behaviour (moderate to highly susceptible). Partially decomposed organic inclusion.	W	MD				
7.0 [+8.1]						Silty fine to medium SAND; grey. Medium dense, wet. Interbedded with 0.1-0.15m beds of medium to coarse GRAVEL. Gravel is grey, subangular to subrounded, moderately weathered greywacke.		D MD				

Core Run / Recovery (%)
50
78
91
89
100
78
100
89
67
100
48
78
38
67

TESTS & SAMPLES / ROCK MASS DEFECTS: Depth, Type, Inclinations, Roughness, Texture, Aperture, Coating		
RX 1		
SPT 2	3,1, 1,2, 2,3, [N=8]	1
RX 3		
SPT 4	1,0, 1,1, 1,2, [N=5]	2
RX 5		
		3
SPT 6 RX 7	1,0, 0,1, 0,1, [N=2]	
		4
SPT 8	4,0, 0,0, 0,1, [N=1]	5
RX 9		
		6
SPT 10	2,2, 3,6, 5,5, [N=19]	
RX 11		7
SPT 12	8,6, 10,9, 10,20, [N=49]	8
RX 13		
		9
SPT 14	2,2, 3,5, 6,5, [N=19]	10

Stronger Christchurch
Infrastructure Rebuild Team

BOREHOLE LOG

Site Identification **10534-BH-02**
Sheet 2 of 4

Project: Innes & Knowles Catchment Pump Stations
Client: SCIRT
Site: Innes and Knowles catchment
Job No.: 10534

Coordinates: **E** 392679.79, **N** 810243.77
Datum:
Surface RL (m): +15.1m
Total Depth: 30.5m
Commenced: 24-Apr-12
Completed: 27-Apr-12
Contractor: McNeill Drilling
Driller: McNeill Drilling

Equipment: Truck Rotary Universal 600
Inclination: -90
Shear Vane:
Comments: SPT N values are uncorrected
Bore Diameter (mm): 114

Logged: E Petaia
Processed: E Petaia
Checked:

Depth (m)/ [Elev.]	Drilling Method	Core Run / Recovery (%)	Support / Casing (m)	Water	Geological Fm	Classification	Graphic Log	SOIL DESCRIPTION: (Soil Code), Soil Name [minor MAJOR], colour, structure [zoning, defects, cementing], plasticity or grain size, secondary components, structure. (Geological Formation) / ROCK DESCRIPTION: Weathering, colour, fabric, ROCK NAME (Formation Name)	Moisture Condition	Consistency/ Relative Density	Weathering	Estimated Rock Strength EW VW W MS S VS ES	RQD (%)	Defect Spacing (mm) 20 60 200 600 2000	TESTS & SAMPLES / ROCK MASS DEFECTS: Depth, Type, Inclinations, Roughness, Texture, Aperture, Coating	
	Rotary Coring	0	114mm (HQ)												RX 15	
		0						Silty fine to medium SAND; grey. Medium dense, wet. Interbedded with 0.1-0.15m beds of medium to coarse GRAVEL. Gravel is grey, subangular to subrounded, moderately weathered greywacke.								
11		56								MD					SPT 16	2,2, 3,4, 4,5, [N=16]
11.5 [+3.6] 12		19						Silty fine to medium SAND; grey. Medium dense, wet. Quick behaviour (moderately to highly susceptible).	W						RX 17	
		56								MD					SPT 18	2,2, 2,5, 6,12, [N=25]
13		29													RX 19	
14		67								D					SPT 20	1,3, 7,7, 11,9, [N=34]
15		100													RX 21	
		67								D					SPT 22	1,3, 4,8, 10,13, [N=35]
16		19													RX 23	
17		56								D					SPT 24	1,3, 6,10, 12,17, [N=45]
18		29													RX 25	
		44								VD					SPT 26	5,5, 9,12, 15,14, [>50]
19		10													RX 27	
20																

BOREHOLE LOG

Site Identification **10534-BH-02**

Sheet 3 of 4

Project: Innes & Knowles Catchment Pump Stations
Client: SCIRT
Site: Innes and Knowles catchment
Job No.: 10534

Coordinates: **E** 392679.79, **N** 810243.77
Datum:
Surface RL (m): +15.1m
Total Depth: 30.5m
Commenced: 24-Apr-12
Completed: 27-Apr-12
Contractor: McNeill Drilling
Driller: McNeill Drilling

Equipment: Truck Rotary Universal 600
Shear Vane:
Bore Diameter (mm): 114
Inclination: -90
Comments: SPT N values are uncorrected

Logged:	E Petaia
Processed:	E Petaia
Checked:	

Depth (m)/ [Elev.]	Drilling Method	Support / Casing (m)	Water	Moisture Condition	Consistency/ Relative Density	SOIL DESCRIPTION: (Soil Code), Soil Name [minor MAJOR], colour, structure [zoning, defects, cementing], plasticity or grain size, secondary components, structure. (Geological Formation) / ROCK DESCRIPTION: Weathering, colour, fabric, ROCK NAME (Formation Name)
	Rotary Coring	114mm (HQ)	Driller reports inflowing artesian groundwater at 23.0m	W	D	Silty fine to medium SAND; grey. Medium dense, wet. Quick behaviour (moderately to highly susceptible). Partially decomposed, highly compressed tree root; dark brown.
21.2 [-6.1]				M		Fine sandy SILT with trace clay and some organic inclusions; brownish grey. Stiff, moist.
21.4 [-6.3]				W	MD	Silty fine SAND; grey, stained brown. Medium dense, wet. Quick behaviour (moderate to highly susceptible).
22.0 [-6.9]				S	MD MD VD L MD	Silty sandy fine to coarse GRAVEL; grey. Gravel is subrounded to subangular, slightly weathered greywacke. Sand is fine to coarse grained, well graded. Silt is non plastic.

Depth scale: 21, 22, 23, 24, 25, 26, 27, 28, 29, 30

Core Run / Recovery (%): 89, 67, 89, 14, 67, 100, 44, 29, 67, 43, 22, 29, 67, 51

Geological Fm, Classification, Weathering, Estimated Rock Strength (EW VW W MS S VS ES), RQD (%), Defect Spacing (mm) (20 60 200 600 2000): no entries

TESTS & SAMPLES / ROCK MASS DEFECTS: Depth, Type, Inclinations, Roughness, Texture, Aperture, Coating	
SPT 28	1,2, 3,7, 10,11, [N=31]
RX 29	
SPT 30	2,4, 4,4, 5,4, [N=17]
RX 31	
SPT 32	10,12, 12,9, 11,9, [N=41]
RX 33	
SPT 34	3,2, 3,4, 6,7, [N=20]
RX 35	
SPT 36	5,11, 10,20, 20,*, [>50]
RX 37	
SPT 38	2,3, 1,2, 1,2, [N=6]
RX 39	
SPT 40	8,6, 4,6, 8,8, [N=26]
RX 41	

BOREHOLE LOG

Site Identification **10534-BH-02**

Sheet 4 of 4

Project: Innes & Knowles Catchment Pump Stations
Client: SCIRT
Site: Innes and Knowles catchment
Job No.: 10534

Coordinates: **E** 392679.79, **N** 810243.77
Surface RL (m): +15.1m
Datum:
Total Depth: 30.5m
Commenced: 24-Apr-12
Completed: 27-Apr-12
Contractor: McNeill Drilling
Driller: McNeill Drilling

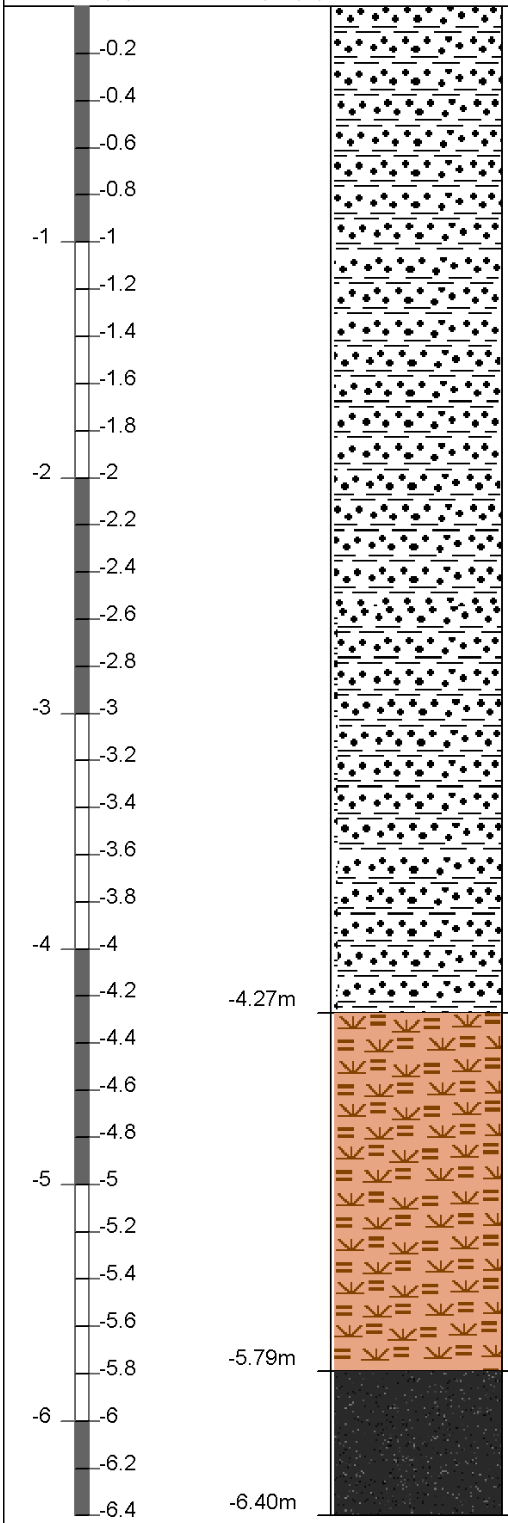
Equipment: Truck Rotary Universal 600
Inclination: -90
Shear Vane:
Comments: SPT N values are uncorrected
Bore Diameter (mm): 114

Logged:	E Petaia
Processed:	E Petaia
Checked:	

Depth (m)/ [Elev.]	Drilling Method	Core Run / Recovery (%)	Support / Casing (m)	Water	Geological Fm	Classification	Graphic Log	SOIL DESCRIPTION: (Soil Code), Soil Name [minor MAJOR], colour, structure [zoning, defects, cementing], plasticity or grain size, secondary components, structure. (Geological Formation) / ROCK DESCRIPTION: Weathering, colour, fabric, ROCK NAME (Formation Name)	Moisture Condition	Consistency/ Relative Density	Weathering	Estimated Rock Strength EW VW W MS S VS ES	RQD (%)	Defect Spacing (mm) 20 60 200 600 2000	TESTS & SAMPLES / ROCK MASS DEFECTS: Depth, Type, Inclinations, Roughness, Texture, Aperture, Coating	
		56						Silty sandy fine to coarse GRAVEL; grey. Gravel is subrounded to subangular, slightly weathered greywacke. Sand is fine to coarse grained, well graded. Silt is non plastic.	S						RX 41	
		51								D					SPT 42	8,13, 10,9, 8,12, [N=39]
31 31.0 [-15.9]								Termination Depth = 30.45m, Target Depth								31
32																32
33																33
34																34
35																35
36																36
37																37
38																38
39																39
40																40

