Waltham Community Cottage

BU 2385-001 EQ2

Detailed Engineering Evaluation

Quantitative Report

Christchurch City Council

Christchurch City Council

Waltham Community Cottage

Detailed Engineering Evaluation Quantitative Report

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Reference: 6-QUCCC.58
Status: Final

Waltham Community Cottage
BU 2385-001 EQ2

Detailed Engineering Evaluation
Quantitative Report - SUMMARY
Final

201 Hastings Street East, Waltham, Christchurch

Background

This is a summary of the Quantitative report for the building structure, and is based on the Detailed Engineering Evaluation Procedure document (draft) issued by the Structural Advisory Group on 19 July 2011, visual inspections on 15 December 2011and a set of drawings showing proposed new garage and toy library for the Waltham Community Centre dated 17 June 1999.

Key Damage Observed

There was minor cracking to wall and ceiling lining in corners and around the internal chimney breast. The timber-framed structure did not appear to suffer significant structural damage.

Critical Structural Weaknesses

No critical structural weaknesses have been identified for this building.

Indicative Building Strength

Based on the information available, and from undertaking a quantitative assessment, the building's original capacity has been assessed to be in the order of 34% NBS along the building and 53% NBS across the building and post-earthquake capacity in the order of 34% NBS along the building and 53% NBS across the building and is therefore not classed as an earthquake prone building.

Recommendations

It is recommended that:

1. A strengthening scheme be developed to increase the overall capacity of the building to at least 67% NBS.

2. The existing foundations are considered to be suitable for the ground conditions. We do not believe any further geotechnical investigations are warranted at this site at this stage.

Contents

1 Introduction

Opus International Consultants Limited has been engaged by Christchurch City Council (CCC) to undertake a detailed seismic assessment of the Waltham Community Cottage, located at 201 Hastings Street East, Waltham, Christchurch, following the M6.3 Christchurch earthquake on 22 February 2011.

The purpose of the assessment is to determine if the building is classed as being earthquake prone in accordance with the Building Act 2004.

The seismic assessment and reporting have been undertaken based on the 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 will require a detailed engineering evaluation to be carried out for all buildings (other than those exempt from the Earthquake Prone Building definition in the Building Act). It is anticipated that CERA will adopt the Detailed Engineering Evaluation Procedure (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.

We anticipate that any building with a capacity of less than 34% of new building standard (including consideration of critical structural weaknesses) will need to be strengthened to a target of 67% as required by 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).

Section 115 – Change of Use

This section requires that the territorial authority (in this case Christchurch City Council (CCC) 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 CCC as being 67% of the strength of an equivalent new building. This is also the minimum level recommended by the New Zealand Society for Earthquake Engineering (NZSEE).

2.2.1 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 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.

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:

- 36% increase in the basic seismic design load for Christchurch (Z factor increased from 0.22 to 0.3);
- Increased serviceability requirements.

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	Improvement of Structural Performance	
					Legal Requirement	NZSEE Recommendation
Low Risk Building	A or B	Low	Above 67	Acceptable (improvement may be desirable)	The Building Act sets no required level of structural improvement (unless change in use) This is for each TA to decide. Improvement is not limited to 34%NBS.	100%NBS desirable. Improvement should achieve at least 67%NBS
Moderate Risk Building	B or C	Moderate	34 to 66	Acceptable legally. Improvement recommended		Not recommended. Acceptable only in exceptional circumstances
Risk Building	D or E	High	33 or lower	Unacceptable (Improvement required under Act)	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). It is noted that the current seismic risk in Christchurch results in a 6% risk of exceedance in the next year.

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

Table 1: %NBS compared to relative risk of failure

4 Building Description

4.1 General

The Waltham Community Cottage is a single storey timber-framed structure and is located at 201 Hastings Street East, Waltham, Christchurch. For the purposes of this report we refer to the direction parallel to Hastings Street as the west to east direction and the direction perpendicular to Hastings Street as the north to south direction.

There was no information provided as to when the cottage was constructed thus the age of the building is unknown, although it is expected that the building was constructed in the 1920s. The building is clad with timber weatherboards and the rooftop structure is light-weight coloursteel corrugated roof cladding. The building structure is supported on shallow pile foundations with a concrete foundation wall around the perimeter of the building.

The building is approximately 12.3m long in the north to south direction and 11m wide in the west to east direction. The roof apex is approximately 5.6m above ground level.

4.2 Gravity Load Resisting System

The walls are timber-framed with 100mm x 50mm studs and a stud height of approximately 2700mm. The floor is a suspended timber floor consisting of joints and bearers supported on shallow piles. The foundation is made up of internal piles with a concrete foundation wall around the perimeter of the building.

4.3 Seismic Load Resisting System

The seismic load resisting system in both principal directions consists of plasterboard bracing elements provided in the timber-framed walls.

It has been assumed that the plaster board ceiling panel is providing a form of diaphragm action in distributing seismic loads to the load resisting elements.

5 Survey

The building currently has a green placard (not issued as part of this inspection and authorised by an engineer working for a company other than Opus International Consultants).

Copies of the following archive drawings were used during this assessment:

- A set of drawings showing proposed new garage and toy library for the Waltham Community Centre dated 17 June 1999.

No copies of the design calculations have been obtained as part of the documentation set.

The drawings have been used to confirm the structural systems, investigate potential critical structural weaknesses (CSW) wherever possible and identify details which required particular attention.

6 Damage Assessment

There was no significant structural damage found in or around the Waltham Community cottage structure.

There were however various areas of minor but noticeable damage to the wall and ceiling linings through the building. There was also noticeable damage local to the existing chimney breast.

7 General Observations

Overall the building has performed well under seismic conditions which would be expected for a modern single storey structure. The building has sustained little damage and continues to be fully operational.

Due to the non-intrusive nature of the original survey, many connection details could not be ascertained.

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.

There were no critical structural weaknesses identified for the Waltham Community cottage building.

8.2 Detailed Seismic Assessment Methodology

The seismic design parameters based on current design requirements from NZS 1170.5:2004 and the NZBC clause B1 for this building 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
- Return period factor R_u = 1.0 from Table 3.5, NZS 1170.5:2004, for an Importance Level 2 structure with a 50 year design life.

The calculations are based on guidelines from the New Zealand Society if Earthquake Engineers "Assessment and Improvement of the Structural Performance of Buildings in Earthquake" published June 2006.

8.3 Expected Ductility Factors

Based on our assessment of the structural details our estimates for the expected maximum structural ductility factors for the main seismic resisting systems is:

- μ_{max} = 2.0 for the timber-framed buildings.

8.4 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

Structural Element/System	Failure mode and description of limiting criteria	Critical Structural Weakness and Collapse Hazard	% NBS based on calculated capacity
Wall capacity in the north to south direction i.e. along the building	Bracing capacity of wall linings along the building	No	34%
Wall capacity in the west to east direction, i.e. across the building	Bracing capacity of wall linings across the building	No	53%
Concrete foundation perimeter wall	Bracing capacity of the concrete foundation perimeter wall capacity	No	68%

8.5 Discussion of Results

The building has a calculated seismic capacity of 34% NBS along the building and 53% NBS across the building. The lateral capacity of the building is provided by a series of plasterboard bracing systems in the timber-framed walls.

8.6 Limitations and Assumptions in Results

The results have been reported as a %NBS and the stated value is that 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 the many assumptions and simplifications which are made during the assessment. These include:

- Simplifications made in the analysis, including boundary conditions such as foundation fixity;
- Assessments of material strengths based on limited drawings, specifications and site inspections;
- 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.

9 Geotechnical Appraisal

9.1 Discussion

ECan borehole logs and some CPT results indicate the presence of a shallow gravel layer from 2m bgl. However, the presence of the shallow gravels does not appear to be consistent across the area. CPT WTM_21 140m south-west and CPT WTM_19 165m north-east of the site indicate liquefiable layers from 2m to 8m bgl.

The magnitude of seismically induced settlement which has occurred on site is minor (<5mm) and is not considered to have caused damage to the building. Buildings are typically designed to allow for up to 50mm of land settlement in a serviceability limit state (SLS) event, or up to 100mm in an ultimate limit state event (ULS).

The building is likely to be founded on shallow perimeter strip footings, of an unknown size to an unknown depth. The existing foundations have performed satisfactorily and do not appear to have sustained damage. The existing foundations are considered appropriate for the building, however it must be noted that minor settlement, similar to what has already occurred, may occur in future seismic events.

The land at Waltham Community Cottage, Hastings Street East, has performed well in the Darfield and Canterbury earthquakes and their associated aftershocks. We would expect that similar liquefaction and ground damage could occur in a future earthquake. GNS Science indicates an elevated risk of seismic activity is expected in the Canterbury region as a result of the earthquakes. Recent advice[1] indicates an 18% probability of another Magnitude 6 or greater earthquake over the next 12 months in the Canterbury region. Liquefaction of a similar order of magnitude is possible in such an event, dependent on the location of the epicentre.

The Waltham Community Cottage is located in the CERA "green" zone. The "green" zone has been further categorised into technical categories by the Department of Building and Housing (DBH), this site has been identified as "Technical Category 3" (TC3) released in October 2011. The DBH technical categories are guidelines for residential foundations, however are likely to be used as a guideline by Christchurch City Council for building consent. TC3 identifies the area may be subject to moderate to significant land damage from liquefaction in future large earthquakes and site specific geotechnical investigations.

9.2 Geotechnical Recommendations

- No evidence of differential settlement has been observed on site at Waltham Community Cottage;
- Based on the building performance in recent earthquakes, the existing foundations are deemed suitable in terms of future ULS and SLS loadings, although CCC may have to accept the risk for potential differential settlement of up to 50mm;
- No further site investigations are recommended for the Waltham Community Cottage at this stage.

The full geotechnical report is contained in Appendix C of this report.

10 Remedial Options

The building has a seismic capacity greater than 33% NBS however we recommend a strengthening scheme is developed to increase the overall building capacity to at least 67% NBS to tolerate future earthquake events. This could be achieved by upgrading existing wall linings.

11 Conclusions

(a) The building has a seismic capacity of 34% NBS in the north to south (along building) direction and 53% NBS in the west to east (across building) direction.

(b) Strengthening works in both principal direction is required to increase the overall building capacity to at least 67% NBS.

(c) There were no critical structural weaknesses identified for the building.

(d) The timber-framed building and the supporting concrete foundations appear to have performed well under seismic loading. The existing foundations are considered to be

[1] GNS Science reporting on Geonet Website, updated 3 February 2011.

suitable for the ground conditions. We do not believe any further geotechnical investigations are warranted at this site at this stage.

12 Recommendations

(a) Strengthening options be developed for increasing the seismic capacity of the building to at least 67% NBS.

13 Limitations

(a) This report is based on an inspection of the structure with a focus on the damage sustained from the 22 February 2011 Canterbury Earthquake and aftershocks only. Some non-structural damage is mentioned but this is not intended to be a comprehensive list of non-structural items.

(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.

Appendix A – Photographs

Photo 1 – South (front) elevation of building

Photo 2 – West side elevation of building

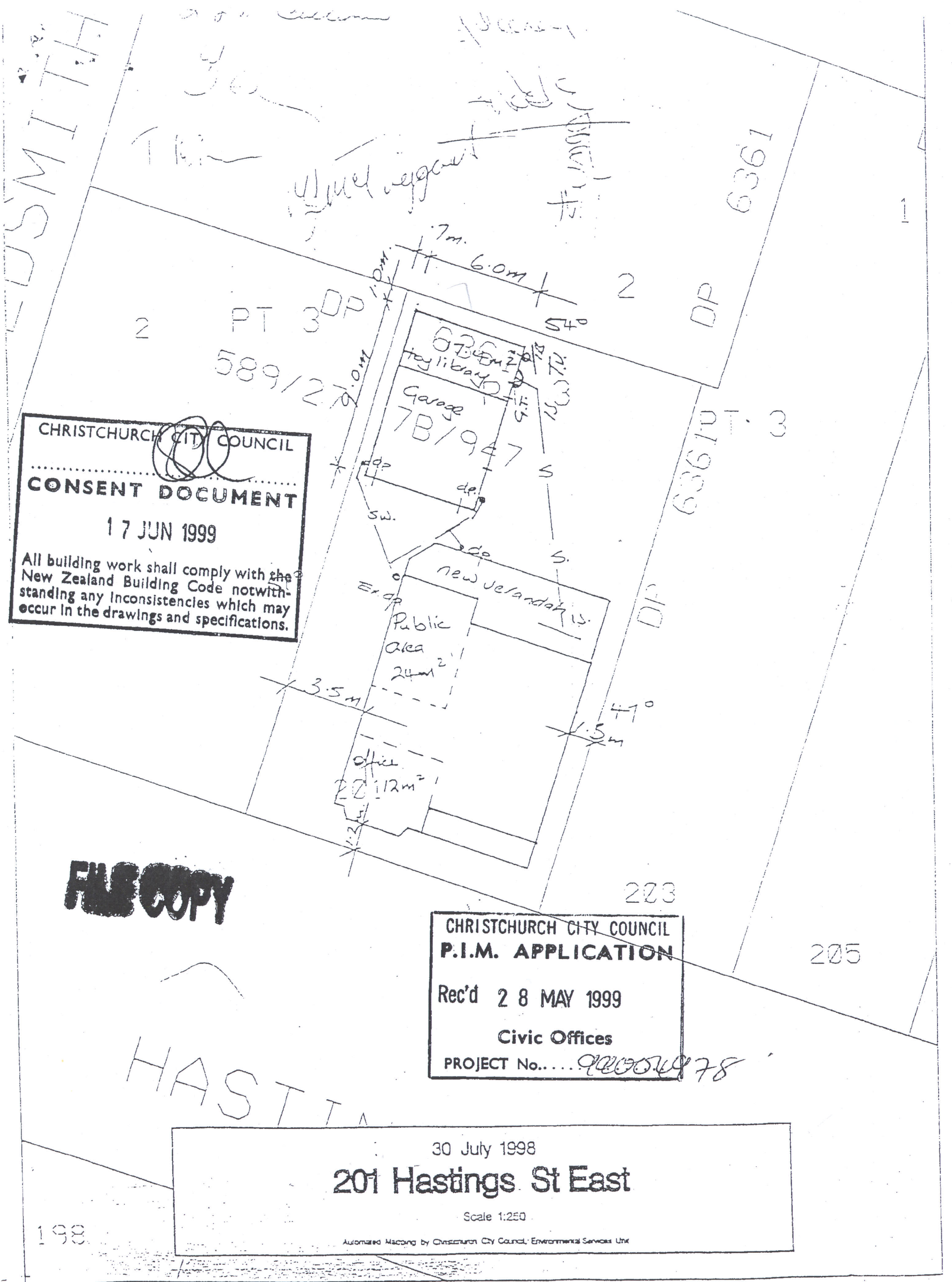
Photo 3 – North (rear) elevation of building

