

REPORT

Earthquake Commission

Christchurch Earthquake Recovery
Geotechnical Factual Report
Papanui



Tonkin & Taylor

ENVIRONMENTAL AND ENGINEERING CONSULTANTS



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Applicability

This report was produced for the Earthquake Commission (EOC) to assist in assessing insurance claims made under the Earthquake Commission Act 1993. This report is not intended for any other purpose. It is recognised, however, that this report may assist central and local government planning for effective long-term solutions for the affected communities. Neither Tonkin & Taylor Ltd (T&T) nor the Earthquake Commission accepts any liability to any third party with respect to this report.

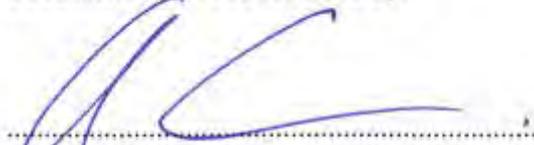
Limitations

This document is released for general information purposes only and should only be used for design purposes by appropriately qualified and experienced Scientists, Geologists and/or Professional Engineers.

All of the data and information which is contained in this document may only be used for the purposes of recovery and repair of land and building damage associated with the Canterbury Earthquakes (04 September 2010 and 22 February 2011).

This report comprises a main body and separate appendices which must be read in their entirety and are to be used in conjunction with each other.

Document approved for issue by:



Anthony Fairclough
Project Director

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1 Introduction

The Earthquake Commission (EQC) engaged Tonkin & Taylor (T&T) to undertake site investigations around selected suburbs of Canterbury following the Christchurch Earthquake sequence that started on 4 September 2010. These site investigations comprise:

- a) Cone penetration testing,
- b) Machine boreholes,
- c) Geophysical testing,
- d) Groundwater observations, and,
- e) Laboratory testing.

Site investigation works and factual reporting is being undertaken for a number of suburbs that were affected by liquefaction induced land damage.

This report only contains factual geotechnical information and is intended to provide a source of geotechnical data to support council consent applications for the suburb. This report presents all currently available geotechnical and engineering geological investigations that were commissioned by EQC during 2010/2011 and all readily available data that Environment Canterbury (ECan) and Christchurch City Council (CCC) hold for the suburb.

This is a factual report of field investigations. The field investigations have been undertaken at discrete locations and no inferences about the nature and continuity of ground conditions away from the investigations locations are made. No interpretation of investigation results has been made in this report.

2 Project background

The Christchurch earthquake sequence began with a magnitude (M) 7.1 earthquake (the Darfield Earthquake) which occurred on 4 September 2010. The epicentre of this earthquake was located close to the town of Darfield, approximately 40 km west of Christchurch. A (M) 6.3 earthquake (the Christchurch Earthquake) occurred on 22 February 2011. The epicentre of this earthquake was located close to Lyttelton, approximately 11 km south-east of Christchurch City. A further (M) 6.3 earthquake occurred on 13 June 2011. The epicentre of this earthquake was located approximately 10km east of Christchurch City. These earthquakes caused extensive ground liquefaction in localised areas of Canterbury and Christchurch City. The liquefaction resulted in major ground settlement, lateral spreading and, to a lesser extent, foundation support failure with consequential building damage.

T&T have carried out a broad geotechnical land damage assessment and mapping of the main urban areas in the Canterbury region that have been significantly affected by strong ground motion arising from these earthquakes. The results of that assessment are presented in the T&T Stage 1 report (Ref 1) dated October 2010 and released to the general public by EQC. The Stage 1 report presented the land damage categorisation, mapping methodology, information and results generated to 1 October 2010. Land remediation concepts and generalised land remediation options were also presented.

The T&T Stage 2 report (Ref 2) dated November 2010 and released to the general public by EQC is based on a detailed suburb-by-suburb engineering assessment into the nature and extent of land damage. Further land damage mapping and assessments were carried out by T&T after the 22 February 2011 and 13 June 2011 Christchurch aftershock events. The results of these assessments were summarised prior to issue to the NZ Government to assist them in their decision making

process. The Canterbury Land Information Map for residential properties was publicly announced by the NZ Government and Canterbury Earthquake Recovery Authority (Cera) on 23 June 2011.