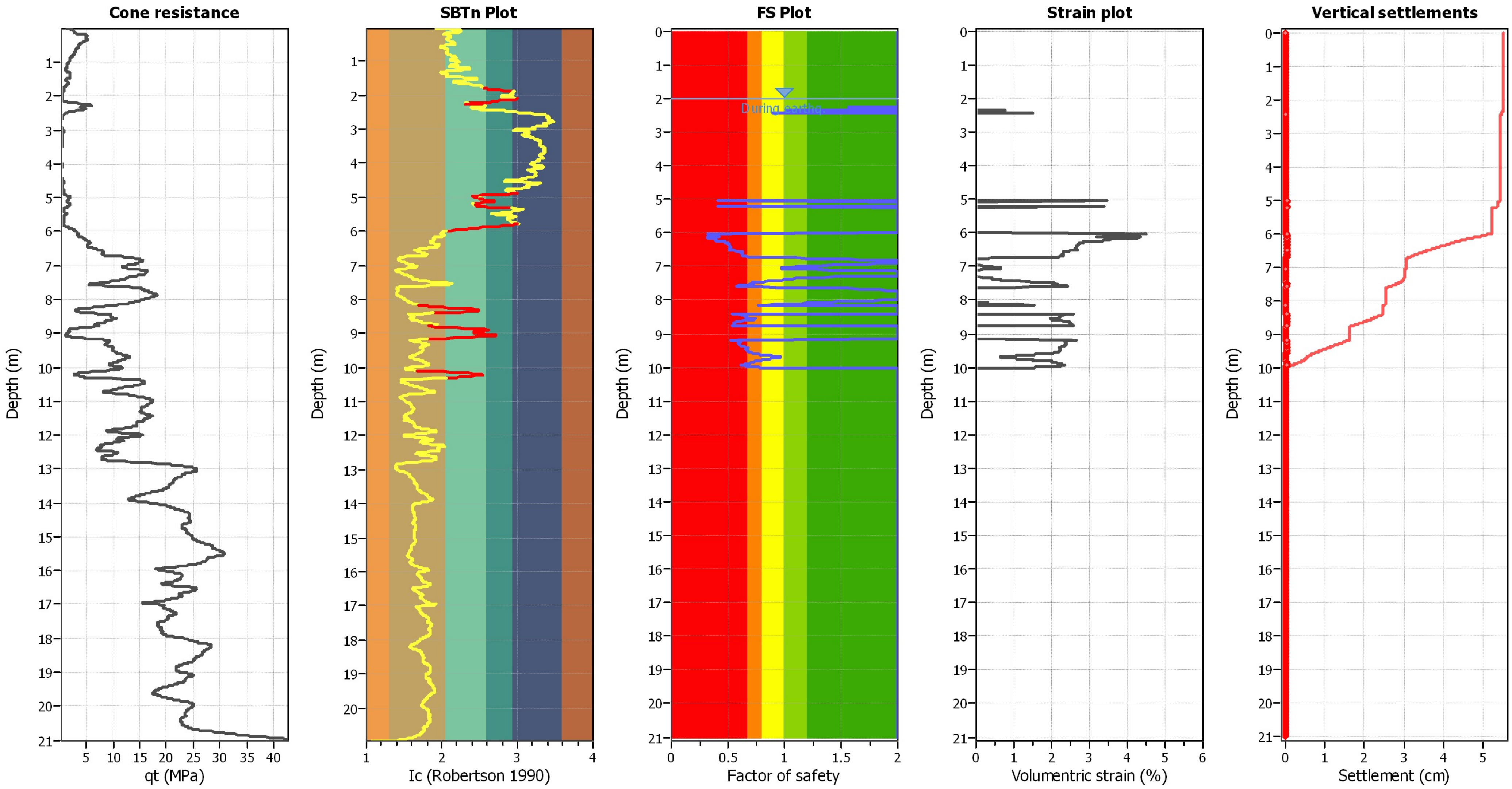
Borelog for well M35/13178

Gridref: M35:81010-45646 Accuracy : 3 (1=high, 5=low)
Ground Level Altitude : 7.57 +MSD
Well name : CCC BorelogID 1445
Drill Method : Not Recorded
Drill Depth : -6.4m Drill Date : 1/01/1956



Water Level	Depth(m)	Full Drillers Description	Formation Code
		clay and sand	
	-4.27m	blue peat and sandy silt	
	-5.79m	peat	
	-6.40m		

Estimation of post-earthquake settlements



Abbreviations

q_t:	Total cone resistance (cone resistance q_c corrected for pore water effects)
I_c:	Soil Behaviour Type Index
FS:	Calculated Factor of Safety against liquefaction
Volumentric strain:	Post-liquefaction volumentric strain

Important notice

This map and data was prepared and/or compiled for the Earthquake Commission (EQC) to assist in assessing insurance claims made under the Earthquake Commission Act 1993 and/or for the Canterbury Geotechnical Database on behalf of the Canterbury Earthquake Recovery Authority (CERA). It was not intended for any other purpose. EQC, CERA, their data suppliers and their engineers, Tonkin & Taylor, have no liability to any user of this map and data or for the consequences of any person relying on them in any way. Each Canterbury Geotechnical Database (https://canterburygeotechnicaldatabase.projectorbit.com/) map and data is made available solely on the basis that:

- Any Database user has read and agrees to the terms of use for the Database;
- Any Database user has read any explanatory text accompanying this map; and
- The "Important notice" accompanying the map and data must be reproduced wherever the map or data are reproduced.

SOURCE: canterburyrecovery.projectorbit.com (Accessed on 21/11/12)

Opus International Consultants Ltd
Auckland Office
The Westhaven
100 Beaumont St, Auckland
New Zealand

Tel: +64 9 355 9500 Fax: +64 9 355 9680

OPUS

Project: 403 Innes Road

Geotechnical Desktop Study

Project No.: 6-QUCC2.16/55AC

Client: Christchurch City Council

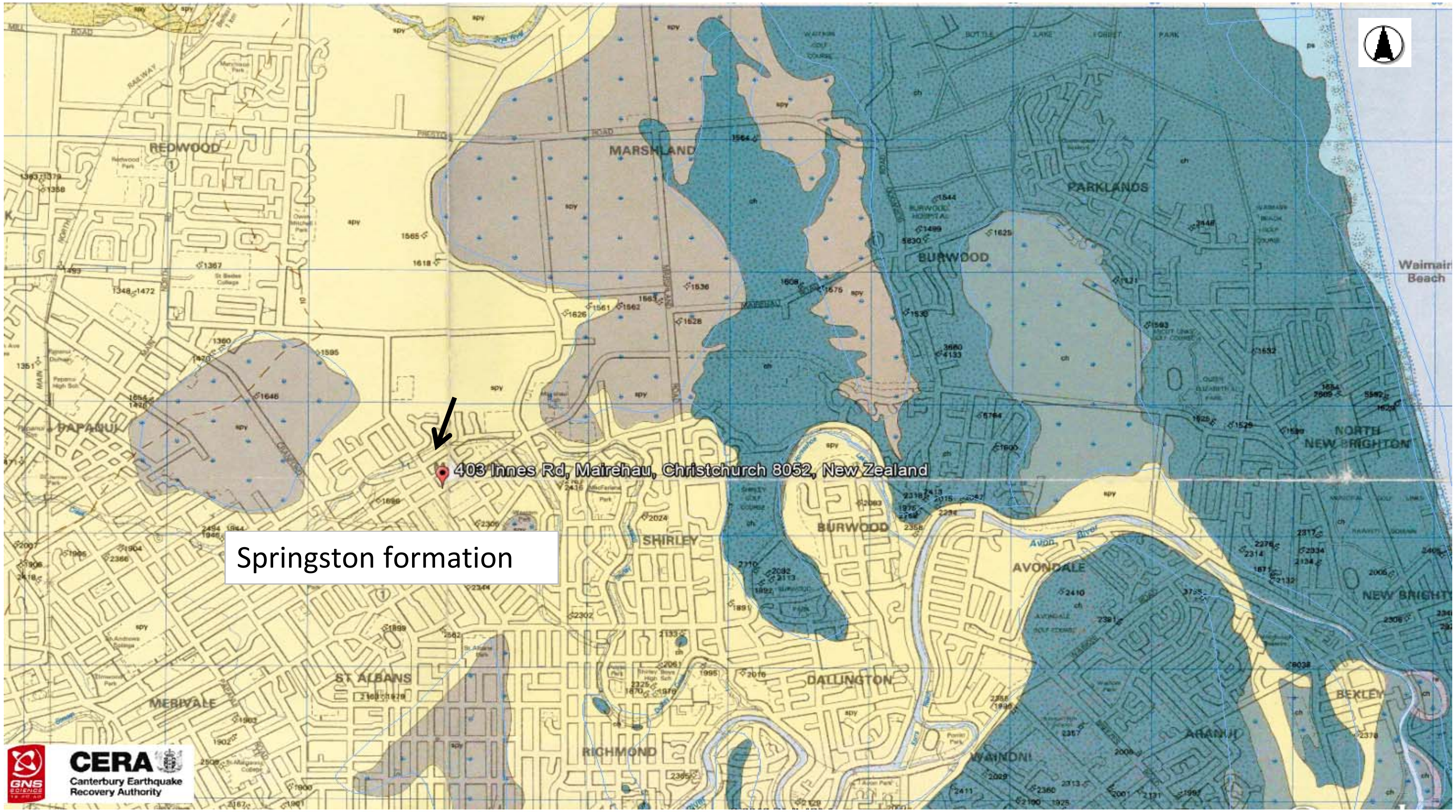
Figure B.2 Location of existing Ground investigation

Drawn: Opus Geotechnical Engineer

Date: 21/11/2012

Appendix C:

Geology



Christchurch Urban Geology: Description and Key

Springston Formation:

The Springston Formation includes postglacial fluvial and over-bank sediments accumulated along the inland margin of the Christchurch Formation (deposition ceased circa 3000years BP). These deposits consist of poorly graded (well sorted) gravel, sand and silt. Springston Formation has a maximum recorded thickness of 20m.

From Leithfield Beach to the Rakaia River mouth Springston Formation gravel is inter-bedded with finer sediments of the Christchurch Formation. Five distinct alluvial fan surfaces have been mapped on the south bank of the Waimakariri River which form the basis for the 5 separate members described within the Springston Formation.