Photo 4 – View of the kitchen facilities

Photo 5 – View of the office room in the building

Photo 6 – View of the office room

Appendix B – Floor Plan



SMITH
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6361
1
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6.0m
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2
DP
54°
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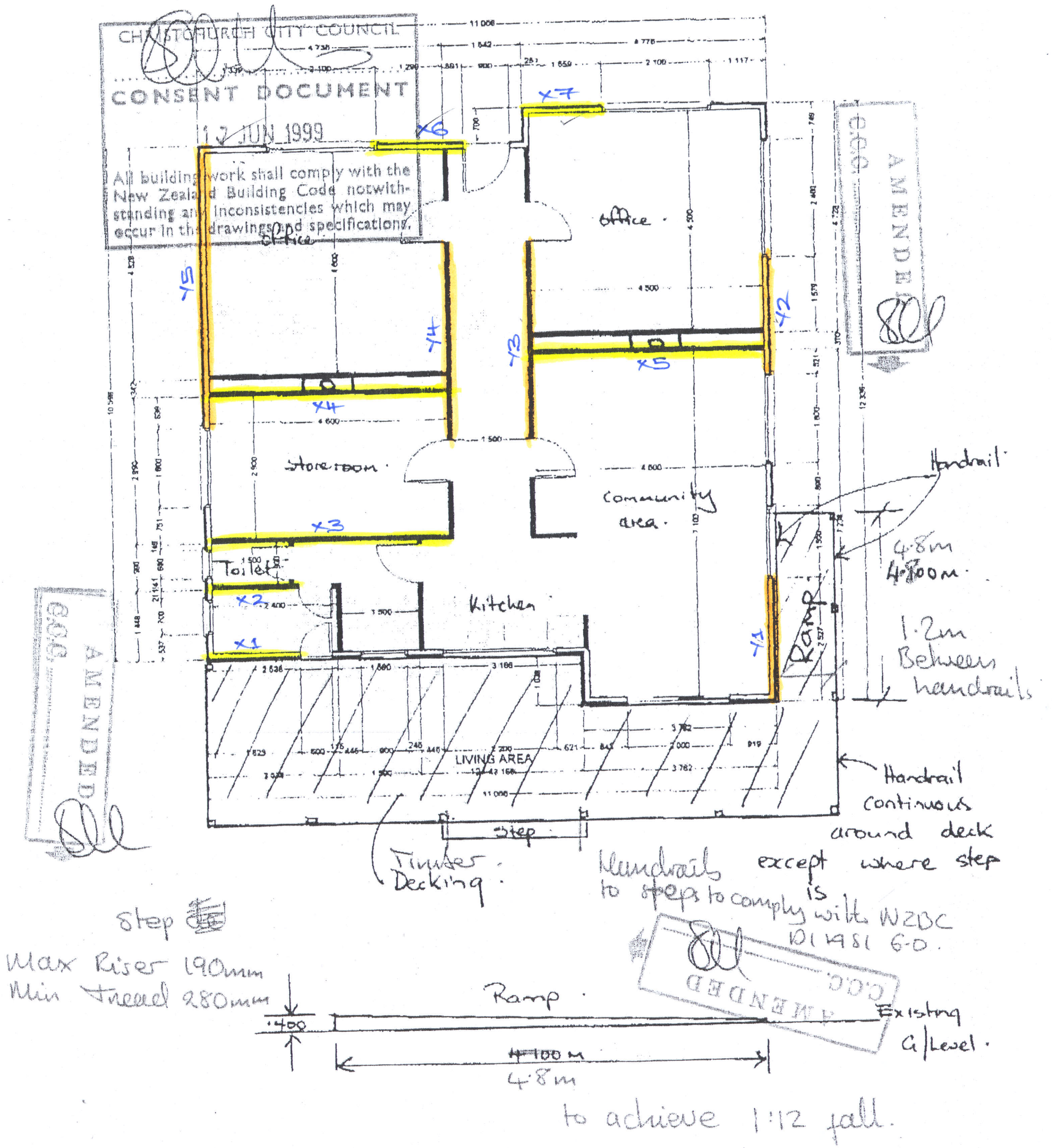
PT 3 DP
636
589/27
9.0m
toy library
Garage
7B/947
PT 3
6361
CHRISTCHURCH CITY COUNCIL
CONSENT DOCUMENT
17 JUN 1999
All building work shall comply with the New Zealand Building Code notwithstanding any inconsistencies which may occur in the drawings and specifications.
dp
dp.
sw.
dp
new verandah
DP
Public area 24m²
3.5m
41°
1.5m
office 12m²
FILE COPY
203
CHRISTCHURCH CITY COUNCIL
P.I.M. APPLICATION
Rec'd 28 MAY 1999
Civic Offices
PROJECT No.....99004978
205
HASTI
30 July 1998
201 Hastings St East
Scale 1:250
Automated Mapping by Christchurch City Council, Environmental Services Unit
198

Site Plan.

ANTI-SLIP: On all access routes (both external and internal), provide anti-slip surfaces complying with NZBC D1/AS1/Table 2 (except that surfaces inside entry doors of housing may be considered as dry areas).

No alterations being made to house —

FILE COPY



Appendix C – Geotechnical Report

7 February 2012

Lindsay Fleming
Christchurch City Council
53 Hereford St
PO Box 237
Christchurch 8140

6-QUCCC.49/005SC

Dear Lindsay

Waltham Community Cottage - Geotechnical Desktop Appraisal

1. Introduction

The Waltham Community Cottage was subjected to severe ground shaking during the Darfield 2010 and Christchurch 2011 earthquakes and subsequent aftershocks. The following report summarises the findings of a geotechnical desk study and site walkover completed by Opus International Consultants (Opus) for the Christchurch City Council (CCC) on 23 January 2012. This desk study assesses the ground conditions and the potential geotechnical hazards that may be present at the site, based on currently available geotechnical data. The scope of further site investigations is recommended to assess the liquefaction potential of the site and to determine the integrity of the existing foundations after the earthquake events.

Some structural damage occurred to the building and a rapid structural inspection was carried out by Opus on 10 March 2011. It is our understanding that this is the first geotechnical inspection following the earthquakes.

2. Desktop Study

2.1 Site Description

The building is located on Hastings Street East, Waltham, bounded by residential buildings to the north-west, north-east and south-east, and Hastings Street East to the south-west. The Heathcote River is located approximately 400m to the south-east of the building. Refer to the Site Plan attached to this report.

The topography of the site is generally flat lying.

2.2 Structural Drawings

No structural drawings of the Waltham Community Cottage have been made available. The age of the building is unknown. The building is a single storey, timber framed and comprises offices, a store room, lounge and kitchen facilities.

Structural drawings of the detached toy library built in 1999 to the rear of the property are available and indicate the building is timber framed and founded on a 300mm perimeter strip footing with a 100mm thick reinforced concrete slab on top of 150mm of hard fill.

2.3 Regional Geology

The 1:250 00 Geological Map of Christchurch (GNS 1992) indicates the site is underlain by Holocene-aged river alluvium in low level river terraces (non active floodplain). These deposits comprise gravel, sand and silt, with some organic materials present.

2.4 Ground Conditions

Four well logs were selected from the Environment Canterbury (ECan) website. The logs were selected due to their depth and close proximity (within 360m) to the Waltham Community Cottage. Refer to the attached Site Plan for existing investigation locations attached to this report.

The following ground conditions are interpreted from the ECan logs at the Waltham Community Cottage:

Stratigraphy	Thickness (m)	Depth Encountered from (m) bgl
SAND and CLAY	1.2 – 2.4m	surface
GRAVEL	1.17 – 12.18m	1.2 – 2.4m
CLAY	1.59 – 2.5m	5.09 – 6m
SAND	7.3 – 7.61m	7.59 – 14m
CLAY and PEAT	6.1 – 6.4m	21.3 – 21.6m
Sandy GRAVEL (Riccarton Formation)	-	27.4 – 28.9m

Table 1 Interpreted Ground Conditions

The approximate locations of the boreholes relative to the Waltham Community Cottage are shown on the attached Site Plan. Refer to the attached borehole logs attached to this report.

Six CPTs were located within 330m of the site. The CPTs confirm the material beneath the Waltham area is comprised of sands, clays, silts and gravels. The CPTs also indicate layers where liquefaction is likely to occur. Three CPTs probe deeper than 2.5m below ground level (bgl), they are CPT SYD_03, CPT WTH_19 and CPT WTH_21. These three CPTs all indicate the upper 4 to 5.5m of sandy material is liquefiable, with liquefiable lenses between the depths 7 to 18.5m. CPT WTH_16, CPT WTH_17 and CPT WTH_18 all terminated on a suspected shallow gravel layer, typically at 2m bgl. Refer to the attached CPT results at the end of this report.

The Orion water table map[1] indicates the groundwater in the area is between 2 and 3m bgl. The Brown and Weeber "Geology of Christchurch Urban Area" map[2] suggest a water table within 1m bgl.

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[1] Orion, 2005, *Orion Pole Load Test Programme – Cone Penetration Tests,* conducted by Site Investigations Ltd.

2.5 Liquefaction Hazard

The 2004 ECan Solid Facts Liquefaction Study indicates the Waltham Community Cottage site is in an area designated as 'moderate liquefaction may be expected', based on low groundwater conditions. According to this study, based on a low groundwater table, ground damage is expected to be moderate and subsidence likely to be between 100mm and 300mm.

Liquefaction maps prepared by Tonkin and Taylor indicate liquefaction in close vicinity to the site in both the February 2011 and June 2011 earthquake events, with no liquefaction in the area after the September 2010 event. However, the operator of the Community Cottage noted no liquefaction on the property in any earthquake event, but liquefaction did occur in nearby properties and on the road in front of the property in the 22 February 2011 earthquake. Refer to the Site Walkover Plan attached to this report.

2.6 Ground Damage

A walkover inspection of the exterior of the building and internal ground floor was carried out by Danielle Belcher, Opus Engineering Geologist on 23 January 2012. Minor ground damage was observed. Refer to the attached Site Walkover Plan showing all ground observations.

A minor crack (<2mm) was evident in the asphalt that leads from the footpath to the concrete driveway on the property, resulting in minor heave of approximately 10mm. Refer to Photo 4. The crack is likely to be a result of the asphalt and concrete slab pounding against each other during earthquake shaking.

An open crack (20mm) is identified on the attached Site Walkover Plan between a concreted area of the cottage and the south-eastern wall. Upon close inspection it is unlikely that this damage was due to earthquake shaking and may have existed since construction of the ramp. The timber panels of the wall do not appear to be damaged. Refer to Photo 5.

Minor cracking is evident in the concrete foundation of the cottage. Refer to Photos 6, 7 and 8. Three vertical cracks were identified in the perimeter foundation. No vertical displacement was observed during the inspection that would indicate differential settlement.

There was no evidence of lateral spreading at the Waltham Community Cottage site.

3.0 Appraisal

ECan borehole logs and some CPT results indicate the presence of a shallow gravel layer from 2m bgl. However, the presence of the shallow gravels does not appear to be consistent across the area. CPT WTM_21 140m south-west and CPT WTM_19 165m north-east of the site indicate liquefiable layers from 2m to 8m bgl.

The magnitude of seismically induced settlement which has occurred on site is minor (<5mm) and is not considered to have caused damage to the building. Buildings are typically designed to allow for up to 50mm of land settlement in a serviceability limit state (SLS) event, or up to 100mm in an ultimate limit state event (ULS).

The building is likely to be founded on shallow perimeter strip footings, of an unknown size to an unknown depth. The existing foundations have performed satisfactorily and do not appear to have sustained damage. The existing foundations are considered appropriate for the building, however it must be noted that minor settlement, similar to what has already occurred, may occur in future seismic events.

The land at Waltham Community Cottage, Hastings Street East, has performed well in the Darfield and Canterbury earthquakes and their associated aftershocks. We would expect that similar liquefaction and ground damage could occur in a future earthquake. GNS Science indicates an elevated risk of seismic activity is expected in the Canterbury region as a result of the earthquakes. Recent advice[3] indicates an 18% probability of another Magnitude 6 or greater earthquake over the next 12 months in the Canterbury region. Liquefaction of a similar order of magnitude is possible in such an event, dependent on the location of the epicentre.

The Waltham Community Cottage is located in the CERA "green" zone. The "green" zone has been further categorised into technical categories by the Department of Building and Housing (DBH), this site has been identified as "Technical Category 3" (TC3) released in October 2011. The DBH technical categories are guidelines for residential foundations, however are likely to be used as a guideline by Christchurch City Council for building consent. TC3 identifies the area may be subject to moderate to significant land damage from liquefaction in future large earthquakes and site specific geotechnical investigations.

4.0 Recommendations

- No evidence of differential settlement has been observed on site at Waltham Community Cottage;
- Based on the building performance in recent earthquakes, the existing foundations are deemed suitable in terms of future ULS and SLS loadings, although CCC may have to accept the risk for potential differential settlement of up to 50mm;
- No further site investigations are recommended for the Waltham Community Cottage at this stage.

Prepared By:	Reviewed By:
Danielle Belcher Engineer Geologist	Graham Brown Senior Geotechnical Engineer

<u>Attachments:</u>

Site Plan
ECan Borehole Logs
CPT Logs
Site Walkover Plan

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[3] GNS Science reporting on Geonet Website, updated 3 February 2011.

Photos of the Waltham Community Cottage taken 23 January 2012.

Photo 1: View of Waltham Community Cottage from Hastings Street East.

Photo 2: View of Waltham Community Cottage from Hastings Street East with Toy Library located at the end of the driveway.

Photo 3: Toy Library located at the rear of the property.

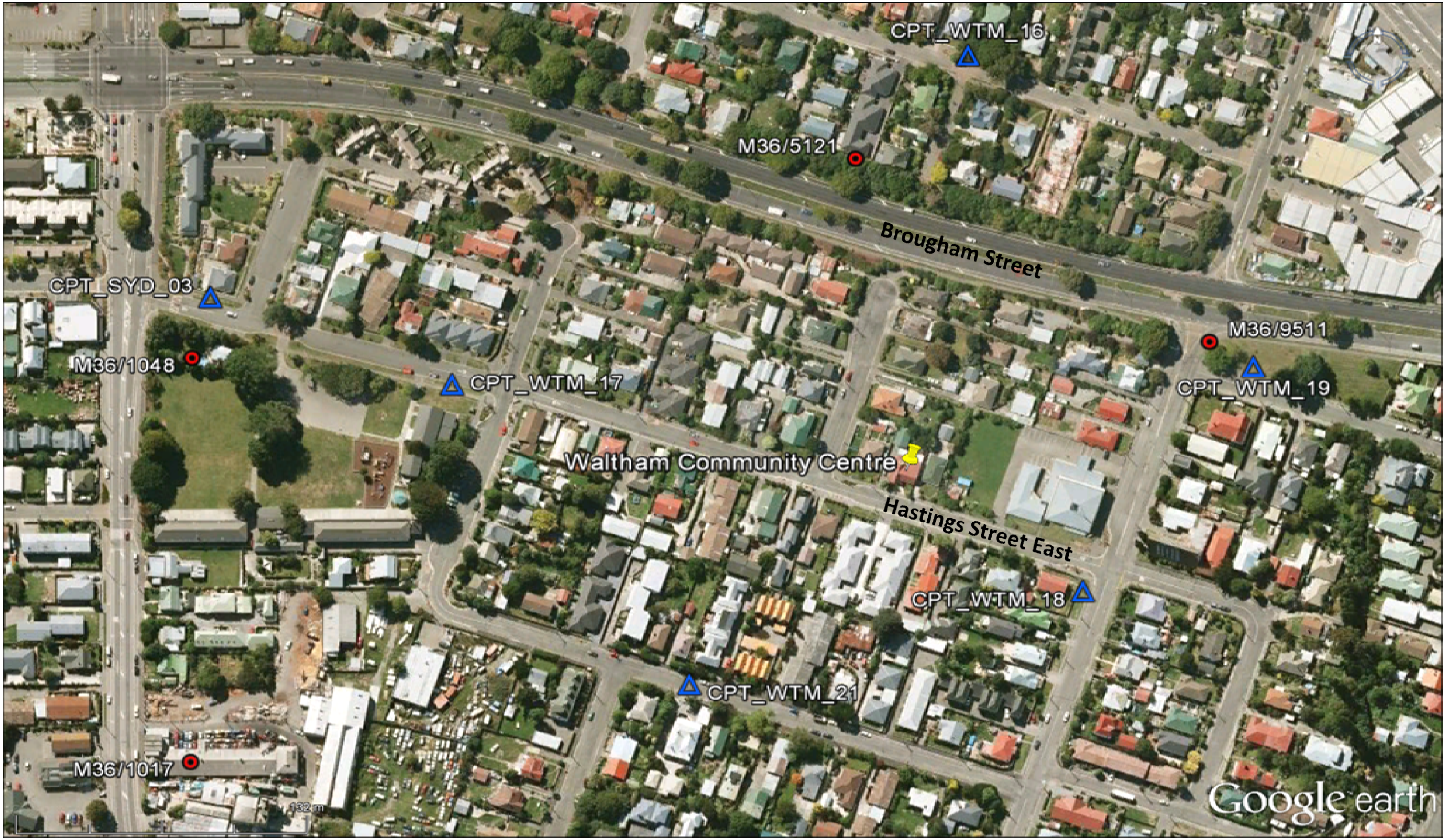
Photo 4: Crack (2mm) in asphalt in driveway resulting in minor heave (10mm).

