APPENDIX 1
CERTIFICATE OF TITLE

COMPUTER FREEHOLD REGISTER
UNDER LAND TRANSFER ACT 1952

Search Copy

R.W. Muir
Registrar-General
of Land

Identifier	**703340**
Land Registration District	**South Auckland**
Date Issued	30 June 2015

Prior References
618062

Estate	Fee Simple
Area	8.0251 hectares more or less
Legal Description	Lot 12 Deposited Plan 372970 and Lot 27-28 Deposited Plan 326716 and Allotment 28B9B2A Parish of Rangitaiki

Proprietors
Ian Wallace Lysaght and Adrianne June Lysaght

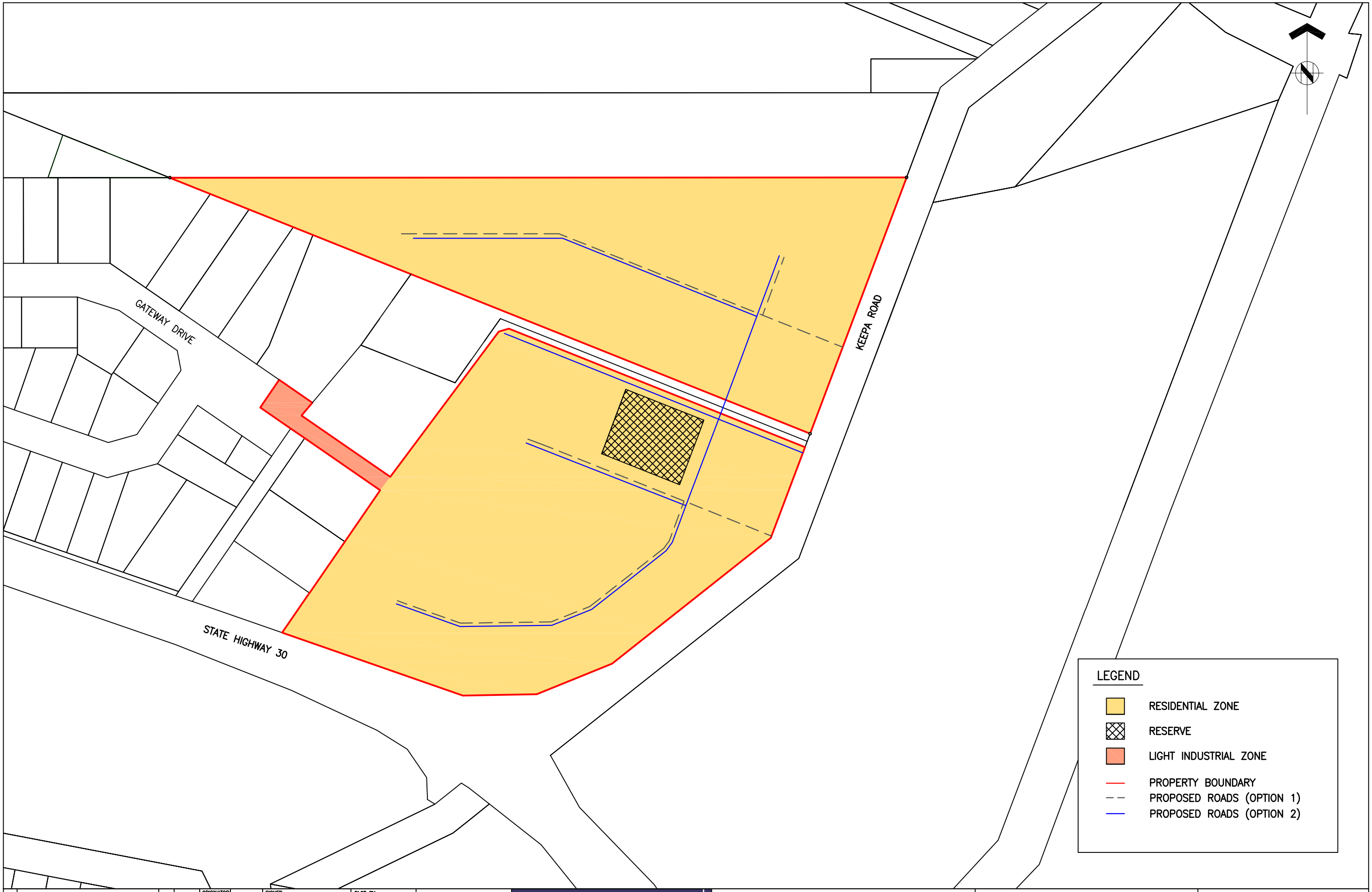
Interests

H859770 Gazette Notice declaring State Highway No.30 (Pokeno - Wellington) to be a limited access road - 16.3.1989 at 1:31 pm

Subject to a right (in gross) to drain sewage and stormwater over part Lot 28 DP 326716 marked A and over part Lot 27 DP 326716 marked B all on DP 326716 in favour of Whakatane District Council created by Transfer B657416.2 - produced 7.5.2001 at 11:00 am and entered 22.5.2001 at 9:00 am

The easements created by Transfer B657416.2 are subject to Section 243(a) Resource Management Act 1991

APPENDIX 2
KEEPA ROAD STRUCTURE PLAN



REF	REVISIONS	BY	DATE
D	REMOVE CYCLE/PEDESTRIAN PATHS & STORMWATER	SRW	22/06/17
C	INCREASE THE SIZE OF THE RESERVE	SRW	15/05/17
B	ADD OPTION 2 FOR ROADING	SRW	09/05/17

ORIGINATOR: -		SIGNED:	PLOT BY: SRW
DRAWN: SRW	02/02/2017	SIGNED:	PLOT DATE: 15/02/2017
CHECKED: BWP	15/02/2017	SIGNED:	SURVEY BY: -
APPROVED: SRW	15/02/2017	SIGNED:	SURVEY DATE: -

EAST BAY SURVEYORS (2014) LTD
Surveying & Land Development

STRUCTURE PLAN
ALLOTMENT 28B9B2A RANGITAIKI PARISH
AND LOT 2 DP 452650

LYSAGHT DEVELOPMENTS
23 & 45 KEEPA ROAD, WHAKATANE

CLIENT ISSUE

PROJECT No:	SCALES:	
2106	A3 1:2000	A3

DRAWING No: STRUCTURE PLAN D

APPENDIX 3
PROPOSED CHANGES TO THE DISTRICT PLAN

1.1.1 PLANNING MAPS

The plan change request is seeking to change the land zoning of 23 & 25 Keepa Road from the existing light Industrial Zoning to Residential Zoning on Planning Maps 105B & 109B.

1.1.2 CHAPTER 2 – STRATEGIC

The following changes are proposed within Chapter 2 – Strategic:

2.2.2 *Structure Plans for Ōpihi, Port Ōhope, Keepa Road and Shaw/Huna Road*

2.2.2.1 *Any subdivision and development at Ōpihi, Port Ōhope, Keepa Road and Shaw/Huna Road shall be undertaken in general accordance with the Structure Plans in Appendix 2.6.1, 2.6.2, ~~and~~ 2.6.3 and 2.6.4 as a Controlled Activity.*

2.2.2.2 *Non-compliance with Rule 2.2.2.1 shall be a Restricted Discretionary activity.*

2.3.4 Subdivision of Residential Zoned Land at Keepa Road

2.3.4.1 Council shall exercise control over

a. the consistency of the development with the Structure Plan in Appendix 2.6.4

b. the means by which the subdivision design addresses the reverse sensitivity of traffic noise from State Highway 30. The method chosen to address this issue shall consider how that method impacts on amenity for the residential development and the wider environment.

c. the design of the acoustic barrier between 25B Keepa Road (Allotment 28B3C1) and Lot 2 DP 452650 (or any resulting lot from the subdivision of Lot 2 DP 452650).

d. the criteria listed in 12.7.1, 13.2.26, 13.2.27, 13.2.28 and 13.2.29;

e. the means by which the interface with industrial land is managed to minimise visual and noise impacts and other reverse sensitivity effects of industrial activities on neighbours;

f. the means by which the interface with 25A and 25B Keepa Road (Allotment 28B3C1 and Lot 1 DPS 18658) is managed to minimise visual, noise and other effects from the adjoining residential zone;

g. the means by which traffic impacts on Keepa Road and the Keepa Road/State Highway 30 intersection are mitigated;

h. the means by which the building platforms comply with Rule 18.2.3.2

2.4 Assessment Criteria for Controlled Activities

2.4.5 Subdivision and Development of Land within the Keepa Road Structure Plan Area not in accordance with the Structure Plan

2.4.5.1 Council shall restrict its discretion over matters listed below;

a. The consistency of the development with the Structure Plan in Appendix 2.6.4;

b. *The means by which the subdivision design addresses the reverse sensitivity of traffic noise from State Highway 30. The method chosen to address this issue shall consider how that method impacts on amenity for the residential development and the wider environment;*

c. *the design of the acoustic barrier between 25B Keepa Road (Allotment 28B3C1) and Lot 2 DP 452650 (or any resulting lot from the subdivision of Lot 2 DP 452650);*

d. *the criteria listed in 12.7.1, 13.2.26, 13.2.27, 13.2.28 and 13.2.29;*

e. *the means by which the interface with industrial land is managed to minimise visual and noise impacts and other reverse sensitivity effects of industrial activities on neighbours;*

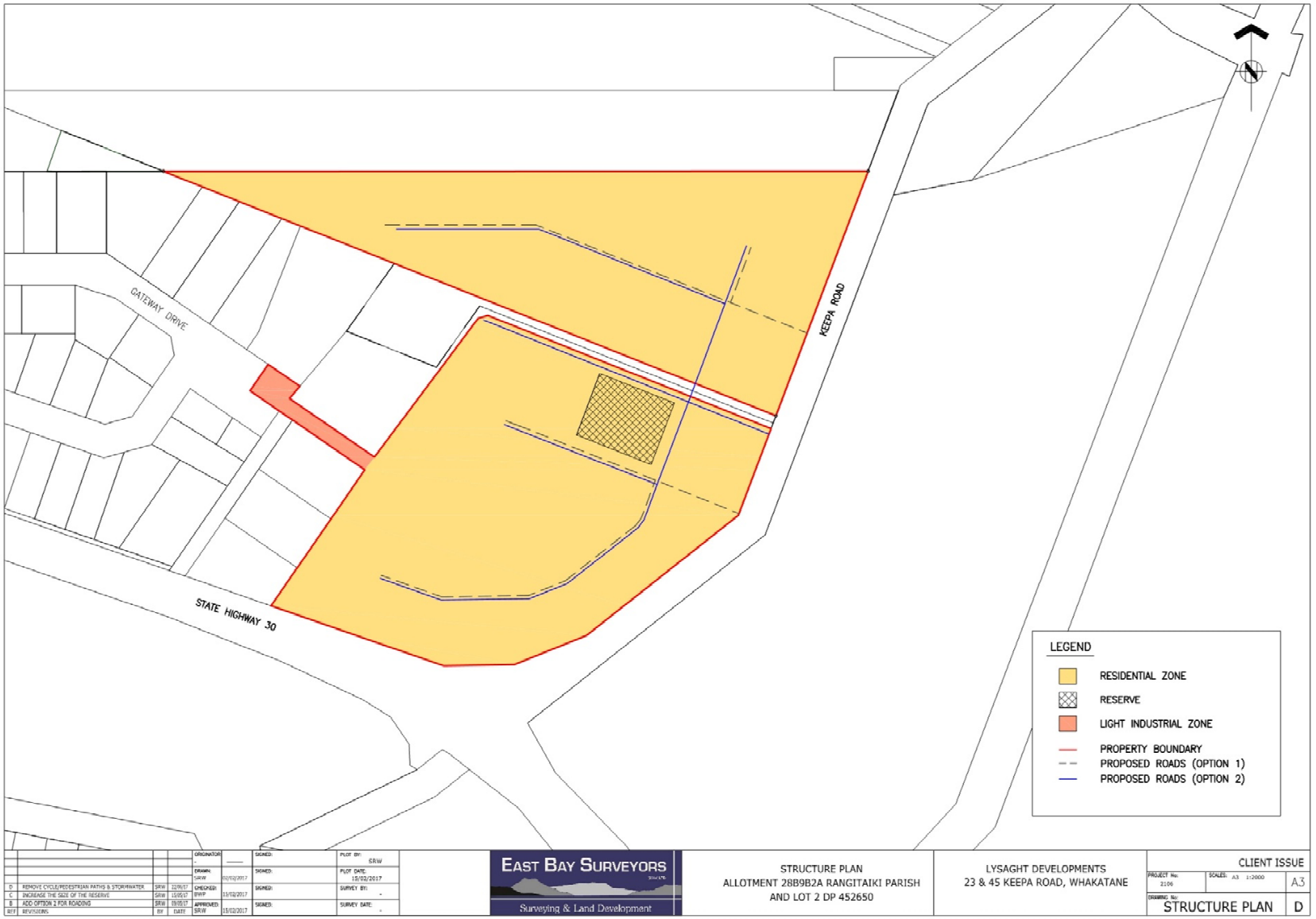
f. *the means by which the interface with 25A and 25B Keepa Road (Allotment 28B3C1 and Lot 1 DPS 18658) is managed to minimise visual, noise and other effects from the adjoining residential zone;*

g. *the means by which traffic impacts on Keepa Road and the Keepa Road/State Highway 30 intersection are mitigated;*

h. *the means by which the building platforms comply with Rule 18.2.3.2;*

That a new Appendix 2.6.4 be added to Section 2.6 of the District Plan as follows:

2.6.4 Keepa Road Structure Plan



1.1.3 CHAPTER 6 – INDUSTRIAL AND LIGHT INDUSTRIAL

The proposal is not seeking to make any changes or additions to the objectives or policies in the District Plan. It should be noted that the following policy in Chapter 6 will still be relevant to the Light Industrial Zone, given that the Hokowhitu Marae will still adjoin Light Industrial Zone land on both the western and southern boundaries.