SOURCE: canterburyrecovery.projectorbit.com (Accessed on 12/12/12)

Opus International Consultants Ltd
Auckland Office
The Westhaven
100 Beaumont St, Auckland
New Zealand

Tel: +64 9 355 9500 Fax: +64 9 355 9680

Project:	403 Innes road Geotechnical Desktop Study
Project No.:	6-QUCC2.16/55AC
Client:	Christchurch City Council

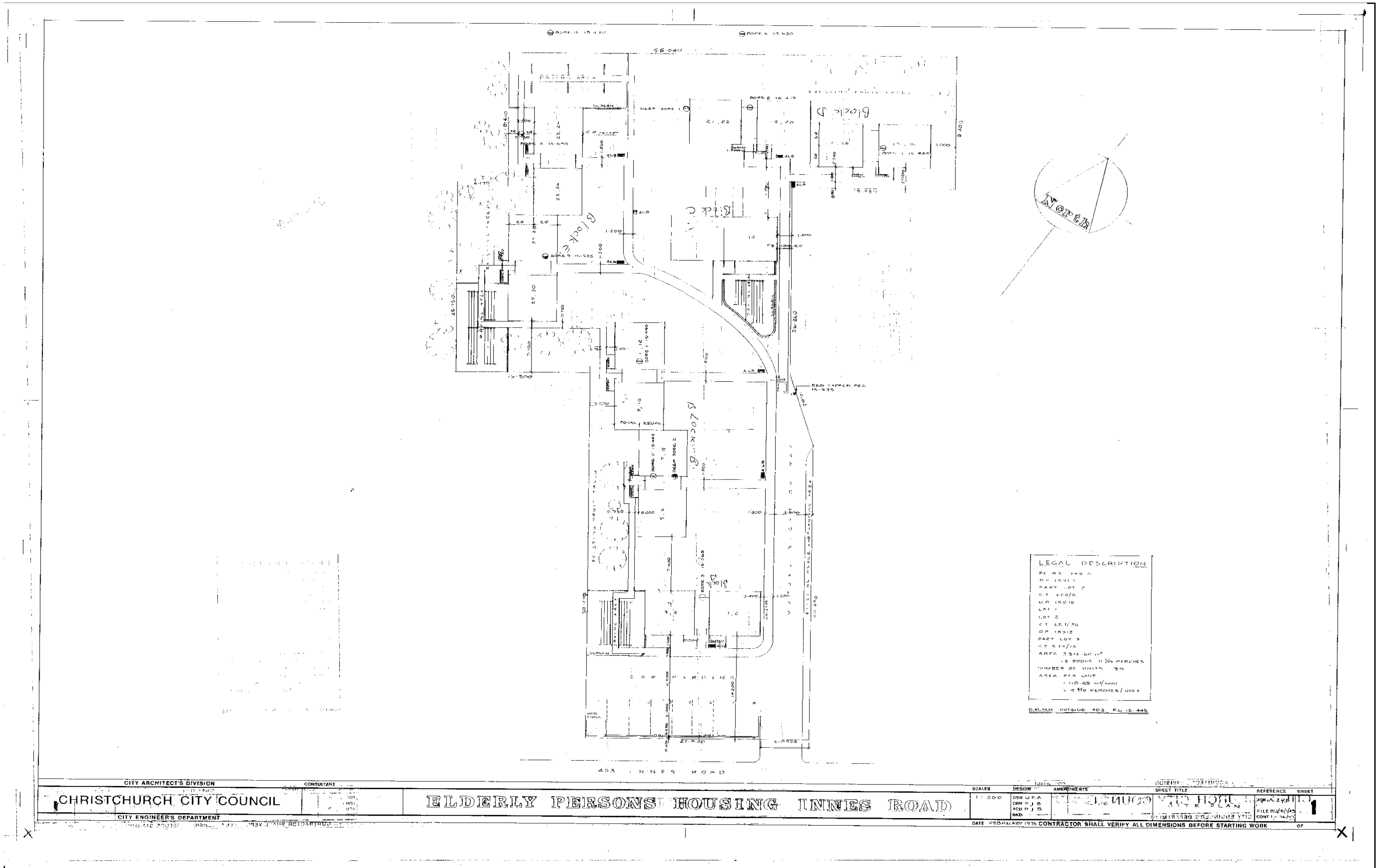
Figure C.1 Site Geology

Opus Geotechnical Engineer

12/12/2012

Appendix D:

Available drawings



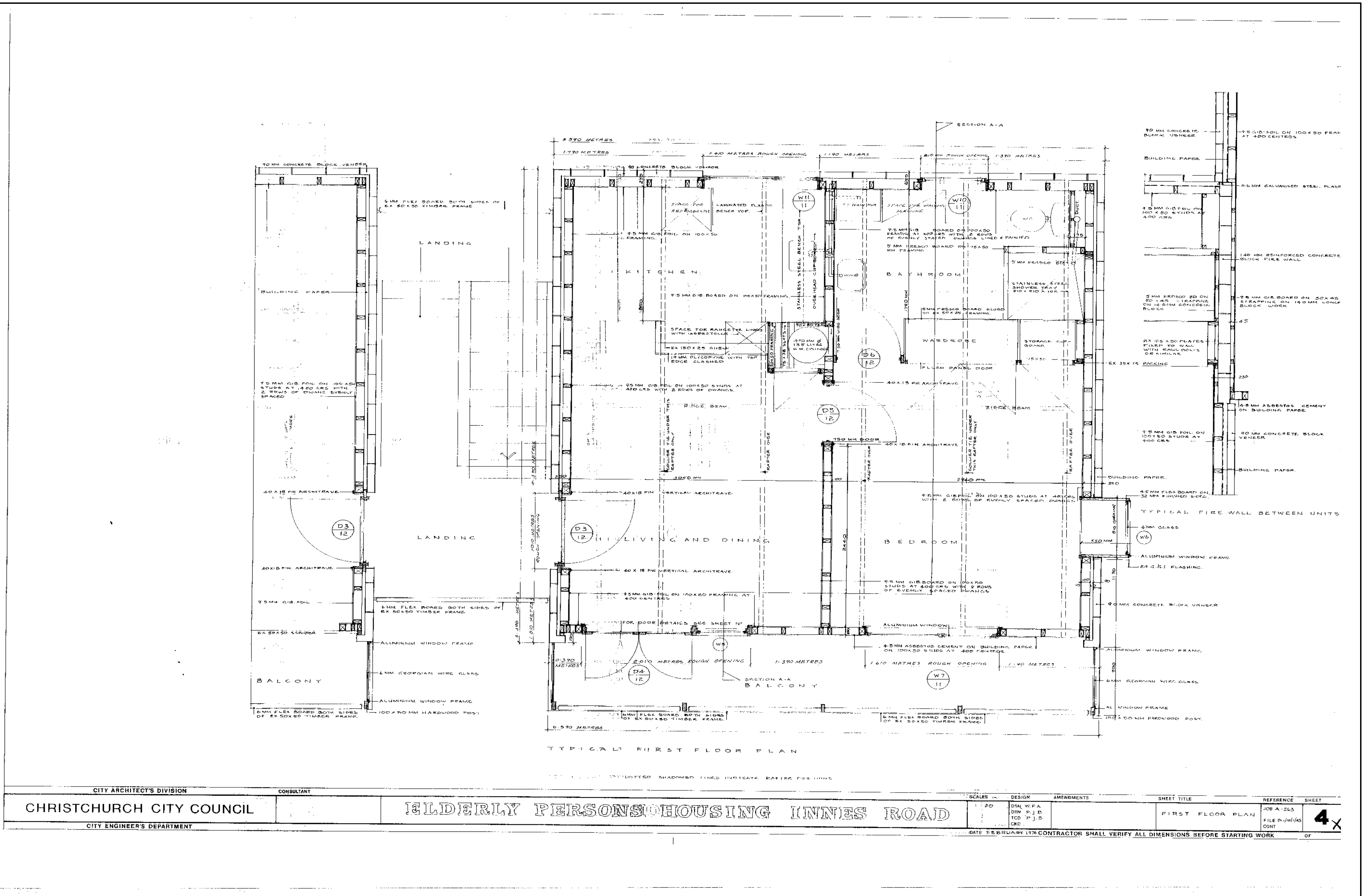
Opus International Consultants Ltd
Auckland Office
The Westhaven
100 Beaumont St, Auckland
New Zealand

Tel: +64 9 355 9500   Fax: +64 9 355 9680

Project: Innes Courts
Geotechnical Desktop Study
Project No.: 6-QUCC2.16AC
Client: Christchurch City Council

Figure D.1 Original Site Plan

Drawn:
Date: 12/12/2012



SOURCE: Christchurch City Council

Opus International Consultants Ltd
Auckland Office
The Westhaven
100 Beaumont St, Auckland
New Zealand

Tel: +64 9 355 9500 Fax: +64 9 355 9680

Project: Geotechnical Desktop Study

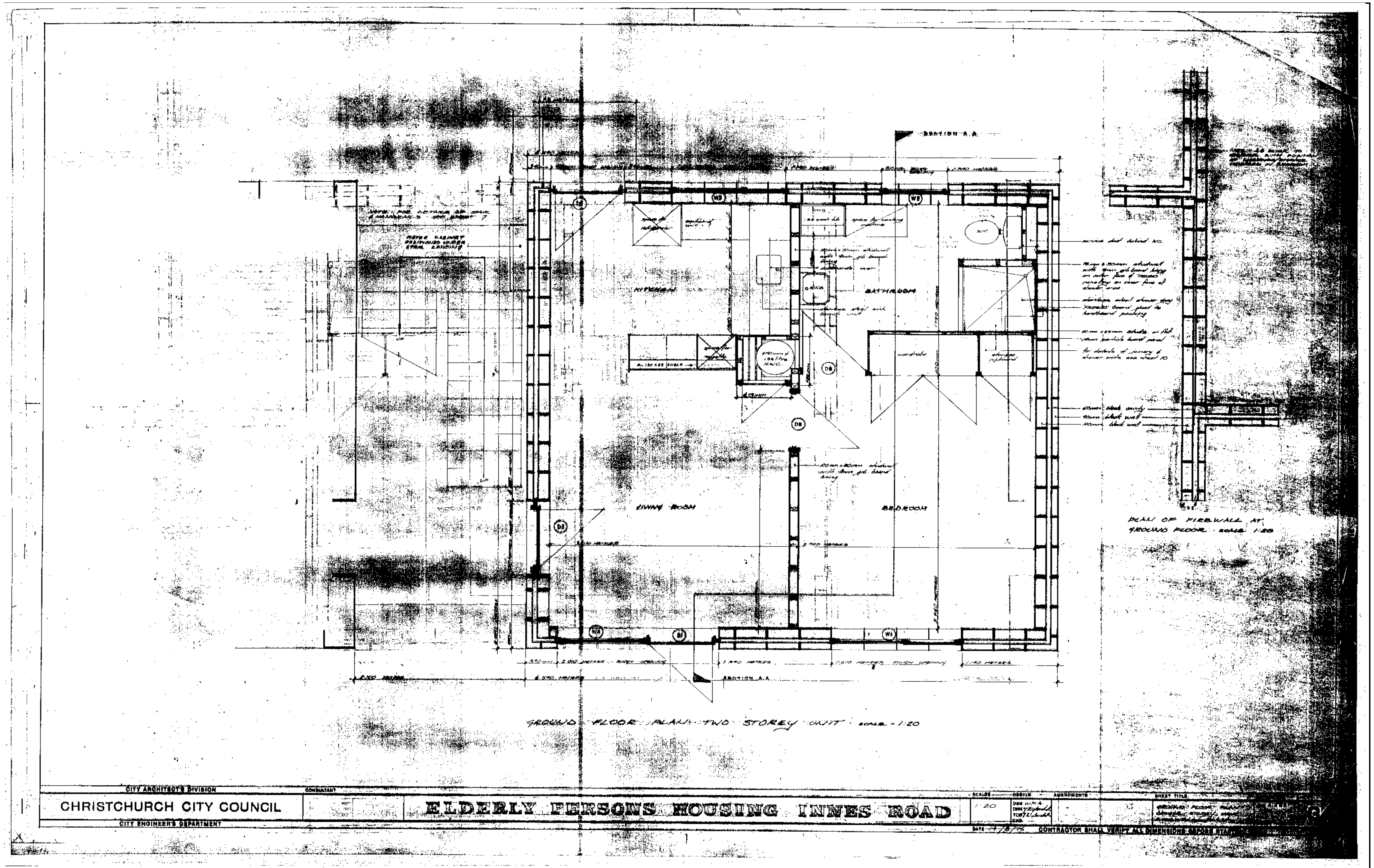
Project No.: 6-QUCC2.16/55AC

Client: Christchurch City Council

Figure D.2 Plan of first floor

Drawn: Opus Geotechnical Engineer

Date: 12/12/2012



Opus International Consultants Ltd
Auckland Office
The Westhaven
100 Beaumont St, Auckland
New Zealand