Photo 5: Crack between south-west wall and concrete path (prior earthquake?).

Photo 6: Crack in foundation, north-west side.

Photo 7: Crack in foundation, north-west side.

Photo 8: Crack in foundation, north-west side.



Key: Blue: CPTs
Red: Boreholes
Yellow: Site Location

OPUS

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20 Moorhouse Ave
PO Box 1482
Christchurch, New Zealand
Tel: +64 3 363 5400 Fax: +64 3 365 7857

Project:	Waltham Community Cottage Geotechnical Desk Study
Project No.:	6-QUCCC.58/005SC
Client:	Christchurch City Council

Site Plan

Drawn:	Danielle Belcher Engineering Geologist
Date:	26-Jan-12

Borelog for well M36/1017

Gridref: M36:815-396 Accuracy : 4 (1=best, 4=worst)
Ground Level Altitude : 7.6 +MSD
Driller : Job Osborne (& Co/Ltd)
Drill Method : Cable Tool
Drill Depth : -32.9m Drill Date : 19/10/1942

Environment Canterbury
Your regional council

Water Level: -1.4CalcMin

Depth(m)	Full Drillers Description	Formation Code
-2.40m	Sand & clay	sp
-4.19m	Brown shingle	sp
-5.09m	Blue shingle	sp
-7.59m	Blue clay & timber	sp
- 14.9m	Blue sand	ch
- 21.6m	Blue sand & gravel	ch
- 28.0m	Blue clay & peat	ch
- 28.3m	Blue shingle	ri
- 32.9m	Brown shingle	ri

Borelog for well M36/1048 page 1 of 2

Gridref: M36:815-398 Accuracy : 4 (1=best, 4=worst)
Ground Level Altitude : 6.3 +MSD
Driller : not known
Drill Method : Unknown
Drill Depth : -99.3m Drill Date :

Water Level	Depth(m)	Full Drillers Description	Formation Code
Artesian	-1.20m	Surface soil & sand	sp
	-6.00m	Blue shingle	sp
	-7.59m	Blue clay	sp
	- 15.2m	Blue sand	ch
	- 21.3m	Blue shingle	sp
	- 27.4m	Blue clay	ch
	- 39.6m	Brown shingle	ri
	- 40.8m	Blue clay & peat	br
	- 42.0m	Brown shingle	br
	- 49.9m	Brown sand	br

Borelog for well M36/1048 page 2 of 2

Environment Canterbury
Your regional council

Gridref: M36:815-398 Accuracy : 4 (1=best, 4=worst)
Ground Level Altitude : 6.3 +MSD
Driller : not known
Drill Method : Unknown
Drill Depth : -99.3m Drill Date :

Water Level	Depth(m)	Full Drillers Description	Formation Code
Artesian	49.9m	Brown sand	br
	- 51.8m	Blue sand	br
	- 53.6m	Blue sand & clay	br
	- 56.6m	Blue clay	br
	- 70.1m	Brown shingle	li
	- 76.2m	Blue clay	li-2
	- 84.7m	Brown shingle	li-3
	- 86.2m	Brown sand	he
	- 89.0m	Brown shingle	he
	- 89.9m	Brown sand	he
	- 92.3m	Brown shingle water rises 1.8m	he
	- 95.0m	Yellow clay	he
	- 99.3m	Brown shingle water rises 6.0m	bu

Scale(m): -50, -55, -60, -65, -70, -75, -80, -85, -90, -95

Borelog for well M36/5121

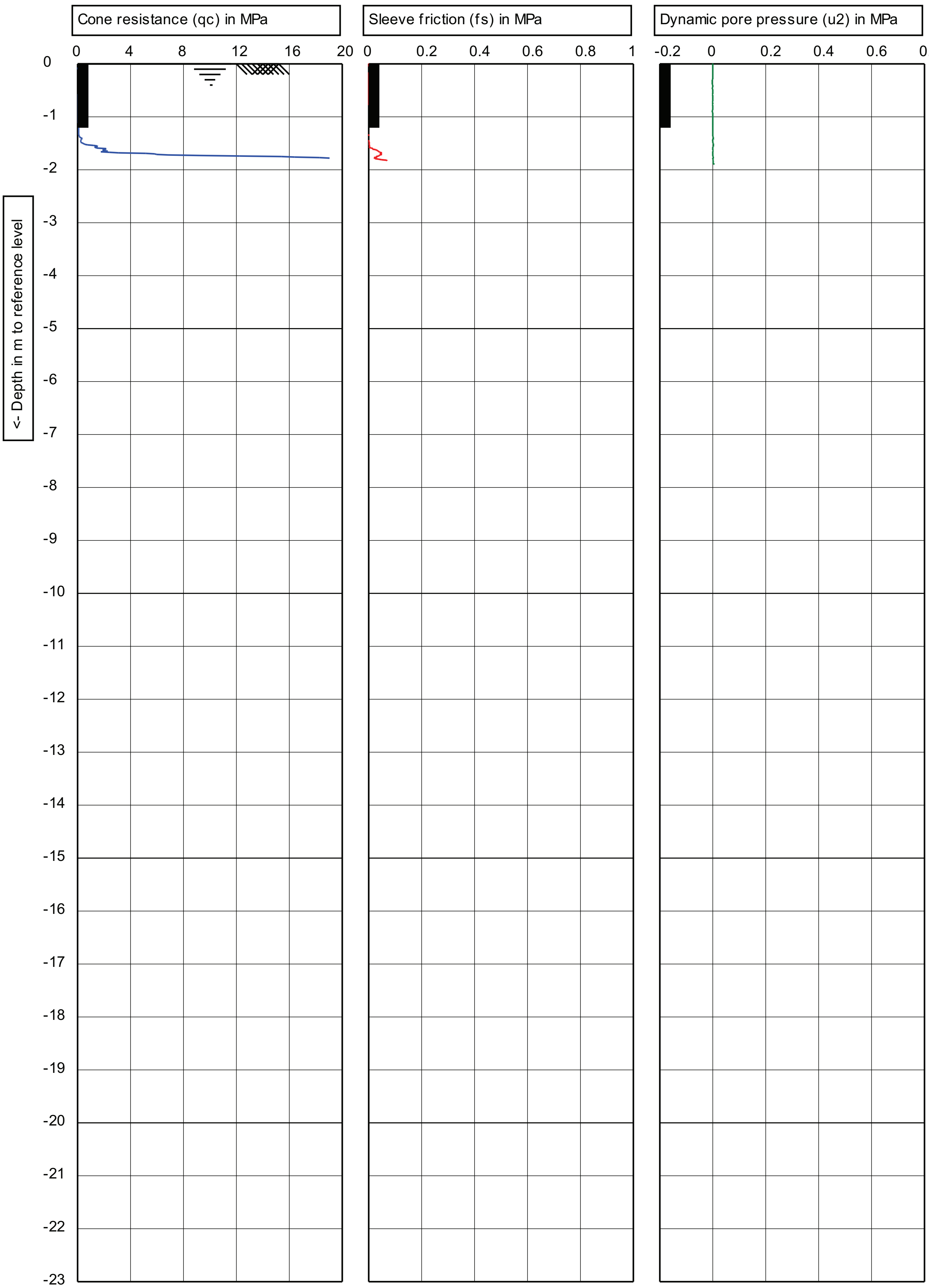
Gridref: M36:818-399 Accuracy : 4 (1=best, 4=worst)
Ground Level Altitude : 6.2 +MSD
Driller : Job Osborne (& Co/Ltd)
Drill Method : Hydraulic/Percussion
Drill Depth : -104.5m Drill Date : 21/10/1890

Water Level	Depth(m)	Full Drillers Description	Formation Code
Artesian	-1.82m	Surface soil and sand	sp?
	-14.0m	Blue gravel	sp?
	-21.3m	Blue sand	ch
	-27.4m	Blue clay	ch
	-38.7m	Blue gravel and sand- 1st strata water rise within 1.5m of surface	ri
	-39.3m	Peat and clay	br
	-40.2m	Brown gravel- water rise within 0.6m of surface	br
	-43.0m	Blue sand	br
	-50.9m	Brown sand	br
	-57.3m	Yellow clay	br
	-67.7m	Brown sand- 3rd strata water within 0.3m of surface	li
	-69.5m	Yellow clay	li
	-80.8m	Brown gravel and sand	li
	-98.1m	Yellow quick sand	he
	-103.6m	Yellow clay	he
	-104.5m	Brown gravel- got water to rise 6.7m at a flow of 24 gals	bu

Borelog for well M36/9511

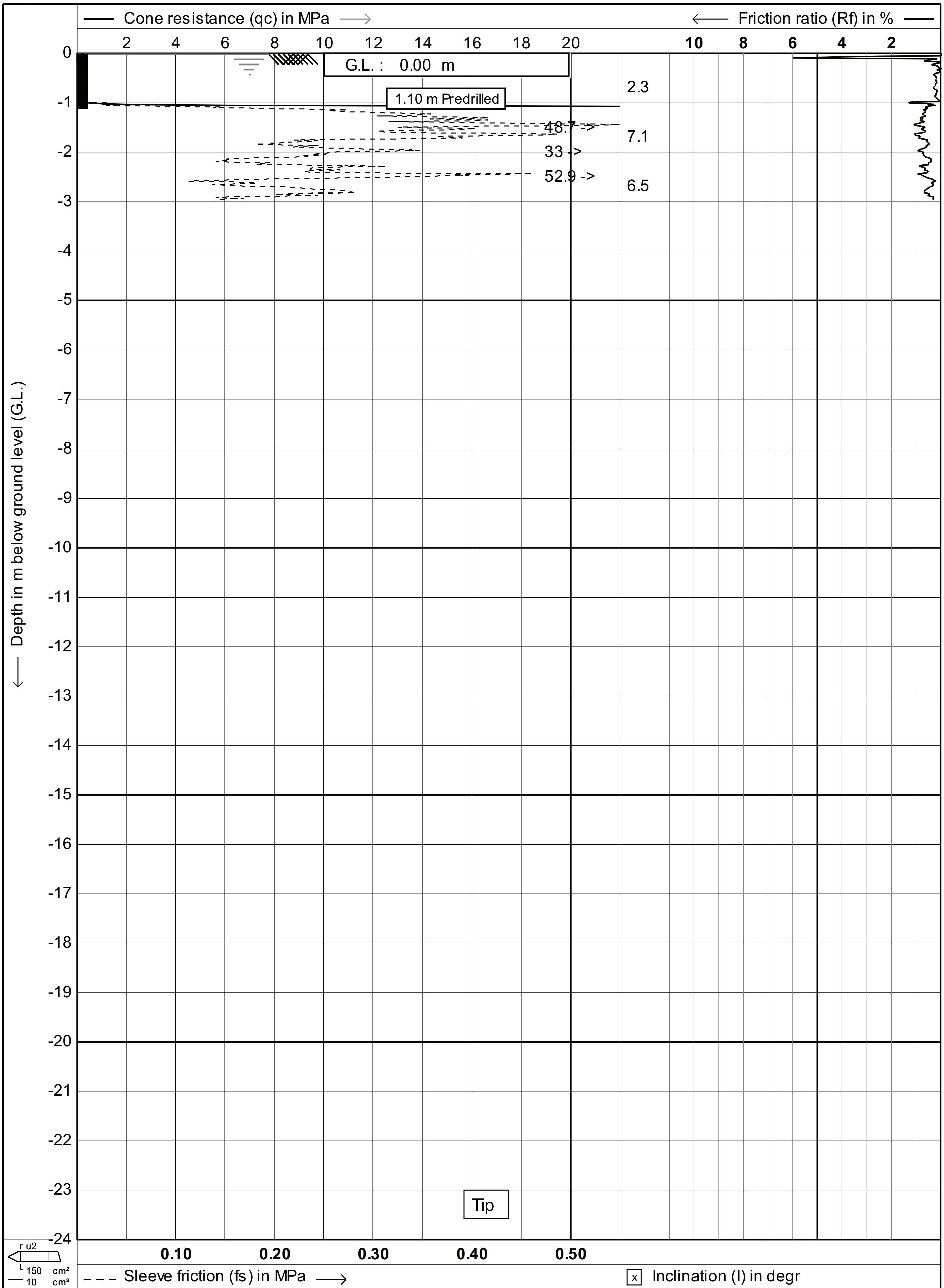
Gridref: M36:82138-39789 Accuracy : 3 (1=high, 5=low)
Ground Level Altitude : 5.8 +MSD
Well name   : CCC BorelogID 3530
Drill Method : Not Recorded
Drill Depth   : -2.39m   Drill Date :

Scale(m)	Water Level	Depth(m)	Full Drillers Description	Formation Code
		-1.22m	yellow sand and clay	
		-2.39m	gravel	



OPUS
HAMILTON LABORATORY

u2 150 cm² 10 cm²	Test according to A.S.T.M standard D-5778-07		Predrill :	1.2
	G.L. **0**	W.L.: **0**	Date:	**20/10/2011**
Project:	**Geotechnical Investigation**		Cone no.:	**C10CFIIP.C10204**
Location:	**GPS: E2481619 N5739795**		Project no.:	**2-68292.11**
Position:			CPT no.:	**CPT-WTM-17** 1/6



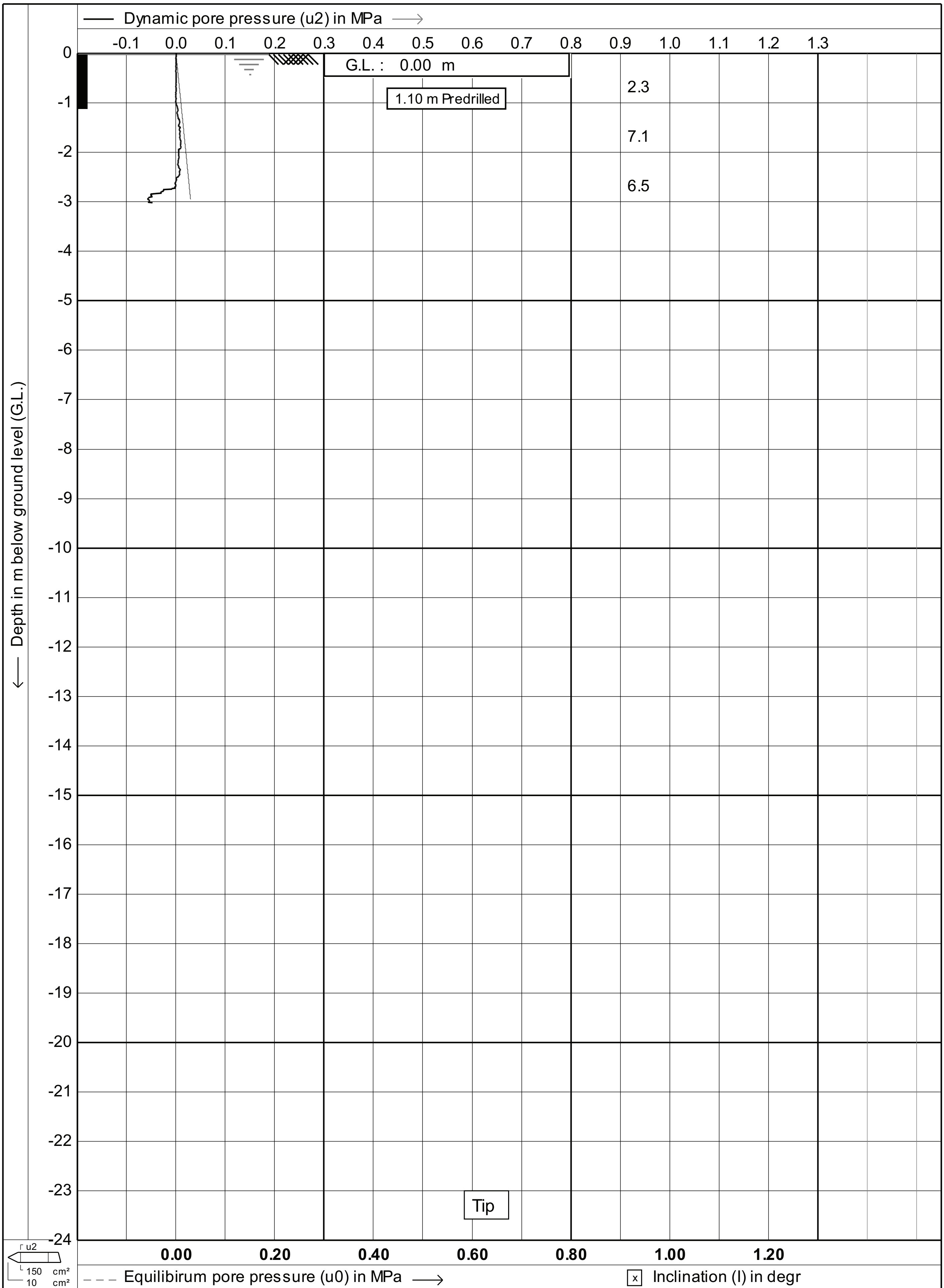
Test according A.S.T.M. Standard D 5778-07