Policy 4 *To ensure that industrial or business activities on sites adjoining the places listed in (a) to (d) below, respect the cultural and amenity values of these places to iwi and hapū:*

a. Te Hokowhitu-a-Tu Marae, Keepa Road, Whakatāne (Allotment 28B3C1 Rangitāiki Parish, and Lot 1 DPS 18658 Planning Map 105B and Appendix 6.6.1);

The following provisions contained in Chapter 6 relate to the site specific yard setback requirements identified on Appendix 6.6.1. The following changes to the provisions in Chapter 6 are proposed as part of this change to reflect that the zoning of the subject land will change from Light Industrial to Residential:

6.2.3 Distance to Boundaries (Yards)

6.2.3.2 In the Light Industrial and Industrial zones no side and rear yards are required except as required by a - c below (see Appendices ~~6.1~~ 6.6.1 to 6.6.3);

a. side and rear yards of at least 5m shall apply on Allotments 28B3C2A (46C State Highway 30) and 28B3C2B (46B State Highway 30) Rangitāiki Parish (see Appendix 6.6.1 and Planning Map 105B);

b. side and rear yards of at least 5m shall apply where the site abuts the Pupuāruhe urupā and church (Rangitāiki Allotments 29X1 and 29X2, Rangitāiki Parish, 93 and 95 Mill Road, Whakatāne) (see Appendix 6.6.2 and Planning Map 108B);

c. side and rear yards of at least 3m shall apply where the site abuts any Residential, Urban Living or Rural Zone, except that;

~~i. the minimum yards for sites adjoining the eastern boundary of Lot 1 DPS 18658 Rangitāiki Parish (25A Keepa Road) shall be 6m along that eastern boundary (see Appendix 6.6.1 and Planning Map 105B);~~

~~ii. the minimum yards for sites adjoining the eastern boundaries of Allotments 28B3C2A and 28B3C2B Rangitāiki Parish shall be 6m along those eastern boundaries (see Appendix 6.6.1 and Planning Map 105B); and~~

iii. the minimum yard for sites adjoining the southern boundary of Allotment 28B3C2B Rangitāiki Parish shall be 5m along that southern boundary, unless a fence or wall (including a wall of a building) is provided along the entire southern boundary of Allotment 28B3C2B in accordance with the rules in 6.2.8.3 (Te Hokowhitu-a-Tu Marae Amenity, Location of Buildings), in which case this yard requirement shall not apply (see Appendix 6.6.1 and Planning Map 105B).

6.2.7 Marae and Urupā Amenity Yard (see Appendices 6.6.1 to 6.6.3)

*6.2.7.1 Rubbish collection areas, business activities or **buildings** used for business activities shall not be located within the following amenity yards;*

*a. a 10m wide amenity yard adjoining the boundary of **Lot** Karatia 3B2A1 Murupara (Tīpapa **Marae**, 1567 Kopuriki Road), as shown on Planning Map 135B and Appendix 6.6.3; and*

~~b. a 20m wide amenity yard parallel to the eastern boundary of Allotment 28B3C1 (25B Keepa Road, Te Hokowhitu a Tu Marae) and a 6m amenity yard parallel to **Lot** 1 DPS 18658 Rangitāiki Parish (25A Keepa Road, Te Hokowhitu a Tu **Marae**) at Whakatāne as shown on Planning Map 105B and Appendix 6.6.1.~~

~~6.2.7.3 When the land comprising the 20m and 6m **Marae** amenity yard east of Te -a Tu Hokowhitu **Marae**, vests in the Council as reserve, the **marae** amenity yard will no longer apply.~~

6.2.8 *Te Hokowhitu-a-Tu Marae Amenity, Location of Buildings (Planning Map 105B and Appendix 6.6.1)*

~~6.2.8.1 No entranceway greater than 1m in width for a **business activity** shall face Te Hokowhitu a Tu **Marae** at Whakatāne, or associated **dwelling**s on **Lot** 1 DPS 18658.~~

~~6.2.8.2 No opening window or door, other than a single door that has a width no greater than 1m, shall be located on the western side of any building on Lot 12 DP 372970 (36 Gateway Drive, or subsequent lot if subdivided) if the opening window or door (other than a door that is permitted by this rule) is less than 20m from and facing the eastern boundary of Allotments 28B3C2A and 28B3C2B Rangitāiki Parish unless the written consent of the owners and occupiers of Allotments 28B3C2A and 28B3C2B Rangitāiki Parish is obtained.~~

6.2.8.3 *No opening window or door, other than a single door that has a width no greater than 1m shall be located on the northern side of any building on Lot X DP XXX ~~Lot 12 DP 372970~~ (36 Gateway Drive, or subsequent lot if subdivided) if the opening window or door (other than a door that is permitted by this rule) is less than 20m from and facing the southern boundary of Allotment 28B3C2B Rangitāiki Parish unless;*

a. the written consent of the owners and occupiers of Allotment 28B3C2B Rangitāiki Parish is obtained; or

b. a solid wall (including a wall of a building with no openings) or acoustic fence with a minimum construction standard of a board-and-batten wooden fence, such solid wall or fence to be at least 2m in height, is constructed along the entire southern boundary of Allotment 28B3C2B Rangitāiki Parish.

6.2.8.4 *No window, door or any other opening shall be located on the eastern side of any building on Lot 9 DPS 46433 (39 Gateway Drive) unless the written consent of the owners and occupiers of 25A Keepa Road (Lot 1 DPS 18658) and 25B Keepa Road (Allotment 28B3C1 Rangitāiki Parish) is obtained.*

6.2.8.5 *Non-compliance with the rules in 6.2.8 shall be a Restricted Discretionary activity.*

~~**6.2.9 Te Hokowhitu-a-Tu Marae Amenity, Acoustic Fence (Planning Map 105B and Appendix 6.6.1)**~~

~~6.2.9.1 The northern boundary of 25B Keepa Road (Allotment 28B3C1 Rangitāiki Parish) from the northwest corner of this Allotment up to a point in line with the eastern boundary of this Allotment shall be screened with an acoustic boundary fence, with a minimum construction standard of a board-and-batten wooden fence of at least 1.8m in height.~~

~~6.2.9.2 Non-compliance with Rule 6.2.9.1 shall be a Restricted Discretionary activity.[Sub 2780]~~

Appendix 6.6.1 as shown in figure 4 below requires the following deletions & amendments –

- Updated new lots – Lot 1 DP 452650 & Lot 2 DP452650.

Appendix 6.6.1 Te Hokowhitu-a-Tu Marae

APPENDIX 4
INDICATIVE SUBDIVISION SCHEME PLANS

Pt Allotment 28B9B
Rangitaiki Parish
(Kope Drain Canal)

LOT 42
306m²
TO VEST AS RESERVE

LOT 40
2710m²
TO VEST AS RESERVE

LOT 17 690m² | LOT 18 550m² | LOT 19 550m² | LOT 20 550m² | LOT 21 550m² | LOT 22 600m² | LOT 23 745m² | LOT 24 603m² | LOT 27 664m² | LOT 28 773m² | LOT 35 818m² | LOT 36 954m²

LOT 41 4848m²
TO VEST AS ROAD (15.0m)

LOT 25 555m² | LOT 26 579m² | LOT 29 615² | LOT 34 658m² | LOT 33 658m² | LOT 37 616m² | LOT 30 547m² | LOT 31 547m² | LOT 32 547m² | LOT 38 626m² | LOT 39 645m²

SEGREGATION STRIP

LOT 16 792m² | LOT 15 835m² | LOT 14 714m² | LOT 13 704m² | LOT 11 556m² | LOT 10 556m² | LOT 9 556m² | LOT 12 756m² | LOT 8 756m² | LOT 6 556m² | LOT 5 556m² | LOT 4 556m² | LOT 7 756m² | LOT 3 756m² | LOT 1 705m² | LOT 2 678m²

KEEPA ROAD

LOT 43
149m²
TO VEST AS RESERVE

LOT 44
85m²
TO VEST AS RESERVE

LOT 45
1252m²
TO VEST AS RESERVE

Pt Allotment 28B22
Rangitaiki Parish
485420

LOT 90 4859m²
TO VEST AS ROAD (16.0m)

LOT 79 1288m² | LOT 82 937m² | LOT 78 712m² | LOT 77 1347m² | LOT 83 727m² | LOT 80 564m² | LOT 81 536m² | LOT 87 779m² | LOT 84 591m² | LOT 85 564m² | LOT 86 564m² | LOT 88 648m² | LOT 89 703m² | LOT 75 706m² | LOT 76 714m² | LOT 74 879m² | LOT 73 605m² | LOT 53 617m² | LOT 52 680m² | LOT 54 625m² | LOT 49 620m² | LOT 48 620m² | LOT 55 625m² | LOT 51 757m² | LOT 46 895m² | LOT 50 890m² | LOT 56 730m² | LOT 57 703m² | LOT 58 711m² | LOT 47 857m² | LOT 70 876m² | LOT 72 605m² | LOT 71 605m² | LOT 69 870m² | LOT 68 675m² | LOT 67 954m² | LOT 66 760m² | LOT 65 750m² | LOT 64 794m² | LOT 62 700m² | LOT 61 728m² | LOT 59 1125m² | LOT 60 1054m² | LOT 63 983m² | LOT 91 1106m²

GATEWAY DRIVE

STATE HIGHWAY 30

Lot 1 DPS 18658
SA17A/983

Allotment 28B3C2A
422542

Allotment 28B3C2B
SA4A/1328

Lot 1 DP 452650

Allotment 28B3C1
Rangitaiki Parish
356691
(Marae)

Lot 9 DPS 46433
CFR SA42B/673
DC Scrimgeour

Lot 2 DPS 91291
CFR SA72B/127
Ashton Inc Ltd

Lot 1 DPS 91291
CFR SA72B/126
Ashton Inc Ltd

ot 2 DPS 71380
CFR SA57B/677
LM & JA Law

es NZ

NOTES:

1. THESE NOTES ARE AN INTEGRAL PART OF THIS PLAN.
2. COORDINATES ARE IN TERMS NZGD2000, BAY OF PLENTY CIRCUIT
3. THIS PLAN HAS BEEN CARRIED OUT TO TOPOGRAPHICAL STANDARDS AND ALL CRITICAL DIMENSIONS AND LEVELS SHOULD BE VERIFIED
4. BOUNDARIES SHOWN ON THIS PLAN ARE FROM LAND INFORMATION NZ DCDB AND HAVE NOT BEEN SURVEYED. A BOUNDARY DEFINITION SURVEY SHOULD BE CARRIED OUT TO ESTABLISH EXACT BOUNDARY POSITIONS ON SITE.
5. ALL EASEMENTS, COVENANTS AND OTHER LEGAL INSTRUMENTS ASSOCIATED WITH THIS SITE MAY NOT BE SHOWN ON THIS PLAN. AN INVESTIGATION OF THE MOST CURRENT LEGAL RECORDS SHOULD BE UNDERTAKEN PRIOR TO DESIGN AND CONSTRUCTION COMMENCING.
6. SERVICES POSITIONS AND ALIGNMENT MAY HAVE BEEN OBTAINED FROM THIRD PARTY RECORDS AND SHOULD BE VERIFIED ON SITE PRIOR TO CONSTRUCTION COMMENCING. EAST BAY SURVEYORS (2014) LTD DOES NOT IN ANY WAY GUARANTEE THE ACCURACY OF ANY UNDERGROUND SERVICE SHOWN ON THIS PLAN.
7. THIS PLAN IS ISSUED FOR A SPECIFIC PROJECT AND MAY NOT BE ALTERED OR USED FOR ANY OTHER PURPOSE WITHOUT THE PRIOR WRITTEN CONSENT OF EAST BAY SURVEYORS (2014) LTD.
8. BOUNDARY BEARINGS AND DISTANCES AND AREAS SHOWN ARE SUBJECT TO A FULL LEGAL SURVEY AND APPROVAL BY LAND INFORMATION NZ.

