

REPORT



Document Control

Title: Rotorua Lakefront Redevelopment, Stage 2 Geotechnical Factual Report					
Date	Version	Description	Prepared by:	Reviewed by:	Authorised by:
6/12/2018	01	Final Issue	Caitlin Murphy	Peter Molyneaux	Craig Davanna



Distribution:

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1 Introduction

Tonkin & Taylor Ltd (T+T) has been commissioned by Rotorua Lakes Council (RLC) to provide engineering services for a proposed redevelopment of the Rotorua Lakefront. To date, two stages of recent ground investigations have been undertaken on the site relating to this development, comprising:

- Stage 1: Onshore ground investigations adjacent to the lakefront; and
- Stage 2: Offshore ground investigations within Lake Rotorua (accessed via barge).

This report presents the factual results of Stage 2 of the ground investigations. The results of Stage 1 are presented in a separate factual report. T+T's services were provided in accordance with our proposal dated 5 July 2018¹.

2 Site Description

The site is located on the lake margins at the southern end of Lake Rotorua. The extent of the proposed development is approximately defined by the red line shown on the site plan in Figure 2.1.

The site is currently used as a grassed and brick paved recreational area with an existing esplanade which borders the lake. A number small timber framed booking offices are located on the esplanade. Two timber pile piers and a number of smaller docking facilities extend from this esplanade. There are several underground storage tanks (USTs) beside one of these offices that contain fuel for boats and aircraft associated with the tourist operations.

Lakefront Drive and Oruawhata Drive run east-west through the site, following the lake margin and a number of car parks are associated with these roads. Three jetties are present on the western part of the site and timber frame steel clad Scout hut on the east, with a small timber piled jetty.

The lakefront water area is used for various mooring of commercial vessels and aircraft.

2.1 Proposed development

The proposed lakefront redevelopment comprises a new boardwalk, concrete and grass terraces, car parking, bus parking, new road pavements, footpaths, play spaces and landscaping. A number of new buildings are also proposed, although these are not included in the current development package. The proposed development has been split into five stages (labelled 1 to 5) with stages 1 and 3 further divided into Stages 1, 1a, 3 and 3a.

The boardwalk and terracing are included within Stages 1, 1a and 3a. Stage 2 includes car and bus parking and pavements. Play spaces are located within Stage 3. Future restaurants, café and kiosks are included within Stage 3a. Stage 4 includes further car parking and pavements. The Wharewaka and Waka Ama buildings, car and trailer parking are included within the Stage 5 works. Footpaths, paving and landscaping are included in all proposed stages. The masterplan and staging plan prepared by Isthmus are presented below in Figure 2.2 and Figure 2.3.

¹ T+T (5 July 2018). Variation VO1 Rev2 – Civil, Structural and Geotechnical Engineering Services for Rotorua Lakefront Redevelopment – Preliminary Site Investigations.



Figure 2.1: Site location plan (source: Rotorua Lakes Council online GIS)

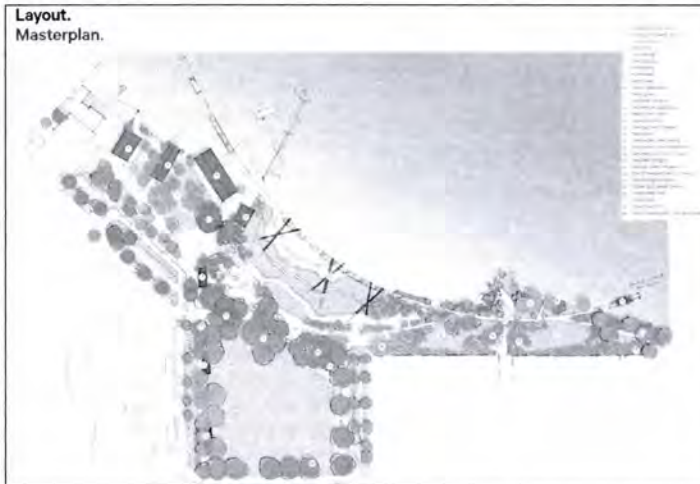


Figure 2.2: Proposed masterplan extracted from RLC Lakefront Redevelopment Developed Design for Stage 1 & 1a, dated August 2018.

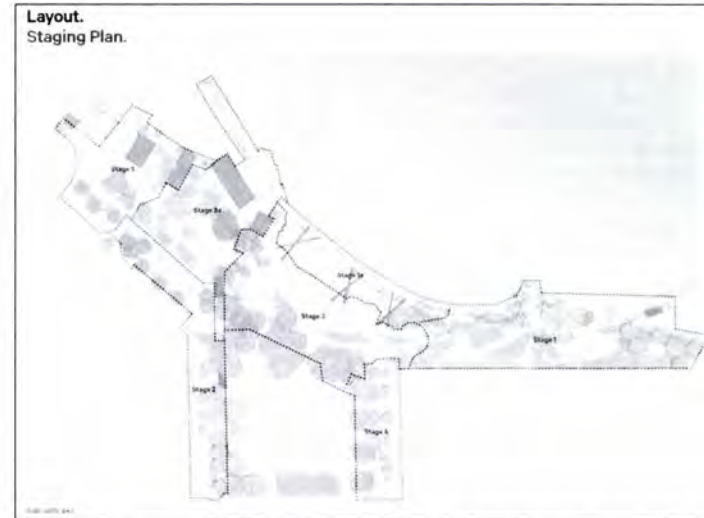


Figure 2.3: Proposed staging plan extracted from RLC Lakefront Redevelopment Developed Design for Stage 1 & 1a, dated August 2018.

3 Ground and Groundwater Conditions

3.1 Published geology

A published geological map of the area² indicates that the onshore ground is underlain by a mixture of undifferentiated rhyolite lavas and alluvium of the Tauranga Group. The mapped geological boundaries do not extend within Lake Rotorua. The location of the site in the context of the onshore regional geology is presented in Figure 3.1.

3.2 Previous ground investigations (Stage 1)

Previous Stage 1 ground investigations for the development were undertaken by Perry Geotech Limited between 30 July 2018 and 2 August 2018 (supervised and logged by T+T Geotechnical Engineers). These investigations comprised:

- 4 No. machine-drilled boreholes (BH); and
- 20 No. Cone Penetration Tests (CPTs).

A summary of the ground investigation data for Stage 1 is presented in the Stage 1 Geotechnical Factual Report, dated 12 October 2018.

² Leonard, G.S.; Begg, J.G.; Wilson, C.J.N. (compilers) 2010: Geology of the Rotorua area. Institute of Geological & Nuclear Sciences 1:250,000 geological map 5. 1 sheet + 102 p. Lower Hutt, New Zealand. GNS Science.



Figure 3.1: Published geological map of the local area

3.3 Current ground investigations (Stage 2)

Recent ground investigations were undertaken within Rotorua Lake between 24 September 2018 and 28 September 2018. The work comprised:

- 4 No. machine-drilled BHs to 20 m below ground level (bgl) with Standard Penetration Tests (SPT) at 1.5 m intervals;
- Logging of BH core and preparation of BH logs to NZGS standards; and
- Collection of soil samples and procurement of laboratory testing.

The works were carried out on a barge using a rotary drilling rig (HQ3 triple tube) operated by Perry Geotech Limited. The works were completed under the full time supervision of a T+T Geotechnical Engineer. The target depth of 19.95 mbgl was achieved in each of the 4 No. BHs.

The locations of the investigations were surveyed by hand-held GPS. The BH locations are presented on Figure 1, Appendix A, and described below in Table 3.1. BH logs and core photographs are presented in Appendix B.

Table 3.1: Machine Borehole Summary

BH ID	Location (NZTM)		Depth (m)	BOPRC Lake water level (m) RL ⁽¹⁾	Depth of water to lakebed (m) ⁽²⁾
	Easting (m)	Northing (m)			
BH05	5774890.00	1885040.00	19.95	279.9	0.5
BH06	5774858.00	1885049.00	19.95	279.9	0.5
BH07	5774633.00	1885503.00	19.95	279.9	0.5
BH08	5774628.00	1885487.00	19.95	279.9	0.5

(1) Source: Bay of Plenty Regional Council <http://monitoring.boprc.govt.nz>. Rounded to two decimal places. Readings taken at midday.
 (2) Approximate only, measured from barge.

3.3.1 Laboratory testing

Samples were taken from BH core and push tubes for laboratory testing. Laboratory testing was undertaken by Geotechnics Labs and Hill Laboratories, which are both IANZ accredited. A summary of samples taken for laboratory testing is presented in Table 3.2. Results of these lab tests are provided in Appendix C.

Table 3.2: Summary of Laboratory Testing

Sample ID	Test Type
BH05 3.10m – 3.15m	NZS 4402:1986 Test 7.1 One-Dimensional Consolidation
BH05 3.15m – 3.25m	Liquid Limit, Plastic Limit and Plasticity Index of Soils - ASTM Test D4318-17e1 (Method A)
BH05 2.30m	Organic Matter Test
BH07 1.20m	
BH08 1.80m	

4 Applicability

This report has been prepared for the exclusive use of our client Rotorua Lakes Council, with respect to the particular brief given to us and it may not be relied upon in other contexts or for any other purpose, or by any person other than our client, without our prior written agreement.

Tonkin & Taylor Ltd

Report prepared by:



Caitlin Murphy
Engineering Geologist

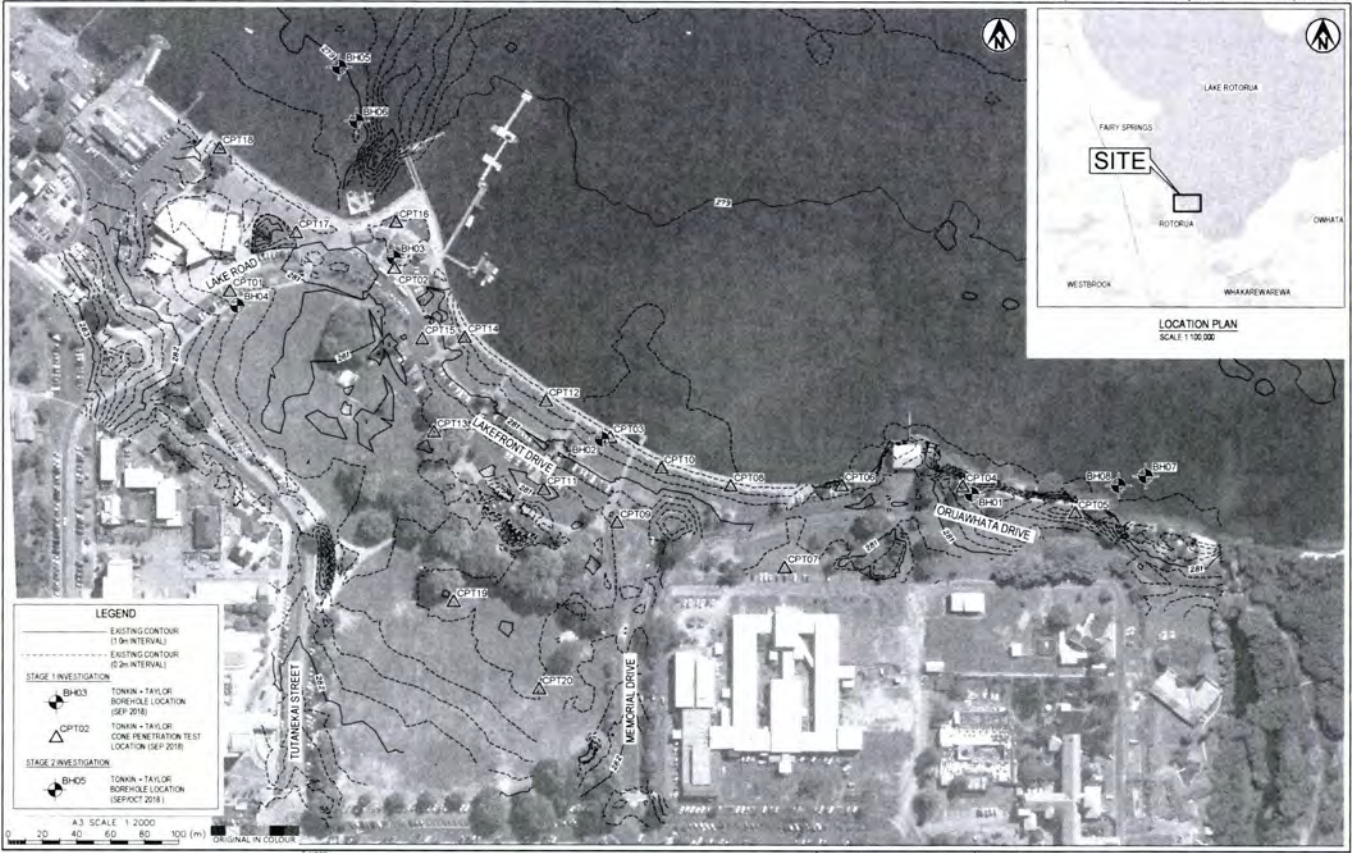
Authorised for Tonkin & Taylor Ltd by:



Craig Davanna
Project Director

CAMY
\\tgroup.local\corporate\tauranga\projects\1007467\1007467.3000\issueddocuments\stage 2\20181206 stage 2 gfr.docx

Appendix A: Site Plan

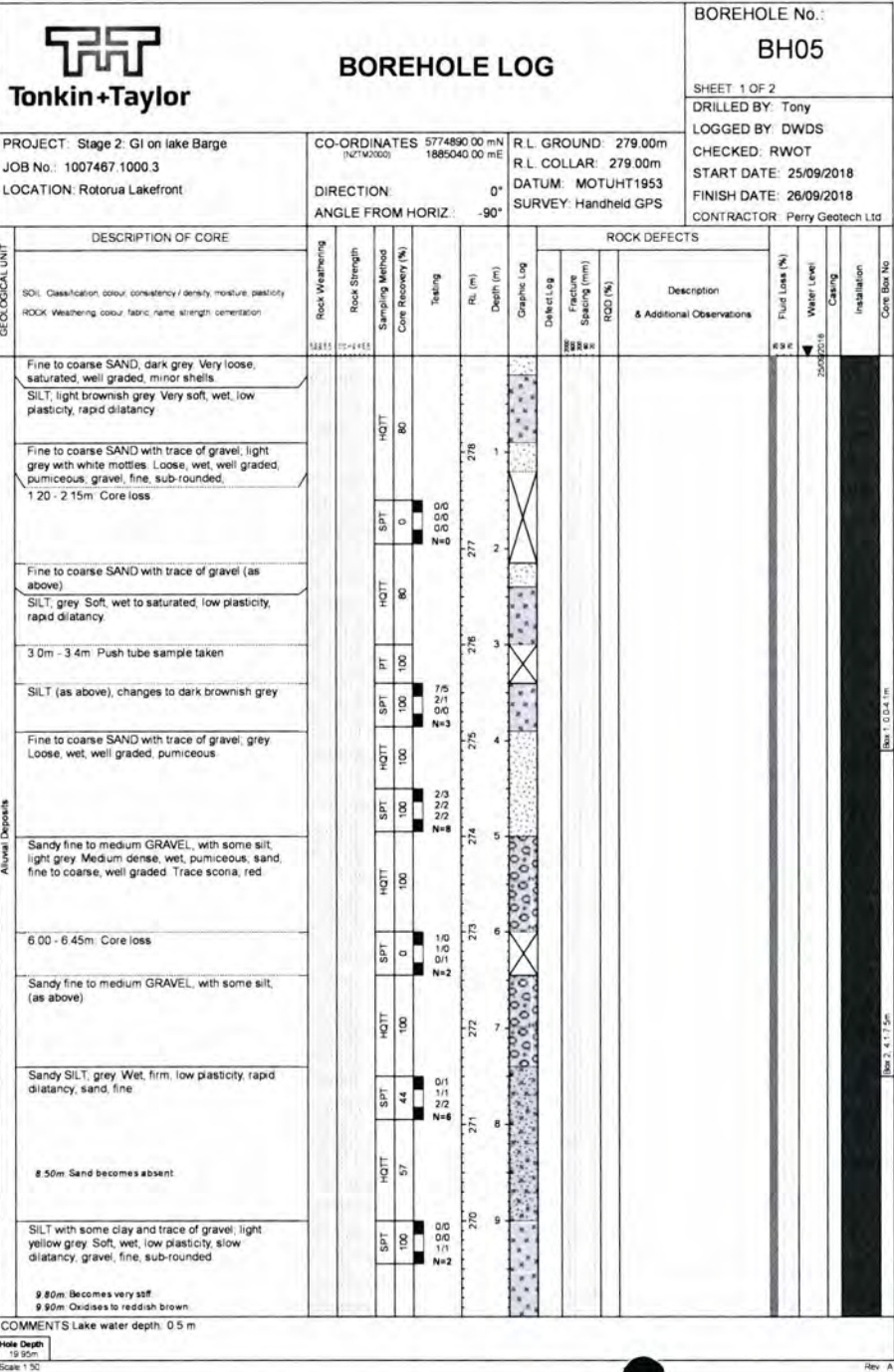


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NOTE
 1 ALL DIMENSION ARE IN METRES UNLESS NOTED OTHERWISE
 2 COORDINATE DATUM NZSD2000, BAY OF PLENTY CIRCUIT COORDINATES
 3 DEVELOPMENT PLAN AND CONTOUR SURVEY METRY SUPPLIED BY JML and Chew LM. REFERENCE TO: 4010 Rotorua Lakefront Development, Landscape Master Plan DATED 31 AUG 2018
 4 STREET MAP SOURCED FROM OpenStreetMap LICENSED UNDER THE OPEN DATA COMMONS OPEN DATABASE LICENSE (ODBL) BY THE OPEN STREET MAP FOUNDATION (OSMF)
 5 AERIAL PHOTO SUPPLIED BY BOPPLASS LM

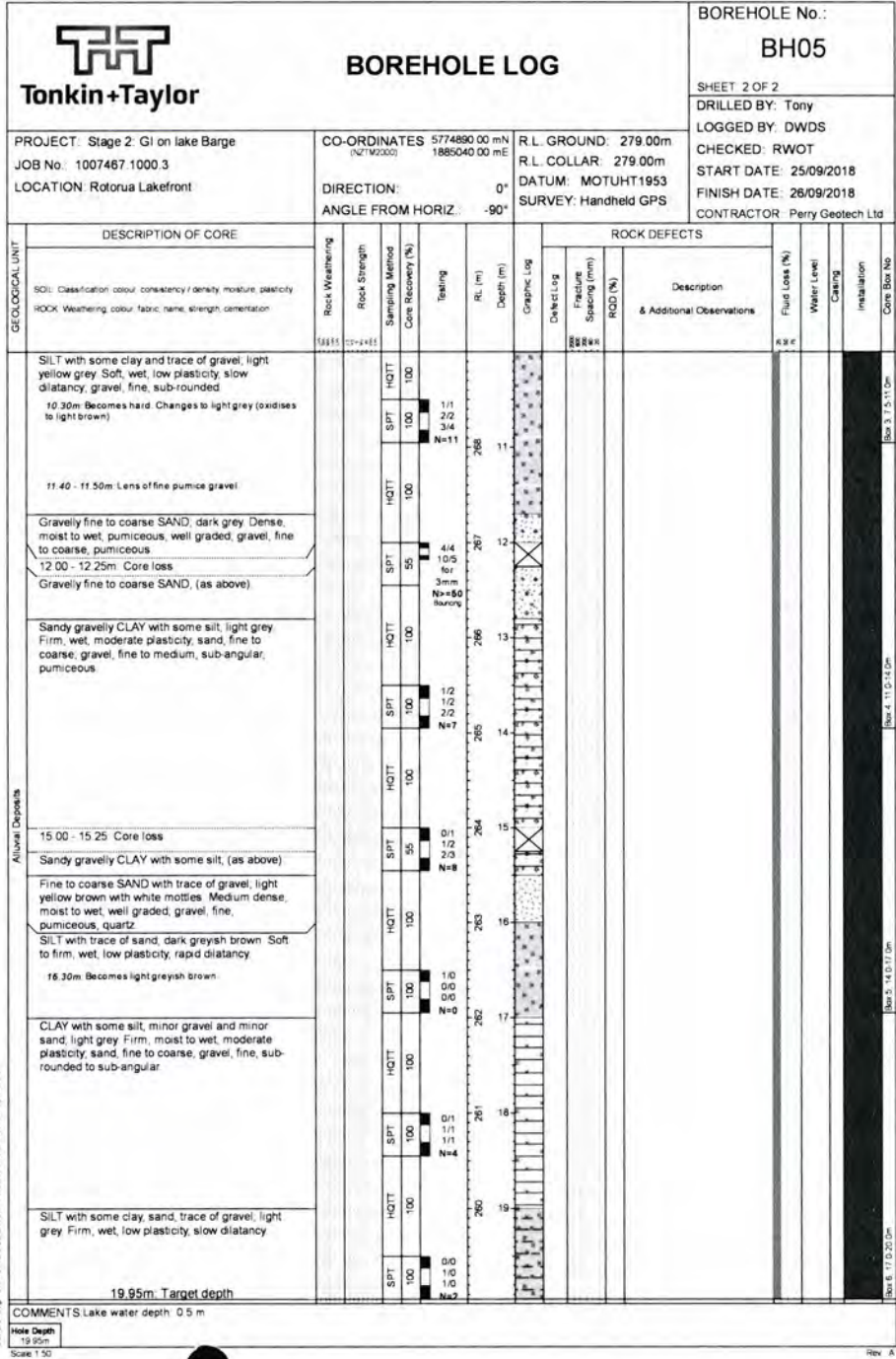
PROJECT No. 1007467 1000		CLIENT	ROTORUA LAKES COUNCIL
DESIGNED	PLMO	PROJECT	ROTORUA LAKEFRONT REDEVELOPMENT
DRAWN	JC	TITLE	GEOTECHNICAL INVESTIGATION
CHECKED	CDAN		STAGE 2 EXPLORATORY HOLE LOCATION PLAN
APPROVED	DATE	SCALE (AS)	1:2000
		FIG No	FIGURE 1
		REV	REV 1

Appendix B: Investigation Logs



General Log: 6/11/2018 9:28:34 AM Produced with Core-OS by Geotec

Rev A



General Log: 6/11/2018 9:29:34 AM Produced with Core-OS by Geotec

Rev A

CORE PHOTOS

BOREHOLE No.: BH05

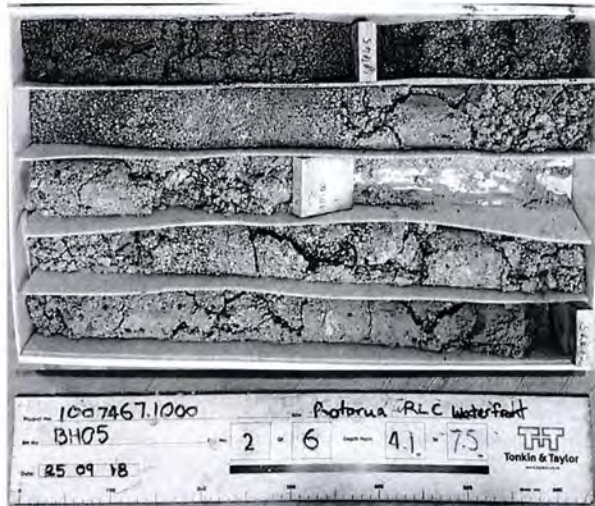
Hole Location: Rotorua Lakefront

SHEET 1 OF 3

PROJECT: Stage 2: GI on lake Barge		LOCATION: Rotorua Lakefront	JOB No.: 1007467.1000.3
CO-ORDINATES (NZTM2000)	5774890.00 mN 1885040.00 mE	DRILL TYPE: ST40 HQ Core Rig	HOLE STARTED: 25/09/2018 HOLE FINISHED: 26/09/2018
R.L.	279.00m	DRILL METHOD: RC	DRILLED BY: Perry Geotech Ltd
DATUM:	MOTUHT1953	DRILL FLUID:	LOGGED BY: DWDS CHECKED: RWOT



0.00-4.10m



4.10-7.50m

CORE PHOTOS

BOREHOLE No.: BH05

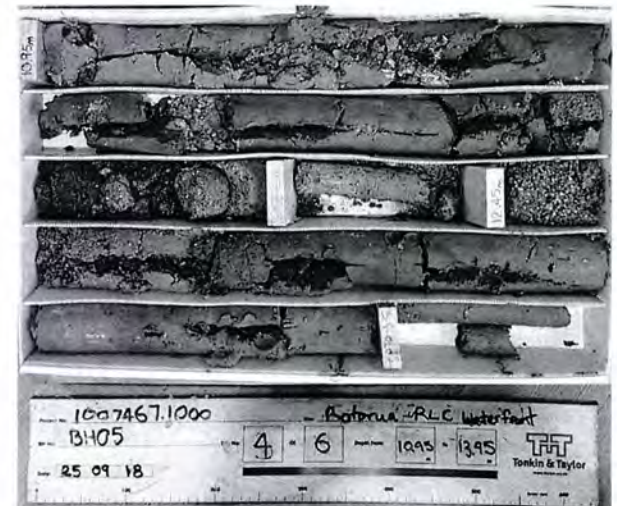
Hole Location: Rotorua Lakefront

SHEET 2 OF 3

PROJECT: Stage 2: GI on lake Barge		LOCATION: Rotorua Lakefront	JOB No.: 1007467.1000.3
CO-ORDINATES (NZTM2000)	5774890.00 mN 1885040.00 mE	DRILL TYPE: ST40 HQ Core Rig	HOLE STARTED: 25/09/2018 HOLE FINISHED: 26/09/2018
R.L.	279.00m	DRILL METHOD: RC	DRILLED BY: Perry Geotech Ltd
DATUM:	MOTUHT1953	DRILL FLUID:	LOGGED BY: DWDS CHECKED: RWOT



7.50-10.95m



10.95-13.95m



CORE PHOTOS

BOREHOLE No.: BH05

Hole Location: Rotorua Lakefront

SHEET 3 OF 3

PROJECT: Stage 2: GI on lake Barge		LOCATION: Rotorua Lakefront	JOB No.: 1007467.1000.3	
CO-ORDINATES (NZTM2000)	5774890.00 mN 1885049.00 mE	DRILL TYPE: ST40 HQ Core Rig	HOLE STARTED: 25/09/2018	HOLE FINISHED: 26/09/2018
R.L.	279.00m	DRILL METHOD: RC	DRILLED BY: Perry Geotech Ltd	LOGGED BY: DWDS
DATUM	MOTUHT1953	DRILL FLUID:	CHECKED: RWOT	



13.95-16.95m



16.95-19.95m

Core Photos - 6/11/2018 10:56:23 AM - Produced with Core-GIS by Geotek



BOREHOLE LOG

BOREHOLE No.: BH06

SHEET 1 OF 2

DRILLED BY: Tony

LOGGED BY: DWDS

CHECKED: RWOT

START DATE: 26/09/2018

FINISH DATE: 26/09/2018

CONTRACTOR: Perry Geotech Ltd

PROJECT: Stage 2: GI on lake Barge
JOB No.: 1007467.1000.3
LOCATION: Rotorua Lakefront

CO-ORDINATES (NZM2000) 5774858.00 mN
1885049.00 mE

R.L. GROUND: 279.00m
R.L. COLLAR: 279.00m

DATUM: MOTUHT1953

SURVEY: Handheld GPS

DIRECTION: 0°
ANGLE FROM HORIZ.: -90°

GEOLOGICAL UNIT	DESCRIPTION OF CORE				ROCK DEFECTS											
	Rock Weathering	Rock Strength	Sampling Method	Core Recovery (%)	Testing	R.L. (m)	Depth (m)	Graphic Log	Fracture Spacing (mm)	ROD (%)	Description & Additional Observations	Fluid Loss (%)	Water Level	Casing	Installation	Core Box No.
			HQTT	66		278	1									
			SPT	100	0.0 0.0 N=0	277	2									
			HQTT	100		276	3									
			SPT	86	1.0 0.1 1/1 N=3	275	4									
			HQTT	100		274	5									
			SPT	44	1.0 0.1 0.0 N=1	273	6									
			HQTT	80		272	7									
			SPT	100	0.0 0.0 N=0	271	8									
			HQTT	100		270	9									
			SPT	100	3/3 4/5 4/4 N=17											

COMMENTS: Lake water depth: 0.5m

Hole Depth: 19.95m
Scale: 1:50

General Log - 6/11/2018 10:56:23 AM - Produced with Core-GIS by Geotek

Box 1: 00313m

Box 2: 310.6m

Box 3: 819.8m

Rev: A



BOREHOLE LOG

BOREHOLE No.:
BH06

SHEET 2 OF 2
 DRILLED BY: Tony
 LOGGED BY: DWDS
 CHECKED: RWOT
 START DATE: 26/09/2018
 FINISH DATE: 26/09/2018
 CONTRACTOR: Perry Geotech Ltd

PROJECT: Stage 2: GI on lake Barge
 JOB No.: 1007467.1000.3
 LOCATION: Rotorua Lakefront

CO-ORDINATES: 5774858.00 mN
 1885049.00 mE
 R.L. GROUND: 279.00m
 R.L. COLLAR: 279.00m
 DATUM: MOTUHT1953
 SURVEY: Handheld GPS

DIRECTION: 0°
 ANGLE FROM HORIZ.: -90°

GEOLOGICAL UNIT	DESCRIPTION OF CORE	Rock Weathering	Rock Strength	Sampling Method	Core Recovery (%)	Testing	RL (m)	Depth (m)	ROCK DEFECTS				Fluid Loss (%)	Water Level	Casing	Installation	Core Box No
									Graphic Log	Fracture Spacing (mm)	ROD (%)	Description & Additional Observations					
	Silty CLAY, with minor gravel, light brownish grey Soft to firm, wet, moderate plasticity, gravel, sub-rounded to sub-angular, pumiceous			HQTT	100	3/3											
	CLAY, with trace of sand, grey Very stiff, dry to moist, high plasticity, sand, fine			SPT	22	3/3											
	10.60m - 10.95m Core loss																
	CLAY, with some sand, light greenish grey Stiff to very stiff, moist, high plasticity, sand, fine to coarse			HQTT	100	2/3											
	Fine to coarse SAND with minor clay, light grey with white mottles. Medium dense to dense, moist, well graded			HQTT	100	4/4											
	12.25m - 12.45m Core loss			SPT	55	5/5											
	SAND, with minor clay. (as above)																
	Gravelly fine to coarse SAND with minor clay, greenish grey Dense, dry to moist, well graded, gravel, fine, pumiceous			HQTT	100	2/1											
	13.20m: Pumice fragments up to 100mm			SPT	22	2/2											
	13.60m - 13.95m Core loss																
	CLAY, with minor sand and minor gravel, light grey Firm to stiff, moist, high plasticity, sand, fine to coarse, gravel, fine, subrounded			HQTT	100	2/2											
	14.30m: Quartz fragments, up to 50mm			SPT	22	2/2											
	14.50m: Becomes stiff to very stiff, dry																
	15.00 - 15.50m With minor sub-rounded cobbles.			SPT	100	2/2											
	16.00m: Becomes hard			HQTT	100	2/2											
	CLAY, with minor sand and trace of gravel, grey Firm to stiff, wet, high plasticity, sand, fine to coarse, pumiceous, gravel, fine, sub-rounded			SPT	100	2/2											
	17.50m: Becomes very stiff			HQTT	100	2/2											
	17.70m: Minor pumice fragments up to 30mm																
	18.10m - 18.45m Core loss			SPT	22	3/5											
	CLAY, with minor sand and minor gravel, (as above)			HQTT	100	6/6											
	19.50m: Becomes firm			SPT	100	5/5											
	19.95m: Target depth			HQTT	100	1/1											

COMMENTS Lake water depth: 0.5 m

Hole Depth: 19.95m
 Scale: 1:50

General Log: 6/11/2018 9:30:09 AM Produced with Core-GIS by Geobac

Rev A



CORE PHOTOS

BOREHOLE No.: **BH06**
 Hole Location: Rotorua Lakefront
 SHEET 1 OF 4

PROJECT: Stage 2: GI on lake Barge
 CO-ORDINATES: 5774858.00 mN
 1885049.00 mE
 R.L.: 279.00m
 DATUM: MOTUHT1953

LOCATION: Rotorua Lakefront
 DRILL TYPE: ST40 HQ Core Rig
 DRILL METHOD: RC
 DRILL FLUID:

JOB No.: 1007467.1000.3
 HOLE STARTED: 26/09/2018
 HOLE FINISHED: 26/09/2018
 DRILLED BY: Perry Geotech Ltd
 LOGGED BY: DWDS
 CHECKED: RWOT



0.00-3.00m



3.00-6.80m

Core Photos: 6/11/2018 10:26:21 AM Produced with Core-GIS by Geobac

CORE PHOTOS

BOREHOLE No.: BH06

Hole Location: Rotorua Lakefront

SHEET 2 OF 4

PROJECT: Stage 2: GI on lake Barge		LOCATION: Rotorua Lakefront	JOB No.: 1007467.1000.3
CO-ORDINATES (NZTM2000)	5774858.00 mN 1885049.00 mE	DRILL TYPE: ST40 HQ Core Rig	HOLE STARTED: 26/09/2018 HOLE FINISHED: 26/09/2018
R.L.	279.00m	DRILL METHOD: RC	DRILLED BY: Perry Geotech Ltd
DATUM	MOTUHT1953	DRILL FLUID:	LOGGED BY: DWDS CHECKED: RWOT



6.80-9.90m



9.90-12.90m

CORE PHOTOS

BOREHOLE No.: BH06

Hole Location: Rotorua Lakefront

SHEET 3 OF 4

PROJECT: Stage 2: GI on lake Barge		LOCATION: Rotorua Lakefront	JOB No.: 1007467.1000.3
CO-ORDINATES (NZTM2000)	5774858.00 mN 1885049.00 mE	DRILL TYPE: ST40 HQ Core Rig	HOLE STARTED: 26/09/2018 HOLE FINISHED: 26/09/2018
R.L.	279.00m	DRILL METHOD: RC	DRILLED BY: Perry Geotech Ltd
DATUM	MOTUHT1953	DRILL FLUID:	LOGGED BY: DWDS CHECKED: RWOT



12.90-15.90m



15.90-19.20m



CORE PHOTOS

BOREHOLE No.: BH06

Hole Location: Rotorua Lakefront

SHEET 4 OF 4

PROJECT: Stage 2: GI on lake Barge		LOCATION: Rotorua Lakefront	JOB No.: 1007467.1000.3
CO-ORDINATES (NZTM2000)	5774858.00 mN 1885049.00 mE	DRILL TYPE: ST40 HQ Core Rig	HOLE STARTED: 26/09/2018
R.L.:	279.00m	DRILL METHOD: RC	HOLE FINISHED: 26/09/2018
DATUM:	MOTUHT1953	DRILL FLUID:	DRILLED BY: Perry Geotech Ltd
			LOGGED BY: DWDS CHECKED: RWOT



19.20-19.95m

Core Photos - 9/11/2018 10:28:24 AM - Produced with Core-CIS by GeHoc



BOREHOLE LOG

BOREHOLE No.:
BH07

SHEET 1 OF 4
 DRILLED BY: Tony
 LOGGED BY: CAMY
 CHECKED: RWOT
 START DATE: 27/09/2018
 FINISH DATE: 27/09/2018
 CONTRACTOR: Perry Geotech Ltd

PROJECT: Stage 2: GI on lake Barge	CO-ORDINATES (NZTM2000)	5774633.00 mN 1885503.00 mE	R.L. GROUND: 279.00m
JOB No.: 1007467.1000.3	DIRECTION:	0°	R.L. COLLAR: 279.00m
LOCATION: Rotorua Lakefront	ANGLE FROM HORIZ.:	-90°	DATUM: MOTUHT1953
			SURVEY: Handheld GPS

GEOLOGICAL UNIT	DESCRIPTION OF CORE		ROCK DEFECTS														
	Rock Weathering	Rock Strength	Sampling Method	Core Recovery (%)	Testing	RL (m)	Depth (m)	Graphic Log	Defect Log	Fracture Spacing (mm)	RCD (%)	Description & Additional Observations	Fluid Loss (%)	Water Level	Casing	Installation	Core Box No
			HQTT	73			0.5										
			1.10m - 1.55m: Core loss.														
			SPT	82			1.5										
			SILT with minor sand and trace of clay, yellowish brown. Soft, wet, low plasticity, sand, fine, burnt wood found within core in this unit.														
			HQTT	100			2.0										
			Alluvial Deposits														
			SPT	44			2.7										
			Fine to coarse SAND with some silt, trace of clay and gravel, light grey. Loose, moist, well graded, gravel, fine, sub-rounded to sub-angular, unweathered, pumice.														
			3.25m - 3.45m: Core loss.														
			Fine to medium SAND, minor silt, yellowish brown. Loose, wet, well graded.														
			HQTT	100			3.5										
			4.00 - 4.50m: Changes to SAND with minor silt and gravel, gravel, fine to medium.														
			SPT	26			4.5										
			Fine to coarse GRAVEL with minor sand and trace of silt, light grey. Medium dense, wet, well graded, sub-rounded to sub-angular, unweathered, pumice, sand, fine to coarse.														
			4.60m - 4.95m: Core loss.														

COMMENTS: Lake water depth 0.5 m

Hole Depth: 19.95m
Scale: 1:25

General Log - 9/11/2018 11:49:26 AM - Produced with Core-CIS by GeHoc

BH07 03/05/18

Rev. A



BOREHOLE LOG

BOREHOLE No.:
BH07

SHEET 2 OF 4
DRILLED BY: Tony
LOGGED BY: CAMY
CHECKED: RWOT
START DATE: 27/09/2018
FINISH DATE: 27/09/2018
CONTRACTOR: Perry Geotech Ltd

PROJECT: Stage 2: GI on lake Barge
JOB No.: 1007467.1000.3
LOCATION: Rotorua
Lakelfront

CO-ORDINATES: 5774633.00 mN
1865503.00 mE
R.L. GROUND: 279.00m
R.L. COLLAR: 279.00m
DIRECTION: 0°
ANGLE FROM HORIZ.: -90°
DATUM: MOTUHT1953
SURVEY: Handheld GPS

GEOLOGICAL UNIT	DESCRIPTION OF CORE	Rock Weathering	Rock Strength	Sampling Method	Core Recovery (%)	Testing	RL (m)	Depth (m)	ROCK DEFECTS				Fluid Loss (%)	Water Level	Casing	Installation	Core Box No
									Graphic Log	Defect Log	Fracture Spacing (mm)	ROD (%)					
Soil	Fine to medium SAND, minor silt and gravel, trace of clay, light grey. Medium dense, moist to wet, gravel, fine to coarse, pumice. 5.05 - 6.90m Changes to bright dark green with a strong sulfur smell. Pumice is easily crushed.			HQTT	100		5.5										
	6.17m - 6.45m Core loss.			SPT	62	1/0 0/1 0/1 N=2	6.0										
	Fine to medium SAND, minor silt and gravel, trace of clay, (as above).			HQTT	100		6.5										
	Sandy SILT with minor clay, light grey. Soft, moist, low plasticity, dilatant, sand, fine, sand content decreases with depth.			HQTT	100		7.0										
	Fine to medium SAND with some silt, greenish grey. Loose, wet, well graded.			SPT	33	1/3 4/8 3/3 N=20	7.5										
	7.85m - 7.95m Core loss.						8.0										
	Sandy SILT, light grey. Soft to firm, wet, low plasticity dilatant sand, fine to medium.			HQTT	100		8.5										
	Fine to coarse SAND with some silt, light grey. Very loose to loose, wet, well graded.			SPT	33	1/0 0/1 0/1 N=2	9.0										
	9.30m - 9.45m Core loss.						9.5										
	Fine to coarse SAND with some silt, light grey. Very loose to loose, wet, well graded.						9.5										

COMMENTS: Lake water depth 0.5 m

Hole Depth 19.95m

Scale 1:25

Rev. A



BOREHOLE LOG

BOREHOLE No.:
BH07

SHEET 3 OF 4
DRILLED BY: Tony
LOGGED BY: CAMY
CHECKED: RWOT
START DATE: 27/09/2018
FINISH DATE: 27/09/2018
CONTRACTOR: Perry Geotech Ltd

PROJECT: Stage 2: GI on lake Barge
JOB No.: 1007467.1000.3
LOCATION: Rotorua
Lakelfront

CO-ORDINATES: 5774633.00 mN
1865503.00 mE
R.L. GROUND: 279.00m
R.L. COLLAR: 279.00m
DIRECTION: 0°
ANGLE FROM HORIZ.: -90°
DATUM: MOTUHT1953
SURVEY: Handheld GPS

GEOLOGICAL UNIT	DESCRIPTION OF CORE	Rock Weathering	Rock Strength	Sampling Method	Core Recovery (%)	Testing	RL (m)	Depth (m)	ROCK DEFECTS				Fluid Loss (%)	Water Level	Casing	Installation	Core Box No
									Graphic Log	Defect Log	Fracture Spacing (mm)	ROD (%)					
Soil	Sandy SILT, light grey. Soft to firm, wet, low plasticity, dilatant, sand, fine.			HQTT	100	0/1 0/0 0/0 N=0	10.5										
	SILT with minor sand and trace of clay, light grey. Firm to stiff, moist to wet, low plasticity, dilatant, sand, fine.			HQTT	100		11.0										
	11.90 - 13.50m Changes to moist.			SPT	100	1/1 1/1 1/2 N=5	12.0										
	12.45 - 14.30m Changes to SILT with minor sand and minor clay.			SPT	100	1/2 2/2 3/3 N=10	12.5										
	13.50 - 14.30m SILT with minor sand, clay and gravel, fine.			HQTT	100		13.0										
	SILT with some gravel, minor sand and trace of clay, light grey. Firm to stiff, moist to wet, low plasticity, dilatant, sand, fine, gravel, fine to medium.			HQTT	100		13.5										

COMMENTS: Lake water depth 0.5 m

Hole Depth 19.95m

Scale 1:25

Rev. A

General Log: 8/11/2018 11:46:28 AM - Produced with Core-GIS by G&B

General Log: 8/11/2018 11:46:28 AM - Produced with Core-GIS by G&B



BOREHOLE LOG

BOREHOLE No.:
BH07

SHEET 4 OF 4

DRILLED BY: Tony

LOGGED BY: CAMY

CHECKED: RWOT

START DATE: 27/09/2018

FINISH DATE: 27/09/2018

CONTRACTOR: Perry Geotech Ltd

PROJECT: Stage 2: GI on lake Barge
JOB No.: 1007467.1000.3
LOCATION: Rotorua Lakefront

CO-ORDINATES: 5774633.00 mN
1855503.00 mE
R.L. GROUND: 279.00m
R.L. COLLAR: 279.00m
DATUM: MOTUHT1953
SURVEY: Handheld GPS

DIRECTION: 0°
ANGLE FROM HORIZ.: -90°

GEOLOGICAL UNIT	DESCRIPTION OF CORE	Rock Weathering	Rock Strength	Sampling Method	Core Recovery (%)	Testing	RL (m)	Depth (m)	ROCK DEFECTS				Fluid Loss (%)	Water Level	Casing	Installation	Core Box No	
									Graphic Log	Defect Log	Fracture Spacing (mm)	ROD (%)						Description & Additional Observations
	SILT with minor gravel, sand and trace of clay, light grey. Firm to stiff, moist to wet, low plasticity, dilatant, sand, fine, gravel, fine, pumice, breccia. 15.10m - 15.45m: Core loss.			SPT	22	1/1 2/2 2/2 N=8	15.10	15.45										
	SILT with minor gravel, sand and trace of clay, (as above). Becomes soft.			HQTT	100		15.5	16.0										
	16.60m - 16.96m: Core loss.			SPT	22	1/0 1/1 2/1 N=5	16.5	16.96										
	SILT with minor gravel, sand and trace of clay, (as above).			HQTT	100		16.5	17.0										
Alluvial Deposits	Unweathered, light grey, fine, BRECCIA. Moderately strong, highly fractured, well graded. Likely a large boulder emplacement.			HQTT	100		17.5	18.0										
	SILT with minor clay, light grey. Soft to stiff, moist to wet, low plasticity, dilatant.			SPT	44	1/2 3/4 4/4 N=15	18.0	18.5										
	18.25m - 18.45m: Core loss.			HQTT	100		18.5	19.0										
	SILT with minor clay and trace of gravel, light grey. Firm to stiff, moist to wet, moderate plasticity, gravel, fine.			SPT	100	0/0 0/2 1/2 N=5	19.5	19.95										
	Unweathered, light grey, fine, BRECCIA. Moderately strong, pumice and breccia likely ignimbrite. Fractured by drilling.			HQTT	100		19.0	19.5										
	SILT with minor clay and gravel, light grey. Firm, moist, dilatant, gravel, fine to medium, sub-rounded to sub-angular, unweathered.			SPT	100		19.5	19.95										

COMMENTS: Lake water depth 0.5 m

Hole Depth: 19.95m
Scale: 1:25



CORE PHOTOS

BOREHOLE No.: **BH07**

Hole Location: Rotorua Lakefront

SHEET 1 OF 4

PROJECT: Stage 2: GI on lake Barge	LOCATION: Rotorua Lakefront	JOB No.: 1007467.1000.3
CO-ORDINATES: 5774633.00 mN 1855503.00 mE	DRILL TYPE: ST40 HQ Core Rig	HOLE STARTED: 27/09/2018
R.L.: 279.00m	DRILL METHOD: RC	HOLE FINISHED: 27/09/2018
DATUM: MOTUHT1953	DRILL FLUID:	DRILLED BY: Perry Geotech Ltd
		LOGGED BY: CAMY
		CHECKED: RWOT



0.00-3.45m



3.45-6.45m

PROJECT: Stage 2: GI on lake Barge	LOCATION: Rotorua Lakefront	JOB No.: 1007467.1000.3
CO-ORDINATES (NZTM2000) 5774633.00 mN 1885503.00 mE	DRILL TYPE: ST40 HQ Core Rig	HOLE STARTED: 27/09/2018 HOLE FINISHED: 27/09/2018
R.L.: 279.00m	DRILL METHOD: RC	DRILLED BY: Perry Geotech Ltd
DATUM: MOTUHT1953	DRILL FLUID:	LOGGED BY: CAMY CHECKED: RWOT



6.45-9.60m

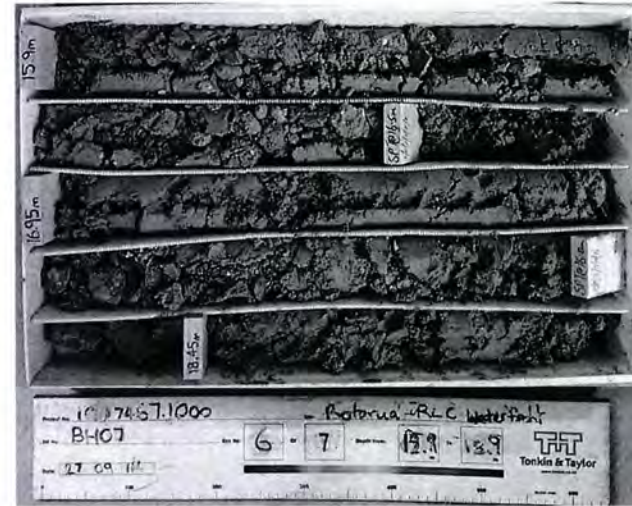


9.60-12.70m

PROJECT: Stage 2: GI on lake Barge	LOCATION: Rotorua Lakefront	JOB No.: 1007467.1000.3
CO-ORDINATES (NZTM2000) 5774633.00 mN 1885503.00 mE	DRILL TYPE: ST40 HQ Core Rig	HOLE STARTED: 27/09/2018 HOLE FINISHED: 27/09/2018
R.L.: 279.00m	DRILL METHOD: RC	DRILLED BY: Perry Geotech Ltd
DATUM: MOTUHT1953	DRILL FLUID:	LOGGED BY: CAMY CHECKED: RWOT



12.70-15.90m



15.90-18.90m



CORE PHOTOS

BOREHOLE No.: BH07

Hole Location: Rotorua Lakefront

SHEET 4 OF 4

PROJECT: Stage 2: GI on lake Barge		LOCATION: Rotorua Lakefront	JOB No.: 1007467.1000.3
CO-ORDINATES (NZTM2000)	5774633.00 mN 1885503.00 mE	DRILL TYPE: ST40 HQ Core Rig	HOLE STARTED: 27/09/2018 HOLE FINISHED: 27/09/2018
R.L.	279.00m	DRILL METHOD: RC	DRILLED BY: Perry Geotech Ltd
DATUM	MOTUHT1953	DRILL FLUID:	LOGGED BY: CAMY CHECKED: RWOT



18.90-19.95m

Core Photos - 01/10/2018 10:28 AM - Produced with Core-GS by G&Bac



BOREHOLE LOG

BOREHOLE No.:
BH08

SHEET: 1 OF 4

DRILLED BY: Tony

LOGGED BY: CAMY

CHECKED: RWOT

START DATE: 28/09/2018

FINISH DATE: 28/09/2018

CONTRACTOR: Perry Geotech Ltd

PROJECT: Stage 2: GI on lake Barge

JOB No.: 1007467.1000.3

LOCATION: Rotorua Lakefront

CO-ORDINATES (NZTM2000)

5774628.00 mN
1885487.00 mE

R.L. GROUND: 279.00m

R.L. COLLAR: 279.00m

DATUM: MOTUHT1953

SURVEY: Handheld GPS

DIRECTION:
ANGLE FROM HORIZ.: -90°

GEOLOGICAL UNIT	DESCRIPTION OF CORE		Rock Weathering	Rock Strength	Sampling Method	Core Recovery (%)	Testing	RL (m)	Depth (m)	Graphic Log	ROCK DEFECTS							
	SOI: Classification, colour, consistency/density, moisture, plasticity ROCK: Weathering, colour, fabric name, strength, cementation										Description & Additional Observations		Fluid Loss (%)	Water Level	Casing	Installation	Core Box No	
	SILT with minor sand, trace of clay, dark yellowish brown. Very soft, saturated, low plasticity, dilatant, sand, fine				HQTT	86		278	0.5									
	0.95m - 1.45m Core loss								1.0									
	SILT with minor sand, trace of clay, (as above)				SPT	100	0/0 0/0 0/0 N=8	277	1.5									
	Fine to medium SAND, minor silt, light grey Dense, moist to wet, dilatant, well graded				HQTT	49		276	2.5									
	Silty fine to medium SAND, dark yellowish brown. Loose, moist to wet, well graded								3.0									
	2.50m - 3.10m Core loss								3.5									
	Fine to coarse SAND with minor gravel, trace of silt, light bluish grey. Medium dense, saturated, well graded, gravel, fine, pumiceous				SPT	22	2/2 3/5 6/5 N=19	276	4.0									
	4.00m - 4.60m Core loss				HQTT	49		275	4.5									
	Fine to medium GRAVEL with minor silt and sand, light grey. Dense, wet, sub-rounded to sub-angular, unweathered, sand, fine to medium, pumice				SPT	22	1/0 1/1 1/1 N=4		5.0									

COMMENTS: Lake water depth: 0.5 m

Hole Depth: 19.95m
Scale: 1:25

General Log - 01/10/2018 9:32:14 AM - Produced with Core-GS by G&Bac

Rev: 1.000-01



BOREHOLE LOG

BOREHOLE No.:
BH08

SHEET: 2 OF 4
DRILLED BY: Tony
LOGGED BY: CAMY
CHECKED: RWOT
START DATE: 28/09/2018
FINISH DATE: 28/09/2018
CONTRACTOR: Perry Geotech Ltd

PROJECT: Stage 2: GI on lake Barge
JOB No.: 1007467.1000.3
LOCATION: Rotorua Lakefront

CO-ORDINATES: 5774628.00 mN
1885487.00 mE
DIRECTION: 0°
ANGLE FROM HORIZ.: -90°

R.L. GROUND: 279.00m
R.L. COLLAR: 279.00m
DATUM: MOTUHT1953
SURVEY: Handheld GPS

GEOLOGICAL UNIT	DESCRIPTION OF CORE	Rock Weathering	Rock Strength	Sampling Method	Core Recovery (%)	Testing	RL (m)	Depth (m)	Graphic Log	ROCK DEFECTS				Fluid Loss (%)	Water Level	Casing	Installation	Core Box No
										Defect Log	Fracture Spacing (mm)	RQD (%)	Description & Additional Observations					
	SOIL Classification: colour, consistency / density, moisture, plasticity ROCK Weathering: colour, fabric, name, strength, cementation																	
	Fine to medium GRAVEL with minor silt and sand, light grey Dense, wet, sub-rounded to sub-angular, unweathered, sand, fine to medium, pumice			HQTT	100		55											
	6.25m - 6.45m Core loss			SPT	44	0/0 0/0 1/1 N=2	60											
	SILT with minor sand and gravel, light grey Soft, wet, low plasticity, dilatant, sand, fine to coarse, gravel, fine to medium, sub-rounded to sub-angular, unweathered 6.60 - 6.75m: Changes to dilatant, rapid			HQTT	100		7.0											
	6.80 - 6.95m: Changes to SILT with minor sand, fine to medium 6.95 - 7.50m: Changes to SILT with trace sand, firm						7.5											
	Sandy SILT, light greyish green Soft, wet, dilatant, sand, fine, becomes more green down unit 7.70m - 7.95m Core loss			SPT	55	0/0 0/0 0/1 N=2	80											
	Sandy SILT, (as above)						85											
	Silty fine SAND, light grey Loose, wet, poorly graded 8.50 - 8.80m: Changes to greenish grey			HQTT	100		90											
	Fine to coarse SAND with some silt; light grey Very loose, wet, well graded			SPT	66	0/0 0/0 1/0 N=1	90											
	9.30m - 9.45m Core loss						95											
	Fine to coarse SAND with some silt, (as above)																	
	Silty fine to medium SAND, light grey Loose, wet, well graded																	

COMMENTS: Lake water depth: 0.5 m

Hole Depth
19.95m

General Log: 6/11/2018 9:30:14 AM Produced with Core-OS by Geotac

Scale: 1:25

Rev: A



BOREHOLE LOG

BOREHOLE No.:
BH08

SHEET: 3 OF 4
DRILLED BY: Tony
LOGGED BY: CAMY
CHECKED: RWOT
START DATE: 28/09/2018
FINISH DATE: 28/09/2018
CONTRACTOR: Perry Geotech Ltd

PROJECT: Stage 2: GI on lake Barge
JOB No.: 1007467.1000.3
LOCATION: Rotorua Lakefront

CO-ORDINATES: 5774628.00 mN
1885487.00 mE
DIRECTION: 0°
ANGLE FROM HORIZ.: -90°

R.L. GROUND: 279.00m
R.L. COLLAR: 279.00m
DATUM: MOTUHT1953
SURVEY: Handheld GPS

GEOLOGICAL UNIT	DESCRIPTION OF CORE	Rock Weathering	Rock Strength	Sampling Method	Core Recovery (%)	Testing	RL (m)	Depth (m)	Graphic Log	ROCK DEFECTS				Fluid Loss (%)	Water Level	Casing	Installation	Core Box No
										Defect Log	Fracture Spacing (mm)	RQD (%)	Description & Additional Observations					
	SOIL Classification: colour, consistency / density, moisture, plasticity ROCK Weathering: colour, fabric, name, strength, cementation																	
	Gravelly fine SAND, light grey Medium dense, moist, gravel, fine, sub-rounded to sub-angular, unweathered, pumice SILT, minor clay, trace of sand, light grey Firm, moist, low plasticity, dilatant, sand, fine 50 mm lens: Fine SAND, minor silt, light grey Medium dense, moist SILT, minor clay, trace sand (as above) Fine to medium SAND with minor silt and gravel, light grey Medium dense, moist to wet, gravel, fine to medium, sub-rounded to sub-angular, unweathered, breccia and pumice 10.50m - 10.85m Core loss Fine to medium SAND with minor silt and gravel, (as above)			HQTT	100	0/1 0/0 0/0 N=0	10.5											
	6.25m - 6.45m Core loss			SPT	22		11.0											
	SILT with minor sand and gravel, light grey Soft, wet, low plasticity, dilatant, sand, fine to coarse, gravel, fine to medium, sub-rounded to sub-angular, unweathered 6.60 - 6.75m: Changes to dilatant, rapid			HQTT	100		11.5											
	6.80 - 6.95m: Changes to SILT with minor sand, fine to medium 6.95 - 7.50m: Changes to SILT with trace sand, firm						12.0											
	Sandy SILT, light greyish green Soft, wet, dilatant, sand, fine, becomes more green down unit 7.70m - 7.95m Core loss			SPT	100	4/5 15/7 5/5 N=32	12.5											
	Sandy SILT, (as above)						13.0											
	Silty fine SAND, light grey Loose, wet, poorly graded 8.50 - 8.80m: Changes to greenish grey			HQTT	100		13.5											
	Fine to coarse SAND with some silt; light grey Very loose, wet, well graded			SPT	100	1/0 0/0 1/1 N=2	14.0											
	9.30m - 9.45m Core loss						14.5											
	Fine to coarse SAND with some silt, (as above)																	
	Silty fine to medium SAND, light grey Loose, wet, well graded			HQTT	100													

COMMENTS: Lake water depth: 0.5 m

Hole Depth
19.95m

General Log: 6/11/2018 9:30:14 AM Produced with Core-OS by Geotac

Scale: 1:25

Rev: A



BOREHOLE LOG

BOREHOLE No.:
BH08

SHEET 4 OF 4

DRILLED BY: Tony

LOGGED BY: CAMY

CHECKED: RWOT

START DATE: 28/09/2018

FINISH DATE: 28/09/2018

CONTRACTOR: Perry Geotech Ltd

PROJECT: Stage 2: GI on lake Barge
JOB No.: 1007467.1000.3
LOCATION: Rotorua Lakefront

CO-ORDINATES 5774628.00 mN
(NZTM2000) 1885487.00 mE
R.L. GROUND: 279.00m
R.L. COLLAR: 279.00m
DATUM: MOTUHT1953
SURVEY: Handheld GPS

DIRECTION: 0°
ANGLE FROM HORIZ.: -90°

GEOLOGICAL UNIT	DESCRIPTION OF CORE	Rock Weathering	Rock Strength	Sampling Method	Core Recovery (%)	Testing	RL (m) Depth (m)	ROCK DEFECTS				Fluid Loss (%)	Water Level	Casing	Installation	Core Box No
								Graphic Log	Defect Log	Fracture Spacing (mm)	RQD (%)					
	15.00m - 15.45m Core loss			SPT	0	1/0 1/1 1/1 N=4	15.0									
	Silty fine to coarse SAND with minor gravel, light grey. Loose, wet, dilatant, well graded, gravel, fine to coarse, sub-rounded to sub-angular, unweathered, pumice			HQTT	100		15.5									
	SILT with some sand and minor clay, light grey Firm to stiff, wet, low plasticity, dilatant			HQTT	100		16.0									
				SPT	100	2/2 4/4 4/7 N=13	16.5									
	SILT with some sand and trace of gravel, light grey Firm to stiff, wet, low plasticity, dilatant, sand, fine to coarse, gravel, fine to medium, sub-rounded to sub-angular, unweathered			HQTT	100		17.0									
	17.60 - 18.00m Changes to SILT with some sand and minor gravel			HQTT	100		17.5									
	18.00m - 18.45m Core loss			SPT	0	1/2 3/2 2/2 N=9	18.0									
	18.45 - 19.00m Changes to SILT with minor sand and trace of gravel. 18.70 - 19.25m Changes to SILT with some sand and minor gravel, pumice and breccia			HQTT	100		18.5									
	Sandy SILT, light brownish grey Firm, wet, low plasticity, dilatant, sand, fine to coarse			HQTT	100		19.0									
	19.85 - 19.95m Loose pumice 19.95m: Target depth			SPT	100	0/1 1/1 1/2 N=5	19.5									

COMMENTS Lake water depth: 0.5 m

Note Depth 19.95m

Scale 1:25



CORE PHOTOS

BOREHOLE No.: BH08

Hole Location: Rotorua Lakefront

SHEET 1 OF 4

PROJECT: Stage 2: GI on lake Barge	LOCATION: Rotorua Lakefront	JOB No.: 1007467.1000.3
CO-ORDINATES 5774628.00 mN (NZTM2000) 1885487.00 mE	DRILL TYPE: ST40 HQ Core Rig	HOLE STARTED: 28/09/2018
R.L.: 279.00m	DRILL METHOD: RC	HOLE FINISHED: 28/09/2018
DATUM: MOTUHT1953	DRILL FLUID:	DRILLED BY: Perry Geotech Ltd
		LOGGED BY: CAMY
		CHECKED: RWOT



0.00-4.00m



4.00-6.45m

CORE PHOTOS

BOREHOLE No.: **BH08**

Hole Location: Rotorua Lakefront

SHEET 2 OF 4

PROJECT: Stage 2: GI on lake Barge		LOCATION: Rotorua Lakefront	JOB No.: 1007467.1000.3
CO-ORDINATES (NZTM2000)	5774628.00 mN 1885487.00 mE	DRILL TYPE: ST40 HQ Core Rig	HOLE STARTED: 28/09/2018 HOLE FINISHED: 28/09/2018
R.L.	279.00m	DRILL METHOD: RC	DRILLED BY: Perry Geotech Ltd
DATUM	MOTUHT1953	DRILL FLUID:	LOGGED BY: CAMY CHECKED: RWOT



6.45-9.00m



9.00-11.40m

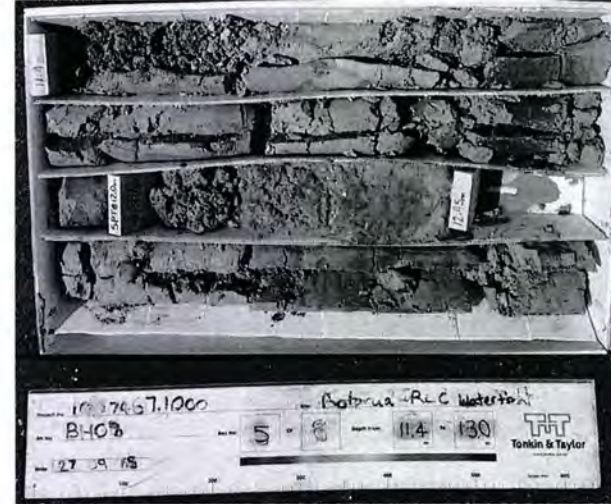
CORE PHOTOS

BOREHOLE No.: **BH08**

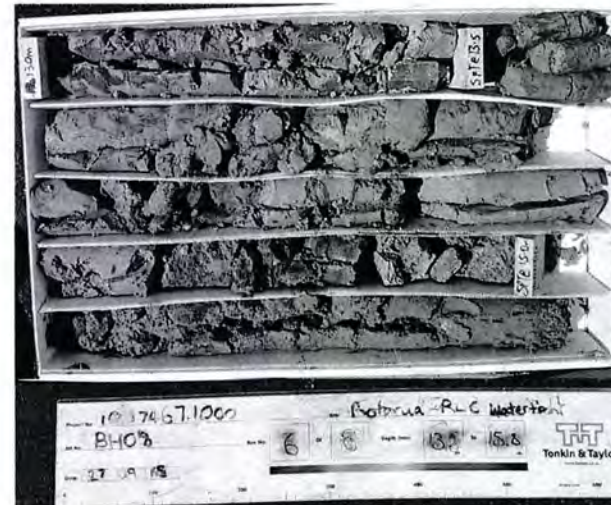
Hole Location: Rotorua Lakefront

SHEET 3 OF 4

PROJECT: Stage 2: GI on lake Barge		LOCATION: Rotorua Lakefront	JOB No.: 1007467.1000.3
CO-ORDINATES (NZTM2000)	5774628.00 mN 1885487.00 mE	DRILL TYPE: ST40 HQ Core Rig	HOLE STARTED: 28/09/2018 HOLE FINISHED: 28/09/2018
R.L.	279.00m	DRILL METHOD: RC	DRILLED BY: Perry Geotech Ltd
DATUM	MOTUHT1953	DRILL FLUID:	LOGGED BY: CAMY CHECKED: RWOT



11.40-13.00m



13.00-15.80m

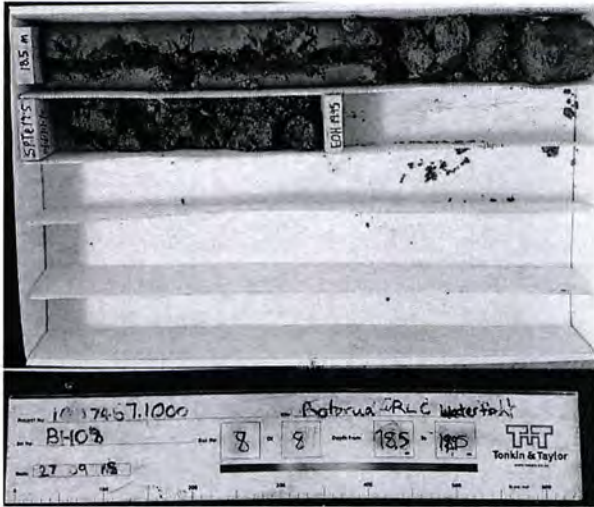
CORE PHOTOS

BOREHOLE No.: **BH08**
 Hole Location: Rotorua Lakefront
 SHEET 4 OF 4

PROJECT: Stage 2: GI on lake Barge		LOCATION: Rotorua Lakefront	JOB No.: 1007467.1000.3
CO-ORDINATES (NZTM2000)	5774628.00 mN 1885487.00 mE	DRILL TYPE ST40 HQ Core Rig	HOLE STARTED 28/09/2018 HOLE FINISHED 28/09/2018
R.L.	278.00m	DRILL METHOD RC	DRILLED BY Perry Geotech Ltd
DATUM	MOTUHT1953	DRILL FLUID	LOGGED BY: CAMY CHECKED: RWOT



15.80-18.50m



18.50-19.95m

Appendix C: Laboratory Test Results



Hill Laboratories
TRIED, TESTED AND TRUSTED

R J Hill Laboratories Limited
28 Duke Street Frankton 3204
Private Bag 3205
Hamilton 3240 New Zealand
T 0508 HILL LAB (44 555 22)
T +64 7 858 2000
E mail@hill-labs.co.nz
W www.hill-laboratories.com

Certificate of Analysis Page 1 of 1

Client: Tonkin & Taylor	Lab No: 2088733	SRV1
Contact: Peter Molyneaux	Date Received: 29-Nov-2018	
C/- Tonkin & Taylor	Date Reported: 05-Dec-2018	
PO Box 9544	Quote No: 80842	
Hamilton 3240	Order No: 1007467.1000	
	Client Reference: 1007467.1000	
	Submitted By: Peter Molyneaux	

Sample Type: Soil			
Sample Name:	BH05 2.3m	BH07 1.2m	BH08 1.8m
	28-Nov-2018	28-Nov-2018	28-Nov-2018
Lab Number:	2088733.1	2088733.2	2088733.3
Organic Matter	g/100g dry wt	5.4	4.9
Ash	g/100g dry wt	95	95

Summary of Methods

The following table(s) gives a brief description of the methods used to conduct the analyses for this job. The detection limits given below are those attainable in a relatively clean matrix. Detection limits may be higher for individual samples should insufficient sample be available, or if the matrix requires that dilutions be performed during analysis. Unless otherwise indicated, analyses were performed at Hill Laboratories, 28 Duke Street, Frankton, Hamilton 3204.

Sample Type: Soil			
Test	Method Description	Default Detection Limit	Sample No
Organic Matter	Calculation: 100 - Ash (dry wt)	0.04 g/100g dry wt	1-3
Ash	Ignition in muffle furnace 550°C, 6hr, gravimetric. APHA 2540 G 22 nd ed. 2012.	0.04 g/100g dry wt	1-3

These samples were collected by yourselves (or your agent) and analysed as received at the laboratory.

Samples are held at the laboratory after reporting for a length of time depending on the preservation used and the stability of the analytes being tested. Once the storage period is completed the samples are discarded unless otherwise advised by the client.

This certificate of analysis must not be reproduced, except in full, without the written consent of the signatory.

Kim Harrison MSc
Client Services Manager - Environmental



Our Ref: 1008611.0.0.0/Rep 1
Customer Ref: 1007467.1000
26 October 2018

Tonkin & Taylor - Hamilton
711 Victoria Street,
Hamilton 3240

Attention: Mr Dan Smith

Dear Dan

**Rotorua Lakefront Redevelopment
Laboratory Test Report**

Sample from the above mentioned site have been tested as received according to your instructions. Test results are included in this report.

Sample was destroyed during testing.

Description is enclosed for your information, but is not covered under the IANZ endorsement of this report.

Please reproduce this report in full when transmitting to others or including in internal reports.

If we can be of any further assistance, feel free to get in touch. Contact details are provided at the bottom of this page.

GEOTECHNICS LTD

Report prepared by:

Sim Tirunahari
I am the author of this document
2018 10 26 17:13:56 +1300

Sim Tirunahari
Soils Laboratory Manager
Approved Signatory

Authorised for Geotechnics by:

Steven Anderson
Project Director

Report checked by:

Steven Anderson
Operations & Technical Manager



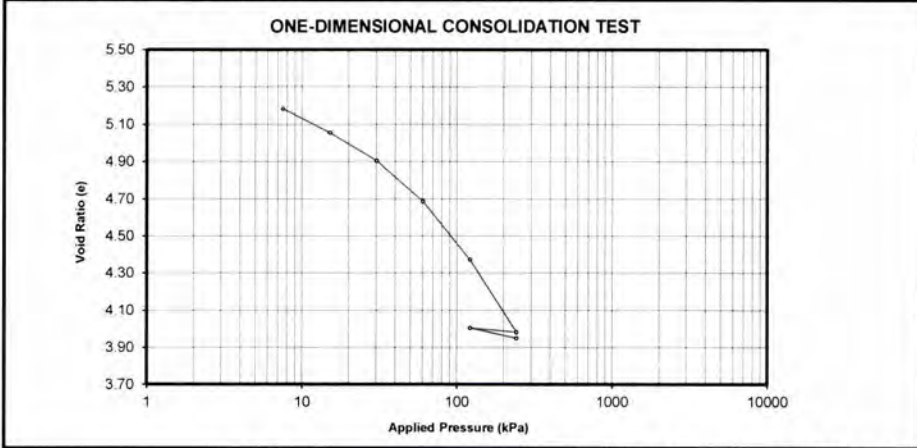
This document consists of 3 pages.

26-Oct-18
t:\geotechnicsgroup\projects\1008611\issueddocuments\20181026.rotorua lakefront redevelopment.st.final.rep1.docx

19-23 Morgan Street, Newmarket, Auckland 1023 | PO Box 9360, Newmarket, Auckland 1149
p +64 9 356 3510 | enquiry@geotechnics.co.nz | www.geotechnics.co.nz

GEOTECHNICS Ground Floor, 19 Morgan Street, Newmarket, Auckland 1023
 PO Box 9360, Newmarket, Auckland 1149
 p 64 9 356 3510
 www.geotechnics.co.nz

Your Job No.: 1007467.1000
 Site: Rotorua Lakefront Redevelopment
 Our Job No.: 1008611.0.0.0
 BH No.: 5 Sample ID: --- Depth: 3.10-3.15 (m)
 Test Method Used: NZS 4402:1986 Test 7.1 One-Dimensional Consolidation



Pressure (kPa)	Void Ratio (e)	Pressure Increment (kPa)	Coefficient of Consolidation Cv (m ² /yr)	Coefficient of Volume Compressibility Mv (m ² /MN)
As received	0	5.246		
Preload	7.5	5.184	NA	1.3
Load	15.1	5.056	7.5 to 15.1	8.7
Load	30.2	4.906	15.1 to 30.2	7.6
Load	60.3	4.687	30.2 to 60.3	6.8
Load	121	4.374	60.3 to 121	6.0
Load	241	3.983	121 to 241	5.6
Unload	121	4.007	241 to 121	NA
Load	241	3.951	121 to 241	NA

Sample History: Undisturbed core trimmed at NWC
 Description: SILT with trace of clay and trace of sand, soft, light greenish grey
 Initial Dry Density (t/m³): 0.32 Initial Water Content: 249%
 Solid Density (t/m³): 2.00 (Assumed) Initial Saturation: 95%
 Temperature During Testing: Max = 19 °C Min = 17 °C
 Remarks: The soil is light weight.
 SQR of time fitting method was used. We have assumed a value of 2.00 t/m³. The calculations of void ratio are affected by the solid density value.
 The test results are IANZ accredited but the sample description is not IANZ accredited.