Tel: +64 9 355 9500 Fax: +64 9 355 9680

Project:	403 Innes Courts Geotechnical Desktop Study
Project No.:	6-QUCC2.13/55AC
Client:	Christchurch City Council

Figure D.3
Plan of typical ground floor`

Drawn:
Date: 12/12/2012

Appendix E:

Site inspection photographs

Site Specific Photographs

Post earthquake Inspection and defects observed during site walkover 22-11-2012

Figure 1 Entrance, facing Block A (NB mailbox is owned by neighbour)

Figure 2 Footpath next to unit 2/7 Block A

Figure 3 Cracks in footpath, same location as figure 3

Figure 4 Detail of various cracks and settlement near gully pot, same location as (figure 3)

Figure 5 Back lawn, block D

Figure 6 Cracking in footpath next to block E.

Figure 7 Cracking in footpath trough the lawn

Figure 8 Cracking in footpath, in between block B unit 11/12 (right) and block C, unit 13/14 (left)

Figure 9 Local depression in footpath

Figure 10 Other side

Figure 11 Typical cracking in footpaths

Figure 12 General ground level depression visible

Figure 13 Cracks in footpath, through the drying area, next to unit 23/30 block E

COMPARISON 2008 – 2012

Photos below provide a comparison between the pre- and post-earthquake photographs. Other photographs taken during the inspection were not suitable for comparison. The photos that have been provided by CCC have been taken in 2008. You can see that some cracks have been developed during earthquake events.

Cracks in footpath pavement

PHOTO TAKEN 2008	**PHOTO TAKEN 2012 (POST EQ)**
	

Cracks in washing area

PHOTO TAKEN 3-1-2008 (No DSC08755)	**PHOTO TAKEN 22-11-2012 (POST EQ)**
	

Appendix F:

Results of Liquefaction analysis

Opus International Consultants Ltd
The Westhaven, 100 Beaumont St
PO Box 5848
Auckland 1141

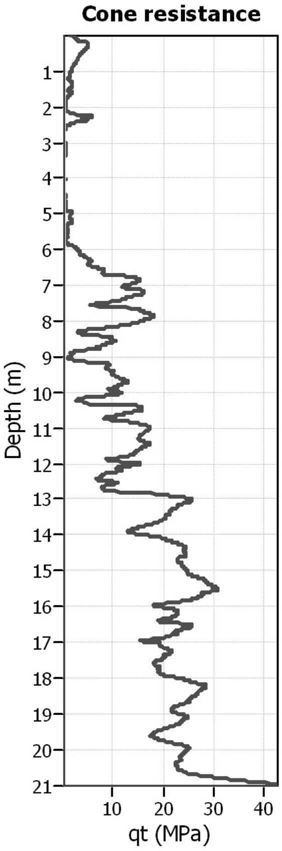
LIQUEFACTION ANALYSIS REPORT

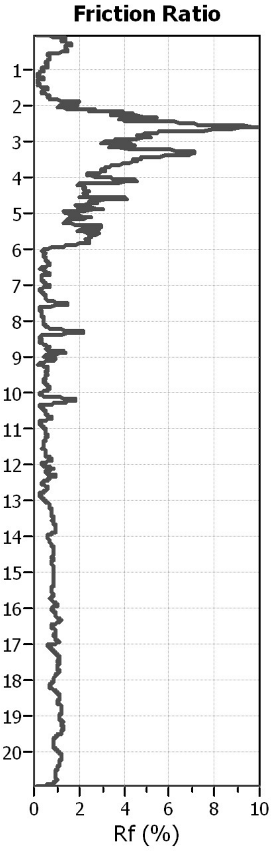
Project title : **Location :**

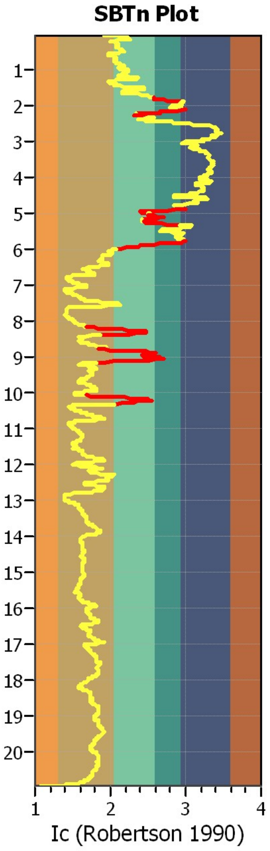
CPT file : CPT_2063

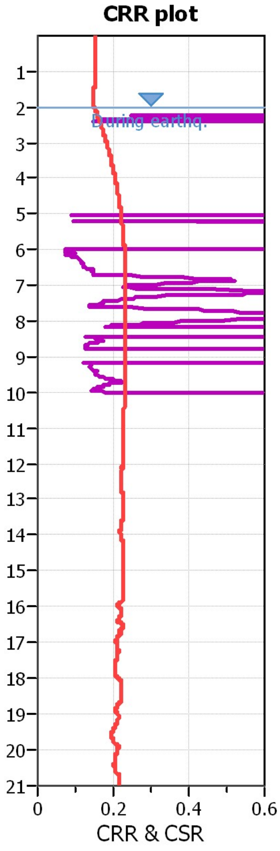
Input parameters and analysis data

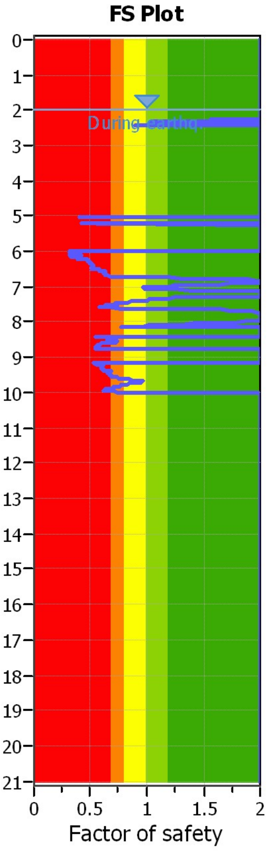
Analysis method:	I&B (2008)	G.W.T. (in-situ):	2.00 m	Use fill:	No	Clay like behavior applied:	Sands only
Fines correction method:	R&W (1998)	G.W.T. (earthq.):	2.00 m	Fill height:	N/A	Limit depth applied:	Yes
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth:	10.00 m
Earthquake magnitude M_w:	6.30	Ic cut-off value:	2.60	Trans. detect. applied:	Yes		
Peak ground acceleration:	0.32	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		