EAST BAY SURVEYORS (2014) LTD
Surveying & Land Development
48 Domain Road, Whakatane 07 307 9088

REF	REVISIONS	BY	DATE
B	ADD LOTS 63 TO 67	SRW	03/02/2017

PROJECT:
PROPOSED SUBDIVISION OF
ALLOTMENT 28B9B2A AND
LOT 2 DP 452650

TITLE:
LYSAGHT DEVELOPMENTS
23 & 45 KEEPA ROAD
WHAKATANE

ORIGINATOR: -	——	SIGNED:	PLOT BY: SRW
DRAWN: SRW	22/11/16	SIGNED:	PLOT DATE: 22/11/16
CHECKED: BWP	03/02/17	SIGNED:	SURVEY BY: -
APPROVED: SRW	03/02/17	SIGNED:	SURVEY DATE: -

ISSUE STATUS: CLIENT ISSUE

PROJECT No: 2106	SCALES: NTS	A3
DRAWING No: 2106-SC02		B

LOT 86
2698m²
TO VEST AS RESERVE

Pt Allotment 28B9B
Rangitaiki Parish
(Kope Drain Canal)

LOT 56 1395m² | LOT 57 735m² | LOT 58 722m² | LOT 59 530m² | LOT 60 540m² | LOT 61 540m² | LOT 62 540m² | LOT 63 540m² | LOT 64 590m² | LOT 65 739m² | LOT 66 581m² | LOT 67 564m² | LOT 68 722m² | LOT 69 509m² | LOT 70 529m² | LOT 71 593m² | LOT 72 604m² | LOT 73 555m² | LOT 74 505m² | LOT 75 650m² | LOT 76 938m² | LOT 77 647m² | LOT 78 776m² | LOT 79 550m² | LOT 80 550m² | LOT 81 692m² | LOT 82 692m² | LOT 83 550m² | LOT 84 601m² | LOT 85 672m²

LOT 89 6104m²
TO VEST AS ROAD (16.0m)

SEGREGATION STRIP

LOT 53 751m² | LOT 54 946m² | LOT 55 778m² | LOT 50 552m² | LOT 51 658m² | LOT 52 787m² | LOT 44 564m² | LOT 45 564m² | LOT 46 605m² | LOT 47 595m² | LOT 48 552m² | LOT 49 552m²

KEEPA ROAD

DPS 91291
SA72B/126
hton Inc Ltd

Lot 9 DPS 46433
CFR SA42B/673
DC Scrimgeour

ot 2 DPS 91291
CFR SA72B/127
Ashton Inc Ltd

Allotment 28B3C1
Rangitaiki Parish
356691
(Marae)

DRIVE

LOT 91 1106m² | LOT 37 900m² | LOT 38 840m² | LOT 39 691m² | LOT 40 603m² | LOT 41 546m² | LOT 42 545m² | LOT 43 545m² | LOT 87 2040m² TO VEST AS RESERVE

Lot 1 DPS 18658
SA17A/983

(Marae)
1061m²
TO VEST AS ROAD

Lot 1 DPS 18658
721m²
TO VEST AS ROAD

LOT 88
1561m²
TO VEST AS ROAD

LOT 1 570m² | LOT 2 560m² | LOT 3 506m² | LOT 4 690m² | LOT 5 778m² | LOT 6 633m² | LOT 7 600m² | LOT 8 600m² | LOT 9 611m² | LOT 10 664m² | LOT 11 697m² | LOT 12 714m² | LOT 13 685m² | LOT 14 600m² | LOT 15 600m² | LOT 16 665m² | LOT 17 934m² | LOT 18 684m² | LOT 19 625m² | LOT 20 601m² | LOT 21 774m² | LOT 22 605m² | LOT 23 846m² | LOT 24 768m² | LOT 25 873m² | LOT 26 695m² | LOT 27 622m² | LOT 28 581m² | LOT 29 621m² | LOT 30 663m² | LOT 31 633m² | LOT 32 784m² | LOT 33 681m² | LOT 34 755m² | LOT 35 725m² | LOT 36 792m²

Allotment 28B3C2A
422542

Allotment 28B3C2B
SA4A/1328

ot 1 DP 452650

LOT 90 6668m²
TO VEST AS ROAD (16.0m)

STATE HIGHWAY 30

LOT 86
552m²
TO VEST AS RESERVE

Pt Allotment 28B22
Rangitaiki Parish
485420

NOTES:

1. THESE NOTES ARE AN INTEGRAL PART OF THIS PLAN.
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3. THIS PLAN HAS BEEN CARRIED OUT TO TOPOGRAPHICAL STANDARDS AND ALL CRITICAL DIMENSIONS AND LEVELS SHOULD BE VERIFIED
4. BOUNDARIES SHOWN ON THIS PLAN ARE FROM LAND INFORMATION NZ DCDB AND HAVE NOT BEEN SURVEYED. A BOUNDARY DEFINITION SURVEY SHOULD BE CARRIED OUT TO ESTABLISH EXACT BOUNDARY POSITIONS ON SITE.
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EAST BAY SURVEYORS (2014) LTD
Surveying & Land Development
48 Domain Road, Whakatane 07 307 9088

REF	REVISIONS	BY	DATE
C	INCREASE THE SIZE OF LOT 87	SRW	15/05/17
B	CREATE LOT 87 TO VEST AS RESERVE	SRW	03/05/17

PROJECT:
PROPOSED SUBDIVISION OF
ALLOTMENT 28B9B2A AND
LOT 2 DP 452650

TITLE:
LYSAGHT DEVELOPMENTS
23 & 45 KEEPA ROAD
WHAKATANE

ORIGINATOR: -		SIGNED:	PLOT BY: SRW
DRAWN: SRW	05/04/17	SIGNED:	PLOT DATE: 05/04/17
CHECKED: -		SIGNED:	SURVEY BY: -
APPROVED: -		SIGNED:	SURVEY DATE: -

ISSUE STATUS: CLIENT ISSUE

PROJECT No: 2106	SCALES: A3 1:1250	A3
DRAWING No: 2106-SC03		C

APPENDIX 5
EAST BAY SURVEYORS - ENGINEERING SERVICES ASSESSMENT

EAST BAY SURVEYORS
(2014) LTD
Surveying & Land Development

Lysaght Developments

Proposed Subdivision of 23 & 45 Keepa Road, Whakatane

ENGINEERING SERVICES ASSESSMENT REPORT FOR RE ZONING APPLICATION

February 2017

Lysaght Developments

Engineering Assessment Report

CONTENTS

APPENDICES

1. INTRODUCTION

The purpose of this report is to provide an engineering services assessment for the proposed subdivision and rezoning of 23 and 45 Keepa Road, Whakatane. Services assessed include water, wastewater and stormwater.

The two underlying allotments are Lot 2 DP 452650 and Allotment 28B9B2A Rangitaiki Parish.

The property details are as follows:

Legal Description	Address	Size	Certificate of Title
Lot 2 DP 452650	23 Keepa Road, Whakatane	4.1010ha	580116
Allotment 28B9B2A	45 Keepa Road, Whakatane	3.3462ha	580116

The local territorial authority is the Whakatane District Council (WDC). The following report considers each of the services outlined above and refers to information provided by the applicant, the Whakatane District Council and from our investigations. This report also refer to the WDC Engineering Code of Practice and NZS 4404:2010 throughout.

2. PROPOSAL

The applicant proposes to subdivide the above two properties into approximately 84 residential sections with access off Keepa Road. To achieve this, the two properties need to be re zoned from light industrial to residential.

A scheme plan illustrating the proposed subdivision is included as Appendix 1.

3. INVESTIGATION

A number of investigations have been completed to date include a topographical survey of Allotment 28B9B2A, a stormwater assessment associated with the design of the pump station situated on the eastern side of Keepa Road, a 2003 Gulf Resource Management LTD ground contamination report and a noise assessment by Hegley Acoustic. See attached appendices for reports.

4. SITE DESCRIPTION / FINDINGS

The project site consists of two properties Lot 2 DP 452650 and Allotment 28B9B2A Rangitaiki Parish, which are situated on the western side of Keepa Road and are separated by the entrance to the adjacent Marae.

The properties are surrounded by the Kope Canal to the north, State Highway 30 to the south and the Marae and the Gateway Industrial area to the west.

A ridge line runs through the adjacent properties to the west of Lot 2 DP 452650 and continues through Allotment 28B9B2A, with an approximate elevation of 3.0m (Moturiki Datum). The two properties slope downwards from the ridgeline to a low point on the eastern boundary of Lot 2 DP 452650, adjacent to the bend in the Keepa Road alignment, where there is a culvert under the road. The approximate elevation of the low point is 1.3m (Moturiki Datum). All of the stormwater runoff from the properties flow to this point apart from the western corner of Allotment 28B9B2A Rangitaiki Parish, where there is a ponding area.

Both properties are covered in pasture with stock proof fencing around the perimeter. Allotment 28B9B2A contains a dwelling and farm sheds associated with the pony club, which operates from the property. There are a number of trees situated on Allotment 28B9B2A and a number of stockpiles of material.

Thirty two bores were completed over the two properties by Shrimpton and Lipinski Ltd in 2001. The majority of the bores recorded the natural ground as bluish gray fine sandy silt, moist, stiff and slightly plastic. The occasional borehole show sand and silty sand material. Ground water was encountered in a number of the boreholes.

This report does not cover the geotechnical nature of the site as a full geotechnical assessment will be undertake by Tonkin and Taylor.

5. WATER SUPPLY

Water demand from the new dwellings is based on the figures stated in the WDC COP and NZS 4404:2010. With daily consumption of 250 litres/person/day and an average number of people per dwelling of 3.1, the maximum daily demand will be 65,100 litres/day from the 84 dwellings. With a peaking factor of 5, we expect the peak demand to be 3.76 litres/second.

The Whakatane District Council staff have indicated that there is capacity within the existing water main running along Keepa Road to supply the development. Also the general pressure within the water main running along Keepa Road is in excess of 80m head, which will provide enough pressure to get water to the second floor of any new dwelling.

6. WASTEWATER

Wastewater demand from the proposed dwellings are based on the figures stated in the WDC COP and NZS 4404:2010. With an average sewage flow of 250 litres per head per day and an average number of people per dwelling of 3.5, the maximum daily demand will 73,500 litres/day from the 84 dwellings. With a peaking factor of 2.5, we expect the peak demand to be 2.13 litre/second.

It is proposed that a new 150mm main will be laid along each of the new roads and will lead to a new pump station situated at a low point adjacent to Keepa Road. A rising main will run from the proposed pump station to the existing sewer situated on Gateway Drive. The Whakatane District Council engineers have confirmed that there is ample capacity within the Gateway Drive sewer system to handle all of the flow from the development.

7. STORMWATER

The development will be serviced by a primary system and a secondary system capable of dealing with surface water runoff, designed to protect people, properties, infrastructure and the receiving environment. The primary system will include a combination of onsite storage or ground soakage, depending on the results of future percolation tests, and a piped network, which leads to the existing pump station and stormwater pond situated on the east side of Keepa Road.

The secondary system will including overland flow paths along roads and right of ways, ponding areas and the piped network, which leads to the existing stormwater pond.

Due to the topography of the two properties, 90% of the site is contained within the catchment of the stormwater pond and pump station situated on the eastern side of Keepa Road. This stormwater pond and pump station was constructed in accordance with an agreement between the Whakatane District Council, Carter Holt Harvey and the developer of the site, Ian Lysaght.

The pump station was designed to maintain a start water level of 0.64m (Moturiki Datum) at the connection to the public stormwater system. This connection point being the western edge of Keepa Road where the existing culvert feeds the stormwater pond.

The level of 0.64m (Moturiki Datum) allows the subject properties to be developed with a gravity stormwater system draining to the existing culvert under Keepa Road. The size of the culvert under Keepa Road will most likely need to be increased as a result of the development or a second culvert installed.

The remaining 10% of the site, which is not contained with the catchment of the existing stormwater pond and pump station on the eastern side of Keepa Road, will still be serviced by the same primary system, however a pond area will be constructed as part of the secondary system.

8. CONCLUSION

We believe that the proposed development of Lot 2 DP 452650 and Allotment 28B9B2A Rangitaiki Parish can be adequately served in terms of the core engineering services – water, wastewater and stormwater. Our recommendations are as follows:

- Two new water connections are made into the Council main running along Keepa Road, which will service the two new roads.
- All sewage from the development will flow to a new sewage pump station constructed adjacent to Keepa Road. A rising main will lead to the Whakatane District Council sewer network running along Gateway Drive, which in turn leads to a pump station and the oxidation ponds.
- All stormwater runoff from the development can be controlled via a primary system including ground soakage, onsite storage and the piped network, which leads to the existing stormwater pump station. A secondary system will included a ponding area situated in the northwest corner of Allotment 28B9B2A Rangitaiki Parish, overland flowpaths along the roads and right of ways, and the piped network, which leads to the existing stormwater pond.