Entered by: JK Date: 26/10/2018 Checked by: ST Date: 26/10/2018

GEOTECHNICS Ground Floor, 19 Morgan Street, Newmarket, Auckland 1023
 p. +64 9 356 3510
 Geotechnics Project ID: 1008611.0.0.0
 Customer Project ID: 1007467.1

Liquid Limit, Plastic Limit and Plasticity Index of Soils - ASTM Test D4318-17e1 (Method A)

TEST DETAILS				
LOCATION	ID	Rotorua lakefront Redevelopment - BH5_3.15-3.25m		
	Description	N/A		
	Data	N/A		
SAMPLE	Geotechnics ID	N/A		
	Reference	N/A	Depth	N/A
	Description	SILT with trace of clay and trace of sand, soft, light greenish grey.		
SPECIMEN	Reference	N/A	Depth	N/A
	Description	N/A		

TEST RESULTS	
Liquid Limit	Not Obtainable*
Plastic Limit	Non Plastic & Not Obtainable
Plasticity Index	Not Obtainable
As Received Water Content	247.0%

TEST REMARKS
 * The material used for testing was natural, fraction passing 425um sieve. * The liquid limit was done with a mechanical device. The plastic limit was mechanically rolled. A metal grooving tool was used. * The soil was mechanically pushed through a 425um sieve. The maximum grain size was approximately <2mm. * Both the final Liquid Limit and Plastic Limit results were unobtainable during the course of testing. * The sample description is not IANZ accredited. * The sample description follows the "NZGS Guidelines for field description of soil and rock"

This test result is IANZ accredited.
 Approved By: ST Date: 26/10/2018



Ground Floor
19 Morgan Street
Newmarket
Auckland 1023
p. +64 9 356 3510

Geotechnics Project ID 1008611.0.0.0
Customer Project ID 1007467.1

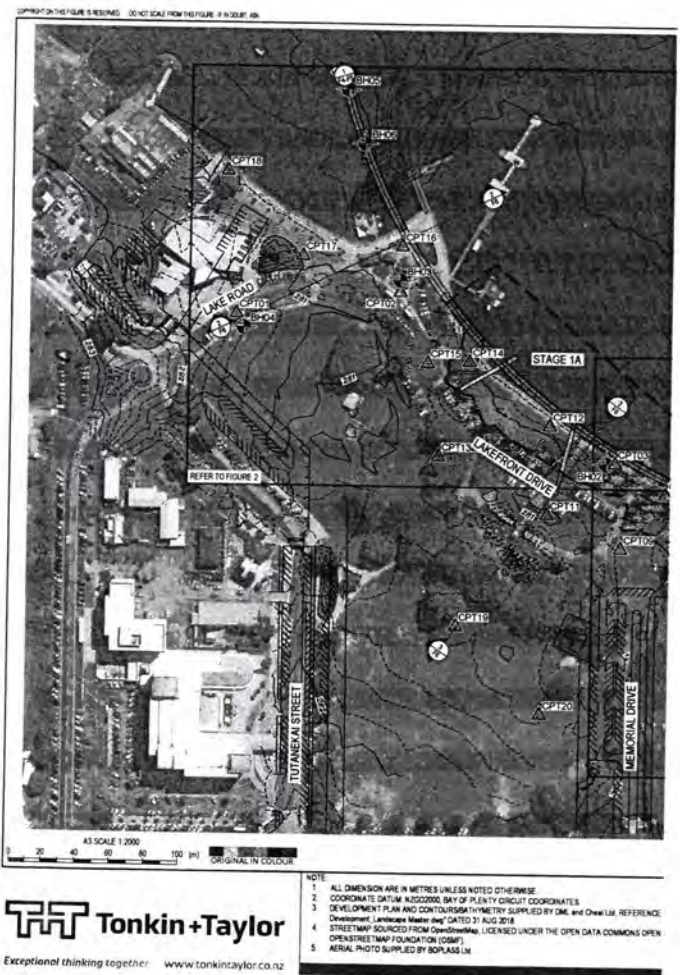
Liquid Limit, Plastic Limit and Plasticity Index of Soils - ASTM Test D4318-17e1 (Method A)

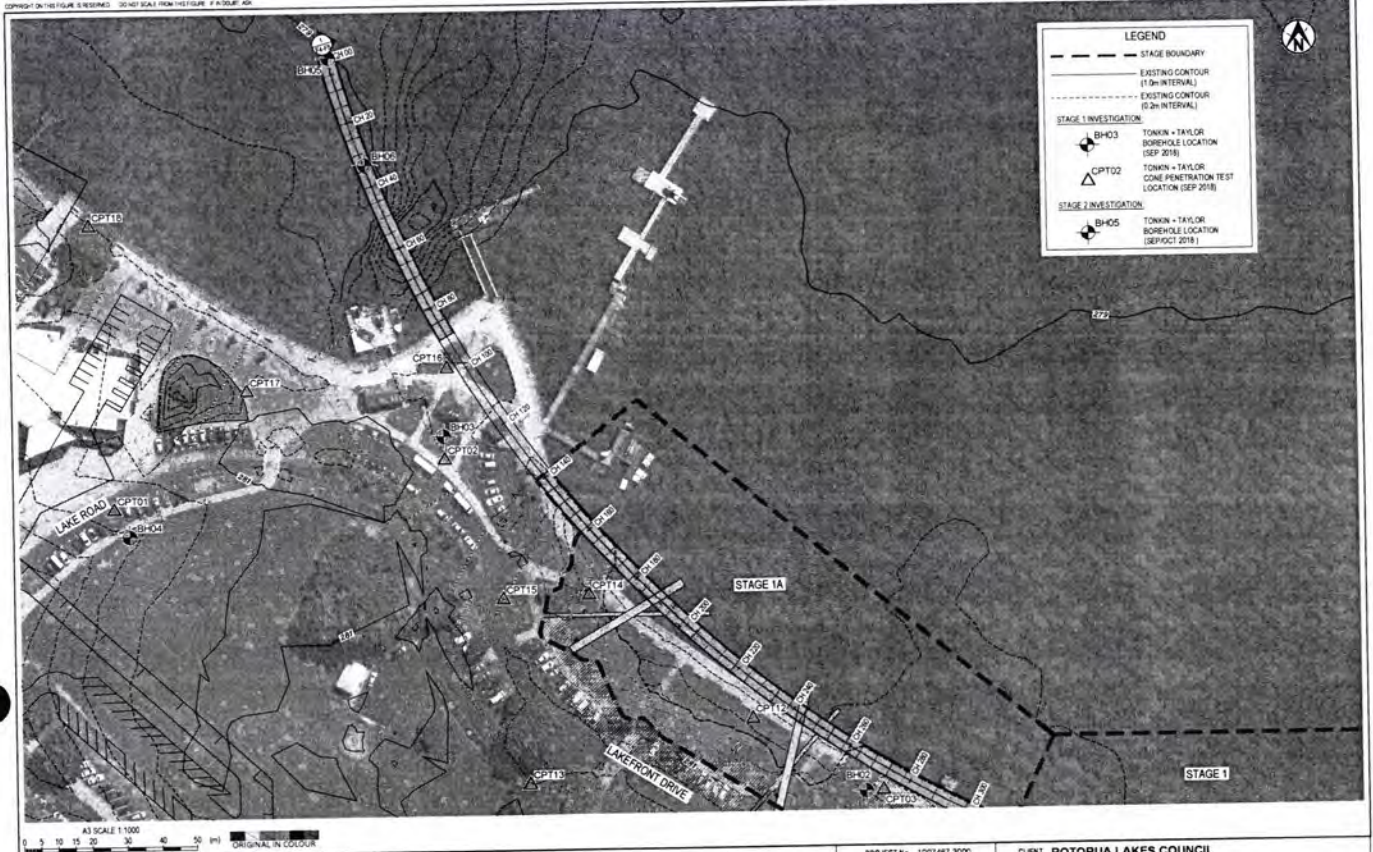
TEST DETAILS				
LOCATION	ID	Rotorua lakefront Redevelopment - BHS_3.15-3.25m		
	Description	N/A		
	Data	N/A		
SAMPLE	Geotechnics ID	N/A		
	Reference	N/A	Depth	N/A
	Description	SILT with trace of clay and trace of sand, soft, light greenish grey.		
SPECIMEN	Reference	N/A	Depth	N/A
	Description	N/A		
TEST RESULTS				
Liquid Limit	Not Suitable		PROVISIONAL	
Plastic Limit	Not Suitable			
Plasticity Index	Not Obtainable			
As Received Water Content	---			
TEST REMARKS				
<p>* The material was unsuitable for testing both the Liquid Limit and the Plastic Limit. * The liquid limit was done with a mechanical device. The plastic limit was mechanically rolled. A metal grooving tool was used. * The soil was mechanically pushed through a 425um sieve. The maximum grain size was approximately <2mm. * Both the final Liquid Limit and Plastic Limit results were unobtainable during the course of testing. * The sample description follows the "NZGS Guidelines for field description of soil and rock".</p>				
<p>This test result is IANZ accredited.</p>				
Approved By	ST	Date	18/10/2018	

Appendix B: Site plans

Tonkin & Taylor Ltd
 Redoubt Lakefront Development - Geotechnical Interpretive Report
 Redoubt Lakes Council

February 2019
 Job No: 1007467/2009

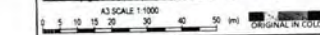
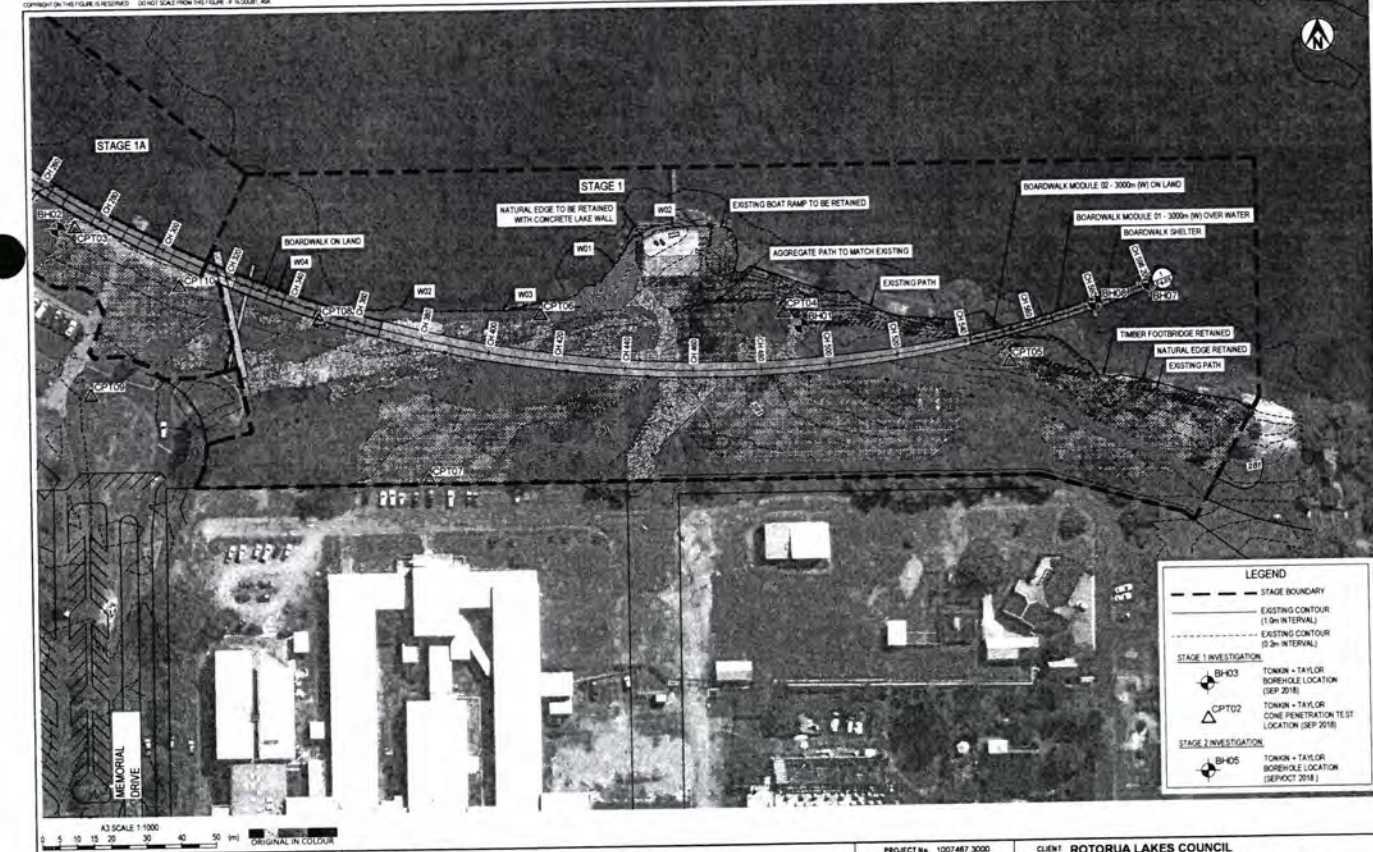




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NOTE:
1. ALL DIMENSION ARE IN METRES UNLESS NOTED OTHERWISE
2. COORDINATE DATUM NZGD2000, BAY OF PLENTY GRID COORDINATES
3. DEVELOPMENT PLAN AND CONTIGUOUS DIMETRY SUPPLIED BY DML and CHAL LM, REFERENCE TOL 4010, Roturua Lakeshore Development Landscape Master Plan DATED 31 AUG 2018
4. STREET MAP SOURCED FROM OpenStreetMap LICENSED UNDER THE OPEN DATA COMMONS OPEN DATABASE LICENSE (ODBL) BY THE OPENSTREETMAP FOUNDATION (OSMF)
5. AERIAL PHOTO SUPPLIED BY BOP/LASS LM

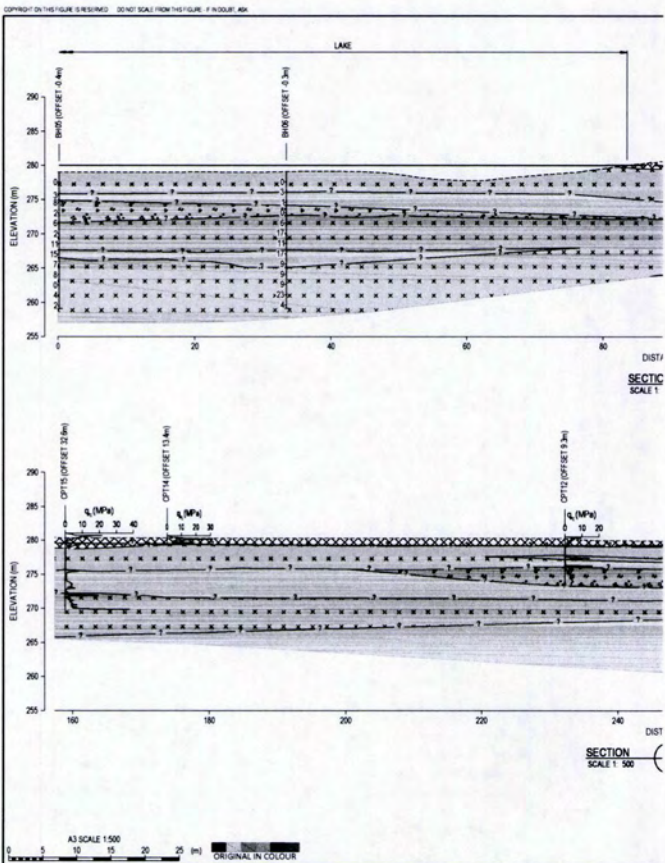
PROJECT No	1007467_3000	CLIENT	ROTORUA LAKES COUNCIL
DESIGNED	PEMO JC Oct 18	PROJECT	ROTORUA LAKEFRONT REDEVELOPMENT
DRAWN	JC Oct 18	TITLE	GEOTECHNICAL INVESTIGATION
CHECKED			SITE PLAN (SHEET 1 OF 2)
C. DAVANA	11/02/19	SCALE (AR)	1:1000
APPROVED	DATE	FIG No	FIGURE 2
			REV 1

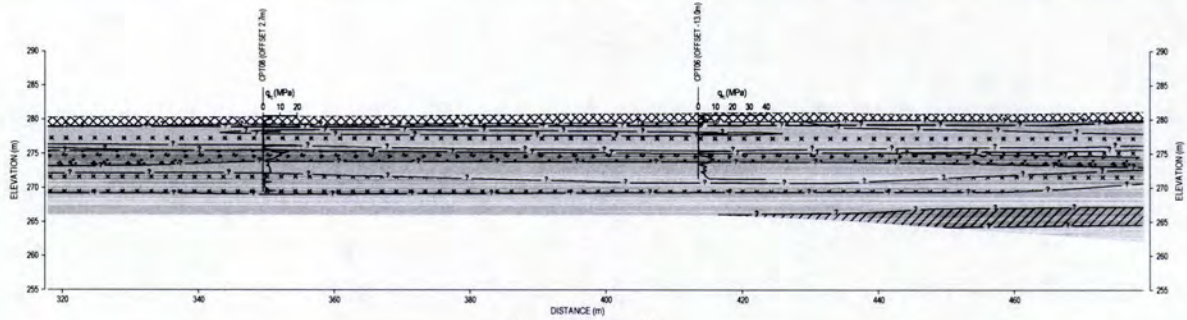


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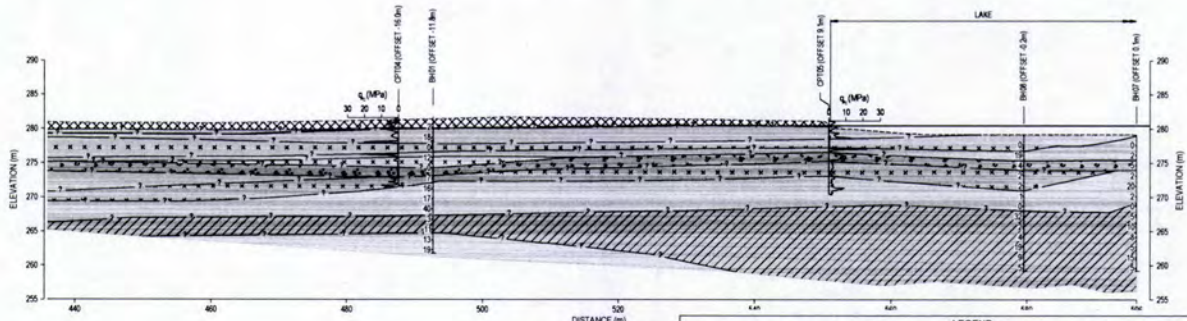
NOTE:
1. ALL DIMENSION ARE IN METRES UNLESS NOTED OTHERWISE
2. COORDINATE DATUM NZGD2000, BAY OF PLENTY GRID COORDINATES
3. DEVELOPMENT PLAN AND CONTIGUOUS DIMETRY SUPPLIED BY DML and CHAL LM, REFERENCE TOL 4010, Roturua Lakeshore Development Landscape Master Plan DATED 31 AUG 2018
4. STREET MAP SOURCED FROM OpenStreetMap LICENSED UNDER THE OPEN DATA COMMONS OPEN DATABASE LICENSE (ODBL) BY THE OPENSTREETMAP FOUNDATION (OSMF)
5. AERIAL PHOTO SUPPLIED BY BOP/LASS LM

PROJECT No	1007467_3000	CLIENT	ROTORUA LAKES COUNCIL
DESIGNED	PEMO JC Oct 18	PROJECT	ROTORUA LAKEFRONT REDEVELOPMENT
DRAWN	JC Oct 18	TITLE	GEOTECHNICAL INVESTIGATION
CHECKED			SITE PLAN (SHEET 2 OF 2)
C. DAVANA	11/02/19	SCALE (AR)	1:1000
APPROVED	DATE	FIG No	FIGURE 3
			REV 1

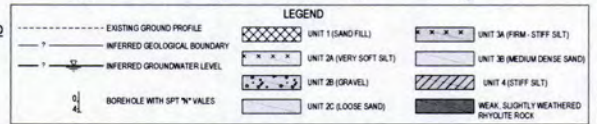




SECTION 1 CONTINUED
SCALE 1:500



SECTION 1 CONTINUED
SCALE 1:500

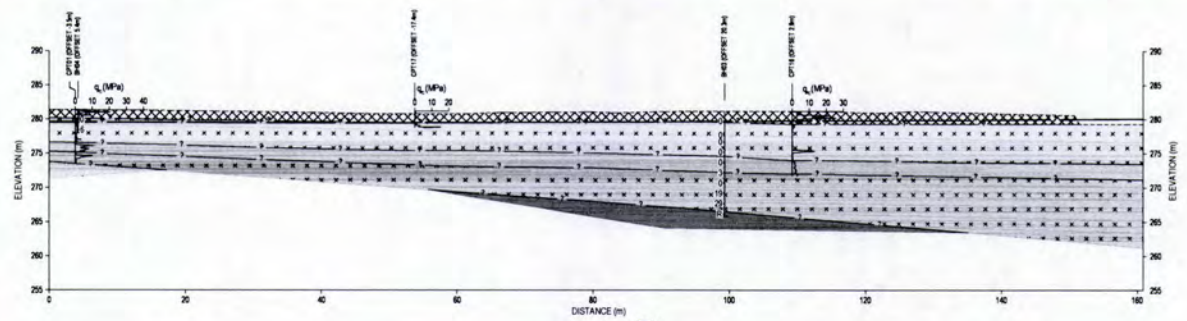


NOTE:
1. ALL DIMENSION ARE IN METRES UNLESS NOTED OTHERWISE
2. LEVEL DATUM LINZ (MSL) (MOTURUKI VERTICAL DATUM 1983)
3. EXISTING GROUND LEVEL BASED ON CONTOURSMATHMETRY SUPPLIED BY IRTMUS L.M. REFERENCE 'topo_hydra_combined.dwg' DATED 25 SEP 2014

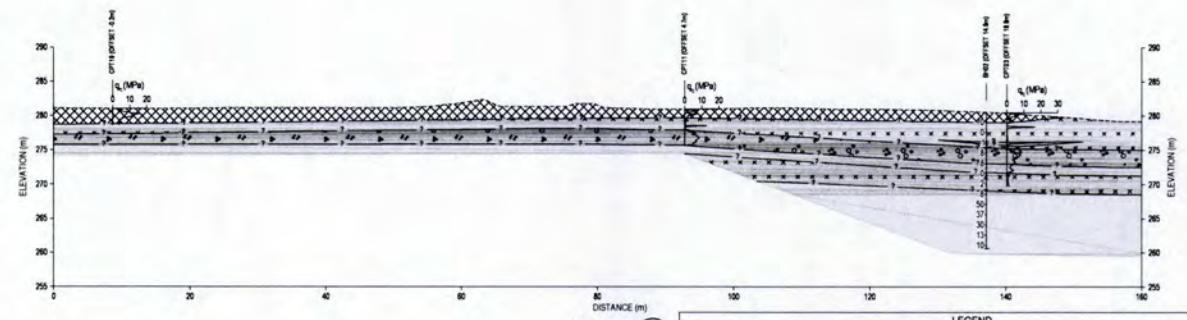
PROJECT No.	1007487_3000
DESIGNED	PEMO JC
DRAWN	JC
CHECKED	JC
APPROVED	C DAVANNA
DATE	11/2/19

CLIENT	ROTORUA LAKES COUNCIL
PROJECT	ROTORUA LAKEFRONT REDEVELOPMENT
TITLE	GEOTECHNICAL INVESTIGATION GEOLOGICAL LONGSECTION (SHEET 2 OF 2)
SCALE (AS)	1:500
FIG No.	FIGURE 5
REV	1

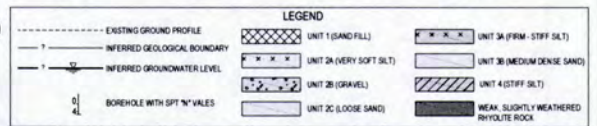
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SECTION 2
SCALE 1:500



SECTION 3
SCALE 1:500

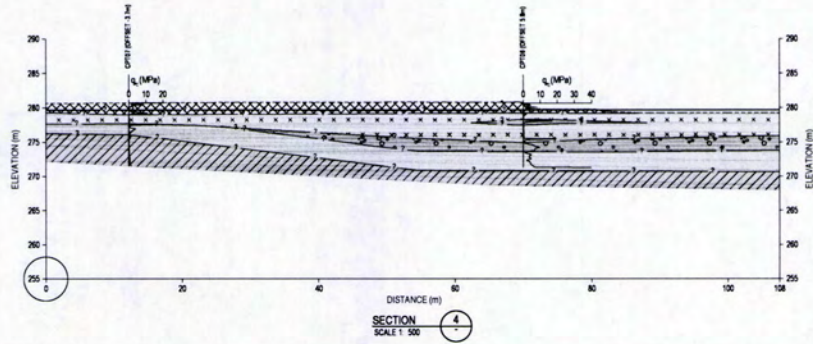


NOTE:
1. ALL DIMENSION ARE IN METRES UNLESS NOTED OTHERWISE
2. LEVEL DATUM
3. EXISTING GROUND LEVEL BASED ON CONTOURSMATHMETRY SUPPLIED BY IRTMUS L.M. REFERENCE 'topo_hydra_combined.dwg' DATED 25 SEP 2014

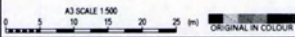
PROJECT No.	1007487_3000
DESIGNED	PEMO JC
DRAWN	JC
CHECKED	JC
APPROVED	C DAVANNA
DATE	11/2/19

CLIENT	ROTORUA LAKES COUNCIL
PROJECT	ROTORUA LAKEFRONT REDEVELOPMENT
TITLE	GEOTECHNICAL INVESTIGATION GEOLOGICAL CROSS SECTIONS (SHEET 1 OF 2)
SCALE (AS)	1:500
FIG No.	FIGURE 6
REV	1

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LEGEND	
---	EXISTING GROUND PROFILE
- - -	INFERRED GEOLOGICAL BOUNDARY
- - -	INFERRED GROUNDWATER LEVEL
○	BOREHOLE WITH SPT "N" VALUES
[Cross-hatched]	UNIT 1 (SAND FILL)
[Dotted]	UNIT 2A (VERY SOFT SILT)
[Stippled]	UNIT 2B (MEDIUM DENSE SAND)
[Diagonal lines]	UNIT 2C (GRAVEL)
[Horizontal lines]	UNIT 3A (FIRM - STIFF SILT)
[Vertical lines]	UNIT 3B (STIFF SILT)
[Wavy lines]	UNIT 4 (STIFF SILT)
[Dark grey]	WEAK, SLIGHTLY WEATHERED RHYOLITE ROCK

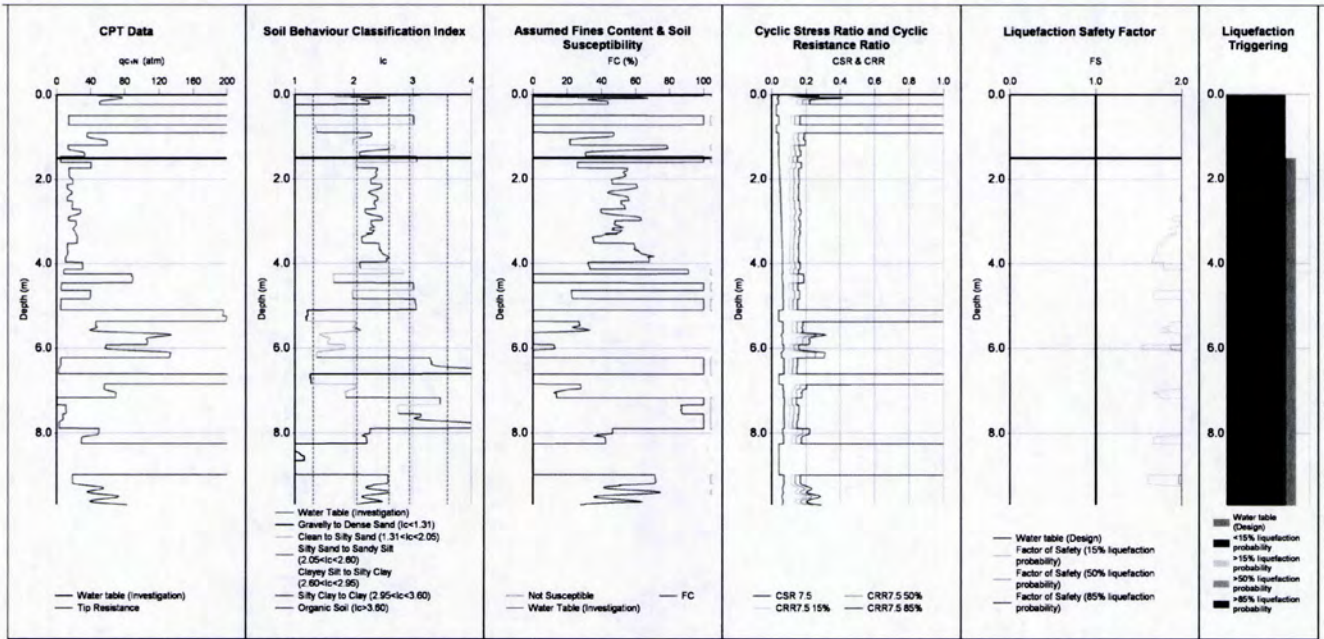


NOTE:
 1. ALL DIMENSIONS ARE IN METRES UNLESS NOTED OTHERWISE
 2. LEVEL DATUM: LINZ (MSL) MOTURKI VERTICAL DATUM 1993
 3. EXISTING GROUND LEVEL BASED ON CONTOURS/GATHMETRY SUPPLIED BY IAHVUKA LIM. REFERENCE 'topo_hydra_combined.dwg' DATED 25 SEP 2018

PROJECT No.	1007467 3000	CLIENT	ROTORUA LAKES COUNCIL	
DESIGNED	PEMO	Nov 18	PROJECT	
DRAWN	JC	Nov 18		ROTORUA LAKEFRONT REDEVELOPMENT
CHECKED			TITLE	
C DAVANNA	11/2/19		GEOLOGICAL CROSS SECTIONS (SHEET 2 OF 2)	
APPROVED		DATE	SCALE (AS)	1:500
			FIG No.	FIGURE 7
			REV	1

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Appendix D: Liquefaction analyses



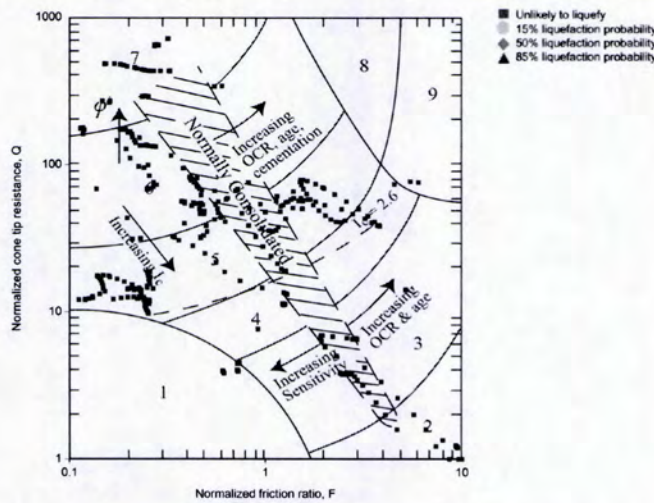
Note: Inverse filtered Qc/Fs data used (10 cm²)

Run Description	NZGD ID	Investigation Date	γ (kN/m ³)	Magnitude	PGA (g)	Trigger Method	Settlement Method	γ (kN/m ³)	Surcharge/Cut/Fill	Surcharge (kPa)	Cut/Fill Height (m)
INPUT	110916	31/07/2018	17	6	0.075	BI-2014	ZRB-2002	17			0
OUTPUT	PL	Sv1d (mm)	CTL (m)	LPI	LSN	CT (m)	LPlish				
	15%	3	0	0	1	9.7	0				
	50%	0	0	0	0	9.7	0				
	85%	0	0	0	0	9.7	0				

Reviewed by:

CPT Inversion	CDAV
Groundwater	CDAV
Susceptibility	CDAV
Triggering	CDAV
Consequence	CDAV

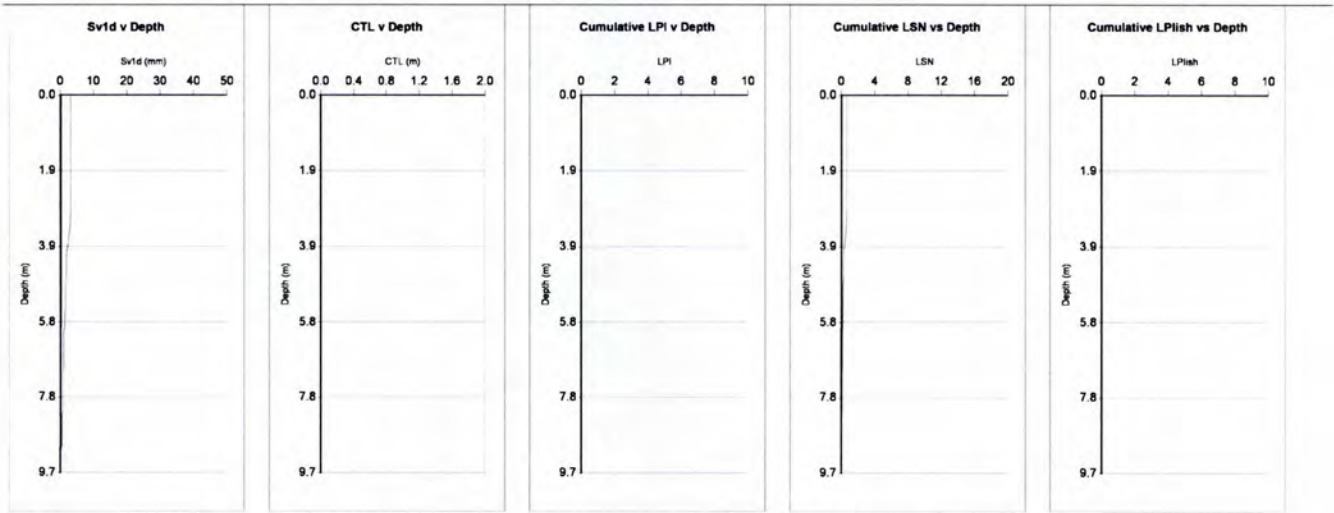
<p>Tonkin + Taylor Exceptional thinking together V2.0</p>	CLIENT	Rotorua Lakes Council	LOCATION	Rotorua	DATE	11/02/2019
	PROJECT	Rotorua Lakefront Redevelopment	JOB NUMBER	1007467.1000	ANALYSED	pemo
	TITLE	1:25 year event SLS	CHECKED		PAGE	1 of 33 pages
	COMMENT					



- 1. Sensitive, fine grained
- 2. Organic soils - peats
- 3. Clays - silty clay to clay
- 4. Silt mixtures - clayey silt to silty clay
- 5. Sand mixtures - silty sand to sandy silt
- 6. Sands - clean sand to silty sand
- 7. Gravelly sand to dense sand
- 8. Very stiff sand to clayey sand *
- 9. Very stiff, fine grained *

*Heavily overconsolidated or cemented
CPT-based soil behavior type classification chart by Robertson (1990)

<p>Tonkin + Taylor Exceptional thinking together V2.0</p>	CLIENT	Rotorua Lakes Council	LOCATION	Rotorua	DATE	11/02/2019
	PROJECT	Rotorua Lakefront Redevelopment	JOB NUMBER	1007467.1000	ANALYSED	pemo
	TITLE	1:25 year event SLS	CHECKED		PAGE	2 of 33 pages
	COMMENT					

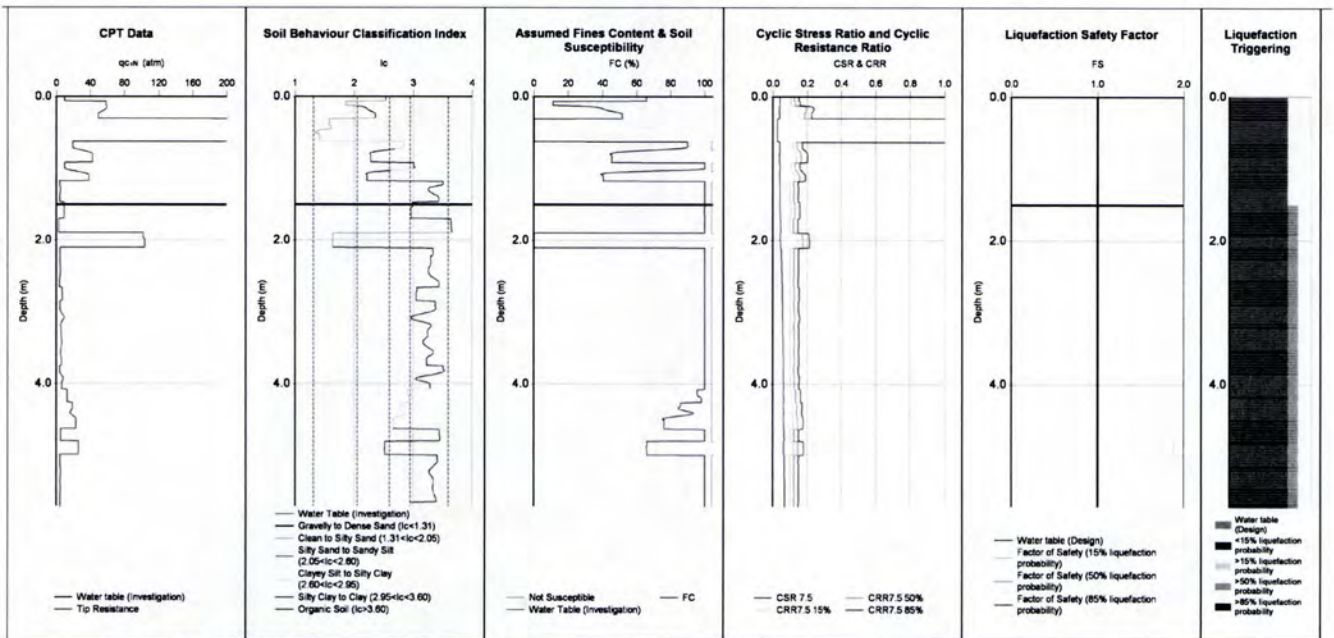


(Assumed pre-drill values)

CPT Name	NZGD ID	Investigation Date	Magnitude	PGA (g)	GWD (m)	Trigger Method	Settlement Method	Pre-drill Depth (m)	qc (MPa)	Fs (MPa)	γ (kN/m ³)
CPT01	110916	31/07/2018	6	0.075	1.5	BI-2014	ZRB-2002	0	2	0.01	17

Thicker lines represent the 50% probability of exceedance case and the thinner lines to the left and right of the thicker lines represent the 85% and 15% probability of exceedance cases respectively.

 Tonkin + Taylor	Tonkin + Taylor Exceptional thinking together V2.0	CLIENT Rotorua Lakes Council	LOCATION Rotorua	DATE 11/02/2019
		PROJECT Rotorua Lakefront Redevelopment	JOB NUMBER 1007467.1000	ANALYSED permo
		TITLE 1:25 year event SLS		CHECKED
		COMMENT 		PAGE 3 of 33 pages



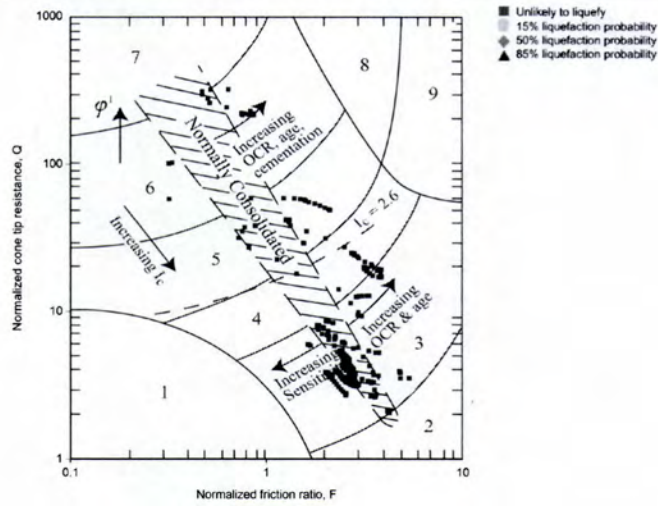
Note: Inverse filtered Qo/Fs data used (10 cm²)

Run Description	NZGD ID	Investigation Date	γ (kN/m ³)	Magnitude	PGA (g)	Trigger Method	Settlement Method	γ (kN/m ³)	Surcharge/Cut/Fill	Surcharge (kPa)	Cut/Fill Height (m)
INPUT	110917	31/07/2018	17	6	0.075	BI-2014	ZRB-2002	17			0

PL	Sv1d (mm)	CTL (m)	LPI	LSN	CT (m)	LPIish
OUTPUT	15%	0	0	0	5.7	0
	50%	0	0	0	5.7	0
	85%	0	0	0	5.7	0

Reviewed by:	
CPT Inversion	CDAV
Groundwater	CDAV
Susceptibility	CDAV
Triggering	CDAV
Consequence	CDAV

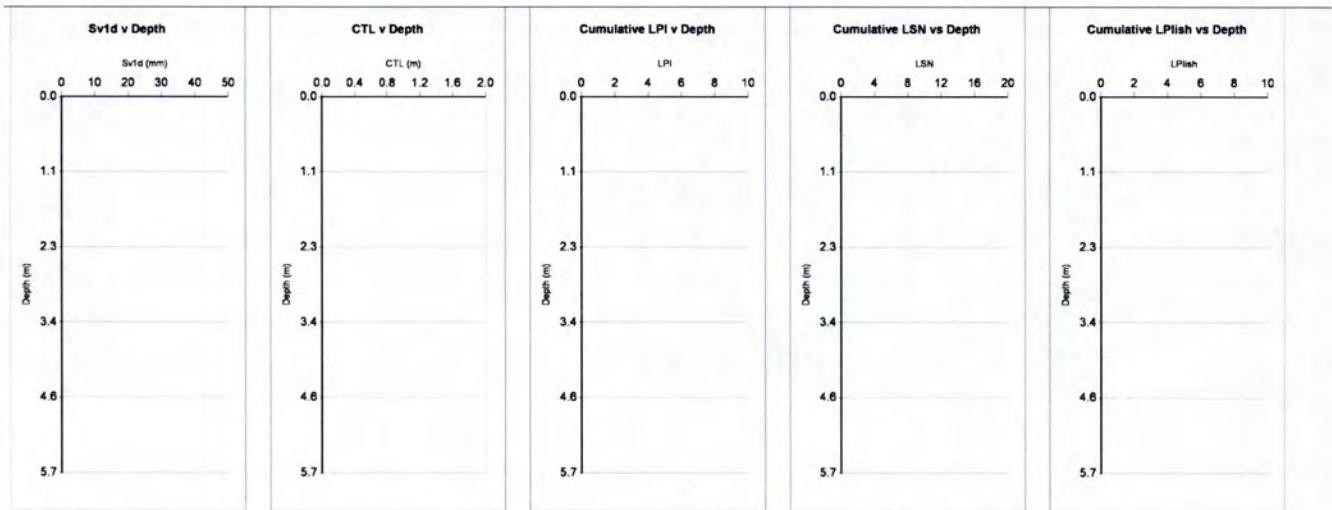
 Tonkin + Taylor	Tonkin + Taylor Exceptional thinking together V2.0	CLIENT Rotorua Lakes Council	LOCATION Rotorua	DATE 11/02/2019
		PROJECT Rotorua Lakefront Redevelopment	JOB NUMBER 1007467.1000	ANALYSED permo
		TITLE 1:25 year event SLS		CHECKED
		COMMENT 		PAGE 4 of 33 pages



- 1. Sensitive, fine grained
- 2. Organic soils - peats
- 3. Clays - silty clay to clay
- 4. Silt mixtures - clayey silt to silty clay
- 5. Sand mixtures - silty sand to sandy silt
- 6. Sands - clean sand to silty sand
- 7. Gravely sand to dense sand
- 8. Very stiff sand to clayey sand *
- 9. Very stiff, fine grained *

*Heavily overconsolidated or cemented
 CPT-based soil behavior type classification chart by Robertson (1990)

	Tonkin + Taylor Exceptional thinking together V2.0	CLIENT Rotorua Lakes Council PROJECT Rotorua Lakefront Redevelopment TITLE 1:25 year event SLS	LOCATION Rotorua DATE 11/02/2019
		COMMENT	ANALYSED pemo CHECKED PAGE 5 of 33 pages

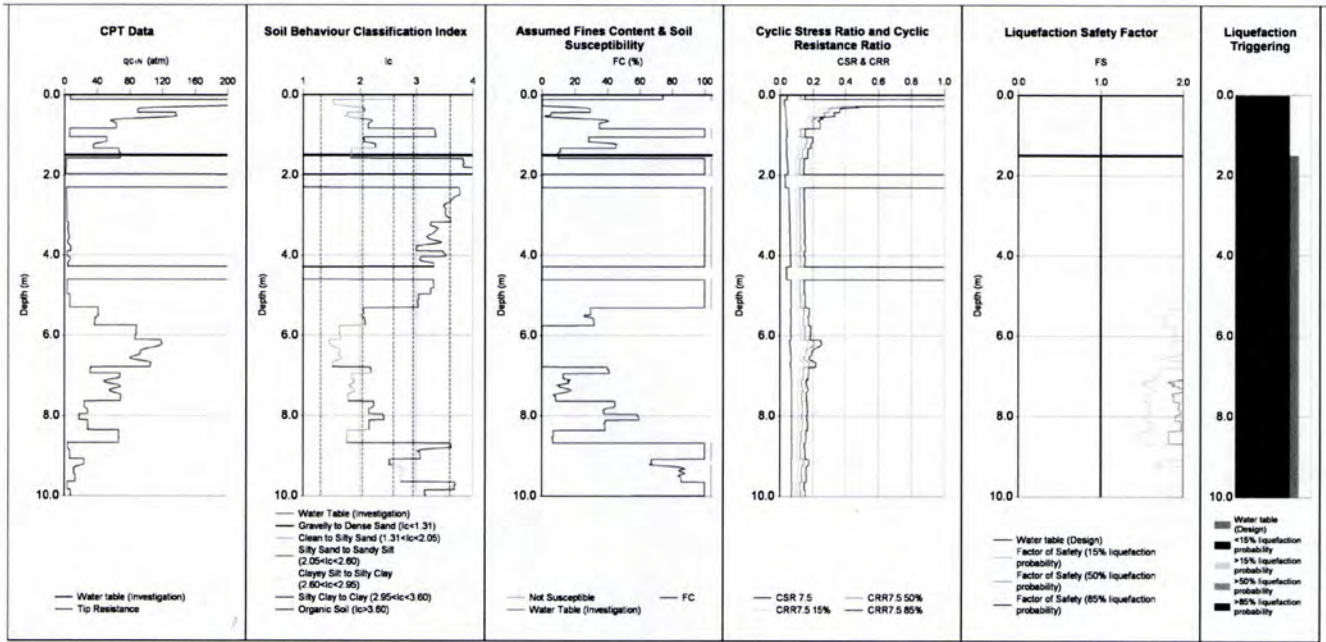


(Assumed pre-drill values)

CPT Name	NZGD ID	Investigation Date	Magnitude	PGA (g)	GWD (m)	Trigger Method	Settlement Method	Pre-drill Depth (m)	qc (MPa)	Fs (MPa)	γ (kN/m³)
CPT02	110917	31/07/2018	6	0.075	1.5	BI-2014	ZRB-2002	0	2	0.01	17

Thicker lines represent the 50% probability of exceedance case and the thinner lines to the left and right of the thicker lines represent the 85% and 15% probability of exceedance cases respectively.

	Tonkin + Taylor Exceptional thinking together V2.0	CLIENT Rotorua Lakes Council PROJECT Rotorua Lakefront Redevelopment TITLE 1:25 year event SLS	LOCATION Rotorua DATE 11/02/2019
		COMMENT	ANALYSED pemo CHECKED PAGE 6 of 33 pages



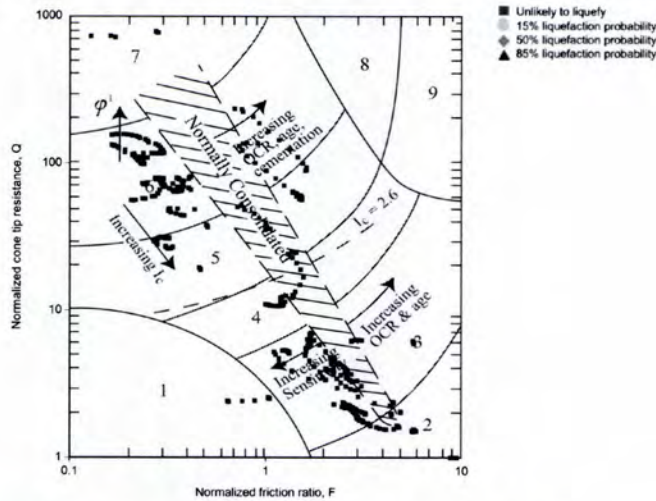
Note: Inverse filtered Q_c/F_s data used (10 cm²)

Run Description	NZGD ID	Investigation Date	γ (kN/m ³)	Magnitude	PGA (g)	Trigger Method	Settlement Method	γ (kN/m ³)	Surcharge/Cut/Fill	Surcharge (kPa)	Cut/Fill Height (m)
INPUT	110918	30/07/2018	17	6	0.075	BI-2014	ZRB-2002	17			0
OUTPUT	PL	Sv1d (mm)	CTL (m)	LPI	LSN	CT (m)	LPI _{slh}				
	15%	5	0	0	1	10	0				
	50%	1	0	0	0	10	0				
	85%	0	0	0	0	10	0				

Reviewed by:

CPT Inversion	CDAV
Groundwater	CDAV
Susceptibility	CDAV
Triggering	CDAV
Consequence	CDAV

<p>Tonkin + Taylor Exceptional thinking together V2.0</p>	CLIENT: Rotorua Lakes Council PROJECT: Rotorua Lakefront Redevelopment TITLE: 1:25 year event SLS COMMENT:	LOCATION: Rotorua DATE: 11/02/2019 ANALYSED: pemo CHECKED: PAGE: 7 of 33 pages
	JOB NUMBER: 1007467.1000	

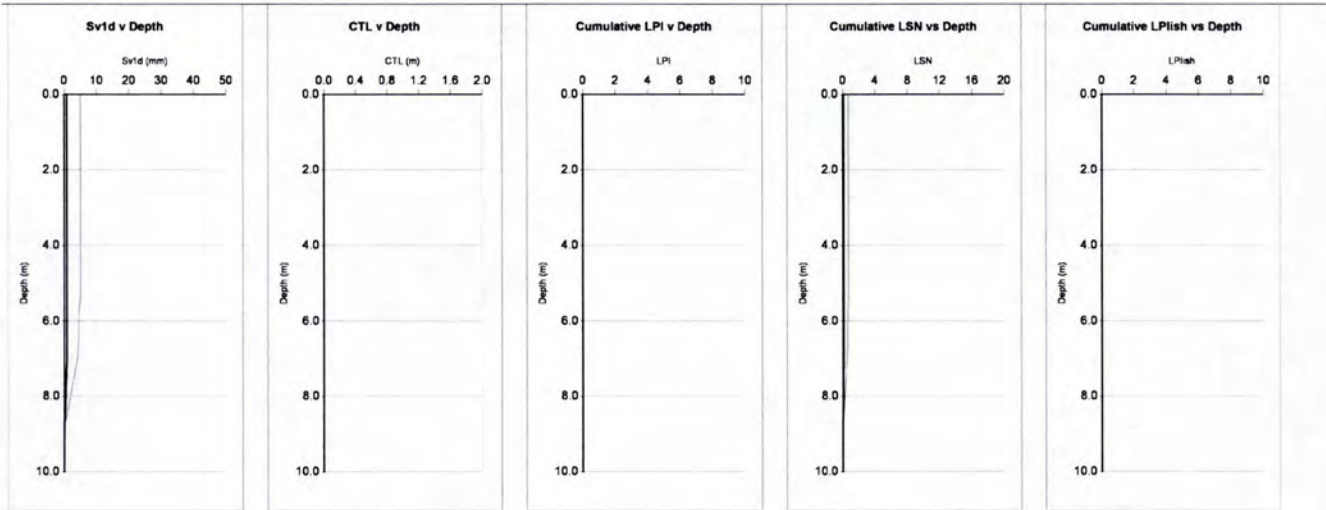


- | | |
|--|-------------------------------------|
| 1. Sensitive, fine grained | 6. Sands - clean sand to silty sand |
| 2. Organic soils - peats | 7. Gravelly sand to dense sand |
| 3. Clays - silty clay to clay | 8. Very stiff sand to clayey sand * |
| 4. Silt mixtures - clayey silt to silty clay | 9. Very stiff, fine grained * |
| 5. Sand mixtures - silty sand to sandy silt | |

*Heavily overconsolidated or cemented

CPT-based soil behavior type classification chart by Robertson (1990)

<p>Tonkin + Taylor Exceptional thinking together V2.0</p>	CLIENT: Rotorua Lakes Council PROJECT: Rotorua Lakefront Redevelopment TITLE: 1:25 year event SLS COMMENT:	LOCATION: Rotorua DATE: 11/02/2019 ANALYSED: pemo CHECKED: PAGE: 8 of 33 pages
	JOB NUMBER: 1007467.1000	

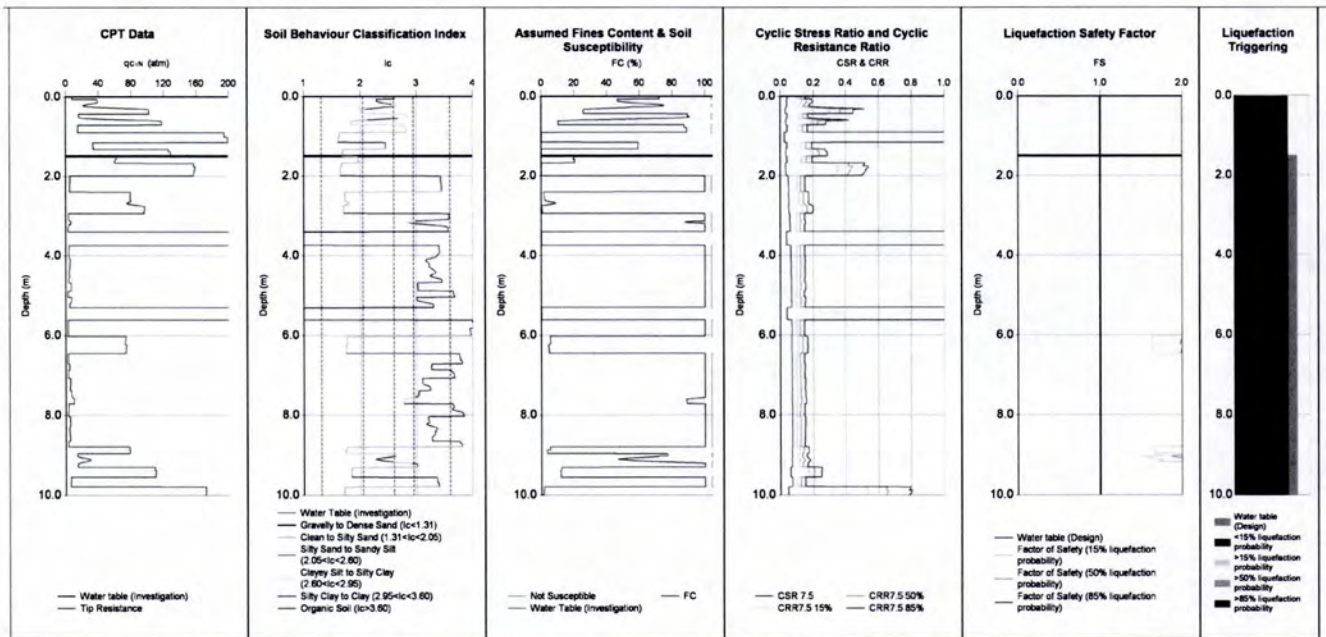


(Assumed pre-drill values)

CPT Name	NZGD ID	Investigation Date	Magnitude	PGA (g)	GWD (m)	Trigger Method	Settlement Method	Pre-drill Depth (m)	qc (MPa)	Fs (MPa)	γ (kN/m ³)
CPT03	110918	30/07/2018	6	0.075	1.5	Bi-2014	ZRB-2002	0	2	0.01	17

Thicker lines represent the 50% probability of exceedence case and the thinner lines to the left and right of the thicker lines represent the 85% and 15% probability of exceedence cases respectively.

 Tonkin+Taylor	Tonkin + Taylor Exceptional thinking together V2.0	CLIENT	Rotorua Lakes Council	LOCATION	Rotorua	DATE	11/02/2019
		PROJECT	Rotorua Lakefront Redevelopment	JOB NUMBER	1007467.1000	ANALYSED	permo
		TITLE	1:25 year event SLS	CHECKED		PAGE	9 of 33 pages



Note: Inverse filtered Qc/Fs data used (10 cm²)

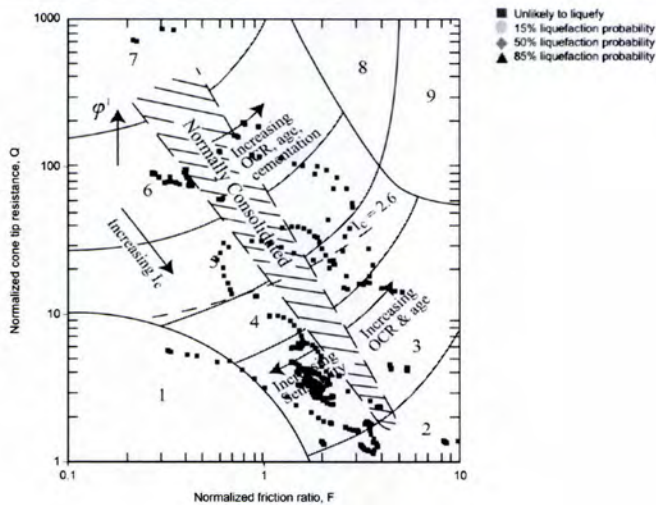
Run Description	NZGD ID	Investigation Date	γ (kN/m ³)	Magnitude	PGA (g)	Trigger Method	Settlement Method	γ (kN/m ³)	Surcharge/Cut/Fill	Surcharge (kPa)	Cut/Fill Height (m)
INPUT	110919	30/07/2018	17	6	0.075	Bi-2014	ZRB-2002	17			0

PL	Sv1d (mm)	CTL (m)	LPI	LSN	CT (m)	LPlish
OUTPUT	15%	1	0	0	0	10
	50%	0	0	0	0	10
	85%	0	0	0	0	10

Reviewed by:

CPT Inversion	CDAV
Groundwater	CDAV
Susceptibility	CDAV
Triggering	CDAV
Consequence	CDAV

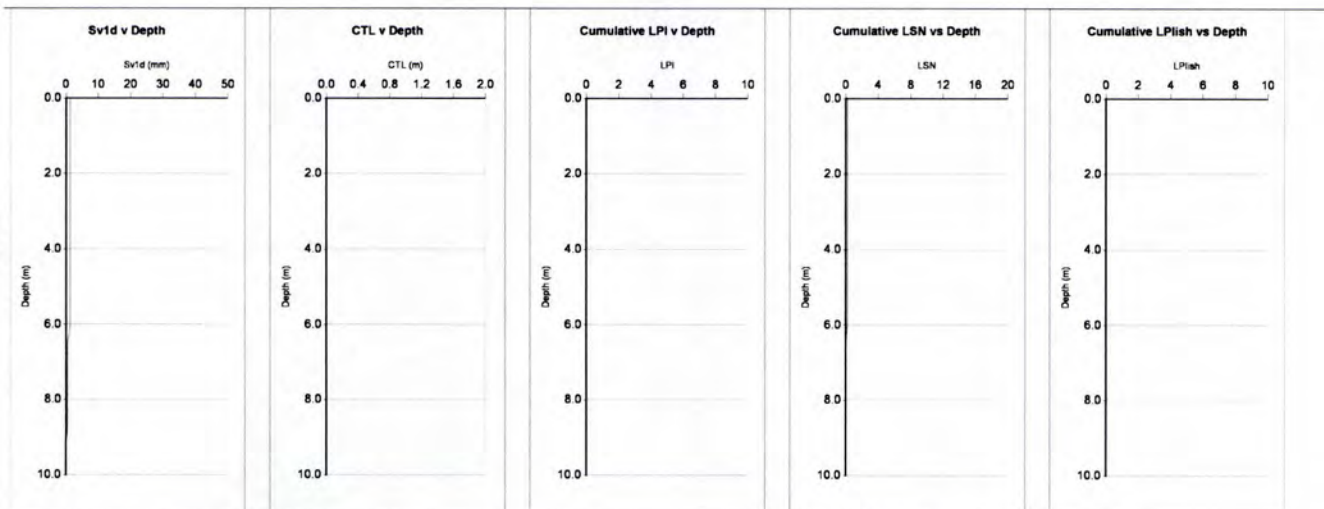
 Tonkin+Taylor	Tonkin + Taylor Exceptional thinking together V2.0	CLIENT	Rotorua Lakes Council	LOCATION	Rotorua	DATE	11/02/2019
		PROJECT	Rotorua Lakefront Redevelopment	JOB NUMBER	1007467.1000	ANALYSED	permo
		TITLE	1:25 year event SLS	CHECKED		PAGE	10 of 33 pages



- 1. Sensitive, fine grained
- 2. Organic soils - peats
- 3. Clays - silty clay to clay
- 4. Silt mixtures - clayey silt to silty clay
- 5. Sand mixtures - silty sand to sandy silt
- 6. Sands - clean sand to silty sand
- 7. Gravelly sand to dense sand
- 8. Very stiff sand to clayey sand *
- 9. Very stiff, fine grained *

*Heavily overconsolidated or cemented
 CPT-based soil behavior type classification chart by Robertson (1990)

 Tonkin + Taylor Exceptional thinking together V2.0	CLIENT: Rotorua Lakes Council PROJECT: Rotorua Lakefront Redevelopment TITLE: 1:25 year event SLS COMMENT:	LOCATION: Rotorua JOB NUMBER: 1007467.1000	DATE: 11/02/2019 ANALYSED: pemo CHECKED: PAGE: 11 of 33 pages
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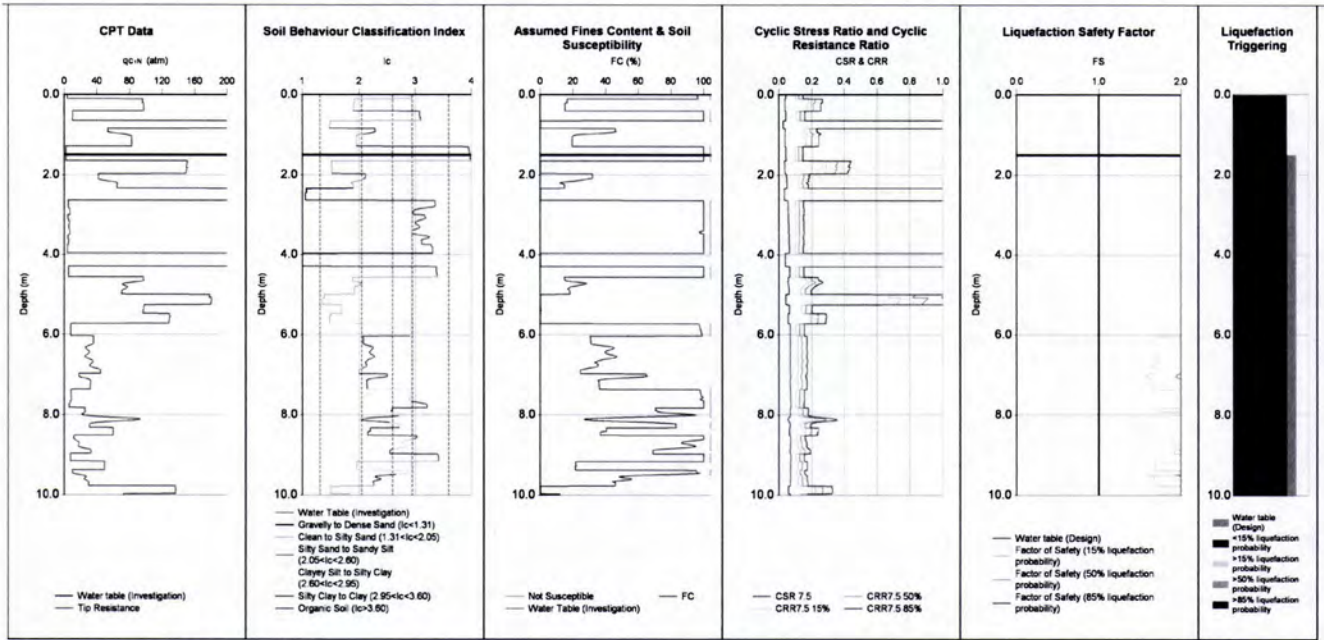


(Assumed pre-drill values)

CPT Name	NZGD ID	Investigation Date	Magnitude	PGA (g)	GWD (m)	Trigger Method	Settlement Method	Pre-drill Depth (m)	qc (MPa)	Fs (MPa)	γ (kN/m³)
CPT04	110919	30/07/2018	6	0.075	1.5	BI-2014	ZRB-2002		0	2	0.01

Thicker lines represent the 50% probability of exceedance case and the thinner lines to the left and right of the thicker lines represent the 85% and 15% probability of exceedance cases respectively.

 Tonkin + Taylor Exceptional thinking together V2.0	CLIENT: Rotorua Lakes Council PROJECT: Rotorua Lakefront Redevelopment TITLE: 1:25 year event SLS COMMENT:	LOCATION: Rotorua JOB NUMBER: 1007467.1000	DATE: 11/02/2019 ANALYSED: pemo CHECKED: PAGE: 12 of 33 pages
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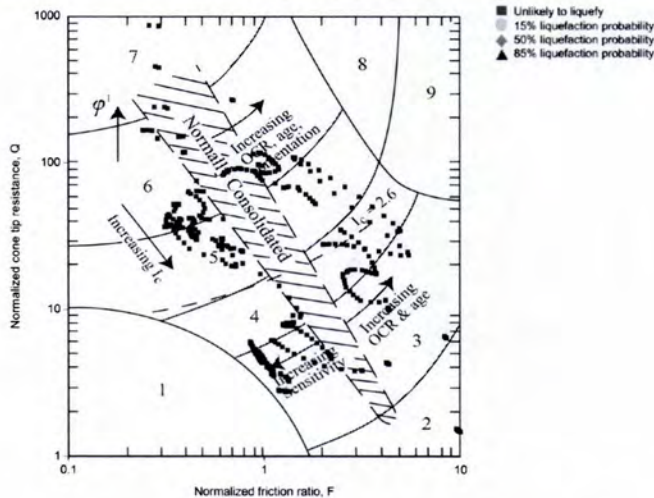


Note: Inverse filtered $QcFs$ data used (10 cm^2)

Run Description	NZGD ID	Investigation Date	γ (kN/m ³)	Magnitude	PGA (g)	Trigger Method	Settlement Method	γ (kN/m ³)	Surcharge/Cut/Fill	Surcharge (kPa)	Cut/Fill Height (m)
INPUT	110920	30/07/2018	17	6	0.075	BI-2014	ZRB-2002	17			0
OUTPUT	PL	Sv1d (mm)	CTL (m)	LPI	LSN	CT (m)	LPish				
	15%	3	0	0	0	10	0				
	50%	0	0	0	0	10	0				
	85%	0	0	0	0	10	0				

Reviewed by:	
CPT Inversion	CDAV
Groundwater	CDAV
Susceptibility	CDAV
Triggering	CDAV
Consequence	CDAV

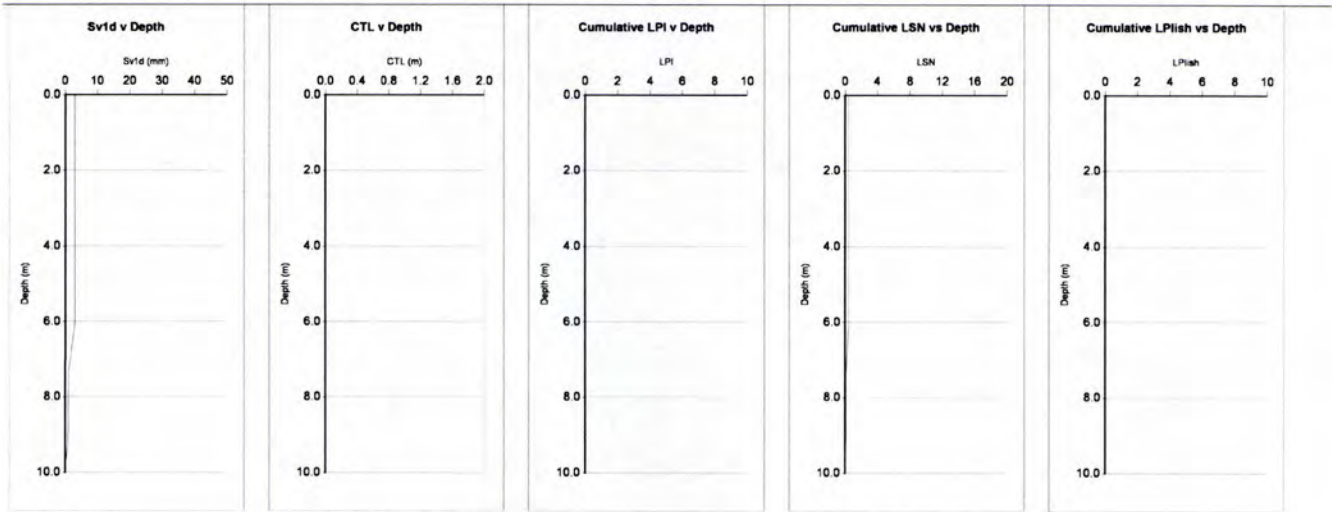
 Tonkin + Taylor Exceptional thinking together V2.0	CLIENT	Rotorua Lakes Council	LOCATION	Rotorua	DATE	11/02/2019
	PROJECT	Rotorua Lakefront Redevelopment	JOB NUMBER	1007467.1000	ANALYSED	permo
	TITLE	1:25 year event SLS			CHECKED	
	COMMENT				PAGE	13 of 33 pages



1. Sensitive, fine grained
2. Organic soils - peats
3. Clays - silty clay to clay
4. Silt mixtures - clayey silt to silty clay
5. Sand mixtures - silty sand to sandy silt
6. Sands - clean sand to silty sand
7. Gravely sand to dense sand
8. Very stiff sand to clayey sand *
9. Very stiff, fine grained *

*Heavily overconsolidated or cemented
 CPT-based soil behavior type classification chart by Robertson (1990)

 Tonkin + Taylor Exceptional thinking together V2.0	CLIENT	Rotorua Lakes Council	LOCATION	Rotorua	DATE	11/02/2019
	PROJECT	Rotorua Lakefront Redevelopment	JOB NUMBER	1007467.1000	ANALYSED	permo
	TITLE	1:25 year event SLS			CHECKED	
	COMMENT				PAGE	14 of 33 pages

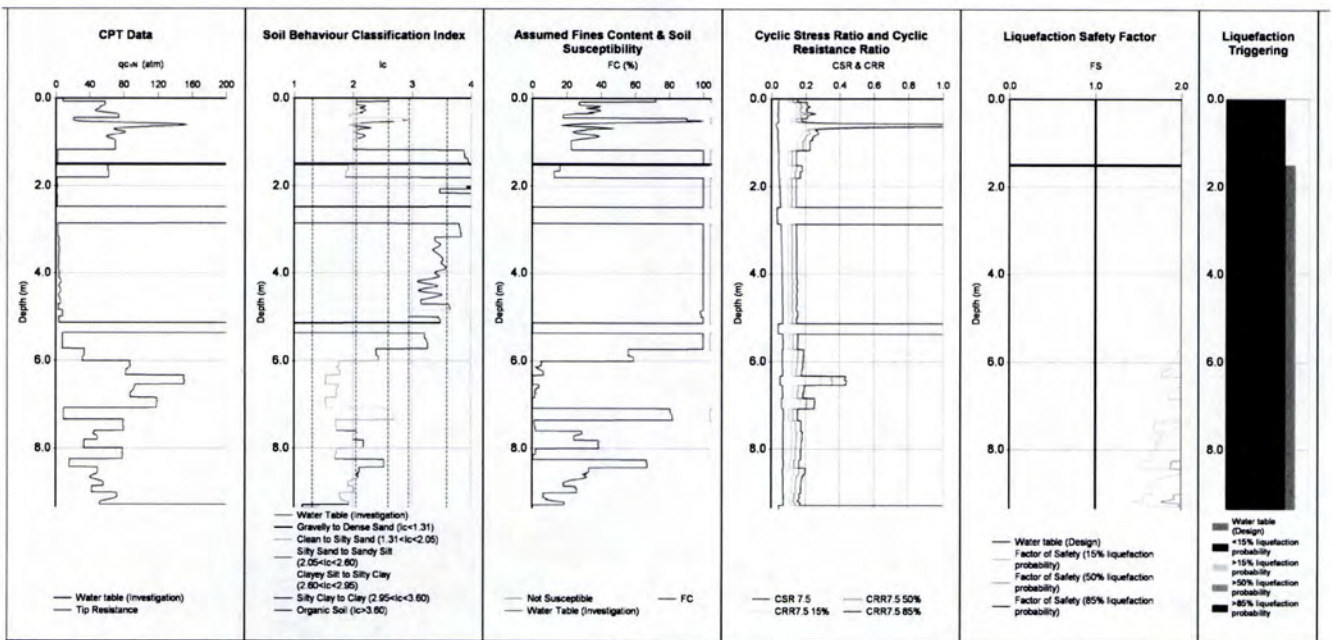


(Assumed pre-drill values)

CPT Name	NZGD ID	Investigation Date	Magnitude	PGA (g)	GWD (m)	Trigger Method	Settlement Method	Pre-drill Depth (m)	qc (MPa)	Fs (MPa)	γ (kN/m ³)
CPT05	110920	30/07/2018	6	0.075	1.5	BI-2014	ZRB-2002	0	2	0.01	17

Thicker lines represent the 50% probability of exceedance case and the thinner lines to the left and right of the thicker lines represent the 85% and 15% probability of exceedance cases respectively.