3 Site description

3.1 General

The suburb of Papanui is located approximately 5km north-west of the Christchurch CBD and is within the jurisdiction of the Christchurch City Council. Dudley Creek flows west-east through the centre of the suburb. The extent of the area within the suburb which is considered in this report (the subject area) is shown on Drawing LOC-PAI-01, Appendix A.

The subject area is low lying and topographically is typically flat.

3.2 Regional geology

The publication "Geology of the Christchurch Urban Area" (Ref 3) shows that the suburb of Papanui is typically underlain by dominantly alluvial sand and silt overbank deposits. To the north-east of the suburb of Papanui, and north of Dudley Creek, there is an area of the suburb which is generally underlain by peat swamps now drained.

4 Geotechnical investigations

4.1 General

The geotechnical investigations which were commissioned by EQC following the Canterbury Earthquakes (2010/2011) were scoped and located under the direction of T&T. The locations were selected taking into account access for the site investigation plant, the presence of services and any traffic management requirements. Investigations which were completed subsequent to the Christchurch Earthquake (22 February 2011) comprise:

- (a) 13 Cone penetration tests (CPTs),
- (b) 1 Machine drilled borehole, and,
- (c) Laboratory testing.

The location of the site investigations are shown on Drawing GIP-PAI-01 (Appendix A) and each of the above investigation techniques is discussed below.

4.2 Cone penetration testing (CPT)

Four companies were commissioned to provide CPT probing services on this project and information on the CPT rig capability is summarised briefly below. The output of each CPT rig varies and therefore the testing data has been produced on a standard T&T template. The company which carried out each CPT test is identified on the CPT log. The companies that carried out the testing were:

- a) Opus International Consultants Ltd (Opus) - 18T truck-mounted rig,
- b) Perry Drilling Ltd (Perry) - 20T rubber tracked truck-mounted rig,
- c) McMillan Drilling Services (McMillan) - 14T truck-mounted rig, and,
- d) Geotech Drilling Ltd (Geotech) - 16T truck-mounted rig.

The Cone Calibration Certificates for each of the above CPT rigs are included in Appendix B.

Selected CPT probes had down-hole seismic shear wave velocity testing carried out. These are identified on each CPT log and are summarised in Table 4-1 below.

Each CPT probe location was pre-dug by hand to a depth of 1.2m to mitigate the risk of a clash with and damage to underground services at the investigation locations.

The CPT test location details are summarised below in Table 4-1.

Table 4-1 Cone penetration testing summary

CPT ID	Depth (m)	Location (mE)	Location (mN)	Ground Surface R.L	Comments
CPT-PAI-01	9.02	2477861.37	5745207.12	15.33	
CPT-PAI-02	9.37	2478297.16	5745347.33	13.00	
CPT-PAI-06	6.63	2478056.15	5744762.76	13.83	Seismic CPT
CPT-PAI-07	2.15	2477983.73	5744619.53	12.70	
CPT-PAI-09	15.06	2478494.71	5744823.51	12.39	
CPT-PAI-10	10.04	2478652.37	5744935.66	11.29	Seismic CPT
CPT-PAI-11	2.28	2478196.55	5744453.22	12.40	
CPT-PAI-12	5.94	2478419.95	5744565.11	11.24	
CPT-PAI-14	20.94	2478706.27	5744546.97	10.94	Seismic CPT
CPT-PAI-15	6.58	2478530.02	5744257.81	11.31	Piezometer installed
CPT-PAI-16	4.40	2478752.87	5744410.65	11.58	Seismic CPT
CPT-PAI-17	21.60	2478983.14	5744606.03	10.60	Piezometer installed
CPT-PAI-18	7.92	2477723.44	5745116.05	16.05	

Full details of the CPT results are presented in Appendix B.

4.3 Machine boreholes

Five companies were commissioned to provide borehole drilling services on the Christchurch Earthquake Recovery project. Their rig capabilities are briefly discussed below. Each borehole log identifies the company which conducted the drilling.