In conclusion, there is no reason from an engineering services perspective, why this development should not proceed.

APPENDIX 1

Subdivision Scheme Plan

Pt Allotment 28B9B
Rangitaiki Parish
(Kope Drain Canal)

LOT 42
306m²
TO VEST AS RESERVE

LOT 40
2710m²
TO VEST AS RESERVE

LOT 17 690m² | LOT 18 550m² | LOT 19 550m² | LOT 20 550m² | LOT 21 550m² | LOT 22 600m² | LOT 23 745m² | LOT 24 603m² | LOT 27 664m² | LOT 28 773m² | LOT 35 818m² | LOT 36 954m²

LOT 41 4848m²
TO VEST AS ROAD (15.0m)

LOT 25 555m² | LOT 26 579m² | LOT 29 615² | LOT 34 658m² | LOT 33 658m² | LOT 37 616m² | LOT 30 547m² | LOT 31 547m² | LOT 32 547m² | LOT 38 626m² | LOT 39 645m²

SEGREGATION STRIP

LOT 16 792m² | LOT 15 835m² | LOT 14 714m² | LOT 13 704m² | LOT 11 556m² | LOT 10 556m² | LOT 9 556m² | LOT 12 756m² | LOT 8 756m² | LOT 6 556m² | LOT 5 556m² | LOT 4 556m² | LOT 7 756m² | LOT 3 756m² | LOT 1 705m² | LOT 2 678m²

KEEPA ROAD

LOT 43
149m²
TO VEST AS RESERVE

LOT 44
85m²
TO VEST AS RESERVE

LOT 45
1252m²
TO VEST AS RESERVE

Pt Allotment 28B22
Rangitaiki Parish
485420

LOT 90 4859m²
TO VEST AS ROAD (16.0m)

LOT 79 1288m² | LOT 82 937m² | LOT 78 712m² | LOT 77 1347m² | LOT 83 727m² | LOT 80 564m² | LOT 81 536m² | LOT 87 779m² | LOT 84 591m² | LOT 85 564m² | LOT 86 564m² | LOT 88 648m² | LOT 89 703m² | LOT 75 706m² | LOT 76 714m² | LOT 74 879m² | LOT 73 605m² | LOT 53 617m² | LOT 52 680m² | LOT 54 625m² | LOT 49 620m² | LOT 48 620m² | LOT 55 625m² | LOT 51 757m² | LOT 46 895m² | LOT 50 890m² | LOT 56 730m² | LOT 57 703m² | LOT 58 711m² | LOT 47 857m² | LOT 70 876m² | LOT 72 605m² | LOT 71 605m² | LOT 69 870m² | LOT 68 675m² | LOT 67 954m² | LOT 66 760m² | LOT 65 750m² | LOT 64 794m² | LOT 62 700m² | LOT 61 728m² | LOT 59 1125m² | LOT 60 1054m² | LOT 63 983m² | LOT 91 1106m²

GATEWAY DRIVE

STATE HIGHWAY 30

Lot 1 DPS 18658
SA17A/983

Allotment 28B3C2A
422542

Allotment 28B3C2B
SA4A/1328

Lot 1 DP 452650

Allotment 28B3C1
Rangitaiki Parish
356691
(Marae)

Lot 9 DPS 46433
CFR SA42B/673
DC Scrimgeour

Lot 2 DPS 91291
CFR SA72B/127
Ashton Inc Ltd

Lot 1 DPS 91291
CFR SA72B/126
Ashton Inc Ltd

ot 2 DPS 71380
CFR SA57B/677
LM & JA Law

es NZ

NOTES:

1. THESE NOTES ARE AN INTEGRAL PART OF THIS PLAN.
2. COORDINATES ARE IN TERMS NZGD2000, BAY OF PLENTY CIRCUIT
3. THIS PLAN HAS BEEN CARRIED OUT TO TOPOGRAPHICAL STANDARDS AND ALL CRITICAL DIMENSIONS AND LEVELS SHOULD BE VERIFIED
4. BOUNDARIES SHOWN ON THIS PLAN ARE FROM LAND INFORMATION NZ DCDB AND HAVE NOT BEEN SURVEYED. A BOUNDARY DEFINITION SURVEY SHOULD BE CARRIED OUT TO ESTABLISH EXACT BOUNDARY POSITIONS ON SITE.
5. ALL EASEMENTS, COVENANTS AND OTHER LEGAL INSTRUMENTS ASSOCIATED WITH THIS SITE MAY NOT BE SHOWN ON THIS PLAN. AN INVESTIGATION OF THE MOST CURRENT LEGAL RECORDS SHOULD BE UNDERTAKEN PRIOR TO DESIGN AND CONSTRUCTION COMMENCING.
6. SERVICES POSITIONS AND ALIGNMENT MAY HAVE BEEN OBTAINED FROM THIRD PARTY RECORDS AND SHOULD BE VERIFIED ON SITE PRIOR TO CONSTRUCTION COMMENCING. EAST BAY SURVEYORS (2014) LTD DOES NOT IN ANY WAY GUARANTEE THE ACCURACY OF ANY UNDERGROUND SERVICE SHOWN ON THIS PLAN.
7. THIS PLAN IS ISSUED FOR A SPECIFIC PROJECT AND MAY NOT BE ALTERED OR USED FOR ANY OTHER PURPOSE WITHOUT THE PRIOR WRITTEN CONSENT OF EAST BAY SURVEYORS (2014) LTD.
8. BOUNDARY BEARINGS AND DISTANCES AND AREAS SHOWN ARE SUBJECT TO A FULL LEGAL SURVEY AND APPROVAL BY LAND INFORMATION NZ.

EAST BAY SURVEYORS (2014) LTD
Surveying & Land Development
48 Domain Road, Whakatane 07 307 9088

REF	REVISIONS	BY	DATE
B	ADD LOTS 63 TO 67	SRW	03/02/2017

PROJECT:
PROPOSED SUBDIVISION OF
ALLOTMENT 28B9B2A AND
LOT 2 DP 452650

TITLE:
LYSAGHT DEVELOPMENTS
23 & 45 KEEPA ROAD
WHAKATANE

ORIGINATOR: -	——	SIGNED:	PLOT BY: SRW
DRAWN: SRW	22/11/16	SIGNED:	PLOT DATE: 22/11/16
CHECKED: BWP	03/02/17	SIGNED:	SURVEY BY: -
APPROVED: SRW	03/02/17	SIGNED:	SURVEY DATE: -

ISSUE STATUS: CLIENT ISSUE

PROJECT No: 2106	SCALES: NTS	A3
DRAWING No: 2106-SC02		B

LOT 86
2698m²
TO VEST AS RESERVE

Pt Allotment 28B9B
Rangitaiki Parish
(Kope Drain Canal)

LOT 56 1395m² | LOT 57 735m² | LOT 58 722m² | LOT 59 530m² | LOT 60 540m² | LOT 61 540m² | LOT 62 540m² | LOT 63 540m² | LOT 64 590m² | LOT 65 739m² | LOT 66 581m² | LOT 67 564m² | LOT 68 722m² | LOT 69 509m² | LOT 70 529m² | LOT 71 593m² | LOT 72 604m² | LOT 73 555m² | LOT 74 505m² | LOT 75 650m² | LOT 76 938m² | LOT 77 647m² | LOT 78 776m² | LOT 79 550m² | LOT 80 550m² | LOT 81 692m² | LOT 82 692m² | LOT 83 550m² | LOT 84 601m² | LOT 85 672m²

LOT 89 6104m²
TO VEST AS ROAD (16.0m)

SEGREGATION STRIP

LOT 53 751m² | LOT 54 946m² | LOT 55 778m² | LOT 50 552m² | LOT 51 658m² | LOT 52 787m² | LOT 44 564m² | LOT 45 564m² | LOT 46 605m² | LOT 47 595m² | LOT 48 552m² | LOT 49 552m²

KEEPA ROAD

DPS 91291
SA72B/126
hton Inc Ltd

Lot 9 DPS 46433
CFR SA42B/673
DC Scrimgeour

ot 2 DPS 91291
CFR SA72B/127
Ashton Inc Ltd

Allotment 28B3C1
Rangitaiki Parish
356691
(Marae)

DRIVE

LOT 91 1106m² | LOT 37 900m² | LOT 38 840m² | LOT 39 691m² | LOT 40 603m² | LOT 41 546m² | LOT 42 545m² | LOT 43 545m² | LOT 87 2040m² TO VEST AS RESERVE

Lot 1 DPS 18658
SA17A/983

(Marae)
1061m²
TO VEST AS ROAD

Lot 1 DPS 18658
721m²
TO VEST AS ROAD

LOT 88
1561m²
TO VEST AS ROAD

LOT 1 570m² | LOT 2 560m² | LOT 3 506m² | LOT 4 690m² | LOT 5 778m² | LOT 6 633m² | LOT 7 600m² | LOT 8 600m² | LOT 9 611m² | LOT 10 664m² | LOT 11 697m² | LOT 12 714m² | LOT 13 685m² | LOT 14 600m² | LOT 15 600m² | LOT 16 665m² | LOT 17 934m² | LOT 18 684m² | LOT 19 625m² | LOT 20 601m² | LOT 21 774m² | LOT 22 605m² | LOT 23 846m² | LOT 24 768m² | LOT 25 873m² | LOT 26 695m² | LOT 27 622m² | LOT 28 581m² | LOT 29 621m² | LOT 30 663m² | LOT 31 633m² | LOT 32 784m² | LOT 33 681m² | LOT 34 755m² | LOT 35 725m² | LOT 36 792m²

Allotment 28B3C2A
422542

Allotment 28B3C2B
SA4A/1328

ot 1 DP 452650

LOT 90 6668m²
TO VEST AS ROAD (16.0m)

STATE HIGHWAY 30

LOT 86
552m²
TO VEST AS RESERVE

Pt Allotment 28B22
Rangitaiki Parish
485420

NOTES:

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8. BOUNDARY BEARINGS AND DISTANCES AND AREAS SHOWN ARE SUBJECT TO A FULL LEGAL SURVEY AND APPROVAL BY LAND INFORMATION NZ.

EAST BAY SURVEYORS (2014) LTD
Surveying & Land Development
48 Domain Road, Whakatane 07 307 9088

REF	REVISIONS	BY	DATE
C	INCREASE THE SIZE OF LOT 87	SRW	15/05/17
B	CREATE LOT 87 TO VEST AS RESERVE	SRW	03/05/17

PROJECT:
PROPOSED SUBDIVISION OF
ALLOTMENT 28B9B2A AND
LOT 2 DP 452650

TITLE:
LYSAGHT DEVELOPMENTS
23 & 45 KEEPA ROAD
WHAKATANE

ORIGINATOR: -		SIGNED:	PLOT BY: SRW
DRAWN: SRW	05/04/17	SIGNED:	PLOT DATE: 05/04/17
CHECKED: -		SIGNED:	SURVEY BY: -
APPROVED: -		SIGNED:	SURVEY DATE: -

ISSUE STATUS: CLIENT ISSUE

PROJECT No: 2106	SCALES: A3 1:1250	A3
DRAWING No: 2106-SC03		C

APPENDIX 2

Certificate of Title

COMPUTER FREEHOLD REGISTER
UNDER LAND TRANSFER ACT 1952

Search Copy

R.W. Muir
Registrar-General
of Land

Identifier	**703340**
Land Registration District	**South Auckland**
Date Issued	30 June 2015

Prior References
618062

Estate	Fee Simple
Area	8.0251 hectares more or less
Legal Description	Lot 12 Deposited Plan 372970 and Lot 27-28 Deposited Plan 326716 and Allotment 28B9B2A Parish of Rangitaiki

Proprietors
Ian Wallace Lysaght and Adrianne June Lysaght

Interests

H859770 Gazette Notice declaring State Highway No.30 (Pokeno - Wellington) to be a limited access road - 16.3.1989 at 1:31 pm

Subject to a right (in gross) to drain sewage and stormwater over part Lot 28 DP 326716 marked A and over part Lot 27 DP 326716 marked B all on DP 326716 in favour of Whakatane District Council created by Transfer B657416.2 - produced 7.5.2001 at 11:00 am and entered 22.5.2001 at 9:00 am

The easements created by Transfer B657416.2 are subject to Section 243(a) Resource Management Act 1991

APPENDIX 3

Keepa Road Pump Station Report

Stormwater SOLUTIONS

Pump Station Options Review

WDC Approval Information

CHH Landfill, Keepa Road

Whakatane

PREPARED FOR

CARTER HOLT HARVEY

PREPARED BY

STORMWATER SOLUTIONS CONSULTING LTD

7TH NOVEMBER 2008

Distribution:

Harrison and Grierson	1 copy
SSCL	2 copies
CHH	1 copy
Gill Chappell	1 copy
WDC	2 copies
Martin Williams	1 copy

PO Box 25 598, St Heliers, Auckland Ph 09 974 2170 Fax 09 522 2129

Table of Contents

Appendices:

1 INTRODUCTION

An options assessment for the proposed stormwater pump station to be located on the Carter Holt Harvey (CHH) landfill site has been undertaken at the request of CHH. This assessment considers the design parameters as discussed between Whakatane District Council (WDC), Lysaght Developments Ltd and CHH representatives between August and October 2008.