<p>Tonkin + Taylor Exceptional thinking together V2.0</p>	CLIENT	Rotorua Lakes Council	LOCATION	Rotorua	DATE	11/02/2019
	PROJECT	Rotorua Lakefront Redevelopment	JOB NUMBER	1007467.1000	ANALYSED	pemo
	TITLE	1:25 year event SLS	CHECKED		PAGE	15 of 33 pages
	COMMENT					



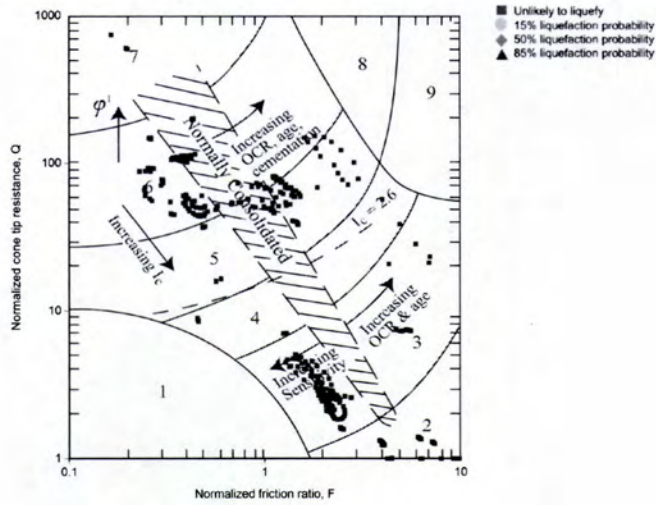
Note: Inverse filtered Qc/Fs data used (10 cm²)

Run Description	NZGD ID	Investigation Date	γ (kN/m ³)	Magnitude	PGA (g)	Trigger Method	Settlement Method	γ (kN/m ³)	Surcharge/Cut/Fill	Surcharge (kPa)	Cut/Fill Height (m)
INPUT	110921	30/07/2018	17	6	0.075	BI-2014	ZRB-2002	17			0
OUTPUT	PL	Sv1d (mm)	CTL (m)	LPI	LSN	CT (m)	LPlish				
	15%	3	0	0	0	9.4	0				
	50%	0	0	0	0	9.4	0				
	85%	0	0	0	0	9.4	0				

Reviewed by:

CPT Inversion	CDAV
Groundwater	CDAV
Susceptibility	CDAV
Triggering	CDAV
Consequence	CDAV

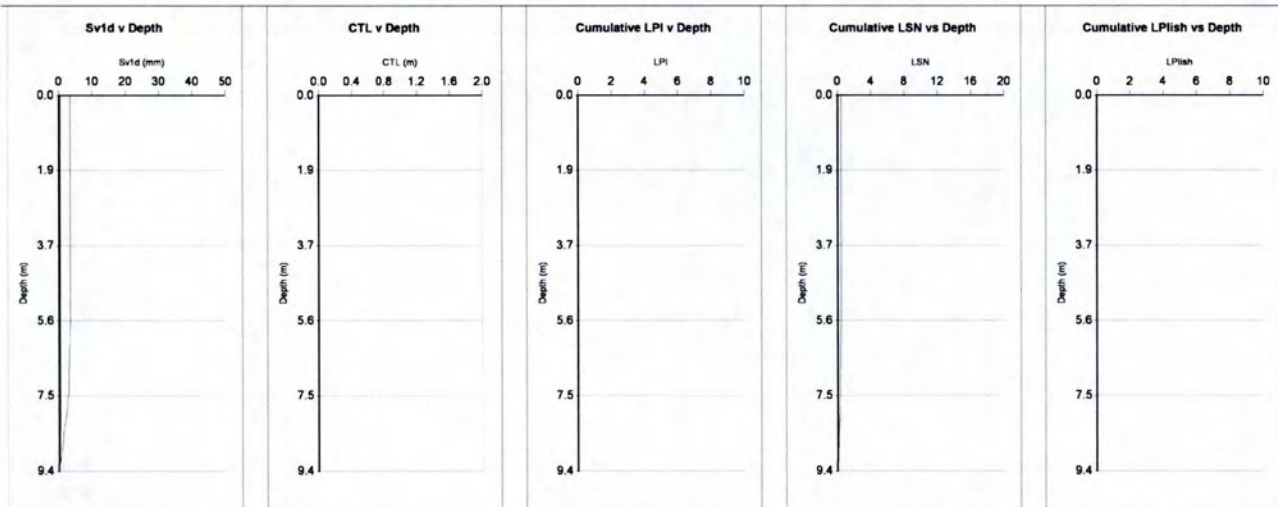
<p>Tonkin + Taylor Exceptional thinking together V2.0</p>	CLIENT	Rotorua Lakes Council	LOCATION	Rotorua	DATE	11/02/2019
	PROJECT	Rotorua Lakefront Redevelopment	JOB NUMBER	1007467.1000	ANALYSED	pemo
	TITLE	1:25 year event SLS	CHECKED		PAGE	16 of 33 pages
	COMMENT					



- 1. Sensitive, fine grained
- 2. Organic soils - peats
- 3. Clays - silty clay to clay
- 4. Silt mixtures - clayey silt to silty clay
- 5. Sand mixtures - silty sand to sandy silt
- 6. Sands - clean sand to silty sand
- 7. Gravelly sand to dense sand
- 8. Very stiff sand to clayey sand *
- 9. Very stiff, fine grained *

*Heavily overconsolidated or cemented
 CPT-based soil behavior type classification chart by Robertson (1990)

	Tonkin + Taylor	CLIENT	Rotorua Lakes Council	LOCATION	Rotorua	DATE	11/02/2019
	Exceptional thinking together	PROJECT	Rotorua Lakefront Redevelopment	JOB NUMBER	1007467.1000	ANALYSED	pemo
	V2.0	TITLE	1:25 year event SLS	CHECKED		PAGE	17 of 33 pages
		COMMENT					

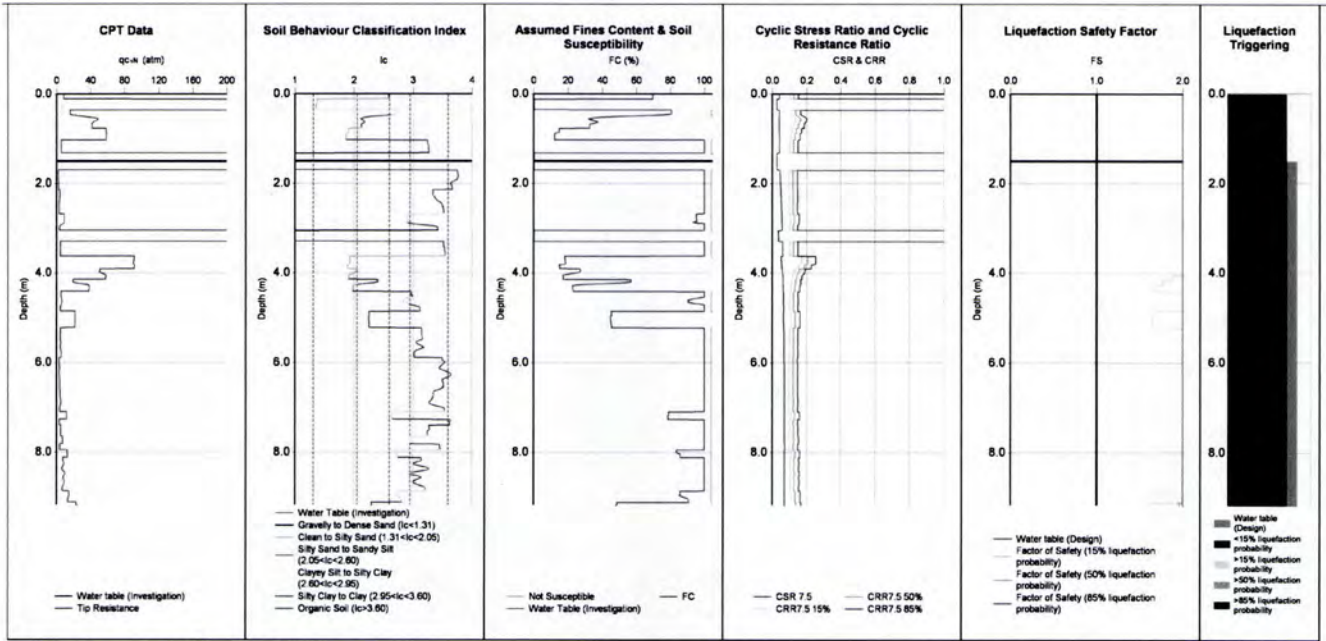


(Assumed pre-drill values)

CPT Name	NZGD ID	Investigation Date	Magnitude	PGA (g)	GWD (m)	Trigger Method	Settlement Method	Pre-drill Depth (m)	qc (MPa)	Fs (MPa)	γ (kN/m³)
CPT06	110921	30/07/2018	6	0.075	1.5	BI-2014	ZRB-2002	0	2	0.01	17

Thicker lines represent the 50% probability of exceedance case and the thinner lines to the left and right of the thicker lines represent the 85% and 15% probability of exceedance cases respectively.

	Tonkin + Taylor	CLIENT	Rotorua Lakes Council	LOCATION	Rotorua	DATE	11/02/2019
	Exceptional thinking together	PROJECT	Rotorua Lakefront Redevelopment	JOB NUMBER	1007467.1000	ANALYSED	pemo
	V2.0	TITLE	1:25 year event SLS	CHECKED		PAGE	18 of 33 pages
		COMMENT					



Note: Inverse filtered $Q_{o/Fs}$ data used (10 cm^2)

Run Description	NZGD ID	Investigation Date	γ (kN/m ³)	Magnitude	PGA (g)	Trigger Method	Settlement Method	γ (kN/m ³)	Surcharge/Cut/Fill	Surcharge (kPa)	Cut/Fill Height (m)
INPUT	110922	30/07/2018	17	6	0.075	BI-2014	ZRB-2002	17			0
OUTPUT	PL	Sv1d (mm)	CTL (m)	LPI	LSN	CT (m)	LPlish				
	15%	1	0	0	0	9.2	0				
	50%	0	0	0	0	9.2	0				
	85%	0	0	0	0	9.2	0				

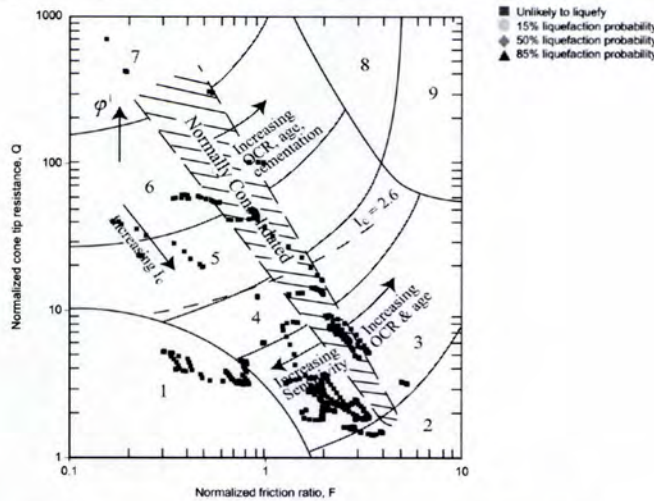
Reviewed by:	
CPT Inversion	CDAV
Groundwater	CDAV
Susceptibility	CDAV
Triggering	CDAV
Consequence	CDAV



Tonkin + Taylor
 Exceptional thinking together
 V2.0

CLIENT	PROJECT	TITLE	COMMENT
Rotorua Lakes Council	Rotorua Lakefront Redevelopment	1:25 year event SLS	

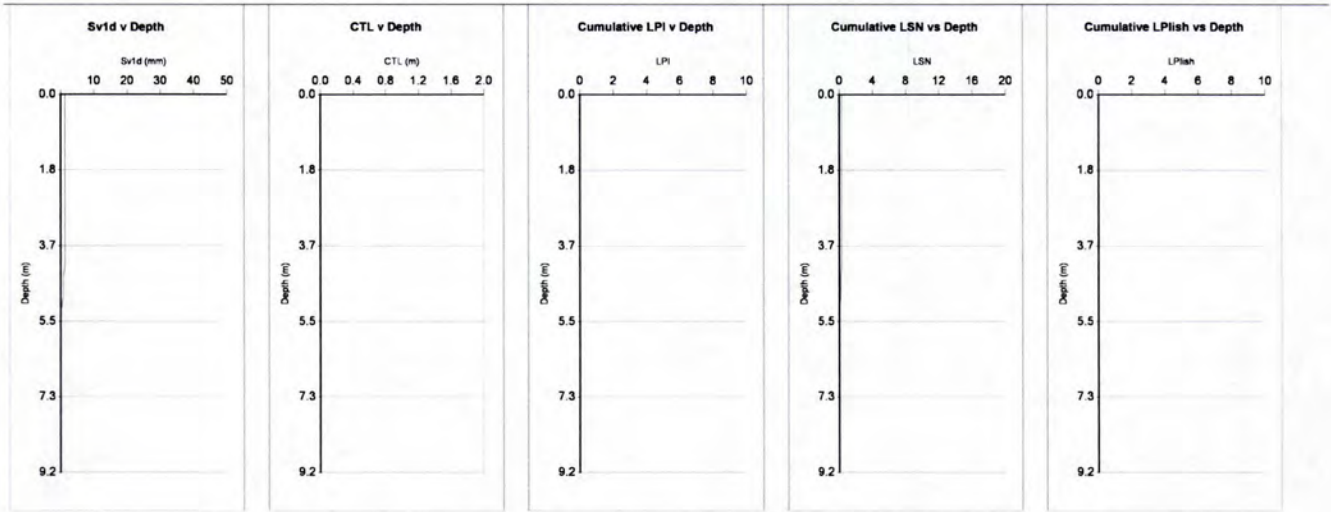
LOCATION	DATE
Rotorua	11/02/2019
JOB NUMBER	ANALYSED
1007467.1000	permo
PAGE	CHECKED
PAGE	CHECKED



Tonkin + Taylor
 Exceptional thinking together
 V2.0

CLIENT	PROJECT	TITLE	COMMENT
Rotorua Lakes Council	Rotorua Lakefront Redevelopment	1:25 year event SLS	

LOCATION	DATE
Rotorua	11/02/2019
JOB NUMBER	ANALYSED
1007467.1000	permo
PAGE	CHECKED
PAGE	CHECKED

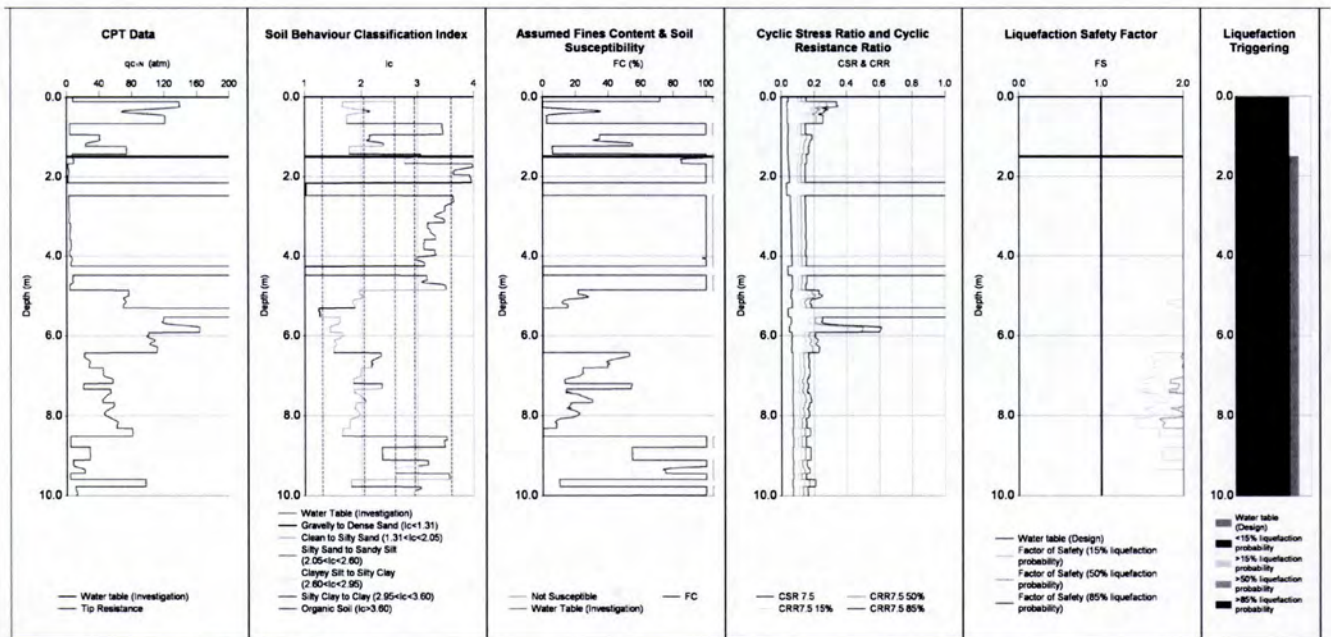


(Assumed pre-drill values)

CPT Name	NZGD ID	Investigation Date	Magnitude	PGA (g)	GWD (m)	Trigger Method	Settlement Method	Pre-drill Depth (m)	qc (MPa)	Fs (MPa)	γ (kN/m ³)
CPT07	110922	30/07/2018	6	0.075	1.5	BI-2014	ZRB-2002	0	2	0.01	17

Thicker lines represent the 50% probability of exceedance case and the thinner lines to the left and right of the thicker lines represent the 85% and 15% probability of exceedance cases respectively.

 Tonkin+Taylor	Tonkin + Taylor Exceptional thinking together V2.0	CLIENT PROJECT Rotorua Lakes Council Rotorua Lakefront Redevelopment TITLE 1:25 year event SLS COMMENT	LOCATION Rotorua DATE 11/02/2019 ANALYSED pemo CHECKED PAGE 21 of 33 pages
			JOB NUMBER 1007467.1000



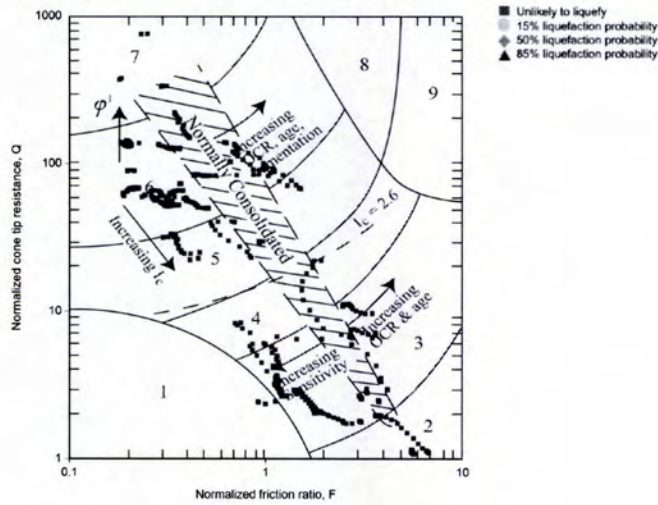
Note: Inverse filtered Qc/Fs data used (10 cm²)

Run Description	NZGD ID	Investigation Date	γ (kN/m ³)	Magnitude	PGA (g)	Trigger Method	Settlement Method	γ (kN/m ³)	Surcharge/Cut/Fill	Surcharge (kPa)	Cut/Fill Height (m)
INPUT	110923	30/07/2018	17	6	0.075	BI-2014	ZRB-2002	17		0	
OUTPUT	PL	Svd1d (mm)	CTL (m)	LPI	LSN	CT (m)	LPlish				
	15%	5	0	0	0	10	0				
	50%	1	0	0	0	10	0				
	85%	0	0	0	0	10	0				

Reviewed by:

CPT Inversion	CDAV
Groundwater	CDAV
Susceptibility	CDAV
Triggering	CDAV
Consequence	CDAV

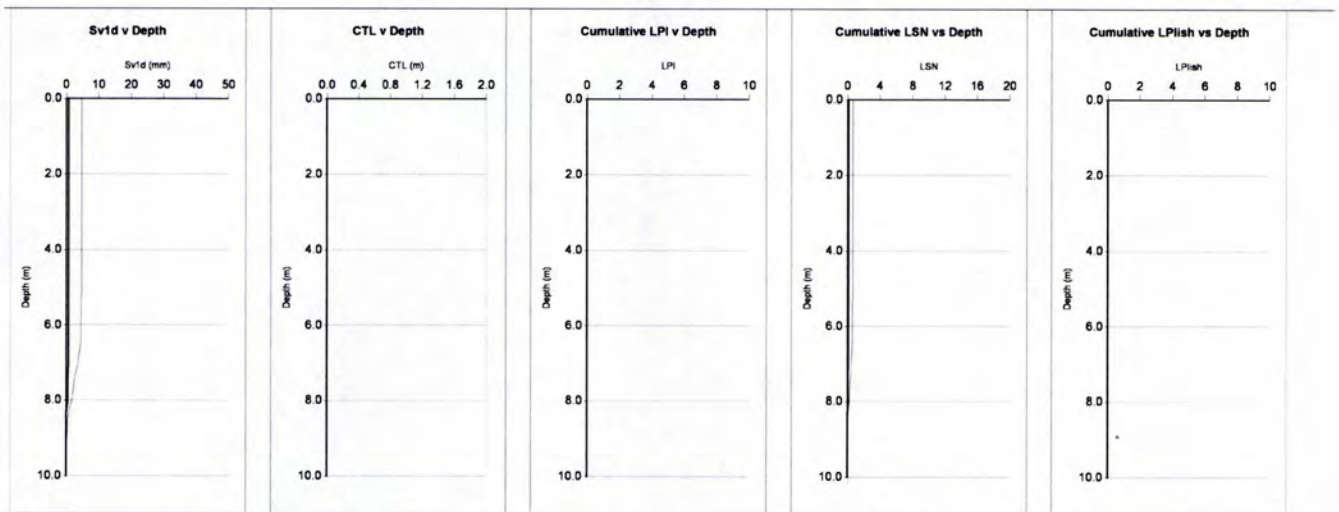
 Tonkin+Taylor	Tonkin + Taylor Exceptional thinking together V2.0	CLIENT PROJECT Rotorua Lakes Council Rotorua Lakefront Redevelopment TITLE 1:25 year event SLS COMMENT	LOCATION Rotorua DATE 11/02/2019 ANALYSED pemo CHECKED PAGE 22 of 33 pages
			JOB NUMBER 1007467.1000



- 1. Sensitive, fine grained
- 2. Organic soils - peats
- 3. Clays - silty clay to clay
- 4. Silt mixtures - clayey silt to silty clay
- 5. Sand mixtures - silty sand to sandy silt
- 6. Sands - clean sand to silty sand
- 7. Gravelly sand to dense sand
- 8. Very stiff sand to clayey sand *
- 9. Very stiff, fine grained *

*Heavily overconsolidated or cemented
 CPT-based soil behavior type classification chart by Robertson (1990)

	Tonkin + Taylor Exceptional thinking together V2.0	CLIENT	Rotorua Lakes Council	LOCATION	Rotorua	DATE	11/02/2019
		PROJECT	Rotorua Lakefront Redevelopment	JOB NUMBER	1007467.1000	ANALYSED	permo
		TITLE	1:25 year event SLS	CHECKED			
		COMMENT		PAGE	23 of 33 pages		

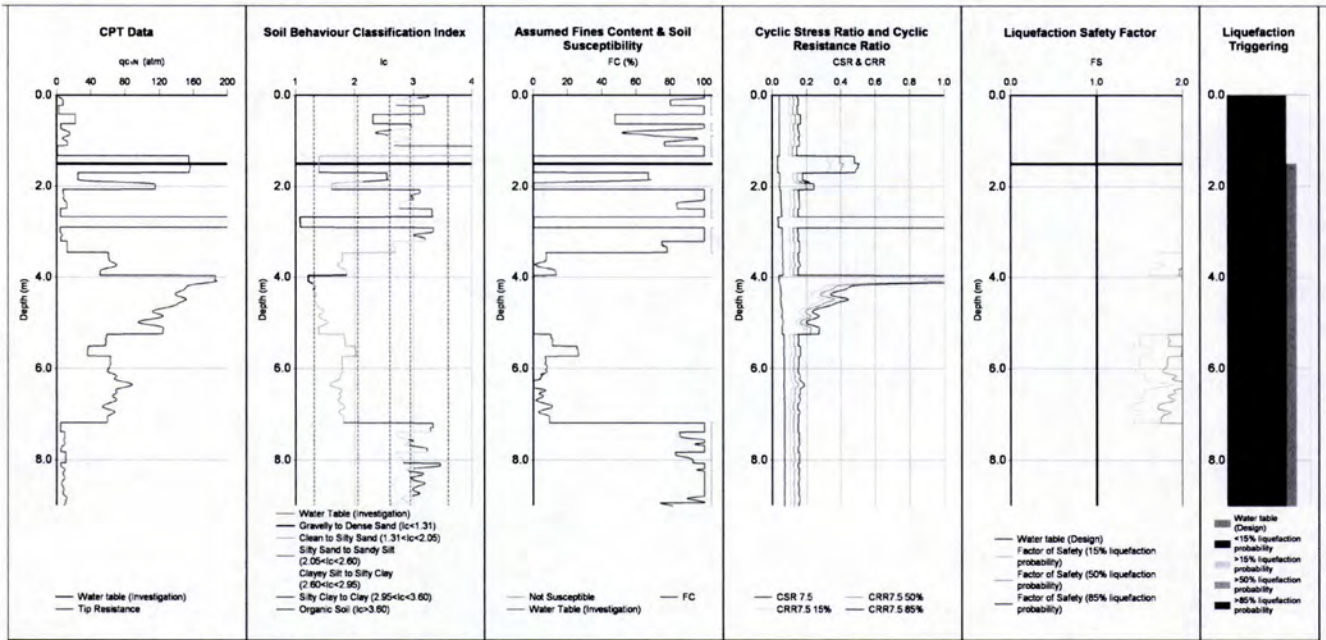


(Assumed pre-drill values)

CPT Name	NZGD ID	Investigation Date	Magnitude	PGA (g)	GWD (m)	Trigger Method	Settlement Method	Pre-drill Depth (m)	qc (MPa)	Fs (MPa)	γ (kN/m³)
CPT08	110923	30/07/2018	6	0.075	1.5	BI-2014	ZRB-2002		0	2	0.01

Thicker lines represent the 50% probability of exceedance case and the thinner lines to the left and right of the thicker lines represent the 85% and 15% probability of exceedance cases respectively.

	Tonkin + Taylor Exceptional thinking together V2.0	CLIENT	Rotorua Lakes Council	LOCATION	Rotorua	DATE	11/02/2019
		PROJECT	Rotorua Lakefront Redevelopment	JOB NUMBER	1007467.1000	ANALYSED	permo
		TITLE	1:25 year event SLS	CHECKED			
		COMMENT		PAGE	24 of 33 pages		

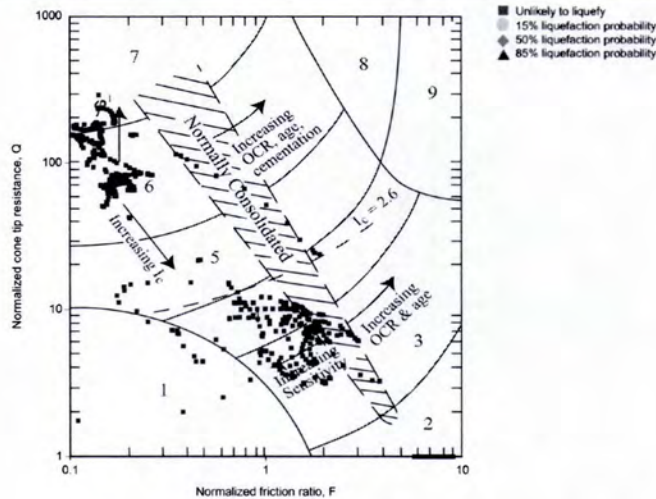


Note: Inverse filtered Qc/Fs data used (10 cm²)

Run Description	NZGD ID	Investigation Date	γ (kN/m ³)	Magnitude	PGA (g)	Trigger Method	Settlement Method	γ (kN/m ³)	Surcharge/Cut/Fill	Surcharge (kPa)	Cut/Fill Height (m)
INPUT	110924	1/08/2018	17	17	6	0.075 BI-2014	ZRB-2002	17			0
OUTPUT	PL	Sv1d (mm)	CTL (m)	LPI	LSN	CT (m)	LPlish				
	15%	6	0	0	1	9	0				
	50%	2	0	0	0	9	0				
	85%	0	0	0	0	9	0				

Reviewed by	
CPT Inversion	CDAV
Groundwater	CDAV
Susceptibility	CDAV
Triggering	CDAV
Consequence	CDAV

<p>Tonkin + Taylor Exceptional thinking together V2.0</p>	<p>CLIENT: Rotorua Lakes Council</p> <p>PROJECT: Rotorua Lakefront Redevelopment</p> <p>TITLE: 1:25 year event SLS</p> <p>COMMENT:</p>	<p>LOCATION: Rotorua</p> <p>JOB NUMBER: 1007467.1000</p>	<p>DATE: 11/02/2019</p> <p>ANALYSED: pemo</p> <p>CHECKED:</p> <p>PAGE: 25 of 33 pages</p>
	<p>CLIENT: Rotorua Lakes Council</p> <p>PROJECT: Rotorua Lakefront Redevelopment</p> <p>TITLE: 1:25 year event SLS</p> <p>COMMENT:</p>		<p>LOCATION: Rotorua</p> <p>JOB NUMBER: 1007467.1000</p>

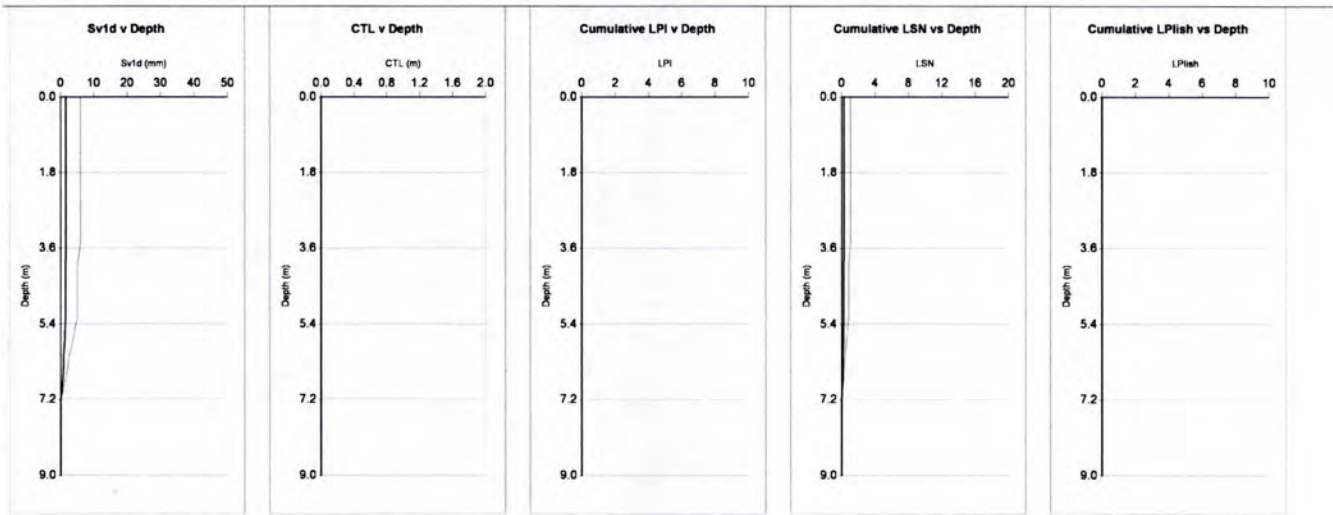


1. Sensitive, fine grained
2. Organic soils - peats
3. Clays - silty clay to clay
4. Silt mixtures - clayey silt to silty clay
5. Sand mixtures - silty sand to sandy silt
6. Sands - clean sand to silty sand
7. Gravely sand to dense sand
8. Very stiff sand to clayey sand *
9. Very stiff, fine grained *

*Heavily overconsolidated or cemented

CPT-based soil behavior type classification chart by Robertson (1990)

<p>Tonkin + Taylor Exceptional thinking together V2.0</p>	<p>CLIENT: Rotorua Lakes Council</p> <p>PROJECT: Rotorua Lakefront Redevelopment</p> <p>TITLE: 1:25 year event SLS</p> <p>COMMENT:</p>	<p>LOCATION: Rotorua</p> <p>JOB NUMBER: 1007467.1000</p>	<p>DATE: 11/02/2019</p> <p>ANALYSED: pemo</p> <p>CHECKED:</p> <p>PAGE: 25 of 33 pages</p>
	<p>CLIENT: Rotorua Lakes Council</p> <p>PROJECT: Rotorua Lakefront Redevelopment</p> <p>TITLE: 1:25 year event SLS</p> <p>COMMENT:</p>		<p>LOCATION: Rotorua</p> <p>JOB NUMBER: 1007467.1000</p>

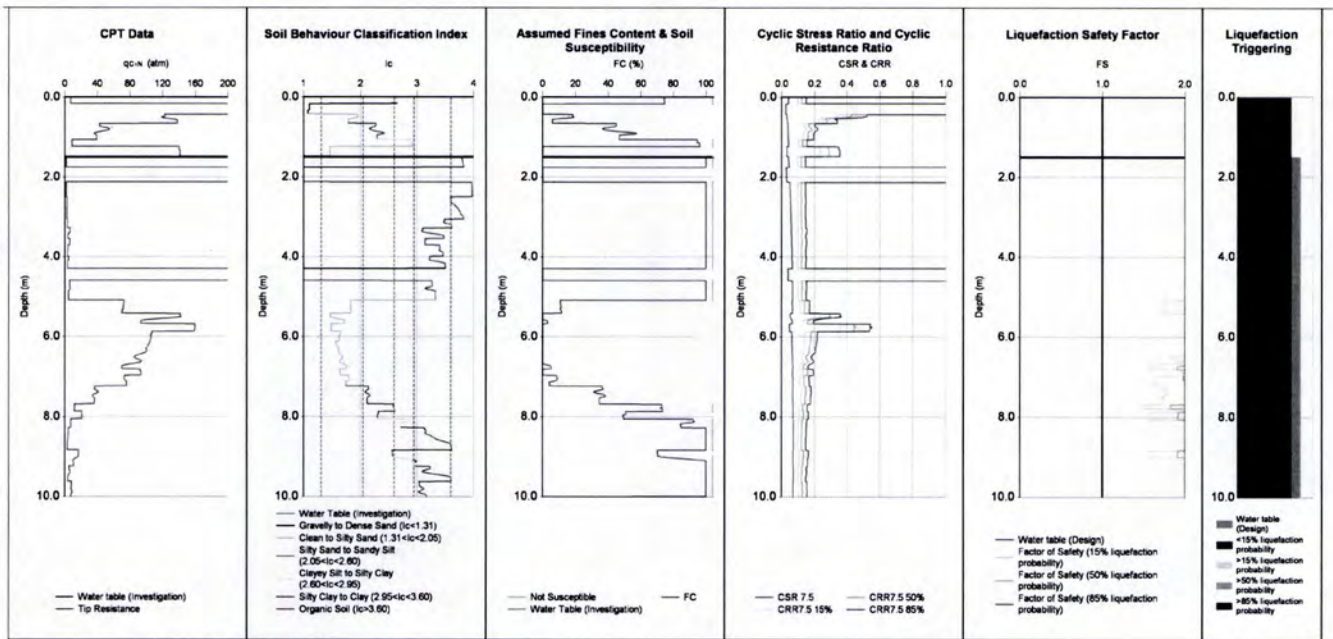


(Assumed pre-drill values)

CPT Name	NZGD ID	Investigation Date	Magnitude	PGA (g)	GWD (m)	Trigger Method	Settlement Method	Pre-drill Depth (m)	qc (MPa)	Fs (MPa)	γ (kN/m ³)
CPT09	110924	1/08/2018	6	0.075	1.5	BI-2014	ZRB-2002	0	2	0.01	17

Thicker lines represent the 50% probability of exceedence case and the thinner lines to the left and right of the thicker lines represent the 85% and 15% probability of exceedence cases respectively.

 Tonkin+Taylor	Tonkin + Taylor Exceptional thinking together V2.0	CLIENT	Rotorua Lakes Council	LOCATION	Rotorua	DATE	11/02/2019
		PROJECT	Rotorua Lakefront Redevelopment	JOB NUMBER	1007467.1000	ANALYSED	permo
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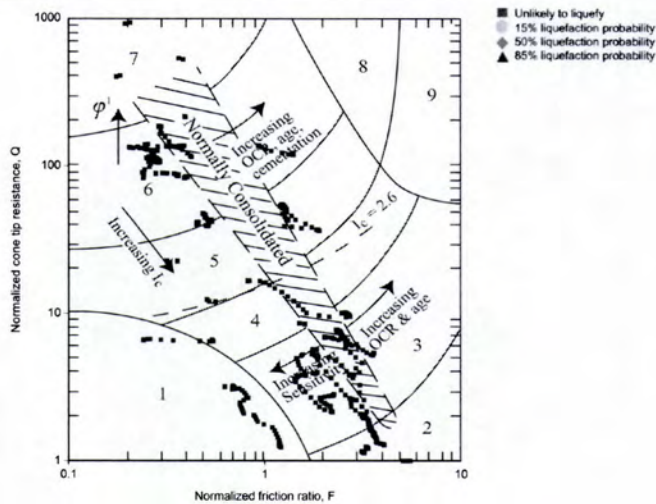


Note: Inverse filtered Qc/Fs data used (10 cm²)

Run Description	NZGD ID	Investigation Date	γ (kN/m ³)	Magnitude	PGA (g)	Trigger Method	Settlement Method	γ (kN/m ³)	Surcharge/Cut/Fill	Surcharge (kPa)	Cut/Fill Height (m)
INPUT	110925	30/07/2018	17	6	0.075	BI-2014	ZRB-2002	17			0
OUTPUT	PL	Sv1d (mm)	CTL (m)	LPI	LSN	CT (m)	LPlish				
	15%	3	0	0	0	10	0				
	50%	0	0	0	0	10	0				
	85%	0	0	0	0	10	0				

Reviewed by:	
CPT Inversion	CDAV
Groundwater	CDAV
Susceptibility	CDAV
Triggering	CDAV
Consequence	CDAV

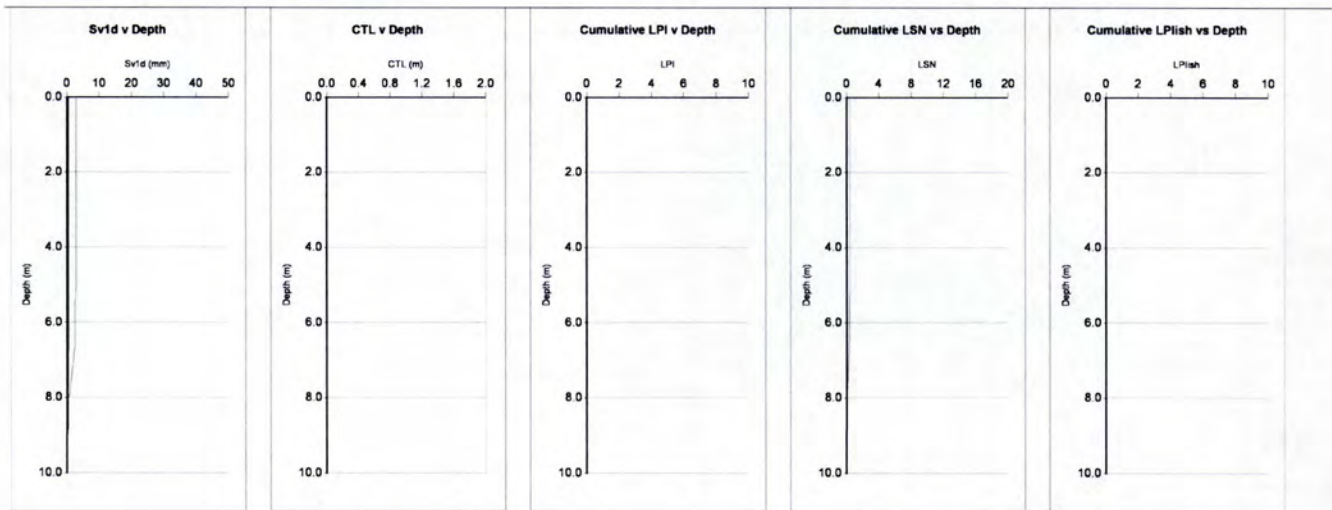
 Tonkin+Taylor	Tonkin + Taylor Exceptional thinking together V2.0	CLIENT	Rotorua Lakes Council	LOCATION	Rotorua	DATE	11/02/2019
		PROJECT	Rotorua Lakefront Redevelopment	JOB NUMBER	1007467.1000	ANALYSED	permo
COMMENT			1:25 year event SLS	CHECKED		PAGE	28 of 33 pages



- 1. Sensitive, fine grained
- 2. Organic soils - peats
- 3. Clays - silty clay to clay
- 4. Silt mixtures - clayey silt to silty clay
- 5. Sand mixtures - silty sand to sandy silt
- 6. Sands - clean sand to silty sand
- 7. Gravely sand to dense sand
- 8. Very stiff sand to clayey sand *
- 9. Very stiff, fine grained *

*Heavily overconsolidated or cemented
 CPT-based soil behavior type classification chart by Robertson (1990)

	Tonkin + Taylor	CLIENT	Rotorua Lakes Council	LOCATION	Rotorua	DATE	11/02/2019
	Exceptional thinking together	PROJECT	Rotorua Lakefront Redevelopment			ANALYSED	pemo
	V2.0	TITLE	1:25 year event SLS	JOB NUMBER	1007467.1000	CHECKED	
		COMMENT				PAGE	29 of 33 pages



(Assumed pre-drill values)

CPT Name	NZGD ID	Investigation Date	Magnitude	PGA (g)	GWD (m)	Trigger Method	Settlement Method	Pre-drill Depth (m)	qc (MPa)	Fs (MPa)	γ (kN/m³)
CPT10	110925	30/07/2018	6	0.075	1.5	BI-2014	ZRB-2002	0	2	0.01	17

Thicker lines represent the 50% probability of exceedance case and the thinner lines to the left and right of the thicker lines represent the 85% and 15% probability of exceedance cases respectively.


	Tonkin + Taylor	CLIENT	Rotorua Lakes Council	LOCATION	Rotorua	DATE	11/02/2019
	Exceptional thinking together	PROJECT	Rotorua Lakefront Redevelopment			ANALYSED	pemo
	V2.0	TITLE	1:25 year event SLS	JOB NUMBER	1007467.1000	CHECKED	
		COMMENT				PAGE	30 of 33 pages

The inputs listed in Table 1.1-1 below have been adopted for the liquefaction analysis.


Table 1.1-1 Summary of inputs for liquefaction analysis

NZ	110916	110917	110918	110919	110920	110921
CPT Name	05TT06_CPT01	05TT06_CPT02	05TT06_CPT03	05TT06_CPT04	05TT06_CPT05	05TT06_CPT06
PGA	0.075g	0.075g	0.075g	0.075g	0.075g	0.075g
Magnitude	6	6	6	6	6	6
Depth to groundwater	1.5m	1.5m	1.5m	1.5m	1.5m	1.5m
Predrill depth	0m	0m	0m	0m	0m	0m
Assumed predrill tip resistance and skin friction	qc= 2MPa & Fs= 0.01MPa	qc= 2MPa & Fs= 0.01MPa	qc= 2MPa & Fs= 0.01MPa	qc= 2MPa & Fs= 0.01MPa	qc= 2MPa & Fs= 0.01MPa	qc= 2MPa & Fs= 0.01MPa
Trigger method	Boulanger & Idriss (2014)	Boulanger & Idriss (2014)	Boulanger & Idriss (2014)	Boulanger & Idriss (2014)	Boulanger & Idriss (2014)	Boulanger & Idriss (2014)
Settlement method	Zhang, Robertson & Brachman (2002)	Zhang, Robertson & Brachman (2002)	Zhang, Robertson & Brachman (2002)	Zhang, Robertson & Brachman (2002)	Zhang, Robertson & Brachman (2002)	Zhang, Robertson & Brachman (2002)
CFC	0	0	0	0	0	0
Total depth of CPT	9.69m	5.71m	10.84m	10.13m	10.79m	9.36m
Minimum depth of analysis	0m	0m	0m	0m	0m	0m
Maximum depth of analysis	10m	10m	10m	10m	10m	10m
RL	0	0	0	0	0	0


CPT	From Depth (m)	To Depth (m)	lc
	lc from (m)	lc to (m)	lc
117883	0	0	0
117883	0	10	2.6
117894	0	0	0
117894	0	10	2.6
117895	0	0	0
117895	0	10	2.6
117896	0	0	0
117896	0	10	2.6
117897	0	0	0
117897	0	10	2.6
117898	0	0	0
117898	0	10	2.6
117899	0	0	0
117899	0	10	2.6
117900	0	0	0
117900	0	10	2.6
117901	0	0	0
117901	0	10	2.6
117902	0	0	0
117902	0	10	2.6
	Fc from (m)	Fc to (m)	Fc
117883	0	10	0
117894	0	10	0
117895	0	10	0
117896	0	10	0
117897	0	10	0

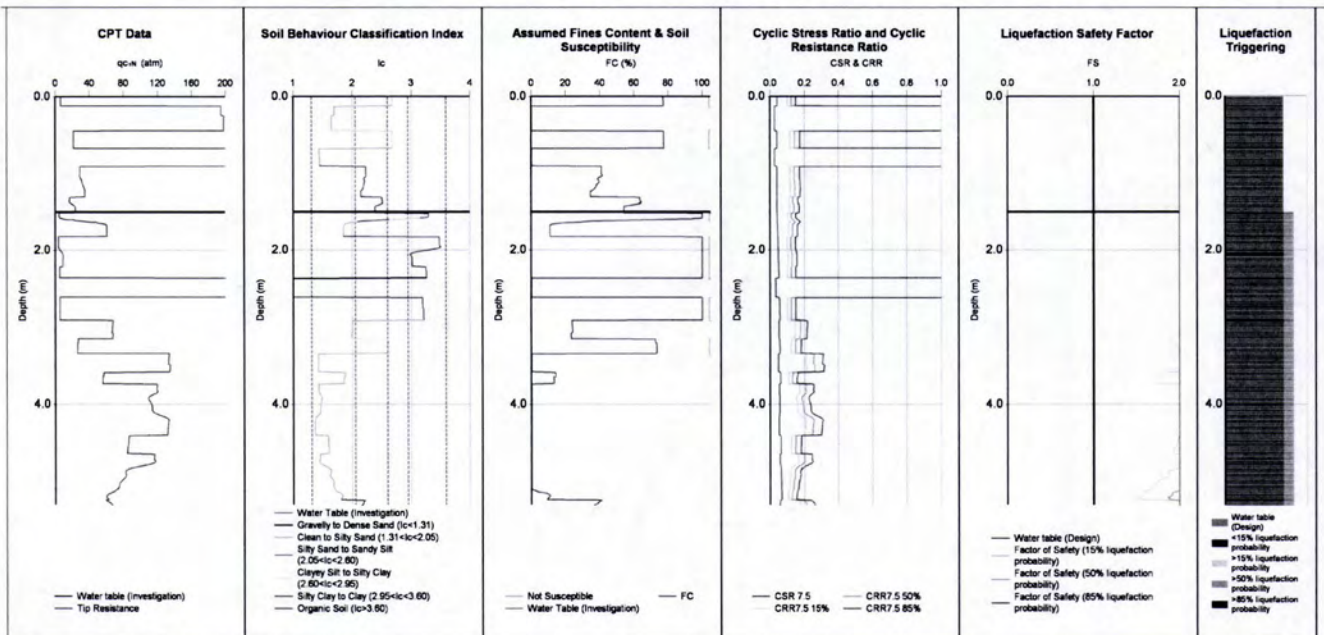
	Tonkin + Taylor Exceptional thinking together V2.0	CLIENT	Rotorua Lakes Council	LOCATION	Rotorua	DATE	11/02/2019
		PROJECT	Rotorua Lakefront Redevelopment			ANALYSED	permo
		TITLE	1:25 year event SLS			CHECKED	
		COMMENT				PAGE	31 of 33 pages

110922	110923	110924	110925
05TT06_CPT07	05TT06_CPT08	05TT06_CPT09	05TT06_CPT10
0.075g	0.075g	0.075g	0.075g
6	6	6	6
1.5m	1.5m	1.5m	1.5m
0m	0m	0m	0m
qc= 2MPa & Fs= 0.01MPa	qc= 2MPa & Fs= 0.01MPa	qc= 2MPa & Fs= 0.01MPa	qc= 2MPa & Fs= 0.01MPa
Boulanger & Idriss (2014)	Boulanger & Idriss (2014)	Boulanger & Idriss (2014)	Boulanger & Idriss (2014)
Zhang, Robertson & Brachman (2002)	Zhang, Robertson & Brachman (2002)	Zhang, Robertson & Brachman (2002)	Zhang, Robertson & Brachman (2002)
0	0	0	0
9.18m	11.13m	9m	12.18m
0m	0m	0m	0m
10m	10m	10m	10m
0	0	0	0

	Tonkin + Taylor Exceptional thinking together V2.0	CLIENT	Rotorua Lakes Council	LOCATION	Rotorua	DATE	11/02/2019
		PROJECT	Rotorua Lakefront Redevelopment			ANALYSED	permo
		TITLE	1:25 year event SLS			CHECKED	
		COMMENT				PAGE	32 of 33 pages

117898	0	10	0
117899	0	10	0
117900	0	10	0
117901	0	10	0
117902	0	10	0

	Tonkin + Taylor	CLIENT	Rotorua Lakes Council	LOCATION	Rotorua	DATE	11/02/2019
	Exceptional thinking together	PROJECT	Rotorua Lakefront Redevelopment			ANALYSED	permo
	V2.0	TITLE	1:25 year event SLS	JOB NUMBER	1007467.1000	CHECKED	
		COMMENT				PAGE	33 of 33 pages




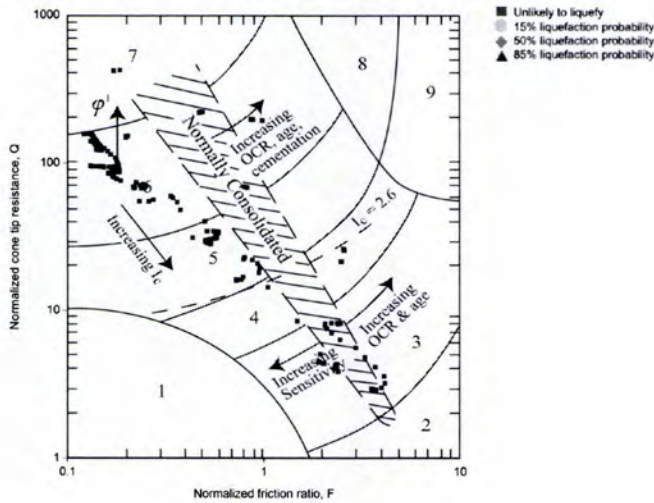
Note: Inverse filtered Cq/Fs data used (10 cm²)

Run Description	NZGD ID	Investigation Date	γ (kN/m ³)	Magnitude	PGA (g)	Trigger Method	Settlement Method	γ (kN/m ³)	Surcharge/Cut/Fill	Surcharge (kPa)	Cut/Fill Height (m)
INPUT	110926	1/08/2018	17	6	0.075	BI-2014	ZRB-2002	17			0
OUTPUT	PL	Sv1d (mm)	CTL (m)	LPI	LSN	CT (m)	LPish				
	15%	1	0	0	0	5.3	0				
	50%	0	0	0	0	5.3	0				
	85%	0	0	0	0	5.3	0				

Reviewed by:

CPT Inversion	CDAV
Groundwater	CDAV
Susceptibility	CDAV
Triggering	CDAV
Consequence	CDAV

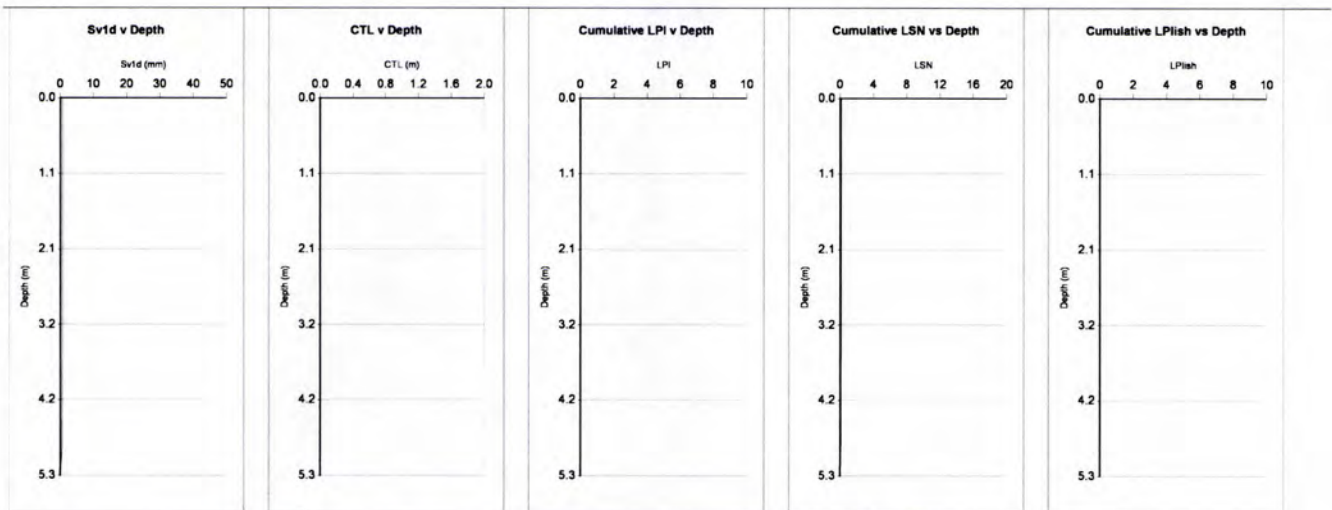
	Tonkin + Taylor	CLIENT	Rotorua Lakes Council	LOCATION	Rotorua	DATE	11/02/2019
	Exceptional thinking together	PROJECT	Rotorua Lakefront Redevelopment			ANALYSED	permo
	V2.0	TITLE	1:25 year event sLS	JOB NUMBER	1007467.1000	CHECKED	
		COMMENT				PAGE	1 of 35 pages



- 1. Sensitive, fine grained
- 2. Organic soils - peats
- 3. Clays - silty clay to clay
- 4. Silt mixtures - clayey silt to silty clay
- 5. Sand mixtures - silty sand to sandy silt
- 6. Sands - clean sand to silty sand
- 7. Gravely sand to dense sand
- 8. Very stiff sand to clayey sand *
- 9. Very stiff, fine grained *

*Heavily overconsolidated or cemented
 CPT-based soil behavior type classification chart by Robertson (1990)

	Tonkin + Taylor Exceptional thinking together V2.0	CLIENT	Rotorua Lakes Council	LOCATION	Rotorua	DATE	11/02/2019
		PROJECT	Rotorua Lakefront Redevelopment	JOB NUMBER	1007467.1000	ANALYSED	permo
		TITLE	1:25 year event sLS	CHECKED		PAGE	2 of 35 pages
		COMMENT					

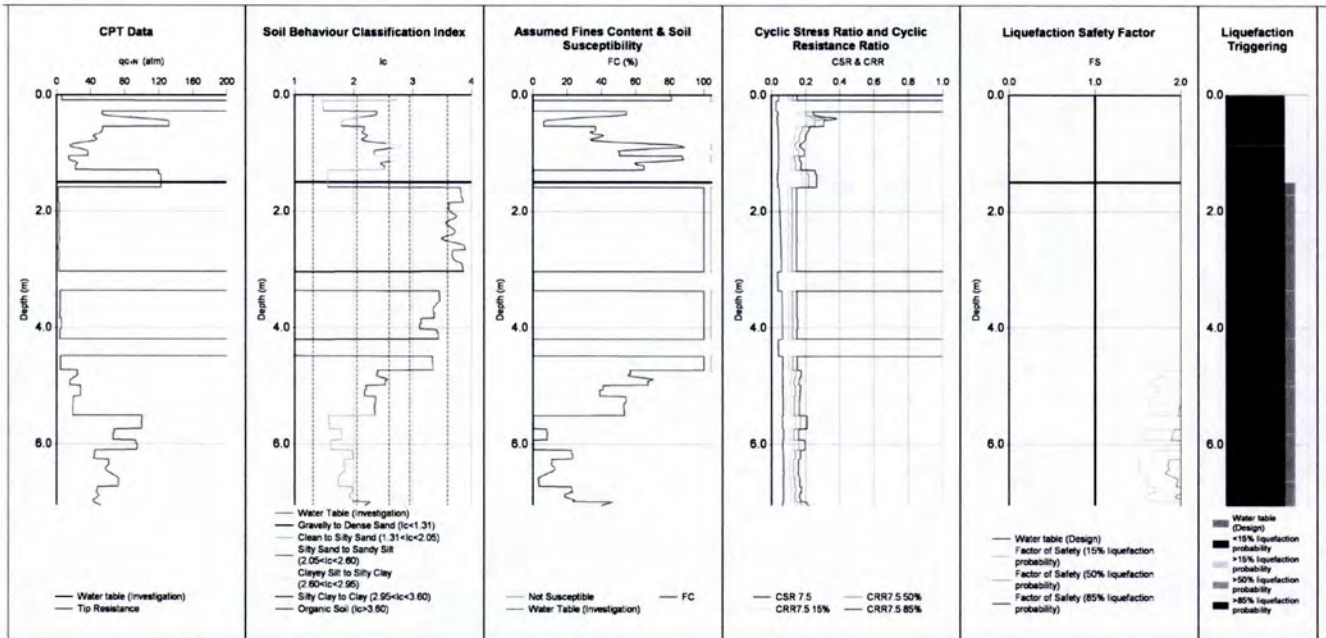


(Assumed pre-drill values)

CPT Name	NZGD ID	Investigation Date	Magnitude	PGA (g)	GWD (m)	Trigger Method	Settlement Method	Pre-drill Depth (m)	qc (MPa)	Fs (MPa)	γ (kN/m³)
CPT11	110926	1/08/2018	6	0.075	1.5	BI-2014	ZRB-2002	0	2	0.01	17

Thicker lines represent the 50% probability of exceedance case and the thinner lines to the left and right of the thicker lines represent the 85% and 15% probability of exceedance cases respectively.

	Tonkin + Taylor Exceptional thinking together V2.0	CLIENT	Rotorua Lakes Council	LOCATION	Rotorua	DATE	11/02/2019
		PROJECT	Rotorua Lakefront Redevelopment	JOB NUMBER	1007467.1000	ANALYSED	permo
		TITLE	1:25 year event sLS	CHECKED		PAGE	3 of 35 pages
		COMMENT					

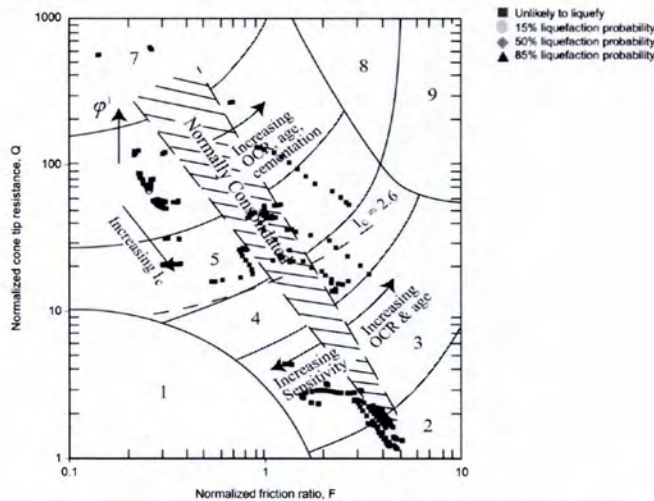


Note: Inverse filtered Cc/Fs data used (10 cm²)

Run Description	NZGD ID	Investigation Date	γ (kN/m ³)	Magnitude	PGA (g)	Trigger Method	Settlement Method	γ (kN/m ³)	Surcharge/Cut/Fill	Surcharge (kPa)	Cut/Fill Height (m)
INPUT	110927	30/07/2018	17	17	6	0.075 Bi-2014	ZRB-2002	17			0
OUTPUT	PL	Sv1d (mm)	CTL (m)	LPI	LSN	CT (m)	LPlish				
	15%	4	0	0	1	7	0				
	50%	0	0	0	0	7	0				
	85%	0	0	0	0	7	0				

Reviewed by:	
CPT Inversion	CDAV
Groundwater	CDAV
Susceptibility	CDAV
Triggering	CDAV
Consequence	CDAV

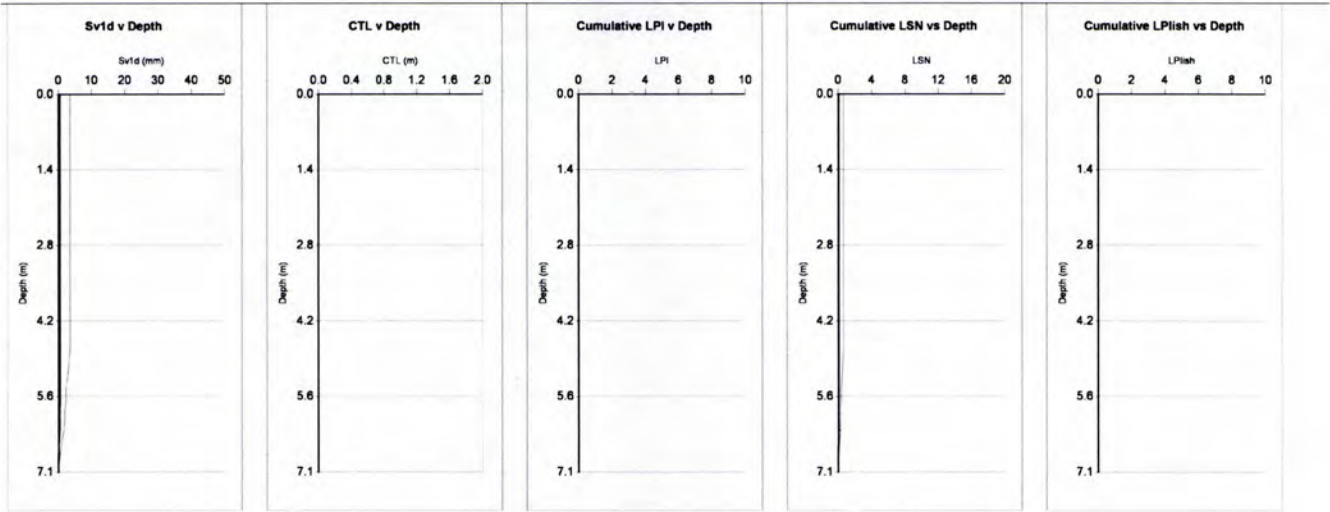
 Tonkin+Taylor	Tonkin + Taylor Exceptional thinking together V2.0	CLIENT	Rotorua Lakes Council	LOCATION	Rotorua	DATE	11/02/2019
		PROJECT	Rotorua Lakefront Redevelopment			ANALYSED	pemo
		TITLE	1:25 year event sLS	JOB NUMBER	1007467.1000	CHECKED	
		COMMENT		PAGE		PAGE	4 of 35 pages



- | | |
|--|-------------------------------------|
| 1. Sensitive, fine grained | 6. Sands - clean sand to silty sand |
| 2. Organic soils - peats | 7. Gravely sand to dense sand |
| 3. Clays - silty clay to clay | 8. Very stiff sand to clayey sand * |
| 4. Silt mixtures - clayey silt to silty clay | 9. Very stiff, fine grained * |
| 5. Sand mixtures - silty sand to sandy silt | |

*Heavily overconsolidated or cemented
 CPT-based soil behavior type classification chart by Robertson (1990)

 Tonkin+Taylor	Tonkin + Taylor Exceptional thinking together V2.0	CLIENT	Rotorua Lakes Council	LOCATION	Rotorua	DATE	11/02/2019
		PROJECT	Rotorua Lakefront Redevelopment			ANALYSED	pemo
		TITLE	1:25 year event sLS	JOB NUMBER	1007467.1000	CHECKED	
		COMMENT		PAGE		PAGE	5 of 35 pages

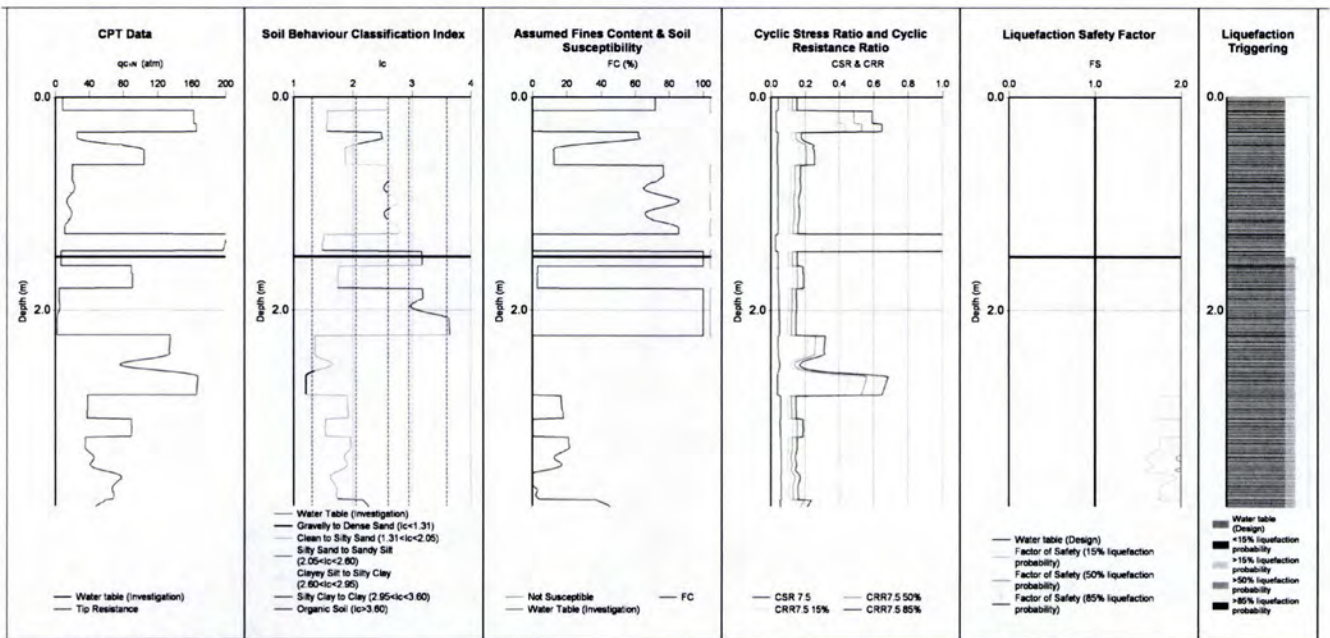


(Assumed pre-drill values)

CPT Name	NZGD ID	Investigation Date	Magnitude	PGA (g)	GWD (m)	Trigger Method	Settlement Method	Pre-drill Depth (m)	qc (MPa)	Fs (MPa)	γ (kN/m ³)
CPT12	110927	30/07/2018	6	0.075	1.5	BI-2014	ZRB-2002	0	2	0.01	17

Thicker lines represent the 50% probability of exceedance case and the thinner lines to the left and right of the thicker lines represent the 85% and 15% probability of exceedance cases respectively.

<p>Tonkin + Taylor Exceptional thinking together V2.0</p>	CLIENT	Rotorua Lakes Council	LOCATION	Rotorua	DATE	11/02/2019
	PROJECT	Rotorua Lakefront Redevelopment	JOB NUMBER	1007467.1000	ANALYSED	permo
	TITLE	1:25 year event sLS	CHECKED		PAGE	6 of 35 pages
	COMMENT					



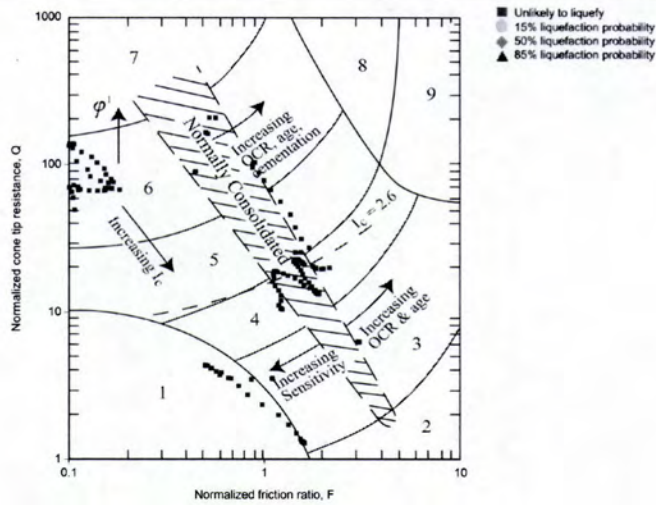
Note: Inverse filtered Q_c/F_s data used (10 cm²)

Run Description	NZGD ID	Investigation Date	γ (kN/m ³)	Magnitude	PGA (g)	Trigger Method	Settlement Method	γ (kN/m ³)	Surcharge/Cut/Fill	Surcharge (kPa)	Cut/Fill Height (m)
INPUT	110928	31/07/2018	17	6	0.075	BI-2014	ZRB-2002	17			0
OUTPUT	PL	Sv1d (mm)	CTL (m)	LPI	LSN	CT (m)	LPlish				
	15%	1	0	0	0	3.8	0				
	50%	0	0	0	0	3.8	0				
	85%	0	0	0	0	3.8	0				

Reviewed by:

CPT Inversion	CDAV
Groundwater	CDAV
Susceptibility	CDAV
Triggering	CDAV
Consequence	CDAV

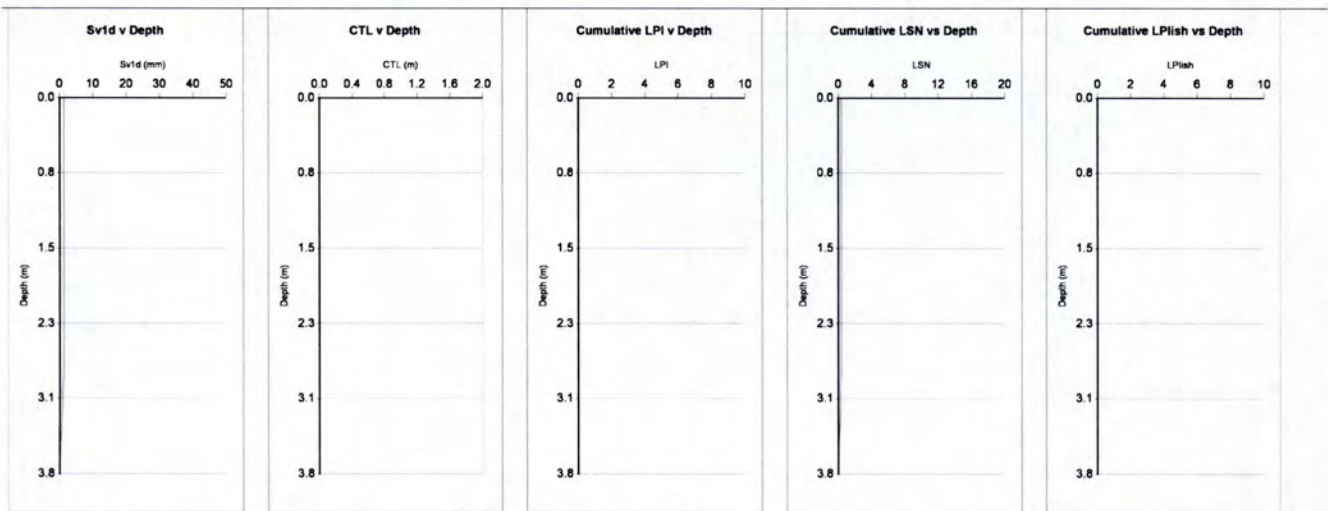
<p>Tonkin + Taylor Exceptional thinking together V2.0</p>	CLIENT	Rotorua Lakes Council	LOCATION	Rotorua	DATE	11/02/2019
	PROJECT	Rotorua Lakefront Redevelopment	JOB NUMBER	1007467.1000	ANALYSED	permo
	TITLE	1:25 year event sLS	CHECKED		PAGE	7 of 35 pages
	COMMENT					



- 1. Sensitive, fine grained
- 2. Organic soils - peats
- 3. Clays - silty clay to clay
- 4. Silt mixtures - clayey silt to silty clay
- 5. Sand mixtures - silty sand to sandy silt
- 6. Sands - clean sand to silty sand
- 7. Gravely sand to dense sand
- 8. Very stiff sand to clayey sand *
- 9. Very stiff, fine grained *

*Heavily overconsolidated or cemented
 CPT-based soil behavior type classification chart by Robertson (1990)

	Tonkin + Taylor Exceptional thinking together V2.0	CLIENT Rotorua Lakes Council PROJECT Rotorua Lakefront Redevelopment TITLE 1:25 year event sLS COMMENT	LOCATION Rotorua JOB NUMBER 1007467.1000	DATE 11/02/2019 ANALYSED pemo CHECKED PAGE 8 of 35 pages

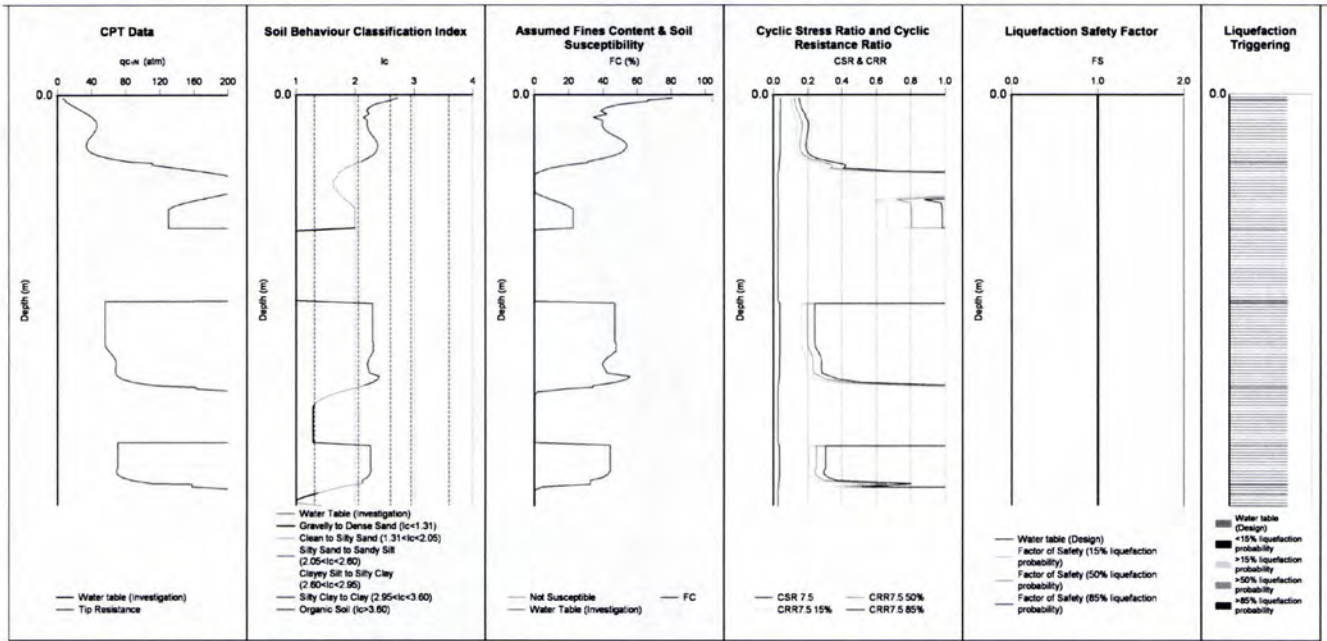


(Assumed pre-drill values)

CPT Name	NZGD ID	Investigation Date	Magnitude	PGA (g)	GWD (m)	Trigger Method	Settlement Method	Pre-drill Depth (m)	qc (MPa)	Fs (MPa)	γ (kN/m³)
CPT13	110928	31/07/2018	6	0.075	1.5	BI-2014	ZRB-2002	0	2	0.01	17

Thicker lines represent the 50% probability of exceedance case and the thinner lines to the left and right of the thicker lines represent the 85% and 15% probability of exceedance cases respectively.