Project : **Site Investigations**

Location: **Waltham - Christchurch City**

Date	: **17-10-2011**
Cone no.	: **C10CFIIP.E59**
Project no.	: **01TT31**
CPT no.	: **WTM-18** **1/14**

CPTask V1.31



CPTask V1.31

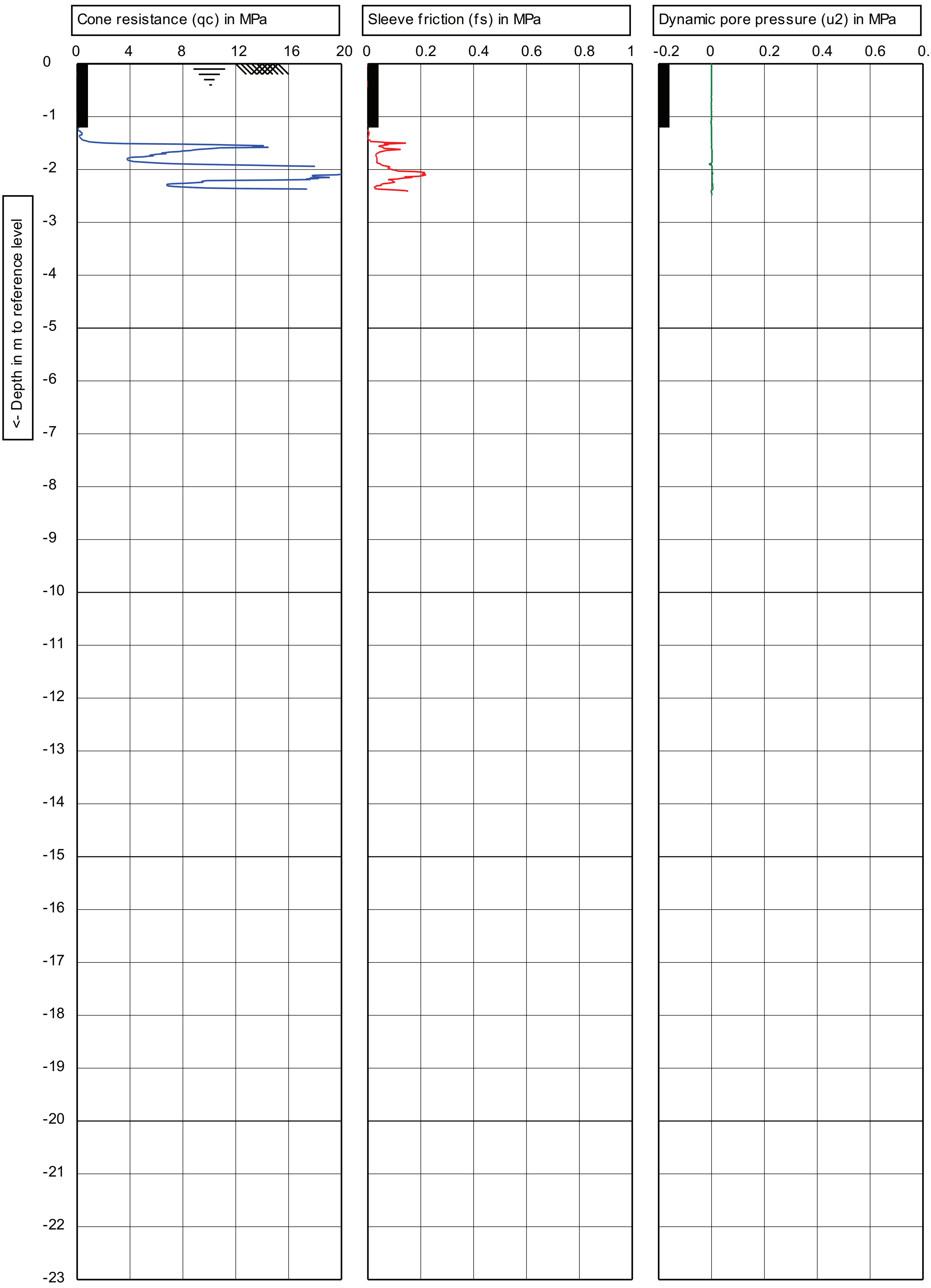
Test according A.S.T.M. Standard D 5778-07

Project : **Site Investigations**

Location: **Waltham - Christchurch City**

Date	: **17-10-2011**
Cone no.	: **C10CFIIP.E59**
Project no. :	**01TT31**
CPT no.	: **WTM-18**

2/14



OPUS
HAMILTON LABORATORY

u2
150 cm²
10 cm²

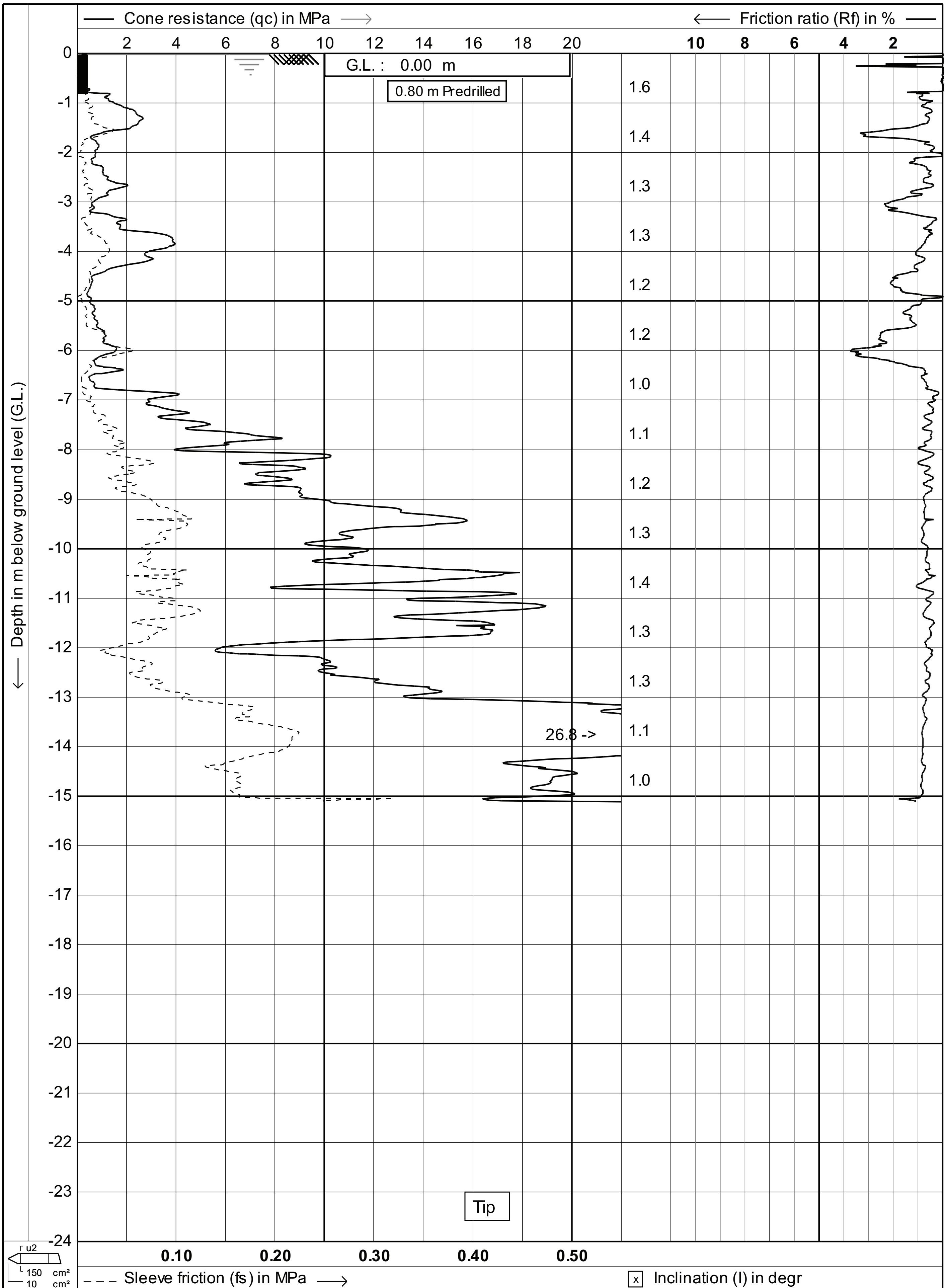
Test according to A.S.T.M standard D-5778-07

G.L. **0** W.L.: **0**

Project: **Geotechnical Investigation**
Location: **GPS:E2481847 N5739952**
Position:

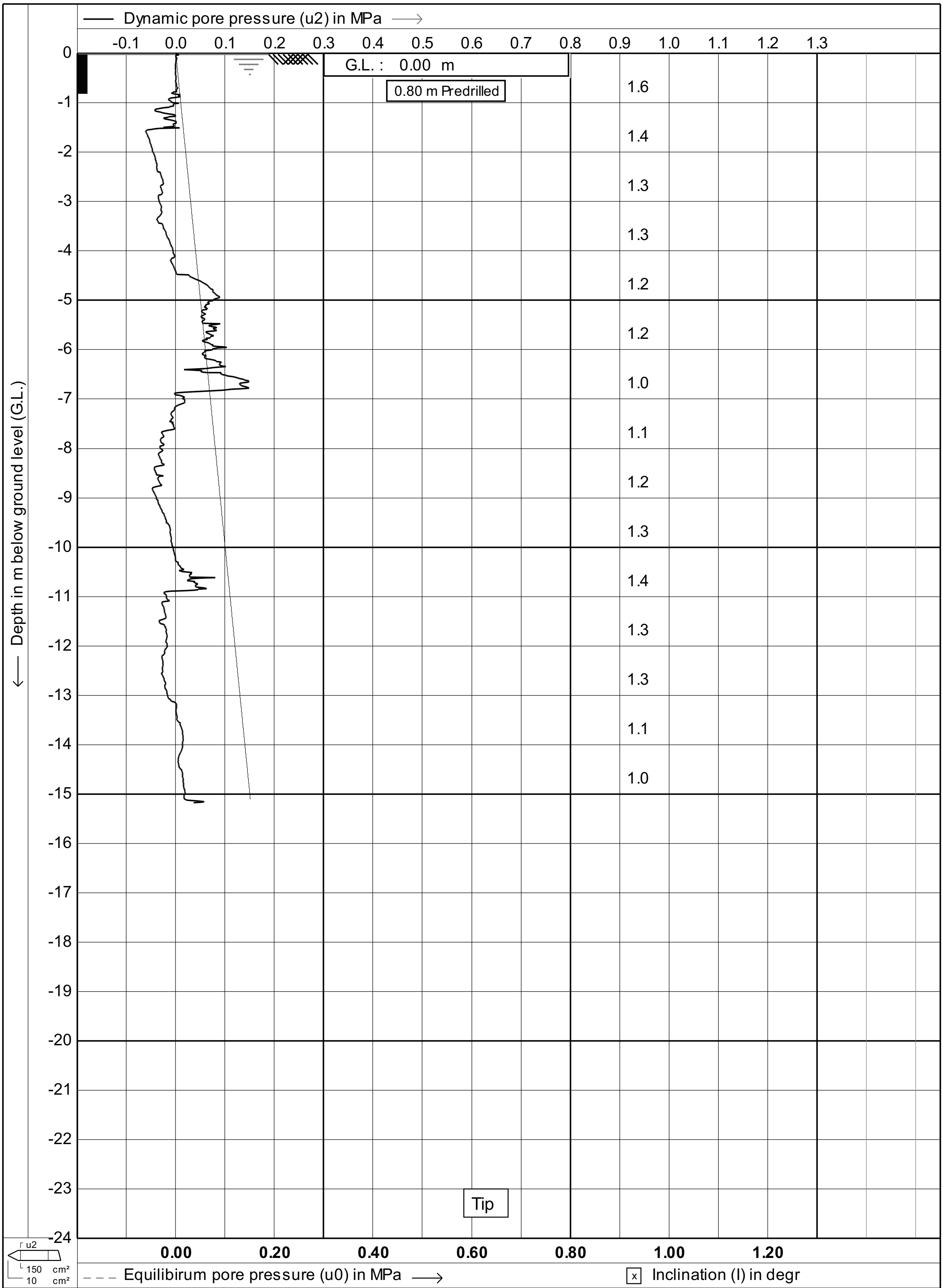
Predrill :	**1.2**
Date:	**20/10/2011**
Cone no.:	**C10CFIIP.C10204**
Project no.:	**2-68292.11**
CPT no.:	**CPT-WTM-16** 1/6

CPTask V1.20



CPTask V1.25

Perry Drilling / Geo Probe — Ground Drilling and Environmental Specialists	Test according A.S.T.M. Standard D 5778-07	Date	: **6-5-2011**
	Project : **Site Investigations**	Cone no.	: **C10CFIIP.F14**
		Project no.	: **01TT10**
	Location: **Sydenham - Christchurch City**	CPT no.	: **SYD-03** **1/14**