This report covers the background to the options review, catchment characteristics, pump station options and operation as well as recommendations for implementation of the best practicable option for a pump station.

This report includes information presented within the Pump Station Options Review report, dated 19th September 2008, and the Additional Information report, dated 8th October 2008.

2 BACKGROUND INFORMATION

The CHH landfill site has a current land use consent, which was issued in 1986, with conditions to provide for drainage for the contributing catchment by way of construction of a pump station to pump stormwater to the Whakatane River. Recent discussions with all affected parties have resulted in agreement for a pump station to be constructed to provide adequate drainage for the contributing catchment during a 10year average recurrence interval (ARI) rainfall event.

The design of the pump station is to incorporate various catchment demands and ensure upstream contributions during rainfall events are managed to WDC and Environment Bay of Plenty (EBoP) standards.

2.1 BACKGROUND DATA

The review and assessment of the catchment and stormwater management have been based on the following documents and plans:

- Rainford and Rutledge drawing 1899/1, July 1984, which formed part of the consent application
- John Rainford and Co[1] drawing 1899/1, July 1984 with additional information added in June 1986 as stated on the drawing. The additional information added survey levels

[1] Rainford and Rutledge changed its name to John Rainford and Co between 1984 and 1986 then subsequently to Rainford Patterson and Kane Ltd in 1988

- Beca Simons Drawings numbers 701026-3, 4 and 5, October 1986
- Survey of Landfill site, post filling, undertaken by Harrison Grierson, drawing supplied by MSC Consulting Group Ltd, September 2006
- Whakatane District Council Engineering Code of Practice, Issue 6.0 March 1998 ("CoP Issue 6.0")
- Whakatane District Council Engineering Code of Practice Issue 8.0 (April 2008) ("CoP Issue 8.0").

2.2 RESOURCE CONSENT STATUS

The catchment currently discharges stormwater runoff through a 450mm diameter culvert to the Whakatane River, as shown in drawing 1039/SK507, Appendix A. This culvert was provided for the purpose of stormwater discharge and conveyance by the predecessor of EBoP when the stop bank was built.

A resource consent for discharge of stormwater from the pump station to the Whakatane River is expected to be required from EBoP. In addition, approval from EBoP will need to be obtained to construct the Pump station and the associated discharge pipeline, from the pump station, through the stop bank, as per the current floodway and drainage bylaw or any other bylaw that is relevant.

3 CATCHMENT CONDITIONS AND ASSESSMENT CRITERIA

The stormwater management catchment is defined as that contributing to the existing 450mm diameter culvert that discharges the runoff to the Whakatane River. This catchment has changed during the last 20 years with the development of "the Hub" which is adjacent to the catchment. The catchment has been assessed at present day drainage conditions.

This assessment is also based on the Rational Method runoff coefficients for the 10year annual recurrence interval (ARI) rainfall events. The Rational Method runoff coefficients and rainfall event return period is also described in detail in the following sub sections

3.1 CATCHMENT CONDITIONS

The catchment has changed in size from 1986 to present day due to the development of the Hub, adjacent to SH30. In total the original catchment area was 32.6ha, whilst the present day catchment area is 21.9ha. The catchment is divided into 3 sub catchments, as shown in drawing SK507, Appendix A, and described briefly as follows:

- Sub catchment A:
    - 8.0ha in total
    - west of Keepa Road
    - The Lysaght Developments Ltd property is situated within this sub catchment
- Sub catchment B
    - 1ha, more or less
    - situated south of State Highway 30
    - Originally included the Hub development which now drains to the new pump station situated within CHH land to the south of SH30
- Sub catchment C
    - 12.9ha
    - situated east of Keepa Road
    - the Landfill site.

The whole catchment has a relatively flat ground surface slope of approximately 0.5%, on average, and is serviced by interconnecting culverts and drains. Sub catchments A and B discharge to sub catchment C via culverts under Keepa Road and State Highway 30 respectively.

The subcatchment C outlet is the 450mm diameter culvert beneath the Whakatane River Stop bank. This culvert has an invert level of RL 0.55m (Moturiki Datum). During rainfall events the flap gate at the outlet of the 450mm diameter culvert closes as the Whakatane River water level rises above the invert level of the culvert. When this happens the catchment has no outlet until the Whakatane River level subsides and the flap gate re-opens.

3.2 RAINFALL DURATION AND RETURN PERIOD

The appropriate rainfall event return period for the design of the pump station is a 1 in 10 year average recurrence interval (ARI). This is consistent with WDC Code of Practice (CoP) issue 8.0.

The total duration of the design storm is 72 hours, being representative of the duration that the Whakatane River water levels can be affected by a significant catchment-wide rainfall event.

The "critical storm duration" is the duration of the storm which results in the highest top water level during a 10 year rainfall event. This will vary depending on the pump station selection and operation.

The 100year ARI flood assessment has also been undertaken with various pump station options to assess the effects of the maximum flood level during this event on any built environment within the catchment and meeting the EBoP recommendation of RL2.2m for the minimum finished floor level of any building within the catchment. The assessment is based on the Rational Method with higher runoff coefficients due to the more saturated soil conditions in the 100year ARI event.

3.3 RUNOFF COEFFICIENTS

Infiltration testing has been carried out within the Landfill to determine appropriate runoff coefficients for the 100year ARI rainfall events within sub-catchment C. The surface and subsoil strata have been tested in three separate locations by double ring infiltration and constant head permeability tests respectively. The resultant volumetric runoff coefficients vary for the various rainfall duration applications, between 0.71 and 0.32, as presented in Table 1.The results of the testing are appended, Appendix B.

The runoff coefficients for the 10year ARI event follow the recommendations within the WDC Engineering Code of Practice, which has been agreed by all parties during caucusing, whilst those for the 100year ARI event are taken from the test results and presented in Table 1.

Note that the runoff coefficients referred to in this report and used for modelling are volumetric coefficients, i.e. the coefficient is the fraction of rainfall that contributes to the volume of runoff for a particular duration.

Table 1: Runoff coefficients in 10year and 100year ARI events

Scenario	Fully Developed Commercial Land	Grassed Surface
10year ARI	0.85	0.35
100year ARI	0.9	0.71-0.32
Rainfall duration;		
10 min		0.71
20min		0.64
30min		0.64
1 hr		0.51
2 hr		0.32

3.4 RIVER LEVELS

Design of the pump station assumes that the flap gate associated with the 450mm culvert that discharges to the Whakatane River is shut over a period of 72 hours. This assumption is derived from hydrological modelling that was undertaken by EBoP of the Whakatane River catchment and is the period of time that the Whakatane River water level will be elevated during a catchment wide rainfall event causing the 450mm diameter culvert flap gate to be shut.

3.5 DEVELOPMENT POTENTIAL

In terms of assessing the stormwater effects that one activity has on another part of the catchment it is common practice to assume that the catchment is developed to its full potential.

The zones and the levels of development possible within specific zones are governed by the Whakatane District Plan zone standards. The landfill site (sub catchment C) is zoned Rural 1 and it can be assumed that any development other than that consistent with rural type development would be unlikely in the absence of a plan change. Sub catchments A and B are zoned Business 3 and therefore can be developed for this purpose.

4 PUMP STATION DESIGN CRITERIA

There are a number of aspects that need to be considered for the design of the pump station. These have been divided into two groups, being principal design criteria which have been the subject of previous discussions and are the main drivers in selecting pump flow capacities and additional criteria, which are related to detailed design.

4.1 PRINCIPAL DESIGN CRITERIA

The pump station is to be designed as part of the stormwater management solution for the contributing catchment to cater for a 10 year ARI rainfall event. The design criteria agreed at the scoping meeting held between representatives of WDC, Lysaght Developments Ltd and CHH on 12/9/08 are:

- Top water level at the western edge of Keepa Road to be between RL0.84m and RL1.14m
- The pump start level to be between RL0.6m and RL0.7m
- The minimum water level adjacent to the pump station during pump station operation shall be between RL0.2m and RL0.3m.

The effects of the above design criteria on the number of pumps and the pump sizes required have been addressed in detail by modelling a number of scenarios incorporating the previously agreed range of parameters. These scenarios are described in Section 5.

Additional principal design criteria that need to be taken into account, in addition to pump size, are as follows:

- Pump start level: level set to ensure hydraulics of upstream catchment are not adversely affected i.e. a stormwater pipe design with soffit level at RL0.64m west of Keepa Road.
- Frequency of pump operation: start level is set to avoid frequent pump start/stop operations.
- Pump stop level: minimum level of draw down and influence of groundwater flows.
- Pump station configuration: influence of minimum water level on submergence, construction costs and geotechnical risk.
- Addressing whether or not to retain 450mm culvert.
- Top water level during a 100year ARI rainfall event, meeting the freeboard requirements and minimum floor level of RL2.2m for the built environment.

Each of these considerations is reviewed in detail in Section 8.

4.2 ADDITIONAL DESIGN CRITERIA

The additional design criteria that need to be considered during detailed design stage of the project are as follows:

- Ensuring the pump station structure does not have adverse effects on stop bank stability during construction and in the long term. This will be mainly related to the detailed location and design and construction of the pump station and is not considered in this report
- Ensuring minimal effects of the pumped discharge on stop bank stability and on the river itself. This will be addressed in detailed design and for the consent application to discharge pumped water to the Whakatane River
- Allowing ongoing uninterrupted access along the crest of the stop bank
- Pump station configuration, which will include, but not limited to, the inlet shape, minimizing submergence, inlet screens and penstocks

- Access to the pump station for maintenance purposes
- Electrical supply, preference for electrical supply versus onsite generator
- Provision within the electrical components for the connection of temporary power generation should it be required

5 PUMP STATION SCENARIOS

Pump station design scenarios have been established to assess the optimum pumping capacity to service the catchment under fully developed conditions. These scenarios take into consideration the design criteria that have been established by all parties involved in the development of the catchment, as described in section 4. The scenarios are described in Table 2.

The pump station capacity selection was originally made assuming two duty pumps with one standby pump. Further review has been undertaken to assess the implications of having three duty pumps, based on a variation of scenario 9 and run as scenario 13. This option assumes no standby operation and should one pump fail there would be significant reduction in pump station capacity until the pump is repaired or replaced.

The pump start and stop levels, as shown in Table 2, are for the first duty pump. The second duty pump's start and stop levels have been taken as 100mm above those of the first duty pump. The third duty pump, which has been applied to scenario 13 only, start/stop is taken as 100mm above those of the second duty pump.

- Access to the pump station for maintenance purposes
- Electrical supply, preference for electrical supply versus onsite generator
- Provision within the electrical components for temporary power generation should it be required

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The pump start and stop levels, as shown in Table 2, are for the first duty pump. The second duty pump's start and stop levels have been taken as 100mm above those of the first duty pump. The third duty pump, which has been applied to scenario 13 only, start/stop is taken as 100mm above those of the second duty pump.

Table 2: Design scenarios for pump station optimization

Scenario	Top water level west of Keepa Road(RL m)	No. of duty pumps	Pump start level (RL m)	Minimum (stop) water level (RL m)
1	1.14	2	0.6	0.2
2	1.14	2	0.6	0.3
3	1.14	2	0.7	0.2
4	1.14	2	0.7	0.3
5	0.84	2	0.6	0.2
6	0.84	2	0.6	0.3
7	0.84	2	0.7	0.2
8	0.84	2	0.7	0.3
9	1.0	2	0.6	0.2
10	1.0	2	0.6	0.3
11	1.0	2	0.7	0.2
12	1.0	2	0.7	0.3
13	1.0	3	0.6	0.2

6 MODELLING METHODOLOGY

The hydrological and hydraulic modelling for the various scenarios to optimize the pump station capacity has been simulated using MOUSE[2] software. The catchment characteristics and storage within the landfill have been determined from the catchment condition information, as per Section 3.

The pump station capacity selection has been taken as the optimum pump capacity rather than applying a discharge rating curve. The pump station discharge rating will be detailed at the next design stage. It has also been determined by the various parties, during the scoping meeting on the 12th September 2008, for this options review to have two duty pumps with one standby pump. Further review has been undertaken to assess the implications of having three duty pumps, based on a variation of scenario 9 and run as scenario 13, which is to be noted would not have a standby pump.

The inflow hydrograph for the hydrological input is based on the Rational Method, as per WDC CoP Issue 8. The inflow hydrographs for the various rainfall durations are appended for information only, in Appendix B. The rainfall depths utilized, as presented in Appendix C, have been provided by WDC. They take into consideration the effects of future increases in rainfall intensities due to climate change and are to supersede the current Table 2, CoP Issue 8.