- a) McMillan Drilling Services (McMillan) used a direct push drilling rig with Standard Penetration Tests (SPT) at typically 1.2 m centres where appropriate. The direct push yields nearly continuous core recovery and generally extended to a minimum depth of 20 metres with a core diameter of 50 mm.
- b) DCN Drilling Limited (DCN) used a combination vibratory sonic and top drive rotary with HQ coring. Standard Penetration Tests (SPT) were carried out at typically 1.5 m centres. Achievable depth range was typically 20-30 metres.
- c) Pro-Drill Ltd (Prodrill) used a top drive rotary with HQ coring. Standard Penetration Tests (SPT) were carried out at typically 1.5 m centres. Achievable depth range was typically 20-30 metres.
- d) McNeill Drilling Co Ltd (McNeill) used a top drive rotary with HQ coring. Standard Penetration Tests (SPT) were carried out at typically 1.5 m centres. Achievable depth range was typically 20-30 metres.
- e) Griffiths Drilling Ltd (Griffiths) used a top drive rotary with HQ coring. Standard Penetration Tests (SPT) were carried out at typically 1.5 m centres. Achievable depth range was typically up to 20 metres.

On completion of drilling the boreholes were finished in one of three ways, as listed below:

- (a) Backfilling the hole to comply with Environment Canterbury requirements (typically filled with grout or bentonite).
- (b) Installation of a piezometer, or,
- (c) Installation of PVC ducting to enable down-hole shear wave velocity testing.

The recovered core samples were either presented in clear plastic liners or placed into core boxes. The samples were returned to the T&T office in Christchurch for logging, typically within 24 hours of the borehole being completed.

The core recovered from the boreholes was logged by a geotechnician, who was supervised by a Senior Engineering Geologist, in general accordance with the New Zealand Geotechnical Society Guidelines (Ref 4). Representative samples were selected from the borehole materials for laboratory testing.

The machine borehole location details are summarised below in Table 4-2.

Table 4-2 Machine borehole drilling summary

Borehole ID	Depth (m)	Location (mE)	Location (mN)	Ground level R.L	Method	Comment
BH-PAI-01	20.55	2478636.28	5744632.17	11.30	Dual tube	McMillan

The borehole logs are presented in Appendix C and photographs of the borehole core in Appendix D.

5 Groundwater observations

In Papanui, during the investigations, groundwater depth was observed to range between 3.3 m and 0.5m below existing ground level. These identified levels were based on dynamic pore water pressure results in CPT testing.

6 Laboratory testing

Geotechnics Ltd (Tauranga) were commissioned by T&T to undertake various laboratory tests on samples obtained from the investigation boreholes. Samples recovered from boreholes were couriered to Tauranga for soil classification tests. The samples typically comprised disturbed samples.

The tests undertaken include:

- (a) Fines content (wet sieve) testing generally in accordance with NZS 4402:1986 Test 2.8.1 (Ref 5), and,
- (b) Particle size distribution testing in accordance with NZS 4402:1986 Test 2.8.1 (Ref 5).

Copies of the laboratory test results are included in Appendix E.

7 Environment Canterbury information

Additional borehole data, which is held by Environment Canterbury for the subject area, has been included in Appendix F. This data has been reproduced with the permission of Environment Canterbury and forms part of previous investigations undertaken by a variety of geotechnical

consultants and/or groundwater well construction contractors. Records for boreholes outside of the area covered by this report may be obtained from Environment Canterbury.

8 References

1. Tonkin & Taylor Ltd (October 2010), prepared for the Earthquake Commission *Christchurch Earthquake 4 September 2010 Geotechnical Land Damage Assessment & Reinstatement Report STAGE 1 REPORT.*
2. Tonkin & Taylor Ltd (November 2010), prepared for the Earthquake Commission *Christchurch Earthquake 4 September 2010 Geotechnical Land Damage Assessment & Reinstatement Report STAGE 2 REPORT.*
3. Brown, L.J.; Weeber, J.H. (1992), *Geology of the Christchurch urban area.* Institute of Geological & Nuclear Sciences 1:25,000 geological map 1. 1 sheet + 104p. Lower Hutt, New Zealand, Institute of Geological and Nuclear Sciences Limited.
4. NZ Geotechnical Society (December 2005), *Field Description for Soil and Rock. Guideline for the Field Classification and Description of Soil and Rock for Engineering Purposes.*
5. New Zealand Standards (1986), *NZS4402: Methods of testing for civil engineering purposes.*



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