	Tonkin + Taylor Exceptional thinking together V2.0	CLIENT Rotorua Lakes Council PROJECT Rotorua Lakefront Redevelopment TITLE 1:25 year event sLS COMMENT	LOCATION Rotorua JOB NUMBER 1007467.1000	DATE 11/02/2019 ANALYSED pemo CHECKED PAGE 9 of 35 pages

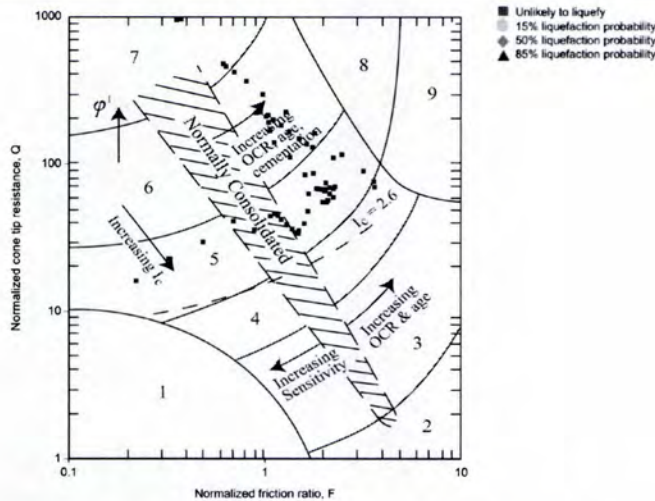


Note: Inverse filtered Q_o/F_s data used (10 cm²)

Run Description	NZGD ID	Investigation Date	γ (kN/m ³)	Magnitude	PGA (g)	Trigger Method	Settlement Method	γ (kN/m ³)	Surcharge/Cut/Fill	Surcharge (kPa)	Cut/Fill Height (m)
INPUT	110929	30/07/2018	17	6	0.075	BI-2014	ZRB-2002	17			0
OUTPUT	PL	Sv1d (mm)	CTL (m)	LPI	LSN	CT (m)	LPlish				
	15%	0	0	0	0	1.3	0				
	50%	0	0	0	0	1.3	0				
	85%	0	0	0	0	1.3	0				

Reviewed by:	
CPT Inversion	CDAV
Groundwater	CDAV
Susceptibility	CDAV
Triggering	CDAV
Consequence	CDAV

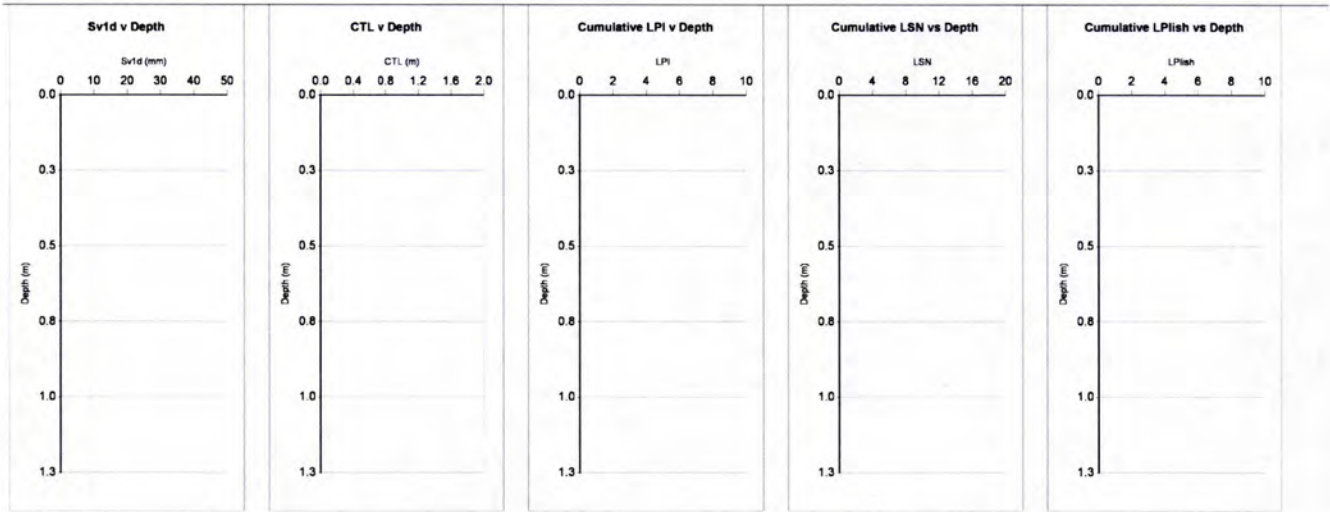
<p>Tonkin+Taylor Exceptional thinking together V2.0</p>	CLIENT	Rotorua Lakes Council	LOCATION	Rotorua	DATE	11/02/2019
	PROJECT	Rotorua Lakefront Redevelopment	JOB NUMBER	1007467.1000	ANALYSED	pemo
	TITLE	1:25 year event sLS	CHECKED		PAGE	10 of 35 pages
	COMMENT					



1. Sensitive, fine grained
2. Organic soils - peats
3. Clays - silty clay to clay
4. Silt mixtures - clayey silt to silty clay
5. Sand mixtures - silty sand to sandy silt
6. Sands - clean sand to silty sand
7. Gravelly sand to dense sand
8. Very stiff sand to clayey sand *
9. Very stiff, fine grained *

*Heavily overconsolidated or cemented
CPT-based soil behavior type classification chart by Robertson (1990)

<p>Tonkin+Taylor Exceptional thinking together V2.0</p>	CLIENT	Rotorua Lakes Council	LOCATION	Rotorua	DATE	11/02/2019
	PROJECT	Rotorua Lakefront Redevelopment	JOB NUMBER	1007467.1000	ANALYSED	pemo
	TITLE	1:25 year event sLS	CHECKED		PAGE	11 of 35 pages
	COMMENT					

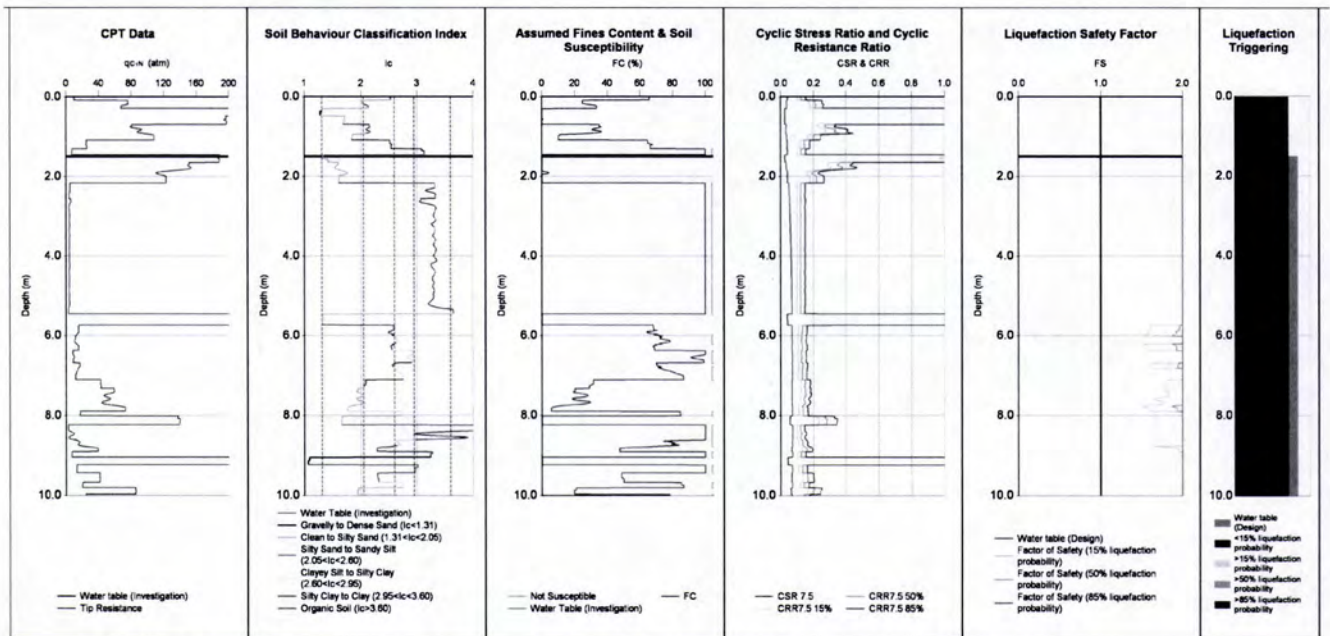


(Assumed pre-drill values)

CPT Name	NZGD ID	Investigation Date	Magnitude	PGA (g)	GWD (m)	Trigger Method	Settlement Method	Pre-drill Depth (m)	qc (MPa)	Fs (MPa)	γ (kN/m ³)
CPT14a	110929	30/07/2018	6	0.075	1.5	BI-2014	ZRB-2002	0	2	0.01	17

Thicker lines represent the 50% probability of exceedence case and the thinner lines to the left and right of the thicker lines represent the 85% and 15% probability of exceedence cases respectively.

	Tonkin + Taylor Exceptional thinking together V2.0	CLIENT	Rotorua Lakes Council	LOCATION	Rotorua	DATE	11/02/2019
		PROJECT	Rotorua Lakefront Redevelopment	ANALYSED	permo		
		TITLE	1:25 year event sLS	JOB NUMBER	1007467.1000	CHECKED	
		COMMENT		PAGE	12 of 35 pages		



Note: Inverse filtered Qo/Fs data used (10 cm²)

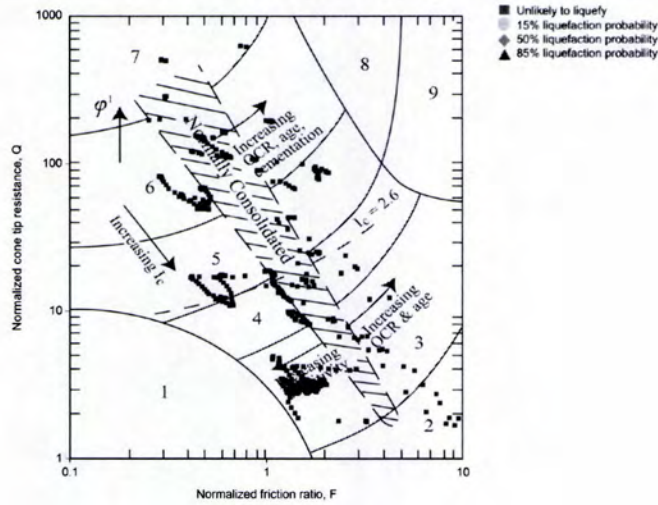
Run Description	NZGD ID	Investigation Date	γ (kN/m ³)	Magnitude	PGA (g)	Trigger Method	Settlement Method	γ (kN/m ³)	Surcharge/Cut/Fill	Surcharge (kPa)	Cut/Fill Height (m)
INPUT	110930	30/07/2018	17	6	0.075	BI-2014	ZRB-2002	17			0

OUTPUT	PL	Sv1d (mm)	CTL (m)	LPI	LSN	CT (m)	LPlish
15%	2	0	0	0	10	10	0
50%	0	0	0	0	10	10	0
85%	0	0	0	0	10	10	0

Reviewed by:

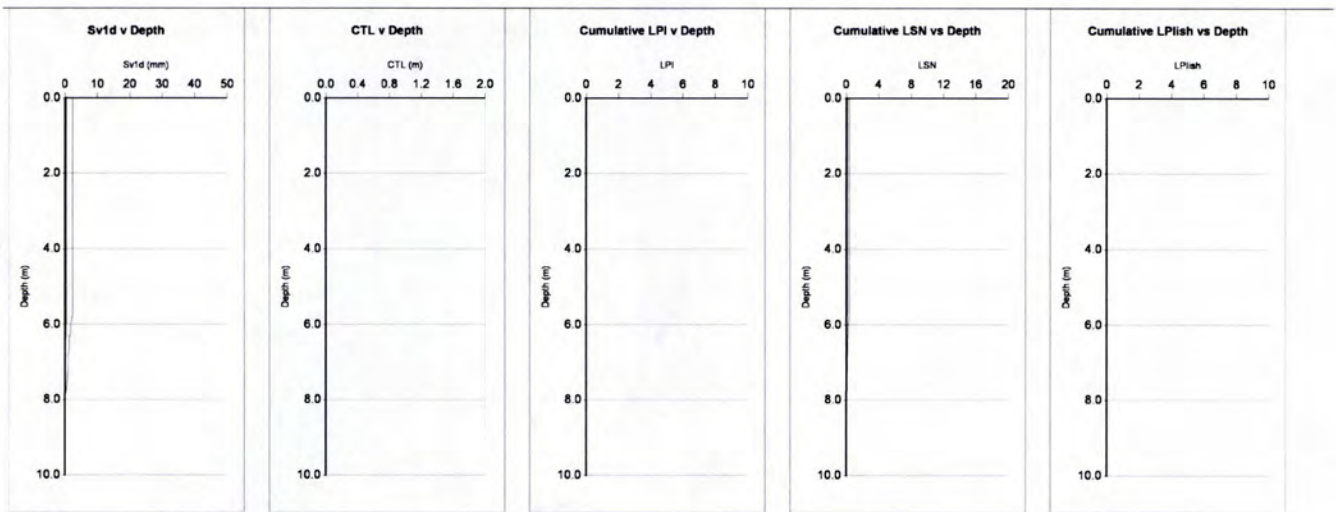
CPT Inversion	CDAV
Groundwater	CDAV
Susceptibility	CDAV
Triggering	CDAV
Consequence	CDAV

	Tonkin + Taylor Exceptional thinking together V2.0	CLIENT	Rotorua Lakes Council	LOCATION	Rotorua	DATE	11/02/2019
		PROJECT	Rotorua Lakefront Redevelopment	ANALYSED	permo		
		TITLE	1:25 year event sLS	JOB NUMBER	1007467.1000	CHECKED	
		COMMENT		PAGE	13 of 35 pages		



- 1. Sensitive, fine grained
 - 2. Organic soils - peats
 - 3. Clays - silty clay to clay
 - 4. Silt mixtures - clayey silt to silty clay
 - 5. Sand mixtures - silty sand to sandy silt
 - 6. Sands - clean sand to silty sand
 - 7. Gravely sand to dense sand
 - 8. Very stiff sand to clayey sand *
 - 9. Very stiff, fine grained *
- *Heavily overconsolidated or cemented
 CPT-based soil behavior type classification chart by Robertson (1990)

	Tonkin + Taylor	CLIENT	Rotorua Lakes Council	LOCATION	Rotorua	DATE	11/02/2019
	Exceptional thinking together	PROJECT	Rotorua Lakefront Redevelopment	JOB NUMBER	1007467.1000	ANALYSED	permo
	V2.0	TITLE	1:25 year event sLS	CHECKED		PAGE	14 of 35 pages
		COMMENT					

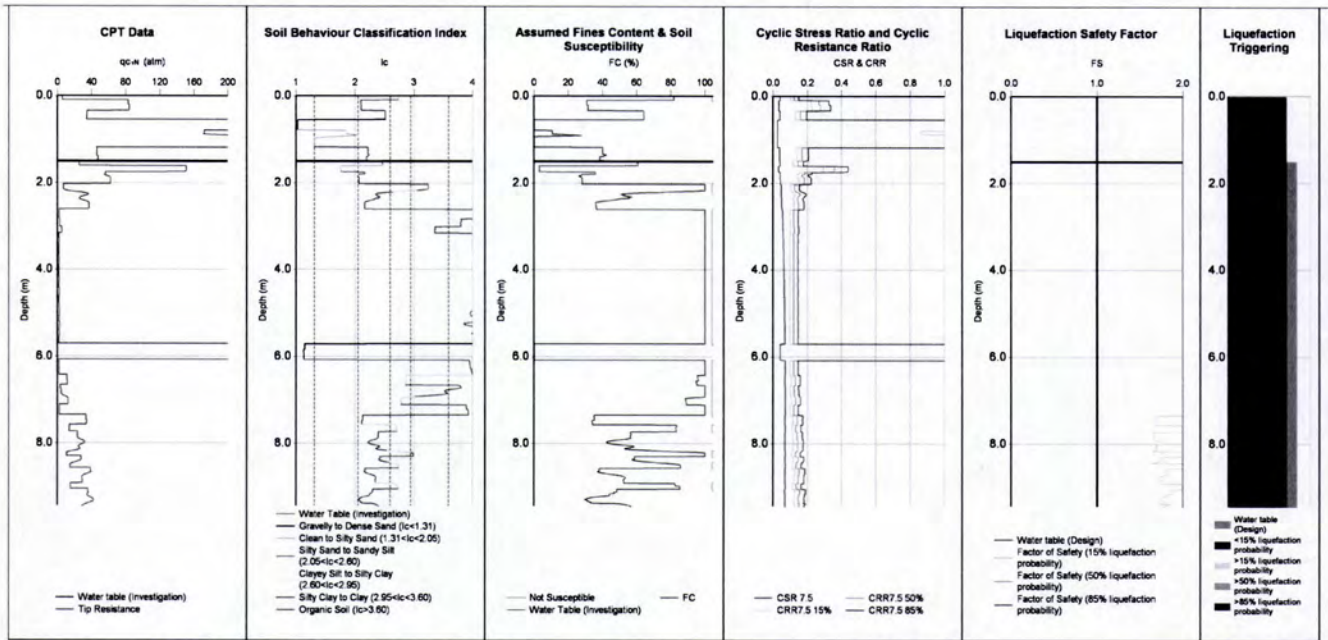


(Assumed pre-drill values)

CPT Name	NZGD ID	Investigation Date	Magnitude	PGA (g)	GWD (m)	Trigger Method	Settlement Method	Pre-drill Depth (m)	qc (MPa)	Fs (MPa)	γ (kN/m ³)
CPT15	110930	30/07/2018	6	0.075	1.5	BI-2014	ZRB-2002	0	2	0.01	17

Thicker lines represent the 50% probability of exceedance case and the thinner lines to the left and right of the thicker lines represent the 85% and 15% probability of exceedance cases respectively.

	Tonkin + Taylor	CLIENT	Rotorua Lakes Council	LOCATION	Rotorua	DATE	11/02/2019
	Exceptional thinking together	PROJECT	Rotorua Lakefront Redevelopment	JOB NUMBER	1007467.1000	ANALYSED	permo
	V2.0	TITLE	1:25 year event sLS	CHECKED		PAGE	15 of 35 pages
		COMMENT					

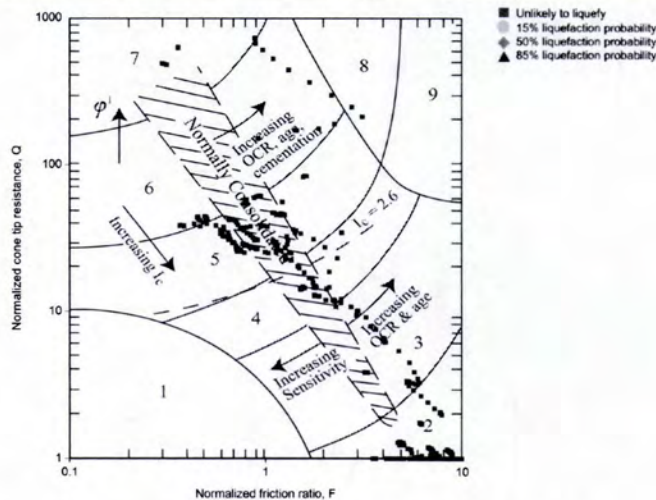


Note: Inverse filtered Qc/Fs data used (10 cm²)

Run Description	NZGD ID	Investigation Date	γ (kN/m ³)	Magnitude	PGA (g)	Trigger Method	Settlement Method	γ (kN/m ³)	Surcharge/Cut/Fill	Surcharge (kPa)	Cut/Fill Height (m)
INPUT	110931	30/07/2018	17	17	6	0.075 BI-2014	ZRB-2002	17			0
OUTPUT	PL	Sv1d (mm)	CTL (m)	LPI	LSN	CT (m)	LPlish				
	15%	2	0	0	0	9.4	0				
	50%	0	0	0	0	9.4	0				
	85%	0	0	0	0	9.4	0				

Reviewed by:	CDAV
CPT Inversion	CDAV
Groundwater	CDAV
Susceptibility	CDAV
Triggering	CDAV
Consequence	CDAV

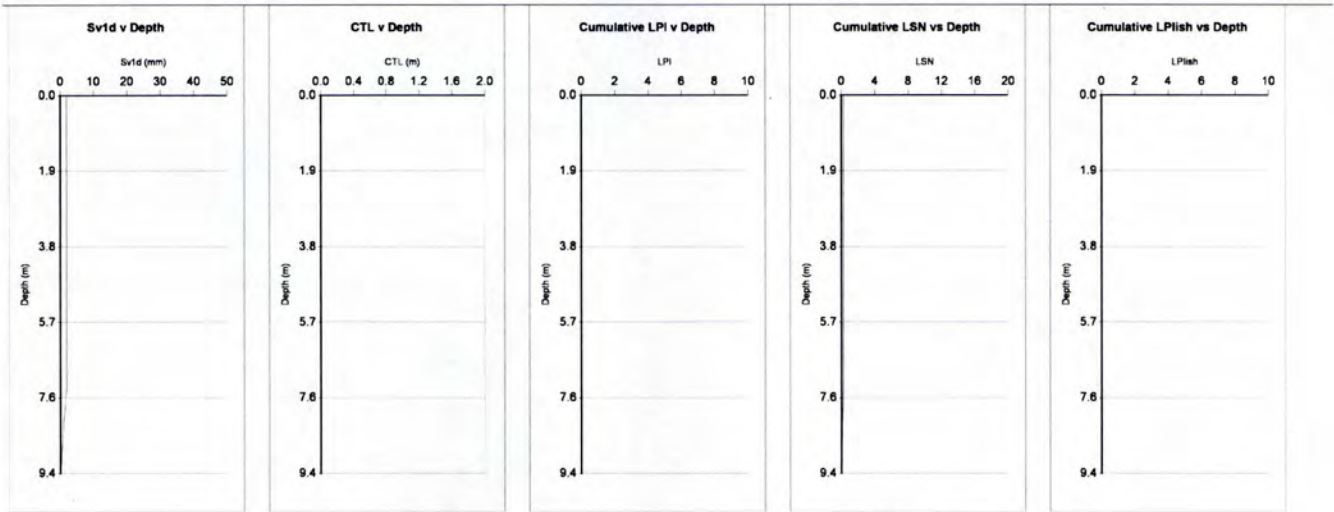
 Tonkin + Taylor Exceptional thinking together V2.0	CLIENT: Rotorua Lakes Council PROJECT: Rotorua Lakefront Redevelopment TITLE: 1:25 year event sLS COMMENT:	LOCATION: Rotorua JOB NUMBER: 1007467.1000	DATE: 11/02/2019 ANALYSED: pemo CHECKED: PAGE: 16 of 35 pages
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- 1. Sensitive, fine grained
- 2. Organic soils - peats
- 3. Clays - silty clay to clay
- 4. Silt mixtures - clayey silt to silty clay
- 5. Sand mixtures - silty sand to sandy silt
- 6. Sands - clean sand to silty sand
- 7. Gravely sand to dense sand
- 8. Very stiff sand to clayey sand *
- 9. Very stiff, fine grained *

*Heavily overconsolidated or cemented
 CPT-based soil behavior type classification chart by Robertson (1990)

 Tonkin + Taylor Exceptional thinking together V2.0	CLIENT: Rotorua Lakes Council PROJECT: Rotorua Lakefront Redevelopment TITLE: 1:25 year event sLS COMMENT:	LOCATION: Rotorua JOB NUMBER: 1007467.1000	DATE: 11/02/2019 ANALYSED: pemo CHECKED: PAGE: 17 of 35 pages
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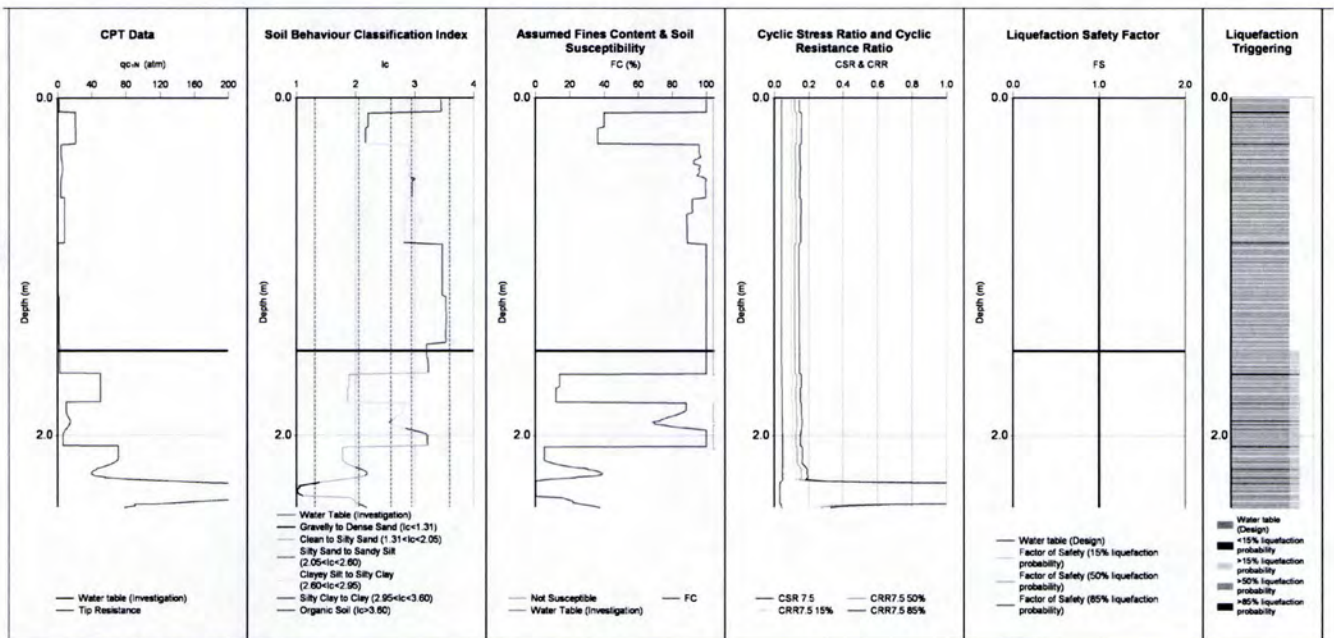


(Assumed pre-drill values)

CPT Name	NZGD ID	Investigation Date	Magnitude	PGA (g)	GWD (m)	Trigger Method	Settlement Method	Pre-drill Depth (m)	qc (MPa)	Fs (MPa)	γ (kN/m ³)
CPT16	110931	30/07/2018	6	0.075	1.5	BI-2014	ZRB-2002	0	2	0.01	17

Thicker lines represent the 50% probability of exceedance case and the thinner lines to the left and right of the thicker lines represent the 85% and 15% probability of exceedance cases respectively.

<p>Tonkin + Taylor Exceptional thinking together V2.0</p>	CLIENT Rotorua Lakes Council	LOCATION Rotorua	DATE 11/02/2019
	PROJECT Rotorua Lakefront Redevelopment	JOB NUMBER 1007467.1000	ANALYSED permo
	TITLE 1:25 year event sLS	CHECKED	PAGE 18 of 35 pages



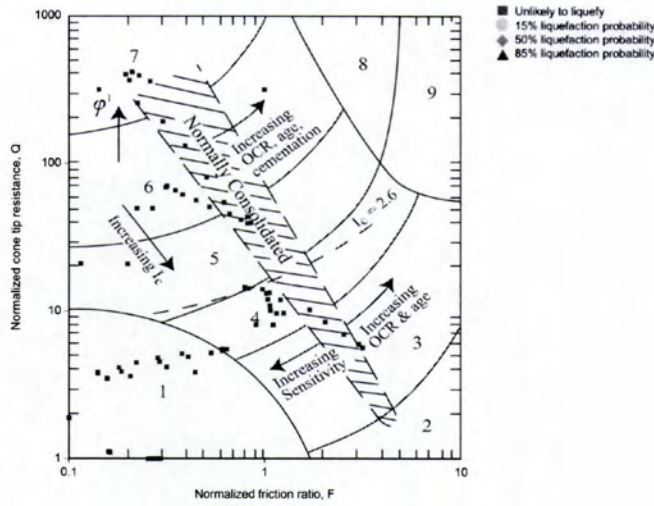
Note: Inverse filtered Qc/Fs data used (10 cm²)

Run Description	NZGD ID	Investigation Date	γ (kN/m ³)	Magnitude	PGA (g)	Trigger Method	Settlement Method	γ (kN/m ³)	Surcharge/Cut/Fill	Surcharge (kPa)	Cut/Fill Height (m)
INPUT	110932	31/07/2018	17	6	0.075	BI-2014	ZRB-2002	17			0
OUTPUT	PL	Sv1d (mm)	CTL (m)	LPI	LSN	CT (m)	LPIish				
	15%	0	0	0	0	2.4	0				
	50%	0	0	0	0	2.4	0				
	85%	0	0	0	0	2.4	0				

Reviewed by:

CPT Inversion	CDAV
Groundwater	CDAV
Susceptibility	CDAV
Triggering	CDAV
Consequence	CDAV

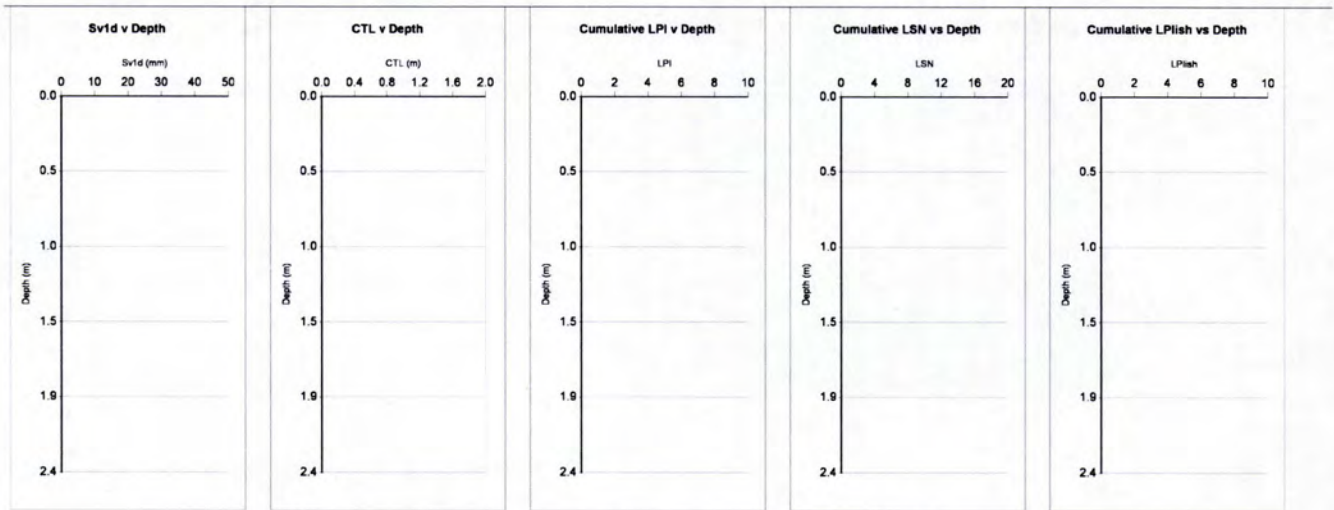
<p>Tonkin + Taylor Exceptional thinking together V2.0</p>	CLIENT Rotorua Lakes Council	LOCATION Rotorua	DATE 11/02/2019
	PROJECT Rotorua Lakefront Redevelopment	JOB NUMBER 1007467.1000	ANALYSED permo
	TITLE 1:25 year event sLS	CHECKED	PAGE 19 of 35 pages



- 1. Sensitive, fine grained
- 2. Organic soils - peats
- 3. Clays - silty clay to clay
- 4. Silt mixtures - clayey silt to silty clay
- 5. Sand mixtures - silty sand to sandy silt
- 6. Sands - clean sand to silty sand
- 7. Gravely sand to dense sand
- 8. Very stiff sand to clayey sand *
- 9. Very stiff, fine grained *

*Heavily overconsolidated or cemented
 CPT-based soil behavior type classification chart by Robertson (1990)

	Tonkin + Taylor Exceptional thinking together V2.0	CLIENT Rotorua Lakes Council PROJECT Rotorua Lakefront Redevelopment TITLE 1:25 year event sLS COMMENT	LOCATION Rotorua DATE 11/02/2019 ANALYSED pemo CHECKED PAGE 20 of 35 pages
		JOB NUMBER 1007467.1000	

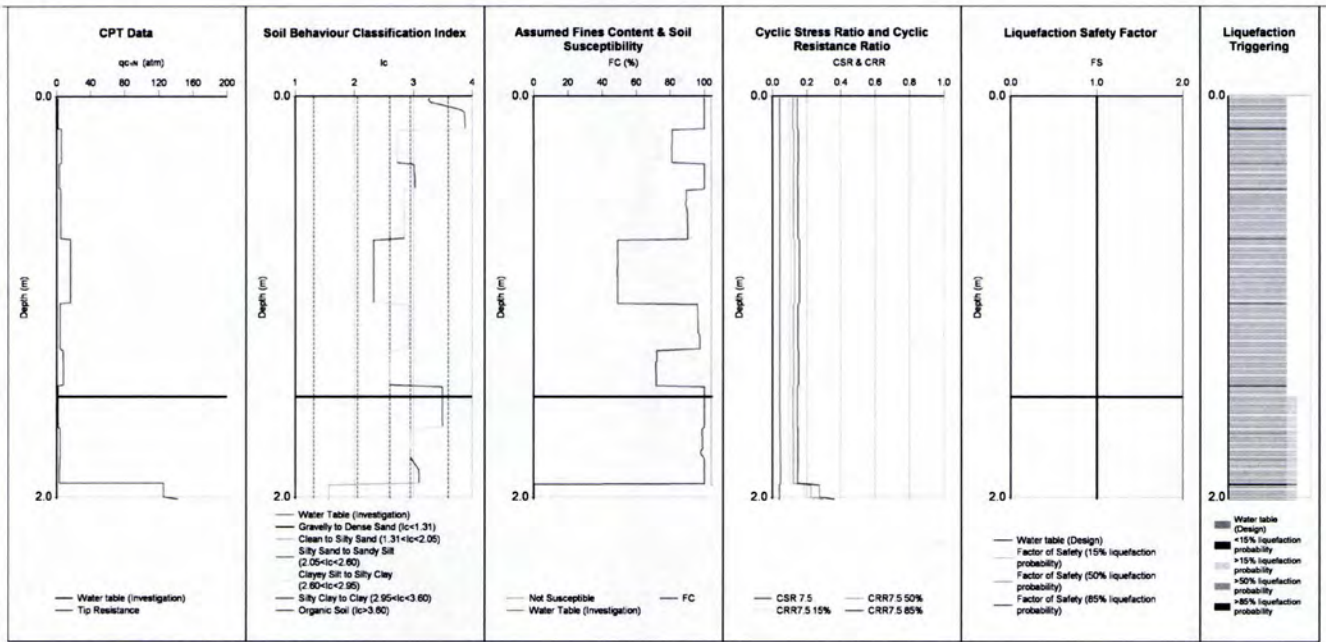


(Assumed pre-drill values)

CPT Name	NZGD ID	Investigation Date	Magnitude	PGA (g)	GWD (m)	Trigger Method	Settlement Method	Pre-drill Depth (m)	qc (MPa)	Fs (MPa)	γ (kN/m³)
CPT17a	110932	31/07/2018	6	0.075	1.5	BI-2014	ZRB-2002	0	2	0.01	17

Thicker lines represent the 50% probability of exceedance case and the thinner lines to the left and right of the thicker lines represent the 85% and 15% probability of exceedance cases respectively.

	Tonkin + Taylor Exceptional thinking together V2.0	CLIENT Rotorua Lakes Council PROJECT Rotorua Lakefront Redevelopment TITLE 1:25 year event sLS COMMENT	LOCATION Rotorua DATE 11/02/2019 ANALYSED pemo CHECKED PAGE 21 of 35 pages
		JOB NUMBER 1007467.1000	

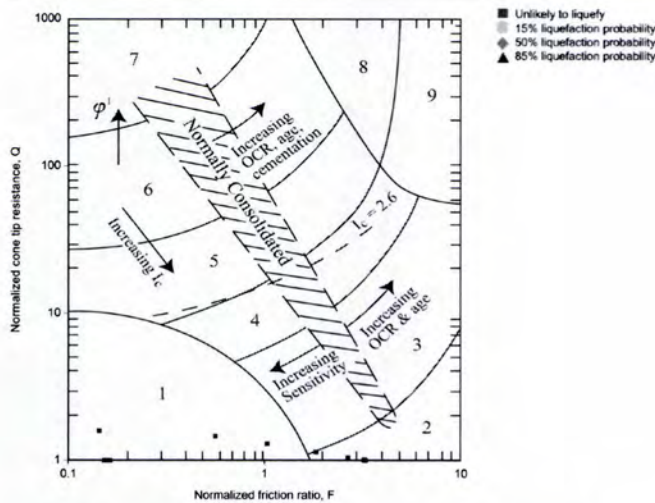


Note: Inverse filtered Q_c/F_s data used (10 cm²)

Run Description	NZGD ID	Investigation Date	γ (kN/m ³)	Magnitude	PGA (g)	Trigger Method	Settlement Method	γ (kN/m ³)	Surcharge/Cut/Fill	Surcharge (kPa)	Cut/Fill Height (m)
INPUT	110933	31/07/2018	17	6	0.075	BI-2014	ZRB-2002	17			0
OUTPUT	PL	Sv1d (mm)	CTL (m)	LPI	LSN	CT (m)	LPlish				
	15%	0	0	0	0	2	0				
	50%	0	0	0	0	2	0				
	85%	0	0	0	0	2	0				

Reviewed by	Consequence
CPT Inversion	CDAV
Groundwater	CDAV
Susceptibility	CDAV
Triggering	CDAV
Consequence	CDAV

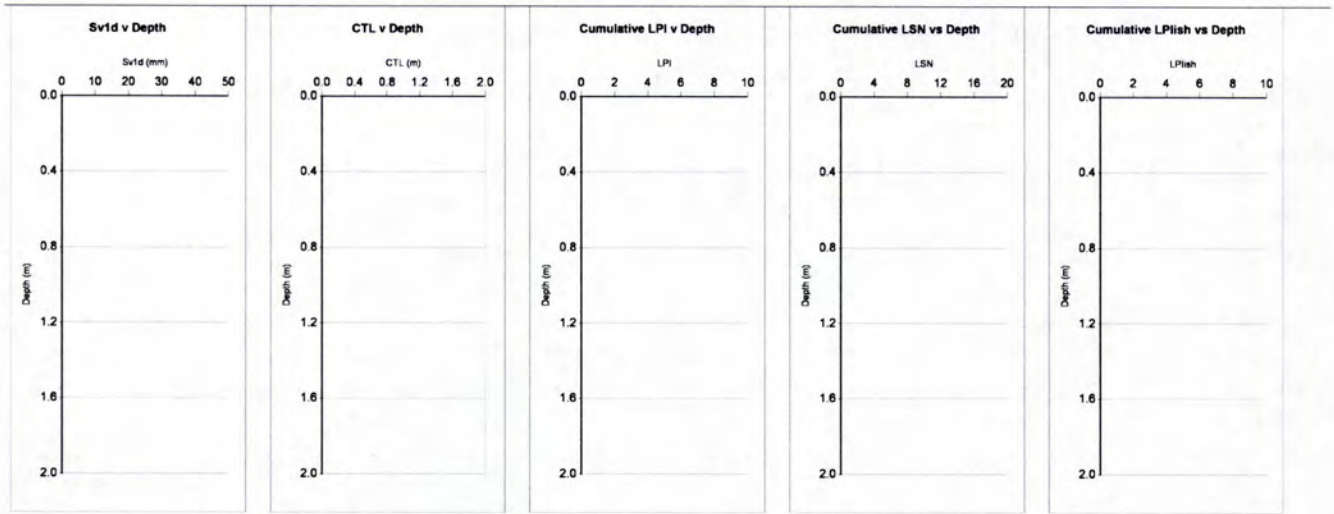
<p>Tonkin + Taylor Exceptional thinking together V2.0</p>	CLIENT	Rotorua Lakes Council	LOCATION	Rotorua	DATE	11/02/2019
	PROJECT	Rotorua Lakefront Redevelopment	TITLE		ANALYSED	pemo
	COMMENT	1:25 year event sLS	JOB NUMBER	1007467.1000	CHECKED	
			PAGE	22 of 35 pages		



- Sensitive, fine grained
- Organic soils - peats
- Clays - silty clay to clay
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- Sand mixtures - silty sand to sandy silt
- Sands - clean sand to silty sand
- Gravelly sand to dense sand
- Very stiff sand to clayey sand *
- Very stiff, fine grained *

*Heavily overconsolidated or cemented
 CPT-based soil behavior type classification chart by Robertson (1990)

<p>Tonkin + Taylor Exceptional thinking together V2.0</p>	CLIENT	Rotorua Lakes Council	LOCATION	Rotorua	DATE	11/02/2019
	PROJECT	Rotorua Lakefront Redevelopment	TITLE		ANALYSED	pemo
	COMMENT	1:25 year event sLS	JOB NUMBER	1007467.1000	CHECKED	
			PAGE	23 of 35 pages		

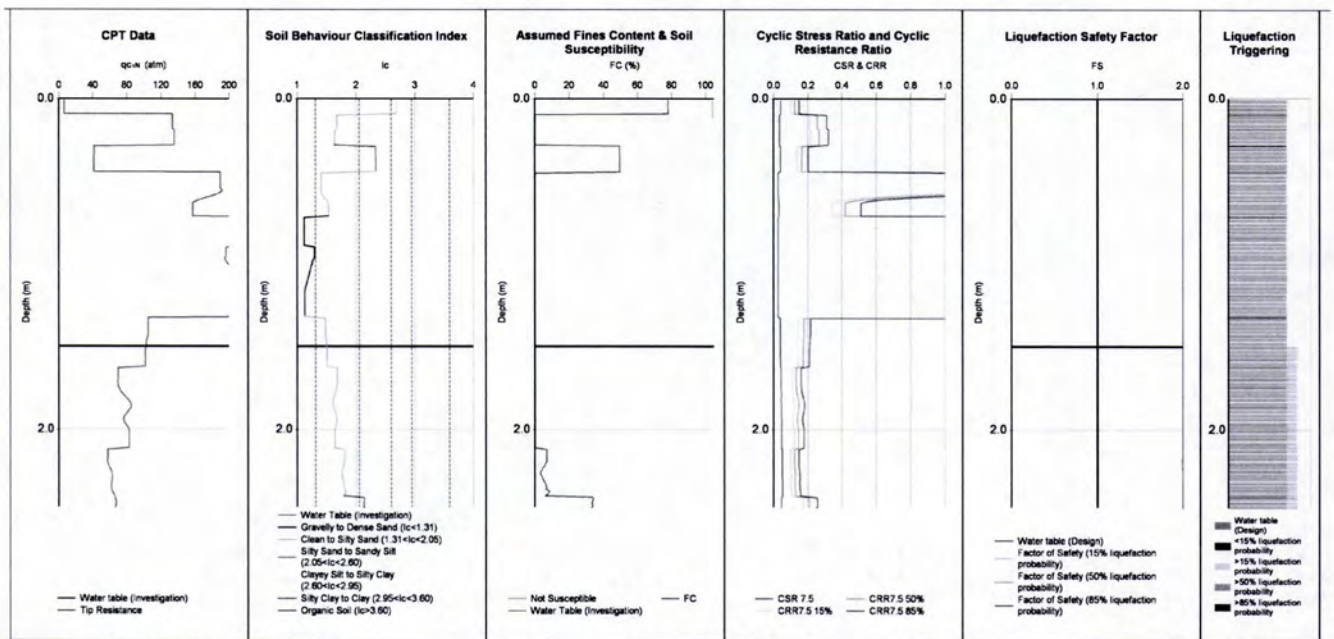


(Assumed pre-drill values)

CPT Name	NZGD ID	Investigation Date	Magnitude	PGA (g)	GWD (m)	Trigger Method	Settlement Method	Pre-drill Depth (m)	qc (MPa)	Fs (MPa)	γ (kN/m ³)
CPT18a	110933	31/07/2018	6	0.075	1.5	BI-2014	ZRB-2002	0	2	0.01	17

Thicker lines represent the 50% probability of exceedance case and the thinner lines to the left and right of the thicker lines represent the 85% and 15% probability of exceedance cases respectively.

	Tonkin + Taylor Exceptional thinking together V2.0	CLIENT Rotorua Lakes Council	PROJECT Rotorua Lakefront Redevelopment	LOCATION Rotorua	DATE 11/02/2019
		TITLE 1:25 year event sLS		JOB NUMBER 1007467.1000	ANALYSED pemo
					CHECKED
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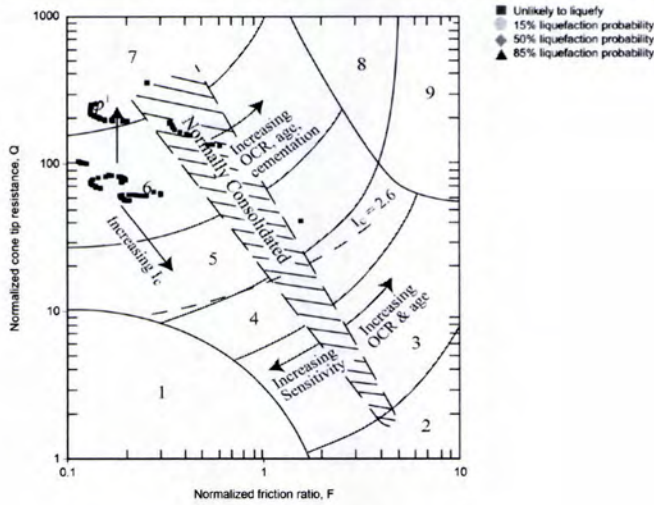
Note: Inverse filtered Qc/Fs data used (10 cm²)

Run Description	NZGD ID	Investigation Date	γ (kN/m ³)	Magnitude	PGA (g)	Trigger Method	Settlement Method	γ (kN/m ³)	Surcharge/Cut/Fill	Surcharge (kPa)	Cut/Fill Height (m)
INPUT	110934	31/07/2018	17	6	0.075	BI-2014	ZRB-2002	17		0	
OUTPUT											
	PL	Sv1d (mm)	CTL (m)	LPI	LSN	CT (m)	LPlish				
		15%	0	0	0	0	2.5	0			
		50%	0	0	0	0	2.5	0			
		85%	0	0	0	0	2.5	0			

Reviewed by:

CPT Inversion	CDAV
Groundwater	CDAV
Susceptibility	CDAV
Triggering	CDAV
Consequence	CDAV

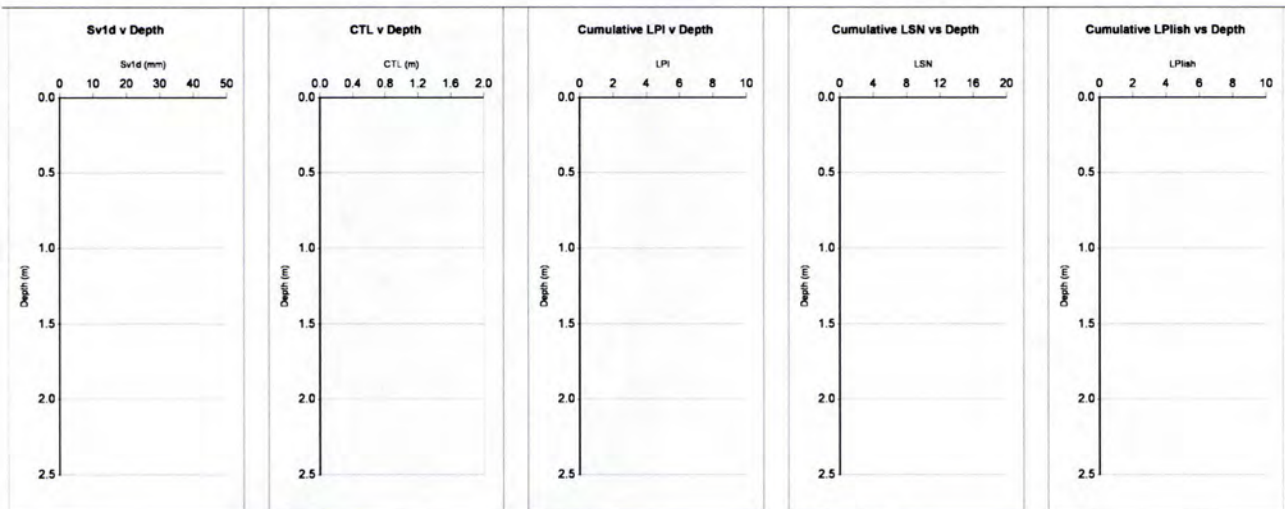
	Tonkin + Taylor Exceptional thinking together V2.0	CLIENT Rotorua Lakes Council	PROJECT Rotorua Lakefront Redevelopment	LOCATION Rotorua	DATE 11/02/2019
		TITLE 1:25 year event sLS		JOB NUMBER 1007467.1000	ANALYSED pemo
					CHECKED
					PAGE 25 of 35 pages



- 1. Sensitive, fine grained
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- 5. Sand mixtures - silty sand to sandy silt
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- 8. Very stiff sand to clayey sand *
- 9. Very stiff, fine grained *

*Heavily overconsolidated or cemented
 CPT-based soil behavior type classification chart by Robertson (1990)

	Tonkin + Taylor Exceptional thinking together V2.0	CLIENT Rotorua Lakes Council	PROJECT Rotorua Lakefront Redevelopment	LOCATION Rotorua	DATE 11/02/2019
		TITLE 1:25 year event sLS		JOB NUMBER 1007467.1000	ANALYSED pemo
		COMMENT			CHECKED
					PAGE 26 of 35 pages

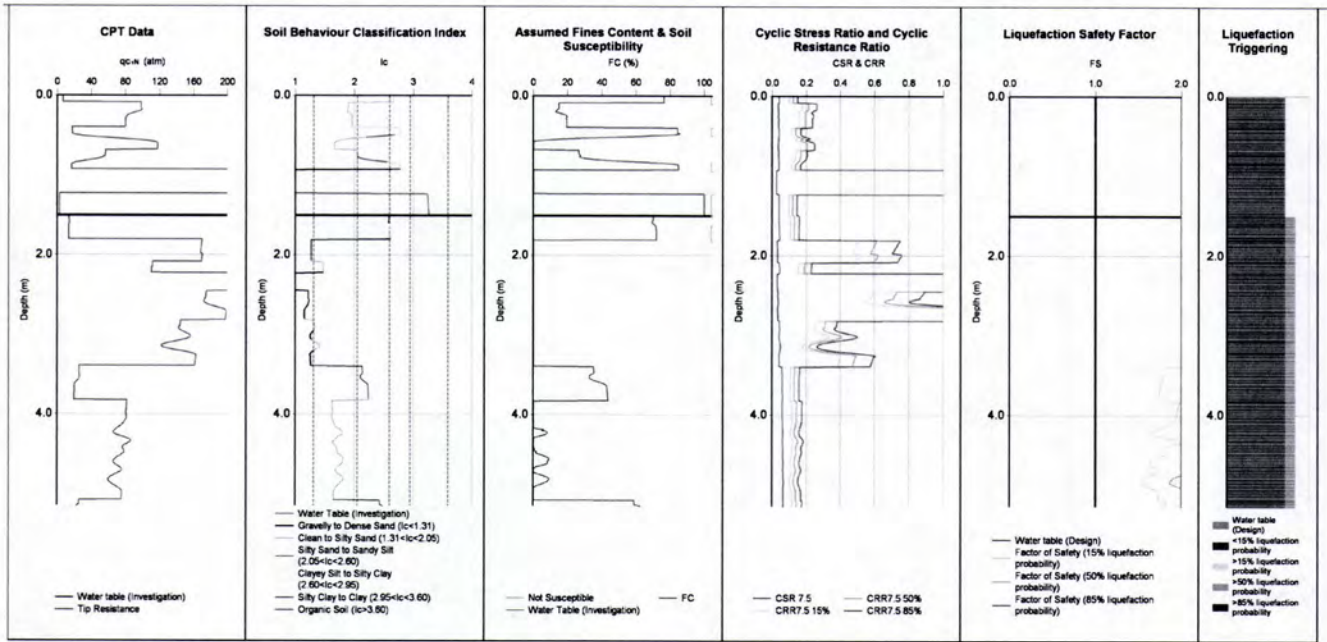


(Assumed pre-drill values)

CPT Name	NZGD ID	Investigation Date	Magnitude	PGA (g)	GWD (m)	Trigger Method	Settlement Method	Pre-drill Depth (m)	qc (MPa)	Fs (MPa)	γ (kN/m³)
CPT19	110934	31/07/2018	6	0.075	1.5	BI-2014	ZRB-2002	0	2	0.01	17

Thicker lines represent the 50% probability of exceedance case and the thinner lines to the left and right of the thicker lines represent the 85% and 15% probability of exceedance cases respectively.

	Tonkin + Taylor Exceptional thinking together V2.0	CLIENT Rotorua Lakes Council	PROJECT Rotorua Lakefront Redevelopment	LOCATION Rotorua	DATE 11/02/2019
		TITLE 1:25 year event sLS		JOB NUMBER 1007467.1000	ANALYSED pemo
		COMMENT			CHECKED
					PAGE 27 of 35 pages

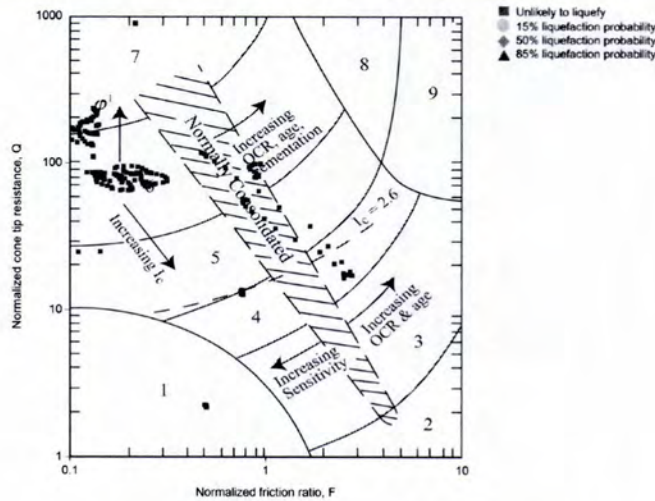


Note: Inverse filtered Q_c/F_s data used (10 cm^2)

Run Description	NZGD ID	Investigation Date	γ (kN/m ³)	Magnitude	PGA (g)	Trigger Method	Settlement Method	γ (kN/m ³)	Surcharge/Cut/Fill	Surcharge (kPa)	Cut/Fill Height (m)
INPUT	110935	31/07/2018	17	17	6	0.075 BI-2014	ZRB-2002	17	17	0	0
OUTPUT	PL	Sv1d (mm)	CTL (m)	LPI	LSN	CT (m)	LPlish				
	15%	2	0	0	0	5.2	0				
	50%	0	0	0	0	5.2	0				
	85%	0	0	0	0	5.2	0				

Reviewed by	CDAV
CPT Inversion	CDAV
Groundwater	CDAV
Susceptibility	CDAV
Triggering	CDAV
Consequence	CDAV

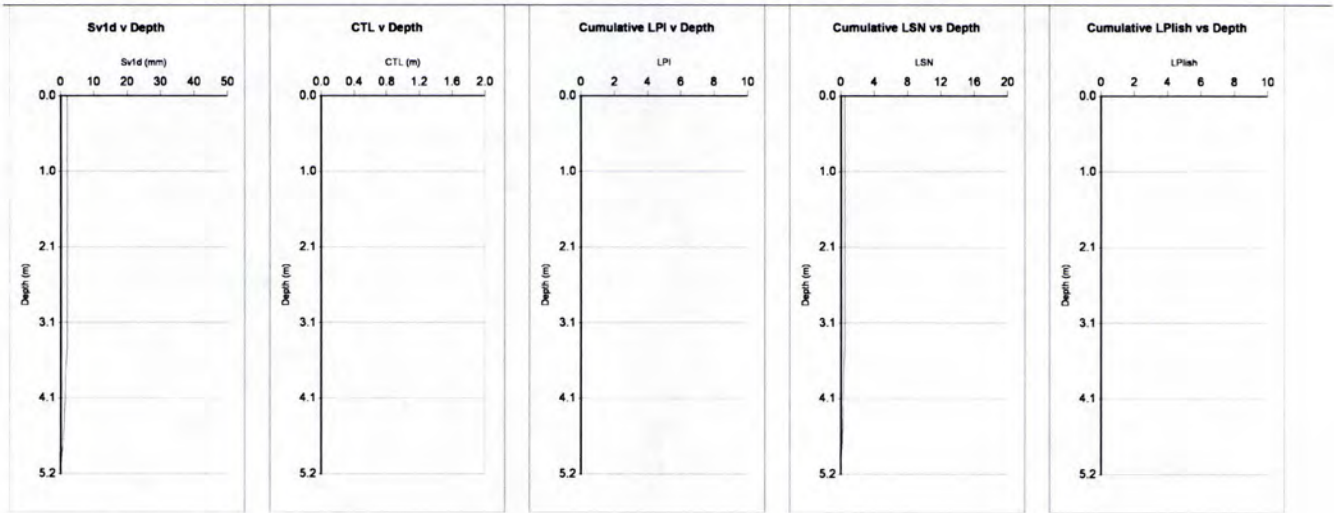
<p>Tonkin + Taylor Exceptional thinking together V2.0</p>	<p>CLIENT: Rotorua Lakes Council</p> <p>PROJECT: Rotorua Lakefront Redevelopment</p> <p>TITLE: 1:25 year event sLS</p> <p>COMMENT:</p>	<p>LOCATION: Rotorua</p> <p>JOB NUMBER: 1007467.1000</p>	<p>DATE: 11/02/2019</p> <p>ANALYSED: pemo</p> <p>CHECKED:</p> <p>PAGE: 28 of 35 pages</p>
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1. Sensitive, fine grained
2. Organic soils - peats
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CPT-based soil behavior type classification chart by Robertson (1990)

<p>Tonkin + Taylor Exceptional thinking together V2.0</p>	<p>CLIENT: Rotorua Lakes Council</p> <p>PROJECT: Rotorua Lakefront Redevelopment</p> <p>TITLE: 1:25 year event sLS</p> <p>COMMENT:</p>	<p>LOCATION: Rotorua</p> <p>JOB NUMBER: 1007467.1000</p>	<p>DATE: 11/02/2019</p> <p>ANALYSED: pemo</p> <p>CHECKED:</p> <p>PAGE: 29 of 35 pages</p>
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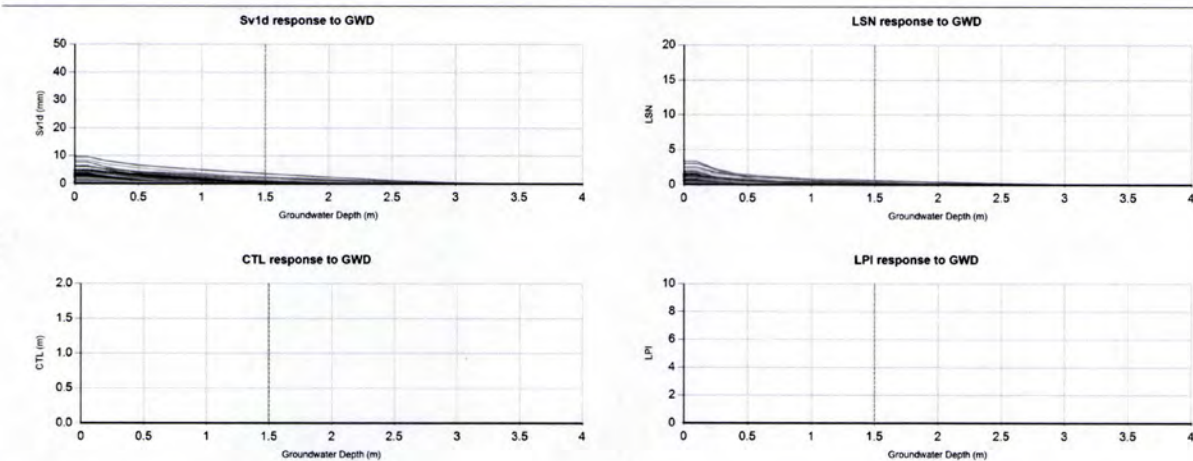


(Assumed pre-drill values)

CPT Name	NZGD ID	Investigation Date	Magnitude	PGA (g)	GWD (m)	Trigger Method	Settlement Method	Pre-drill Depth (m)	qc (MPa)	Fs (MPa)	γ (kN/m ³)
CPT20	110935	31/07/2018	6	0.075	1.5	BI-2014	ZRB-2002	0	2	0.01	17

Thicker lines represent the 50% probability of exceedance case and the thinner lines to the left and right of the thicker lines represent the 85% and 15% probability of exceedance cases respectively.

<p>Tonkin + Taylor Exceptional thinking together V2.0</p>	<p>CLIENT Rotorua Lakes Council</p> <p>PROJECT Rotorua Lakefront Redevelopment</p> <p>TITLE 1:25 year event sLS</p> <p>COMMENT</p>	LOCATION	DATE
		<p>Rotorua</p> <p>JOB NUMBER 1007467.1000</p>	<p>11/02/2019</p> <p>ANALYSED pemo</p> <p>CHECKED</p> <p>PAGE 30 of 35 pages</p>



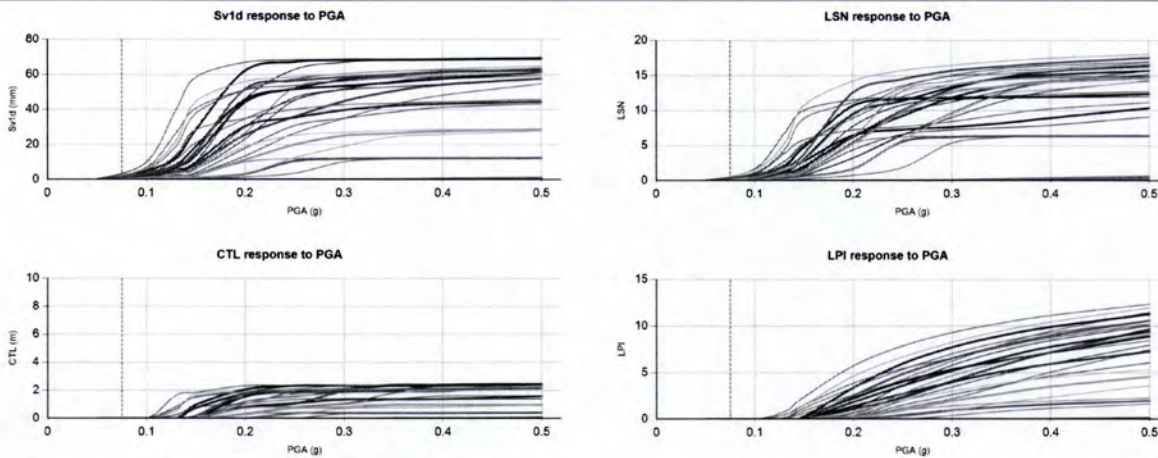
Vertical dashed lines indicate user specified GWD at the CPT locations. (actual GWD)

(Assumed pre-drill values)

CPT Name	NZGD ID	Investigation Date	Event and Model (PGA & GWD)	Magnitude	PGA (g)	GWD (m)	Trigger Method	Settlement Method	Pre-drill Depth (m)	qc (MPa)	Fs (MPa)	γ (kN/m ³)
CPT11	110926	1/08/2018	User Specified	6	0.075	1.5	BI-2014	ZRB-2002	0	2	0.01	17
CPT12	110927	30/07/2018	User Specified	6	0.075	1.5	BI-2014	ZRB-2002	0	2	0.01	17
CPT13	110928	31/07/2018	User Specified	6	0.075	1.5	BI-2014	ZRB-2002	0	2	0.01	17
CPT14a	110929	30/07/2018	User Specified	6	0.075	1.5	BI-2014	ZRB-2002	0	2	0.01	17
CPT15	110930	30/07/2018	User Specified	6	0.075	1.5	BI-2014	ZRB-2002	0	2	0.01	17
CPT16	110931	30/07/2018	User Specified	6	0.075	1.5	BI-2014	ZRB-2002	0	2	0.01	17
CPT17a	110932	31/07/2018	User Specified	6	0.075	1.5	BI-2014	ZRB-2002	0	2	0.01	17
CPT18a	110933	31/07/2018	User Specified	6	0.075	1.5	BI-2014	ZRB-2002	0	2	0.01	17
CPT19	110934	31/07/2018	User Specified	6	0.075	1.5	BI-2014	ZRB-2002	0	2	0.01	17
CPT20	110935	31/07/2018	User Specified	6	0.075	1.5	BI-2014	ZRB-2002	0	2	0.01	17

Thicker lines represent the 50% probability of exceedance case and the thinner lines to the bottom and top of the thicker lines represent the 85% and 15% probability of exceedance cases respectively.

<p>Tonkin + Taylor Exceptional thinking together V2.0</p>	<p>CLIENT Rotorua Lakes Council</p> <p>PROJECT Rotorua Lakefront Redevelopment</p> <p>TITLE 1:25 year event sLS</p> <p>COMMENT</p>	LOCATION	DATE
		<p>Rotorua</p> <p>JOB NUMBER 1007467.1000</p>	<p>11/02/2019</p> <p>ANALYSED pemo</p> <p>CHECKED</p> <p>PAGE 31 of 35 pages</p>



Vertical dashed lines indicate user specified PGA at the CPT locations (actual PGA)

CPT Name	NZGD ID	Investigation Date	Event and Model (PGA & GWD)	Magnitude	PGA (g)	GWD (m)	Trigger Method	Settlement Method	Pre-drill Depth (m)	(Assumed pre-drill values)		
										qc (MPa)	Fs (MPa)	γ (kN/m ³)
CPT11	110926	1/08/2018	User Specified	6	0.075	1.5	Bi-2014	ZRB-2002	0	2	0.01	17
CPT12	110927	30/07/2018	User Specified	6	0.075	1.5	Bi-2014	ZRB-2002	0	2	0.01	17
CPT13	110928	31/07/2018	User Specified	6	0.075	1.5	Bi-2014	ZRB-2002	0	2	0.01	17
CPT14a	110929	30/07/2018	User Specified	6	0.075	1.5	Bi-2014	ZRB-2002	0	2	0.01	17
CPT15	110930	30/07/2018	User Specified	6	0.075	1.5	Bi-2014	ZRB-2002	0	2	0.01	17
CPT16	110931	30/07/2018	User Specified	6	0.075	1.5	Bi-2014	ZRB-2002	0	2	0.01	17
CPT17a	110932	31/07/2018	User Specified	6	0.075	1.5	Bi-2014	ZRB-2002	0	2	0.01	17
CPT18a	110933	31/07/2018	User Specified	6	0.075	1.5	Bi-2014	ZRB-2002	0	2	0.01	17
CPT19	110934	31/07/2018	User Specified	6	0.075	1.5	Bi-2014	ZRB-2002	0	2	0.01	17
CPT20	110935	31/07/2018	User Specified	6	0.075	1.5	Bi-2014	ZRB-2002	0	2	0.01	17

Thicker lines represent the 50% probability of exceedance case and the thinner lines to the bottom and top of the thicker lines represent the 85% and 15% probability of exceedance cases respectively.

 Tonkin+Taylor Exceptional thinking together V2.0	CLIENT	Rotorua Lakes Council	LOCATION	Rotorua	DATE	11/02/2019
	PROJECT	Rotorua Lakefront Redevelopment	JOB NUMBER	1007467.1000	ANALYSED	permo
	TITLE	1:25 year event sLS	CHECKED		PAGE	32 of 35 pages
	COMMENT					

The inputs listed in Table 1.1-1 below have been adopted for the liquefaction analysis.