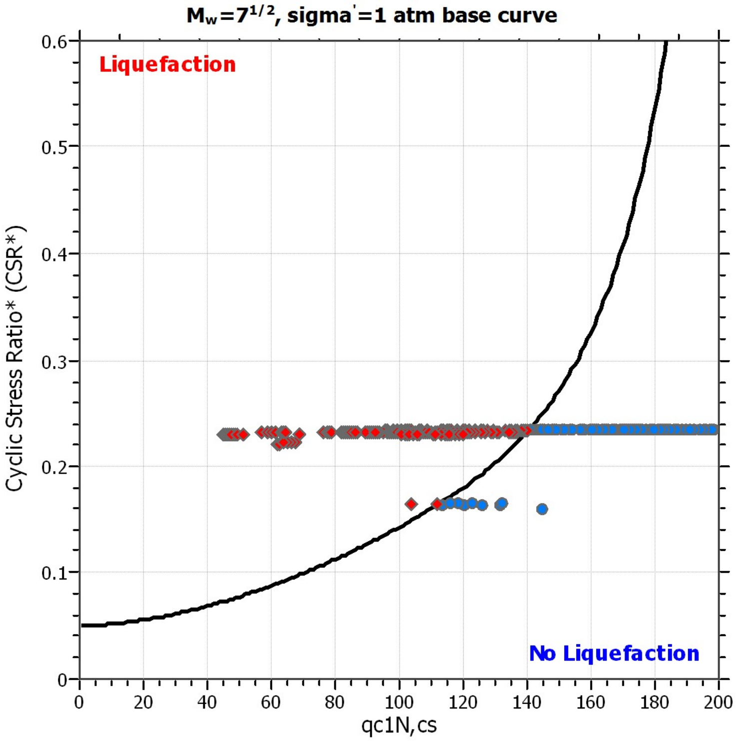

Cone resistance

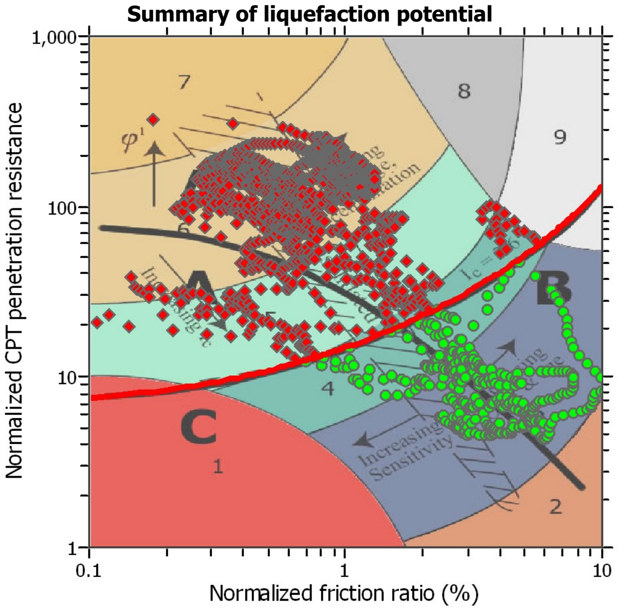

Friction Ratio


SBTn Plot


CRR plot

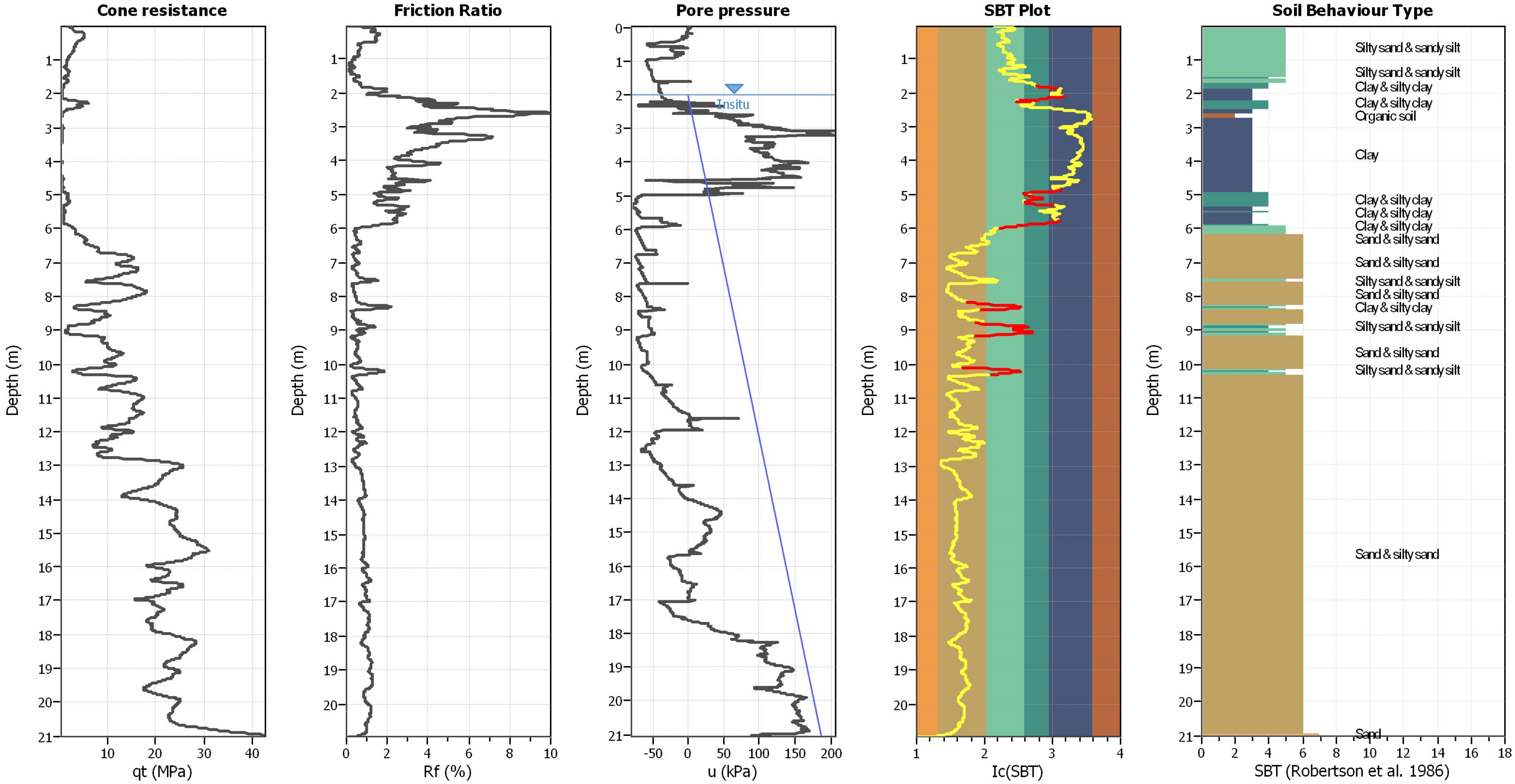

FS Plot


M_w=$7^{1/2}$, sigma'=1 atm base curve


Summary of liquefaction potential

Zone A_1: Cyclic liquefaction likely depending on size and duration of cyclic loading
Zone A_2: Cyclic liquefaction and strength loss likely depending on loading and ground geometry
Zone B: Liquefaction and post-earthquake strength loss unlikely, check cyclic softening
Zone C: Cyclic liquefaction and strength loss possible depending on soil plasticity, brittleness/sensitivity, strain to peak undrained strength and ground geometry

CPT basic interpretation plots



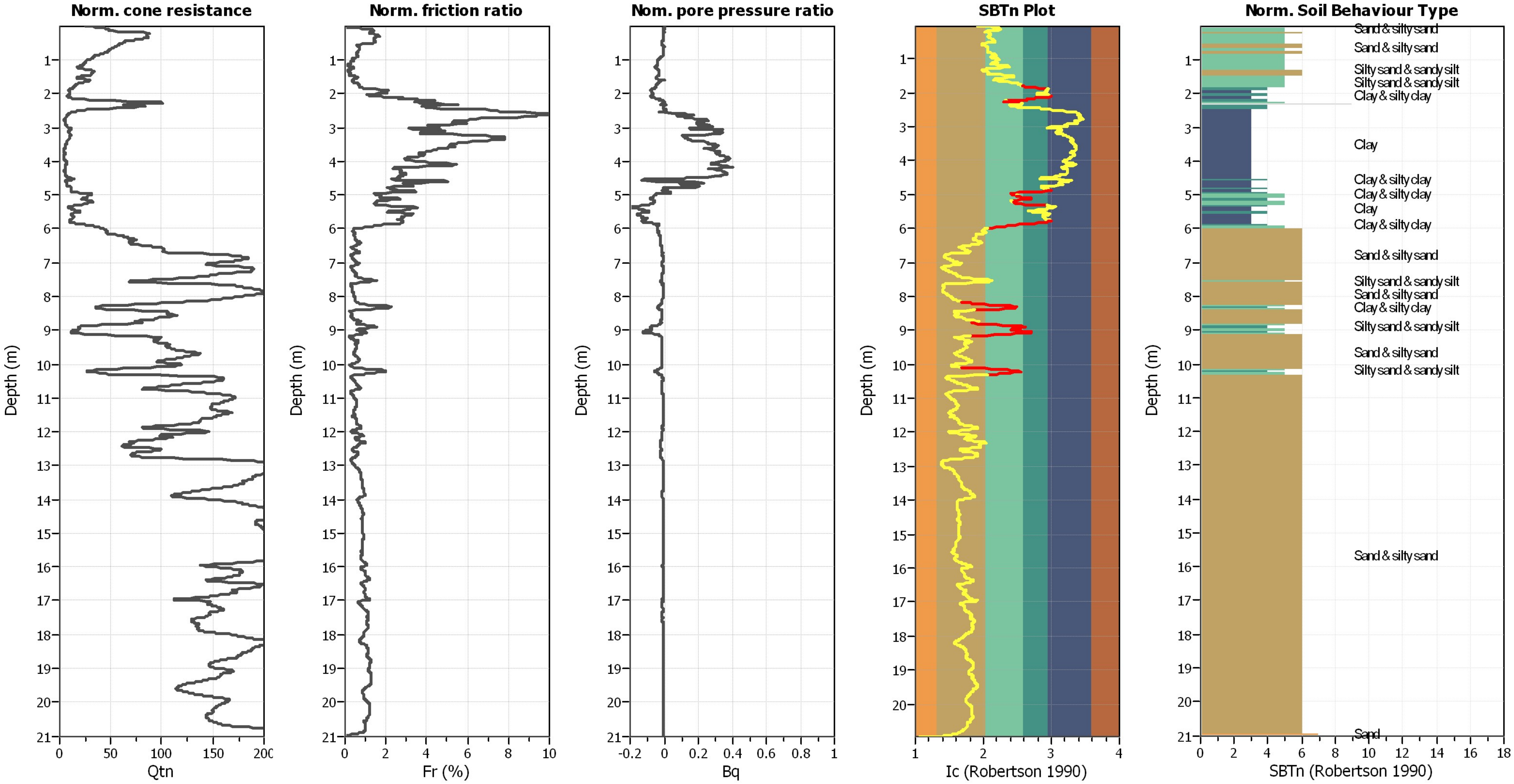
Input parameters and analysis data

Analysis method:	I&B (2008)	Depth to GWT (erthq.):	2.00 m	Fill weight:	N/A
Fines correction method:	R&W (1998)	Average results interval:	3	Transition detect. applied:	Sands only
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.30	Unit weight calculation:	Based on SBT	Clay like behavior applied:	.
Peak ground acceleration:	0.32	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	2.00 m	Fill height:	N/A	Limit depth:	10.00 m

SBT legend

- 🟥 1. Sensitive fine grained
- 🟫 2. Organic material
- 🟦 3. Clay to silty clay
- 🟩 4. Clayey silt to silty
- 🟩 5. Silty sand to sandy silt
- 🟫 6. Clean sand to silty sand
- 🟧 7. Gravely sand to sand
- ⬛ 8. Very stiff sand to
- ⬜ 9. Very stiff fine grained

CPT basic interpretation plots (normalized)