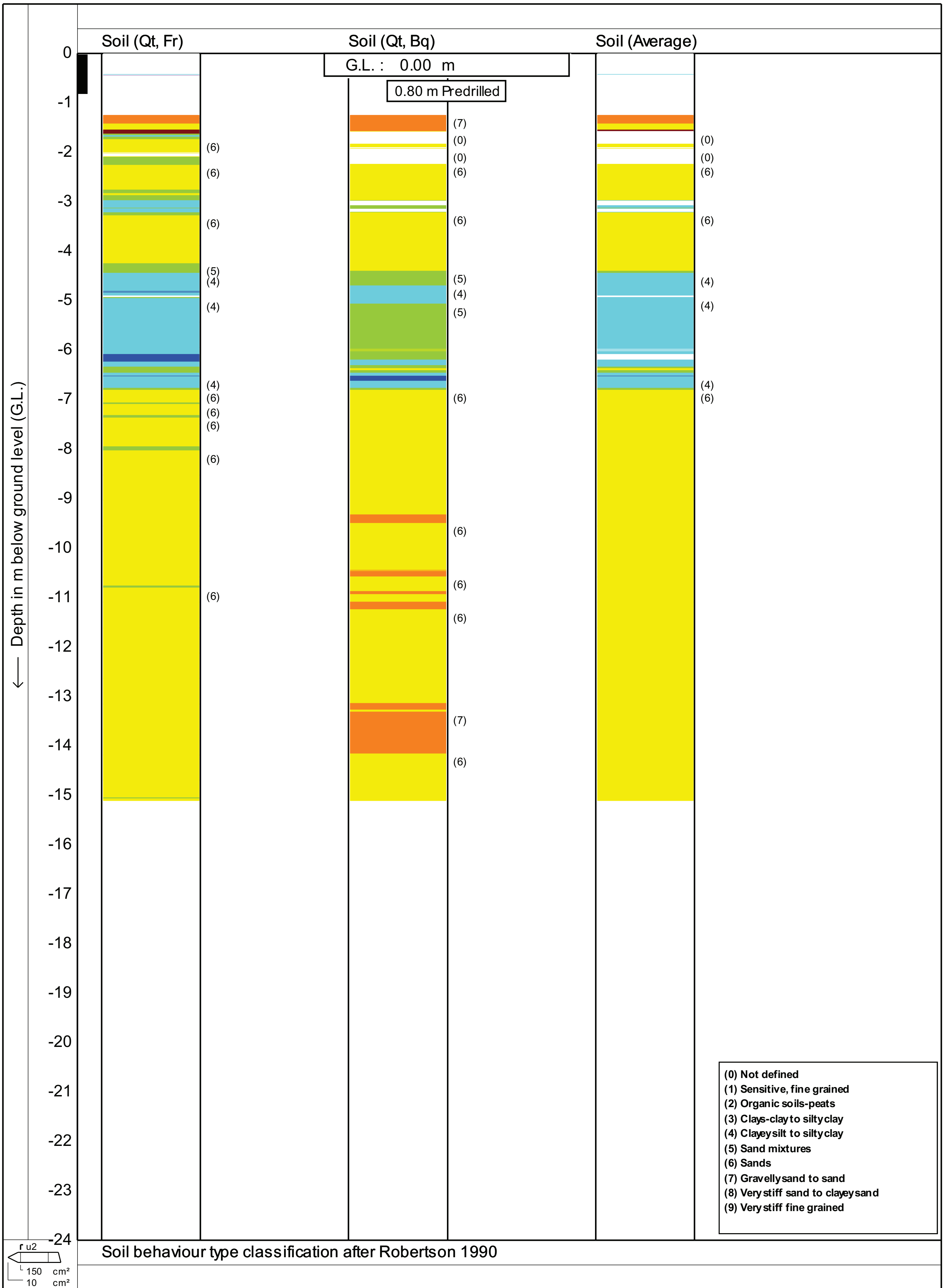


CPTask V1.25

Perry Drilling – Geo Probe – Ground Drilling and Environmental Specialists

Test according A.S.T.M. Standard D 5778-07

Project :	**Site Investigations**
Location:	**Sydenham - Christchurch City**
Date	: **6-5-2011**
Cone no.	: **C10CFIIP.F14**
Project no.	: **01TT10**
CPT no.	: **SYD-03** — **2/14**



Soil behaviour type classification after Robertson 1990

CPTask V1.25

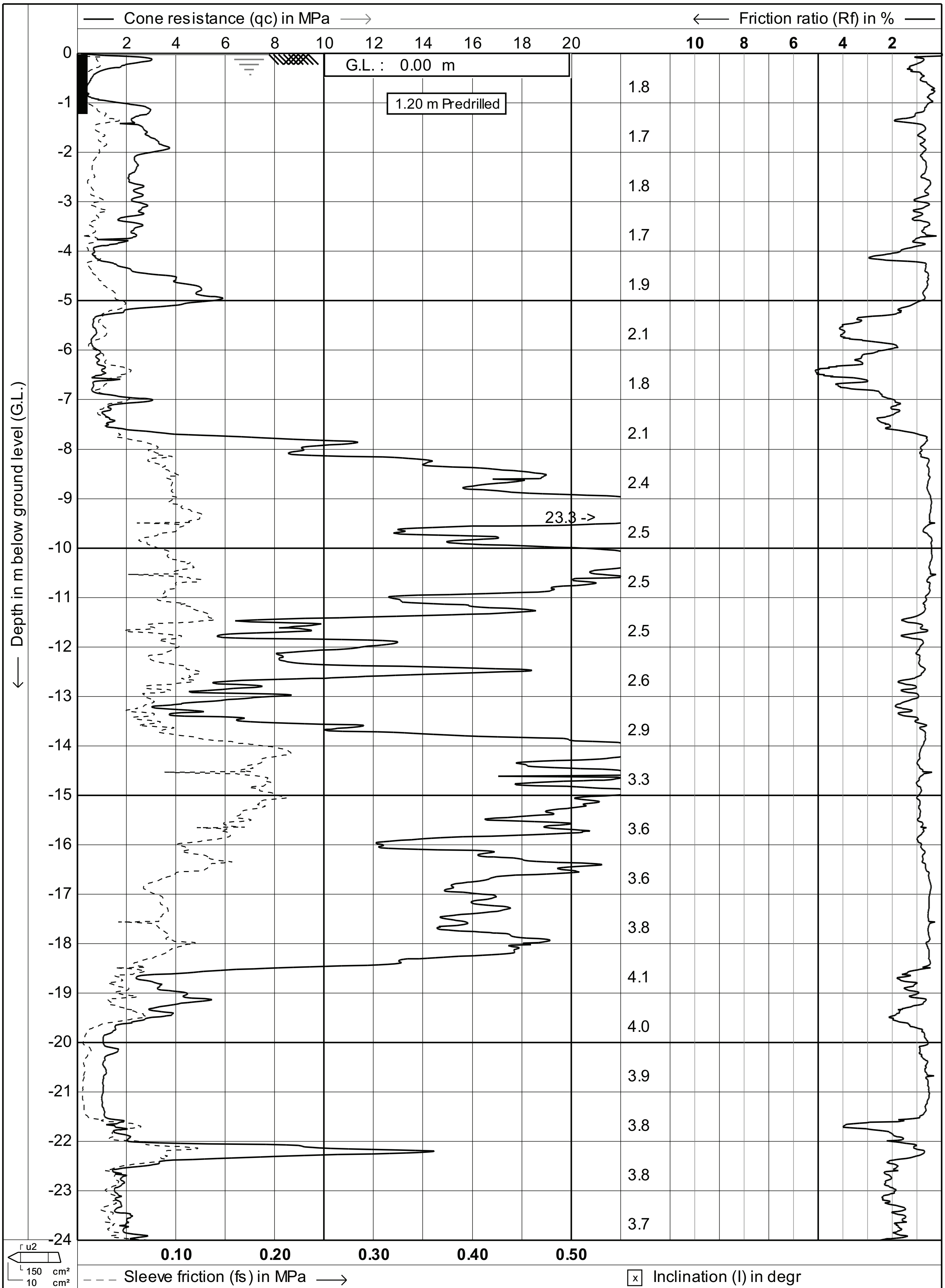
Perry Drilling — GEO PROBE — Ground Drilling and Environmental Specialists

Test according A.S.T.M. Standard D 5778-07

Project : **Site Investigations**

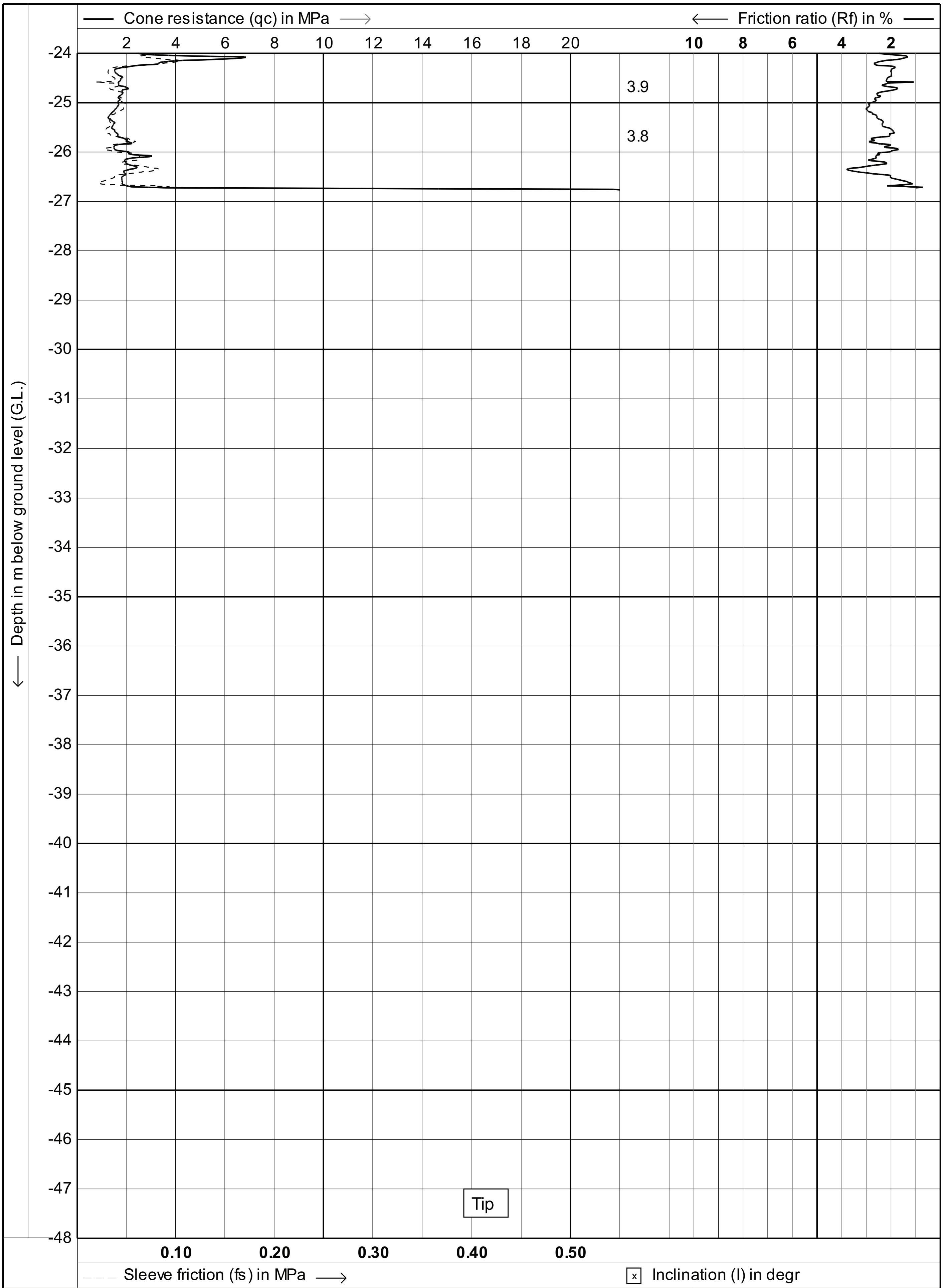
Location: **Sydenham - Christchurch City**

Date	: **6-5-2011**
Cone no.	: **C10CFIIP.F14**
Project no. :	**01TT10**
CPT no.	: **SYD-03**



Test according A.S.T.M. Standard D 5778-07		Date	: **23-6-2011**
Project :	**Site Investigations**	Cone no.	: **C10CFIIP.**
		Project no.	: **01TT31**
Location:	**Waltham - Christchurch City**	CPT no.	: **WTM-21** **1/28**