Table 1.1-1 Summary of inputs for liquefaction analysis

	110926	110927	110928	110929	110930	110931
CPT Name	05TT08_CPT11	05TT08_CPT12	05TT08_CPT13	05TT08_CPT14 a	05TT08_CPT15	05TT08_CPT16
PGA	0.075g	0.075g	0.075g	0.075g	0.075g	0.075g
Magnitude	6	6	6	6	6	6
Depth to groundwater	1.5m	1.5m	1.5m	1.5m	1.5m	1.5m
Predrill depth	0m	0m	0m	0m	0m	0m
Assumed predrill tip resistance and skin friction	qc= 2MPa & Fs= 0.01MPa	qc= 2MPa & Fs= 0.01MPa	qc= 2MPa & Fs= 0.01MPa	qc= 2MPa & Fs= 0.01MPa	qc= 2MPa & Fs= 0.01MPa	qc= 2MPa & Fs= 0.01MPa
Trigger method	Boulanger & Idriss (2014)	Boulanger & Idriss (2014)	Boulanger & Idriss (2014)	Boulanger & Idriss (2014)	Boulanger & Idriss (2014)	Boulanger & Idriss (2014)
Settlement method	Zhang, Robertson & Brachman (2002)	Zhang, Robertson & Brachman (2002)	Zhang, Robertson & Brachman (2002)	Zhang, Robertson & Brachman (2002)	Zhang, Robertson & Brachman (2002)	Zhang, Robertson & Brachman (2002)
CFC	0	0	0	0	0	0
Total depth of CPT	5.31m	7.05m	3.84m	1.3m	11.18m	9.44m
Minimum depth of analysis	0m	0m	0m	0m	0m	0m
Maximum depth of analysis	10m	10m	10m	10m	10m	10m
RL	0	0	0	0	0	0


CPT	From Depth (m)		To Depth (m)	
	lc from (m)	lc to (m)	lc from (m)	lc to (m)
117903	0	10	0	10
117903	0	10	0	2.6
117904	0	10	0	0
117904	0	10	0	2.6
117905	0	10	0	0
117905	0	10	0	2.6
117906	0	10	0	0
117906	0	10	0	2.6
117907	0	10	0	0
117907	0	10	0	2.6
117908	0	10	0	0
117908	0	10	0	2.6
117909	0	10	0	0
117909	0	10	0	2.6
117910	0	10	0	0
117910	0	10	0	2.6
117911	0	10	0	0
117911	0	10	0	2.6
117912	0	10	0	0
117912	0	10	0	2.6
	Fc from (m)	Fc to (m)	Fc from (m)	Fc to (m)
117903	0	10	0	0
117904	0	10	0	0
117905	0	10	0	0
117906	0	10	0	0
117907	0	10	0	0

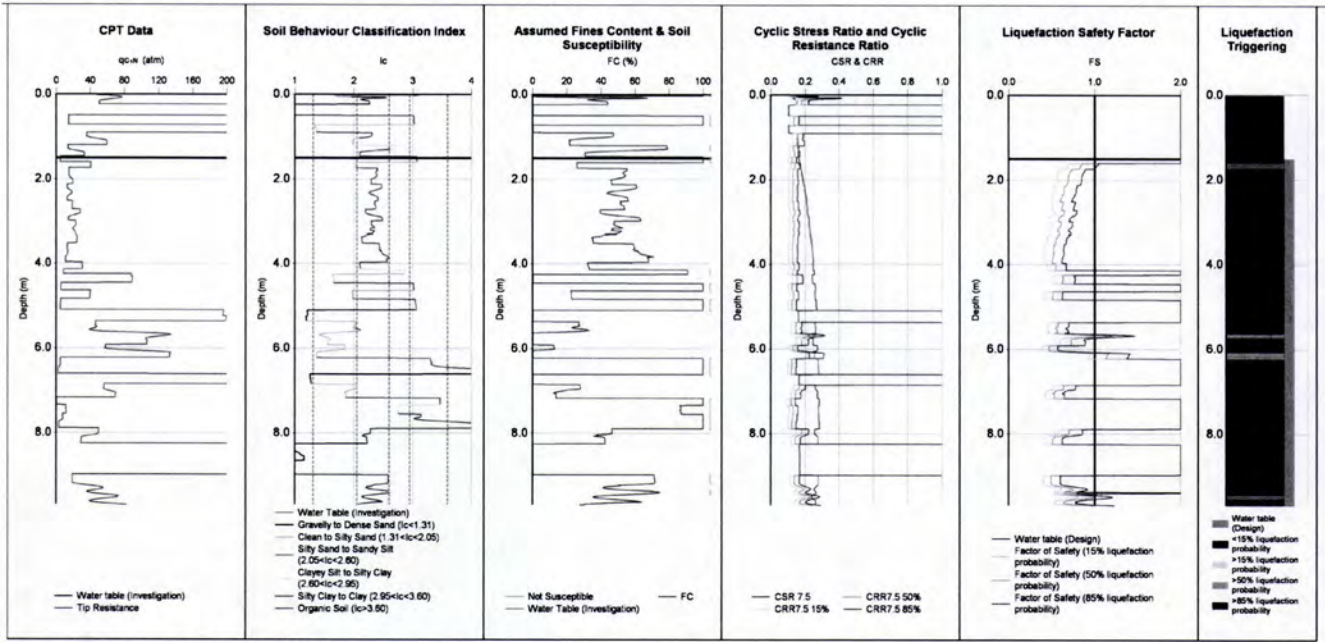
 Tonkin+Taylor Exceptional thinking together V2.0	CLIENT	Rotorua Lakes Council	LOCATION	Rotorua	DATE	11/02/2019
	PROJECT	Rotorua Lakefront Redevelopment	JOB NUMBER	1007467.1000	ANALYSED	permo
	TITLE	1:25 year event sLS	CHECKED		PAGE	33 of 35 pages
	COMMENT					

110932	110933	110934	110935
05TT08_CPT17 a	05TT08_CPT18 a	05TT08_CPT19	05TT08_CPT20
0.075g	0.075g	0.075g	0.075g
6	6	6	6
1.5m	1.5m	1.5m	1.5m
0m	0m	0m	0m
qc= 2MPa & Fs= 0.01MPa	qc= 2MPa & Fs= 0.01MPa	qc= 2MPa & Fs= 0.01MPa	qc= 2MPa & Fs= 0.01MPa
Boulangier & Idriss (2014)	Boulangier & Idriss (2014)	Boulangier & Idriss (2014)	Boulangier & Idriss (2014)
Zhang, Robertson & Brachman (2002)	Zhang, Robertson & Brachman (2002)	Zhang, Robertson & Brachman (2002)	Zhang, Robertson & Brachman (2002)
0	0	0	0
2.43m	2.01m	2.47m	5.15m
0m	0m	0m	0m
10m	10m	10m	10m
0	0	0	0

	Tonkin + Taylor Exceptional thinking together V2.0	CLIENT	Rotorua Lakes Council	LOCATION	Rotorua	DATE	11/02/2019
		PROJECT	Rotorua Lakefront Redevelopment			ANALYSED	pemo
		TITLE	1:25 year event sLS	JOB NUMBER	1007467.1000	CHECKED	
		COMMENT		PAGE	34 of 35 pages		

117908	0	10	0
117909	0	10	0
117910	0	10	0
117911	0	10	0
117912	0	10	0

	Tonkin + Taylor Exceptional thinking together V2.0	CLIENT	Rotorua Lakes Council	LOCATION	Rotorua	DATE	11/02/2019
		PROJECT	Rotorua Lakefront Redevelopment			ANALYSED	pemo
		TITLE	1:25 year event sLS	JOB NUMBER	1007467.1000	CHECKED	
		COMMENT		PAGE	35 of 35 pages		

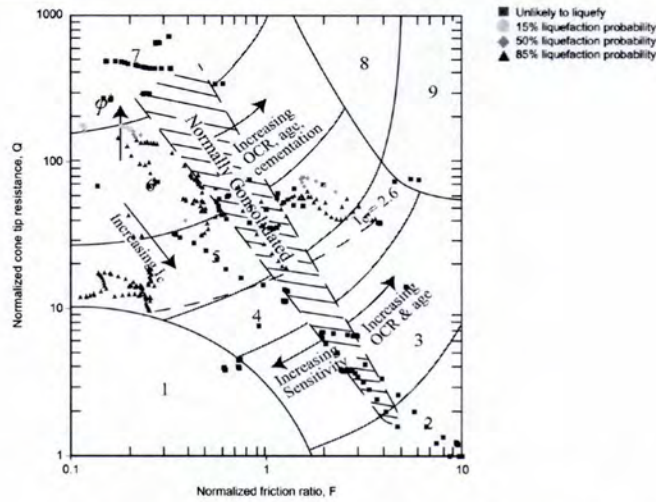


Note: Inverse filtered Qc/Fs data used (10 cm²)

Run Description	NZGD ID	Investigation Date	γ (kN/m ³)	Magnitude	PGA (g)	Trigger Method	Settlement Method	γ (kN/m ³)	Surcharge/Cut/Fill	Surcharge (kPa)	Cut/Fill Height (m)
INPUT	110916	31/07/2018	17	17	6	0.3 BI-2014	ZRB-2002	17			0
OUTPUT	PL	Sv1d (mm)	CTL (m)	LPI	LSN	CT (m)	LPlish				
	15%	145	5.2	19	40	1.7	16				
	50%	143	5	15	40	1.7	13				
	85%	135	4.7	10	37	1.8	8				

Reviewed by:	
CPT Inversion	CDAV
Groundwater	CDAV
Susceptibility	CDAV
Triggering	CDAV
Consequence	CDAV

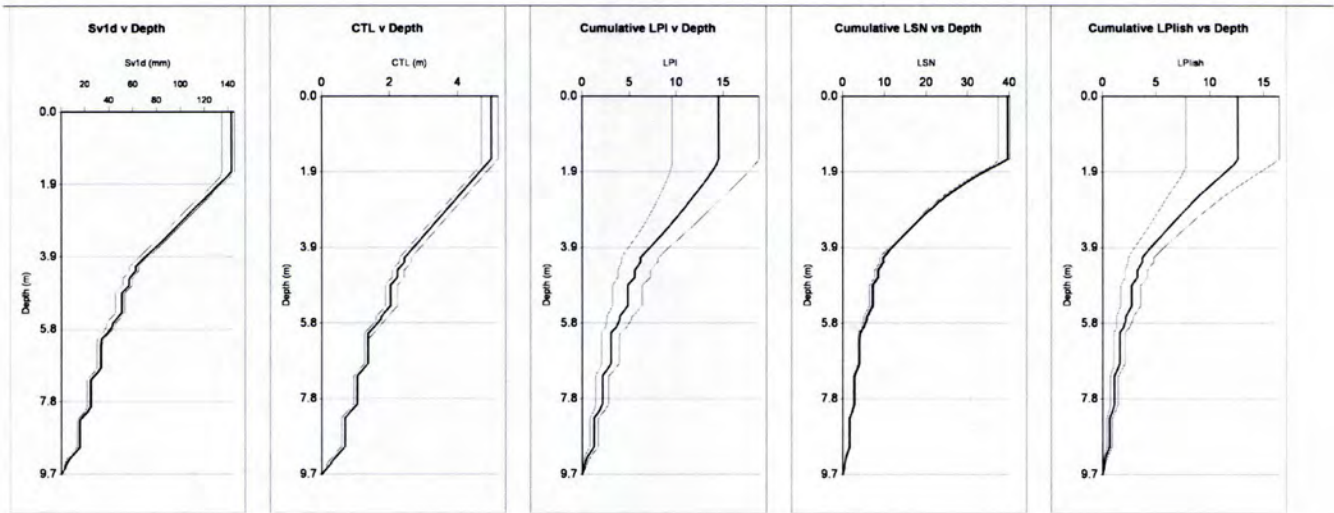
 Tonkin+Taylor	Tonkin + Taylor Exceptional thinking together V2.0	CLIENT Rotorua Lakes Council	PROJECT Rotorua Lakefront Redevelopment	LOCATION Rotorua	DATE 11/02/2019
			TITLE 1:500 year event ULS	JOB NUMBER 1007467.1000	ANALYSED pemo
					CHECKED PAGE 1 of 35 pages



- 1. Sensitive, fine grained
- 2. Organic soils - peats
- 3. Clays - silty clay to clay
- 4. Silt mixtures - clayey silt to silty clay
- 5. Sand mixtures - silty sand to sandy silt
- 6. Sands - clean sand to silty sand
- 7. Gravely sand to dense sand
- 8. Very stiff sand to clayey sand *
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*Heavily overconsolidated or cemented
 CPT-based soil behavior type classification chart by Robertson (1990)

 Tonkin+Taylor	Tonkin + Taylor Exceptional thinking together V2.0	CLIENT Rotorua Lakes Council	PROJECT Rotorua Lakefront Redevelopment	LOCATION Rotorua	DATE 11/02/2019
			TITLE 1:500 year event ULS	JOB NUMBER 1007467.1000	ANALYSED pemo
					CHECKED PAGE 2 of 35 pages

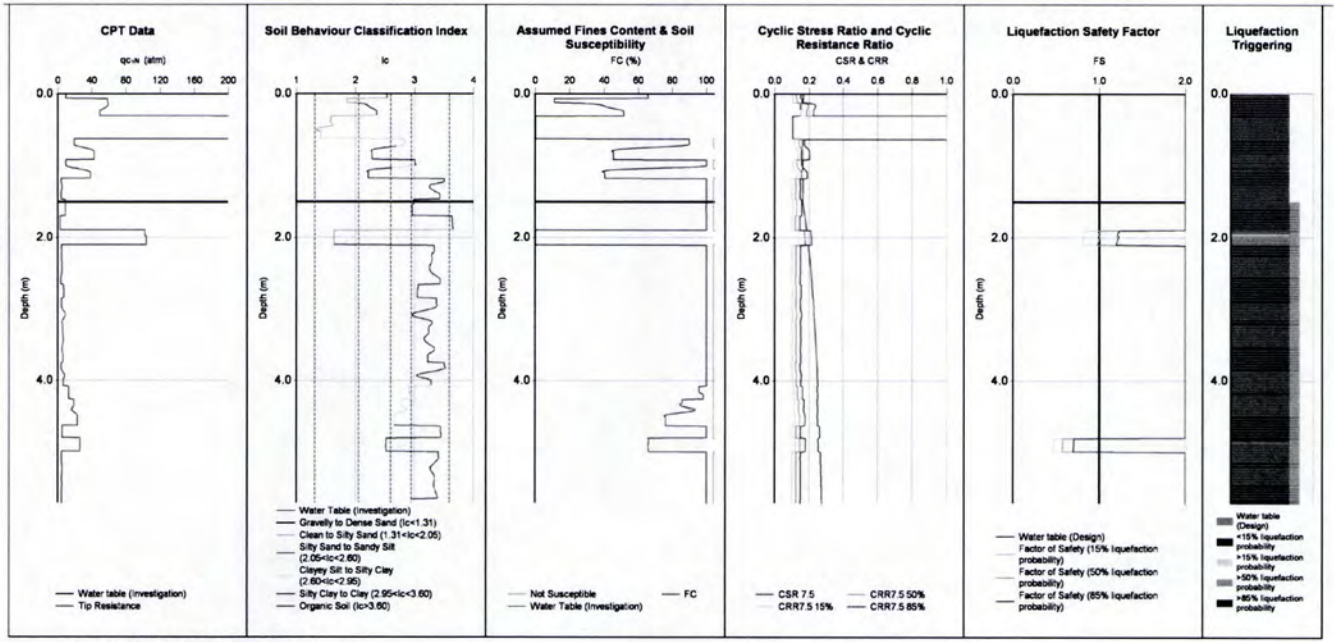


(Assumed pre-drill values)

CPT Name	NZGD ID	Investigation Date	Magnitude	PGA (g)	GWD (m)	Trigger Method	Settlement Method	Pre-drill Depth (m)	qc (MPa)	Fs (MPa)	γ (kN/m ³)
CPT01	110916	31/07/2018	6	0.3	1.5	BI-2014	ZRB-2002	0	2	0.01	17

Thicker lines represent the 50% probability of exceedance case and the thinner lines to the left and right of the thicker lines represent the 85% and 15% probability of exceedance cases respectively.

 Tonkin + Taylor	Tonkin + Taylor Exceptional thinking together V2.0	CLIENT	Rotorua Lakes Council	LOCATION	Rotorua	DATE	11/02/2019
		PROJECT	Rotorua Lakefront Redevelopment	JOB NUMBER	1007467.1000	ANALYSED	permo
TITLE			1:500 year event ULS	CHECKED		PAGE	3 of 35 pages
COMMENT							



Note: Inverse filtered Q_c/F_s data used (10 cm²)

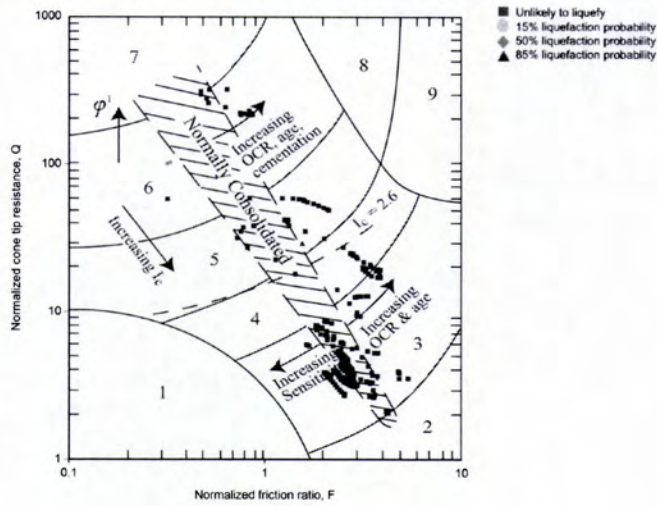
Run Description	NZGD ID	Investigation Date	γ (kN/m ³)	Magnitude	PGA (g)	Trigger Method	Settlement Method	Surcharge/Cut/Fill	Surcharge (kPa)	Cut/Fill Height (m)
INPUT	110917	31/07/2018	17	6	0.3	BI-2014	ZRB-2002			0

PL	Sv1d (mm)	CTL (m)	LPI	LSN	CT (m)	LPlish
15%	9	0.4	1	3	2	1
50%	7	0.3	1	2	2	0
85%	6	0.2	0	1	4.9	0

Reviewed by:

CPT Inversion	CAV
Groundwater	CAV
Susceptibility	CAV
Triggering	CAV
Consequence	CAV

 Tonkin + Taylor	Tonkin + Taylor Exceptional thinking together V2.0	CLIENT	Rotorua Lakes Council	LOCATION	Rotorua	DATE	11/02/2019
		PROJECT	Rotorua Lakefront Redevelopment	JOB NUMBER	1007467.1000	ANALYSED	permo
TITLE			1:500 year event ULS	CHECKED		PAGE	4 of 35 pages
COMMENT							

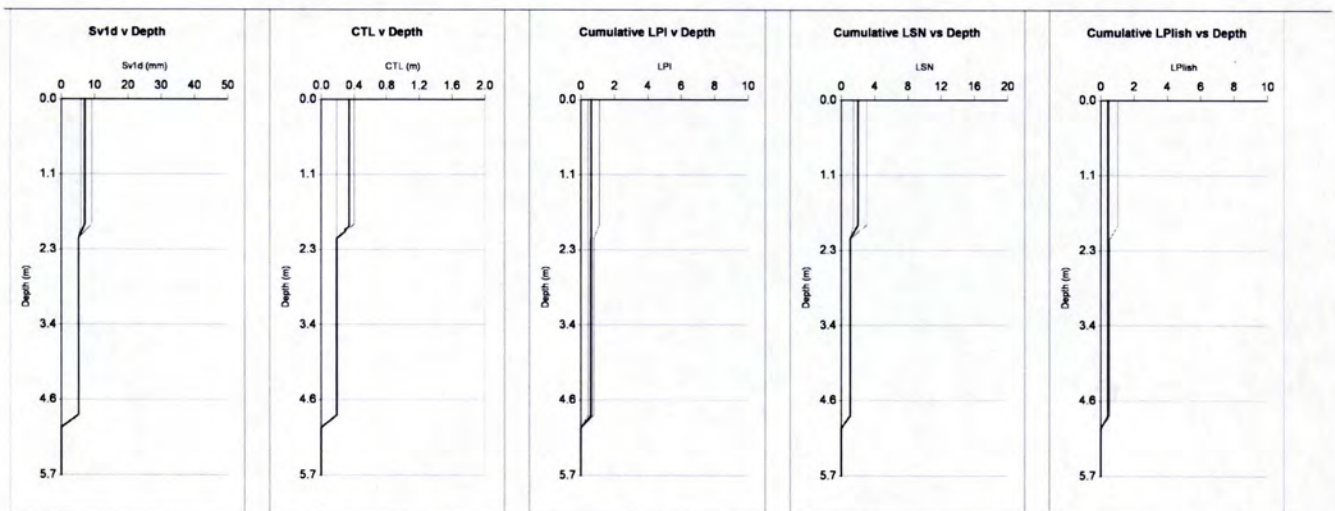


- | | |
|--|-------------------------------------|
| 1. Sensitive, fine grained | 6. Sands - clean sand to silty sand |
| 2. Organic soils - peats | 7. Gravely sand to dense sand |
| 3. Clays - silty clay to clay | 8. Very stiff sand to clayey sand * |
| 4. Silt mixtures - clayey silt to silty clay | 9. Very stiff, fine grained * |
| 5. Sand mixtures - silty sand to sandy silt | |

*Heavily overconsolidated or cemented

CPT-based soil behavior type classification chart by Robertson (1990)

	Tonkin + Taylor	CLIENT	Rotorua Lakes Council	LOCATION	Rotorua	DATE	11/02/2019
	Exceptional thinking together	PROJECT	Rotorua Lakefront Redevelopment	JOB NUMBER	1007467.1000	ANALYSED	pemo
	V2.0	TITLE	1:500 year event ULS	CHECKED		PAGE	5 of 35 pages
		COMMENT					

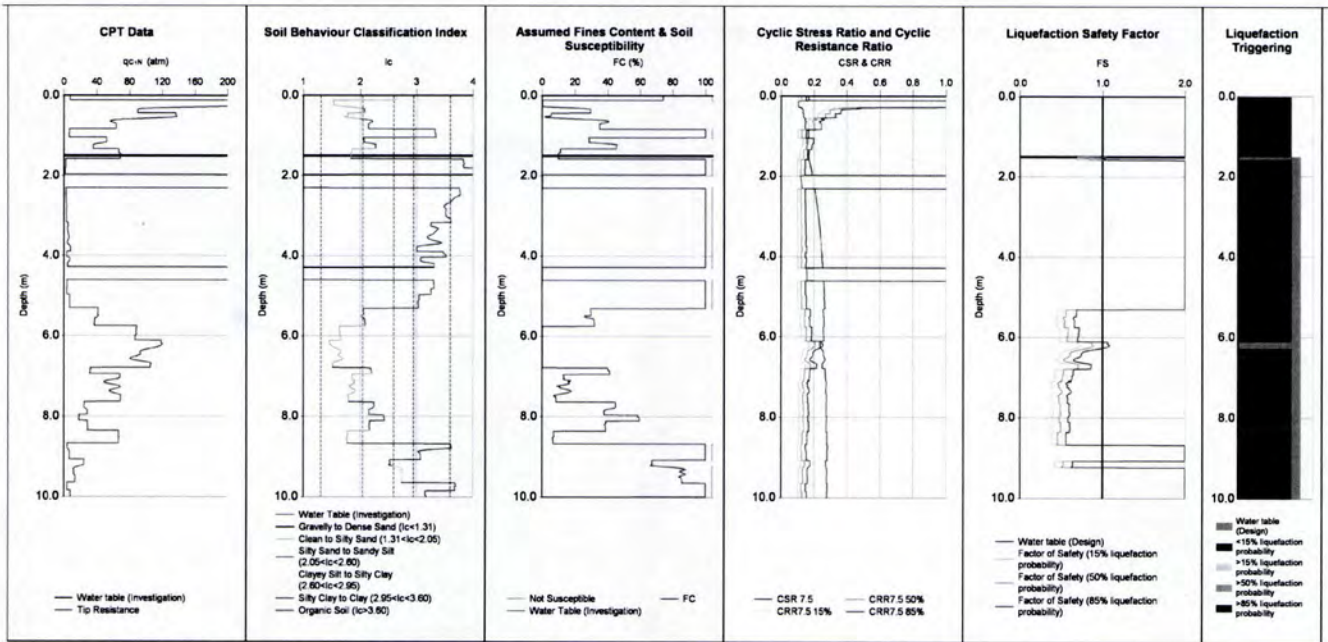


(Assumed pre-drill values)

CPT Name	NZGD ID	Investigation Date	Magnitude	PGA (g)	GWD (m)	Trigger Method	Settlement Method	Pre-drill Depth (m)	qc (MPa)	Fs (MPa)	γ (kN/m ³)
CPT02	110917	31/07/2018	6	0.3	1.5	BI-2014	ZRB-2002	0	2	0.01	17

Thicker lines represent the 50% probability of exceedance case and the thinner lines to the left and right of the thicker lines represent the 85% and 15% probability of exceedance cases respectively.

	Tonkin + Taylor	CLIENT	Rotorua Lakes Council	LOCATION	Rotorua	DATE	11/02/2019
	Exceptional thinking together	PROJECT	Rotorua Lakefront Redevelopment	JOB NUMBER	1007467.1000	ANALYSED	pemo
	V2.0	TITLE	1:500 year event ULS	CHECKED		PAGE	6 of 35 pages
		COMMENT					



Note: Inverse filtered Qo/Fs data used (10 cm²)

Run Description	NZGD ID	Investigation Date	γ (kN/m ³)	Magnitude	PGA (g)	Trigger Method	Settlement Method	γ (kN/m ³)	Surcharge/Cut/Fill	Surcharge (kPa)	Cut/Fill Height (m)
INPUT	110918	30/07/2018	17	6	0.3	BI-2014	ZRB-2002	17			0
OUTPUT	PL	Sv1d (mm)	CTL (m)	LPI	LSN	CT (m)	LPlish				
	15%	102	3.6	13	16	5.3	8				
	50%	100	3.6	10	15	5.3	6				
	85%	96	3.4	8	14	5.4	0				

Reviewed by:

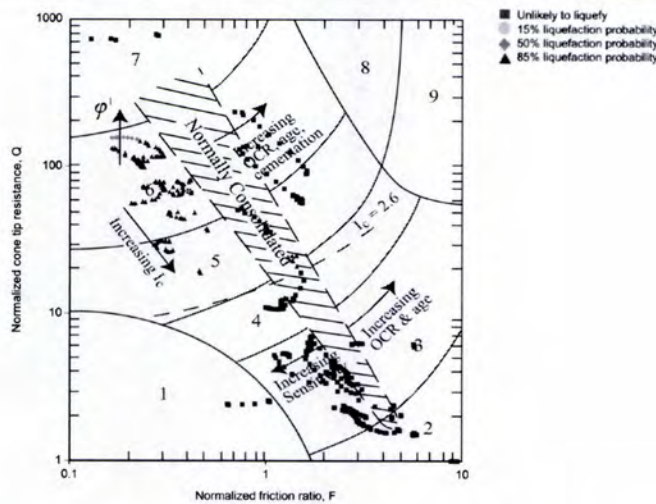
CPT Inversion	CDAV
Groundwater	CDAV
Susceptibility	CDAV
Triggering	CDAV
Consequence	CDAV



Tonkin + Taylor
Exceptional thinking together
V2.0

CLIENT: **Rotorua Lakes Council**
PROJECT: **Rotorua Lakefront Redevelopment**
TITLE: **1:500 year event ULS**

LOCATION: **Rotorua**
DATE: **11/02/2019**
ANALYSED: **pemo**
JOB NUMBER: **1007467.1000**
CHECKED:
PAGE: **7 of 35 pages**



- | | |
|--|-------------------------------------|
| 1. Sensitive, fine grained | 6. Sands - clean sand to silty sand |
| 2. Organic soils - peats | 7. Gravelly sand to dense sand |
| 3. Clays - silty clay to clay | 8. Very stiff sand to clayey sand * |
| 4. Silt mixtures - clayey silt to silty clay | 9. Very stiff, fine grained * |
| 5. Sand mixtures - silty sand to sandy silt | |

*Heavily overconsolidated or cemented

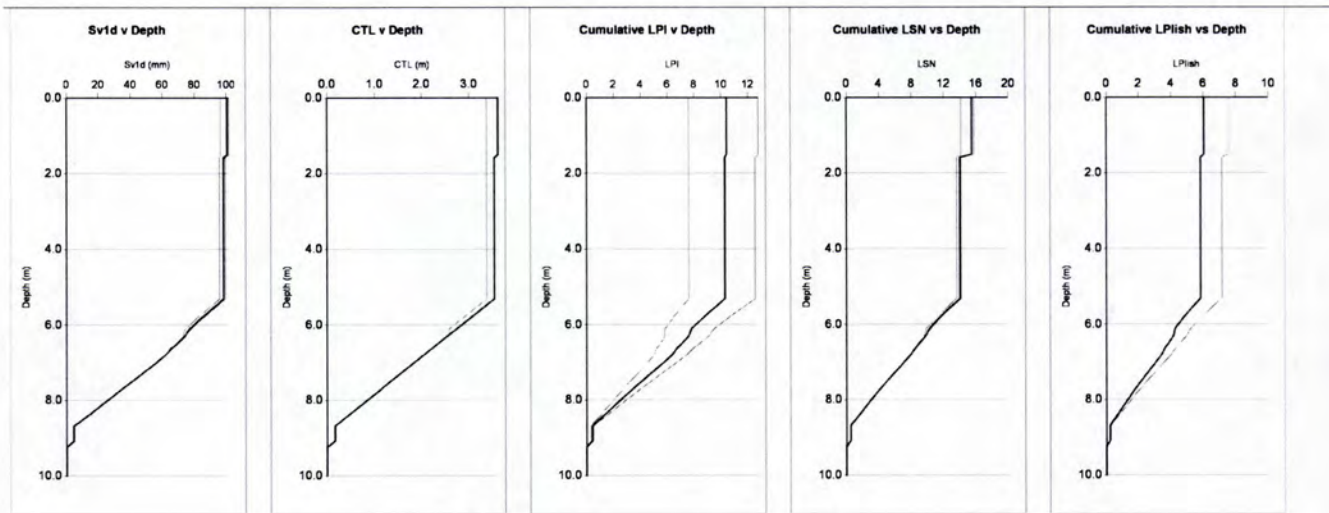
CPT-based soil behavior type classification chart by Robertson (1990)



Tonkin + Taylor
Exceptional thinking together
V2.0

CLIENT: **Rotorua Lakes Council**
PROJECT: **Rotorua Lakefront Redevelopment**
TITLE: **1:500 year event ULS**

LOCATION: **Rotorua**
DATE: **11/02/2019**
ANALYSED: **pemo**
JOB NUMBER: **1007467.1000**
CHECKED:
PAGE: **8 of 35 pages**

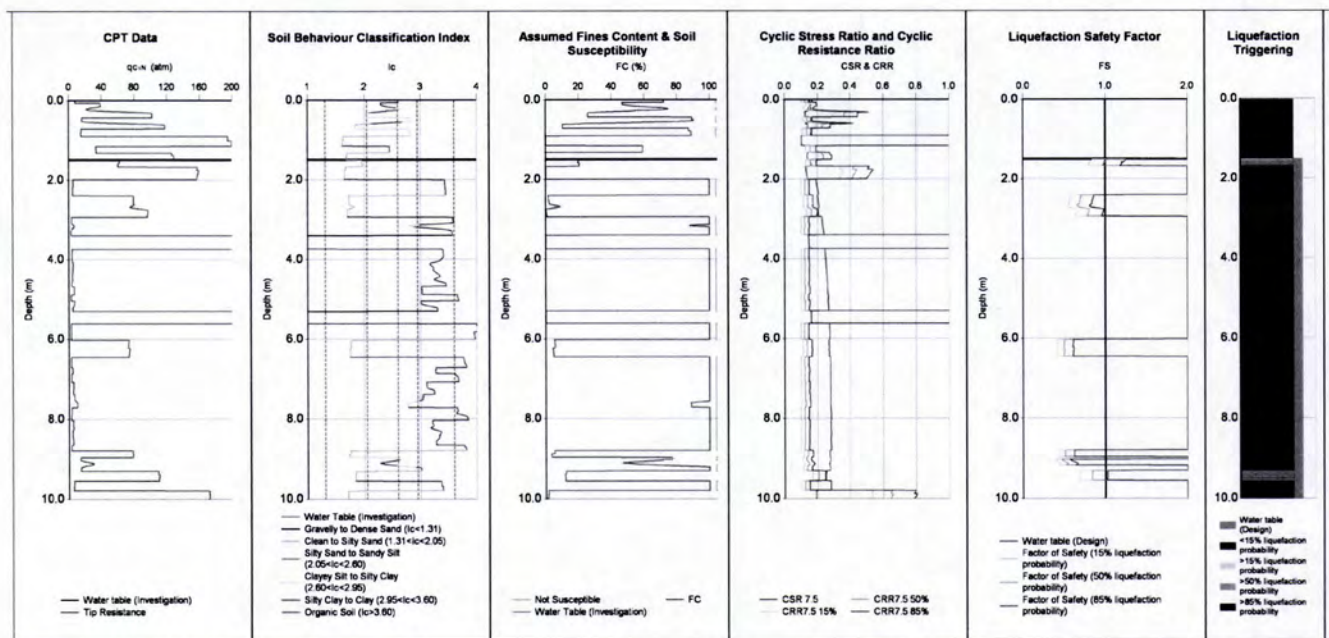


(Assumed pre-drill values)

CPT Name	NZGD ID	Investigation Date	Magnitude	PGA (g)	GWD (m)	Trigger Method	Settlement Method	Pre-drill Depth (m)	qc (MPa)	Fs (MPa)	γ (kN/m ³)
CPT03	110918	30/07/2018	6	0.3	1.5	BI-2014	ZRB-2002	0	2	0.01	17

Thicker lines represent the 50% probability of exceedance case and the thinner lines to the left and right of the thicker lines represent the 85% and 15% probability of exceedance cases respectively.

	Tonkin + Taylor	CLIENT	Rotorua Lakes Council	LOCATION	Rotorua	DATE	11/02/2019
	Exceptional thinking together	PROJECT	Rotorua Lakefront Redevelopment	JOB NUMBER	1007467.1000	ANALYSED	permo
	V2.0	TITLE	1:500 year event ULS	CHECKED		PAGE	9 of 35 pages
		COMMENT					



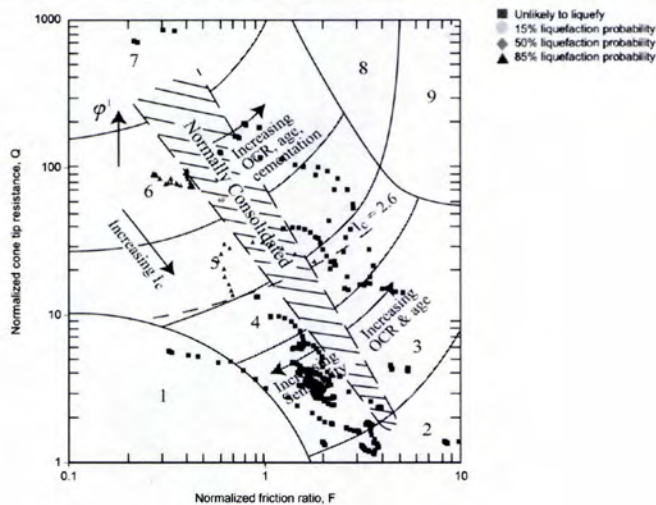
Note: Inverse filtered Qc/Fs data used (10 cm²)

Run Description	NZGD ID	Investigation Date	γ (kN/m ³)	Magnitude	PGA (g)	Trigger Method	Settlement Method	γ (kN/m ³)	Surcharge/Cut/Fill	Surcharge (kPa)	Cut/Fill Height (m)
INPUT	110919	30/07/2018	17	6	0.3	BI-2014	ZRB-2002	17			0
OUTPUT	PL	Sv1d (mm)	CTL (m)	LPI	LSN	CT (m)	LPlish				
	15%	45	1.7	5	11	1.6	4				
	50%	41	1.6	4	10	1.7	3				
	85%	36	1.3	2	8	2.5	1				

Reviewed by:

CPT Inversion	CDAV
Groundwater	CDAV
Susceptibility	CDAV
Triggering	CDAV
Consequence	CDAV

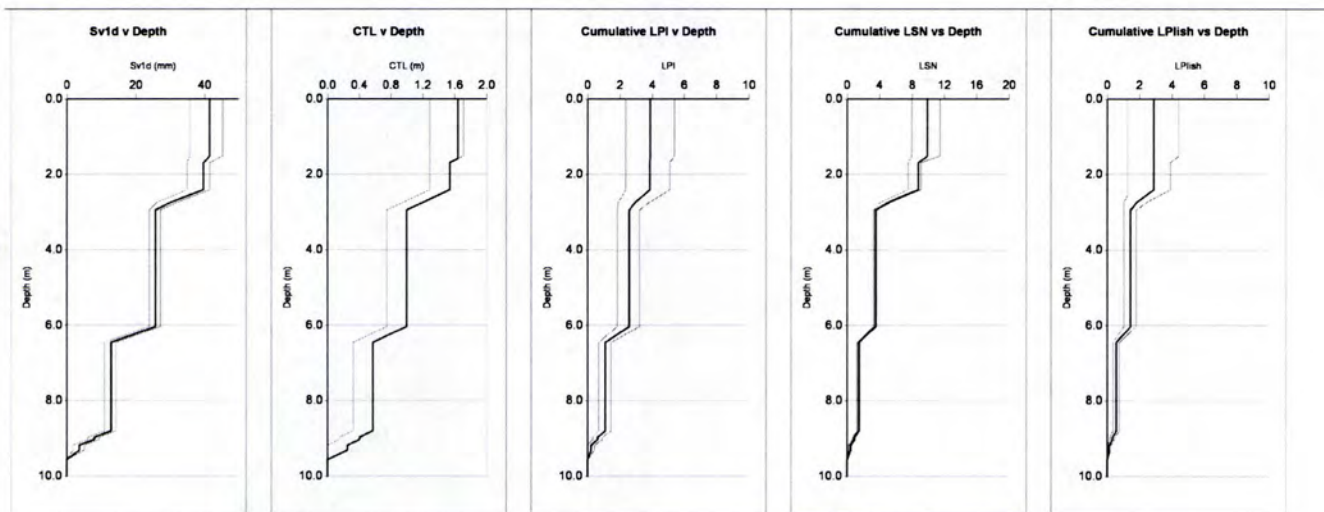
	Tonkin + Taylor	CLIENT	Rotorua Lakes Council	LOCATION	Rotorua	DATE	11/02/2019
	Exceptional thinking together	PROJECT	Rotorua Lakefront Redevelopment	JOB NUMBER	1007467.1000	ANALYSED	permo
	V2.0	TITLE	1:500 year event ULS	CHECKED		PAGE	10 of 35 pages
		COMMENT					



- 1. Sensitive, fine grained
- 2. Organic soils - peats
- 3. Clays - silty clay to clay
- 4. Silt mixtures - clayey silt to silty clay
- 5. Sand mixtures - silty sand to sandy silt
- 6. Sands - clean sand to silty sand
- 7. Gravelly sand to dense sand
- 8. Very stiff sand to clayey sand *
- 9. Very stiff, fine grained *

*Heavily overconsolidated or cemented
 CPT-based soil behavior type classification chart by Robertson (1990)

	Tonkin + Taylor	CLIENT	Rotorua Lakes Council	LOCATION	Rotorua	DATE	11/02/2019
	Exceptional thinking together	PROJECT	Rotorua Lakefront Redevelopment	JOB NUMBER	1007467.1000	ANALYSED	pemo
	V2.0	TITLE	1:500 year event ULS	CHECKED		PAGE	11 of 35 pages
		COMMENT					

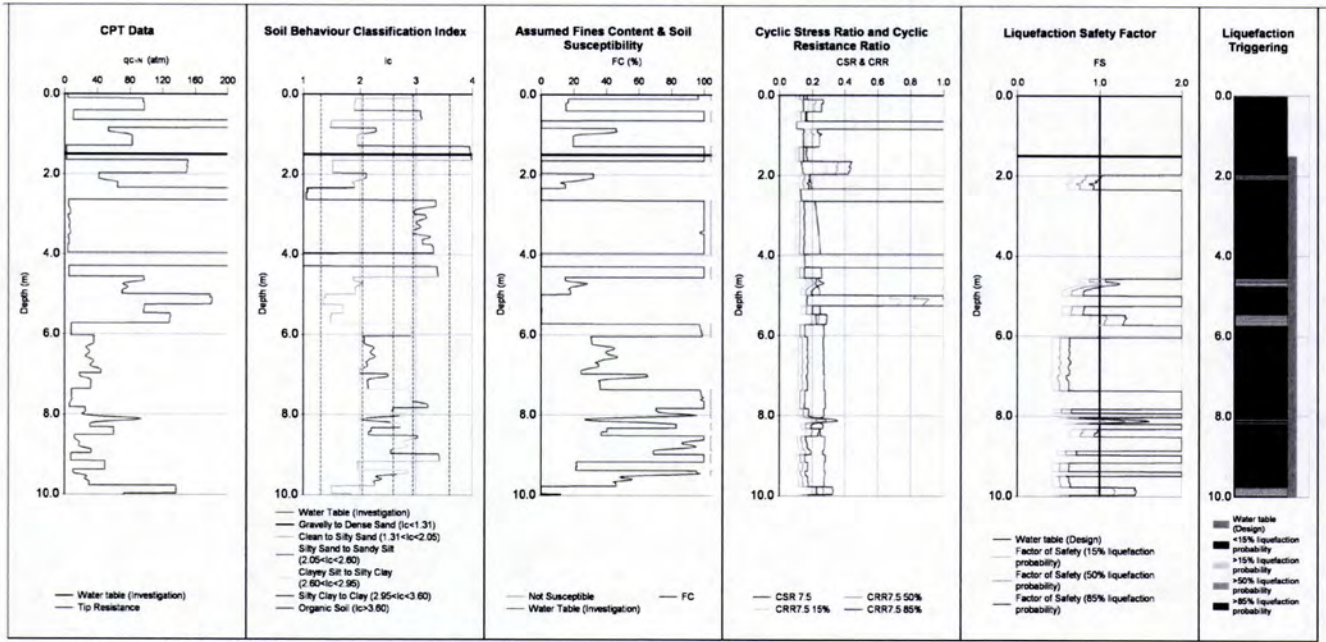


(Assumed pre-drill values)

CPT Name	NZGD ID	Investigation Date	Magnitude	PGA (g)	GWD (m)	Trigger Method	Settlement Method	Pre-drill Depth (m)	qc (MPa)	Fs (MPa)	γ (kN/m³)
CPT04	110919	30/07/2018	6	0.3	1.5	BI-2014	ZRB-2002	0	2	0.01	17

Thicker lines represent the 50% probability of exceedance case and the thinner lines to the left and right of the thicker lines represent the 85% and 15% probability of exceedance cases respectively.

	Tonkin + Taylor	CLIENT	Rotorua Lakes Council	LOCATION	Rotorua	DATE	11/02/2019
	Exceptional thinking together	PROJECT	Rotorua Lakefront Redevelopment	JOB NUMBER	1007467.1000	ANALYSED	pemo
	V2.0	TITLE	1:500 year event ULS	CHECKED		PAGE	12 of 35 pages
		COMMENT					

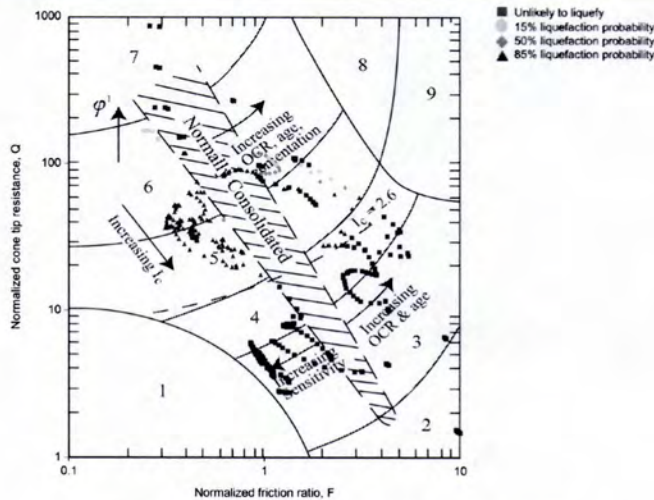


Note: Inverse filtered Qc/Fs data used (10 cm²)

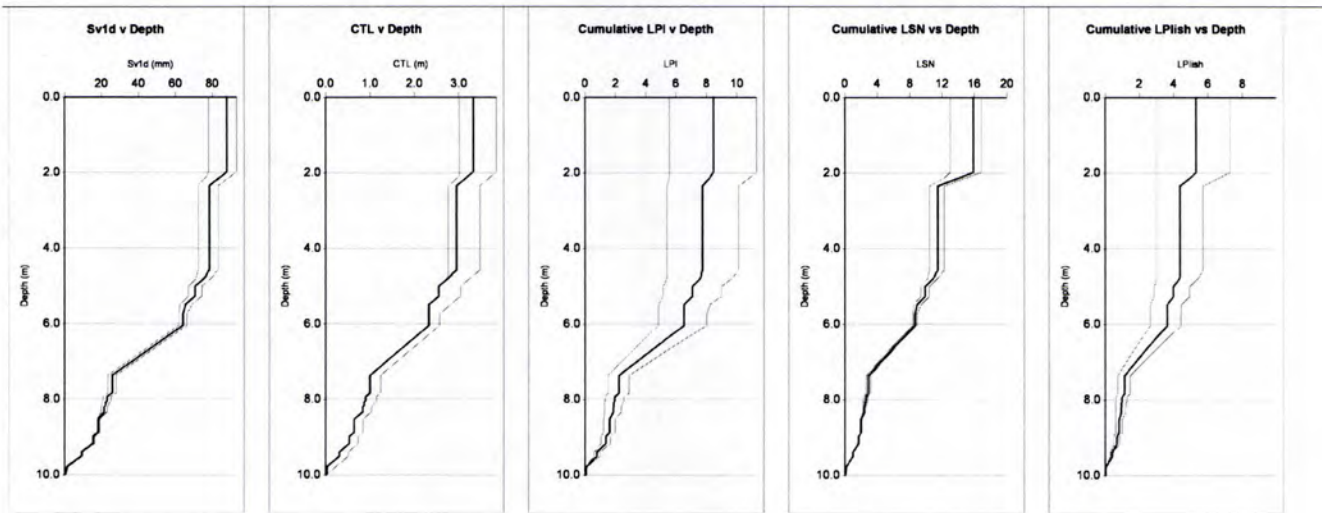
Run Description	NZGD ID	Investigation Date	γ (kN/m³)	Magnitude	PGA (g)	Trigger Method	Settlement Method	γ (kN/m³)	Surcharge/Cut/Fill	Surcharge (kPa)	Cut/Fill Height (m)
INPUT	110920	30/07/2016	17	17	6	0.3 BI-2014	ZRB-2002	17			0
OUTPUT	PL	Sv1d (mm)	CTL (m)	LPI	LSN	CT (m)	LPlish				
	15%	94	3.8	11	17	2.1	7				
	50%	88	3.3	8	16	2.1	5				
	85%	78	3	6	13	2.2	3				

Reviewed by:	
CPT Inversion	CDAV
Groundwater	CDAV
Susceptibility	CDAV
Triggering	CDAV
Consequence	CDAV

<p>Tonkin + Taylor Exceptional thinking together V2.0</p>	CLIENT	Rotorua Lakes Council	LOCATION	Rotorua	DATE	11/02/2019
	PROJECT	Rotorua Lakefront Redevelopment	ANALYSED	permo		
	TITLE	1:500 year event ULS	CHECKED			
	COMMENT		PAGE	13 of 35 pages		



<p>Tonkin + Taylor Exceptional thinking together V2.0</p>	CLIENT	Rotorua Lakes Council	LOCATION	Rotorua	DATE	11/02/2019
	PROJECT	Rotorua Lakefront Redevelopment	ANALYSED	permo		
	TITLE	1:500 year event ULS	CHECKED			
	COMMENT		PAGE	14 of 35 pages		

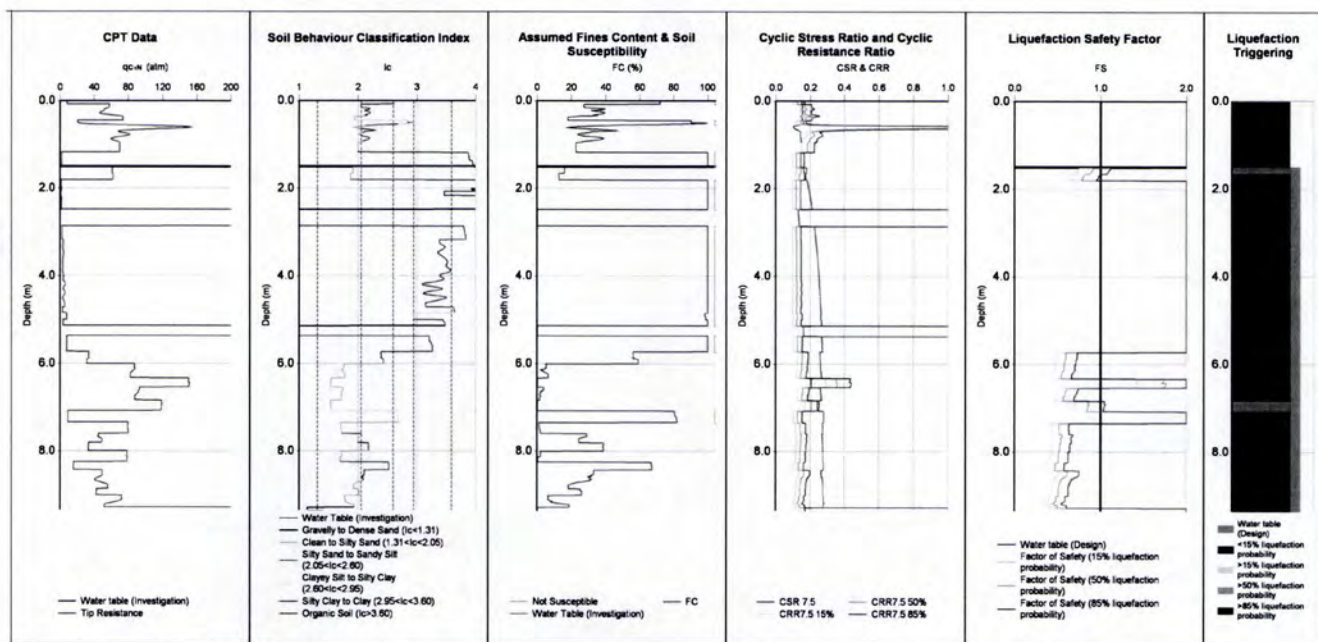


(Assumed pre-drill values)

CPT Name	NZGD ID	Investigation Date	Magnitude	PGA (g)	GWD (m)	Trigger Method	Settlement Method	Pre-drill Depth (m)	qc (MPa)	Fs (MPa)	γ (kN/m ³)
CPT05	110920	30/07/2018	6	0.3	1.5	BI-2014	ZRB-2002	0	2	0.01	17

Thicker lines represent the 50% probability of exceedance case and the thinner lines to the left and right of the thicker lines represent the 85% and 15% probability of exceedance cases respectively.

 Tonkin + Taylor	Tonkin + Taylor Exceptional thinking together V2.0	CLIENT Rotorua Lakes Council	LOCATION Rotorua	DATE 11/02/2019
		PROJECT Rotorua Lakefront Redevelopment	JOB NUMBER 1007467.1000	ANALYSED pemo
		TITLE 1:500 year event ULS		CHECKED
		COMMENT 		PAGE 15 of 35 pages



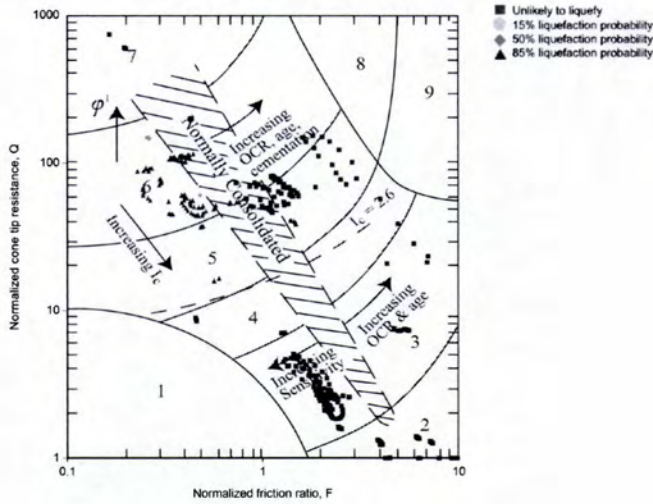
Note: Inverse filtered Qo/Fs data used (10 cm²)

Run Description	NZGD ID	Investigation Date	γ (kN/m ³)	Magnitude	PGA (g)	Trigger Method	Settlement Method	γ (kN/m ³)	Surcharge/Cut/Fill	Surcharge (kPa)	Cut/Fill Height (m)
INPUT	110921	30/07/2018	17	6	0.3	BI-2014	ZRB-2002	17			0
OUTPUT	PL	Sv1d (mm)	CTL (m)	LPI	LSN	CT (m)	LPlish				
	15%	92	3.4	11	16	1.6	7				
	50%	89	3.4	9	15	1.6	5				
	85%	83	3	6	12	1.8	3				

Reviewed by:

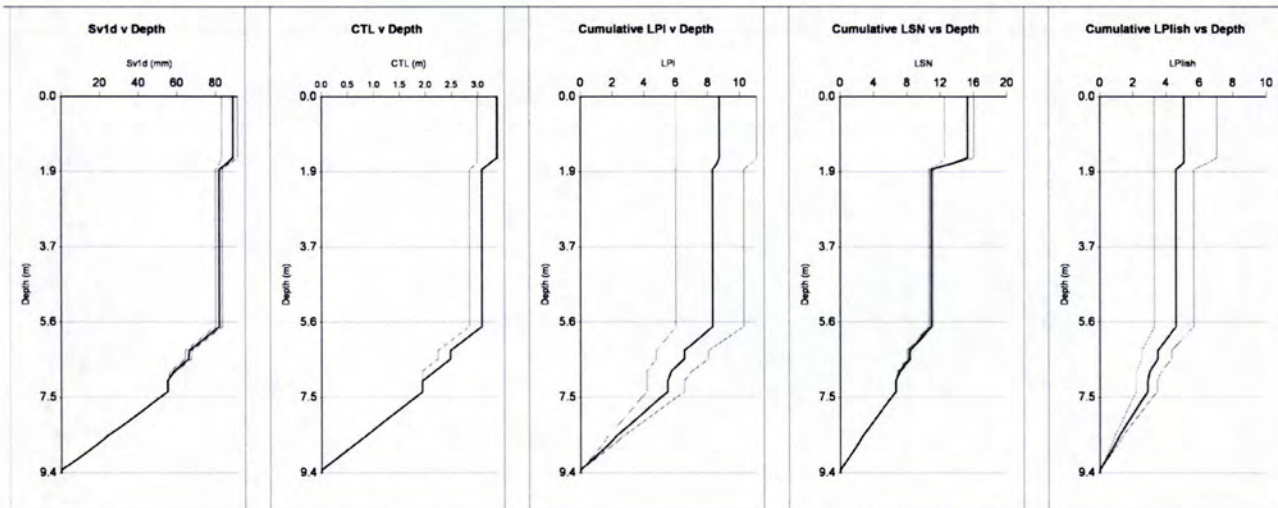
CPT Inversion	CDAV
Groundwater	CDAV
Susceptibility	CDAV
Triggering	CDAV
Consequence	CDAV

 Tonkin + Taylor	Tonkin + Taylor Exceptional thinking together V2.0	CLIENT Rotorua Lakes Council	LOCATION Rotorua	DATE 11/02/2019
		PROJECT Rotorua Lakefront Redevelopment	JOB NUMBER 1007467.1000	ANALYSED pemo
		TITLE 1:500 year event ULS		CHECKED
		COMMENT 		PAGE 16 of 35 pages



- 1. Sensitive, fine grained
 - 2. Organic soils - peats
 - 3. Clays - silty clay to clay
 - 4. Silt mixtures - clayey silt to silty clay
 - 5. Sand mixtures - silty sand to sandy silt
 - 6. Sands - clean sand to silty sand
 - 7. Gravely sand to dense sand
 - 8. Very stiff sand to clayey sand *
 - 9. Very stiff, fine grained *
- *Heavily overconsolidated or cemented
- CPT-based soil behavior type classification chart by Robertson (1990)

	Tonkin + Taylor Exceptional thinking together V2.0	CLIENT Rotorua Lakes Council PROJECT Rotorua Lakefront Redevelopment TITLE 1:500 year event ULS COMMENT	LOCATION Rotorua DATE 11/02/2019 ANALYSED pemo CHECKED PAGE 17 of 35 pages
			JOB NUMBER 1007467.1000

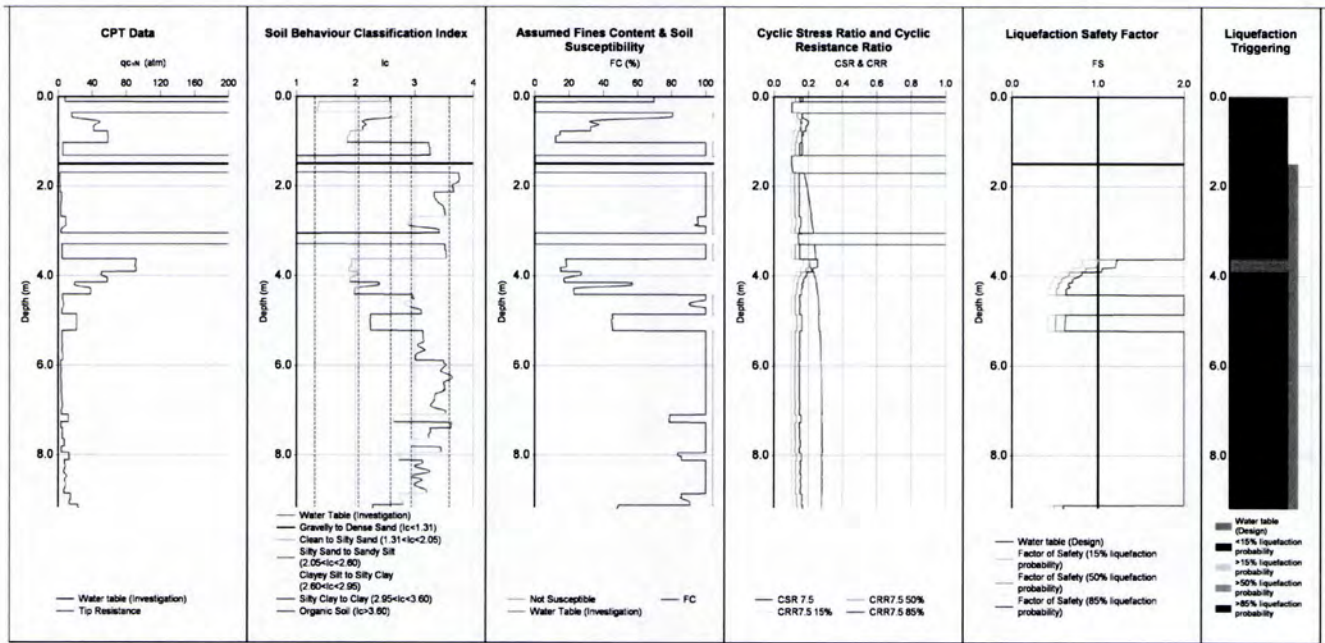


(Assumed pre-drill values)

CPT Name	NZGD ID	Investigation Date	Magnitude	PGA (g)	GWD (m)	Trigger Method	Settlement Method	Pre-drill Depth (m)	qc (MPa)	Fs (MPa)	γ (kN/m³)
CPT06	110921	30/07/2018	6	0.3	1.5	BI-2014	ZRB-2002	0	2	0.01	17

Thicker lines represent the 50% probability of exceedance case and the thinner lines to the left and right of the thicker lines represent the 85% and 15% probability of exceedance cases respectively.

	Tonkin + Taylor Exceptional thinking together V2.0	CLIENT Rotorua Lakes Council PROJECT Rotorua Lakefront Redevelopment TITLE 1:500 year event ULS COMMENT	LOCATION Rotorua DATE 11/02/2019 ANALYSED pemo CHECKED PAGE 18 of 35 pages
			JOB NUMBER 1007467.1000

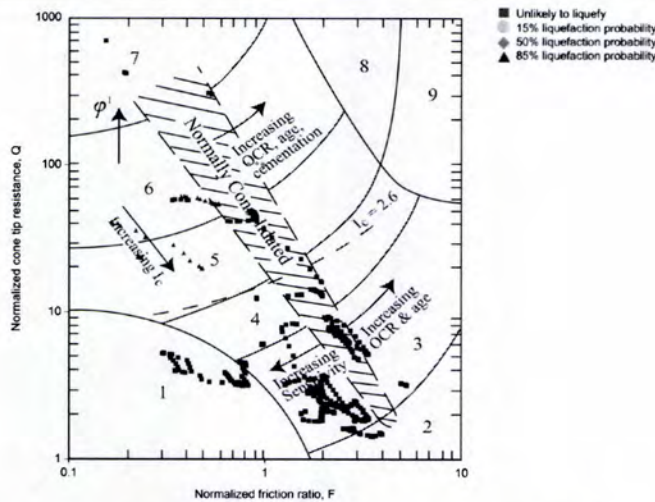


Note: Inverse filtered Q_c/F_s data used (10 cm^2)

Run Description	NZGD ID	Investigation Date	γ (kN/m^3)	Magnitude	PGA (g)	Trigger Method	Settlement Method	γ (kN/m^3)	Surcharge/Cut/Fill	Surcharge (kPa)	Cut/Fill Height (m)
INPUT	110922	30/07/2018	17	6	0.3	BI-2014	ZRB-2002	17			0
OUTPUT	PL	Sv1d (mm)	CTL (m)	LPI	LSN	CT (m)	LPlish				
	15%	33	1.2	5	7	3.7	3				
	50%	31	1.2	3	7	3.7	2				
	85%	29	1	2	6	4	2				

Reviewed by:	
CPT Inversion	CDAV
Groundwater	CDAV
Susceptibility	CDAV
Triggering	CDAV
Consequence	CDAV

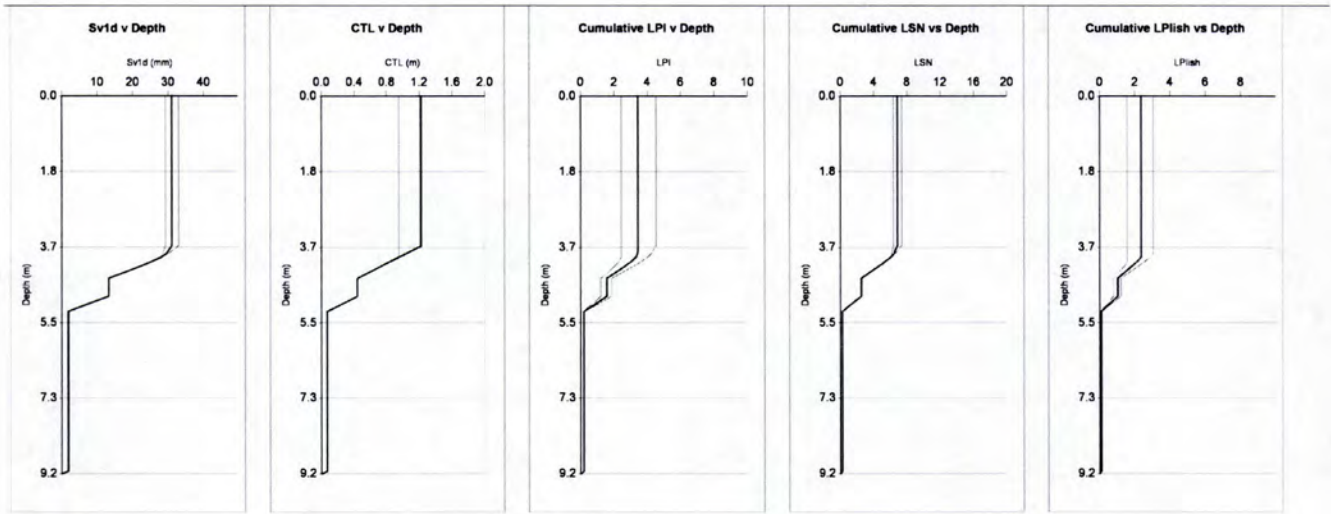
	Tonkin + Taylor Exceptional thinking together V2.0	CLIENT Rotorua Lakes Council	LOCATION Rotorua	DATE 11/02/2019
		PROJECT Rotorua Lakefront Redevelopment	JOB NUMBER 1007467.1000	ANALYSED pemo
		TITLE 1:500 year event ULS		CHECKED
		COMMENT 		PAGE 19 of 35 pages



- 1. Sensitive, fine grained
- 2. Organic soils - peats
- 3. Clays - silty clay to clay
- 4. Silt mixtures - clayey silt to silty clay
- 5. Sand mixtures - silty sand to sandy silt
- 6. Sands - clean sand to silty sand
- 7. Gravelly sand to dense sand
- 8. Very stiff sand to clayey sand *
- 9. Very stiff, fine grained *

*Heavily overconsolidated or cemented
 CPT-based soil behavior type classification chart by Robertson (1990)

	Tonkin + Taylor Exceptional thinking together V2.0	CLIENT Rotorua Lakes Council	LOCATION Rotorua	DATE 11/02/2019
		PROJECT Rotorua Lakefront Redevelopment	JOB NUMBER 1007467.1000	ANALYSED pemo
		TITLE 1:500 year event ULS		CHECKED
		COMMENT 		PAGE 20 of 35 pages

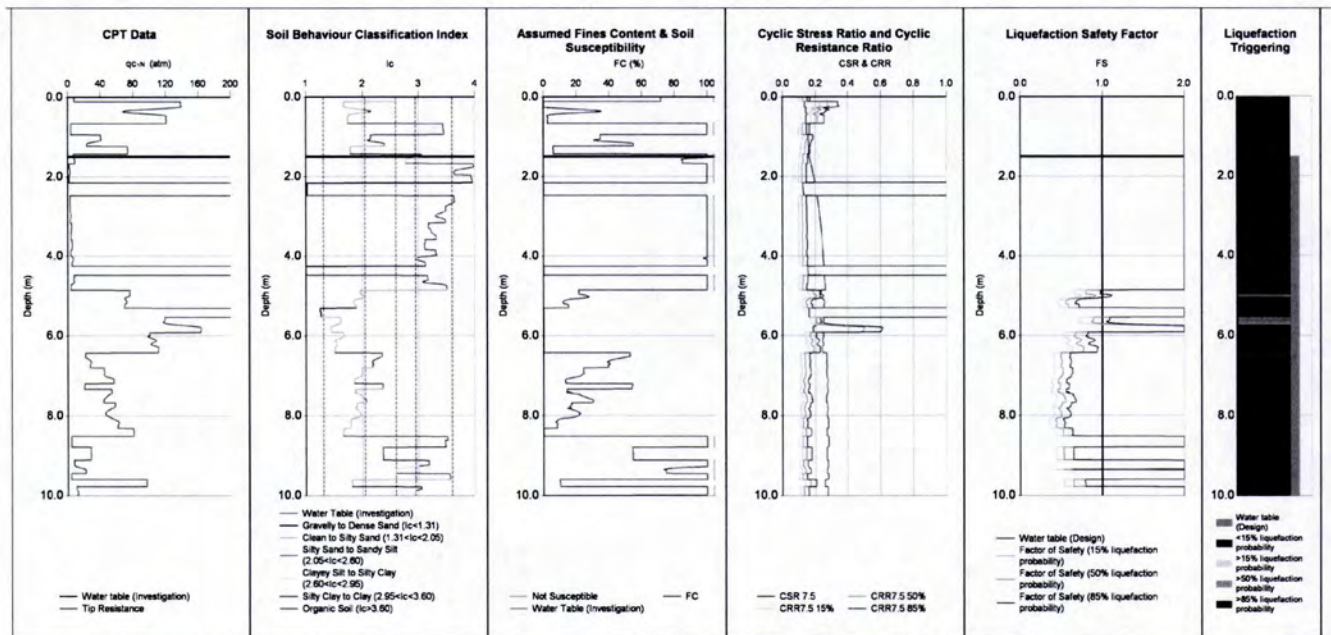


(Assumed pre-drill values)

CPT Name	NZGD ID	Investigation Date	Magnitude	PGA (g)	GWD (m)	Trigger Method	Settlement Method	Pre-drill Depth (m)	qc (MPa)	Fs (MPa)	γ (kN/m ³)
CPT07	110922	30/07/2018	6	0.3	1.5	BI-2014	ZRB-2002	0	2	0.01	17

Thicker lines represent the 50% probability of exceedance case and the thinner lines to the left and right of the thicker lines represent the 85% and 15% probability of exceedance cases respectively.

	Tonkin + Taylor Exceptional thinking together V2.0	CLIENT	Rotorua Lakes Council	LOCATION	Rotorua	DATE	11/02/2019
		PROJECT	Rotorua Lakefront Redevelopment	JOB NUMBER	1007467.1000	ANALYSED	pemo
		TITLE	1:500 year event ULS	CHECKED		PAGE	21 of 35 pages
		COMMENT					



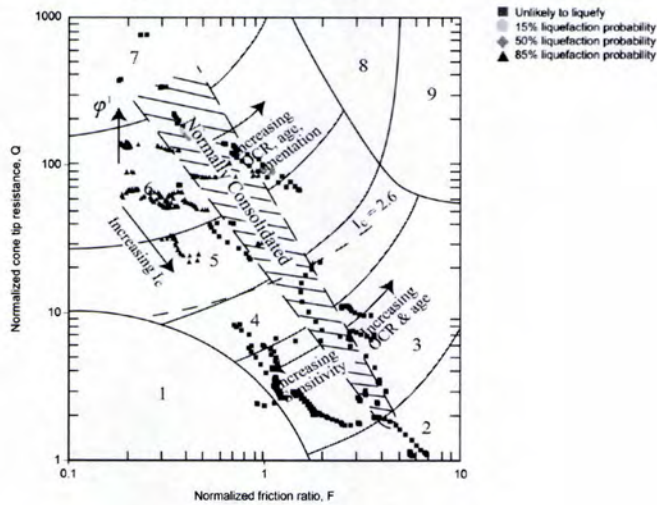
Note: Inverse filtered Qc/Fs data used (10 cm²)

Run Description	NZGD ID	Investigation Date	γ (kN/m ³)	Magnitude	PGA (g)	Trigger Method	Settlement Method	γ (kN/m ³)	Surcharge/Cut/Fill Surcharge (kPa)	Cut/Fill Height (m)
INPUT	110923	30/07/2018	17	6	0.3	BI-2014	ZRB-2002	17		0

PL	Sv1d (mm)	CTL (m)	LPI	LSN	CT (m)	LPlish
15%	102	3.8	13	15	5	6
50%	99	3.7	10	14	5	5
85%	93	3.5	7	13	5	2

Reviewed by:	
CPT Inversion	CDAV
Groundwater	CDAV
Susceptibility	CDAV
Triggering	CDAV
Consequence	CDAV

	Tonkin + Taylor Exceptional thinking together V2.0	CLIENT	Rotorua Lakes Council	LOCATION	Rotorua	DATE	11/02/2019
		PROJECT	Rotorua Lakefront Redevelopment	JOB NUMBER	1007467.1000	ANALYSED	pemo
		TITLE	1:500 year event ULS	CHECKED		PAGE	22 of 35 pages
		COMMENT					

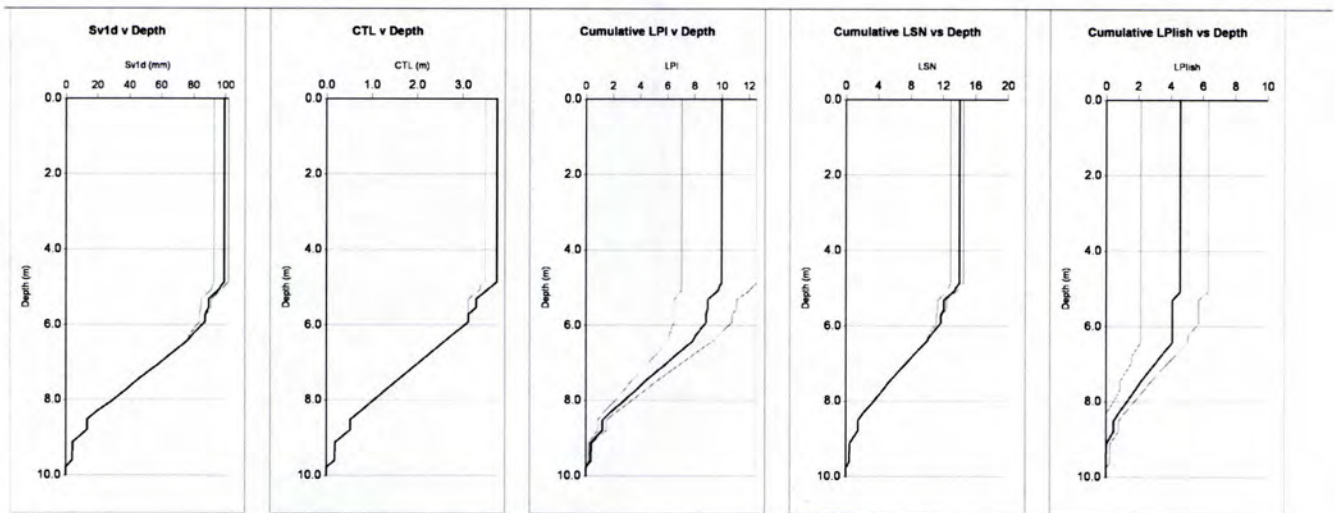


- | | |
|--|-------------------------------------|
| 1. Sensitive, fine grained | 6. Sands - clean sand to silty sand |
| 2. Organic soils - peats | 7. Gravelly sand to dense sand |
| 3. Clays - silty clay to clay | 8. Very stiff sand to clayey sand * |
| 4. Silt mixtures - clayey silt to silty clay | 9. Very stiff, fine grained * |
| 5. Sand mixtures - silty sand to sandy silt | |

*Heavily overconsolidated or cemented

CPT-based soil behavior type classification chart by Robertson (1990)

 Tonkin + Taylor	Tonkin + Taylor Exceptional thinking together V2.0	CLIENT Rotorua Lakes Council	LOCATION Rotorua	DATE 11/02/2019
		PROJECT Rotorua Lakefront Redevelopment	JOB NUMBER 1007467.1000	ANALYSED pemo
		TITLE 1:500 year event ULS		CHECKED
				PAGE 23 of 35 pages

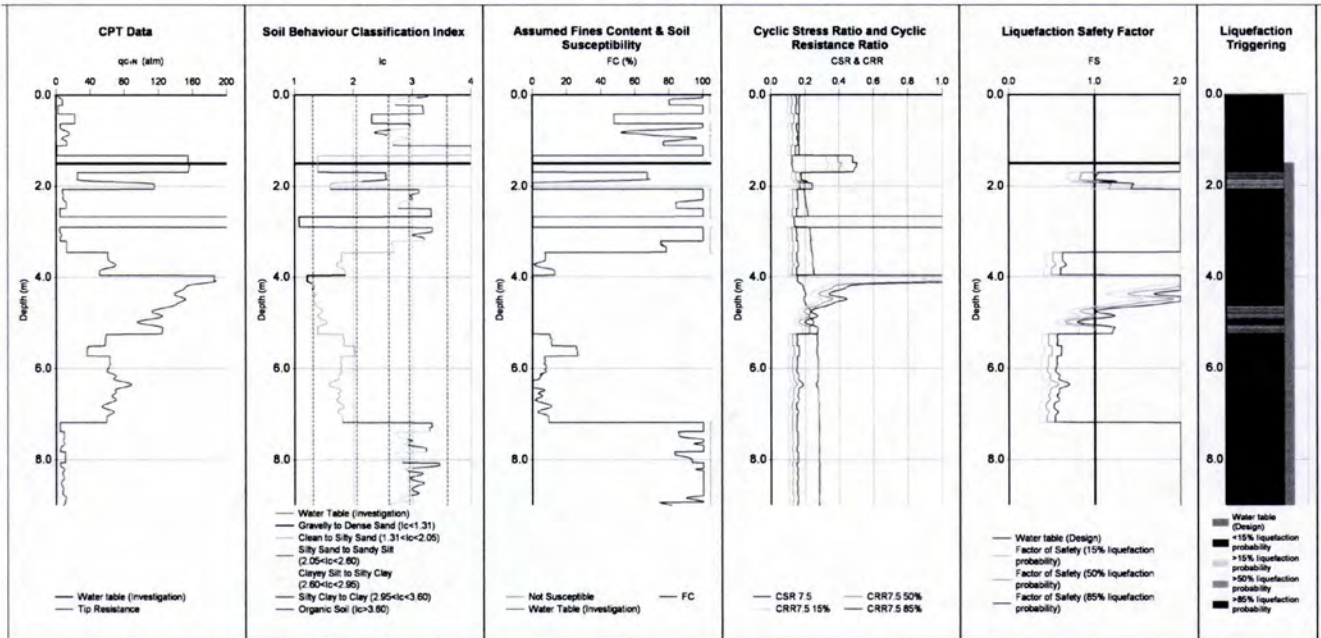


(Assumed pre-drill values)

CPT Name	NZGD ID	Investigation Date	Magnitude	PGA (g)	GWD (m)	Trigger Method	Settlement Method	Pre-drill Depth (m)	qc (MPa)	Fs (MPa)	γ (kN/m ³)
CPT08	110923	30/07/2018	6	0.3	1.5	BI-2014	ZRB-2002	0	2	0.01	17

Thicker lines represent the 50% probability of exceedance case and the thinner lines to the left and right of the thicker lines represent the 85% and 15% probability of exceedance cases respectively.