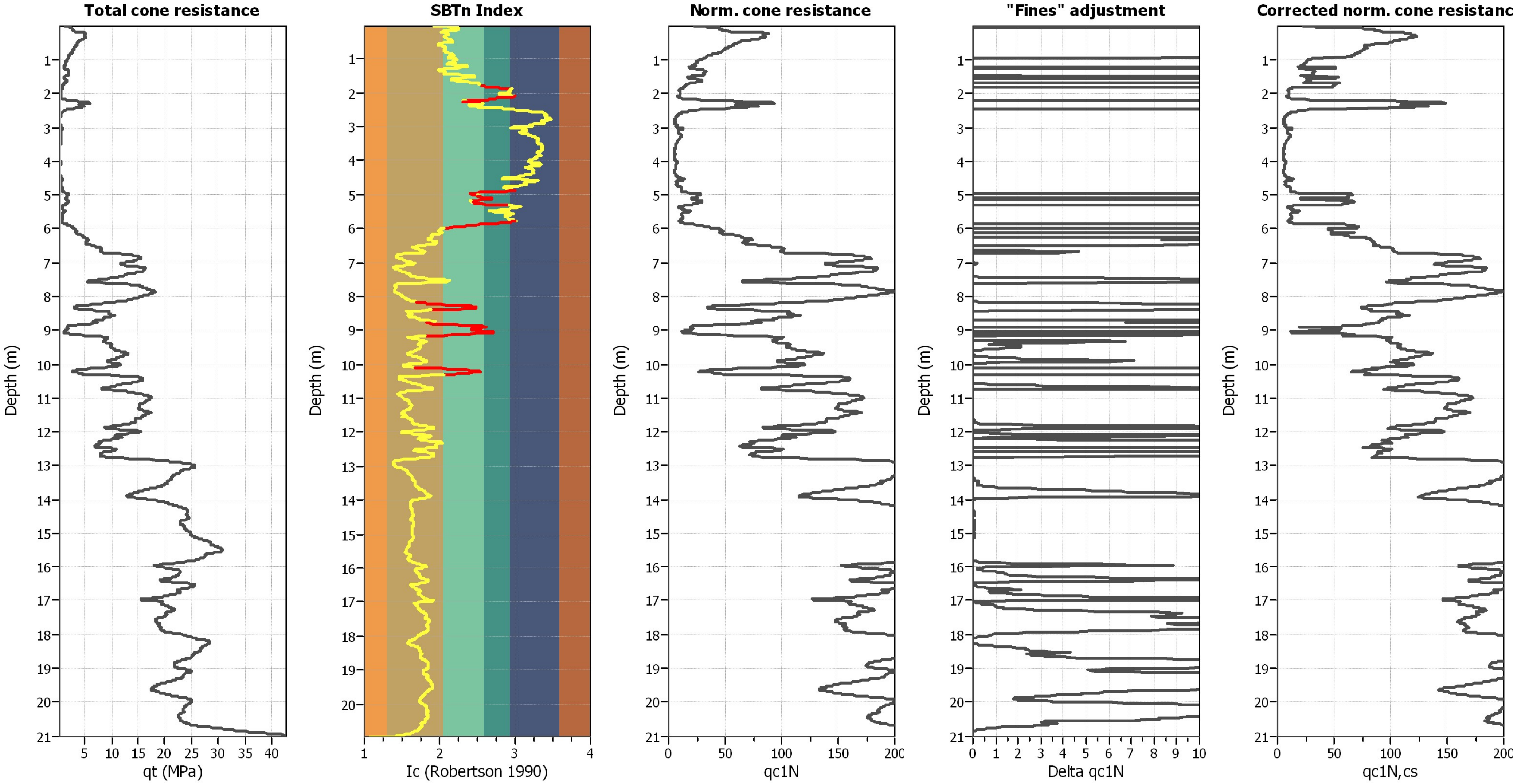
Input parameters and analysis data

Analysis method:	I&B (2008)	Depth to GWT (erthq.):	2.00 m	Fill weight:	N/A
Fines correction method:	R&W (1998)	Average results interval:	3	Transition detect. applied:	Sands only
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.30	Unit weight calculation:	Based on SBT	Clay like behavior applied:	.
Peak ground acceleration:	0.32	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	2.00 m	Fill height:	N/A	Limit depth:	10.00 m

SBTn legend

🟥 1. Sensitive fine grained	🟩 4. Clayey silt to silty	🟧 7. Gravely sand to sand
🟫 2. Organic material	🟩 5. Silty sand to sandy silt	⬛ 8. Very stiff sand to
🟦 3. Clay to silty clay	🟫 6. Clean sand to silty sand	⬜ 9. Very stiff fine grained

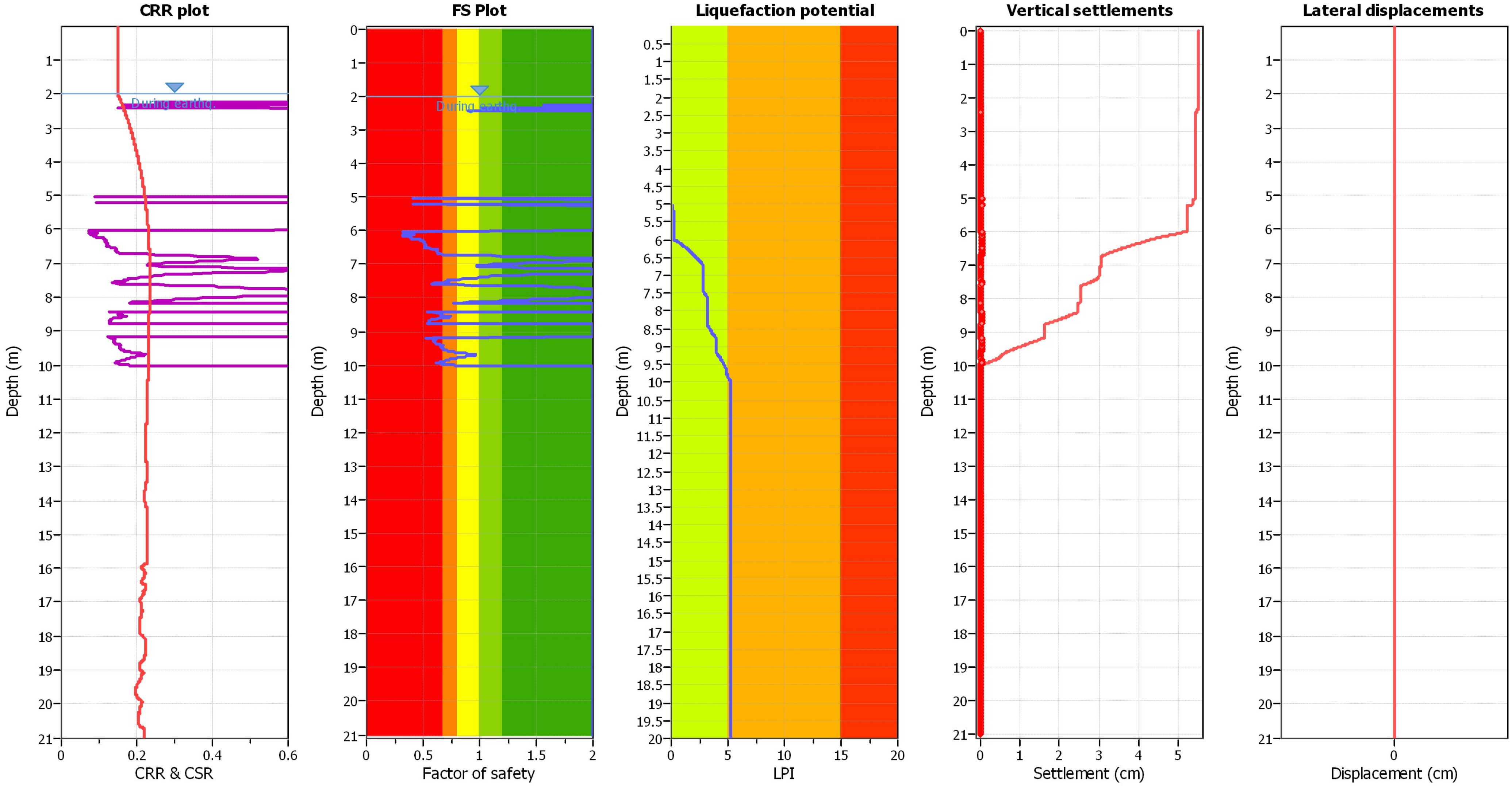
Liquefaction analysis overall plots (intermediate results)



Input parameters and analysis data

Analysis method:	I&B (2008)	Depth to GWT (erthq.):	2.00 m	Fill weight:	N/A
Fines correction method:	R&W (1998)	Average results interval:	3	Transition detect. applied:	Sands only
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.30	Unit weight calculation:	Based on SBT	Clay like behavior applied:	.
Peak ground acceleration:	0.32	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	2.00 m	Fill height:	N/A	Limit depth:	10.00 m

Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method: I&B (2008)
Fines correction method: R&W (1998)
Points to test: Based on Ic value
Earthquake magnitude M_w: 6.30
Peak ground acceleration: 0.32
Depth to water table (insitu): 2.00 m

Depth to GWT (erthq.): 2.00 m
Average results interval: 3
Ic cut-off value: 2.60
Unit weight calculation: Based on SBT
Use fill: No
Fill height: N/A

Fill weight: N/A
Transition detect. applied: Sands only
K_σ applied: Yes
Clay like behavior applied: .
Limit depth applied: Yes
Limit depth: 10.00 m

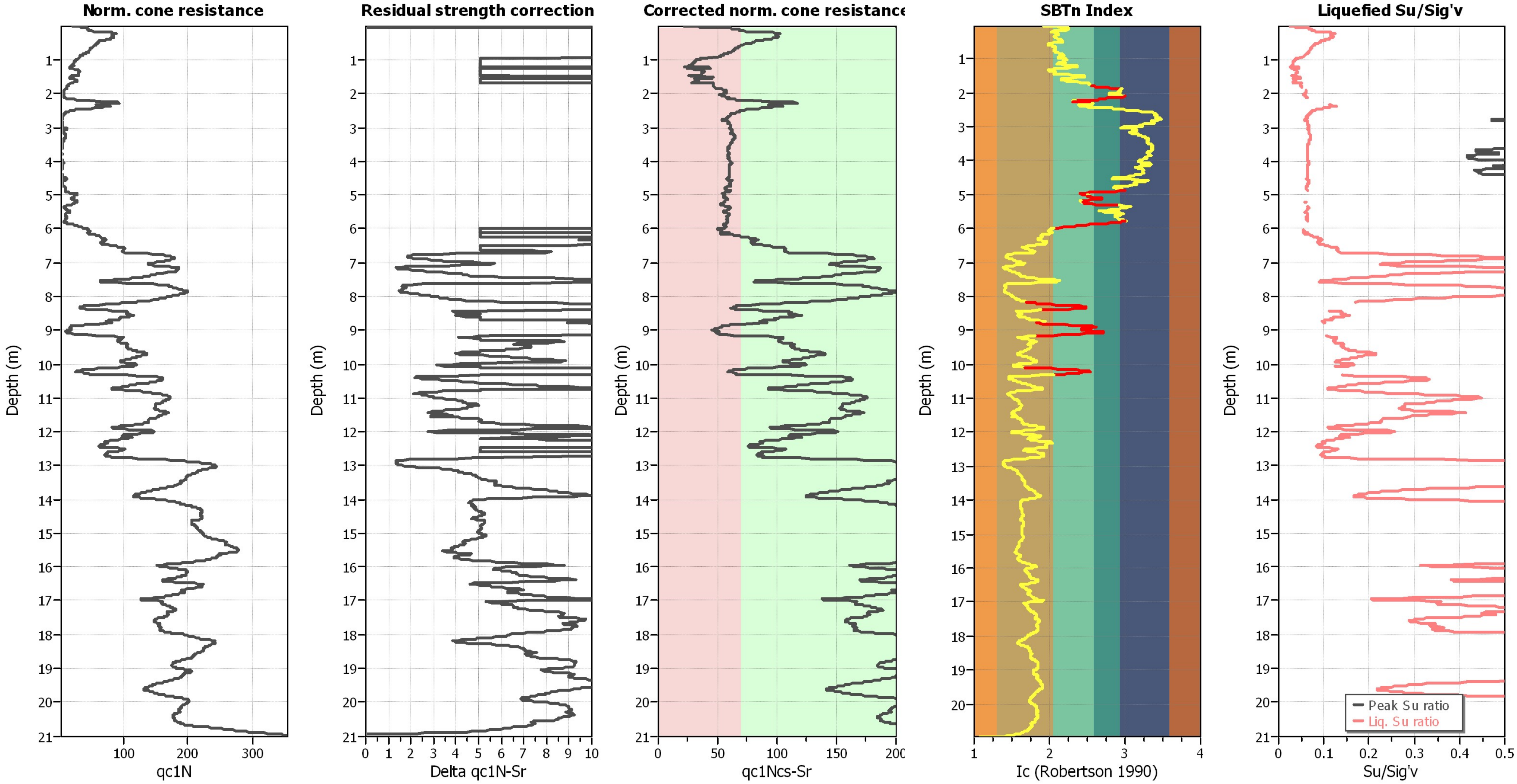
F.S. color scheme

- 🟥 Almost certain it will liquefy
- 🟧 Very likely to liquefy
- 🟨 Liquefaction and no liquefaction are equally likely
- 🟩 Unlike to liquefy
- 🟩 Almost certain it will not liquefy