The model assumes that the existing 600mm culvert within the Landfill immediately downstream of the Keepa Road culvert has been replaced by twin 900mm diameter culverts, which extend under Keepa Road and through to the existing Landfill Drain A, with standard head loss allowances at the inlet and outlet of the culvert.

7 MODELLING OUTCOMES

7.1 OUTCOMES OF SCENARIOS

The 10year ARI rainfall event, with durations between 10 minutes and 72 hours, has been modelled based on the catchment conditions, rainfall and river level criteria, as previously discussed in Section 3.

It is to be noted that the top water levels are presented for both the Landfill site and west of Keepa Road, which is the outfall for Sub-catchment B. The outcomes of the modelling are presented in Table 3 and supporting time series graphs of top water level appended, Appendix C.

[2] MOUSE modelling software, supplied by DHI

Table 3: 10 year ARI modelling outcomes for design scenarios

Scenario	Pump station capacity (L/s)	Top water level (RL m)		Critical storm duration (hours)
		Landfill	West Keepa Road	
1	600	1.07	1.08	1
2	600	1.07	1.08	1
3	620	1.09	1.10	1
4	620	1.09	1.10	1
5	1840	0.73	0.86	0.17 (10 min)
6	1840	0.73	0.86	0.17 (10 min)
7	3000	0.80	0.89	0.33 (20 min)
8	3000	0.80	0.89	0.33 (20 min)
9	900	0.98	1.0	1
10	900	0.98	1.0	1
11	1040	0.98	1.0	1
12	1040	0.98	1.0	1
13	1050	0.96	0.98	1

The optimum pump station capacity ranges between 600L/s to 3000L/s. The top water level has the most influence on the size of the pump station due to the increased opportunity to utilize the storage within the Landfill site. The minimum water level does not have a significant influence on the size of the pump station as shown in the results. This is illustrated by comparing the pump station capacity of scenario 1 and 2 with scenario 3 and 4, scenario 5 and 6 with scenario 7 and 8 and scenarios 9 and 10 with 11 and 12.

The critical storm duration varies from 10 minutes (0.17 hours) through to 2 hours. This is taken from the modelled storm durations between 10 minutes and 72 hours.

For scenarios 5 through to 8 the top water levels in the landfill are close to the start positions of the pump station. Therefore the storage available within the landfill is not

utilized and the required pump capacity is close to the peak discharge of the 10year 10 minute storm event. As a result the largest pump station capacity is required.

No significant changes have been found in the modelling outcomes for changing the number of duty pumps (as per scenario 13), and therefore it is reasonable to assert that the number of duty pumps will not cause adverse effects on top water level at the western side of Keepa Road for the critical duration rainfall event. No further assessment has therefore been conducted with the 3 duty pump option.

The results of the modelling have also indicated that there is no ponding on or surface flow over Keepa Road under the 10year ARI event.

8 OTHER DESIGN CONSIDERATIONS

The design considerations necessary for selecting the pump size have been reviewed. The outcome of the review is detailed in the following sub sections.

8.1 UPSTREAM CATCHMENT HYDRAULIC EFFECTS

The pump start level has an influence on the hydraulic operation of the upstream catchment during rainfall events. To assess the effects, various storm durations for the 10year rainfall event have been modelled based on the following operational assumptions:

- Initial water level within the landfill site is RL0.57m at the beginning of the storm event. This provides an initial nominal head above the invert of the culvert to allow for the start condition of ponded water with gravity drainage of base flows to occur. It is to be noted that the flap gate shuts once the rainfall occurs as the Whakatane River level rises.
- Pump start level is RL 0.6m or RL 0.7m
- Minimum water level during pumping operation is RL 0.2m or RL 0.3m.

For the hydraulic design of the stormwater system in the upstream catchment all rainfall durations have differing tail water conditions. For example should a 900L/s pump station be selected, as per scenario 9 and 10, the tail water condition at west of Keepa Road is RL 1.0m for a storm duration of 1 hour. However, during a 10year ARI 10 minute rainfall event the tail water condition is RL0.73m, being the top water level for that duration storm event.

Previous discussions with WDC, Lysaght Developments Ltd and CHH representatives have indicated that this would be acceptable for stormwater design associated with a proposed development in the upstream catchment. In addition recent agreement (with

the parties indicated previously) that the top water level west of Keepa Road would be no greater than RL1.0m during a 10year ARI rainfall event.

8.2 FREQUENCY OF PUMP OPERATION

The pump station capacity selection needs to consider the frequency of the pump operating. This is needed to check that the pumps will not operate too frequently for short durations, which would be undesirable. An assessment has been undertaken to understand how often the pumps will operate during frequent, relatively small or ongoing rainfall events. Several rainfall durations have been selected based on a 1/3 of a 2year rainfall return period.

The time to reactivate the pump during frequent rainfall events is dependent on the storage available between the minimum (pump stop) water level and the pump start water level, and the rate of inflow that fills up this storage. It does not take into consideration the size of the pump station as no pumps are operating. This assessment is therefore independent of pump capacity. It is only analysing the time to reactivate the pumps in a small rainfall event of various durations.

When water levels adjacent to the pump station reach the initial "start position" the pump will draw down water levels to the selected minimum (stop) level and the pump will stop. Runoff and any groundwater inflow will then fill up the storage available prior to the pump starting again. The selection of the pump start and stop levels will affect the storage available between those levels. The storage available for each pump start and stop scenario is shown in Table 4.

Table 4: Storage available for pump start-stop scenarios

Scenario	**Start - Stop positions** (RL m)	**Storage available** (m^3)
1,5,9,13	0.6 - 0.2	1115
3,7,11	0.7 - 0.2	1590
2,6,10	0.6 - 0.3	935
4,8,12	0.7 - 0.3	1410
Not previously presented	0.6 - 0.0	1390
Not previously presented	0.7 - 0.0	1865

The inclusion of RL 0.0m as stop position was considered to provide an understanding of the implication of utilizing the larger available storage between start and stop positions. A water level of RL 0.0m has been noted as being occurring naturally within

the Landfill, based on observation. However, other factors need to be considered with regard to the stop position, such as effects on ground water levels and the invert of the pump station.

A series of rainfall durations were run through the start-stop scenarios, as presented in Table 4, to understand if the pump would be activated again after the initial draw down to the minimum (stop) water level, due to runoff from the rainfall event. If this occurred an estimation of how long would it take before the pump would be activated again was also assessed. It is to be noted that only the first duty pump would be in operation for the initial draw down. Table 5 presents the rainfall durations together with the results.

Table 5: Frequent rainfall event activation within Landfill storage

Rainfall duration	**Rainfall intensity**[1] (mm/hr)	**Time to re-activate for each range of start/stop positions**(hr)					
		0.6-0.2	**0.7-0.2**	**0.6-0.3**	**0.7-0.3**	**0.6-0.0**	**0.7-0.0**
10min	26	nra[2]	nra	nra	nra	nra	nra
20min	17	nra	nra	nra	nra	nra	nra
30min	14.7	nra	nra	nra	nra	nra	nra
1hr	10.3	nra	nra	nra	nra	nra	nra
2hr	6.8	nra	nra	1.7[3]	nra	nra	nra
3hr	5.3	2.6	nra	2.2	nra	nra	nra
6hr	3.5	3.9	5.6	3.3	5.0	4.9	nra
12hr	2.2	6.2	8.8	5.2	7.8	7.7	10.4
24hr	1.4	9.5	13.6	8.0	12.0	11.9	15.9

Notes:

1. Rainfall intensity is for 1/3 of a 2year rainfall return period
2. nra = not re-activated due to insufficient runoff to reach start position of pump
3. 1.7 = 1.7 hours for the on-site volume between pump stop level and pump start level to be filled with runoff from the catchment.

During frequent rainfall events the first duty pump would be activated and would pump water until the minimum (stop) water level is reached. When this level is reached the pump will stop and the remainder of the runoff will continue to enter the storage volume within the landfill. The entire volume may or may not be utilized. If it is not utilised then the pump will not be activated again. This is the case for the rainfall durations up to and including 1 hour. For longer duration rainfall events the second activation of the first

pump will occur, however it takes at least 1.7 hours (102 minutes) for this to occur. These results show that any of the start/stop positions, of Table 5, would not result in overly frequent pump operation.

Groundwater inflows have not been included in this assessment. From consideration of the site conditions these will be considerably less than the accumulation of runoff due to rainfall and can be ignored for this exercise.

8.3 MINIMUM WATER LEVEL

During pump operation the water will be drawn down to a minimum (stop) level, which could influence the ground water table. During the summer period the ground water level is likely to be at or below RL0.0m, based on field observation. The draw down to RL0.2m or 0.3m will thus not affect the ground water table.

In winter months the ground water table is likely to be higher than summer and could be expected to be at RL0.3m. The pump will draw water down to at or just below this level. The length of time the water will be drawn down to this level is likely to be short. A pump minimum (stop) level, of RL 0.2m or 0.3m, will therefore not affect the groundwater table.

The observed water level within the Landfill during spring conditions is shown in Photo 1 taken on 11th September 2008. The water is sitting at or just above the RL0.0m ledge within the landfill Drain A, that leads to the 450mm culvert under the stop bank. There had been no rainfall during the previous 2 days (anecdotal information).

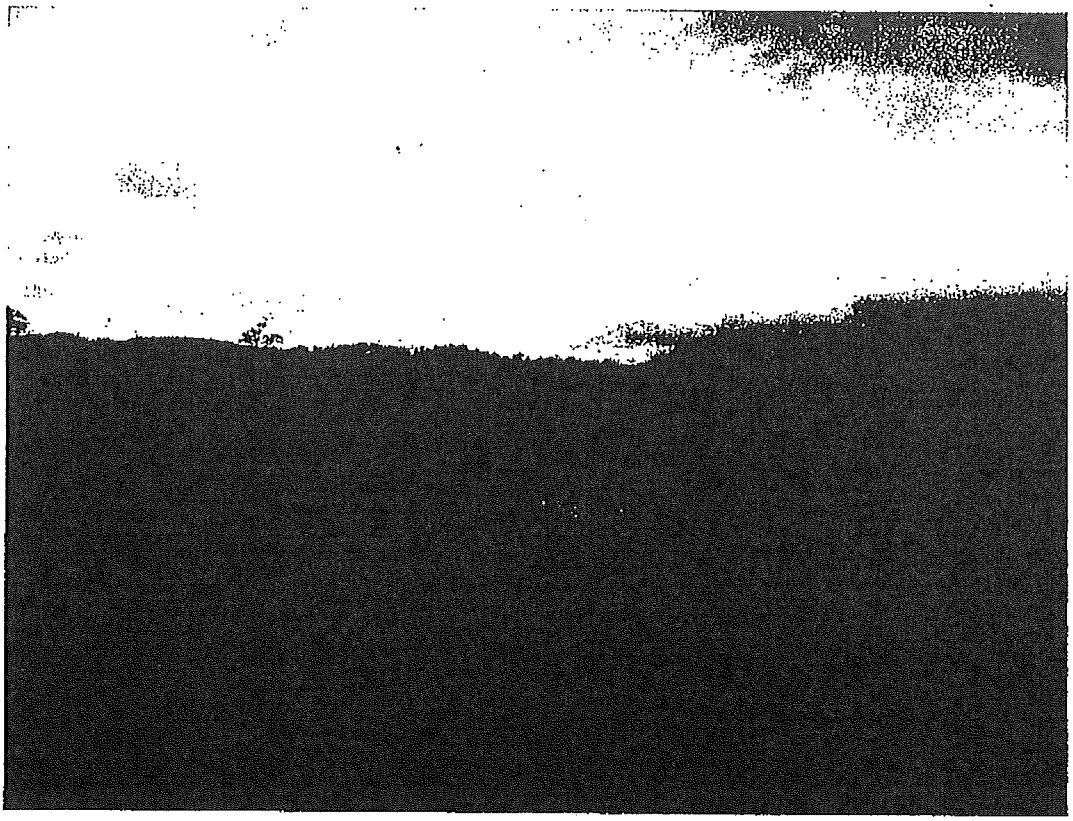


Photo 1: Water level at or just above the RL 0.0m ledge (11th September 2008)

8.4 RETENTION OF EXISTING 450MM CULVERT

The original Beca design, in 1986, included the removal of the 450mm culvert that discharges to the Whakatane River. An assessment has been carried out to ascertain the purpose of the culvert once the pump station is in operation and whether it should be retained.

The suggested start level of the pump at between RL 0.6m and 0.7m, compared with the invert level of the existing culvert of RL0.55m, will result in only very small flows being able to discharge through the culvert before water levels adjacent to the pump station rise sufficiently high to start the pump station. It is thus expected that once the pump station is installed only very small amounts of water collecting within the landfill will flow by gravity through the existing culvert.