 Tonkin + Taylor	Tonkin + Taylor Exceptional thinking together V2.0	CLIENT Rotorua Lakes Council	LOCATION Rotorua	DATE 11/02/2019
		PROJECT Rotorua Lakefront Redevelopment	JOB NUMBER 1007467.1000	ANALYSED pemo
		TITLE 1:500 year event ULS		CHECKED
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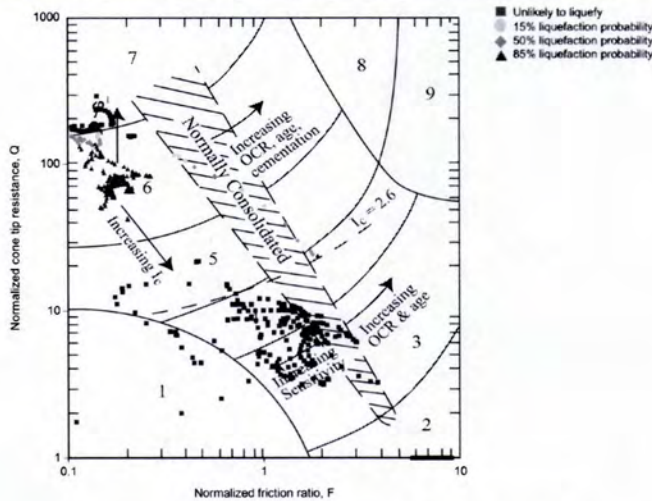


Note: Inverse filtered Q_c/F_s data used (10 cm^2)

Run Description	NZGD ID	Investigation Date	γ (kN/m ³)	Magnitude	PGA (g)	Trigger Method	Settlement Method	γ (kN/m ³)	Surcharge/Cut/Fill	Surcharge (kPa)	Cut/Fill Height (m)
INPUT	110924	1/08/2018	17	17	6	0.3 BI-2014	ZRB-2002	17		0	
OUTPUT	PL	Sv1d (mm)	CTL (m)	LPI	LSN	CT (m)	LPlish				
	15%	100	3.4	12	21	1.8	9				
	50%	95	3.1	10	20	1.8	7				
	85%	88	2.6	7	17	3.5	5				

Reviewed by	
CPT Inversion	CDAV
Groundwater	CDAV
Susceptibility	CDAV
Triggering	CDAV
Consequence	CDAV

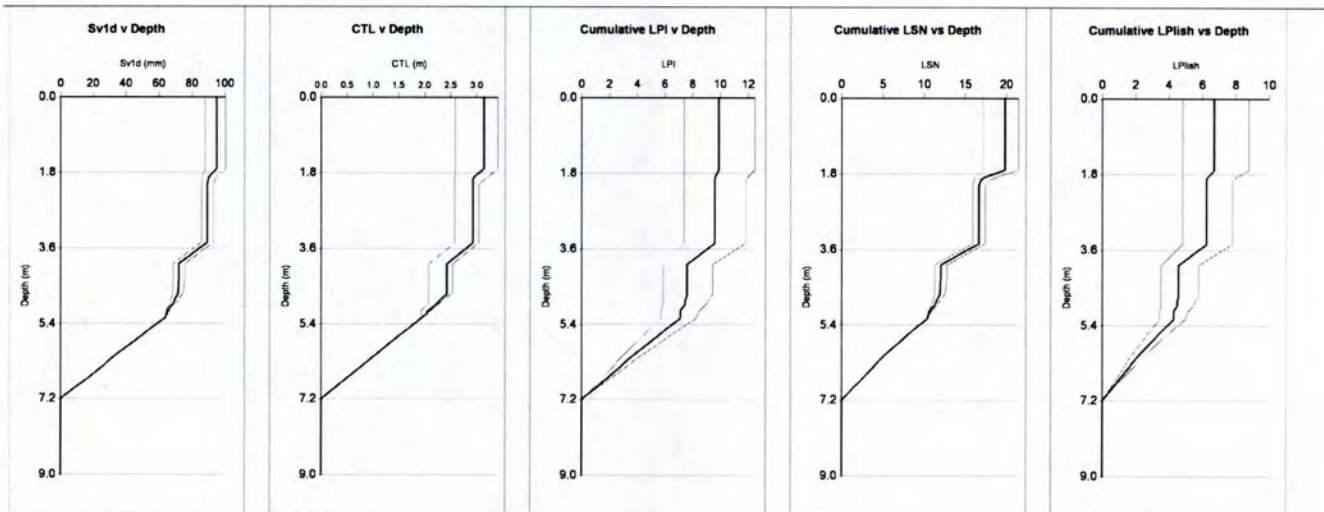
 Tonkin+Taylor	Tonkin + Taylor Exceptional thinking together V2.0	CLIENT	Rotorua Lakes Council	LOCATION	Rotorua	DATE	11/02/2019
		PROJECT	Rotorua Lakefront Redevelopment	JOB NUMBER	1007467.1000	ANALYSED	pemo
TITLE	1:500 year event ULS	COMMENT		CHECKED		PAGE	25 of 35 pages



- 1. Sensitive, fine grained
- 2. Organic soils - peats
- 3. Clays - silty clay to clay
- 4. Silt mixtures - clayey silt to silty clay
- 5. Sand mixtures - silty sand to sandy silt
- 6. Sands - clean sand to silty sand
- 7. Gravely sand to dense sand
- 8. Very stiff sand to clayey sand *
- 9. Very stiff, fine grained *

*Heavily overconsolidated or cemented
 CPT-based soil behavior type classification chart by Robertson (1990)

 Tonkin+Taylor	Tonkin + Taylor Exceptional thinking together V2.0	CLIENT	Rotorua Lakes Council	LOCATION	Rotorua	DATE	11/02/2019
		PROJECT	Rotorua Lakefront Redevelopment	JOB NUMBER	1007467.1000	ANALYSED	pemo
TITLE	1:500 year event ULS	COMMENT		CHECKED		PAGE	26 of 35 pages

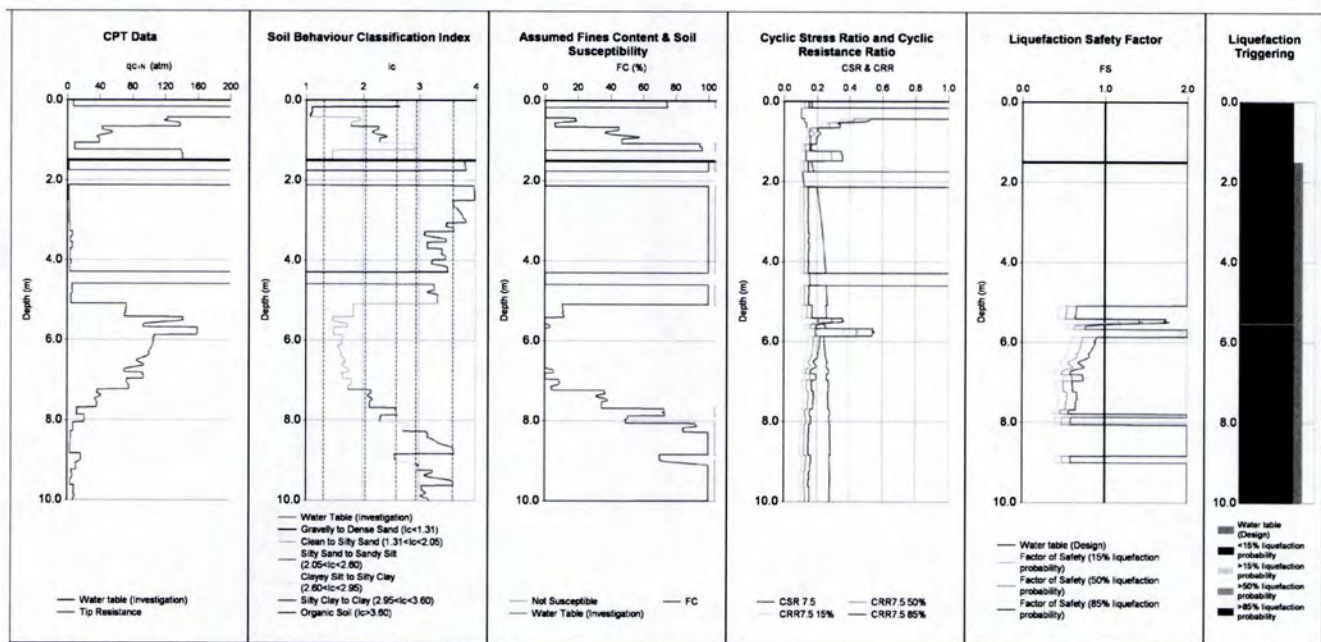


(Assumed pre-drill values)

CPT Name	NZGD ID	Investigation Date	Magnitude	PGA (g)	GWD (m)	Trigger Method	Settlement Method	Pre-drill Depth (m)	qc (MPa)	Fs (MPa)	γ (kN/m ³)
CPT09	110924	1/08/2018	6	0.3	1.5	BI-2014	ZRB-2002	0	2	0.01	17

Thicker lines represent the 50% probability of exceedance case and the thinner lines to the left and right of the thicker lines represent the 85% and 15% probability of exceedance cases respectively.

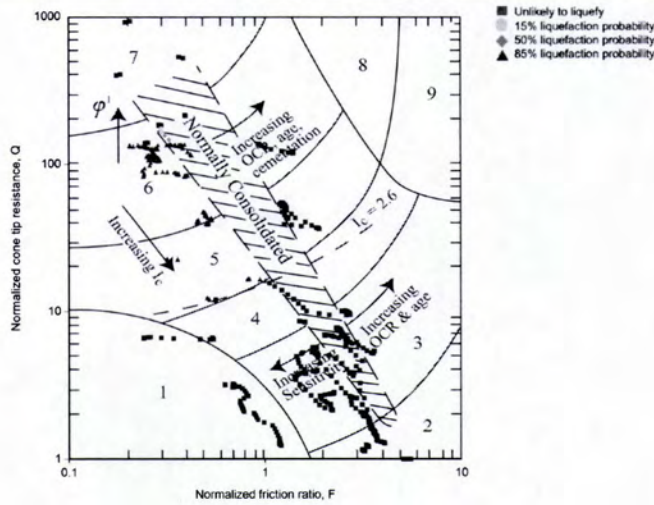
 Tonkin + Taylor	Tonkin + Taylor Exceptional thinking together V2.0	CLIENT Rotorua Lakes Council	LOCATION Rotorua	DATE 11/02/2019
		PROJECT Rotorua Lakefront Redevelopment 1:500 year event ULS	JOB NUMBER 1007467.1000	ANALYSED pemo CHECKED PAGE 27 of 35 pages



Note: Inverse filtered Q_c/F_s data used (10 cm²)

Run Description	NZGD ID	Investigation Date	γ (kN/m ³)	Magnitude	PGA (g)	Trigger Method	Settlement Method	Surcharge/Cut/Fill	Surcharge (kPa)	Cut/Fill Height (m)
INPUT	110925	30/07/2018	17	6	0.3	BI-2014	ZRB-2002			0
OUTPUT	PL	Sv1d (mm)	CTL (m)	LPI	LSN	CT (m)	LPIish	Reviewed by:		
	15%	75	2.8	10	11	5.2	5	CPT Inversion	CDAV	
	50%	74	2.8	8	11	5.2	3	Groundwater	CDAV	
	85%	71	2.7	6	11	5.2	1	Susceptibility	CDAV	
								Triggering	CDAV	
								Consequence	CDAV	

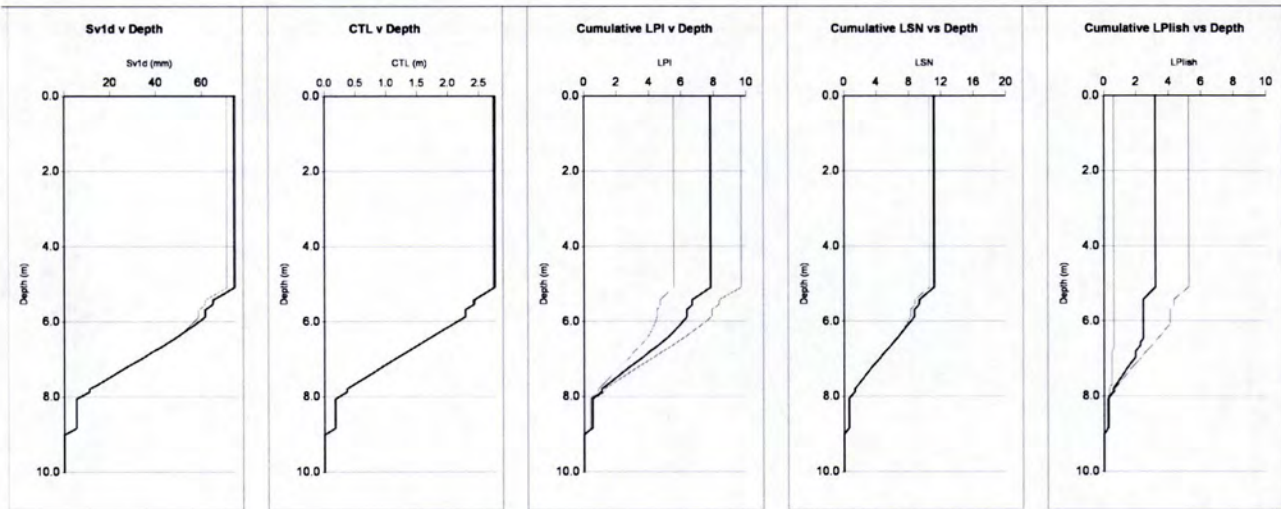
 Tonkin + Taylor	Tonkin + Taylor Exceptional thinking together V2.0	CLIENT Rotorua Lakes Council	LOCATION Rotorua	DATE 11/02/2019
		PROJECT Rotorua Lakefront Redevelopment 1:500 year event ULS	JOB NUMBER 1007467.1000	ANALYSED pemo CHECKED PAGE 28 of 35 pages



- | | |
|--|-------------------------------------|
| 1. Sensitive, fine grained | 6. Sands - clean sand to silty sand |
| 2. Organic soils - peats | 7. Gravelly sand to dense sand |
| 3. Clays - silty clay to clay | 8. Very stiff sand to clayey sand * |
| 4. Silt mixtures - clayey silt to silty clay | 9. Very stiff, fine grained * |
| 5. Sand mixtures - silty sand to sandy silt | |

*Heavily overconsolidated or cemented
 CPT-based soil behavior type classification chart by Robertson (1990)

	Tonkin + Taylor Exceptional thinking together V2.0	CLIENT Rotorua Lakes Council	LOCATION Rotorua	DATE 11/02/2019
		PROJECT Rotorua Lakefront Redevelopment	JOB NUMBER 1007467.1000	ANALYSED pemo
		TITLE 1:500 year event ULS	CHECKED	
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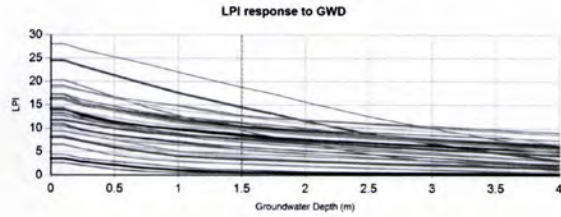
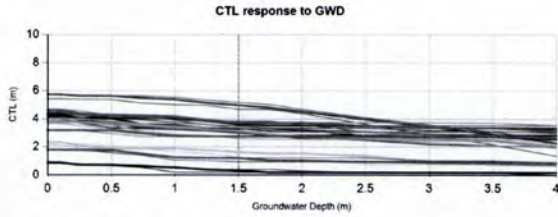
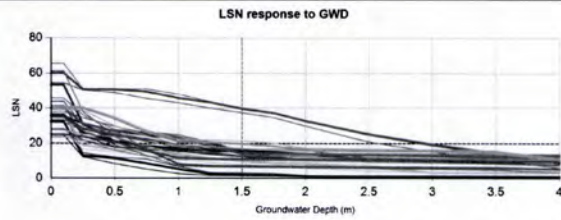
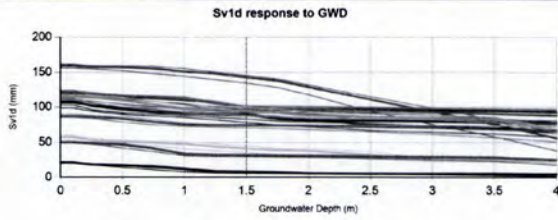


(Assumed pre-drill values)

CPT Name	NZGD ID	Investigation Date	Magnitude	PGA (g)	GWD (m)	Trigger Method	Settlement Method	Pre-drill Depth (m)	qc (MPa)	Fs (MPa)	γ (kN/m³)
CPT10	110925	30/07/2018	6	0.3	1.5	BI-2014	ZRB-2002	0	2	0.01	17

Thicker lines represent the 50% probability of exceedance case and the thinner lines to the left and right of the thicker lines represent the 85% and 15% probability of exceedance cases respectively.

	Tonkin + Taylor Exceptional thinking together V2.0	CLIENT Rotorua Lakes Council	LOCATION Rotorua	DATE 11/02/2019
		PROJECT Rotorua Lakefront Redevelopment	JOB NUMBER 1007467.1000	ANALYSED pemo
		TITLE 1:500 year event ULS	CHECKED	
		COMMENT	PAGE 30 of 35 pages	

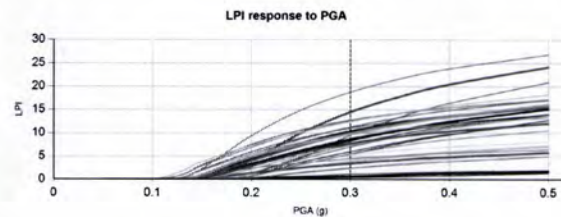
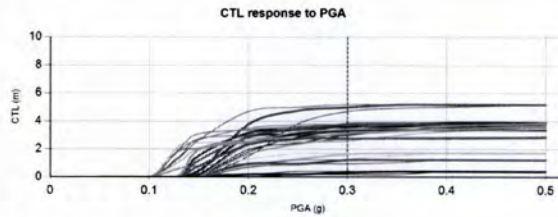
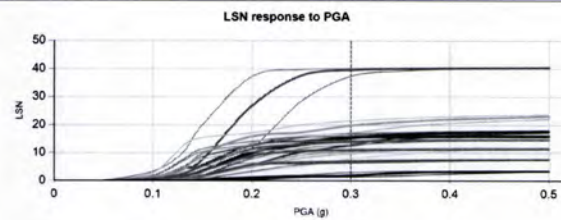
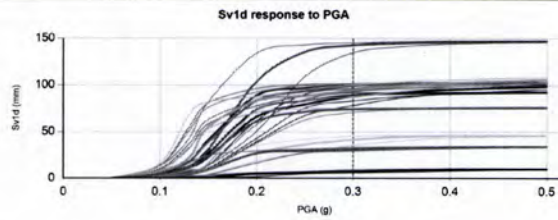


Vertical dashed lines indicate user specified GWD at the CPT locations. (actual GWD)

CPT Name	NZGD ID	Investigation Date	Event and Model (PGA & GWD)	Magnitude	PGA (g)	GWD (m)	Trigger Method	Settlement Method	Pre-drill Depth (m)	(Assumed pre-drill values)		
										qc (MPa)	Fs (MPa)	γ (kN/m ³)
CPT01	110916	31/07/2018	User Specified	6	0.3	1.5 Bi-2014	ZRB-2002	0	2	0.01	17	
CPT02	110917	31/07/2018	User Specified	6	0.3	1.5 Bi-2014	ZRB-2002	0	2	0.01	17	
CPT03	110918	30/07/2018	User Specified	6	0.3	1.5 Bi-2014	ZRB-2002	0	2	0.01	17	
CPT04	110919	30/07/2018	User Specified	6	0.3	1.5 Bi-2014	ZRB-2002	0	2	0.01	17	
CPT05	110920	30/07/2018	User Specified	6	0.3	1.5 Bi-2014	ZRB-2002	0	2	0.01	17	
CPT06	110921	30/07/2018	User Specified	6	0.3	1.5 Bi-2014	ZRB-2002	0	2	0.01	17	
CPT07	110922	30/07/2018	User Specified	6	0.3	1.5 Bi-2014	ZRB-2002	0	2	0.01	17	
CPT08	110923	30/07/2018	User Specified	6	0.3	1.5 Bi-2014	ZRB-2002	0	2	0.01	17	
CPT09	110924	1/08/2018	User Specified	6	0.3	1.5 Bi-2014	ZRB-2002	0	2	0.01	17	
CPT10	110925	30/07/2018	User Specified	6	0.3	1.5 Bi-2014	ZRB-2002	0	2	0.01	17	

Thicker lines represent the 50% probability of exceedance case and the thinner lines to the bottom and top of the thicker lines represent the 85% and 15% probability of exceedance cases respectively.

 Tonkin + Taylor Exceptional thinking together V2.0	CLIENT Rotorua Lakes Council	LOCATION Rotorua	DATE 11/02/2019
	PROJECT Rotorua Lakefront Redevelopment	JOB NUMBER 1007467.1000	ANALYSED pemo
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Vertical dashed lines indicate user specified PGA at the CPT locations. (actual PGA)

CPT Name	NZGD ID	Investigation Date	Event and Model (PGA & GWD)	Magnitude	PGA (g)	GWD (m)	Trigger Method	Settlement Method	Pre-drill Depth (m)	(Assumed pre-drill values)		
										qc (MPa)	Fs (MPa)	γ (kN/m ³)
CPT01	110916	31/07/2018	User Specified	6	0.3	1.5 Bi-2014	ZRB-2002	0	2	0.01	17	
CPT02	110917	31/07/2018	User Specified	6	0.3	1.5 Bi-2014	ZRB-2002	0	2	0.01	17	
CPT03	110918	30/07/2018	User Specified	6	0.3	1.5 Bi-2014	ZRB-2002	0	2	0.01	17	
CPT04	110919	30/07/2018	User Specified	6	0.3	1.5 Bi-2014	ZRB-2002	0	2	0.01	17	
CPT05	110920	30/07/2018	User Specified	6	0.3	1.5 Bi-2014	ZRB-2002	0	2	0.01	17	
CPT06	110921	30/07/2018	User Specified	6	0.3	1.5 Bi-2014	ZRB-2002	0	2	0.01	17	
CPT07	110922	30/07/2018	User Specified	6	0.3	1.5 Bi-2014	ZRB-2002	0	2	0.01	17	
CPT08	110923	30/07/2018	User Specified	6	0.3	1.5 Bi-2014	ZRB-2002	0	2	0.01	17	
CPT09	110924	1/08/2018	User Specified	6	0.3	1.5 Bi-2014	ZRB-2002	0	2	0.01	17	
CPT10	110925	30/07/2018	User Specified	6	0.3	1.5 Bi-2014	ZRB-2002	0	2	0.01	17	

Thicker lines represent the 50% probability of exceedance case and the thinner lines to the bottom and top of the thicker lines represent the 85% and 15% probability of exceedance cases respectively.


 Tonkin + Taylor Exceptional thinking together V2.0	CLIENT Rotorua Lakes Council	LOCATION Rotorua	DATE 11/02/2019
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The inputs listed in Table 1.1-1 below have been adopted for the liquefaction analysis.


Table 1.1-1 Summary of inputs for liquefaction analysis

NZ	110916	110917	110918	110919	110920	110921
CPT Name	05TT06_CPT01	05TT06_CPT02	05TT06_CPT03	05TT06_CPT04	05TT06_CPT05	05TT06_CPT06
PGA	0.3g	0.3g	0.3g	0.3g	0.3g	0.3g
Magnitude	6	6	6	6	6	6
Depth to groundwater	1.5m	1.5m	1.5m	1.5m	1.5m	1.5m
Predrill depth	0m	0m	0m	0m	0m	0m
Assumed predrill tip resistance and skin friction	qc= 2MPa & Fs= 0.01MPa	qc= 2MPa & Fs= 0.01MPa	qc= 2MPa & Fs= 0.01MPa	qc= 2MPa & Fs= 0.01MPa	qc= 2MPa & Fs= 0.01MPa	qc= 2MPa & Fs= 0.01MPa
Trigger method	Boulanger & Idriss (2014)	Boulanger & Idriss (2014)	Boulanger & Idriss (2014)	Boulanger & Idriss (2014)	Boulanger & Idriss (2014)	Boulanger & Idriss (2014)
Settlement method	Zhang, Robertson & Brachman (2002)	Zhang, Robertson & Brachman (2002)	Zhang, Robertson & Brachman (2002)	Zhang, Robertson & Brachman (2002)	Zhang, Robertson & Brachman (2002)	Zhang, Robertson & Brachman (2002)
CFC	0	0	0	0	0	0
Total depth of CPT	9.69m	5.71m	10.84m	10.13m	10.79m	9.36m
Minimum depth of analysis	0m	0m	0m	0m	0m	0m
Maximum depth of analysis	10m	10m	10m	10m	10m	10m
RL	0	0	0	0	0	0


CPT	From Depth (m)		To Depth (m)	
	lc from (m)	lc to (m)	lc from (m)	lc to (m)
117893	0	10	0	0
117893	0	10	2.6	0
117894	0	10	0	0
117894	0	10	2.6	0
117895	0	10	0	0
117895	0	10	2.6	0
117896	0	10	0	0
117896	0	10	2.6	0
117897	0	10	0	0
117897	0	10	2.6	0
117898	0	10	0	0
117898	0	10	2.6	0
117899	0	10	0	0
117899	0	10	2.6	0
117900	0	10	0	0
117900	0	10	2.6	0
117901	0	10	0	0
117901	0	10	2.6	0
117902	0	10	0	0
117902	0	10	2.6	0
	Fc from (m)	Fc to (m)	Fc from (m)	Fc to (m)
117893	0	10	0	0
117894	0	10	0	0
117895	0	10	0	0
117896	0	10	0	0
117897	0	10	0	0

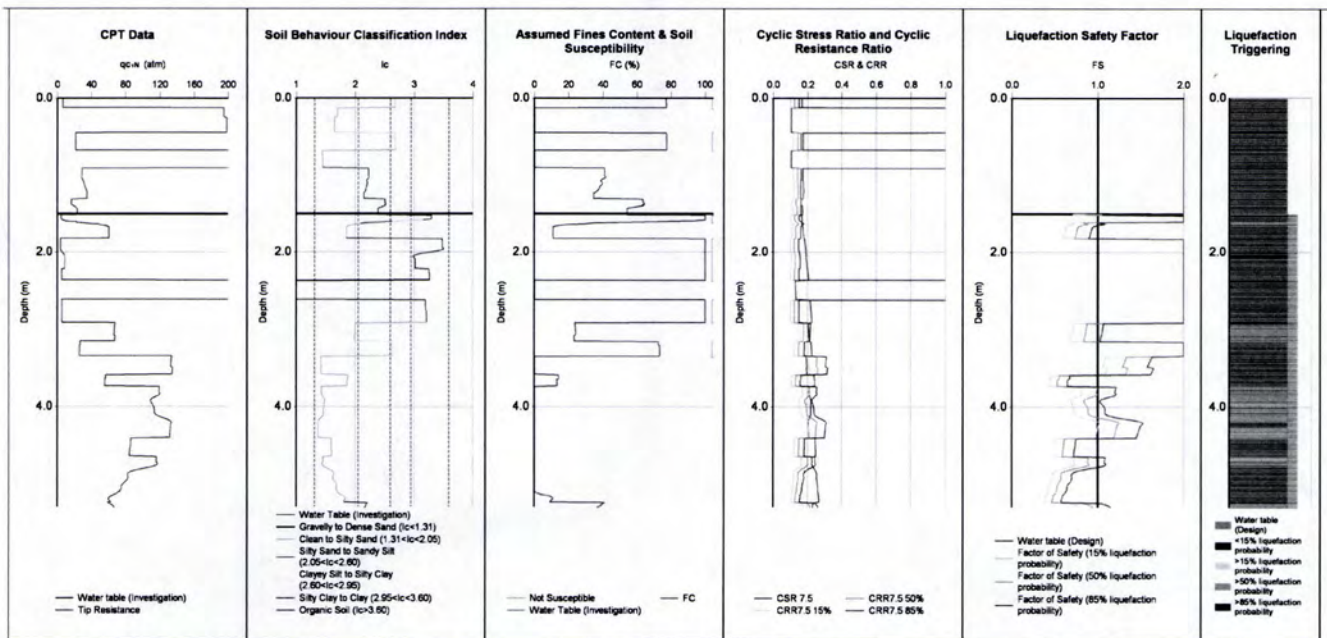
 Tonkin + Taylor Exceptional thinking together V2.0	CLIENT	Rotorua Lakes Council	LOCATION	Rotorua	DATE	11/02/2019
	PROJECT	Rotorua Lakefront Redevelopment	JOB NUMBER	1007467.1000	ANALYSED	pemo
	TITLE	1:500 year event ULS	CHECKED		PAGE	33 of 35 pages
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110922	110923	110924	110925
05TT06_CPT07	05TT06_CPT08	05TT06_CPT09	05TT06_CPT10
0.3g	0.3g	0.3g	0.3g
6	6	6	6
1.5m	1.5m	1.5m	1.5m
0m	0m	0m	0m
qc= 2MPa & Fs= 0.01MPa	qc= 2MPa & Fs= 0.01MPa	qc= 2MPa & Fs= 0.01MPa	qc= 2MPa & Fs= 0.01MPa
Boulanger & Idriss (2014)	Boulanger & Idriss (2014)	Boulanger & Idriss (2014)	Boulanger & Idriss (2014)
Zhang, Robertson & Brachman (2002)	Zhang, Robertson & Brachman (2002)	Zhang, Robertson & Brachman (2002)	Zhang, Robertson & Brachman (2002)
0	0	0	0
9.18m	11.13m	9m	12.18m
0m	0m	0m	0m
10m	10m	10m	10m
0	0	0	0

 Tonkin + Taylor Exceptional thinking together V2.0	CLIENT	Rotorua Lakes Council	LOCATION	Rotorua	DATE	11/02/2019
	PROJECT	Rotorua Lakefront Redevelopment	JOB NUMBER	1007467.1000	ANALYSED	pemo
	TITLE	1:500 year event ULS	CHECKED		PAGE	34 of 35 pages
	COMMENT					

117896	0	10	0
117899	0	10	0
117900	0	10	0
117901	0	10	0
117902	0	10	0

	Tonkin + Taylor Exceptional thinking together V2.0	CLIENT Rotorua Lakes Council	LOCATION Rotorua	DATE 11/02/2019
		PROJECT Rotorua Lakefront Redevelopment	JOB NUMBER 1007467.1000	ANALYSED pemo
		TITLE 1:500 year event ULS		CHECKED
		COMMENT		PAGE 35 of 35 pages




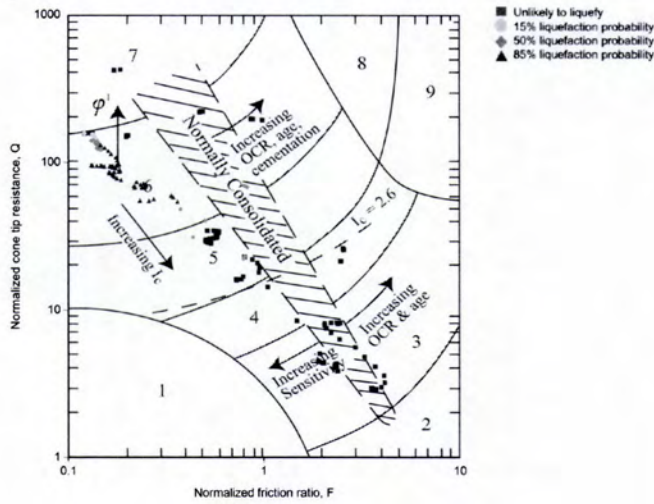
Note: Inverse filtered Q_c/F_s data used (10 cm^2)

Run Description	NZGD ID	Investigation Date	γ (kN/m^3)	Magnitude	PGA (g)	Trigger Method	Settlement Method	γ (kN/m^3)	Surcharge/Cut/Fill	Surcharge (kPa)	Cut/Fill Height (m)
INPUT	110926	1/08/2018	17	6	0.3 BI-2014	ZRB-2002	17			0	
OUTPUT	PL	Sv1d (mm)	CTL (m)	LPI	LSN	CT (m)	LPlish				
	15%	52	2.1	6	15	1.7	5				
	50%	45	1.9	4	13	1.7	3				
	85%	35	1	2	10	1.7	2				

Reviewed by:

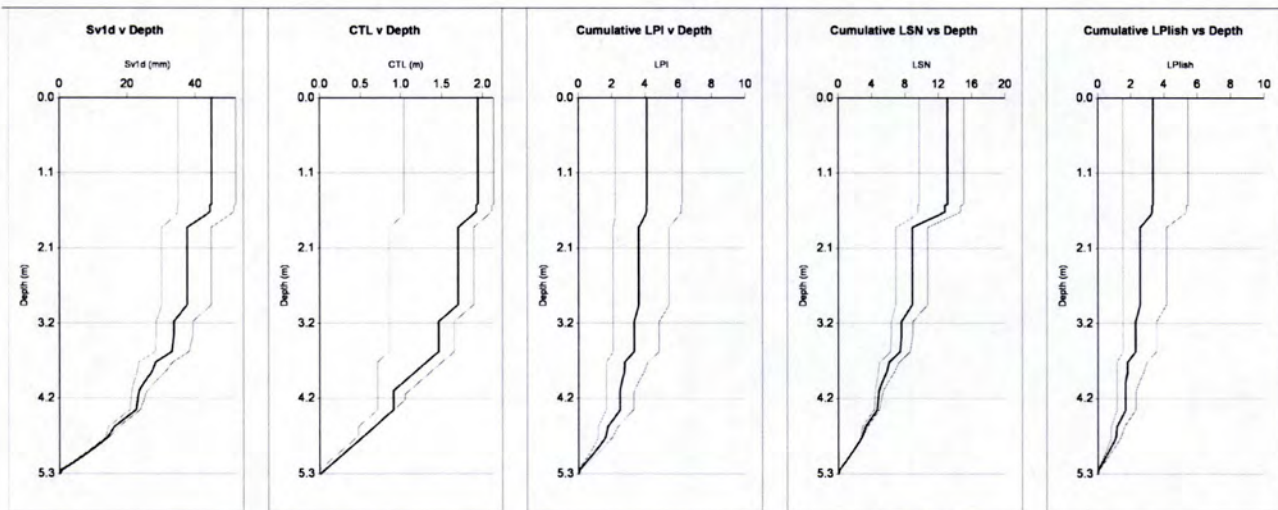
CPT Inversion	CDAV
Groundwater	CDAV
Susceptibility	CDAV
Triggering	CDAV
Consequence	CDAV

	Tonkin + Taylor Exceptional thinking together V2.0	CLIENT Rotorua Lakes Council	LOCATION Rotorua	DATE 11/02/2019
		PROJECT Rotorua Lakefront Redevelopment	JOB NUMBER 1007467.1000	ANALYSED pemo
		TITLE 1:500 year event ULS		CHECKED
		COMMENT		PAGE 1 of 35 pages



1. Sensitive, fine grained
 2. Organic soils - peats
 3. Clays - silty clay to clay
 4. Silt mixtures - clayey silt to silty clay
 5. Sand mixtures - silty sand to sandy silt
 6. Sands - clean sand to silty sand
 7. Gravelly sand to dense sand
 8. Very stiff sand to clayey sand *
 9. Very stiff, fine grained *
- *Heavily overconsolidated or cemented
- CPT-based soil behavior type classification chart by Robertson (1990)

	Tonkin + Taylor	CLIENT	Rotorua Lakes Council	LOCATION	Rotorua	DATE	11/02/2019
	Exceptional thinking together	PROJECT	Rotorua Lakefront Redevelopment	JOB NUMBER	1007467.1000	ANALYSED	permo
	V2.0	TITLE	1:500 year event ULS	CHECKED		PAGE	2 of 35 pages
		COMMENT					

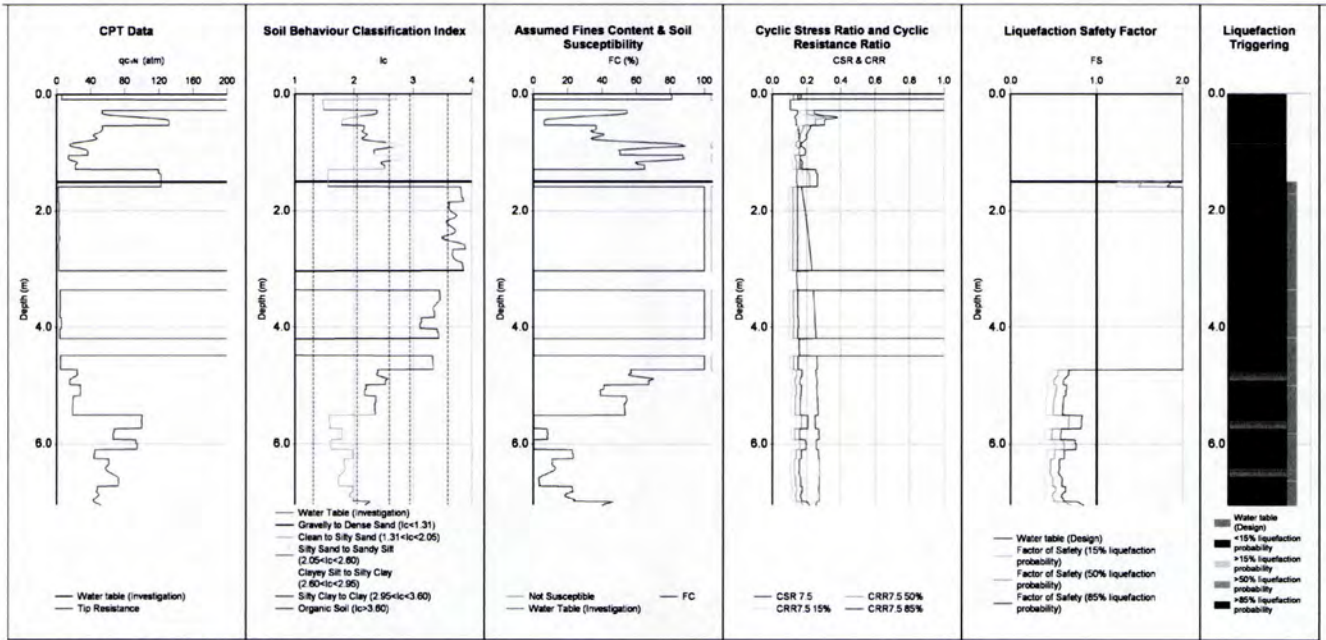


(Assumed pre-drill values)

CPT Name	NZGD ID	Investigation Date	Magnitude	PGA (g)	GWD (m)	Trigger Method	Settlement Method	Pre-drill Depth (m)	qc (MPa)	Fs (MPa)	γ (kN/m ³)
CPT11	110926	1/08/2018	6	0.3	1.5	BI-2014	ZRB-2002	0	2	0.01	17

Thicker lines represent the 50% probability of exceedance case and the thinner lines to the left and right of the thicker lines represent the 85% and 15% probability of exceedance cases respectively.

	Tonkin + Taylor	CLIENT	Rotorua Lakes Council	LOCATION	Rotorua	DATE	11/02/2019
	Exceptional thinking together	PROJECT	Rotorua Lakefront Redevelopment	JOB NUMBER	1007467.1000	ANALYSED	permo
	V2.0	TITLE	1:500 year event ULS	CHECKED		PAGE	3 of 35 pages
		COMMENT					



Note: Inverse filtered Qo/Fs data used (10 cm²)

Run Description	NZGD ID	Investigation Date	γ (kN/m ³)	Magnitude	PGA (g)	Trigger Method	Settlement Method	γ (kN/m ³)	Surcharge/Cut/Fill	Surcharge (kPa)	Cut/Fill Height (m)
INPUT	110927	30/07/2018	17	6	0.3	BI-2014	ZRB-2002	17			0
OUTPUT	PL	Sv1d (mm)	CTL (m)	LPI	LSN	CT (m)	LPlish				
	15%	69	2.3	9	12	4.8	6				
	50%	68	2.3	8	12	4.8	4				
	85%	67	2.3	6	12	4.8	3				

Reviewed by:

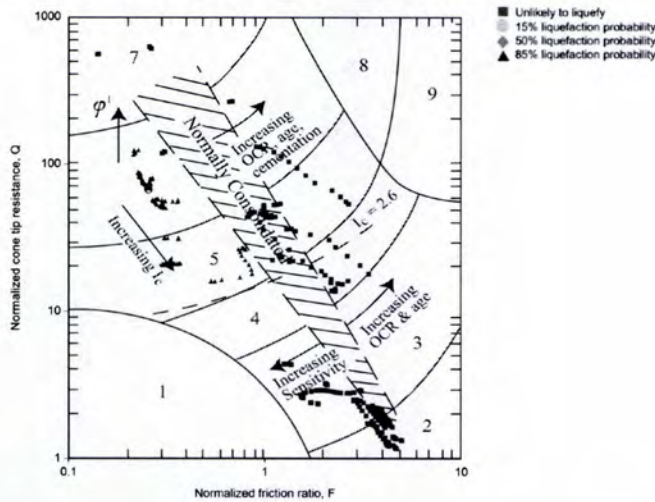
CPT Inversion	CDAV
Groundwater	CDAV
Susceptibility	CDAV
Triggering	CDAV
Consequence	CDAV



Tonkin + Taylor
Exceptional thinking together
V2.0

CLIENT: Rotorua Lakes Council
PROJECT: Rotorua Lakefront Redevelopment
TITLE: 1:500 year event ULS

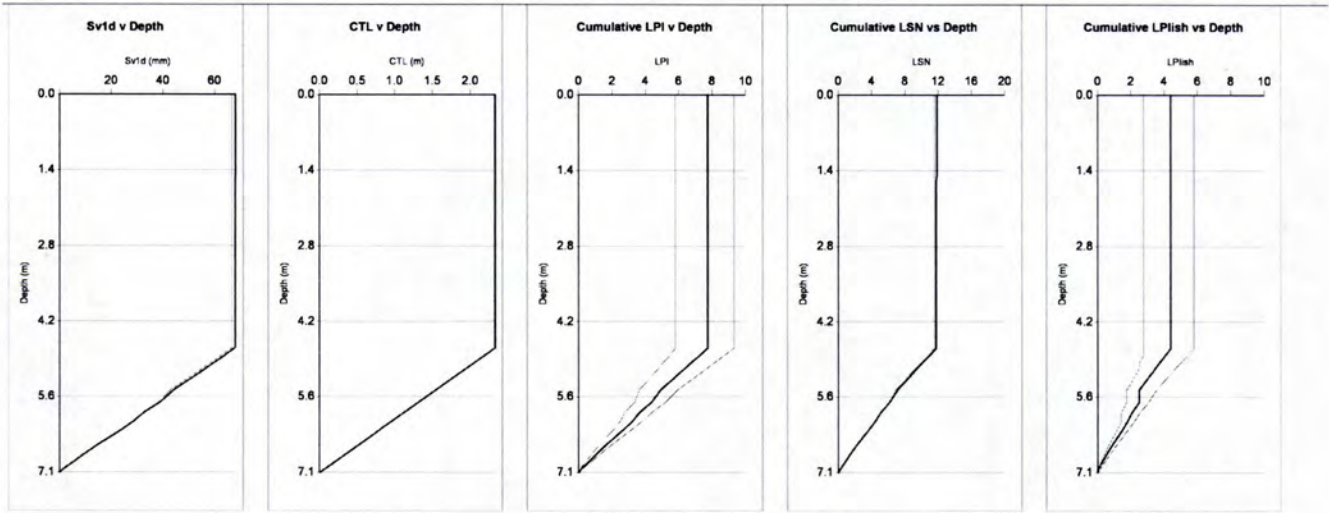
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DATE: 11/02/2019
ANALYSED: pemo
JOB NUMBER: 1007467.1000
CHECKED:
PAGE: 4 of 35 pages



Tonkin + Taylor
Exceptional thinking together
V2.0

CLIENT: Rotorua Lakes Council
PROJECT: Rotorua Lakefront Redevelopment
TITLE: 1:500 year event ULS

LOCATION: Rotorua
DATE: 11/02/2019
ANALYSED: pemo
JOB NUMBER: 1007467.1000
CHECKED:
PAGE: 5 of 35 pages

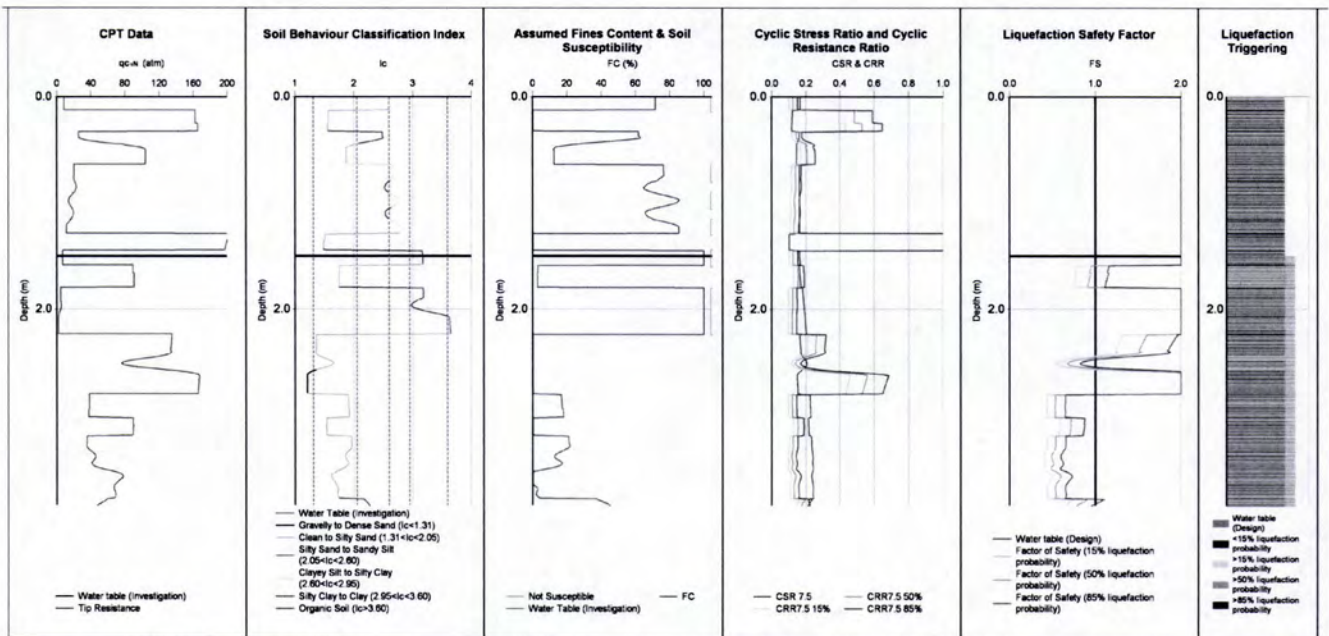


(Assumed pre-drill values)

CPT Name	NZGD ID	Investigation Date	Magnitude	PGA (g)	GWD (m)	Trigger Method	Settlement Method	Pre-drill Depth (m)	qc (MPa)	Fs (MPa)	γ (kN/m ³)
CPT12	110927	30/07/2018	6	0.3	1.5	BI-2014	ZRB-2002	0	2	0.01	17

Thicker lines represent the 50% probability of exceedance case and the thinner lines to the left and right of the thicker lines represent the 85% and 15% probability of exceedance cases respectively.

	Tonkin + Taylor Exceptional thinking together V2.0	CLIENT	Rotorua Lakes Council	LOCATION	Rotorua	DATE	11/02/2019
		PROJECT	Rotorua Lakefront Redevelopment	ANALYSED	permo		
		TITLE	1:500 year event ULS	CHECKED		PAGE	6 of 35 pages
		COMMENT		JOB NUMBER	1007467.1000		



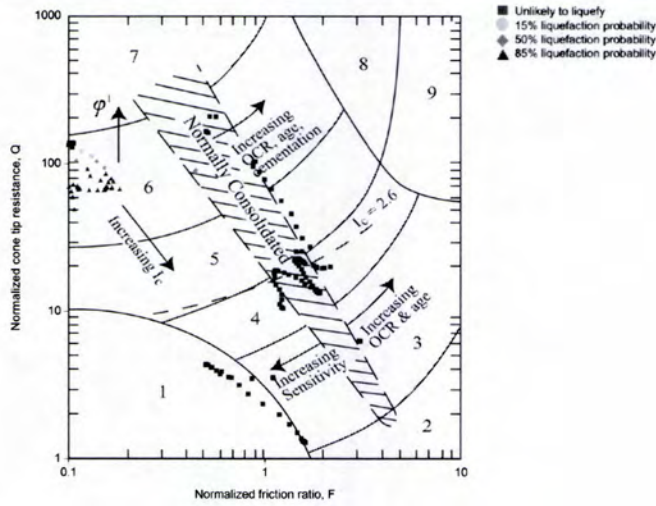
Note: Inverse filtered Qc/Fs data used (10 cm²)

Run Description	NZGD ID	Investigation Date	γ (kN/m ³)	Magnitude	PGA (g)	Trigger Method	Settlement Method	γ (kN/m ³)	Surcharge/Cut/Fill	Surcharge (kPa)	Cut/Fill Height (m)
INPUT	110928	31/07/2018	17	6	0.3	BI-2014	ZRB-2002	17		0	
OUTPUT	PL	Sv1d (mm)	CTL (m)	LPI	LSN	CT (m)	LPlish				
		15%	43	1.4	5	1.7	5				
		50%	40	1.4	4	1.3	4				
		85%	35	1.1	3	1.1	2				

Reviewed by:

CPT Inversion	CDAV
Groundwater	CDAV
Susceptibility	CDAV
Triggering	CDAV
Consequence	CDAV

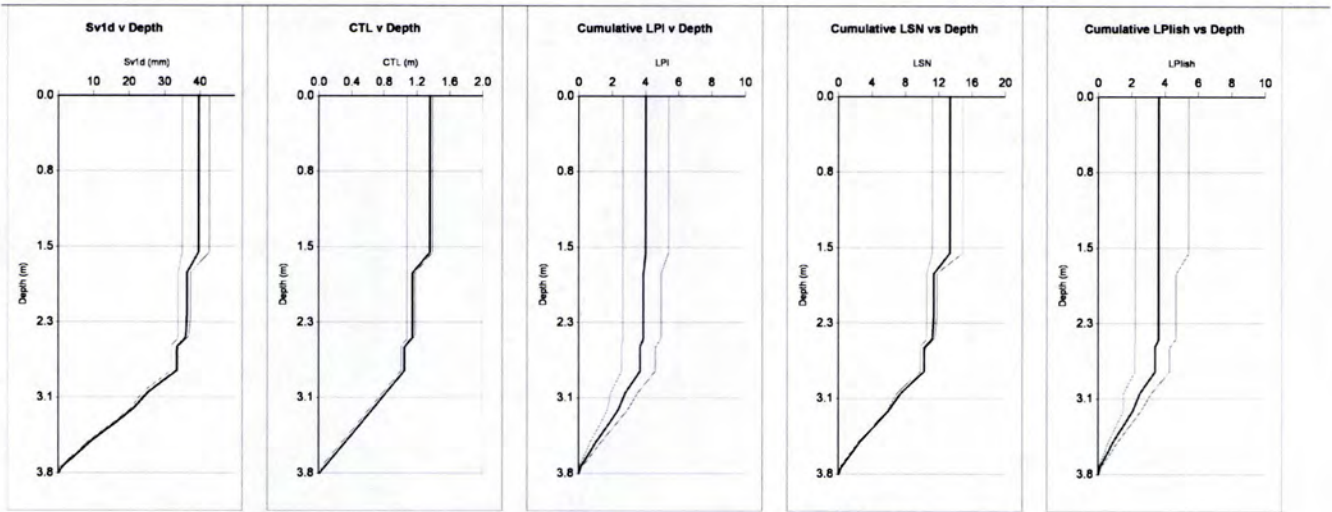
	Tonkin + Taylor Exceptional thinking together V2.0	CLIENT	Rotorua Lakes Council	LOCATION	Rotorua	DATE	11/02/2019
		PROJECT	Rotorua Lakefront Redevelopment	ANALYSED	permo		
		TITLE	1:500 year event ULS	CHECKED		PAGE	7 of 35 pages
		COMMENT		JOB NUMBER	1007467.1000		



- | | |
|--|-------------------------------------|
| 1. Sensitive, fine grained | 6. Sands - clean sand to silty sand |
| 2. Organic soils - peats | 7. Gravelly sand to dense sand |
| 3. Clays - silty clay to clay | 8. Very stiff sand to clayey sand * |
| 4. Silt mixtures - clayey silt to silty clay | 9. Very stiff, fine grained * |
| 5. Sand mixtures - silty sand to sandy silt | |

*Heavily overconsolidated or cemented
 CPT-based soil behavior type classification chart by Robertson (1990)

 Tonkin+Taylor	Tonkin + Taylor Exceptional thinking together V2.0	CLIENT Rotorua Lakes Council PROJECT Rotorua Lakefront Redevelopment TITLE 1:500 year event ULS	LOCATION Rotorua DATE 11/02/2019
		COMMENT	JOB NUMBER 1007467.1000 ANALYSED pemo CHECKED PAGE 8 of 35 pages

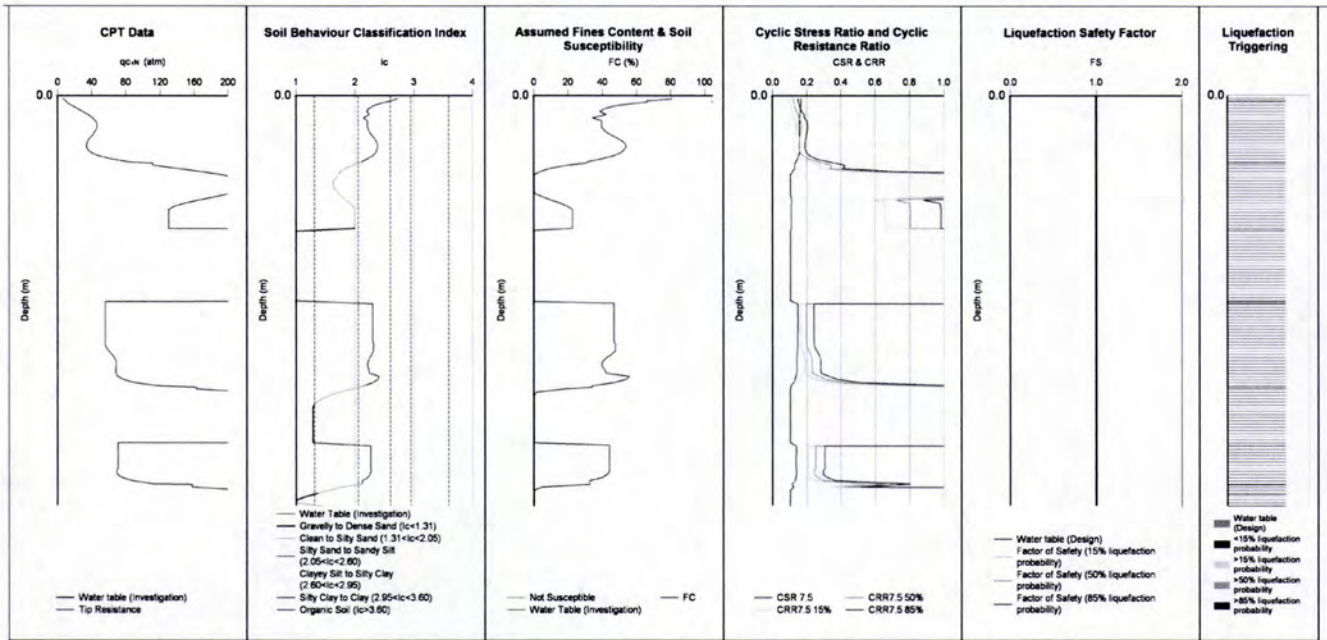


(Assumed pre-drill values)

CPT Name	NZGD ID	Investigation Date	Magnitude	PGA (g)	GWD (m)	Trigger Method	Settlement Method	Pre-drill Depth (m)	qc (MPa)	Fs (MPa)	γ (kN/m³)
CPT13	110928	31/07/2018	6	0.3	1.5	BI-2014	ZRB-2002	0	2	0.01	17

Thicker lines represent the 50% probability of exceedance case and the thinner lines to the left and right of the thicker lines represent the 85% and 15% probability of exceedance cases respectively.

 Tonkin+Taylor	Tonkin + Taylor Exceptional thinking together V2.0	CLIENT Rotorua Lakes Council PROJECT Rotorua Lakefront Redevelopment TITLE 1:500 year event ULS	LOCATION Rotorua DATE 11/02/2019
		COMMENT	JOB NUMBER 1007467.1000 ANALYSED pemo CHECKED PAGE 9 of 35 pages

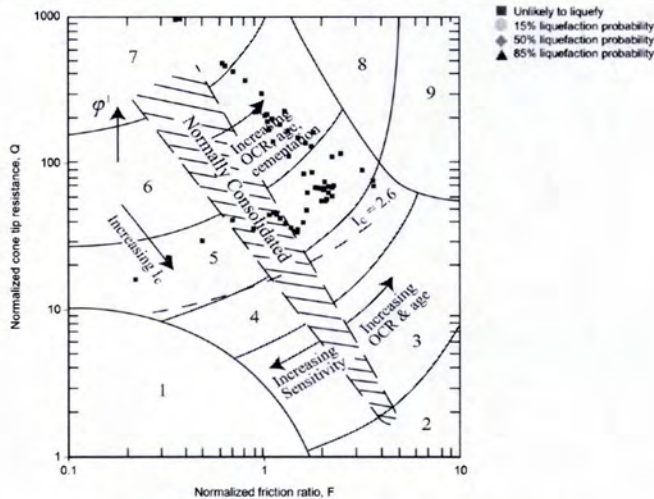


Note: Inverse filtered Q_c/F_s data used (10 cm^2)

Run Description	NZGD ID	Investigation Date	γ (kN/m^3)	Magnitude	PGA (g)	Trigger Method	Settlement Method	γ (kN/m^3)	Surcharge/Cut/Fill	Surcharge (kPa)	Cut/Fill Height (m)
INPUT	110929	30/07/2018	17	17	6	0.3 BI-2014	ZRB-2002	17			0
OUTPUT	PL	Sv1d (mm)	CTL (m)	LPI	LSN	CT (m)	LPlish				
	15%	0	0	0	0	1.3	0				
	50%	0	0	0	0	1.3	0				
	85%	0	0	0	0	1.3	0				

Reviewed by:	
CPT Inversion	CDAV
Groundwater	CDAV
Susceptibility	CDAV
Triggering	CDAV
Consequence	CDAV

<p>Tonkin + Taylor Exceptional thinking together V2.0</p>	CLIENT	Rotorua Lakes Council	LOCATION	Rotorua	DATE	11/02/2019
	PROJECT	Rotorua Lakefront Redevelopment	JOB NUMBER	1007467.1000	ANALYSED	pemo
	TITLE	1:500 year event ULS	CHECKED		PAGE	10 of 35 pages
	COMMENT					

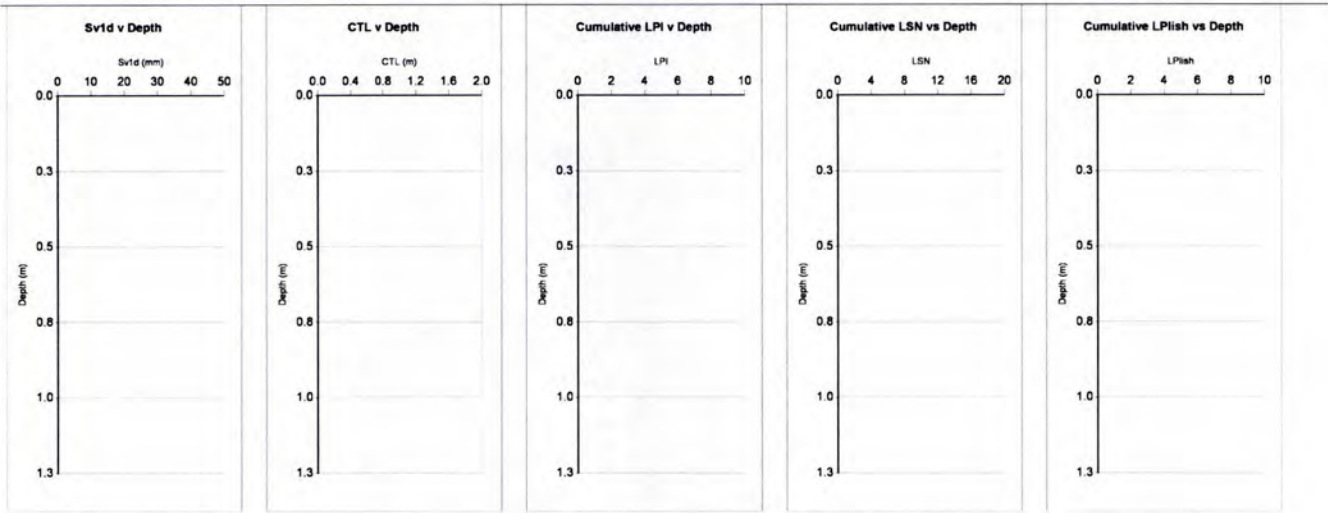


- 1 Sensitive, fine grained
- 2 Organic soils - peats
- 3 Clays - silty clay to clay
- 4 Silt mixtures - clayey silt to silty clay
- 5 Sand mixtures - silty sand to sandy silt
- 6 Sands - clean sand to silty sand
- 7 Gravelly sand to dense sand
- 8 Very stiff sand to clayey sand *
- 9 Very stiff, fine grained *

*Heavily overconsolidated or cemented

CPT-based soil behavior type classification chart by Robertson (1990)

<p>Tonkin + Taylor Exceptional thinking together V2.0</p>	CLIENT	Rotorua Lakes Council	LOCATION	Rotorua	DATE	11/02/2019
	PROJECT	Rotorua Lakefront Redevelopment	JOB NUMBER	1007467.1000	ANALYSED	pemo
	TITLE	1:500 year event ULS	CHECKED		PAGE	11 of 35 pages
	COMMENT					

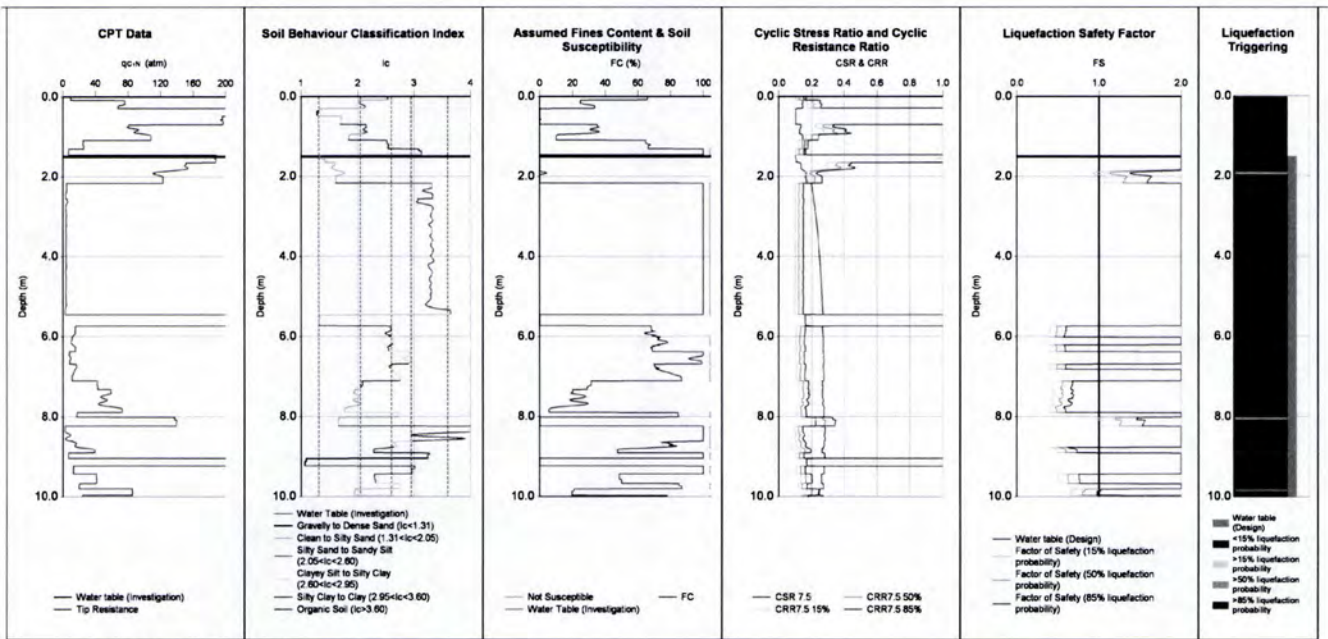


(Assumed pre-drill values)

CPT Name	NZGD ID	Investigation Date	Magnitude	PGA (g)	GWD (m)	Trigger Method	Settlement Method	Pre-drill Depth (m)	qc (MPa)	Fs (MPa)	γ (kN/m ³)
CPT14a	110929	30/07/2018	6	0.3	1.5	BI-2014	ZRB-2002	0	2	0.01	17

Thicker lines represent the 50% probability of exceedance case and the thinner lines to the left and right of the thicker lines represent the 85% and 15% probability of exceedance cases respectively.

<p>Tonkin+Taylor V2.0</p>	<p>Tonkin + Taylor Exceptional thinking together</p>	<p>CLIENT Rotorua Lakes Council</p> <p>PROJECT Rotorua Lakefront Redevelopment</p> <p>TITLE 1:500 year event ULS</p> <p>COMMENT</p>	<p>LOCATION Rotorua</p> <p>JOB NUMBER 1007467.1000</p>	<p>DATE 11/02/2019</p> <p>ANALYSED pemo</p> <p>CHECKED</p> <p>PAGE 12 of 35 pages</p>
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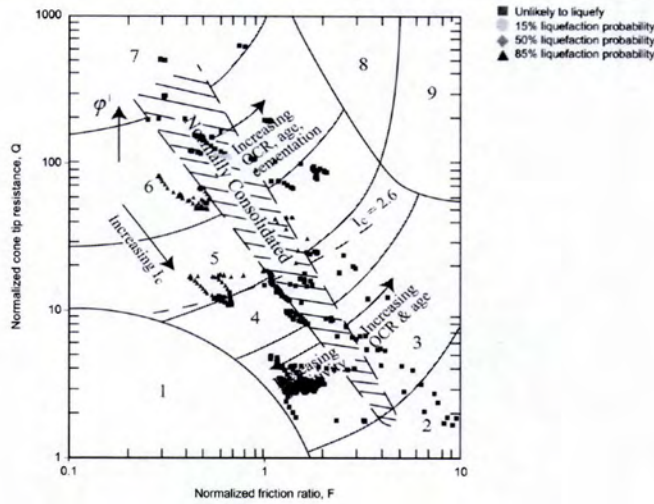


Note: Inverse filtered QoFs data used (10 cm²)

Run Description	NZGD ID	Investigation Date	γ (kN/m ³)	Magnitude	PGA (g)	Trigger Method	Settlement Method	γ (kN/m ³)	Surcharge/Cut/Fill	Surcharge (kPa)	Cut/Fill Height (m)
INPUT	110930	30/07/2018	17	6	0.3	BI-2014	ZRB-2002	17			0
OUTPUT	PL	Sv1d (mm)	CTL (m)	LPI	LSN	CT (m)	LPlish				
	15%	56	2.1	7	8	5.8	4				
	50%	53	1.9	5	8	5.8	0				
	85%	51	1.9	4	7	5.8	0				

Reviewed by:	
CPT Inversion	CDAV
Groundwater	CDAV
Susceptibility	CDAV
Triggering	CDAV
Consequence	CDAV

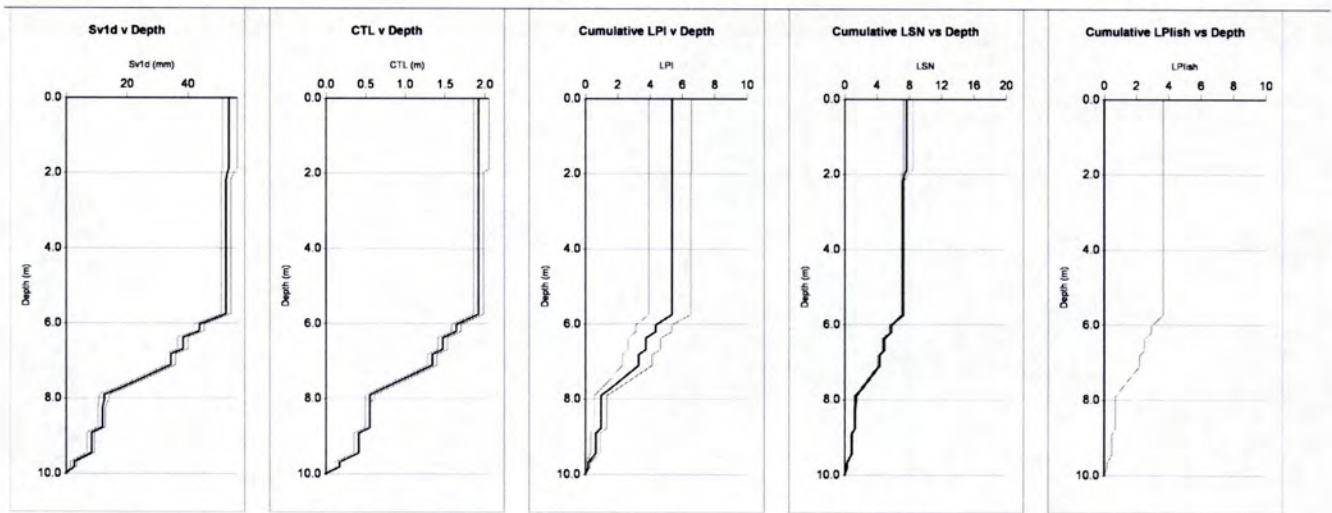
<p>Tonkin+Taylor V2.0</p>	<p>Tonkin + Taylor Exceptional thinking together</p>	<p>CLIENT Rotorua Lakes Council</p> <p>PROJECT Rotorua Lakefront Redevelopment</p> <p>TITLE 1:500 year event ULS</p> <p>COMMENT</p>	<p>LOCATION Rotorua</p> <p>JOB NUMBER 1007467.1000</p>	<p>DATE 11/02/2019</p> <p>ANALYSED pemo</p> <p>CHECKED</p> <p>PAGE 13 of 35 pages</p>
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- 1. Sensitive, fine grained
- 2. Organic soils - peats
- 3. Clays - silty clay to clay
- 4. Silt mixtures - clayey silt to silty clay
- 5. Sand mixtures - silty sand to sandy silt
- 6. Sands - clean sand to silty sand
- 7. Gravely sand to dense sand
- 8. Very stiff sand to clayey sand *
- 9. Very stiff, fine grained *

*Heavily overconsolidated or cemented
 CPT-based soil behavior type classification chart by Robertson (1990)

	Tonkin + Taylor	CLIENT	Rotorua Lakes Council	LOCATION	Rotorua	DATE	11/02/2019
	Exceptional thinking together	PROJECT	Rotorua Lakefront Redevelopment	JOB NUMBER	1007467.1000	ANALYSED	permo
	V2.0	TITLE	1:500 year event ULS	CHECKED		PAGE	14 of 35 pages
		COMMENT					

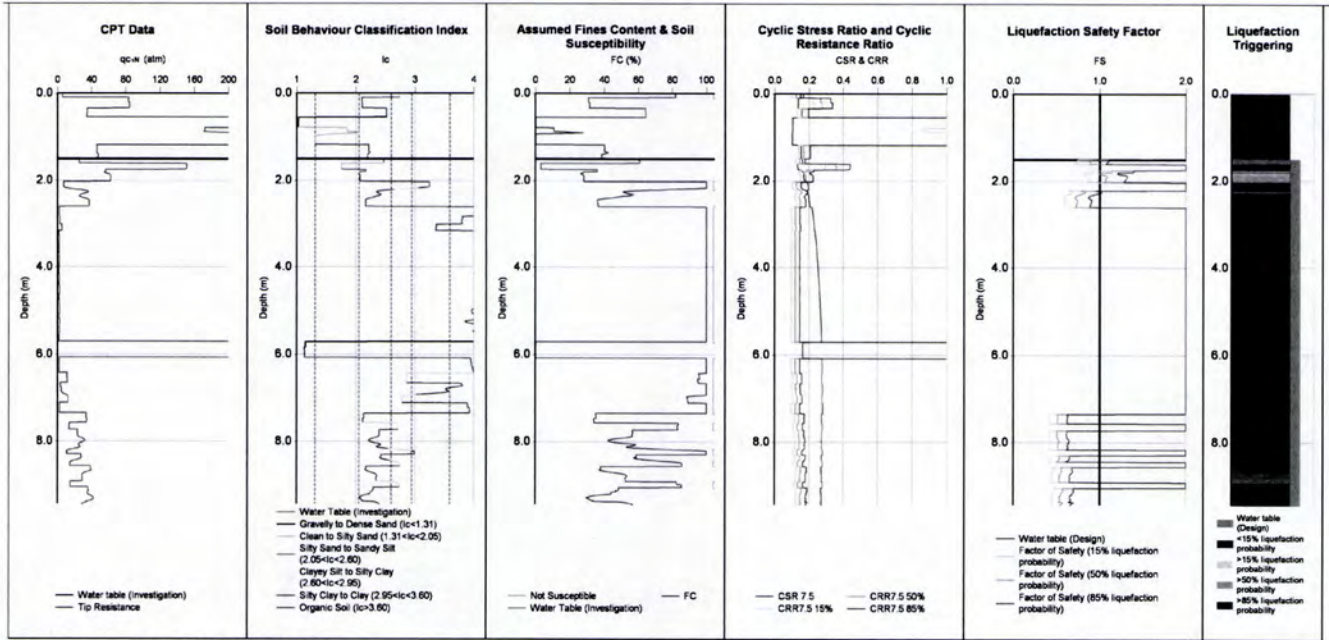


(Assumed pre-drill values)

CPT Name	NZGD ID	Investigation Date	Magnitude	PGA (g)	GWD (m)	Trigger Method	Settlement Method	Pre-drill Depth (m)	qc (MPa)	Fs (MPa)	γ (kN/m³)
CPT15	110930	30/07/2018	6	0.3	1.5	BI-2014	ZRB-2002	0	2	0.01	17

Thicker lines represent the 50% probability of exceedance case and the thinner lines to the left and right of the thicker lines represent the 85% and 15% probability of exceedance cases respectively.