LPI color scheme

- 🟥 Very high risk
- 🟧 High risk
- 🟩 Low risk

Check for strength loss plots (Idriss & Boulanger (2008))



Input parameters and analysis data

Analysis method:	I&B (2008)	Depth to GWT (erthq.):	2.00 m	Fill weight:	N/A
Fines correction method:	R&W (1998)	Average results interval:	3	Transition detect. applied:	Sands only
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.30	Unit weight calculation:	Based on SBT	Clay like behavior applied:	.
Peak ground acceleration:	0.32	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	2.00 m	Fill height:	N/A	Limit depth:	10.00 m

Appendix C – CERA DEE Spreadsheets

Detailed Engineering Evaluation Summary Data V1.11

Location

Building Name: Block F Garage (Innes Courts)

	Unit	No:	Street
Building Address:		407	Innes Road
Legal Description:			

	Degrees	Min	Sec
GPS south:	43	29	52.25
GPS east:	172	38	27.44

Building Unique Identifier (CCC): PRO 0643

Reviewer: Mary Ann Halliday
CPEng No: 67073
Company: Opus International Consultants Ltd.
Company project number: 6-QC138.00
Company phone number: 3635400

Date of submission: 10/06/2013
Inspection Date: 24/04/2013
Revision: Final
Is there a full report with this summary? yes

Site

Site slope: flat
Soil type:
Site Class (to NZS1170.5): D
Proximity to waterway (m, if <100m):
Proximity to clifftop (m, if < 100m):
Proximity to cliff base (m,if <100m):

Max retaining height (m): 0
Soil Profile (if available):

If Ground improvement on site, describe:

Approx site elevation (m): 10.00

Building

No. of storeys above ground: 1 single storey = 1
Ground floor split? no
Storeys below ground 0
Foundation type: other (describe)
Building height (m): 2.70
Floor footprint area (approx): 20
Age of Building (years):

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

if Foundation type is other, describe: Reinforced concrete pad
height from ground to level of uppermost seismic mass (for IEP only) (m): 2.2

Date of design:

Strengthening present? no

If so, when (year)?
And what load level (%g)?
Brief strengthening description:

Use (ground floor): other (specify)
Use (upper floors):
Use notes (if required): Single garage in a multi-residential complex
Importance level (to NZS1170.5): IL1

Gravity Structure

Gravity System: load bearing walls
Roof: timber truss
Floors: concrete flat slab
Beams: none
Columns: load bearing walls
Walls: partially filled concrete masonry

truss depth, purlin type and cladding Timber purlins, Heavy tile roofing
slab thickness (mm) unknown
overall depth x width (mm x mm)
typical dimensions (mm x mm) length of walls x 200mm
thickness (mm) 200

Lateral load resisting structure

Lateral system along: partially filled CMU
Ductility assumed, μ: 2.00
Period along: 0.20 ##### enter height above at H31
Total deflection (ULS) (mm):
maximum interstorey deflection (ULS) (mm):

Note: Define along and across in detailed report!

note total length of wall at ground (m): 3.8
estimate or calculation? estimated
estimate or calculation?
estimate or calculation?

Lateral system across: partially filled CMU
Ductility assumed, μ: 2.00
Period across: 0.20 ##### enter height above at H31
Total deflection (ULS) (mm):
maximum interstorey deflection (ULS) (mm):

note total length of wall at ground (m): 5.2
estimate or calculation? estimated
estimate or calculation?
estimate or calculation?

Separations:

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

leave blank if not relevant

Non-structural elements

Stairs:
Wall cladding:
Roof Cladding: Heavy tiles
Glazing: timber frames
Ceilings: none
Services(list):

describe Tiles

Available documentation

Architectural none
Structural none
Mechanical none
Electrical none
Geotech report full

original designer name/date
original designer name/date
original designer name/date
original designer name/date
original designer name/date Opus/ April 2013

Damage

Site:
(refer DEE Table 4-2)

Site performance: Good

Describe damage:

Settlement: none observed
Differential settlement: none observed
Liquefaction: none apparent
Lateral Spread: none apparent
Differential lateral spread: none apparent
Ground cracks: none apparent
Damage to area: none apparent

notes (if applicable):
notes (if applicable):
notes (if applicable):
notes (if applicable):
notes (if applicable):
notes (if applicable):
notes (if applicable):

Building:

Current Placard Status: green

Along Damage ratio: 0%
Describe (summary):

Describe how damage ratio arrived at:

Across Damage ratio: 0%
Describe (summary):

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

Diaphragms Damage?: no Describe:

CSWs: Damage?: no Describe:

Pounding: Damage?: no Describe:

Non-structural: Damage?: yes Describe: Minor step cracking and vereer pull away

Recommendations

Level of repair/strengthening required: minor non-structural
Building Consent required: yes
Interim occupancy recommendations: full occupancy

Describe:
Describe:
Describe:

Along Assessed %NBS before e'quakes: 100% ##### %NBS from IEP below
Assessed %NBS after e'quakes: 100%

If IEP not used, please detail assessment methodology: Quantitative

Across Assessed %NBS before e'quakes: 42% ##### %NBS from IEP below
Assessed %NBS after e'quakes: 42%

Detailed Engineering Evaluation Summary Data V1.11

Location

Building Name:	Block F House (Innes Courts)		Reviewer:	Mary Ann Halliday
	Unit	No: Street	CPEng No:	67073
Building Address:		407 Innes Road	Company:	Opus International Consultants Ltd.
Legal Description:			Company project number:	6-QC138.00
			Company phone number:	3635400
	Degrees	Min Sec		
GPS south:	43	29 52.25	Date of submission:	10/06/2013
GPS east:	172	38 27.44	Inspection Date:	24/04/2013
			Revision:	Final
Building Unique Identifier (CCC):	PRO 0643		Is there a full report with this summary?	yes

Site

Site slope:	flat	Max retaining height (m):	0
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):	10.00

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):	
Storeys below ground	0			
Foundation type:	other (describe)		if Foundation type is other, describe:	Ordinary Concrete piles with concrete strip footing
Building height (m):	3.50		height from ground to level of uppermost seismic mass (for IEP only) (m):	2.7
Floor footprint area (approx):	130			
Age of Building (years):			Date of design:	
Strengthening present?	no		If so, when (year)?	
			And what load level (%g)?	
Use (ground floor):	other (specify)		Brief strengthening description:	
Use (upper floors):				
Use notes (if required):	Single dwelling in a multi-residential complex			
Importance level (to NZS1170.5):	IL2			

Gravity Structure

Gravity System:	frame system		
Roof:	timber truss	truss depth, purlin type and cladding	Timber purlins, Heavy tile roofing
Floors:	timber	joist depth and spacing (mm)	1000mm c/c approx
Beams:	timber	type	
Columns:			
Walls:	non-load bearing	0	

Lateral load resisting structure

Lateral system along:	lightweight timber framed walls	**Note: Define along and across in detailed report!**		
Ductility assumed, μ:	2.00		note typical wall length (m)	
Period along:	0.20	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:	2.00		note typical wall length (m)	
Period across:	0.20	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:	brick or tile	describe (note cavity if exists)	No cavity, standard red brick veneer tied to timber frame
Roof Cladding:	Heavy tiles	describe	Tiles
Glazing:	timber frames		
Ceilings:	light tiles		
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	full	original designer name/date	Opus/ April 2013

Damage

Site:
(refer DEE Table 4-2)

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

Building:

	Current Placard Status:	green		
Along	Damage ratio:	0%	Describe how damage ratio arrived at:	
	Describe (summary):			
Across	Damage ratio:	0%		
	Describe (summary):			
Diaphragms	Damage?:	no	Describe:	
CSWs:	Damage?:	no	Describe:	
Pounding:	Damage?:	no	Describe:	
Non-structural:	Damage?:	yes	Describe:	Minor step cracking and vereer pull away

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

Recommendations

	Level of repair/strengthening required:	minor non-structural	Describe:	
	Building Consent required:	yes	Describe:	
	Interim occupancy recommendations:	full occupancy	Describe:	
Along	Assessed %NBS before e'quakes:	90% ##### %NBS from IEP below	If IEP not used, please detail assessment methodology:	Quantitative
	Assessed %NBS after e'quakes:	90%		
Across	Assessed %NBS before e'quakes:	85% ##### %NBS from IEP below		
	Assessed %NBS after e'quakes:	85%		

Detailed Engineering Evaluation Summary Data V1.11

Location
Building Name: Innes Couts - Block Type 1
Unit No: Street
Building Address: 403 Innes Road, Mairehau | 403 Innes Road
Legal Description: Christchurch
Degrees Min Sec
GPS south: 43 29 52.00
GPS east: 172 38 27.00
Building Unique Identifier (CCC): PRO 0643

Reviewer: Mary Ann Halliday
CPEng No: 67073
Company: Opus
Company project number: 6-BE 0643 EQ2
Company phone number: 03 363 5400
Date of submission: 10-Jun-13
Inspection Date: 14-Dec-12
Revision: Final
Is there a full report with this summary? yes

Site
Site slope: flat
Soil type:
Site Class (to NZS1170.5): D
Proximity to waterway (m, if <100m):
Proximity to clifftop (m, if < 100m):
Proximity to cliff base (m,if <100m):

Max retaining height (m): 0
Soil Profile (if available):
If Ground improvement on site, describe:
Approx site elevation (m): 10.00

Building
No. of storeys above ground: 2 single storey = 1
Ground floor split? no
Storeys below ground 0
Foundation type: strip footings
Building height (m): 4.70
Floor footprint area (approx): 43
Age of Building (years): 37

Ground floor elevation (Absolute) (m): 10.00
Ground floor elevation above ground (m): 0.00
if Foundation type is other, describe:
height from ground to level of uppermost seismic mass (for IEP only) (m): 4.7
Date of design: 1965-1976

Strengthening present? no
Use (ground floor): multi-unit residential
Use (upper floors): multi-unit residential
Use notes (if required):
Importance level (to NZS1170.5): IL3

If so, when (year)?
And what load level (%g)?
Brief strengthening description:

Gravity Structure
Gravity System: load bearing walls
Roof: timber truss
Floors: precast concrete with topping
Beams: cast-insitu concrete
Columns: brick masonry
Walls: fully filled concrete masonry

truss depth, purlin type and cladding: light steel cladding
unit type and depth (mm), topping: 75, 65
overall depth x width (mm x mm):
typical dimensions (mm x mm): 140
#N/A

Lateral load resisting structure
Lateral system along: fully filled CMU
Ductility assumed, μ: 1.25
Period along: 0.40 ##### enter height above at H31
Total deflection (ULS) (mm):
maximum interstorey deflection (ULS) (mm):

Note: Define along and across in detailed report!

note total length of wall at ground (m):
estimate or calculation? estimated
estimate or calculation?
estimate or calculation?