CPTask V1.25



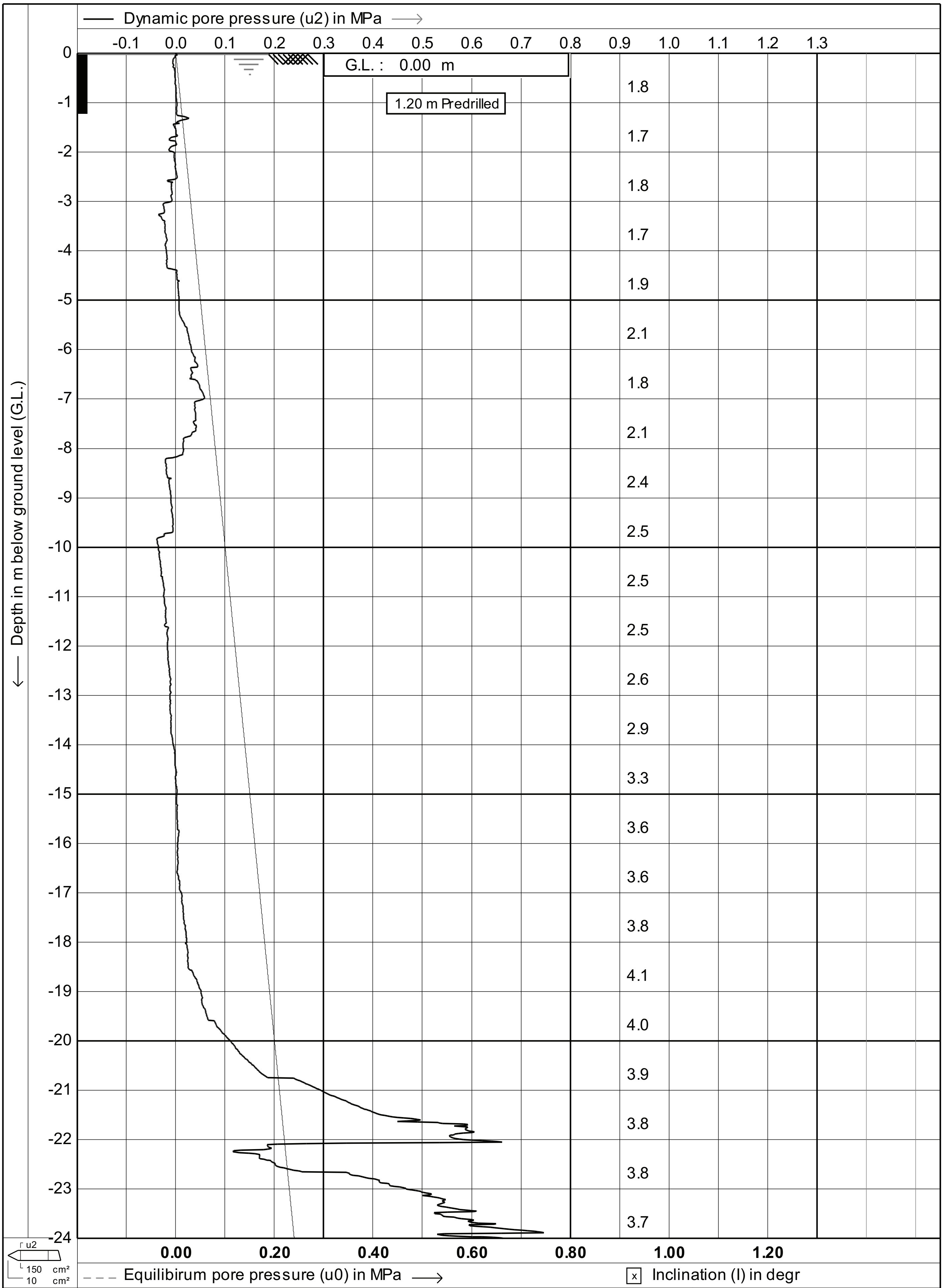
CPTask V1.25

Perry Drilling — Geo Probe — Ground Drilling and Environmental Specialists

Test according A.S.T.M. Standard D 5778-07

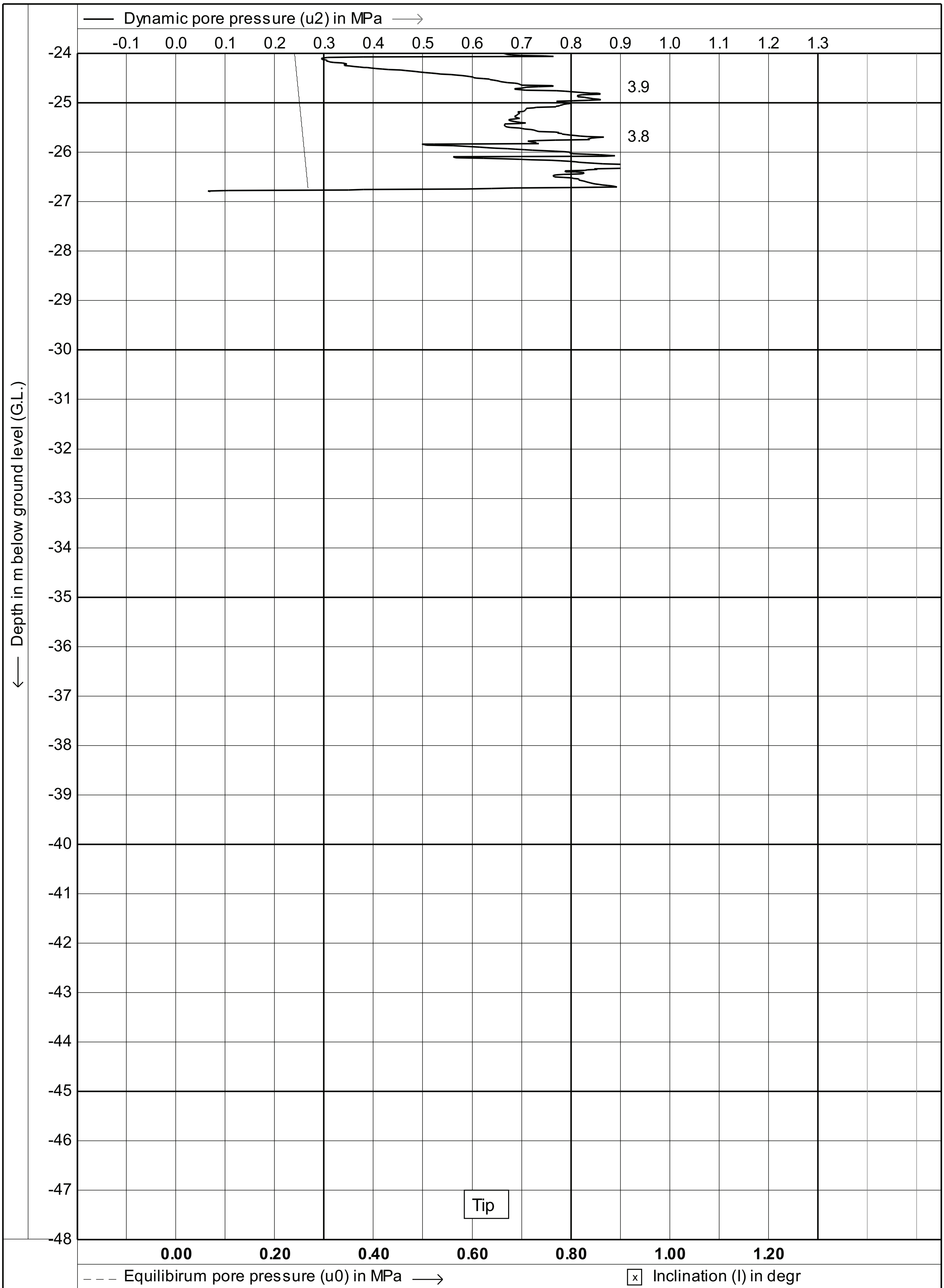
Project :	**Site Investigations**
Location:	**Waltham - Christchurch City**

Date	: **23-6-2011**	
Cone no.	: **C10CFIIP.**	
Project no. :	**01TT31**	
CPT no.	: **WTM-21**	**2/28**



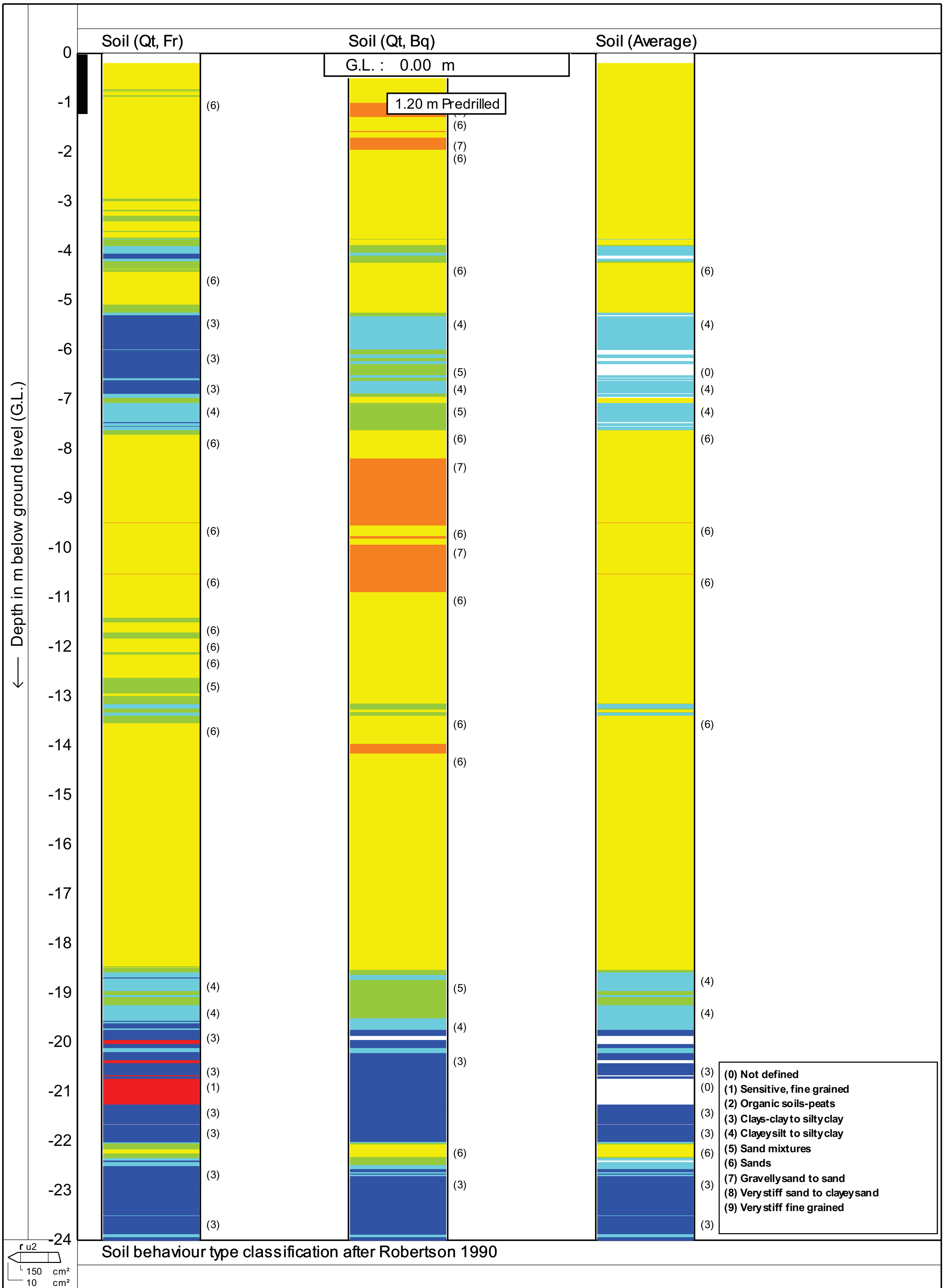
Perry Drilling / Geo Probe – Ground Drilling and Environmental Specialists	Test according A.S.T.M. Standard D 5778-07	Date : **23-6-2011**
		Cone no. : **C10CFIIP.**
	Project : **Site Investigations**	Project no. : **01TT31**
	Location: **Waltham - Christchurch City**	CPT no. : **WTM-21** — **3/28**

CPTask V1.25



CPTask V1.25

Perry Drilling / Geo Probe — Ground Drilling and Environmental Specialists	Test according A.S.T.M. Standard D 5778-07	Date : **23-6-2011**
	Project : **Site Investigations**	Cone no. : **C10CFIIP.**
		Project no. : **01TT31**
	Location: **Waltham - Christchurch City**	CPT no. : **WTM-21** **4/28**



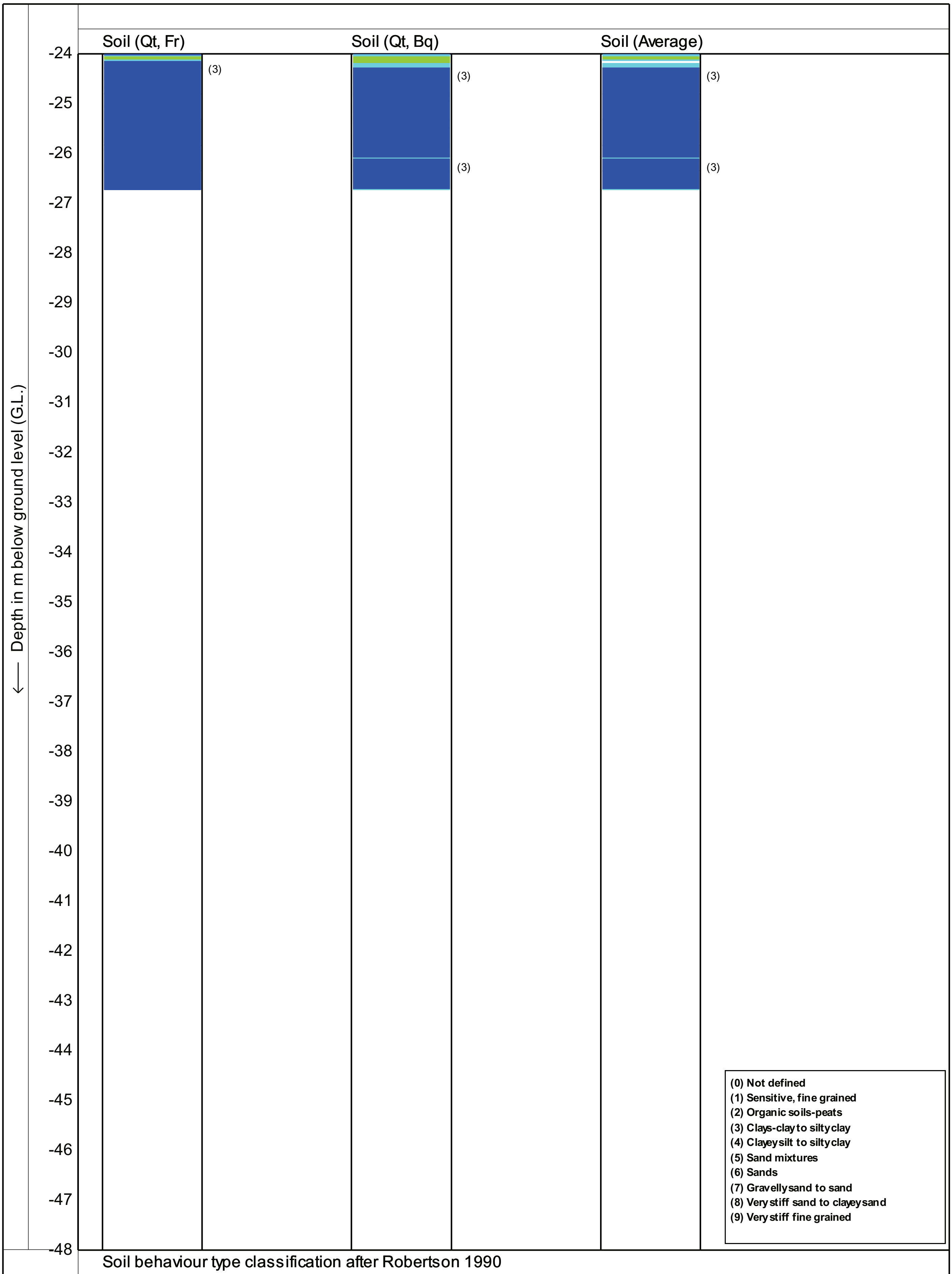
Test according A.S.T.M. Standard D 5778-07

Project : **Site Investigations**

Location: **Waltham - Christchurch City**

Date	: **23-6-2011**
Cone no.	: **C10CFIIP.**
Project no.	: **01TT31**
CPT no.	: **WTM-21**

CPTask V1.25



Soil behaviour type classification after Robertson 1990

CPTask V1.25

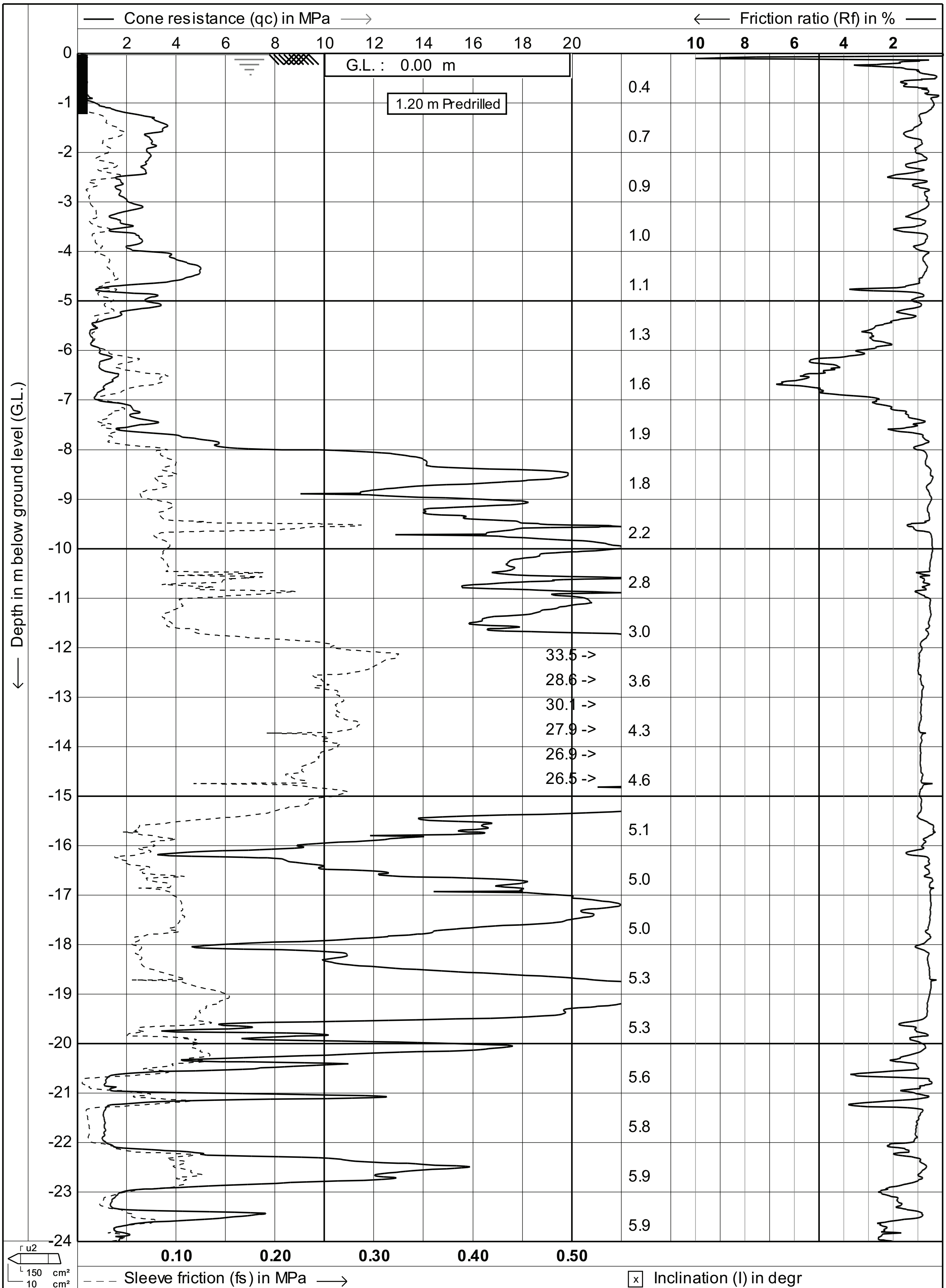
Perry Drilling - GEO PROBE - Ground Drilling and Environmental Specialists