	Tonkin + Taylor	CLIENT	Rotorua Lakes Council	LOCATION	Rotorua	DATE	11/02/2019
	Exceptional thinking together	PROJECT	Rotorua Lakefront Redevelopment	JOB NUMBER	1007467.1000	ANALYSED	permo
	V2.0	TITLE	1:500 year event ULS	CHECKED		PAGE	15 of 35 pages
		COMMENT					



Note: Inverse filtered Q_c/F_s data used (10 cm^2)

Run Description	NZGD ID	Investigation Date	γ (kN/m^3)	Magnitude	PGA (g)	Trigger Method	Settlement Method	γ (kN/m^3)	Surcharge/Cut/Fill	Surcharge (kPa)	Cut/Fill Height (m)
INPUT	110931	30/07/2018	17	6	0.3	BI-2014	ZRB-2002	17			0
OUTPUT	PL	Sv1d (mm)	CTL (m)	LPI	LSN	CT (m)	LPlish				
	15%	61	2.3	7	14	1.6	5				
	50%	57	2.1	5	12	1.6	3				
	85%	52	1.9	3	9	2.4	2				

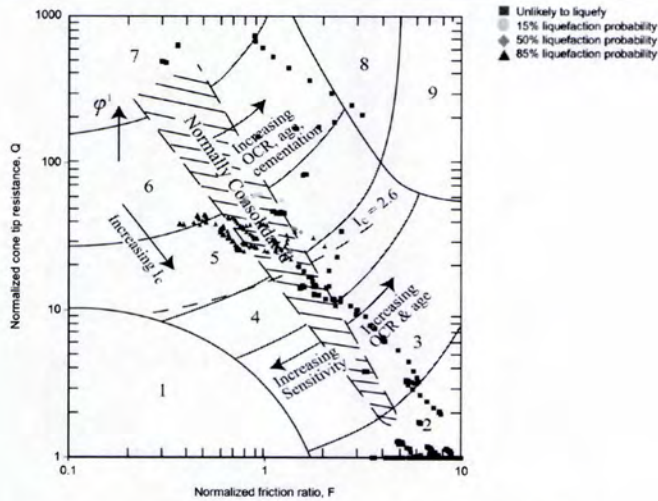
Reviewed by:	
CPT Inversion	CDAV
Groundwater	CDAV
Susceptibility	CDAV
Triggering	CDAV
Consequence	CDAV



Tonkin + Taylor
Exceptional thinking together
V2.0

CLIENT: **Rotorua Lakes Council**
PROJECT: **Rotorua Lakefront Redevelopment**
TITLE: **1:500 year event ULS**

LOCATION: Rotorua
DATE: 11/02/2019
ANALYSED: pemo
JOB NUMBER: 1007467.1000
CHECKED:
PAGE: 16 of 35 pages



- 1. Sensitive, fine grained
- 2. Organic soils - peats
- 3. Clays - silty clay to clay
- 4. Silt mixtures - clayey silt to silty clay
- 5. Sand mixtures - silty sand to sandy silt
- 6. Sands - clean sand to silty sand
- 7. Gravely sand to dense sand
- 8. Very stiff sand to clayey sand *
- 9. Very stiff, fine grained *

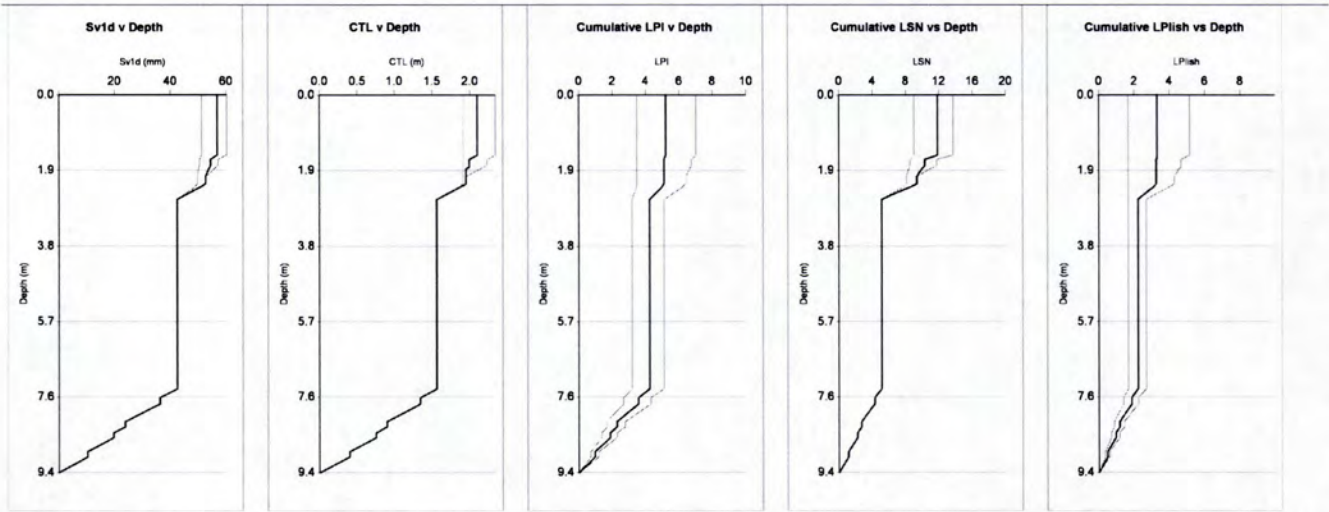
*Heavily overconsolidated or cemented
CPT-based soil behavior type classification chart by Robertson (1990)



Tonkin + Taylor
Exceptional thinking together
V2.0

CLIENT: **Rotorua Lakes Council**
PROJECT: **Rotorua Lakefront Redevelopment**
TITLE: **1:500 year event ULS**

LOCATION: Rotorua
DATE: 11/02/2019
ANALYSED: pemo
JOB NUMBER: 1007467.1000
CHECKED:
PAGE: 17 of 35 pages

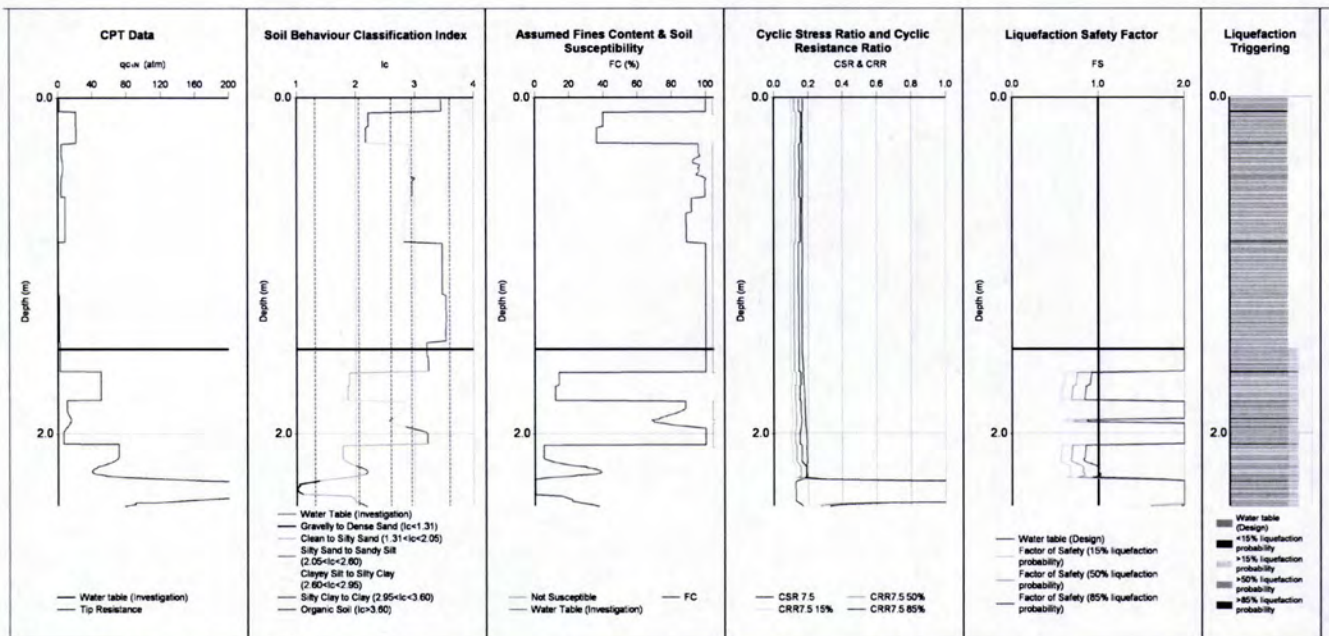


(Assumed pre-drill values)

CPT Name	NZGD ID	Investigation Date	Magnitude	PGA (g)	GWD (m)	Trigger Method	Settlement Method	Pre-drill Depth (m)	qc (MPa)	Fs (MPa)	γ (kN/m ³)
CPT16	110931	30/07/2018	6	0.3	1.5	BI-2014	ZRB-2002	0	2	0.01	17

Thicker lines represent the 50% probability of exceedance case and the thinner lines to the left and right of the thicker lines represent the 85% and 15% probability of exceedance cases respectively

	Tonkin + Taylor Exceptional thinking together V2.0	CLIENT Rotorua Lakes Council	LOCATION Rotorua	DATE 11/02/2019
		PROJECT Rotorua Lakefront Redevelopment 1:500 year event ULS	JOB NUMBER 1007467.1000	ANALYSED pemo
TITLE Rotorua Lakefront Redevelopment 1:500 year event ULS			CHECKED 	PAGE 18 of 35 pages
COMMENT 				



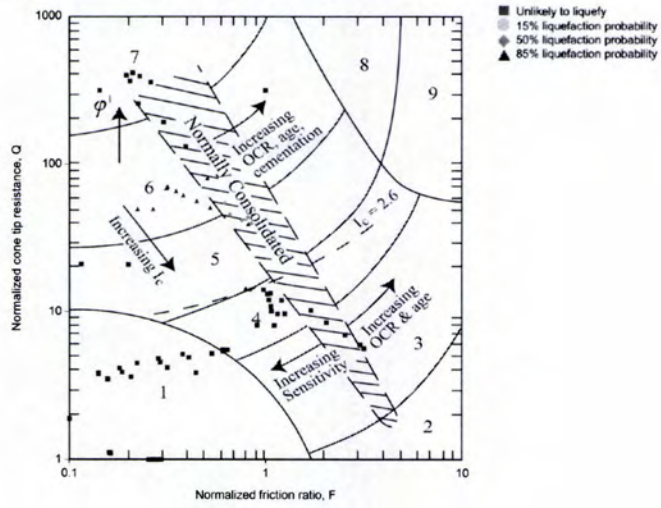
Note: Inverse filtered Qo/Fs data used (10 cm²)

Run Description	NZGD ID	Investigation Date	γ (kN/m ³)	Magnitude	PGA (g)	Trigger Method	Settlement Method	γ (kN/m ³)	Surcharge/Cut/Fill	Surcharge (kPa)	Cut/Fill Height (m)
INPUT	110932	31/07/2018	17	6	0.3	BI-2014	ZRB-2002	17		0	
OUTPUT	PL	Sv1d (mm)	CTL (m)	LPI	LSN	CT (m)	LPlish				
	15%	12	0.4	1	6	1.7	2				
	50%	12	0.4	1	6	1.7	1				
	85%	10	0.3	0	5	1.7	0				

Reviewed by:

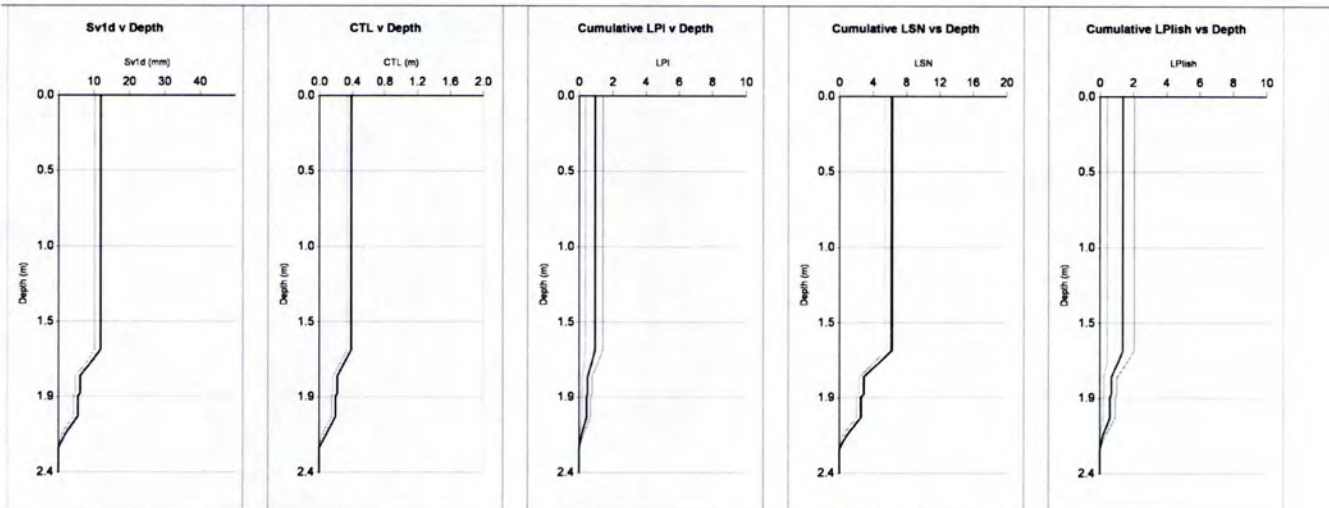
CPT Inversion	CDAV
Groundwater	CDAV
Susceptibility	CDAV
Triggering	CDAV
Consequence	CDAV

	Tonkin + Taylor Exceptional thinking together V2.0	CLIENT Rotorua Lakes Council	LOCATION Rotorua	DATE 11/02/2019
		PROJECT Rotorua Lakefront Redevelopment 1:500 year event ULS	JOB NUMBER 1007467.1000	ANALYSED pemo
TITLE Rotorua Lakefront Redevelopment 1:500 year event ULS			CHECKED 	PAGE 19 of 35 pages
COMMENT 				



- 1. Sensitive, fine grained
 - 2. Organic soils - peats
 - 3. Clays - silty clay to clay
 - 4. Silt mixtures - clayey silt to silty clay
 - 5. Sand mixtures - silty sand to sandy silt
 - 6. Sands - clean sand to silty sand
 - 7. Gravely sand to dense sand
 - 8. Very stiff sand to clayey sand *
 - 9. Very stiff, fine grained *
- *Heavily overconsolidated or cemented
- CPT-based soil behavior type classification chart by Robertson (1990)

	Tonkin + Taylor	CLIENT	Rotorua Lakes Council	LOCATION	Rotorua	DATE	11/02/2019
	Exceptional thinking together	PROJECT	Rotorua Lakefront Redevelopment	JOB NUMBER	1007467.1000	ANALYSED	pemo
	V2.0	TITLE	1:500 year event ULS	CHECKED		PAGE	20 of 35 pages
		COMMENT					

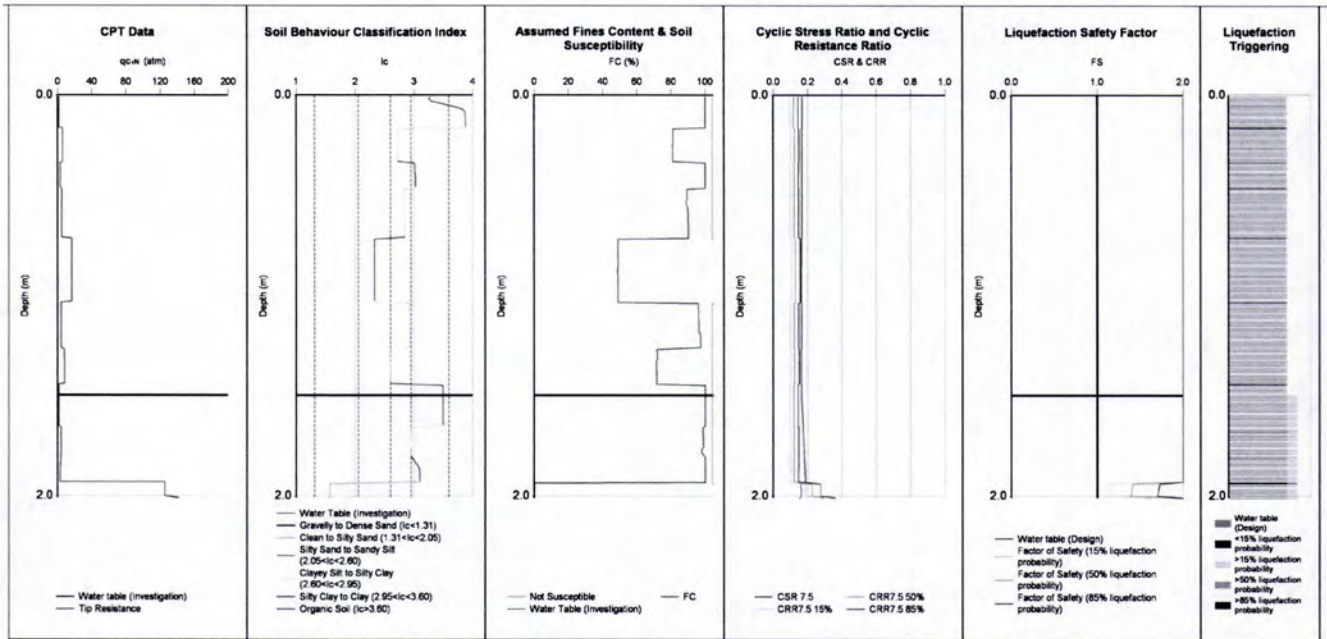


(Assumed pre-drill values)

CPT Name	NZGD ID	Investigation Date	Magnitude	PGA (g)	GWD (m)	Trigger Method	Settlement Method	Pre-drill Depth (m)	qc (MPa)	Fs (MPa)	γ (kN/m³)
CPT17a	110932	31/07/2018	6	0.3	1.5	BI-2014	ZRB-2002	0	2	0.01	17

Thicker lines represent the 50% probability of exceedance case and the thinner lines to the left and right of the thicker lines represent the 85% and 15% probability of exceedance cases respectively.

	Tonkin + Taylor	CLIENT	Rotorua Lakes Council	LOCATION	Rotorua	DATE	11/02/2019
	Exceptional thinking together	PROJECT	Rotorua Lakefront Redevelopment	JOB NUMBER	1007467.1000	ANALYSED	pemo
	V2.0	TITLE	1:500 year event ULS	CHECKED		PAGE	21 of 35 pages
		COMMENT					

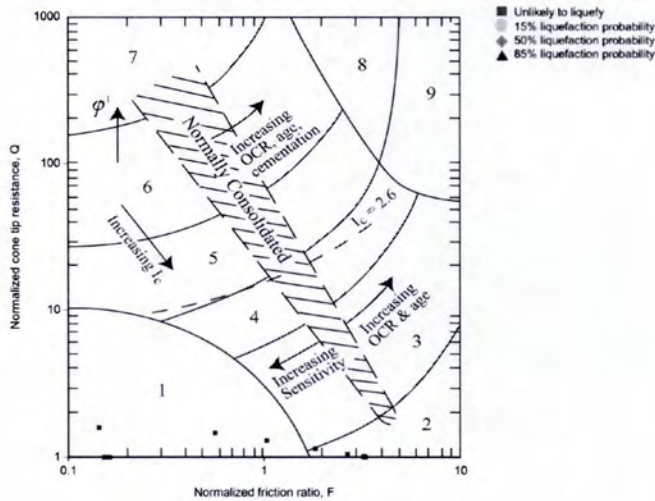


Note: Inverse filtered QcFs data used (10 cm²)

Run Description	NZGD ID	Investigation Date	γ (kN/m ³)	Magnitude	PGA (g)	Trigger Method	Settlement Method	γ (kN/m ³)	Surcharge/Cut/Fill	Surcharge (kPa)	Cut/Fill Height (m)
INPUT	110933	31/07/2018	17	6	0.3	BI-2014	ZRB-2002	17		0	
OUTPUT	PL	Sv1d (mm)	CTL (m)	LPI	LSN	CT (m)	LPIish				
	15%	0	0	0	0	2	0				
	50%	0	0	0	0	2	0				
	85%	0	0	0	0	2	0				

Reviewed by:	
CPT Inversion	CDAV
Groundwater	CDAV
Susceptibility	CDAV
Triggering	CDAV
Consequence	CDAV

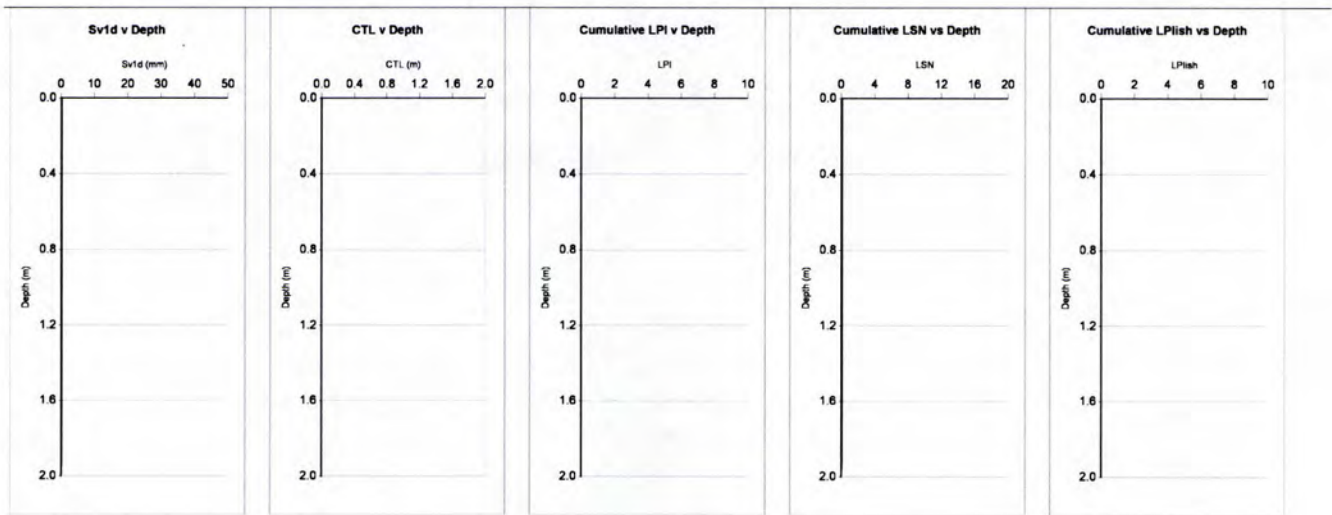
<p>Tonkin + Taylor Exceptional thinking together V2.0</p>	CLIENT	Rotorua Lakes Council	LOCATION	Rotorua	DATE	11/02/2019
	PROJECT	Rotorua Lakefront Redevelopment	JOB NUMBER	1007467.1000	ANALYSED	permo
	TITLE	1:500 year event ULS	CHECKED		PAGE	22 of 35 pages
	COMMENT					



- 1. Sensitive, fine grained
- 2. Organic soils - peats
- 3. Clays - silty clay to clay
- 4. Silt mixtures - clayey silt to silty clay
- 5. Sand mixtures - silty sand to sandy silt
- 6. Sands - clean sand to silty sand
- 7. Gravely sand to dense sand
- 8. Very stiff sand to clayey sand *
- 9. Very stiff, fine grained *

*Heavily overconsolidated or cemented
CPT-based soil behavior type classification chart by Robertson (1990)

<p>Tonkin + Taylor Exceptional thinking together V2.0</p>	CLIENT	Rotorua Lakes Council	LOCATION	Rotorua	DATE	11/02/2019
	PROJECT	Rotorua Lakefront Redevelopment	JOB NUMBER	1007467.1000	ANALYSED	permo
	TITLE	1:500 year event ULS	CHECKED		PAGE	23 of 35 pages
	COMMENT					

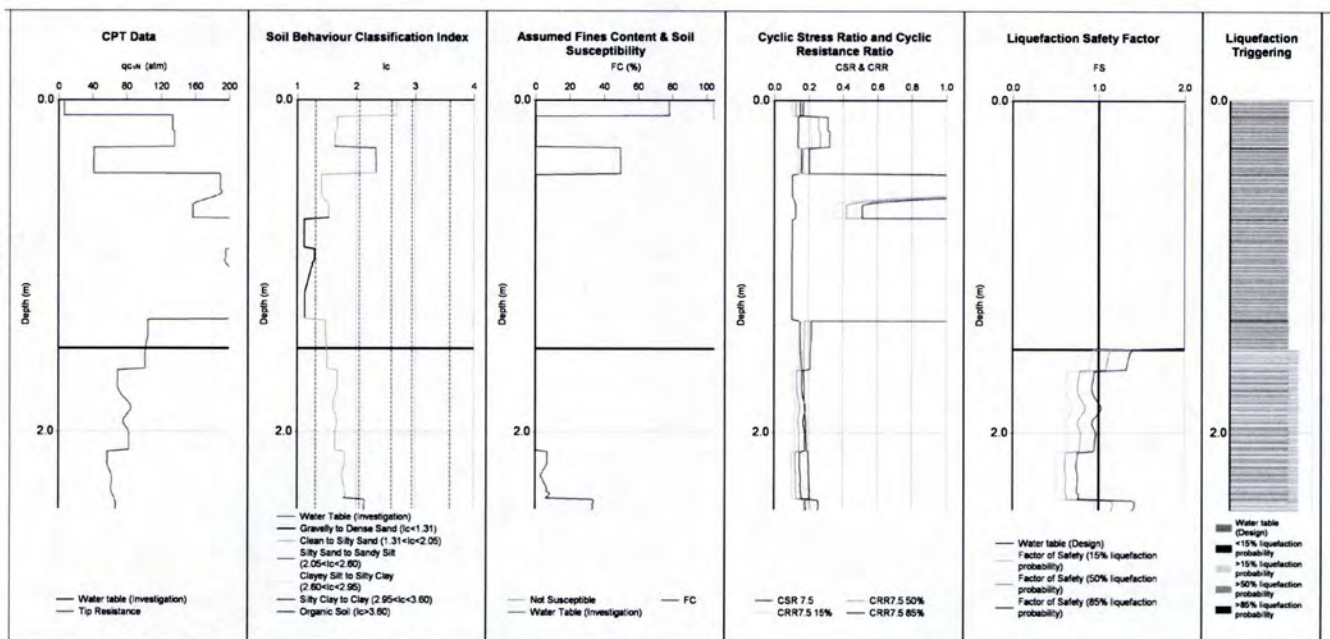


(Assumed pre-drill values)

CPT Name	NZGD ID	Investigation Date	Magnitude	PGA (g)	GWD (m)	Trigger Method	Settlement Method	Pre-drill Depth (m)	qc (MPa)	Fs (MPa)	γ (kN/m ³)
CPT18a	110933	31/07/2018	6	0.3	1.5	BI-2014	ZRB-2002	0	2	0.01	17

Thicker lines represent the 50% probability of exceedence case and the thinner lines to the left and right of the thicker lines represent the 85% and 15% probability of exceedence cases respectively.

	Tonkin + Taylor Exceptional thinking together V2.0	CLIENT Rotorua Lakes Council	PROJECT Rotorua Lakefront Redevelopment 1:500 year event ULS	LOCATION Rotorua	DATE 11/02/2019
		TITLE Rotorua Lakefront Redevelopment 1:500 year event ULS		ANALYSED pemo	
		COMMENT		CHECKED	
			JOB NUMBER 1007467.1000	PAGE 24 of 35 pages	



Note: Inverse filtered Qc/Fs data used (10 cm²)

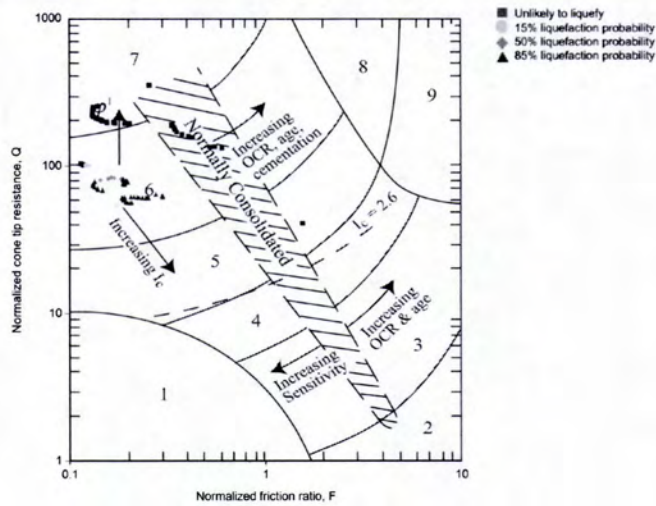
Run Description	NZGD ID	Investigation Date	γ (kN/m ³)	Magnitude	PGA (g)	Trigger Method	Settlement Method	γ (kN/m ³)	Surcharge/Cut/Fill	Surcharge (kPa)	Cut/Fill Height (m)
INPUT	110934	31/07/2018	17	6	0.3	BI-2014	ZRB-2002	17			0

OUTPUT	PL	Sv1d (mm)	CTL (m)	LPI	LSN	CT (m)	LPlish
15%	27	1	3	14	1.6	4	
50%	25	0.8	2	13	1.7	3	
85%	19	0.7	1	9	1.7	1	

Reviewed by:

CPT Inversion	CDAV
Groundwater	CDAV
Susceptibility	CDAV
Triggering	CDAV
Consequence	CDAV

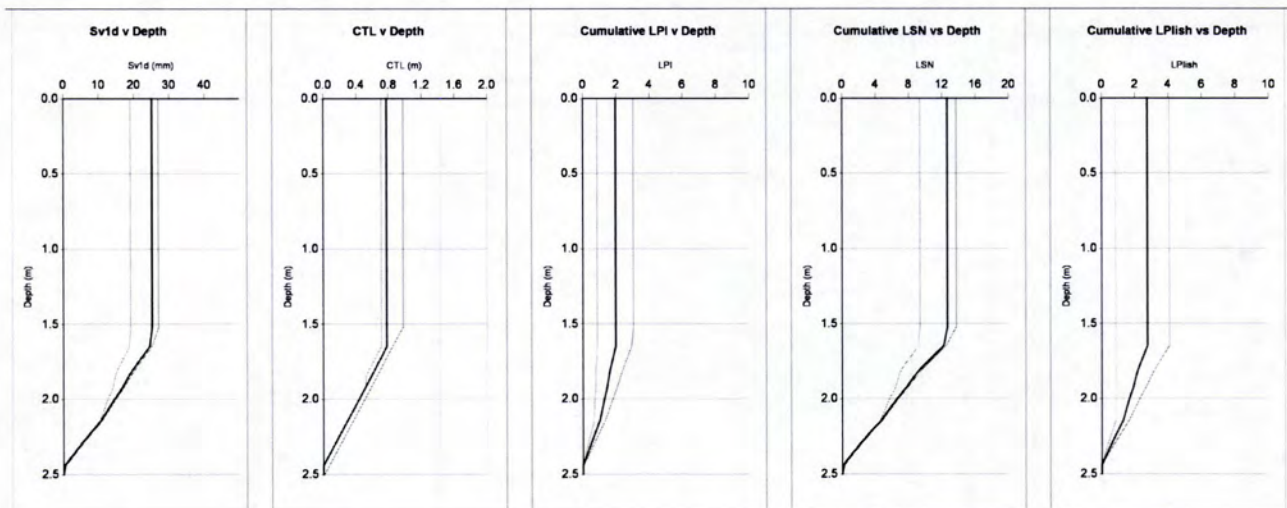
	Tonkin + Taylor Exceptional thinking together V2.0	CLIENT Rotorua Lakes Council	PROJECT Rotorua Lakefront Redevelopment 1:500 year event ULS	LOCATION Rotorua	DATE 11/02/2019
		TITLE Rotorua Lakefront Redevelopment 1:500 year event ULS		ANALYSED pemo	
		COMMENT	JOB NUMBER 1007467.1000	CHECKED	
				PAGE 25 of 35 pages	



- 1. Sensitive, fine grained
- 2. Organic soils - peats
- 3. Clays - silty clay to clay
- 4. Silt mixtures - clayey silt to silty clay
- 5. Sand mixtures - silty sand to sandy silt
- 6. Sands - clean sand to silty sand
- 7. Gravely sand to dense sand
- 8. Very stiff sand to clayey sand *
- 9. Very stiff, fine grained *

*Heavily overconsolidated or cemented
 CPT-based soil behavior type classification chart by Robertson (1990)

	Tonkin + Taylor	CLIENT	Rotorua Lakes Council	LOCATION	Rotorua	DATE	11/02/2019
	Exceptional thinking together	PROJECT	Rotorua Lakefront Redevelopment	JOB NUMBER	1007467.1000	ANALYSED	pemo
	V2.0	TITLE	1:500 year event ULS	CHECKED		PAGE	26 of 35 pages
		COMMENT					

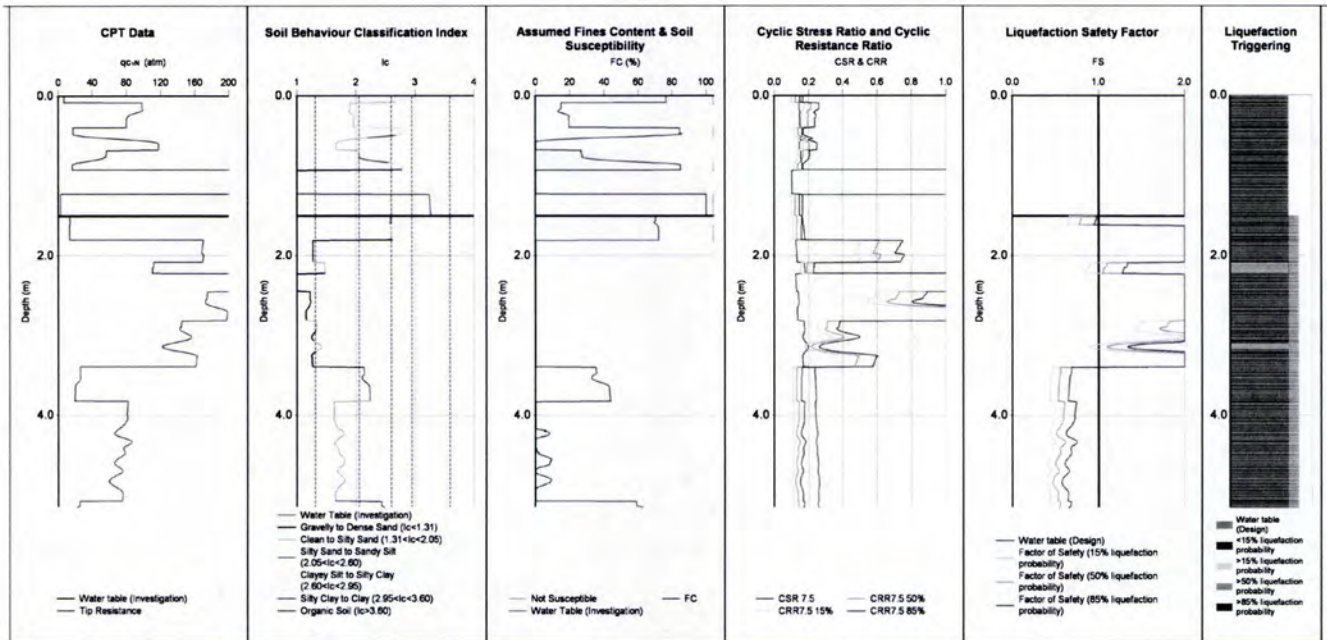


(Assumed pre-drill values)

CPT Name	NZGD ID	Investigation Date	Magnitude	PGA (g)	GWD (m)	Trigger Method	Settlement Method	Pre-drill Depth (m)	qc (MPa)	Fs (MPa)	γ (kN/m³)
CPT19	110934	31/07/2018	6	0.3	1.5	Bi-2014	ZRB-2002	0	2	0.01	17

Thicker lines represent the 50% probability of exceedance case and the thinner lines to the left and right of the thicker lines represent the 85% and 15% probability of exceedance cases respectively.

	Tonkin + Taylor	CLIENT	Rotorua Lakes Council	LOCATION	Rotorua	DATE	11/02/2019
	Exceptional thinking together	PROJECT	Rotorua Lakefront Redevelopment	JOB NUMBER	1007467.1000	ANALYSED	pemo
	V2.0	TITLE	1:500 year event ULS	CHECKED		PAGE	27 of 35 pages
		COMMENT					



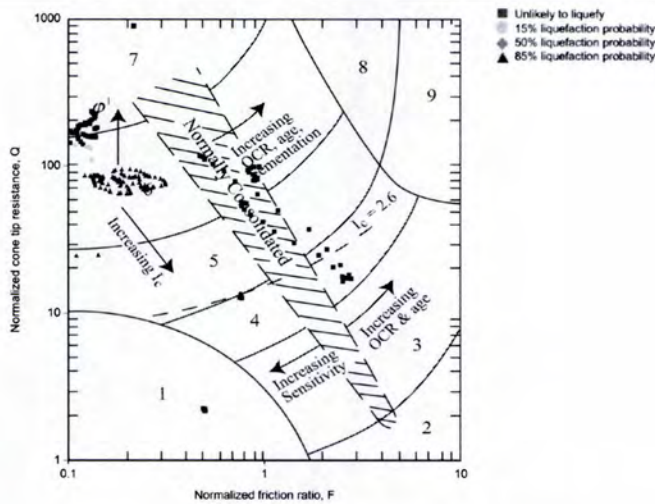
Note: Inverse filtered Qc/Fs data used (10 cm²)

Run Description	NZGD ID	Investigation Date	Magnitude	PGA (g)	Trigger Method	Settlement Method	γ (kN/m ³)	Surcharge/Cut/Fill	Surcharge (kPa)	Cut/Fill Height (m)
INPUT	110935	31/07/2018	17	6	0.3 BI-2014	ZRB-2002	17			0
OUTPUT	PL	Sv1d (mm)	CTL (m)	LPI	LSN	CT (m)	LPlish			
	15%	60	2.1	8	16	1.6	7			
	50%	59	1.9	7	16	1.6	5			
	85%	56	1.9	5	14	1.6	4			

Reviewed by:

CPT Inversion	CDAV
Groundwater	CDAV
Susceptibility	CDAV
Triggering	CDAV
Consequence	CDAV

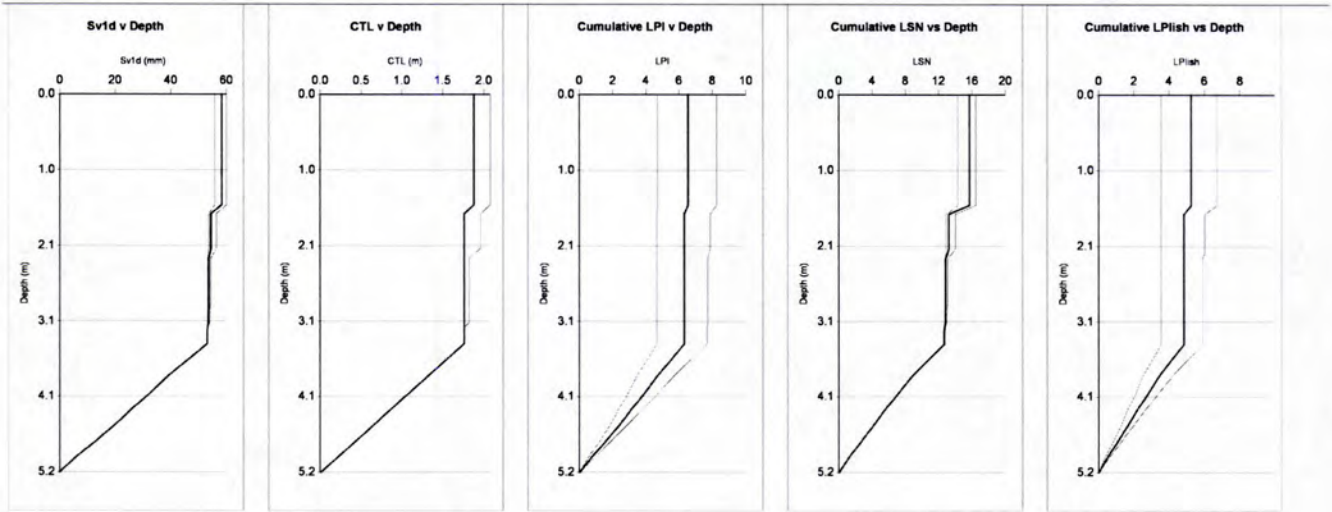
<p>Tonkin + Taylor Exceptional thinking together V2.0</p>	CLIENT	Rotorua Lakes Council	LOCATION	Rotorua	DATE	11/02/2019
	PROJECT	Rotorua Lakefront Redevelopment	JOB NUMBER	1007467.1000	ANALYSED	permo
	TITLE	1:500 year event ULS	CHECKED		PAGE	28 of 35 pages
	COMMENT					



1. Sensitive, fine grained
2. Organic soils - peats
3. Clays - silty clay to clay
4. Silt mixtures - clayey silt to silty clay
5. Sand mixtures - silty sand to sandy silt
6. Sands - clean sand to silty sand
7. Gravelly sand to dense sand
8. Very stiff sand to clayey sand *
9. Very stiff, fine grained *

*Heavily overconsolidated or cemented
 CPT-based soil behavior type classification chart by Robertson (1990)

<p>Tonkin + Taylor Exceptional thinking together V2.0</p>	CLIENT	Rotorua Lakes Council	LOCATION	Rotorua	DATE	11/02/2019
	PROJECT	Rotorua Lakefront Redevelopment	JOB NUMBER	1007467.1000	ANALYSED	permo
	TITLE	1:500 year event ULS	CHECKED		PAGE	29 of 35 pages
	COMMENT					

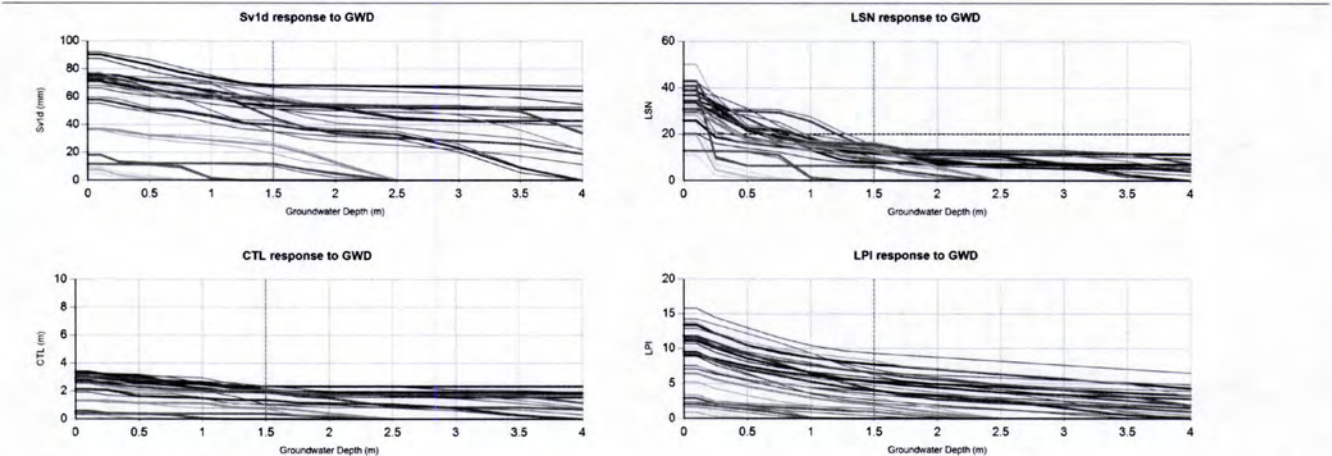


(Assumed pre-drill values)

CPT Name	NZGD ID	Investigation Date	Magnitude	PGA (g)	GWD (m)	Trigger Method	Settlement Method	Pre-drill Depth (m)	qc (MPa)	Fs (MPa)	γ (kN/m ³)
CPT20	110935	31/07/2018	6	0.3	1.5	BI-2014	ZRB-2002	0	2	0.01	17

Thicker lines represent the 50% probability of exceedance case and the thinner lines to the left and right of the thicker lines represent the 85% and 15% probability of exceedance cases respectively.

 Tonkin+Taylor	Tonkin + Taylor Exceptional thinking together V2.0	CLIENT Rotorua Lakes Council	PROJECT Rotorua Lakefront Redevelopment	LOCATION Rotorua	DATE 11/02/2019
		TITLE 1:500 year event ULS		JOB NUMBER 1007467.1000	ANALYSED pemo
					CHECKED
					PAGE 30 of 35 pages



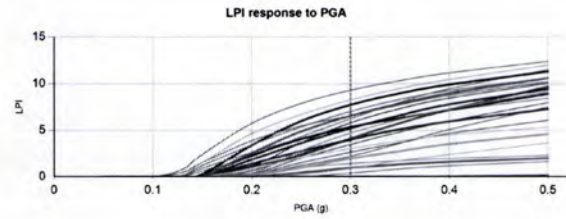
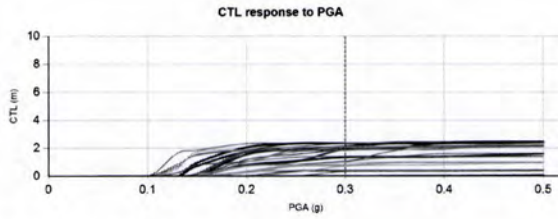
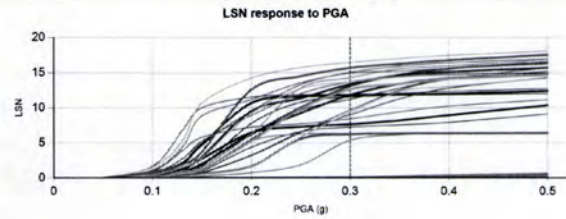
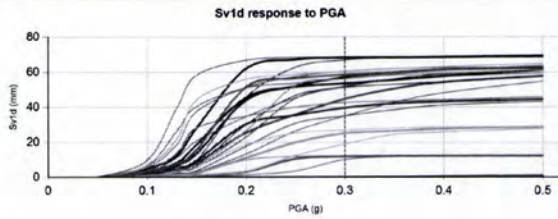
Vertical dotted lines indicate user specified GWD at the CPT locations (actual GWD)

(Assumed pre-drill values)

CPT Name	NZGD ID	Investigation Date	Event and Model (PGA & GWD)	Magnitude	PGA (g)	GWD (m)	Trigger Method	Settlement Method	Pre-drill Depth (m)	qc (MPa)	Fs (MPa)	γ (kN/m ³)
CPT11	110926	1/08/2018	User Specified	6	0.3	1.5	BI-2014	ZRB-2002	0	2	0.01	17
CPT12	110927	30/07/2018	User Specified	6	0.3	1.5	BI-2014	ZRB-2002	0	2	0.01	17
CPT13	110928	31/07/2018	User Specified	6	0.3	1.5	BI-2014	ZRB-2002	0	2	0.01	17
CPT14a	110929	30/07/2018	User Specified	6	0.3	1.5	BI-2014	ZRB-2002	0	2	0.01	17
CPT15	110930	30/07/2018	User Specified	6	0.3	1.5	BI-2014	ZRB-2002	0	2	0.01	17
CPT16	110931	30/07/2018	User Specified	6	0.3	1.5	BI-2014	ZRB-2002	0	2	0.01	17
CPT17a	110932	31/07/2018	User Specified	6	0.3	1.5	BI-2014	ZRB-2002	0	2	0.01	17
CPT18a	110933	31/07/2018	User Specified	6	0.3	1.5	BI-2014	ZRB-2002	0	2	0.01	17
CPT19	110934	31/07/2018	User Specified	6	0.3	1.5	BI-2014	ZRB-2002	0	2	0.01	17
CPT20	110935	31/07/2018	User Specified	6	0.3	1.5	BI-2014	ZRB-2002	0	2	0.01	17

Thicker lines represent the 50% probability of exceedance case and the thinner lines to the bottom and top of the thicker lines represent the 85% and 15% probability of exceedance cases respectively.

 Tonkin+Taylor	Tonkin + Taylor Exceptional thinking together V2.0	CLIENT Rotorua Lakes Council	PROJECT Rotorua Lakefront Redevelopment	LOCATION Rotorua	DATE 11/02/2019
		TITLE 1:500 year event ULS		JOB NUMBER 1007467.1000	ANALYSED pemo
					CHECKED
					PAGE 31 of 35 pages



Vertical dashed lines indicate user specified PGA at the CPT locations (actual PGA)

(Assumed pre-drill values)

CPT Name	NZGD ID	Investigation Date	Event and Model (PGA & GWD)	Magnitude	PGA (g)	GWD (m)	Trigger Method	Settlement Method	Pre-drill Depth (m)	qc (MPa)	Fs (MPa)	γ (kN/m ³)
CPT11	110926	1/08/2018	User Specified	6	0.3	1.5	BI-2014	ZRB-2002	0	2	0.01	17
CPT12	110927	30/07/2018	User Specified	6	0.3	1.5	BI-2014	ZRB-2002	0	2	0.01	17
CPT13	110928	31/07/2018	User Specified	6	0.3	1.5	BI-2014	ZRB-2002	0	2	0.01	17
CPT14a	110929	30/07/2018	User Specified	6	0.3	1.5	BI-2014	ZRB-2002	0	2	0.01	17
CPT15	110930	30/07/2018	User Specified	6	0.3	1.5	BI-2014	ZRB-2002	0	2	0.01	17
CPT16	110931	30/07/2018	User Specified	6	0.3	1.5	BI-2014	ZRB-2002	0	2	0.01	17
CPT17a	110932	31/07/2018	User Specified	6	0.3	1.5	BI-2014	ZRB-2002	0	2	0.01	17
CPT18a	110933	31/07/2018	User Specified	6	0.3	1.5	BI-2014	ZRB-2002	0	2	0.01	17
CPT19	110934	31/07/2018	User Specified	6	0.3	1.5	BI-2014	ZRB-2002	0	2	0.01	17
CPT20	110935	31/07/2018	User Specified	6	0.3	1.5	BI-2014	ZRB-2002	0	2	0.01	17

Thicker lines represent the 50% probability of exceedance case and the thinner lines to the bottom and top of the thicker lines represent the 85% and 15% probability of exceedance cases respectively.

 Tonkin + Taylor Exceptional thinking together V2.0	CLIENT	Rotorua Lakes Council	LOCATION	Rotorua	DATE	11/02/2019
	PROJECT	Rotorua Lakefront Redevelopment	JOB NUMBER	1007467.1000	ANALYSED	peho
	TITLE	1:500 year event ULS	CHECKED		PAGE	32 of 35 pages
	COMMENT					

The inputs listed in Table 1.1-1 below have been adopted for the liquefaction analysis.


Table 1.1-1 Summary of inputs for liquefaction analysis

NZ	110926	110927	110928	110929	110930	110931
CPT Name	05TT08_CPT11	05TT08_CPT12	05TT08_CPT13	05TT08_CPT14 a	05TT08_CPT15	05TT08_CPT16
PGA	0.3g	0.3g	0.3g	0.3g	0.3g	0.3g
Magnitude	6	6	6	6	6	6
Depth to groundwater	1.5m	1.5m	1.5m	1.5m	1.5m	1.5m
Pre-drill depth	0m	0m	0m	0m	0m	0m
Assumed pre-drill tip resistance and skin friction	qc= 2MPa & Fs= 0.01MPa	qc= 2MPa & Fs= 0.01MPa	qc= 2MPa & Fs= 0.01MPa	qc= 2MPa & Fs= 0.01MPa	qc= 2MPa & Fs= 0.01MPa	qc= 2MPa & Fs= 0.01MPa
Trigger method	Boulanger & Idriss (2014)	Boulanger & Idriss (2014)	Boulanger & Idriss (2014)	Boulanger & Idriss (2014)	Boulanger & Idriss (2014)	Boulanger & Idriss (2014)
Settlement method	Zhang, Robertson & Brachman (2002)	Zhang, Robertson & Brachman (2002)	Zhang, Robertson & Brachman (2002)	Zhang, Robertson & Brachman (2002)	Zhang, Robertson & Brachman (2002)	Zhang, Robertson & Brachman (2002)
CFC	0	0	0	0	0	0
Total depth of CPT	5.31m	7.05m	3.84m	1.3m	11.18m	9.44m
Minimum depth of analysis	0m	0m	0m	0m	0m	0m
Maximum depth of analysis	10m	10m	10m	10m	10m	10m
RL	0	0	0	0	0	0


CPT	From Depth (m)		To Depth (m)	
	lc from (m)	lc to (m)	lc from (m)	lc to (m)
117903	0	0	0	0
117903	0	10	2.6	2.6
117904	0	0	0	0
117904	0	10	2.6	2.6
117905	0	0	0	0
117905	0	10	2.6	2.6
117906	0	0	0	0
117906	0	10	2.6	2.6
117907	0	0	0	0
117907	0	10	2.6	2.6
117908	0	0	0	0
117908	0	10	2.6	2.6
117909	0	0	0	0
117909	0	10	2.6	2.6
117910	0	0	0	0
117910	0	10	2.6	2.6
117911	0	0	0	0
117911	0	10	2.6	2.6
117912	0	0	0	0
117912	0	10	2.6	2.6
	Fc from (m)	Fc to (m)	Fc from (m)	Fc to (m)
117903	0	10	0	0
117904	0	10	0	0
117905	0	10	0	0
117906	0	10	0	0
117907	0	10	0	0

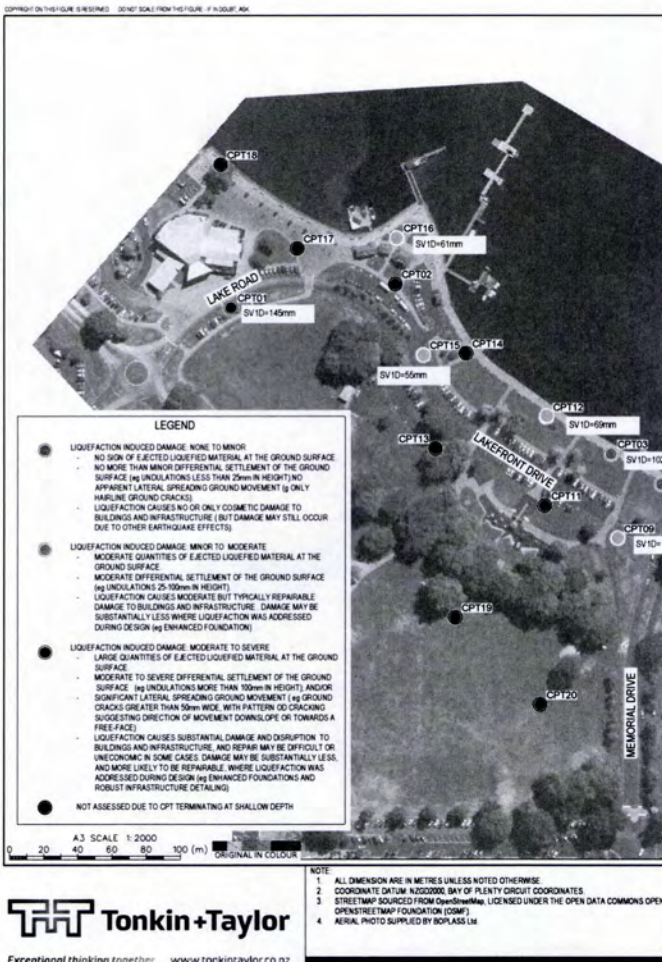
 Tonkin + Taylor Exceptional thinking together V2.0	CLIENT	Rotorua Lakes Council	LOCATION	Rotorua	DATE	11/02/2019
	PROJECT	Rotorua Lakefront Redevelopment	JOB NUMBER	1007467.1000	ANALYSED	peho
	TITLE	1:500 year event ULS	CHECKED		PAGE	33 of 35 pages
	COMMENT					

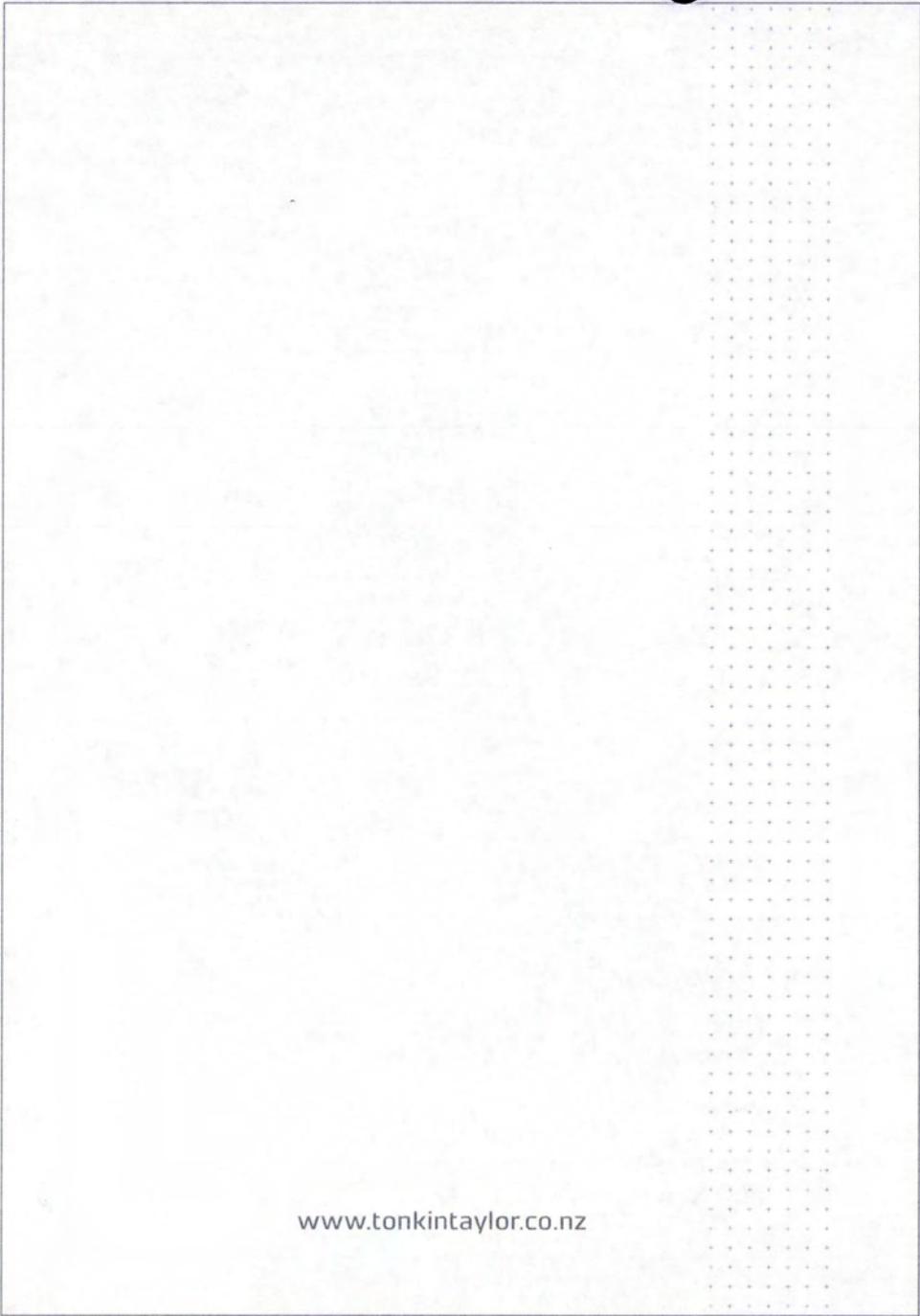
110932	110933	110934	110935
05T108_CPT17 a	05T108_CPT18 a	05T108_CPT19	05T108_CPT20
0.3g	0.3g	0.3g	0.3g
6	6	6	6
1.5m	1.5m	1.5m	1.5m
0m	0m	0m	0m
qc= 2MPa & Fs= 0.01MPa	qc= 2MPa & Fs= 0.01MPa	qc= 2MPa & Fs= 0.01MPa	qc= 2MPa & Fs= 0.01MPa
Boulanger & Idriss (2014)	Boulanger & Idriss (2014)	Boulanger & Idriss (2014)	Boulanger & Idriss (2014)
Zhang, Robertson & Brachman (2002)	Zhang, Robertson & Brachman (2002)	Zhang, Robertson & Brachman (2002)	Zhang, Robertson & Brachman (2002)
0	0	0	0
2.43m	2.01m	2.47m	5.15m
0m	0m	0m	0m
10m	10m	10m	10m
0	0	0	0

 Tonkin+Taylor	Tonkin + Taylor Exceptional thinking together V2.0	CLIENT	Rotorua Lakes Council	LOCATION	Rotorua	DATE	11/02/2019
		PROJECT	Rotorua Lakefront Redevelopment			ANALYSED	permo
		TITLE	1:500 year event ULS	JOB NUMBER	1007467.1000	CHECKED	
		COMMENT				PAGE	34 of 35 pages

117908	0	10	0
117909	0	10	0
117910	0	10	0
117911	0	10	0
117912	0	10	0

 Tonkin+Taylor	Tonkin + Taylor Exceptional thinking together V2.0	CLIENT	Rotorua Lakes Council	LOCATION	Rotorua	DATE	11/02/2019
		PROJECT	Rotorua Lakefront Redevelopment			ANALYSED	permo
		TITLE	1:500 year event ULS	JOB NUMBER	1007467.1000	CHECKED	
		COMMENT				PAGE	35 of 35 pages

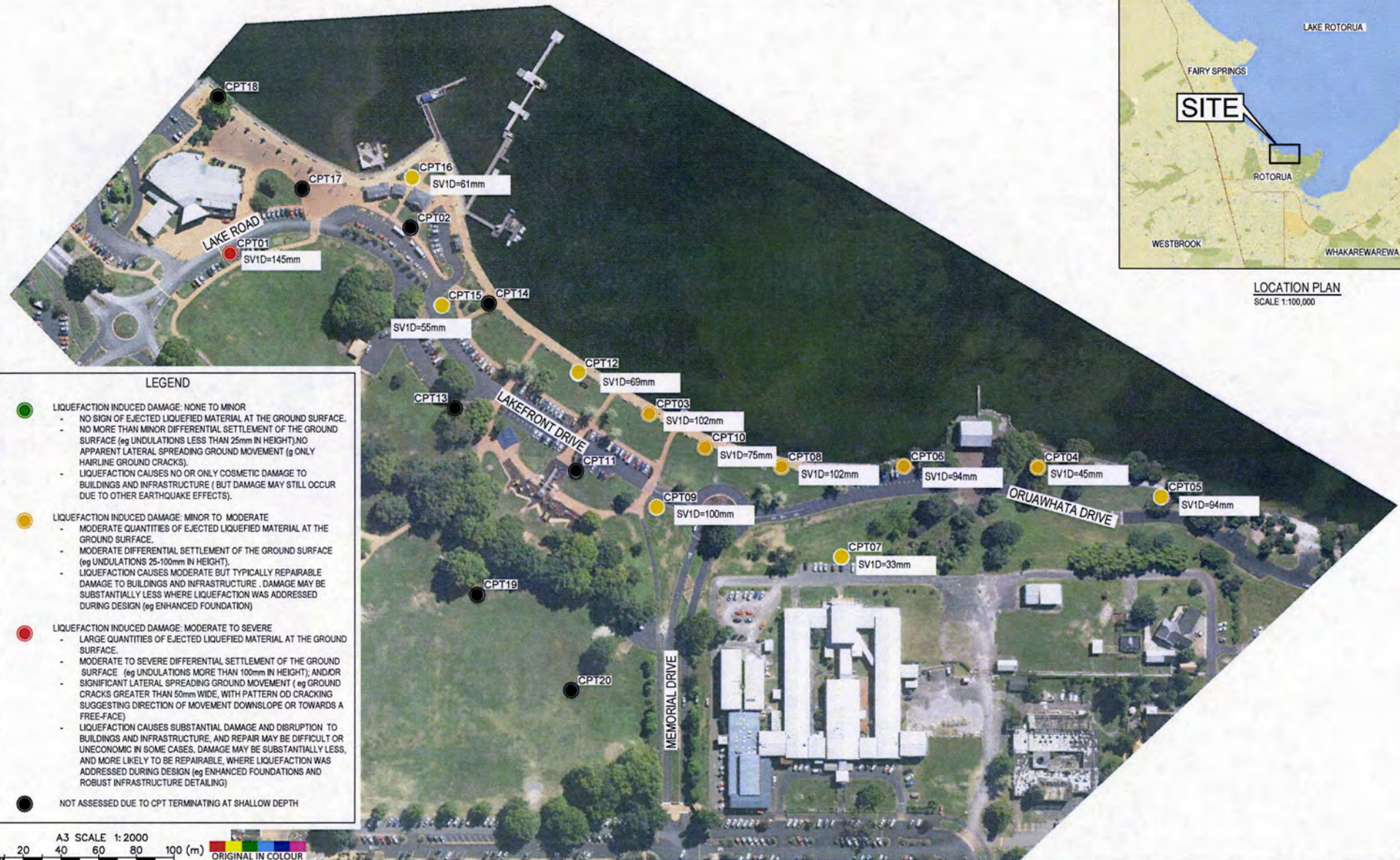




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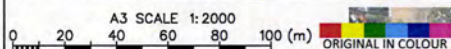


LOCATION PLAN
SCALE 1:100,000



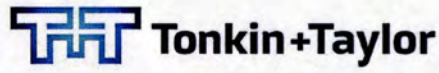
LEGEND

- LIQUEFACTION INDUCED DAMAGE: NONE TO MINOR
 - NO SIGN OF EJECTED LIQUEFIED MATERIAL AT THE GROUND SURFACE.
 - NO MORE THAN MINOR DIFFERENTIAL SETTLEMENT OF THE GROUND SURFACE (eg UNDULATIONS LESS THAN 25mm IN HEIGHT), NO APPARENT LATERAL SPREADING GROUND MOVEMENT (g ONLY HAIRLINE GROUND CRACKS).
 - LIQUEFACTION CAUSES NO OR ONLY COSMETIC DAMAGE TO BUILDINGS AND INFRASTRUCTURE (BUT DAMAGE MAY STILL OCCUR DUE TO OTHER EARTHQUAKE EFFECTS).
- LIQUEFACTION INDUCED DAMAGE: MINOR TO MODERATE
 - MODERATE QUANTITIES OF EJECTED LIQUEFIED MATERIAL AT THE GROUND SURFACE.
 - MODERATE DIFFERENTIAL SETTLEMENT OF THE GROUND SURFACE (eg UNDULATIONS 25-100mm IN HEIGHT).
 - LIQUEFACTION CAUSES MODERATE BUT TYPICALLY REPAIRABLE DAMAGE TO BUILDINGS AND INFRASTRUCTURE. DAMAGE MAY BE SUBSTANTIALLY LESS WHERE LIQUEFACTION WAS ADDRESSED DURING DESIGN (eg ENHANCED FOUNDATION)
- LIQUEFACTION INDUCED DAMAGE: MODERATE TO SEVERE
 - LARGE QUANTITIES OF EJECTED LIQUEFIED MATERIAL AT THE GROUND SURFACE.
 - MODERATE TO SEVERE DIFFERENTIAL SETTLEMENT OF THE GROUND SURFACE (eg UNDULATIONS MORE THAN 100mm IN HEIGHT), AND/OR SIGNIFICANT LATERAL SPREADING GROUND MOVEMENT (eg GROUND CRACKS GREATER THAN 50mm WIDE, WITH PATTERN OF CRACKING SUGGESTING DIRECTION OF MOVEMENT DOWNSLOPE OR TOWARDS A FREE-FACE)
 - LIQUEFACTION CAUSES SUBSTANTIAL DAMAGE AND DISRUPTION TO BUILDINGS AND INFRASTRUCTURE, AND REPAIR MAY BE DIFFICULT OR UNECONOMIC IN SOME CASES. DAMAGE MAY BE SUBSTANTIALLY LESS, AND MORE LIKELY TO BE REPAIRABLE, WHERE LIQUEFACTION WAS ADDRESSED DURING DESIGN (eg ENHANCED FOUNDATIONS AND ROBUST INFRASTRUCTURE DETAILING)
- NOT ASSESSED DUE TO CPT TERMINATING AT SHALLOW DEPTH



NOTE:

1. ALL DIMENSION ARE IN METRES UNLESS NOTED OTHERWISE.
2. COORDINATE DATUM: NZGD2000, BAY OF PLENTY CIRCUIT COORDINATES.
3. STREETMAP SOURCED FROM OpenStreetMap, LICENSED UNDER THE OPEN DATA COMMONS OPEN DATABASE LICENSE (ODBL) BY THE OPENSTREETMAP FOUNDATION (OSMF).
4. AERIAL PHOTO SUPPLIED BY BOPLASS Ltd.

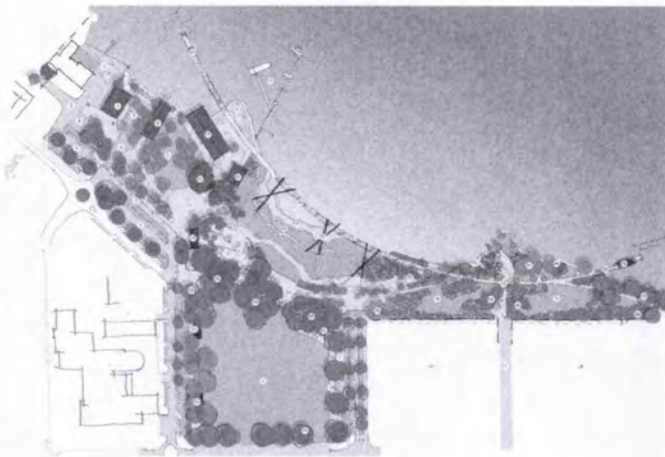


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PROJECT No. 1007467.3000		
DESIGNED	PEMO	Oct 18
DRAWN	JC	Oct 18
CHECKED		
APPROVED	DATE	

CLIENT	ROTORUA LAKES COUNCIL	
PROJECT	ROTORUA LAKEFRONT REDEVELOPMENT	
TITLE	GEOTECHNICAL INVESTIGATION ULS 1/500-YEAR VULNERABILITY PLAN	
SCALE (A3)	1:2000	FIG No. GEO-FIGURE 3
REV	1	

Rotorua Lakefront
Rotorua CBD



Lighting Calculation Drawings

Detailed Design

Sheet Number	Sheet Name	Current Revision
L00	Lighting Title Sheet	
L01	Lakefront Overview	
L02	Stage One Overview	
L03	Stage One & Overview	
L04	Horizontal Luminaire Access & Luminaire Schedule	
L05	Horizontal Luminaire Pathway 1 of 3	
L06	Horizontal Luminaire Pathway 2 of 3	
L07	Horizontal Luminaire Pathway 3 of 3	
L08	Horizontal Luminaire Pathway Calculation Summary	
L09	Vertical Luminaire Pathway 1 of 3	
L10	Vertical Luminaire Pathway 2 of 3	
L11	Vertical Luminaire Pathway 3 of 3	
L12	Vertical Luminaire Pathway Calculation Summary	
L13	Vertical Luminaire Pathway 1 of 3	
L14	Vertical Luminaire Pathway 2 of 3	
L15	Vertical Luminaire Pathway Calculation Summary	
L20	Luminaire Schedule - Boardwalk, Takutuku Bridge & Pavilion	
L21	Horizontal Luminaire Access Boardwalk, Takutuku Bridge & Pavilion	
L22	Horizontal Luminaire Boardwalk, Takutuku Bridge & Pavilion	
L23	Vertical Luminaire Boardwalk, Takutuku Bridge & Pavilion	
L24	Vertical Luminaire Boardwalk, Takutuku Bridge & Pavilion	
L25	Horizontal Luminaire Boardwalk, Takutuku Bridge & Pavilion Calculation Summary	
L26	Vertical Luminaire Boardwalk, Takutuku Bridge & Pavilion Calculation Summary	
L27	Lighting Renders	

Scale of Note:
Drawing is for information purposes
only. do not scale off drawing.

No	Description	Date

SCALE OF NOTE
Detailed Design

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101 Eglam Street
Rotorua, New Zealand

PROJECT
Rotorua Lakefront

FILE
Lighting Title Sheet

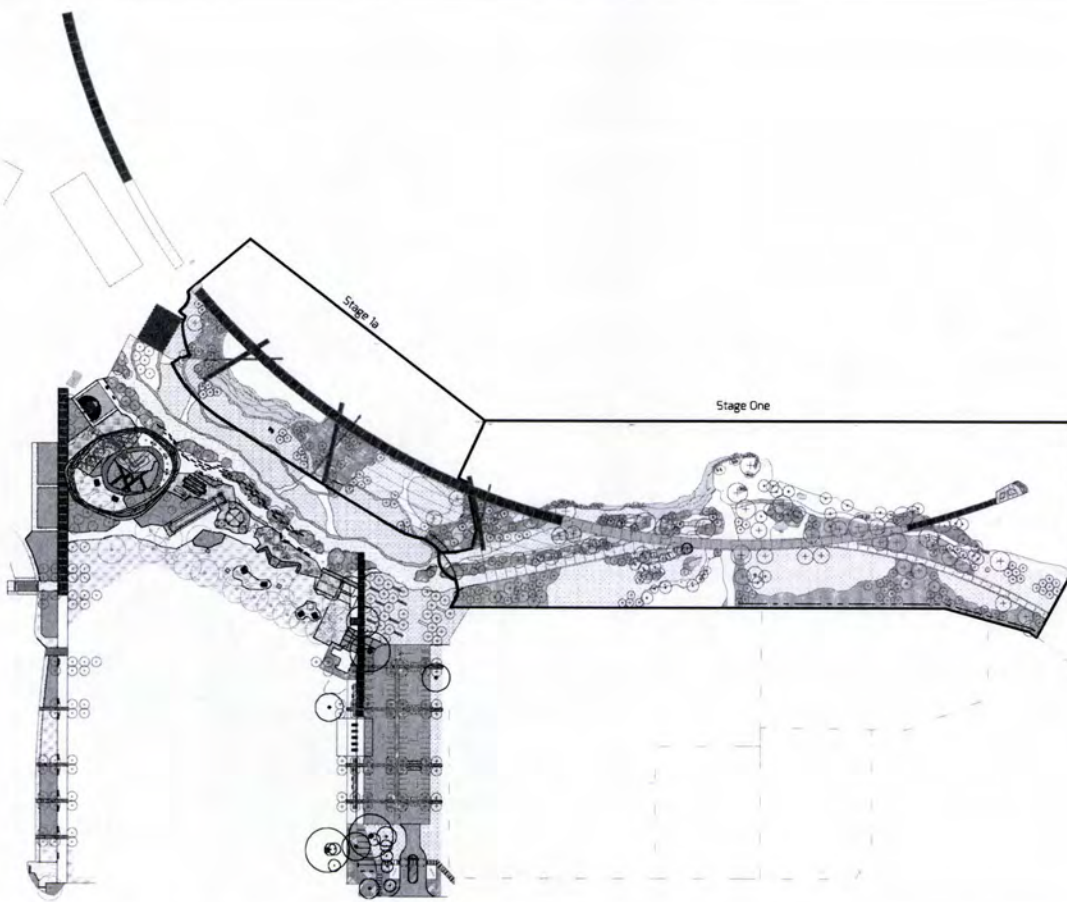
CLIENT
Rotorua Lakes Council

DRAWN BY: BW REVIEWED BY: RB DATE: 21.02.2019

SCALE 1:1000 PROJECT NUMBER: S1B-037

DRAWING NUMBER: **S1B-037- L00** 1/27

21/02/2019 9:16:42 AM



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No	Description	Date

SCALE OF NOTE
Detailed Design

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101 Eglam Street
Rotorua, New Zealand

PROJECT
Rotorua Lakefront

FILE
Lakefront Overview

CLIENT
Rotorua Lakes Council

DRAWN BY: BW REVIEWED BY: BW DATE: 21.02.2019

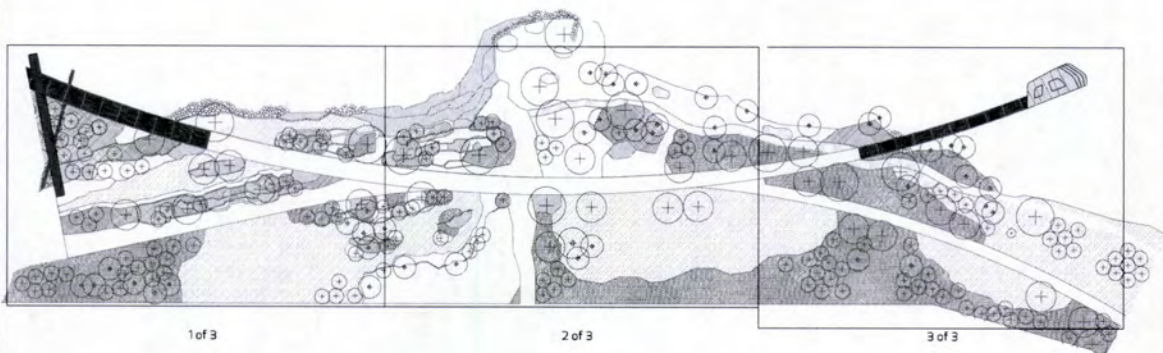
SCALE 1:1000 PROJECT NUMBER: S1B-037

DRAWING NUMBER: **S1B-037- L01** 1/27

21/02/2019 9:16:42 AM

General Note:
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Stage 1



1 of 3

2 of 3

3 of 3

Rev	Description	Date

PHASE OF WORK
Detailed Design

CONSULTANT
SEG CONSULTANTS
CORPORATE UNIT 1
11, BROADWAY CENTRE
ROTORUA 3100

PROJECT
Rotorua Lakefront

STAGE
Stage One Overview

CLIENT
Rotorua Lakes Council

DRAWN BY: BW REVIEWED BY: RB DATE: 21.02.2019

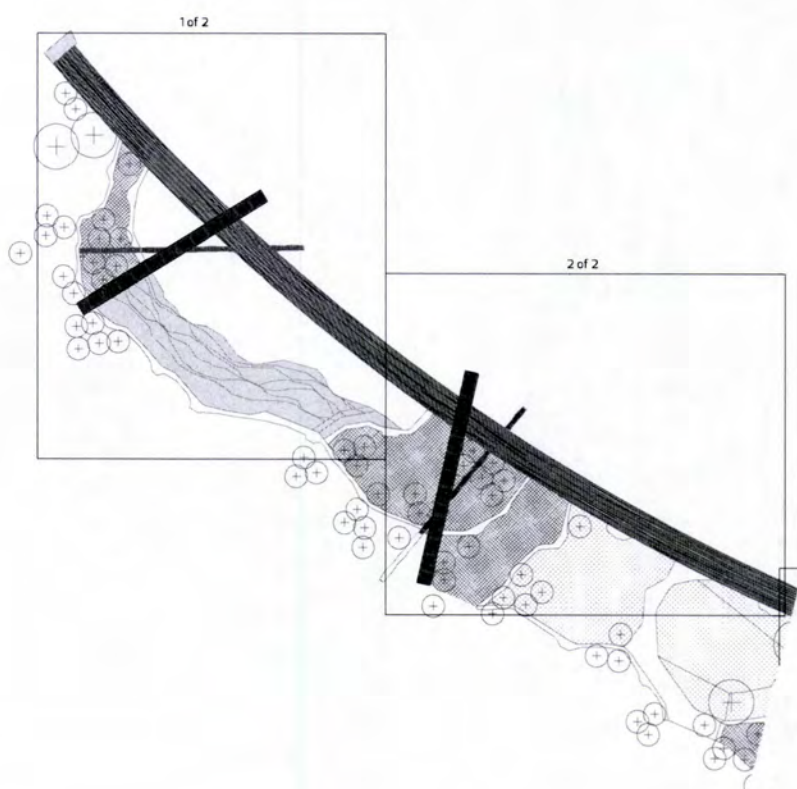
SCALE (SHEET): 1:450 PROJECT NUMBER: S18-037

DRAWING NUMBER: S18-037-L02 REV: 001

27/02/2019 9:16:52 AM

General Note:
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Stage 1A



1 of 2

2 of 2

Rev	Description	Date

PHASE OF WORK
Detailed Design

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CORPORATE UNIT 1
11, BROADWAY CENTRE
ROTORUA 3100

PROJECT
Rotorua Lakefront

STAGE
Stage One A Overview

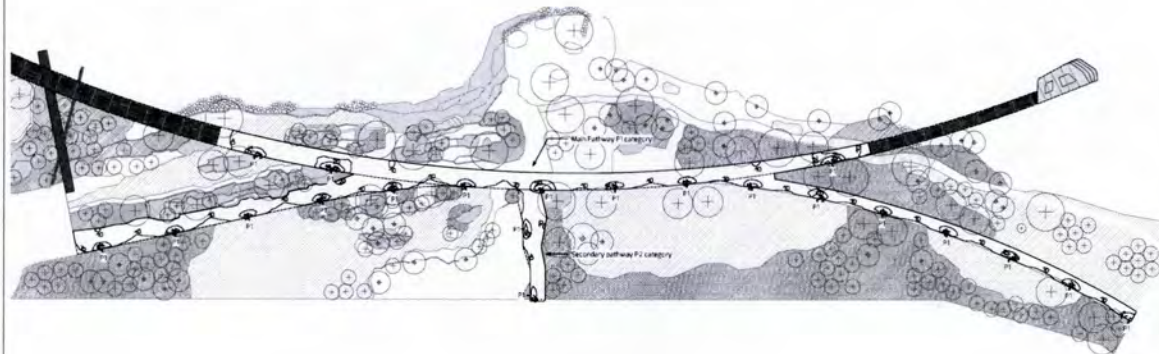
CLIENT
Rotorua Lakes Council

DRAWN BY: BW REVIEWED BY: BW DATE: 21.02.2019

SCALE (SHEET): 1:300 PROJECT NUMBER: S18-037

DRAWING NUMBER: S18-037-L03 REV: 001

27/02/2019 9:16:54 AM



Luminaire parts list									
Item	Manufacturer	Luminaire type	Item number	Fitting	Luminaire flux	Light loss factor	Connected load	Mounting height	Quantity
P1	AEC ILLUMINAZIONE SRL	MOD 2.0 URBAN 200 0F2H 805 3 7-2M	MOD 2.0 URBAN 200 0F2H 805 3 7-2M	T4 - MOD 0F2H1-3000-700-2M-70-25	4380 lm	0.83	36 W	6000mm	21



- Notes:**
- Lighting along main pathway to meet Category P1 under NZS 1593.3.1
 - Lighting along secondary pathways designed to meet Category P2 under NZS 1593.3.1
 - Footcandle level measured at a height of 6m
 - Trees to be relocated to suit pole locations, underground conduits and draw off locations.