Lateral system across: fully filled CMU
Ductility assumed, μ: 1.25
Period across: 0.40 ##### enter height above at H31
Total deflection (ULS) (mm):
maximum interstorey deflection (ULS) (mm):

note total length of wall at ground (m):
estimate or calculation? estimated
estimate or calculation?
estimate or calculation?

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

Non-structural elements
Stairs: timber
Wall cladding: other heavy
Roof Cladding: Metal
Glazing: aluminium frames
Ceilings: fibrous plaster, fixed
Services(list):

describe supports
describe 90mm partially filled CMU
describe

Available documentation
Architectural partial
Structural partial
Mechanical none
Electrical none
Geotech report none

original designer name/date S.D. Smith / 1976
original designer name/date S.D. Smith / 1976
original designer name/date
original designer name/date
original designer name/date

Damage
Site:
(refer DEE Table 4-2)
Site performance: Good
Settlement: none observed
Differential settlement: none observed
Liquefaction: none apparent
Lateral Spread: none apparent
Differential lateral spread: none apparent
Ground cracks: none apparent
Damage to area: none apparent

Describe damage:
notes (if applicable):
notes (if applicable):
notes (if applicable):
notes (if applicable):
notes (if applicable):
notes (if applicable):
notes (if applicable):

Building:
Current Placard Status: green
Along Damage ratio: 0%
Describe (summary):
Describe how damage ratio arrived at:
Across Damage ratio: 0%
Describe (summary):

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

Diaphragms Damage?: no Describe:
CSWs: Damage?: no Describe:
Pounding: Damage?: no Describe:
Non-structural: Damage?: no Describe:

Recommendations
Level of repair/strengthening required: minor non-structural
Building Consent required: yes
Interim occupancy recommendations: full occupancy

Describe:
Describe:
Describe:

Along Assessed %NBS before e'quakes: 42% ##### %NBS from IEP below
Assessed %NBS after e'quakes: 42%

If IEP not used, please detail assessment methodology: Quantitative

Across Assessed %NBS before e'quakes: 34% ##### %NBS from IEP below
Assessed %NBS after e'quakes: 34%

Detailed Engineering Evaluation Summary Data

V1.11

Location

Building Name: Innes Couts - Block Type 2

Unit No: Street

Building Address: 403 Innes Road, Mairehau | 403 Innes Road

Legal Description: Christchurch

	Degrees	Min	Sec
GPS south:	43	29	52.00
GPS east:	172	38	27.00

Building Unique Identifier (CCC): PRO 0643

Reviewer: Mary Ann Halliday
CPEng No: 67073
Company: Opus
Company project number: 6-BE 0643 EQ2
Company phone number: 03 363 5400

Date of submission: 10-Jun-13
Inspection Date: 14-Dec-12
Revision: Final
Is there a full report with this summary? yes

Site

Site slope: flat
Soil type:
Site Class (to NZS1170.5): D
Proximity to waterway (m, if <100m):
Proximity to clifftop (m, if < 100m):
Proximity to cliff base (m,if <100m):

Max retaining height (m): 0
Soil Profile (if available):
If Ground improvement on site, describe:
Approx site elevation (m): 10.00

Building

No. of storeys above ground: 2 single storey = 1
Ground floor split? no
Storeys below ground 0
Foundation type: strip footings
Building height (m): 4.70
Floor footprint area (approx): 86
Age of Building (years): 37

Ground floor elevation (Absolute) (m): 10.00
Ground floor elevation above ground (m): 0.00
if Foundation type is other, describe:
height from ground to level of uppermost seismic mass (for IEP only) (m): 4.7
Date of design: 1965-1976

Strengthening present? no

If so, when (year)?
And what load level (%g)?
Brief strengthening description:

Use (ground floor): multi-unit residential
Use (upper floors): multi-unit residential
Use notes (if required):
Importance level (to NZS1170.5): IL3

Gravity Structure

Gravity System: load bearing walls
Roof: timber truss
Floors: precast concrete with topping
Beams: cast-insitu concrete
Columns: brick masonry
Walls: fully filled concrete masonry

truss depth, purlin type and cladding light steel cladding
unit type and depth (mm), topping 75, 65
overall depth x width (mm x mm)
typical dimensions (mm x mm) 140
#N/A

Lateral load resisting structure

Lateral system along: fully filled CMU
Ductility assumed, μ: 1.25
Period along: 0.40 ##### enter height above at H31
Total deflection (ULS) (mm):
maximum interstorey deflection (ULS) (mm):

Note: Define along and across in detailed report!

note total length of wall at ground (m):
estimate or calculation? estimated
estimate or calculation?
estimate or calculation?

Lateral system across: fully filled CMU
Ductility assumed, μ: 1.25
Period across: 0.40 ##### enter height above at H31
Total deflection (ULS) (mm):
maximum interstorey deflection (ULS) (mm):

note total length of wall at ground (m):
estimate or calculation? estimated
estimate or calculation?
estimate or calculation?

Separations:

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

Non-structural elements

Stairs: timber
Wall cladding: other heavy
Roof Cladding: Metal
Glazing: aluminium frames
Ceilings: fibrous plaster, fixed
Services(list):

describe supports
describe 90mm partially filled CMU
describe

Available documentation

Architectural	partial	original designer name/date	S.D. Smith / 1976
Structural	partial	original designer name/date	S.D. Smith / 1976
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:	none observed	notes (if applicable):	
Liquefaction:	none apparent	notes (if applicable):	
Lateral Spread:	none apparent	notes (if applicable):	
Differential lateral spread:	none apparent	notes (if applicable):	
Ground cracks:	none apparent	notes (if applicable):	
Damage to area:	none apparent	notes (if applicable):	

Building:

Current Placard Status: green

Along Damage ratio: 0%
Describe (summary):
Describe how damage ratio arrived at:

Across Damage ratio: 0%
Describe (summary):

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

Diaphragms Damage?: no Describe:

CSWs: Damage?: no Describe:

Pounding: Damage?: no Describe:

Non-structural: Damage?: no Describe:

Recommendations

Level of repair/strengthening required: minor non-structural Describe:
Building Consent required: yes Describe:
Interim occupancy recommendations: full occupancy Describe:

Along Assessed %NBS before e'quakes: 42% ##### %NBS from IEP below
Assessed %NBS after e'quakes: 42%

If IEP not used, please detail assessment methodology: Quantitative

Across Assessed %NBS before e'quakes: 34% ##### %NBS from IEP below
Assessed %NBS after e'quakes: 34%

Detailed Engineering Evaluation Summary Data V1.11

Location

Building Name: Innes Couts - Block Type 3
Unit No: Street
Building Address: 403 Innes Road, Mairehau | 403 Innes Road
Legal Description: Christchurch

Degrees Min Sec
GPS south: 43 29 52.00
GPS east: 172 38 27.00

Building Unique Identifier (CCC): PRO 0643

Reviewer: Mary Ann Halliday
CPEng No: 67073
Company: Opus
Company project number: 6-BE 0643 EQ2
Company phone number: 03 363 5400

Date of submission: 10-Jun-13
Inspection Date: 14-Dec-12
Revision: Final
Is there a full report with this summary? yes

Site

Site slope: flat
Soil type:
Site Class (to NZS1170.5): D
Proximity to waterway (m, if <100m):
Proximity to clifftop (m, if < 100m):
Proximity to cliff base (m,if <100m):

Max retaining height (m): 0
Soil Profile (if available):

If Ground improvement on site, describe:

Approx site elevation (m): 10.00

Building

No. of storeys above ground: 2 single storey = 1
Ground floor split? no
Storeys below ground 0
Foundation type: strip footings
Building height (m): 2.60
Floor footprint area (approx): 43
Age of Building (years): 37

Ground floor elevation (Absolute) (m): 10.00
Ground floor elevation above ground (m): 0.00

if Foundation type is other, describe:
height from ground to level of uppermost seismic mass (for IEP only) (m): 2.6

Date of design: 1965-1976

Strengthening present? no

If so, when (year)?
And what load level (%g)?
Brief strengthening description:

Use (ground floor): multi-unit residential
Use (upper floors):
Use notes (if required):
Importance level (to NZS1170.5): IL3

Gravity Structure

Gravity System: load bearing walls
Roof: timber truss
Floors:
Beams: timber
Columns:
Walls:

truss depth, purlin type and cladding light steel cladding
75, 65
type
140

Lateral load resisting structure

Lateral system along: lightweight timber framed walls
Ductility assumed, μ: 2.00
Period along: 0.40 0.00
Total deflection (ULS) (mm):
maximum interstorey deflection (ULS) (mm):

Note: Define along and across in detailed report!

note typical wall length (m)
estimate or calculation? estimated
estimate or calculation?
estimate or calculation?

Lateral system across: lightweight timber framed walls
Ductility assumed, μ: 2.00
Period across: 0.40 0.00
Total deflection (ULS) (mm):
maximum interstorey deflection (ULS) (mm):

note typical wall length (m)
estimate or calculation? estimated
estimate or calculation?
estimate or calculation?

Separations:

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

leave blank if not relevant

Non-structural elements

Stairs:
Wall cladding: other heavy
Roof Cladding: Metal
Glazing: aluminium frames
Ceilings: fibrous plaster, fixed
Services(list):

describe 90mm partially filled CMU
describe

Available documentation

Architectural partial
Structural partial
Mechanical none
Electrical none
Geotech report none

original designer name/date S.D. Smith / 1976
original designer name/date S.D. Smith / 1976
original designer name/date
original designer name/date
original designer name/date

Damage

Site:
(refer DEE Table 4-2)

Site performance: Good

Describe damage:

Settlement: none observed
Differential settlement: none observed
Liquefaction: none apparent
Lateral Spread: none apparent
Differential lateral spread: none apparent
Ground cracks: none apparent
Damage to area: none apparent

notes (if applicable):
notes (if applicable):
notes (if applicable):
notes (if applicable):
notes (if applicable):
notes (if applicable):
notes (if applicable):

Building:

Current Placard Status: green

Along Damage ratio: 0%
Describe (summary):

Describe how damage ratio arrived at:

Across Damage ratio: 0%
Describe (summary):

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

Diaphragms Damage?: no
Describe:

CSWs: Damage?: no
Describe:

Pounding: Damage?: no
Describe:

Non-structural: Damage?: no
Describe:

Recommendations

Level of repair/strengthening required: minor non-structural
Building Consent required: yes
Interim occupancy recommendations: full occupancy

Describe:
Describe:
Describe:

Along Assessed %NBS before e'quakes: 67% ##### %NBS from IEP below
Assessed %NBS after e'quakes: 67%

If IEP not used, please detail assessment methodology: Quantitative

Across Assessed %NBS before e'quakes: 35% ##### %NBS from IEP below
Assessed %NBS after e'quakes: 35%

Opus International Consultants Ltd
20 Moorhouse Avenue
PO Box 1482, Christchurch Mail Centre,
Christchurch 8140
New Zealand

t: +64 3 363 5400
f: +64 3 365 7858
w: www.opus.co.nz