Test according A.S.T.M. Standard D 5778-07

Project : **Site Investigations**

Location: **Waltham - Christchurch City**

Date	: **23-6-2011**
Cone no.	: **C10CFIIP.**
Project no.	: **01TT31**
CPT no.	: **WTM-21**



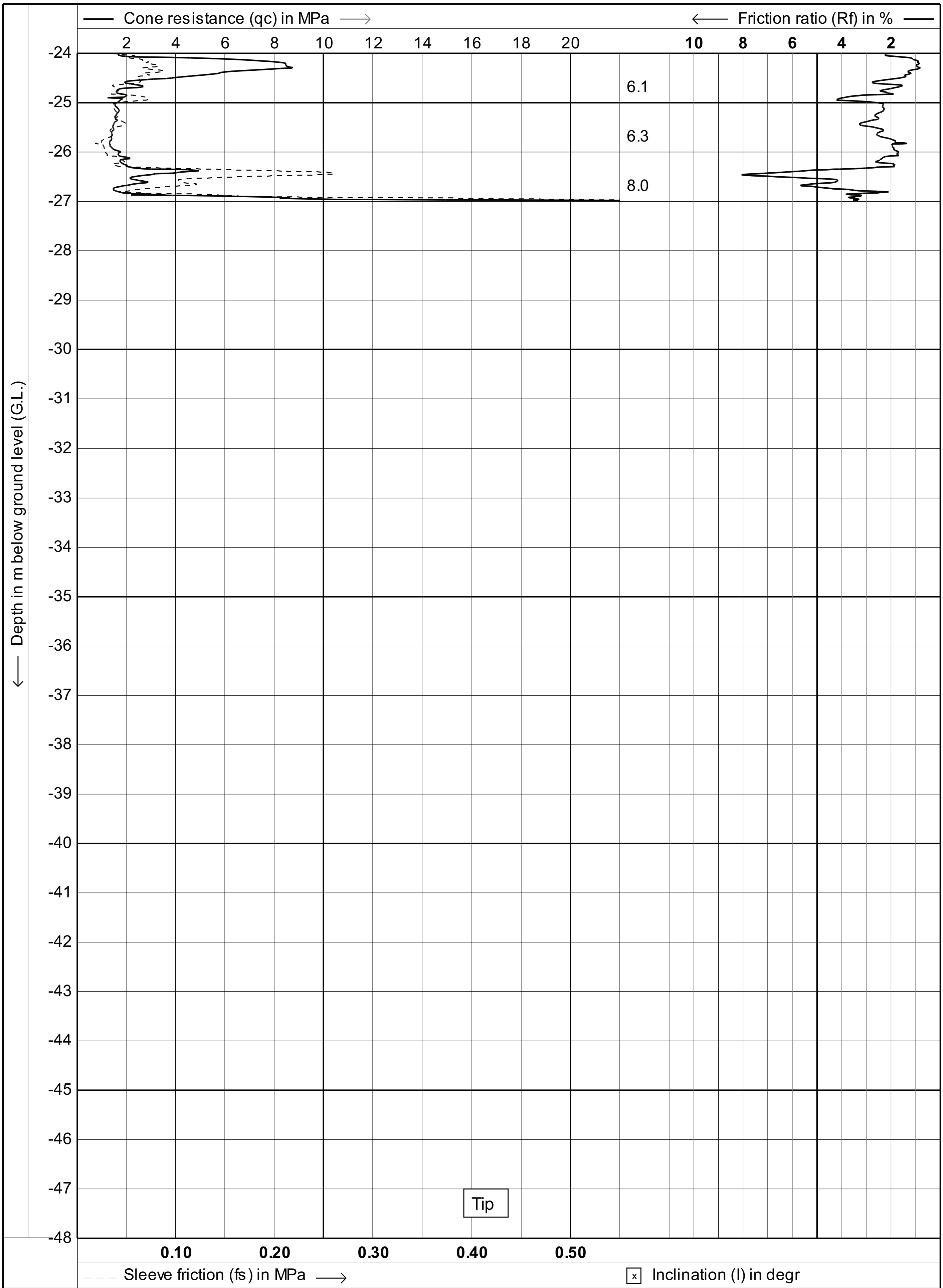
Test according A.S.T.M. Standard D 5778-07

Project : **Site Investigations**

Location: **Waltham - Christchurch City**

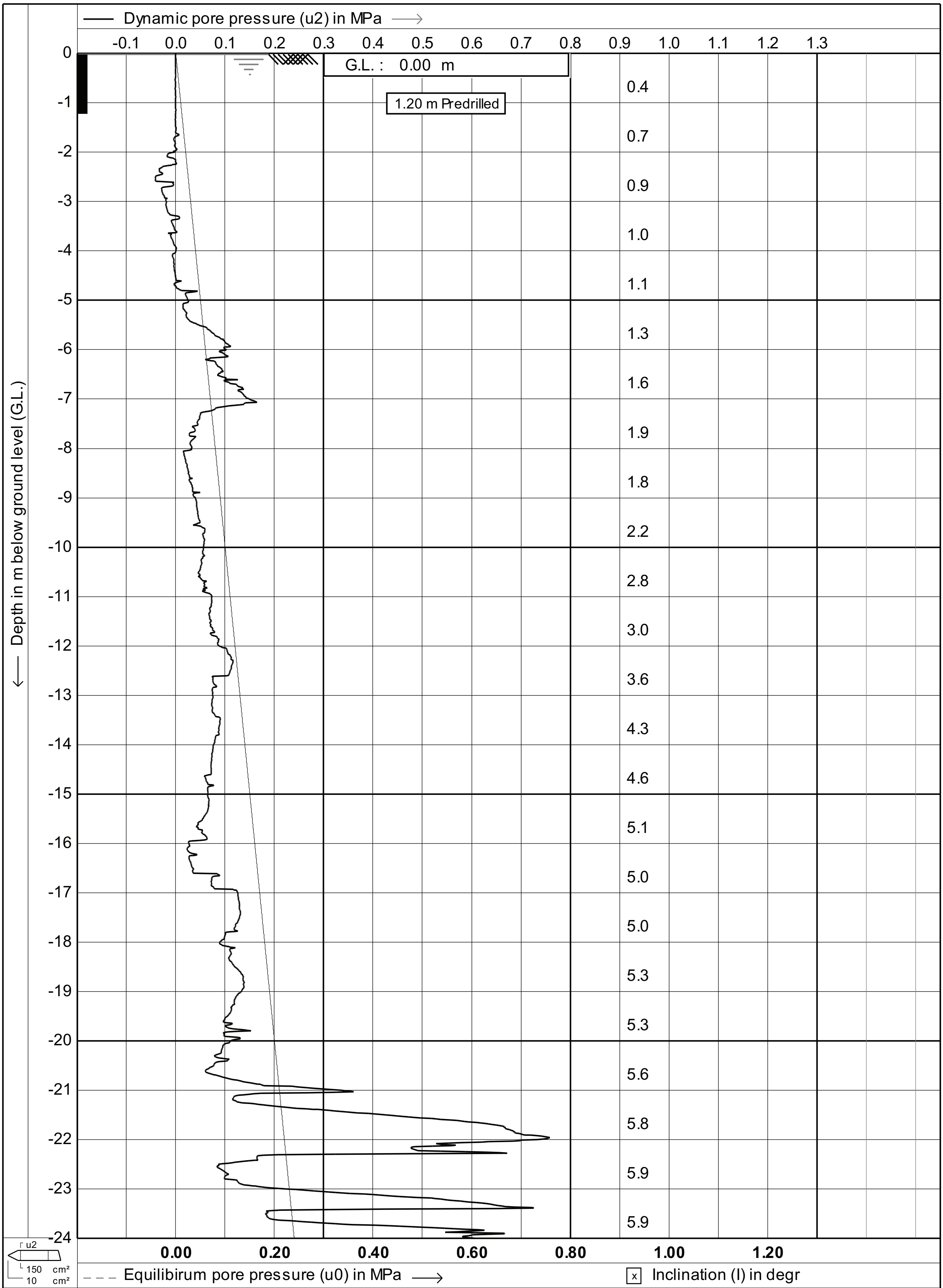
Date	: **23-6-2011**
Cone no.	: **C10CFIIP.**
Project no.	: **01TT31**
CPT no.	: **WTM-19** **1/28**

CPTask V1.25



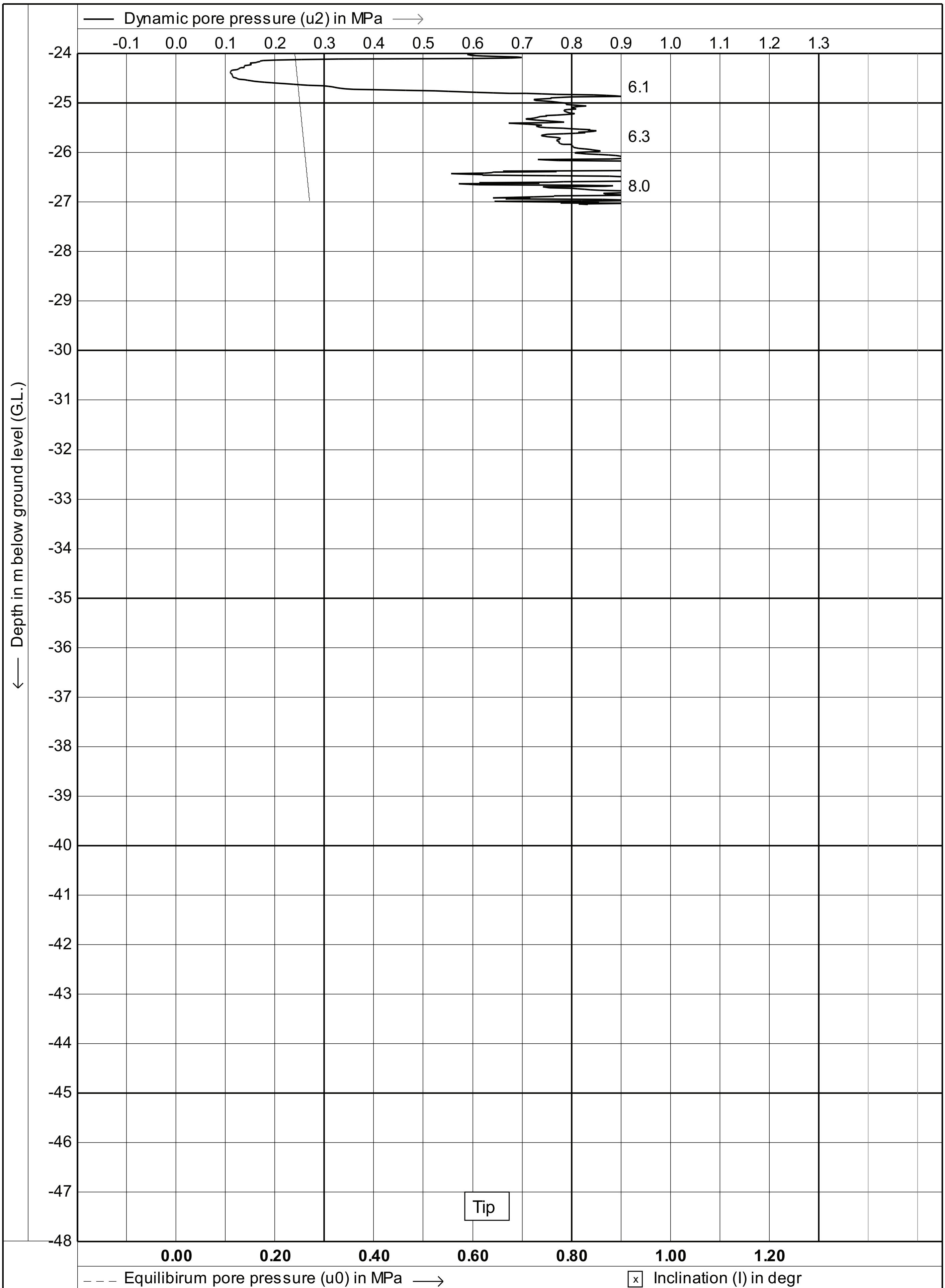
CPTask V1.25

Test according A.S.T.M. Standard D 5778-07	Date	: **23-6-2011**
Project : **Site Investigations**	Cone no.	: **C10CFIIP.**
	Project no.	: **01TT31**
Location: **Waltham - Christchurch City**	CPT no.	: **WTM-19** **2/28**



Perry Drilling / Geo Probe — Ground Drilling and Environmental Specialists	Test according A.S.T.M. Standard D 5778-07	Date : **23-6-2011**	
	Project : **Site Investigations**	Cone no. : **C10CFIIP.**	
		Project no. : **01TT31**	
	Location: **Waltham - Christchurch City**	CPT no. : **WTM-19**	**3/28**

CPTask V1.25



CPTask V1.25

Perry Drilling — Geo Probe — Ground Drilling and Environmental Specialists

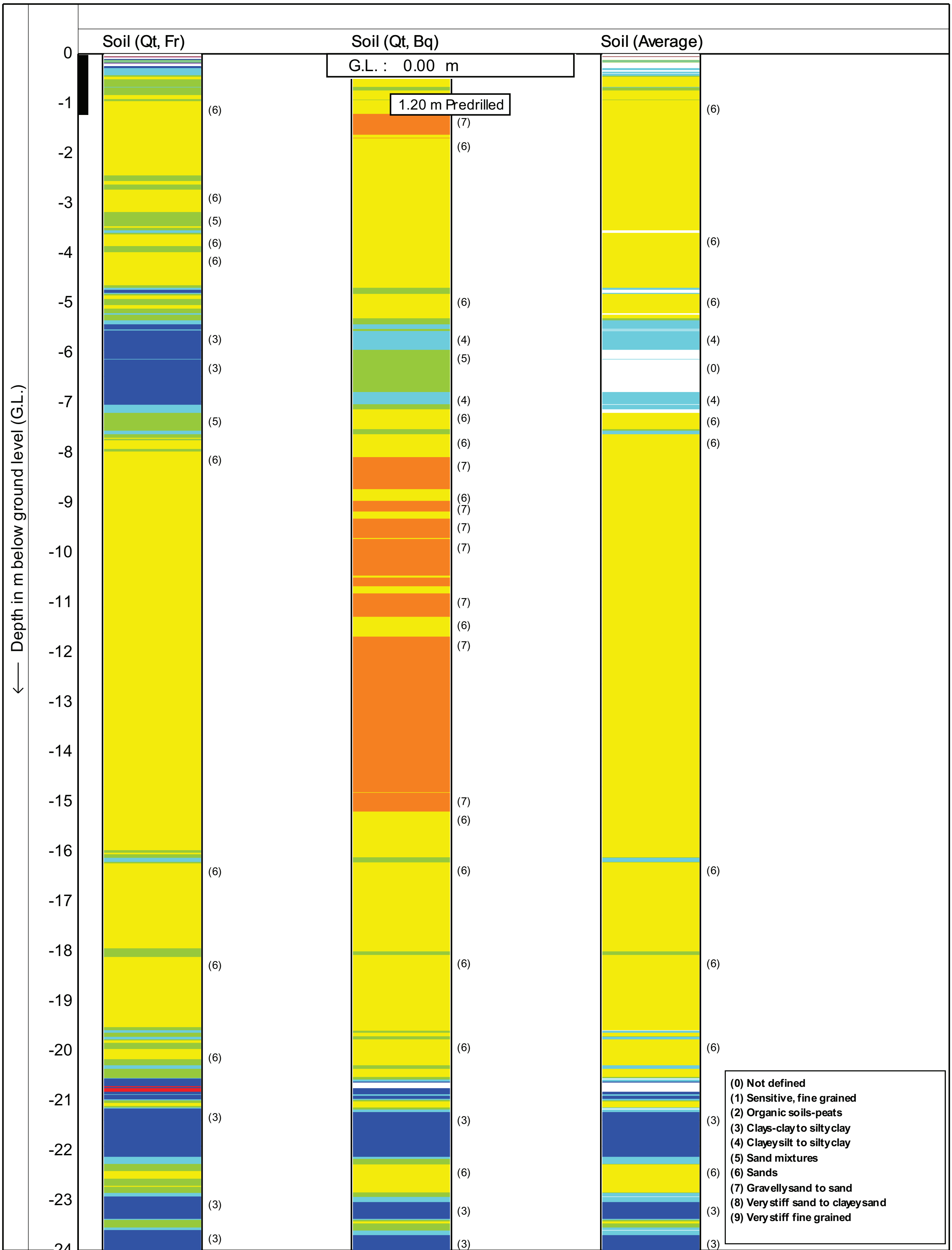
Test according A.S.T.M. Standard D 5778-07