There is a risk of entry of water from the Whakatane River to the landfill drain in the event of malfunctioning of the flap gate for example due to lodgment of debris under the flap gate. However appropriate maintenance regimes can address this concern.

In the event of a significant period of power outage when the pump station cannot operate there is a significant benefit in retaining the existing culvert to provide gravity drainage of accumulated water when river levels allow.

Therefore it is recommended that the existing culvert and flap gate are retained with ongoing regular inspection and maintenance of the culvert and flap gate to maintain its integrity and function.

9 PUMP STATION DETAILS

Pump station capacity options of 650L/s, 1000L/s, 2000L/s and 3000L/s have been considered to assess the various differences in capital and operational costs associated with the pump station scenarios. These four capacity options cover the range of pump station capacities that obtained the top water levels required under the various scenarios presented in Tables 2 and 3. Although these are not the exact pump station capacities previously discussed, as per Table 3, the small variance is insignificant for undertaking the comparison within this section of pump station design.

9.1 PUMP STATION CONFIGURATION

The pump station configuration varies in both footprint and submergence requirements of the selected pump. The option as to whether or not the standby pump is required will alter the footprint size only.

The pump station configuration for three duty pumps of 1000L/s total capacity remains unchanged from the two duty pumps and one standby arrangement. The only difference is the impellor blade angle.

The configuration of the various pump station capacities with and without the standby pump is presented in Table 6.

Table 6: Pump station configuration

Capacity (L/s)	No. of duty pumps	Pump model (Flygt pumps)	Submergence (mm)	Minimum water level to invert[1] (mm)	Footprint $(m)^2$	
					Duty pumps	Standby
650	2	7050/680	700	1050	2.8 x 3.0	2.8 x 4.6
1000	2	7050/680	700	1050	2.8 x 3.0	2.8 x 4.6
1000	3	7050/680	700	1050	2.8 x 4.6	-
2000	2	7061/735	800	1200	3.2 x 3.4	3.2 x 5.2
3000	2	7101/835	1200	1800	4.8 x 5.0	4.8 x 7.6

Note:
1. Distance between the minimum (pump stop) water level and the invert of the wet well
2. Internal wet well dimensions

The footprint of the larger pump station capacities are greater than the smaller, as expected, which is also reflected in the submergence and invert of wet well requirements.

9.2 POWER COSTS

The operation and maintenance costs for power including fixed (line charge) and operating costs have been estimated. Bay of Plenty Energy (Chris Power pers. comm. 19/9/08) advises that line costs include costs related to pump start current, voltage and power use, with start current being the major component. He has provided a spreadsheet for calculating line charges. He also advises power usage charges for a proposed pump station would be currently in the order of $0.1 per kW hour.

Line charge and power consumption costs have been assessed for the range of pump sizes considered for the contributing catchment of 21.9ha and annual runoff volume of 260,610 m^3. The results are presented in Table 7 with supporting calculations appended, Appendix F.

Table 7: Annual power costs for 2 duty pumps

Pump station capacity (L/s)	Average annual pump hours	Average annual costs ($ excl. GST)		
		Line	Power	Total
650	223	9,318	628	9,946
1000	145	9,293	550	9,844
2000	72	32,394	666	33,060
3000	48	44,695	555	45,250

Providing two pumps of total capacity 2000 L/s or 3000 L/s results in a significant increase in annual line and subsequent total costs, however the comparison of total costs between 650L/s and 1000L/s is not great.

A detailed comparison of annual power requirement for 1000L/s pump station between two duty pumps and three duty pumps was undertaken to assess the effects on the annual costs. The results are presented in Table 8.

Table 8: Annual power cost (excl. GST) comparison for 2 vs. 3 duty pumps

	2 x 500L/s	3 x 333L/s
Annual pump hours	145 hrs	217 hrs
Pump power rating	38 kW	28 kW
Annual power usage	5502 kW	6174 kW
Annual line costs	$9,293	$12,354
Annual power costs	$550	$617
Total annual costs	$9,844	$12,972

The results show that there is a 32% increase in total annual electrical charges for three pumps from two pumps for the total capacity of 1000 L/s with the major increase being the line costs. The majority of the annual cost is the line charge, which is primarily dependant on the start current of the selected pumps. The pump start currents are the same in this comparison and therefore the annual costs are very similar. The power usage cost (annual power cost) is negligible in comparison to the annual line cost, due to the short operation hours.

9.3 CAPITAL COSTS FOR PUMPS

The pump capital costs associated with the various pump options have been sourced on a "rough order" supply basis only, as shown in Table 9. In addition there is the discharge column associated with each pump, which has been estimated at between $15K – 20K and presented as $20K each column in Table 9.

Table 9: Pump rough order costs

Capacity (L/s)	Pump model (Flygt pumps)	No. of pumps		Rough order costs ($K)[1]		Total ($K)
		duty	standby	pump	Discharge column	
650	7050/680	2	1	108	60	168
650	7050/680	2	-	72	40	112
1000	7050/680	2	1	108	60	168
1000	7050/680	3	-	108	60	168
2000	7061/735	2	1	120	60	180
2000	7061/735	2	-	80	40	120

Note:

1. Costs are supply only excluding GST, delivery and installation

The above shows that the provision of a standby pump increases the cost for the pumps as well as the footprint of the pump station itself.

9.4 DIESEL VS ELECTRICAL SUPPLY

Diesel generation for power supply has been suggested by WDC representatives. This power supply option has been informally reviewed by H&G on behalf of WDC. Information has been gathered from Environment Waikato which has diesel supply to several large pump stations of discharge capacity greater than 3.4m^3/s. The pump stations have been retrofitted for diesel generation therefore the cost benefit of initially supplying the pump station with diesel generation over electrical has not been tested. It is to be noted that electrical supply is still required for the switching and telemetry However it can be assumed from the information supplied that the cost-benefit for smaller pump stations, i.e. less than 3.4m^3/s, is not supported for diesel generation.

The pump stations investigated for this project have a capacity much less than the 3.4m^3/s, therefore diesel generation would not be a power source that could be economically applied in this instance.

WDC requires provision for connection of a temporary power generation to the pump station.

10 100 YEAR ARI RAINFALL EVENT

The 100 year flood assessment has been undertaken for scenarios 9 to 12, as presented in Section 5, to determine the top water levels within the Landfill and west of Keepa Road. This assessment is also based on the runoff coefficients for fully developed commercial land of 0.9 whilst the landfill runoff follow those determined from field testing, see Table 1 Section 3.3, of between 0.71 and 0.32. The results are presented in Table 10.

Table 10: 100 year ARI modelling outcomes

Scenario	Pump station capacity (L/s)	Top water level (RL m)		Critical storm duration (hours)
		Landfill	West Keepa Road	
9	900	1.32	1.37	1
10	900	1.32	1.37	1
11	1040	1.31	1.36	1
12	1040	1.31	1.36	1

The range of top water levels for the Landfill is between RL 1.32m and RL 1.31m, whilst west of Keepa Road is between RL1.36m and RL 1.37m. The top water level plus an additional 0.5m for freeboard will therefore meet the minimum requirements for finished floor levels, of RL 2.2m, as per EBoP and WDC requirements.

11 DISCUSSION AND RECOMMENDATIONS

The outcome of the modelling scenarios provided a range of pump station flow capacities from 600L/s to 3000L/s. This range illustrates the sensitivity of the maximum top water level in the overall operation of the stormwater system servicing the catchment. Should the top water level be RL1.10m west of Keepa Road, a relatively low pump station capacity of 600L/s is required, however should top water level be RL 0.89m then a relatively high pump station capacity of 3000L/s is required.

The higher the top water level west of Keepa Road, the more sensitive the hydraulic design becomes to the tail water effects of the Landfill site. However an analysis of the tail water conditions shows that the higher RL1.10m is associated with a critical storm

duration of 1 hour, during a 10 year ARI rainfall event, therefore during the more frequent storm durations the top water level is somewhat lower than this. Detailed design of the stormwater management system in this upper catchment will need to take the varying tail water conditions into consideration.

The minimum (stop) water level does not have a significant influence on the pump size selection, however it does affect the invert level of the wet well of the pump station. The range of stop levels considered (RL0.2m and RL 0.3m) have only 100mm difference in level and are therefore unlikely to have a large difference in construction costs. These stop levels have very little effect on ground water levels.

The size of the pump station does affect the submergence and invert level of the pump station wet well. Should a large pump size be chosen the difference in invert is approximately 0.75m (750mm) which will have an influence on construction costs and possibly stability during construction (to be confirmed by geotechnical analysis).

It is therefore recommended that the optimal capacity of the pump station is 1040L/s compared with smaller or a larger capacity, with respect to the following attributes:

- Capacity to maintain the top water level at or below RL1.0m on the western side of Keepa Road
- Submergence and invert of the wet well is minimised with respect to the influence of ground water tables and constructability
- Footprint of the pump station is less than for larger pump stations
- Annual electrical charges are the lesser of the four options
- Start and stop levels of the 1st duty pump at RL0.7m and RL0.3m respectively with the 2nd duty pump start and stop levels 0.1m (100mm) above these levels.
- Pump station static head operating levels as shown in drawing SK503 (Rev B)

Maintaining the top water level at or below RL1.0m on the western side of Keepa Road ensures that any industrial development in the western catchment (Sub catchment A), can be developed with a gravitational drainage system discharging to the Landfill. During rainfall events of 10 minutes duration the top water level will be somewhat less than RL1.0m , however during the critical storm duration of 1 hour, the top water level will rise to RL1.0m for only a short period of time.

The pump station of 1040L/s capacity has an economical configuration in comparison to the larger capacities of 2000L/s and 3000L/s with respect to submergence and footprint requirements. The smaller pump station capacity of 650L/s has the same submergence requirements. In addition the 1040L/s pump selection allows for utilisation of the storage

available within the Landfill site where as the larger pump options do not optimise this storage.

The total annual electrical costs are less for the 1040L/s pump station than for the other options. The larger pumps have less annual pump hours however the line costs are significantly higher.

There is very little difference in annual electricity charges between the 2 or 3 duty pump options. From the above together with consideration of overall capital cost and size of the pump station, it is probably preferable to use 2 duty pumps of total capacity of 1040 L/sec.

It is further recommended that the pump start level to be RL 0.7m and stop level be RL 0.3m, with provision in detailed pump station design to adjust these as part of ongoing pump station operation. This recommendation is aligned with the scenario 12 pumpstation.

11.1 1000L/S PUMP STATION DETAILS

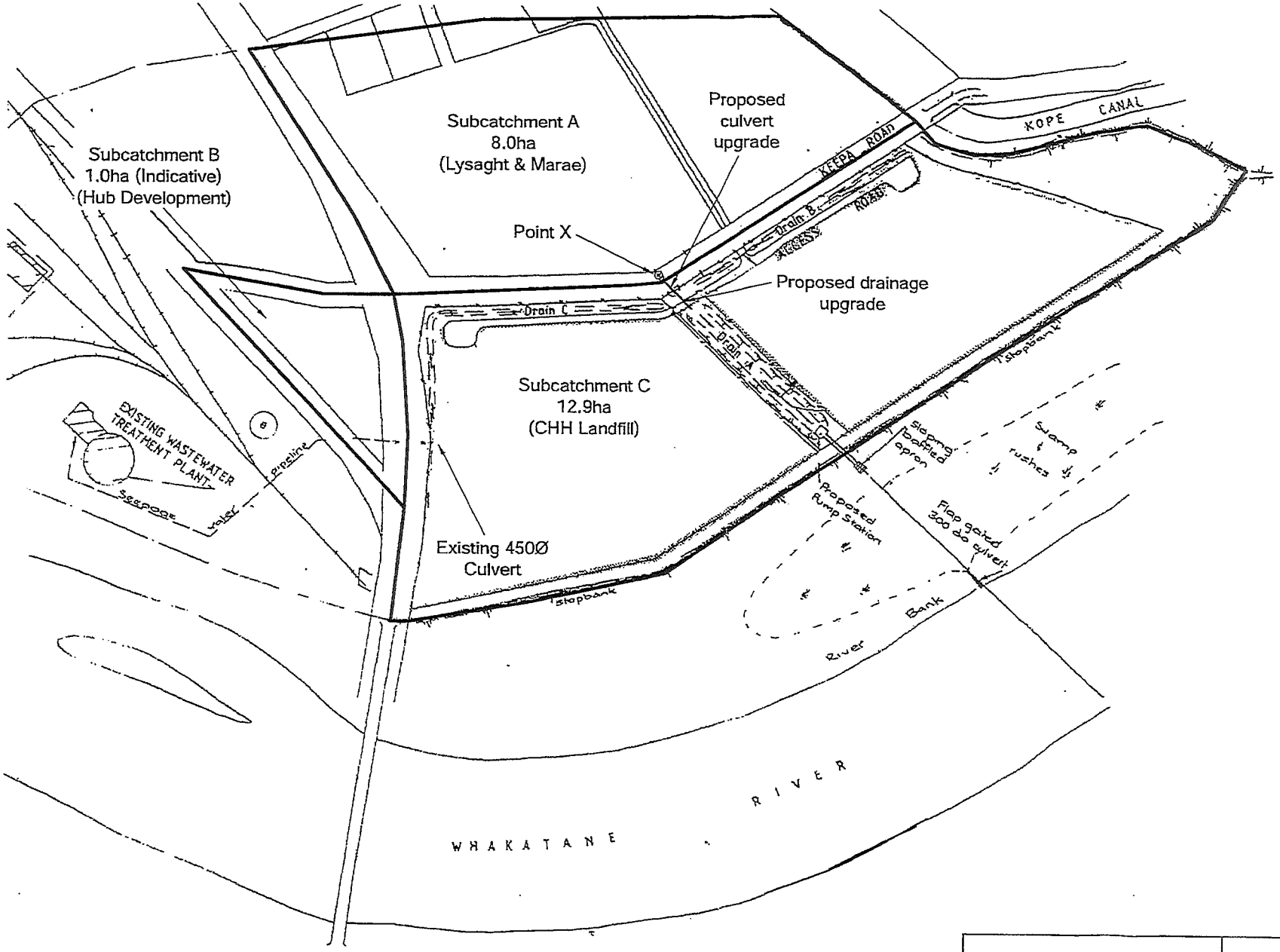
Details of the recommended 1040L/s capacity pump station are presented in Table 11 with a schematic layout shown in sketch SK502. A section through this pumpstation is also shown in SK503 Rev B, in Appendix A.