General Note:
Drawing is for information purposes
only, do not scale off drawing

Rev	Description	Date

PROJECT: Rotorua Lakefront

FILE: Horizontal Illuminance Isolines & Luminaire Schedule

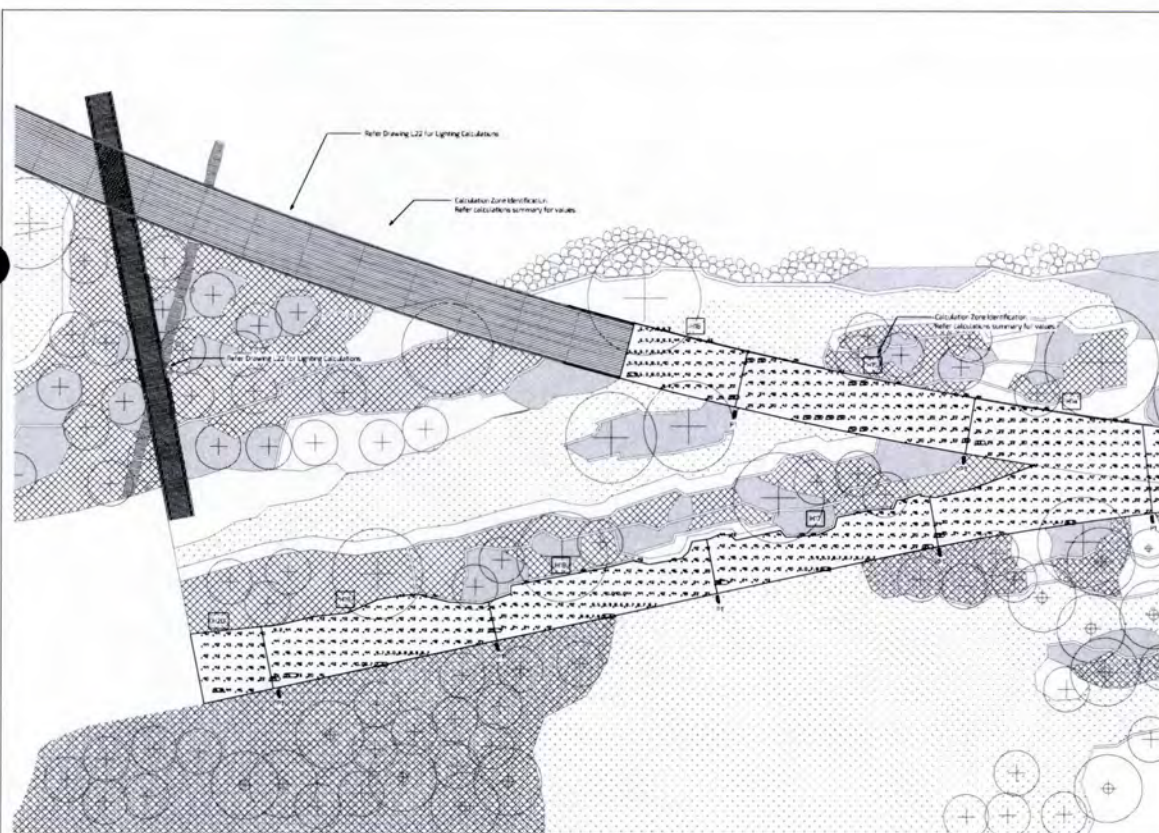
CLIENT: Rotorua Lakes Council

DESIGNED BY: BW CHECKED BY: RB DATE: 21.02.2019

SCALE (SHEET): As indicated PROJECT NUMBER: 518-037

DRAWING NUMBER: 518-037-LD4 1/21

7:02/2019 9:14:50 AM



- Notes:**
- Lighting along main pathway to meet Category P1 under NZS 1593.3.1
 - Lighting along secondary pathways designed to meet Category P2 under NZS 1593.3.1
 - Footcandle level measured at a height of 6m
 - Trees to be relocated to suit pole locations, underground conduits and draw off locations.

General Note:
Drawing is for information purposes
only, do not scale off drawing

Rev	Description	Date

PROJECT: Rotorua Lakefront

FILE: Horizontal Illuminance Pathway 1 of 3

CLIENT: Rotorua Lakes Council

DESIGNED BY: BW CHECKED BY: RB DATE: 21.02.2019

SCALE (SHEET): 1:150 PROJECT NUMBER: 518-037

DRAWING NUMBER: 518-037-L05 1/21

7:02/2019 9:14:50 AM

General Note:
Drawings are for information purposes
only & not to be off drawing

No	Description	Date

PROJECT OF TITLE
Detailed Design

CONSULTANT
SEG 108.611 Lane 6,
P.O. Box 100, Te Anau, South
Island, New Zealand

PROJECT
Rotorua Lakefront

FILE
Horizontal Illuminance Pathway 2 of 3

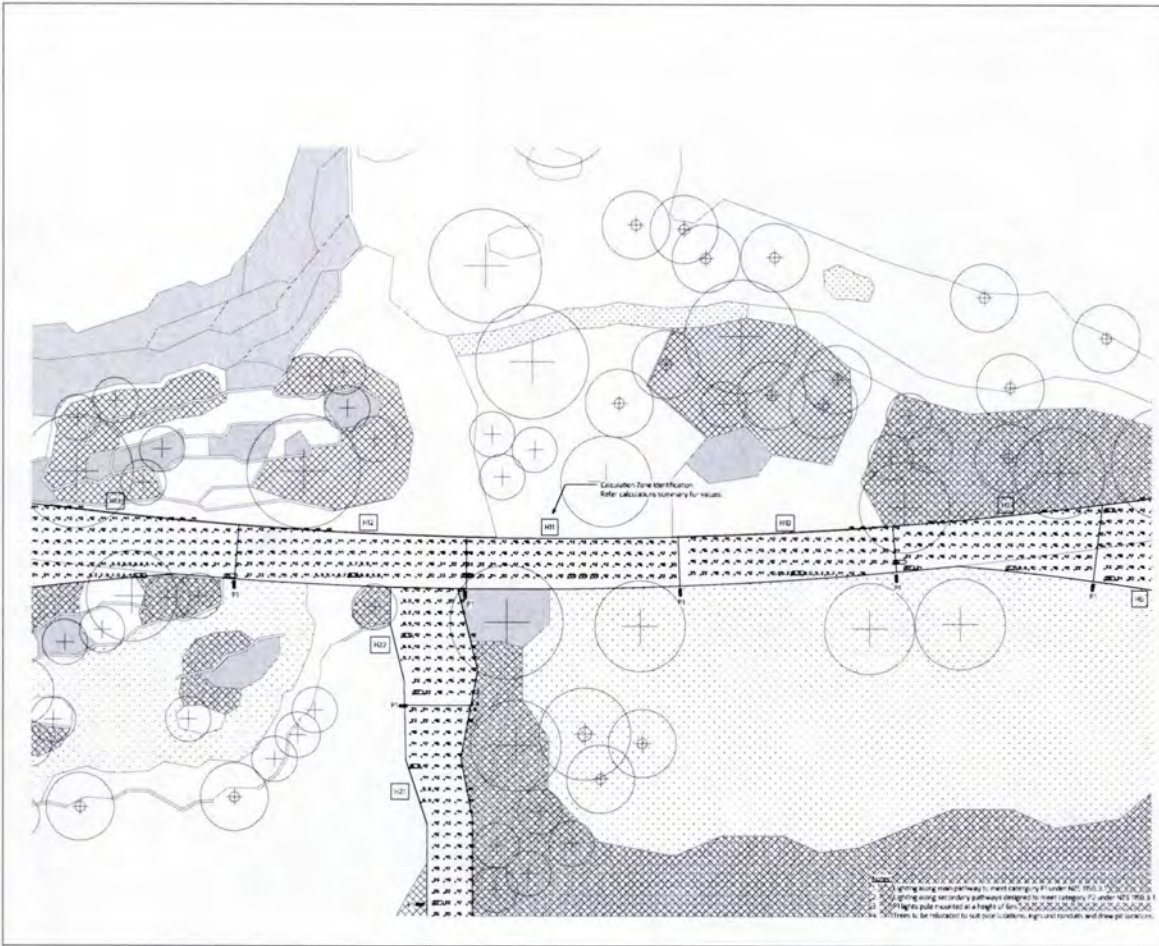
CLIENT
Rotorua Lakes Council

ISSUED BY: **RB** REVIEWED BY: **RB** DATE: **21.02.2019**

TITLE (B/E): **1 - ISO** PROJECT NUMBER: **518-037**

DRAWING NUMBER: **518-037-L06** REV: **001**

21/02/2019 3:16:30 PM



General Note:
Drawings are for information purposes
only & not to be off drawing

No	Description	Date

PROJECT OF TITLE
Detailed Design

CONSULTANT
SEG 108.611 Lane 6,
P.O. Box 100, Te Anau, South
Island, New Zealand

PROJECT
Rotorua Lakefront

FILE
Horizontal Illuminance Pathway 3 of 3

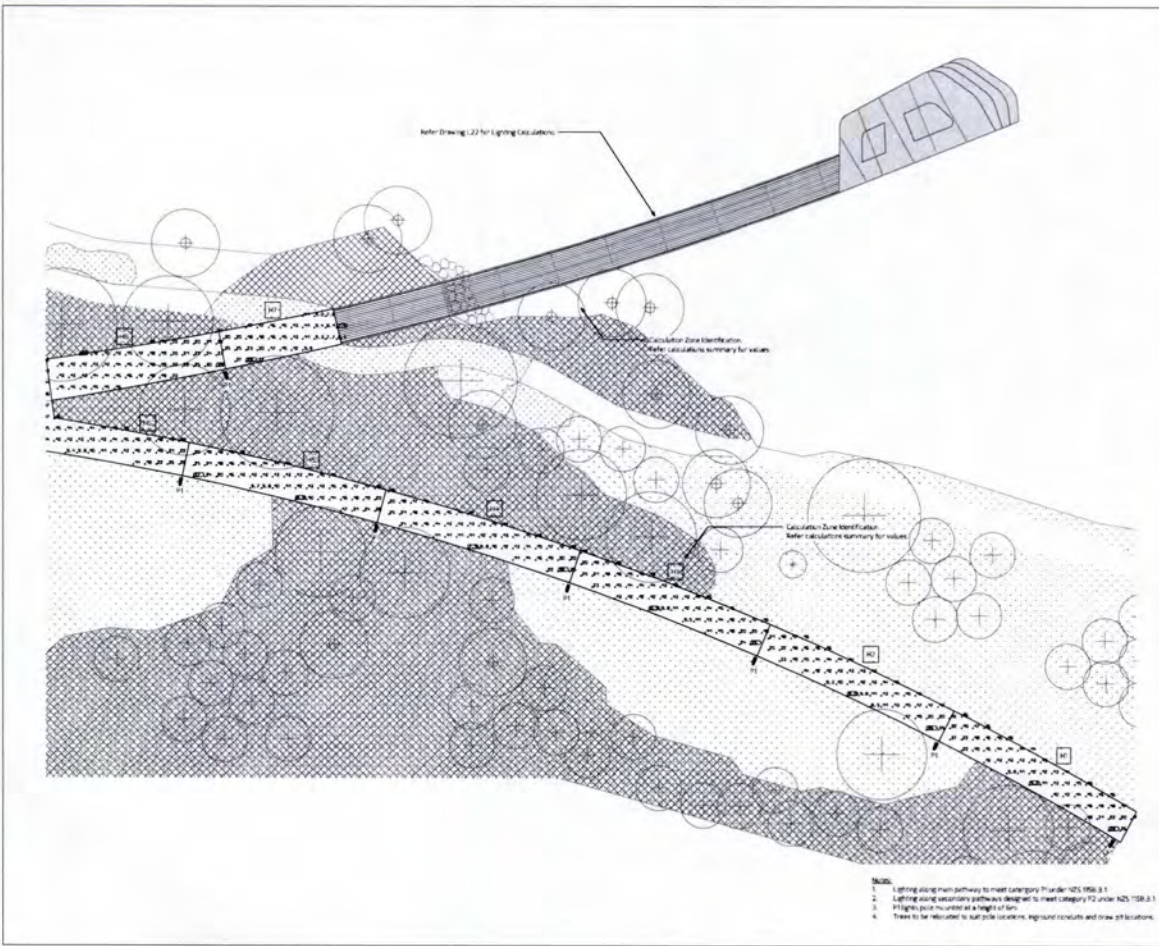
CLIENT
Rotorua Lakes Council

ISSUED BY: **RB** REVIEWED BY: **RB** DATE: **21.02.2019**

TITLE (B/E): **1 - ISO** PROJECT NUMBER: **518-037**

DRAWING NUMBER: **518-037-L07** REV: **001**

21/02/2019 3:16:30 PM



- Notes:
1. Lighting along main pathway to meet category 'P' under NZS 1595.3.1
 2. Lighting along secondary pathways designed to meet category 'P2' under NZS 1595.3.1
 3. P1 lights pole mounted at a height of 6m.
 4. Trees to be relocated to suit site conditions, ground contours and show pit locations.

Table 2.1: Horizontal Illuminance Results Table

#	Calculation Area	Parameter	Min (lx)	Max	Average (lx)	Min:Max	Max:Average	Min:Max
1	H1	Horizontal Illuminance	9.71 lx	27.4 lx	15.7 lx	0.59	1.79	0.34
2	H2	Horizontal Illuminance	8.89 lx	26.5 lx	15.5 lx	0.57	1.70	0.34
3	H3	Horizontal Illuminance	7.91 lx	25.5 lx	15.4 lx	0.51	1.65	0.31
4	H4	Horizontal Illuminance	8.77 lx	26.7 lx	15.9 lx	0.55	1.67	0.33
5	H5	Horizontal Illuminance	10.9 lx	33.8 lx	17.5 lx	0.62	1.93	0.32
6	H6	Horizontal Illuminance	8.00 lx	25.8 lx	15.5 lx	0.52	1.66	0.31
7	H7	Horizontal Illuminance	9.81 lx	25.3 lx	13.7 lx	0.72	1.84	0.39
8	H8	Horizontal Illuminance	7.74 lx	27.4 lx	14.8 lx	0.52	1.65	0.28
9	H9	Horizontal Illuminance	7.55 lx	26.3 lx	15.5 lx	0.48	1.60	0.27
10	H10	Horizontal Illuminance	8.85 lx	26.5 lx	14.5 lx	0.61	1.75	0.34
11	H11	Horizontal Illuminance	11.1 lx	29.3 lx	15.9 lx	0.70	1.83	0.38
12	H12	Horizontal Illuminance	8.27 lx	27.0 lx	15.6 lx	0.53	1.73	0.31
13	H13	Horizontal Illuminance	8.84 lx	28.0 lx	14.7 lx	0.59	1.90	0.31
14	H14	Horizontal Illuminance	5.92 lx	25.1 lx	13.6 lx	0.43	1.84	0.24
15	H15	Horizontal Illuminance	8.22 lx	32.8 lx	16.8 lx	0.48	1.95	0.25
16	H16	Horizontal Illuminance	7.57 lx	24.9 lx	13.9 lx	0.54	1.79	0.30
17	H17	Horizontal Illuminance	11.7 lx	33.5 lx	16.8 lx	0.70	1.95	0.36
18	H18	Horizontal Illuminance	8.43 lx	27.8 lx	15.3 lx	0.44	1.76	0.19
19	H19	Horizontal Illuminance	6.78 lx	25.4 lx	14.6 lx	0.46	1.73	0.27
20	H20	Horizontal Illuminance	9.17 lx	27.5 lx	15.9 lx	0.56	1.72	0.33
21	H21	Horizontal Illuminance	6.72 lx	26.2 lx	14.0 lx	0.48	1.87	0.28
22	H22	Horizontal Illuminance	8.48 lx	27.0 lx	14.6 lx	0.58	1.84	0.31

Calculation Parameters:

- Calculations to AS/NZS 1582:2005 Computer procedures for the calculation of light technical parameters for Category V and Category P lighting for outdoor road lighting.
- Software is version 5.11.4 (AS/NZS Lighting Calculation Software).
- Surface reflectance factor is accordance with the manufacturer's recommendations for 2017 ambient and 900000 Fluores - D83 and ceiling in accordance with AS/NZS 1582:2005 Table F1 assuming reflectance factor of 24 month coating (D83) resulting in a total maintenance factor of 0.83. There are a few considerations when looking at the lighting levels. They are as follows: (taken) from "Road Lighting for roads and streets" performance metrics.
- Safety** - Pedestrians must be safe. Surface lighting ensures that pedestrians do not get tripped. Pedestrians should be able to see clearly of their own free will. Pedestrians should be able to see the physical terrain without the help of their physical vision. To increase the level of safety, lighting for pedestrian safety is recommended to be provided by lighting the sidewalk, walkway, and other pedestrian in flow.
 - Lighting for roads and public spaces, part 1: Lighting for roads and public spaces.
 - Lighting for roads and public spaces, part 2: Pedestrian area lighting.
- Personal safety & security** - Public lighting has a primary purpose to ensure that pedestrians can see the physical terrain without the help of their physical vision. Pedestrians should be able to see clearly of their own free will. Pedestrians should be able to see the physical terrain without the help of their physical vision. To increase the level of safety, lighting for pedestrian safety is recommended to be provided by lighting the sidewalk, walkway, and other pedestrian in flow.
 - Lighting for roads and public spaces, part 1: Lighting for roads and public spaces.
 - Lighting for roads and public spaces, part 2: Pedestrian area lighting.
- Attention** - Attraction to lighting has a positive effect on pedestrian safety and security. It is not just the lighting that matters, but the way it is used. Attention to lighting has a positive effect on pedestrian safety and security. It is not just the lighting that matters, but the way it is used. Attention to lighting has a positive effect on pedestrian safety and security. It is not just the lighting that matters, but the way it is used.

TABLE 2.6
VALUES OF LIGHT TECHNICAL PARAMETERS AND PERMISSIBLE LUMINAIRE TYPES FOR ROADS IN LOCAL AREAS AND FOR PATHWAYS

Lighting category	Light technical parameters				Permissible luminaire type (see Table 2.16)
	Average horizontal illuminance ^a (E _h) lux	Point horizontal illuminance ^b (E _p) lux	Uniformity (E _{min} /E _{max}) ^c	Point vertical illuminance ^d (E _v) lux	
P1	7	2	0.6	2	Type 4
P2	1.5	0.7	0.6	0.7	Type 4 or 5
P2*	8.75	0.3	0.6	0.4*	Type 3, 4, 4 or 6
P2**	8.5	0.3	0.6	N/A	Type 3, 4 or 6
P2**	8.5	0.3	0.6	N/A	Type 3, 4 or 6

TABLE 2.2
LIGHTING CATEGORIES FOR PATHWAYS (INCLUDING CYCLEWAYS)

General description	Reference criteria ^a				Applicable lighting category
	Basic operating characteristics	Pedestrian cycle activity	Risk of crime ^b	Need to enhance prestige	
Pedestrian on cycle oriented pathways, e.g. secondary paths, including those along local roads ^c and "shared use" multi-use lanes, park paths, cycleways	Pedestrian/cycle only	N/A	High	Low	P1*
		High	Medium	High	P2*
		Medium	Low	Medium	P1
		Low	Low	N/A	P4

General Note:
Drawing set for information purposes only. Do not include off drawing.

Rev	Description	Date

PHASE OF WORK
Detailed Design

CONSULTANT
SEG CONSULTANTS
10810 Lakeshore Drive, Suite 100
Richmond, BC V6X 4A7

PROJECT
Rotorua Lakefront

FILE
Horizontal Illuminance Pathway Calculation Summary

CLIENT
Rotorua Lakes Council

DESIGNED BY
RB

REVISED BY
RB

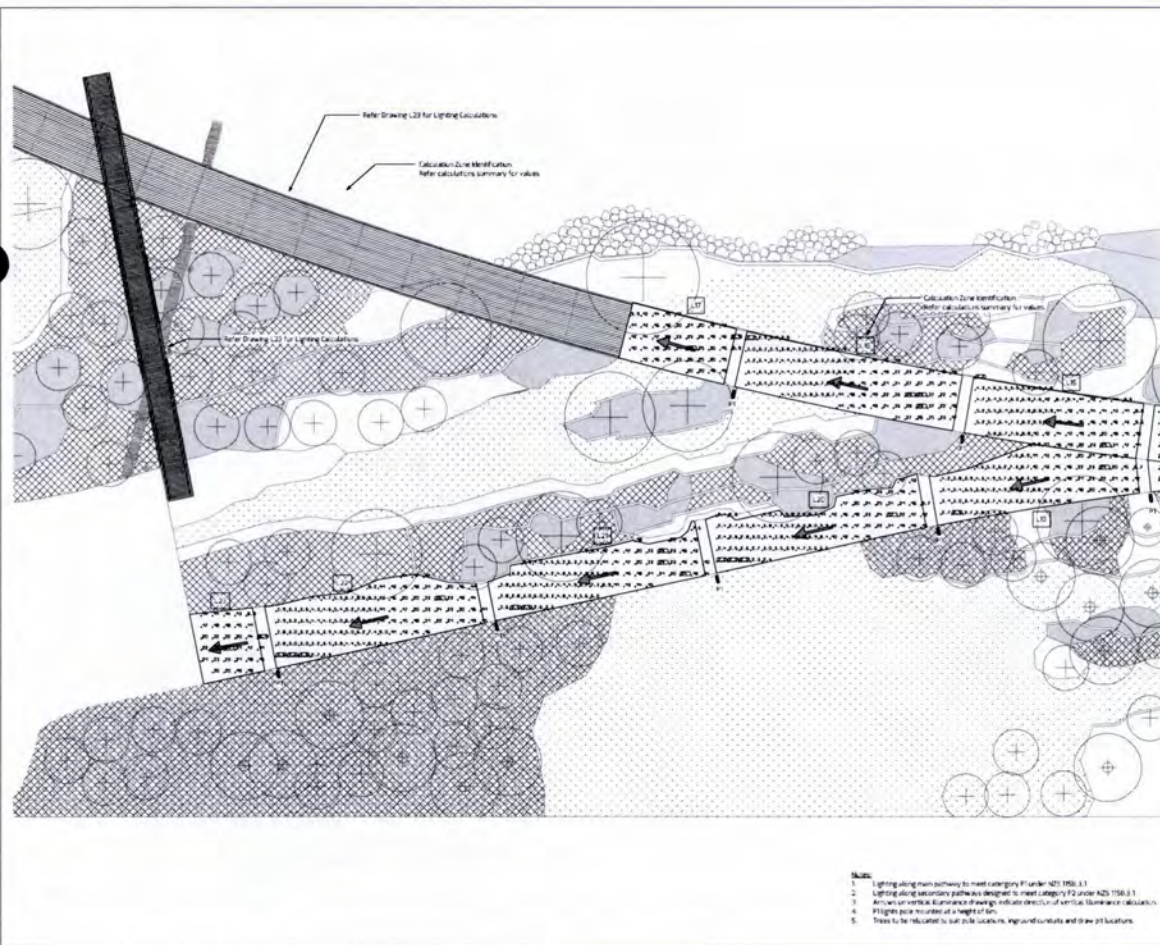
DATE
21.02.2019

TITLE SHEET
518-037

PROJECT NUMBER
518-037-L08

REV

27/02/2019 10:01 AM



General Note:
Drawing set for information purposes only. Do not include off drawing.

Rev	Description	Date

PHASE OF WORK
Detailed Design

CONSULTANT
SEG CONSULTANTS
10810 Lakeshore Drive, Suite 100
Richmond, BC V6X 4A7

PROJECT
Rotorua Lakefront

FILE
Vertical Illuminance Pathway (Left) of 3

CLIENT
Rotorua Lakes Council

DESIGNED BY
RB

REVISED BY
RB

DATE
21.02.2019

TITLE SHEET
1-150

PROJECT NUMBER
518-037

DESIGNED NUMBER
518-037-L09

REV

27/02/2019 10:03 AM

- Notes:
- Lighting along main pathway to meet Category P1 under AS/NZS 1582:2005.
 - Lighting along secondary pathways designed to meet Category P2 under AS/NZS 1582:2005.
 - Area of vertical illuminance design indicates specific vertical illuminance objectives.
 - Flights path is marked at a height of 6m.
 - Trees to be relocated to suit the layout in highlighted areas and to new locations.

General Note:
Drawings are for information purposes
only. Do not scale off drawing.

No.	Description	Date

PURPOSE OF DRAWING:
Detailed Design

CLIENT NAME:
SEG CONSULTANTS
11 Ebbw Vale Road,
Stange, Waikato

PROJECT:
Rotorua Lakefront

FILE:
Vertical Illuminance Pathway (Left) 2
of 3

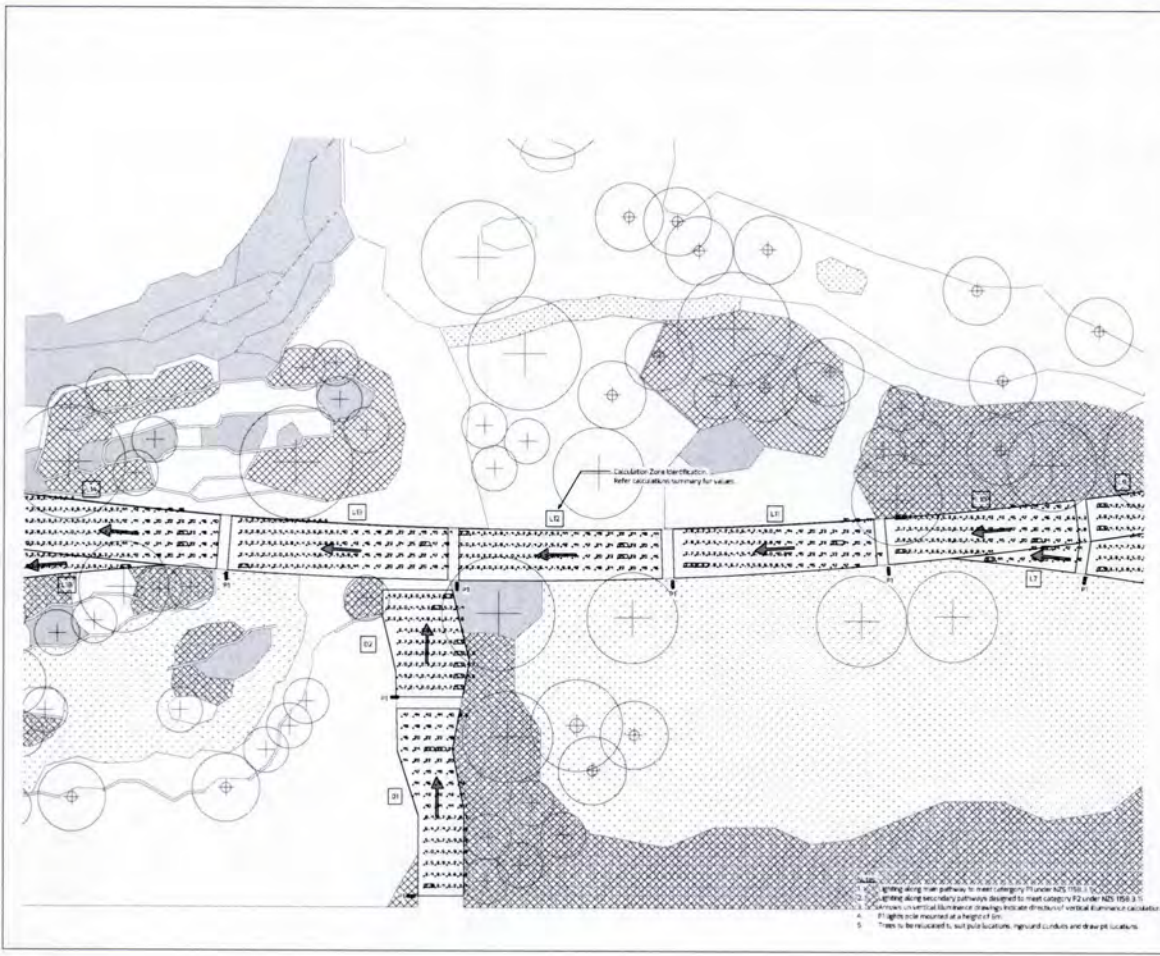
CLIENT:
Rotorua Lakes Council

DRAWN BY: RB RECEIVED BY: DATE: 21.02.2019

SCALE 1:150 PROJECT NUMBER: 518-037

DRAWING NUMBER: 518-037-L10

7/10/2019 9:35:04 AM



- Notes:
- Lighting along main pathway to meet Category P1 under NZS 1552.1
 - Lighting along secondary pathways designed to meet category P2 under NZS 1552.1
 - Pathways on vertical illuminance drawings include direction of vertical illuminance calculation.
 - Flights are measured at a height of 1.0m.
 - There to be re-evaluated to suit pole locations, regional conditions and draw off locations.

General Note:
Drawings are for information purposes
only. Do not scale off drawing.

No.	Description	Date

PURPOSE OF DRAWING:
Detailed Design

CLIENT NAME:
SEG CONSULTANTS
11 Ebbw Vale Road,
Stange, Waikato

PROJECT:
Rotorua Lakefront

FILE:
Vertical Illuminance Pathway (Left) 3
of 3

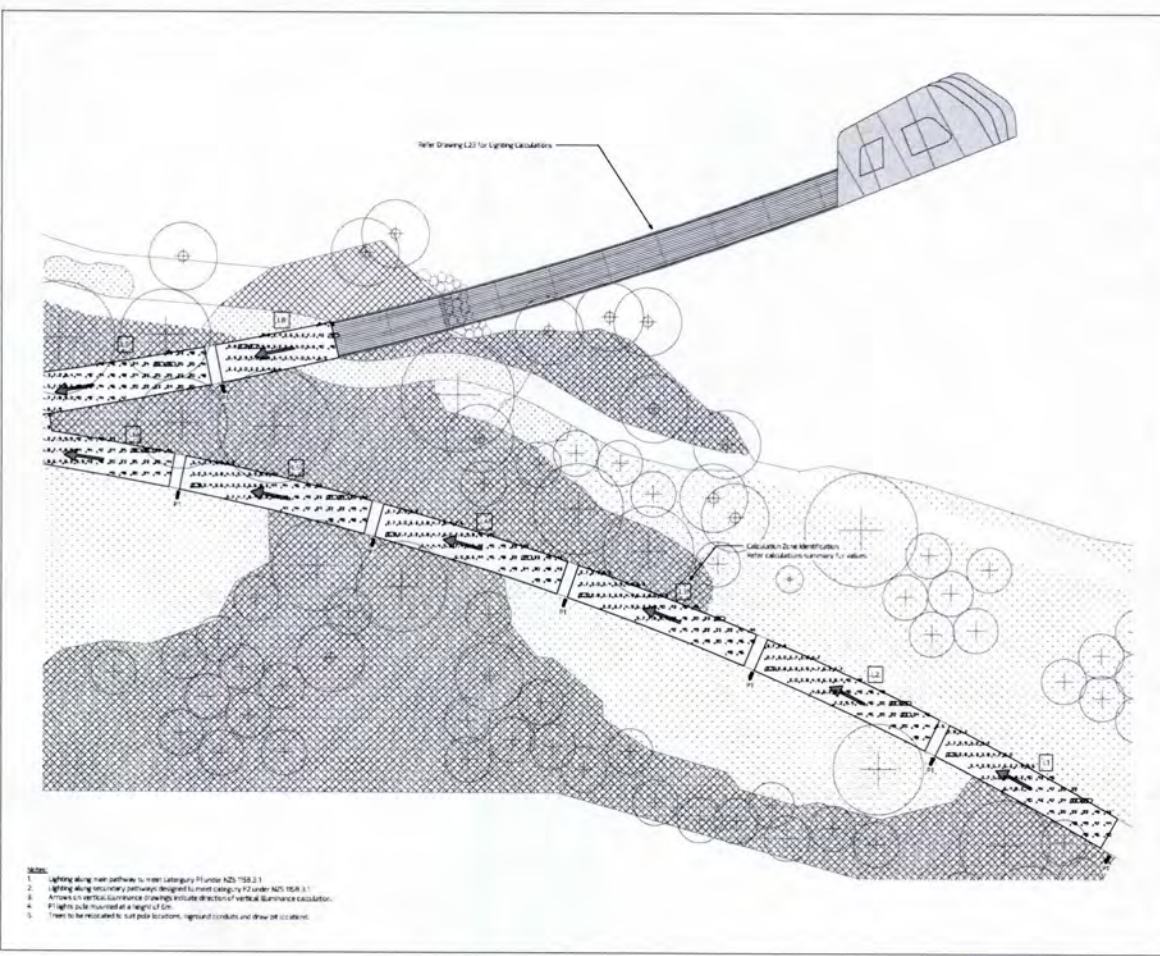
CLIENT:
Rotorua Lakes Council

DRAWN BY: RB RECEIVED BY: DATE: 21.02.2019

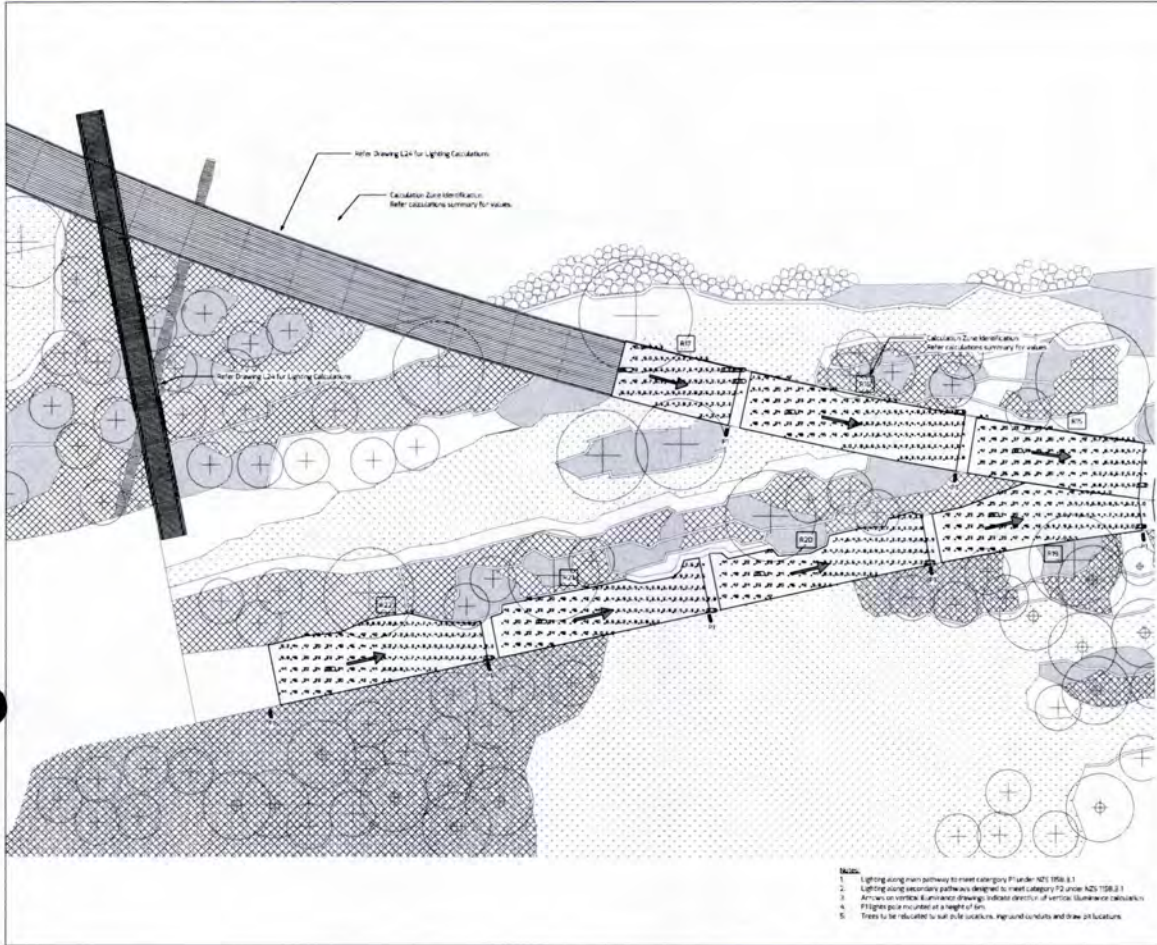
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DRAWING NUMBER: 518-037-L11

7/10/2019 9:35:04 AM



- Notes:
- Lighting along main pathway to meet Category P1 under NZS 1552.1
 - Lighting along secondary pathways designed to meet category P2 under NZS 1552.1
 - Pathways on vertical illuminance drawings include direction of vertical illuminance calculation.
 - Flights are measured at a height of 1.0m.
 - There to be re-evaluated to suit pole locations, regional conditions and draw off locations.



- Notes:
1. Lighting along main pathway to meet category P1 under NZS 1550:3.1
 2. Lighting along secondary pathways designed to meet category P2 under NZS 1550:3.1
 3. Arrows on vertical illuminance drawings indicate direction of vertical illuminance calculation.
 4. Fixtures are measured at a height of 5m.
 5. Trees to be relocated to suit site conditions, improved conditions and draw on location.

General Note:
Drawings are for information purposes only. Do not scale off drawing.

Rev	Description	Date

PHASE OF WORK
Detailed Design

CONSULTANT
SEG 108/102 Lake T.
P.O. Box 1111, Rotorua, New Zealand

PROJECT
Rotorua Lakefront

TITLE
Vertical Illuminance Pathway (Right) of 3

CLIENT
Rotorua Lakes Council

DESIGNED BY
SW

REVISED BY
RB

DATE
21.02.2019

SCALE DRAWING
1:150

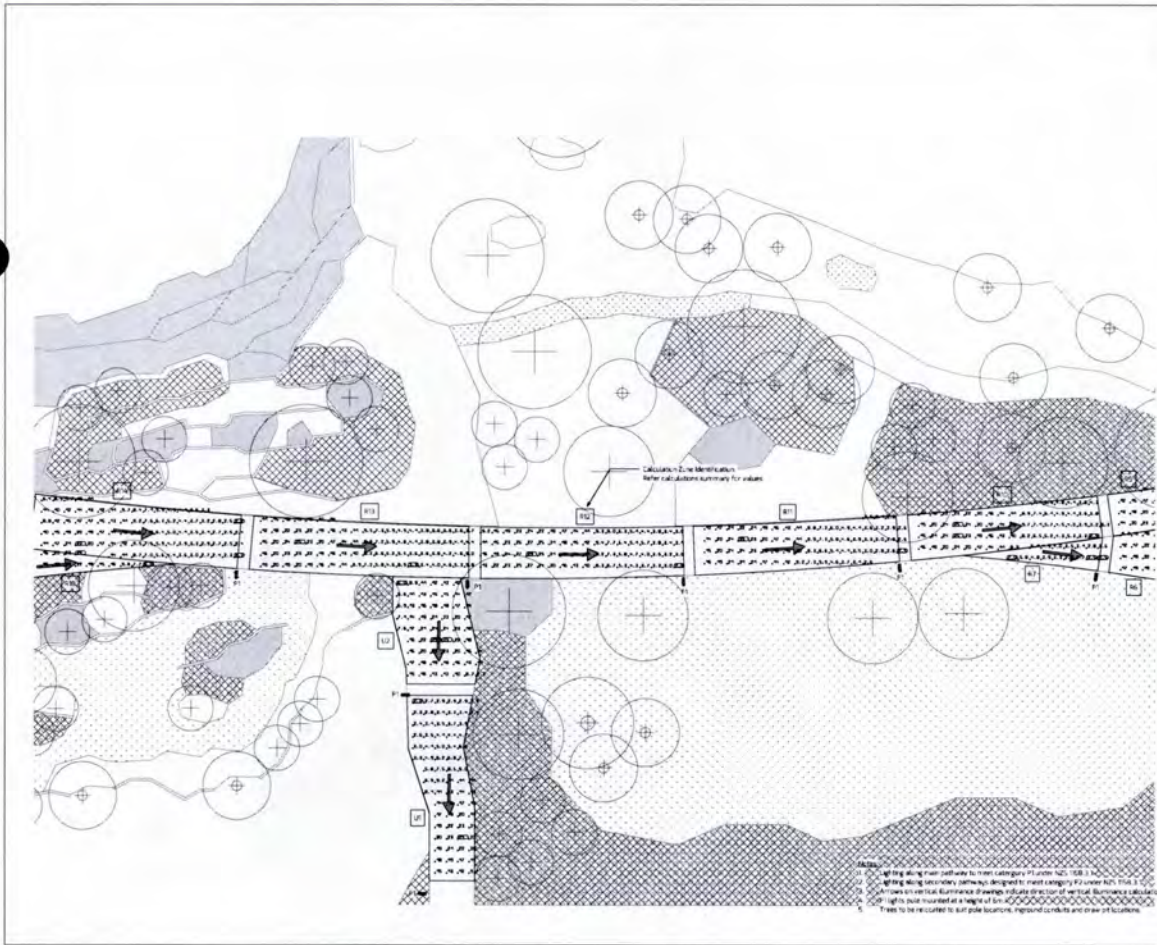
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PROJECT NUMBER
S18-037

DRAWING NUMBER
S18-037-L12

REV

21.02.2019 15:07:46



- Notes:
1. Lighting along main pathway to meet category P1 under NZS 1550:3.1
 2. Lighting along secondary pathways designed to meet category P2 under NZS 1550:3.1
 3. Arrows on vertical illuminance drawings indicate direction of vertical illuminance calculation.
 4. Fixtures are measured at a height of 5m.
 5. Trees to be relocated to suit site conditions, improved conditions and draw on location.

General Note:
Drawings are for information purposes only. Do not scale off drawing.

Rev	Description	Date

PHASE OF WORK
Detailed Design

CONSULTANT
SEG 108/102 Lake T.
P.O. Box 1111, Rotorua, New Zealand

PROJECT
Rotorua Lakefront

TITLE
Vertical Illuminance Pathway (Right) 2 of 3

CLIENT
Rotorua Lakes Council

DESIGNED BY
SW

REVISED BY
RB

DATE
21.02.2019

SCALE DRAWING
1:150

SCALE PLAN
1:500

PROJECT NUMBER
S18-037

DRAWING NUMBER
S18-037-L13

REV

21.02.2019 15:08:46

Luminaire parts list								
Index	Manufacturer	Article name	Item number	Fitting	Luminaire size	Light loss factor	Connected load	Quantity
S1	BRIGHT LIGHT	12W 24V NEON ARC WARM WHITE LED	BL-LS-4800-27	60x5000 3000K IP68 DIMMABLE	420 mm	0.75	12 W/m	535m
S1 Alternate	ACCLAIM (IMPRESSIONS LIGHTING)	FLEX TUBE 6E 6C 3K	FLEX TUBE 6E 6C 3000K 24V DC	3000K IP68 DIMMABLE	171 mm	0.75	3.3 W/m	535m
R1	GHONI (IMPRESSIONS LIGHTING)	Signo 8x 45 2W Led 3K flood 47°	1008 BOM T	LED 3000K	225 mm	0.75	2 W	112
R2	GHONI (IMPRESSIONS LIGHTING)	Signo Walk 45 1.5W 3K	1361 BAK T	LED 3000K	170 mm	0.75	1.5 W	22

S1 NEON ARC



R1 SIGNO 8x 45



R2 SIGNO WALK 45



General Note:
Drawings are for information purposes only. Do not scale off drawing.

Rev	Description	Date

PHASE OF WORK
Detailed Design

CONSULTANT
SEG CONSULTANTS
100/101 Lakeside Drive, Tauranga 3101

PROJECT
Rotorua Lakefront

TITLE
Luminaire Schedule - Boardwalk
Tukutuku Bridge & Pavilion

CLIENT
Rotorua Lakes Council

DESIGNED BY
BW

REVISED BY
RB

DATE
21.02.2019

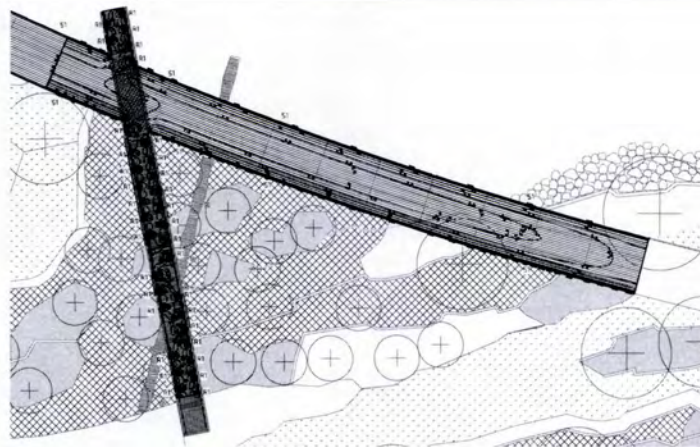
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As indicated

PROJECT NUMBER
S1B-037

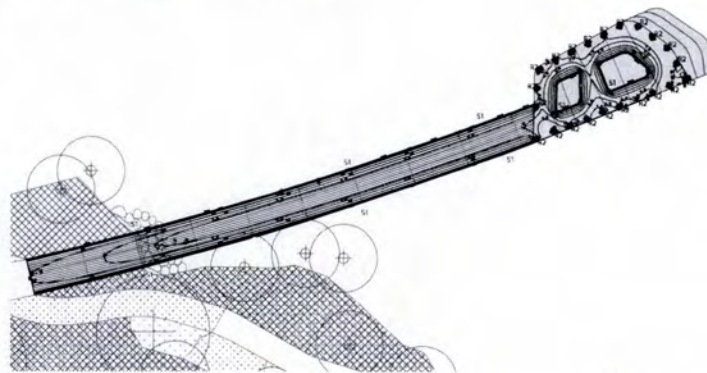
DRAWING NUMBER
S1B-037-L20

REV

27/02/2019 5:15:12 AM



2 Horizontal Illuminance Isolines - Boardwalk & Tukutuku Bridge



1 Horizontal Illuminance Isolines - Boardwalk & Pavilion

Notes:

1. S1 lamp lighting calculated at a dimmed output of approximately 50%.

General Note:
Drawings are for information purposes only. Do not scale off drawing.

Rev	Description	Date

PHASE OF WORK
Detailed Design

CONSULTANT
SEG CONSULTANTS
100/101 Lakeside Drive, Tauranga 3101

PROJECT
Rotorua Lakefront

TITLE
Horizontal Illuminance Isolines
Boardwalk, Tukutuku Bridge &
Pavilion

CLIENT
Rotorua Lakes Council

DESIGNED BY
BW

REVISED BY
RB

DATE
21.02.2019

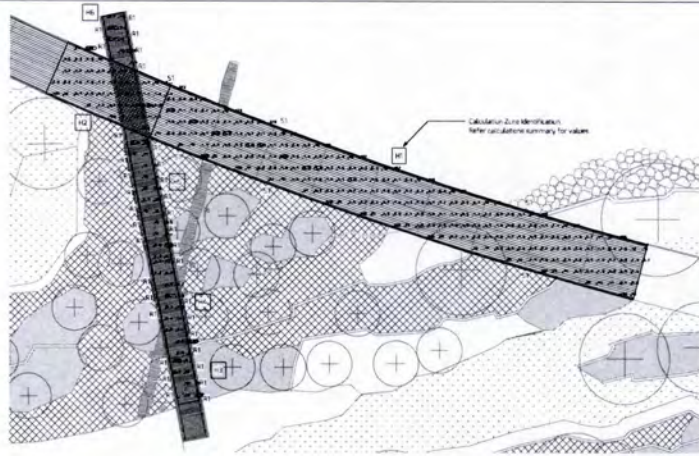
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As indicated

PROJECT NUMBER
S1B-037

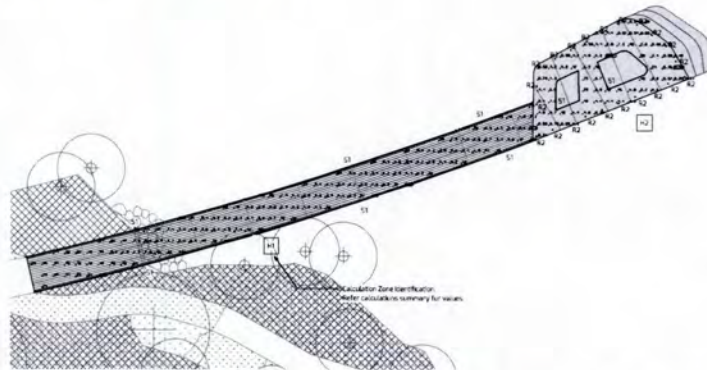
DRAWING NUMBER
S1B-037-L21

REV

27/02/2019 5:15:14 AM



① Horizontal Illuminance - Boardwalk & Tukutuku Bridge
1:50



② Horizontal Illuminance - Boardwalk & Pavilion
1:50

Notes:

1. Strip lighting calculated at a dimmed output of approximately 50%.

General Note:
Drawings are for information purposes
only & do not scale off drawing.

No.	Description	Date

PURPOSE OF ISSUE

Detailed Design

CONSULTANT
SEG

100/101 Lot 1,
11 Enderby Street,
Rotorua 3100

PROJECT

Rotorua Lakefront

TITLE

Horizontal Illuminance Boardwalk,
Tukutuku Bridge & Pavilion

CLIENT

Rotorua Lakes Council

DRAWN BY

BW

REVIEWED BY

RB

DATE

21.02.2019

SCALE 1:50

As Indicated

PROJECT NUMBER

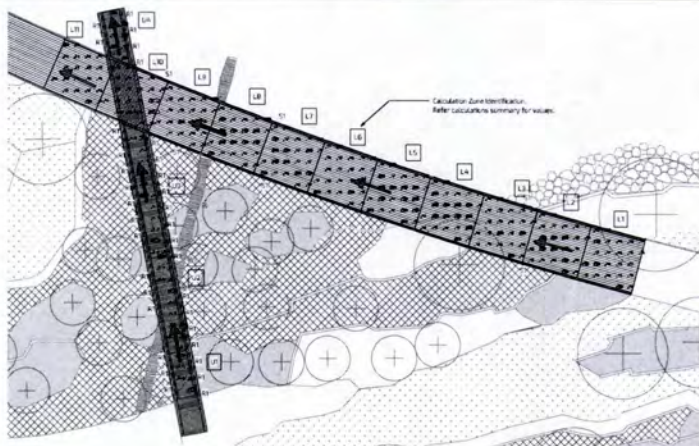
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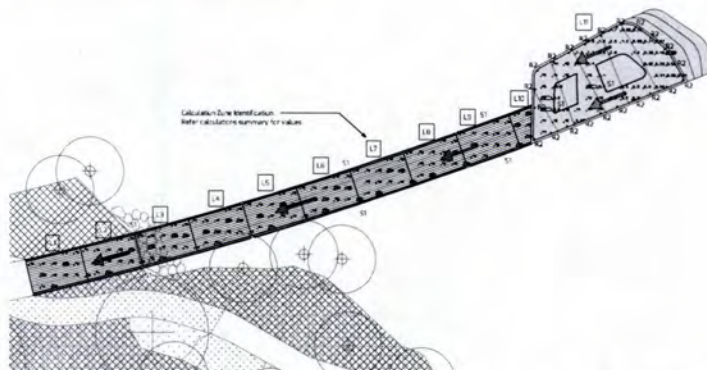
518-037-L22

REV

21/02/2019 9:35:17 AM



① Vertical Illuminance (Left) - Boardwalk & Tukutuku Bridge
1:50



② Vertical Illuminance (Left) - Boardwalk & Pavilion
1:50

Notes:

1. Arrows on vertical illuminance drawings indicate direction of vertical illuminance calculation.
2. Strip lighting calculated at a dimmed output of approximately 50%.

General Note:
Drawings are for information purposes
only & do not scale off drawing.

No.	Description	Date

PURPOSE OF ISSUE

Detailed Design

CONSULTANT
SEG

100/101 Lot 1,
11 Enderby Street,
Rotorua 3100

PROJECT

Rotorua Lakefront

TITLE

Vertical Illuminance Boardwalk,
Tukutuku Bridge & Pavilion (Left)

CLIENT

Rotorua Lakes Council

DRAWN BY

BW

REVIEWED BY

RB

DATE

21.02.2019

SCALE 1:50

As Indicated

PROJECT NUMBER

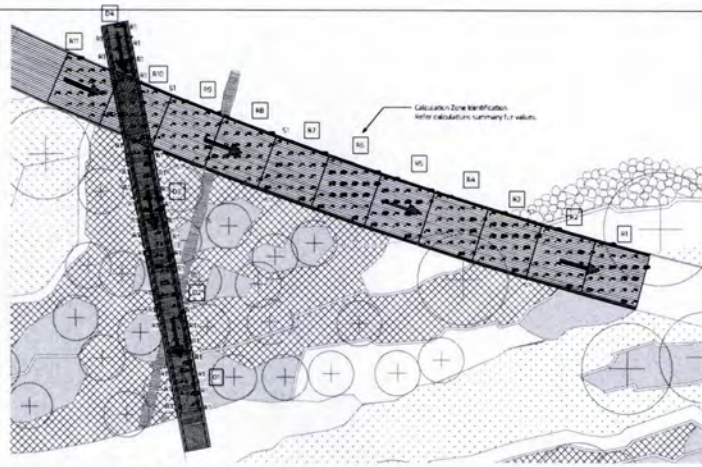
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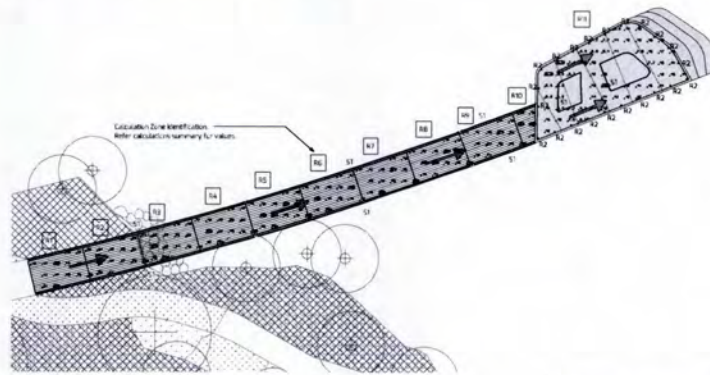
518-037-L23

REV

21/02/2019 9:35:17 AM



1 Vertical Illuminance (Right) - Boardwalk & Tukutuku Bridge



2 Vertical Illuminance (Right) - Boardwalk & Pavillion

General Note:
Drawings are for information purposes only. do not scale off drawing.

Rev	Description	Date

PURPOSE OF ISSUE:
Detailed Design

CONTRACTOR:
SEG CONSULTING ENGINEERS
100/100 Lakefront Drive, Whangarei, New Zealand

PROJECT:
Rotorua Lakefront

FILE:
Vertical Illuminance Boardwalk, Tukutuku Bridge & Pavilion (Right)

CUSTOMER:
Rotorua Lakes Council

DRAWN BY:
BW

REVIEWED BY:
RB

DATE:
21.02.2019

SCALE (if any):
As Indicated

PROJECT NUMBER:
S1B-037

DRAWING NUMBER:
S1B-037-L24

REV

7/20/2019 5:19:38 AM

Burwood & Tukutuku Bridge

#	Calculation Area	Parameter	Min ($E_{v,z}$)	Max	Average ($E_{v,z}$)	Midrange	Maxrange ($E_{v,z}$)	Minmax
1	H1	Horizontal Illuminance	1.15 lx	696 lx	33.9 lx	0.034	20.5	0.002
2	H2	Horizontal Illuminance	0.72 lx	488 lx	23.3 lx	0.021	20.8	0.001
3	H3	Horizontal Illuminance	0.94 lx	571 lx	33.0 lx	0.027	8.87	0.014
4	H4	Horizontal Illuminance	0.85 lx	44.7 lx	11.8 lx	0.069	3.85	0.018
5	H5	Horizontal Illuminance	3.15 lx	181 lx	22.7 lx	0.14	7.97	0.017
6	H6	Horizontal Illuminance	2.12 lx	914 lx	118 lx	0.016	7.74	0.002

Burwood & Pavilion

#	Calculation Area	Parameter	Min ($E_{v,z}$)	Max	Average ($E_{v,z}$)	Midrange	Maxrange ($E_{v,z}$)	Minmax
1	H1	Horizontal Illuminance	1.72 lx	799 lx	48.5 lx	0.055	12.4	0.002
2	H2	Horizontal Illuminance	0.17 lx	379 lx	23.9 lx	0.007	24.2	0.000

- Calculation Parameters:**
- Calculations AS/NZS 159-2:2005 computer procedures for the calculation of light technical parameters for Category V and Category P lighting for diffuse mounting.
 - Calculation software: SEG 5.8.1 A 1507 Lighting Calculation Software
 - Surface Finishes and reflectances based on the provided architectural information.
 - Luminaire maintenance factor in accordance with manufacturer recommendations for 20% ambient and 80000 hours = 0.91 and cleaning in accordance with AS/NZS 159-2 Table 1 assuming medium pollution and 24 month cleaning = 0.95 resulting in a total maintenance factor of 0.86.
 - There are no calculations when looking at the lighting levels, they are as follows - (none) from "think lighting for safe and attractive pedestrian street".
 - Safety** - Pedestrians must be safe. Safe public lighting ensures the pedestrian does not get scared. Pedestrians should be able to see clearly through lighting their possible obstacles and structures in the physical areas without discomfort or physical harm. To ensure the risk of near misses or collisions, pedestrians should be easily visible to all other users of the space, such as cyclists, and other pedestrians. In low density lighting for pedestrian safety is considered to be covered by lighting standards for mobility.
 - Lighting for roads and public spaces part 1: lighting for roads and public spaces.
 - Lighting for roads and public spaces part 2: pedestrian and bicycle lighting.
 - Personal safety & security** - Public lighting for pedestrian personal security - to reduce the potential for harm to pedestrians and should deliver some comfort to users. Enhancing actual or perceived levels of personal security for pedestrians crosses the threshold of what people will walk. Lighting may contribute to providing pedestrians with a feeling of being "ugged & attended" and lighting may increase the presence or likelihood of antisocial behaviour and understand urban lighting. These types of effects can be difficult to predict or measure, but there is evidence that the lighting of a facility may increase pedestrian perceptions of risk of physical harm or of encountering antisocial behaviour. The effects of lighting on personal security are referred to in AS/NZS 159-2:2005 particularly in Appendix C. Selection of lighting technology's based on risk of crime or need to enhance prestige. The Crime Prevention through Environmental Design (CPTED) principles also apply.
 - Attractiveness** - Attractive public lighting has a positive effect on pedestrians and contributes to their enjoyment of the walking experience and experience. Walking requires a high degree of risk reduction with the urban environment. Lighting can be used to create, communicate or contribute to an area's atmosphere, and can help make walking a more pleasurable experience and a more appealing activity and mode of transport - this includes the mode of walking. The potential for pedestrian lighting to be so attractive as to enhance the walking experience, and thereby increase the numbers of pedestrians, is outside the coverage of AS/NZS 159-2:2005.
 - Lighting designed to meet minimum level and AS/NZS 159-2:2005 Table 2.2.2.2 of AS/NZS 159-2:2005 below:
Boardwalk Horizontal Illuminance - **Not completed**
Tukutuku Bridge Horizontal Illuminance - **Not completed**
 - Final lighting design and luminaire layouts to be approved and accepted by the Rotorua Lakes Council.

General Note:
Drawings are for information purposes only. do not scale off drawing.

Rev	Description	Date

PURPOSE OF ISSUE:
Detailed Design

CONTRACTOR:
SEG CONSULTING ENGINEERS
100/100 Lakefront Drive, Whangarei, New Zealand

PROJECT:
Rotorua Lakefront

FILE:
Horizontal Illuminance Boardwalk, Tukutuku Bridge & Pavilion Calculation Summary

CUSTOMER:
Rotorua Lakes Council

DRAWN BY:
BW

REVIEWED BY:
RB

DATE:
21.02.2019

SCALE (if any):
As Indicated

PROJECT NUMBER:
S1B-037

DRAWING NUMBER:
S1B-037-L25

REV

7/20/2019 5:19:38 AM

AS/NZS Lighting for roads & public spaces performance criteria:

Lighting subcategory	Light technical parameters				Permissible luminaire type (see Table 2.6)
	Average horizontal illuminance ¹⁾ ($E_{h,z}$) lx	Point horizontal illuminance ²⁾ ($E_{p,z}$) lx	Ellipsoidal (horizontal) uniformity ³⁾ $U_{e,h}$	Point vertical illuminance ⁴⁾ ($E_{v,z}$) lx	
P1	1	2	10	2	Type 2 where part of a road network in Types 2, 3, 4 at 5 m intervals
	1.5	0.7	10	0.3	
	1.75	0.2	10	0.5	
	0.35	0.14	10	N/A	
P2	0.5	0.07	10	N/A	N/A
	0.5	0.07	10	10	

General description	Selection criteria ¹⁾				Applicable lighting subcategory
	Road opening characteristics	Pedestrian cycle activity	Risk of crime ²⁾	Need to enhance prestige	
Pedestrian or cycle oriented pathway, e.g. Bourkeville, including those along local roads ³⁾ and arterial roads ⁴⁾ walkways, lanes, path, public cycleways	Pedestrian/cycle traffic only	N/A	High	N/A	P1 ⁵⁾
	High	High	Medium	High	P2 ⁵⁾
	Medium	Low	Medium	Medium	P3
	Low	Low	Low	N/A	P4

Rotarua Lakes Bridge Pavement Surface Results Table

#	Calculation Area	Parameter	Min (E _u)	Max	Average (E _u)	Min/Max	Min/Average (E _u)	Max/Average (E _u)
1	L1	Vertical Illuminance	11.5 lx	20.0 lx	15.6 lx	0.57	1.31	0.48
2	L2	Vertical Illuminance	11.7 lx	19.9 lx	15.8 lx	0.59	1.36	0.58
3	L3	Vertical Illuminance	10.8 lx	19.9 lx	16.7 lx	0.65	1.39	0.54
4	L4	Vertical Illuminance	11.1 lx	19.4 lx	16.3 lx	0.67	1.37	0.57
5	L5	Vertical Illuminance	11.0 lx	20.0 lx	16.6 lx	0.66	1.30	0.55
6	L6	Vertical Illuminance	11.1 lx	21.8 lx	16.6 lx	0.67	1.31	0.51
7	L7	Vertical Illuminance	11.5 lx	19.9 lx	16.5 lx	0.70	1.32	0.61
8	L8	Vertical Illuminance	10.7 lx	20.0 lx	16.4 lx	0.65	1.35	0.57
9	L9	Vertical Illuminance	11.1 lx	19.8 lx	16.4 lx	0.66	1.34	0.58
10	L10	Vertical Illuminance	8.19 lx	18.0 lx	12.3 lx	0.62	1.30	0.45
11	L11	Vertical Illuminance	9.43 lx	20.0 lx	16.0 lx	0.53	1.43	0.37
12	U1	Vertical Illuminance	1.24 lx	4.66 lx	2.87 lx	0.43	1.61	0.27
13	U2	Vertical Illuminance	1.79 lx	7.35 lx	3.07 lx	0.59	2.42	0.25
14	U3	Vertical Illuminance	1.85 lx	5.88 lx	4.01 lx	0.46	1.46	0.31
15	U4	Vertical Illuminance	10.7 lx	13.2 lx	12.3 lx	0.87	1.57	0.81

#	Calculation Area	Parameter	Min (E _u)	Max	Average (E _u)	Min/Max	Min/Average (E _u)	Max/Average (E _u)
1	R1	Vertical Illuminance	11.6 lx	19.4 lx	17.3 lx	0.67	1.12	0.60
2	R2	Vertical Illuminance	11.4 lx	19.7 lx	17.3 lx	0.66	1.14	0.58
3	R3	Vertical Illuminance	11.7 lx	19.7 lx	17.4 lx	0.67	1.13	0.59
4	R4	Vertical Illuminance	11.7 lx	20.1 lx	17.7 lx	0.66	1.13	0.58
5	R5	Vertical Illuminance	10.2 lx	20.0 lx	18.0 lx	0.70	1.16	0.61
6	R6	Vertical Illuminance	10.8 lx	22.4 lx	18.4 lx	0.70	1.21	0.58
7	R7	Vertical Illuminance	10.3 lx	21.0 lx	19.3 lx	0.70	1.13	0.62
8	R8	Vertical Illuminance	10.8 lx	24.5 lx	21.0 lx	0.66	1.16	0.56
9	R9	Vertical Illuminance	8.83 lx	24.1 lx	17.4 lx	0.50	1.38	0.36
10	R10	Vertical Illuminance	7.15 lx	18.0 lx	11.8 lx	0.60	1.25	0.45
11	R11	Vertical Illuminance	9.88 lx	17.3 lx	14.4 lx	0.63	1.20	0.52
12	D1	Vertical Illuminance	4.88 lx	8.57 lx	5.66 lx	0.86	1.16	0.74
13	D2	Vertical Illuminance	4.87 lx	8.71 lx	6.86 lx	0.72	1.28	0.56
14	D3	Vertical Illuminance	8.19 lx	10.2 lx	10.3 lx	0.79	1.16	0.68
15	D4	Vertical Illuminance	0.004 lx	3.94 lx	2.02 lx	0.002	1.85	0.001

Rotarua Lakes Bridge Pavement Surface Results Table

#	Calculation Area	Parameter	Min (E _u)	Max	Average (E _u)	Min/Max	Min/Average (E _u)	Max/Average (E _u)
1	L1	Vertical Illuminance	11.2 lx	19.7 lx	16.4 lx	0.68	1.20	0.57
2	L2	Vertical Illuminance	10.7 lx	19.7 lx	15.7 lx	0.68	1.19	0.57
3	L3	Vertical Illuminance	10.9 lx	19.3 lx	15.6 lx	0.70	1.17	0.60
4	L4	Vertical Illuminance	11.1 lx	19.9 lx	15.7 lx	0.71	1.19	0.58
5	L5	Vertical Illuminance	10.8 lx	19.4 lx	15.9 lx	0.68	1.19	0.58
6	L6	Vertical Illuminance	10.4 lx	19.2 lx	15.9 lx	0.66	1.22	0.54
7	L7	Vertical Illuminance	10.8 lx	19.1 lx	16.0 lx	0.68	1.19	0.57
8	L8	Vertical Illuminance	12.2 lx	19.9 lx	16.9 lx	0.72	1.17	0.61
9	L9	Vertical Illuminance	11.6 lx	20.3 lx	16.8 lx	0.69	1.20	0.57
10	L10	Vertical Illuminance	10.5 lx	19.8 lx	15.3 lx	0.78	1.18	0.66
11	L11	Vertical Illuminance	0.001 lx	18.7 lx	7.37 lx	0.000	2.46	0.000

Calculation Parameters

1. Calculation Method: AS/NZS 1582:2005 Computer Simulation Method for the Calculation of Light Metrics Parameters for Lighting Systems (Computer Simulation Method).
2. Calculation Method: AS/NZS 1582:2005 Computer Simulation Method for the Calculation of Light Metrics Parameters for Lighting Systems (Computer Simulation Method).
3. Calculation Method: AS/NZS 1582:2005 Computer Simulation Method for the Calculation of Light Metrics Parameters for Lighting Systems (Computer Simulation Method).
4. Calculation Method: AS/NZS 1582:2005 Computer Simulation Method for the Calculation of Light Metrics Parameters for Lighting Systems (Computer Simulation Method).

**TABLE 2.6
VALUES OF LIGHT TECHNICAL PARAMETERS AND PERMISSIBLE LUMINAIRE TYPES FOR ROADS IN LOCAL AREAS AND FOR PATHWAYS**

Lighting category	Light technical parameters					Permissible luminaire type (see Table 2.8)
	Average horizontal illuminance ¹⁾	Peak horizontal illuminance ²⁾	Illuminance ³⁾	Point vertical illuminance ⁴⁾	Uniformity ⁵⁾	
	lx	lx	lx	lx		
R1	7	2	10	7		Type 1
R2	2.5	0.7	10	0.5		Type 2
R3	1.7	0.5	10	0.5		Type 3
R4	0.4	0.4	10	N/A		Type 4 - 1 & 2
R5	0.5	0.5	10	N/A		Type 5

**TABLE 2.7
LIGHTING CATEGORIES FOR PATHWAYS (INCLUDING CYCLEWAYS)**

Type of pathway	Selective criteria ¹⁾				Applicable luminaire category
	General description	Basic operating characteristics	Preferred luminaire features	Max. of luminaire	
Urban streets	Urban streets	Urban streets	N/A	High	N/A
Suburban streets	Suburban streets	Suburban streets	N/A	Medium	High
Rural roads	Rural roads	Rural roads	Medium	Low	Medium
Footpaths	Footpaths	Footpaths	Low	Low	N/A

Date of Issue: 21/02/2019
Drawing No: R18-037-L26

No.	Description	Date

PREPARED BY: Detailed Design

CHECKED BY: SEG (Signature)

DATE: 21/02/2019

PROJECT: Rotorua Lakefront

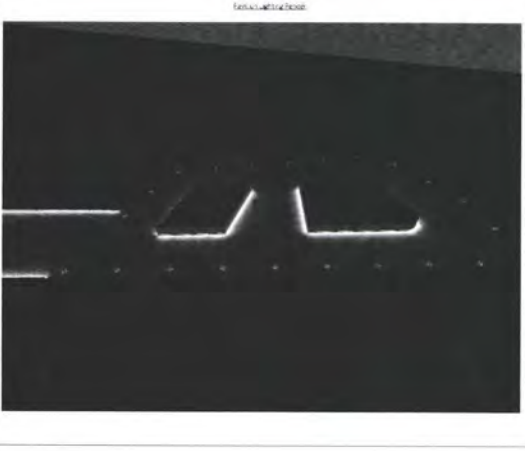
DESCRIPTION: Vertical Illuminance Boardwalk, Tukutuku Bridge & Pavilion, Calculation Summary

CUSTOMER: Rotorua Lakes Council

SCALE: As shown

PROJECT NO: R18-037-L26

DRAWING NO: 518-037-L26



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No.	Description	Date

PREPARED BY: Detailed Design

CHECKED BY: SEG (Signature)

DATE: 21/02/2019

PROJECT: Rotorua Lakefront

DESCRIPTION: Lighting Renders

CUSTOMER: Rotorua Lakes Council

SCALE: As shown

PROJECT NO: R18-037-L26

DRAWING NO: 518-037-L26