Project : **Site Investigations**

Location: **Waltham - Christchurch City**

Date	: **23-6-2011**
Cone no.	: **C10CFIIP.**
Project no.	: **01TT31**
CPT no.	: **WTM-19**

4/28



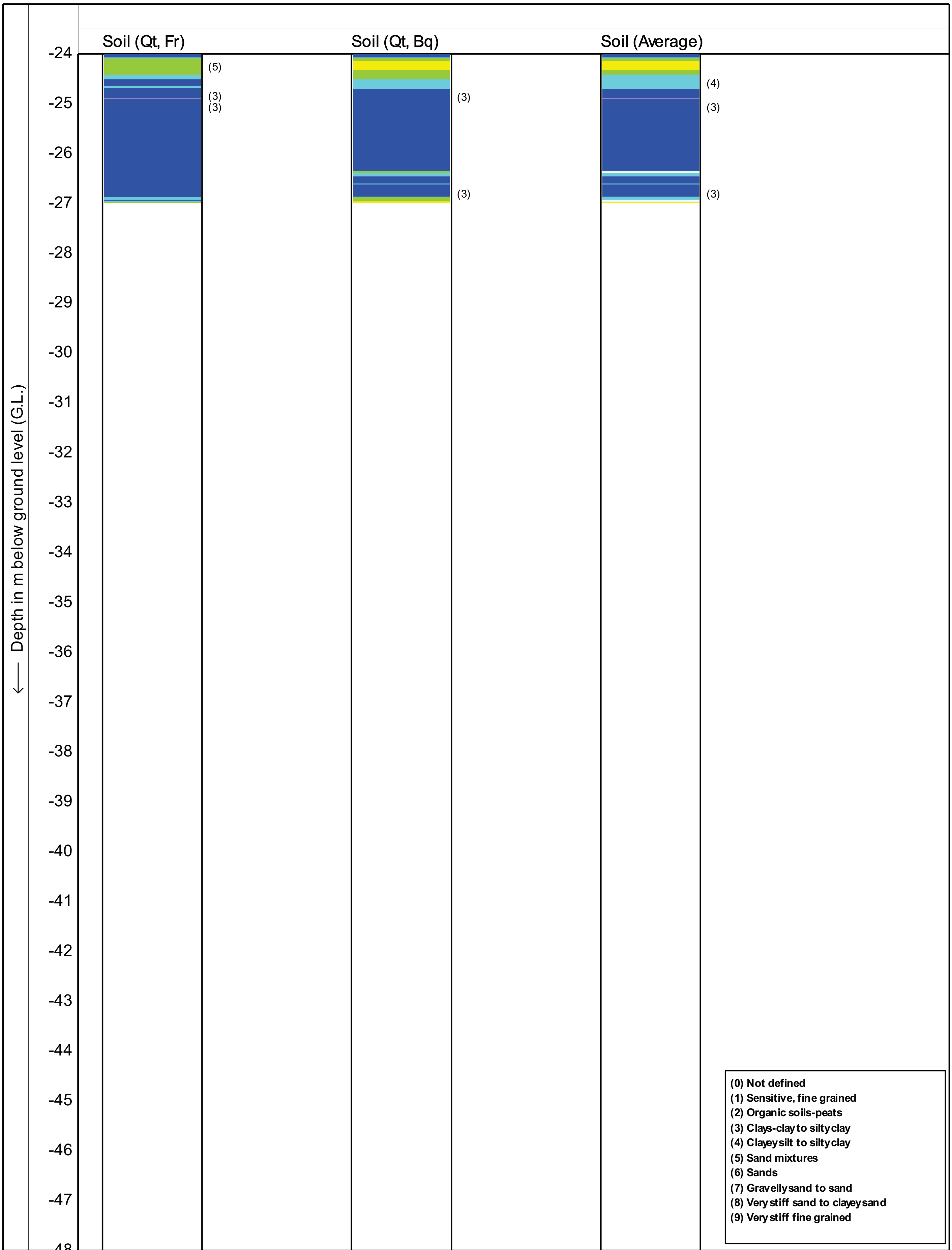
Soil behaviour type classification after Robertson 1990

r u2 150 cm² 10 cm²

Perry DRILLING GEO PROBE Ground Drilling and Environmental Specialists

CPTask V1.25

Test according A.S.T.M. Standard D 5778-07	Date : 23-6-2011
Project : **Site Investigations**	Cone no. : C10CFIIP.
	Project no. : **01TT31**
Location: **Waltham - Christchurch City**	CPT no. : **WTM-19** 25/28

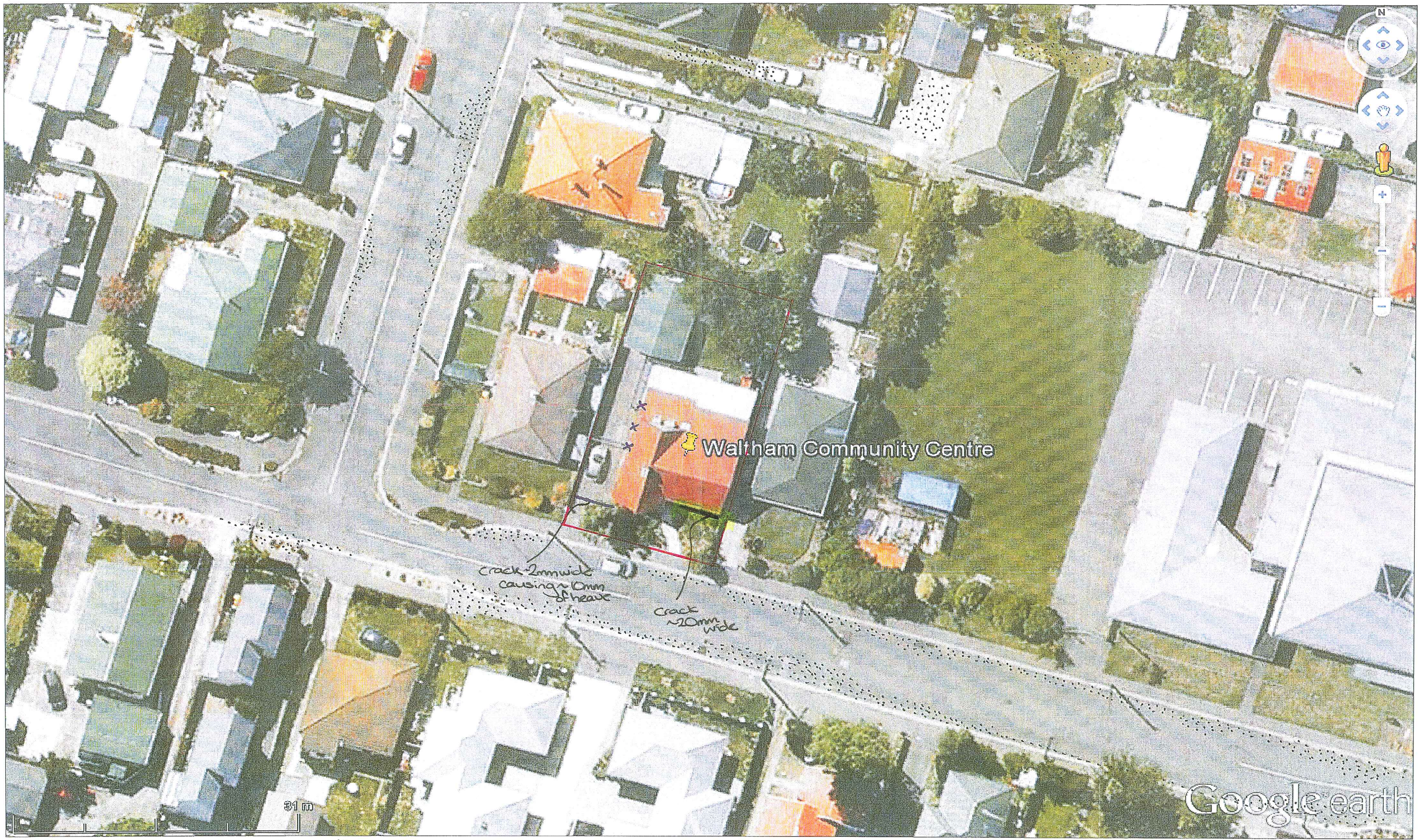


Soil behaviour type classification after Robertson 1990

Test according A.S.T.M. Standard D 5778-07

Project :	**Site Investigations**
Location:	**Waltham - Christchurch City**
Date	: **23-6-2011**
Cone no.	: **C10CFIIP.**
Project no. :	**01TT31**
CPT no.	: **WTM-19**

CPTask V1.25



X : Location of cracks in the foundation.
— : Cracks.
⁘ : Liquefaction 22nd February 2011.

Opus International Consultants Ltd
Christchurch Office
20 Moorhouse Ave
PO Box 1482
Christchurch, New Zealand
Tel: +64 3 363 5400   Fax: +64 3 365 7857

Project:	Waltham Community Cottage Geotechnical Desk Study	**Site Walkover Plan**	
Project No.:	6-QUCCC.58/005SC	**Drawn:**	Danielle Belcher Engineering Geologist
Client:	Christchurch City Council	**Date:**	23-Jan-12

Appendix D – CERA DEE Spreadsheet

Detailed Engineering Evaluation Summary Data V1.11

Location

Building Name:	Waltham Community Cottage	Reviewer:	Alistair Boyce
	Unit / No: / Street	CPEng No:	209860
Building Address:	210 Hastings Street East	Company:	Opus International Consultants
Legal Description:		Company project number:	6-QUCCC.58
		Company phone number:	03 363 5400
	Degrees / Min / Sec		
GPS south:	43 / 32 / 57.20	Date of submission:	20-Sep-12
GPS east:	172 / 39 / 4.25	Inspection Date:	15/12/2011
		Revision:	Final
Building Unique Identifier (CCC):	BU 2385-001 EQ2	Is there a full report with this summary?	yes

Site

Site slope:	flat	Max retaining height (m):	0
Soil type:	silt	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):	5.00

Building

No. of storeys above ground:	1 (single storey = 1)	Ground floor elevation (Absolute) (m):	5.00
Ground floor split?	no	Ground floor elevation above ground (m):	0.30
Storeys below ground	0		
Foundation type:	timber piles	if Foundation type is other, describe:	Concrete perimeter walls, shallow piles
Building height (m):	5.60	height from ground to level of uppermost seismic mass (for IEP only) (m):	
Floor footprint area (approx):	135		
Age of Building (years):	90	Date of design:	Pre 1935
Strengthening present?	no	If so, when (year)?	
		And what load level (%g)?	
Use (ground floor):	public	Brief strengthening description:	
Use (upper floors):			
Use notes (if required):			
Importance level (to NZS1170.5):	IL2		

Gravity Structure

Gravity System:	load bearing walls		
Roof:	timber framed	rafter type, purlin type and cladding	Corrugated iron cladding
Floors:	timber	joist depth and spacing (mm)	
Beams:	timber	type	
Columns:	timber	typical dimensions (mm x mm)	
Walls:			

Lateral load resisting structure

Note: Define along and across in detailed report!

Lateral system along:	lightweight timber framed walls	note typical wall length (m)	1.5m - 5m
Ductility assumed, μ:	2.00		
Period along:	0.40 (0.00)	estimate or calculation?	estimated
Total deflection (ULS) (mm):		estimate or calculation?	
maximum interstorey deflection (ULS) (mm):		estimate or calculation?	
Lateral system across:	lightweight timber framed walls	note typical wall length (m)	1.5m - 5m
Ductility assumed, μ:	2.00		
Period across:	0.40 (0.00)	estimate or calculation?	estimated
Total deflection (ULS) (mm):		estimate or calculation?	
maximum interstorey deflection (ULS) (mm):		estimate or calculation?	

Separations:

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

leave blank if not relevant

Non-structural elements

Stairs:			
Wall cladding:	other light	describe	Timber weatherboards
Roof Cladding:	Metal	describe	Corrugated iron
Glazing:	timber frames		
Ceilings:	plaster, fixed		Plasterboard
Services(list):			

Available documentation

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

Damage

Site:
(refer DEE Table 4-2)

Site performance:		Describe damage:	
Settlement:	0-25mm	notes (if applicable):	Less than 5mm
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?:	no	Describe:	

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

Recommendations

Level of repair/strengthening required:	minor structural	Describe:	
Building Consent required:	no	Describe:	
Interim occupancy recommendations:	full occupancy	Describe:	

Along	Assessed %NBS before:	34%	##### %NBS from IEP below	If IEP not used, please detail assessment methodology:
	Assessed %NBS after:	34%		
Across	Assessed %NBS before:	53%	##### %NBS from IEP below	
	Assessed %NBS after:	53%		

IEP

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

Period of design of building (from above): Pre 1935

h_n from above: m

Seismic Zone, if designed between 1965 and 1992:

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

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

Note:1 for specifically design public buildings, to the code of the day: pre-1965 = 1.25; 1965-1976, Zone A =1.33; 1965-1976, Zone B = 1.2; all else 1.0	1.00
Note 2: for RC buildings designed between 1976-1984, use 1.2	1.0
Note 3: for buildngs designed prior to 1935 use 0.8, except in Wellington (1.0)	1.0

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

2.2 Near Fault Scaling Factor

Near Fault scaling factor, from NZS1170.5, cl 3.1.6: 1.00

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

2.3 Hazard Scaling Factor

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

2.4 Return Period Scaling Factor

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

2.5 Ductility Scaling Factor

	along	across
Assessed ductility (less than max in Table 3.2)	1.00	1.00
Ductility scaling factor: =1 from 1976 onwards; or =kμ, if pre-1976, fromTable 3.3:		
Ductiity Scaling Factor, **Factor D**:	0.00	0.00

2.6 Structural Performance Scaling Factor:

	along	across
Sp:	1.000	1.000
Structural Performance Scaling Factor **Factor E**:	1	1

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

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

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

3.1. Plan Irregularity, factor A: 1

3.2. Vertical irregularity, Factor B: 1

3.3. Short columns, Factor C: 1

3.4. Pounding potential

Pounding effect D1, from Table to right: 1.0
Height Difference effect D2, from Table to right: 1.0
Therefore, Factor D: 1

3.5. Site Characteristics 1

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

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

3.6. Other factors, Factor F

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

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

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

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