Table 11: Recommended 1040L/s Pump station design

Design storm event (ARI)	**Critical storm duration** (hrs)	**Number of duty pumps**	**1st Duty pump start level** (RL m)	**1st Duty pump stop level** (RL m)	**Top water level** (RL m)	
					West of Keepa Road	**Landfill site**
10 year	1	2	0.7	0.3	1.0	0.97
100year	1	2	0.7	0.3	1.37	1.29

Appendix A

Drawings



NOTE:
(1) Reference to Beca Simons Drawing 701026-3

CHH LANDFILL Locality Plan	Stormwater SOLUTIONS	
	DWG NO. : 1039/SK507	DRAWN: A.P.
	SCALE : 1:3000 @ A3	DATE: OCT 2008

APPENDIX 6
TONKIN AND TAYLOR – CONTAMINATED LAND SITE INVESTIGATIONS

Tonkin & Taylor

20 DEC

T&T job no: 60762
15 December 2004

Kohi Commercial Developments Ltd
C/- Gellert Ivanson Lawyers
PO Box 25 239
St Heliers
Auckland

Attention: Tony Ivanson

Dear Tony

Kohi Commercial Developments - Keepa Road Whakatane

Tonkin & Taylor Ltd is pleased to present this letter report into the environmental investigations undertaken across the property located at Keepa Road, Whakatane. The Site is described as Allot 28B9B2A Rangataiki Parish, being located on the southern side of the Kopeopeo drainage canal. This report is further to an initial draft report dated 20 October 2004.

1 Introduction

Tonkin & Taylor Ltd was engaged by Kohi Commercial Developments Ltd to undertake further investigations into identified fill areas across the property. The investigations were undertaken in accordance with our proposal dated 6 September 2004 and written instruction to proceed dated 8 September 2004. The investigation included the following tasks:

- Review the existing reports prepared for the site;
- Undertaking an initial site investigation and sampling of fill areas identified across the site;
- Analysing selected soil sample for metals, PCP and dioxins; and
- Preparation of a report outlining the results of the investigation including recommendations for further investigation and /or remediation options.

2 Background

In March 2003 Gulf Resource Management Ltd were engaged by Environment Bay of Plenty (EBOP) to undertake a risk assessment of sites that were identified to have received potentially contaminated wood wastes. As part of the investigation a geophysical survey across the site was undertaken. This survey identified fill material in two general locations across the property (Figure 1). The dates when the fill material was placed on the property were unable to be accurately determined.

3 Field Investigations

On the 16 September 2004 an intrusive investigation was undertaken by Tonkin & Taylor Ltd across the property. The investigation focused on those areas identified in the geophysical survey as possibly containing wood waste material. The testpit locations relative to site boundaries are outlined in Figure 2. A total of 18 testpits were dug to a maximum depth of 1.8m below ground level, or until natural ground was encountered.

Soil samples were collected at regular intervals through the testpits or where differing fill material were encountered. The investigation and sampling was undertaken in accordance with the *Ministry for the Environment Contaminated Land Management Guidelines No. 5 – Site Investigation and Analysis of Soils.* Samples collected from the waste material were stored in glass jars while background samples from the balance of the property were collected in zip lock plastic bags. The samples were placed in a chilly bin and cooled prior to transporting to Hill Laboratories Ltd, under chain of custody documentation.

Following the site investigation the main waste area was trenched to determine the approximate extent of the identified waste fill area. The edge of the waste material was marked with a survey peg and later surveyed. This survey area is shown in Figure 2. No waste material was found in the second area, on the southern boundary of the site, identified in the geophysical survey.

An area of coal ash/clinker was found in the area around the old milking shed (testpits 13 and 14). The extent of the material was difficult to determine, however it was approximately 0.3m deep in these two testpits and has also been placed on the access ways within the property and to the Marae located on the western boundary.

4 Results

A total of 83 samples were collected from across the site, however only ten samples were initially tested for metals and PCP. The results are outlined below with full transcripts attached in Appendix A. Following discussions with Kohi Commercial Developments it was recommended that three samples be tested for dioxins, the results are also outlined in the following table and full transcripts are attached in Appendix A.

Table 1: Results of initial soil sampling

	Boron mg/kg	Arsenic mg/kg	Cadmium mg/kg	Chromium mg/kg	Copper mg/kg	Nickel mg/kg	Lead mg/kg	Zinc mg/kg	PCP mg/kg	Dioxins Total I-TEQ µg/kg
TP1 0.5	108	7	0.1	15	26	29	16	77	<0.05	0.0209[4]
TP2 0.7	22	5	0.2	18	32	12	70.9	164	<0.05	
TP3 1.3	<20	6	0.1	19	31	9	82.3	136	37.5	0.0237[5]
TP6 0.7	<20	<2	<0.1	8	14	6	8.9	49	<0.05	0.0162[4]
TP 6 1.0	<20	5	<0.1	3	9	3	5.6	27	<0.05	
TP7 0.5	<20	3	<0.1	10	18	9	17	67	<0.05	
TP10 0.3	<20	4	<0.1	6	11	6	8.4	53	<0.05	
TP13 0.1	1800	31	0.1	19	78	50	4.1	42	<0.05	
TP13 0.3	1020	28	0.1	19	48	40	4.9	44	<0.05	
TP16 0.1	<20	4	0.2	6	10	5	9.4	53	<0.05	
Guidelines	NL	650[1]	100[3]	510[1,2]	NL	3,000[3]	1,500[3]	35,000[3]	1000[1]	90[1]

NL = Not Limiting

[1]Ministry for the Environment, Ministry of Health 1997. Health and Environmental Guidelines for Selected Timber Treatment Chemicals. Paved Industrial.

[2]For the purpose of this assessment all chromium is assumed to be Chromium 6.

[3]National Environmental Protection Council, 1999. Assessment of Site Contamination. Commercial/Industrial

[4]OCDD Screen

[5]Full congener

5 Discussion

5.1 Wood Waste Material

The fill area across the site has been well delineated by the geophysical survey undertaken by Gulf Resource Management Ltd in June 2003 and by recent trenching. The fill comprises wood waste, containing bark, sawdust, ash, wood waste and other inorganic material, such as plastic and glass. The waste fill area has an approximate area of 2,000 square metres, and is approximately 1m in thickness, having an estimated volume of 2,000 cubic metres. Refer to the testpit logs attached in Appendix B for detailed descriptions of the waste.

The waste material has elevated concentrations of metals, and one sample recorded an elevated concentration of PCP. The concentrations of metals, PCP and dioxin meet the current national guidelines for commercial sites.

5.2 Ash/Clinker Material

An area of coarse black ash/clinker material was found adjacent to the old milking shed, around testpits 13 and 14. The ash was also noticed on the access ways within the property and to the Marae located on the western boundary. The extent and quantity of the ash material is difficult to determine, however a conservative figure of 180 cubic metres in the area for the milking shed is assumed (approximately 25m x 25m x 0.3m thick). Discussions

with WDC indicate that disposal of ash/clinker material at the Whakatane Landfill is not possible as it would not meet the landfill acceptance criteria. Therefore the material needs to be disposed of elsewhere or used onsite. We note that the ash material could be used beneath the paved areas, and this is more fully discussed in the geotechnical report.

Measures to control dust from the ash/clinker material during earthworks should be incorporated to ensure that there is not a discharge to air and nuisance to neighbouring properties.

6 Summary

In summary we note the following:

- The concentrations of metals, PCP and dioxins in the wood waste meets current New Zealand guidelines of commercial operations. The waste therefore could remain onsite without remediation, subject to its geotechnical suitability (to be reported separately); and
- The site is currently classified as a contaminated site under EBOP Proposed Regional Water and Land Plan, and a consent for a discretionary (restricted) activity would be required for any disturbance of the wood waste. A discharge consent from EBOP may also be required should the wood waste material and ash clinker be relocated elsewhere on the site.

7 Applicability

This report has been prepared for the benefit of Kohi Commercial Developments Ltd with respect to the particular brief given to us and it may not be relied upon in other contexts or for any other purpose without our prior review and agreement.

Recommendations and opinions in this report are based on data from 18 testpits dug across the property. The nature and continuity of the subsoils away from the testpits are inferred but it must be appreciated that actual conditions could vary from the assumed model.

If you have any queries or would like to discuss and aspect outlined in the report please feel free to contact either of the undersigned on 07 834 1228.

TONKIN & TAYLOR LTD

Environmental and Engineering Consultants

Report prepared by: Authorised for Tonkin & Taylor by:

Glen Nicholson
Environmental Scientist

p/p Peter Cochrane
Senior Environmental Scientist

16-Dec-04
j:\60762\041214ggn.final report.doc

KOPEOPEO CANAL

KEEPA ROAD

'ESCENT

'EWAY DRIVE

WASTE FILL AREA

TP 1
TP 2
TP 3
TP 4
TP 5
TP 6
TP 7
TP 8
TP 9
TP 10
TP 11
TP 12
TP 13
TP 14
TP 15
TP 16
TP 17
TP 18

CPT1
CPT2
CPT3
CPT4
CPT5
CPT6
CPT7
CPT8
CPT9
CPT10
CPT11

BH1
BH2

SS

KEY:

TP 11 — Testpit Locations

CPT1 — Cone Penetrometer Test (CPT)

SS — Surface Scrap

SCALE 1: 1,250

0 10 20 30 40 50 60 70 80 (m)

NOTES :

1. All dimensions are in metres unless noted otherwise.
2. Base plan by ...
3. Building extents as provided by I Lysaght, 6 Sep 04.

Tonkin & Taylor
Environmental & Engineering Consultants
■ Hamilton
□ Auckland □ Christchurch
□ Nelson □ Wellington □ Whangarei

DRAWN	DWM	Sep.04
DRAFTING CHECKED		
APPROVED		
CADFILE : L...\60762		
SCALES (AT A3 SIZE) 1: 1,250		
PROJECT No 60762		

Kohi Commercial Developments Ltd

Environmental Site Investigation
Keepa Road, Whakatane
SITE PLAN

FIG. No. Figure 1 REV. A

Tonkin+Taylor

Job No: 61977
14 December 2015

IW & AJ Lysaght Family Trust
PO Box 2095
Whakatane

Attention: Ian Lysaght

Rough Order Cost Estimate for Removal of Contaminated Material - Keepa Road Whakatane

Introduction

Tonkin & Taylor Ltd (T+T) is pleased to provide a rough order cost estimate for the removal of contaminated material from a 3.3 hectare area of land at 45 Keepa Road, Whakatane ('the site') associated with possible residential subdivision.

The work was undertaken in accordance with our proposal dated 14 September 2015 and our variation of 28 October 2015 (VO1).

Background and proposed works

We understand that Lysaght Developments is intending to develop 45 Keepa Road (Allotment 28B9B2A Rangitaiki Parish) as a residential subdivision. The site is currently used for pastoral grazing. The Kopeopeo Canal is located on the northern boundary of the site. The Whakatane River is located approximately 400m east of the site.

T+T undertook ground contamination investigations at the site in 2004 for Kohi Commercial Developments (T+T reference 60762). The investigation identified wood waste material and ash/clinker material in areas at the site. Laboratory testing showed elevated concentrations of metals and pentachlorophenol (PCP), although contaminant concentrations were lower than the New Zealand guidelines for commercial operations at the time.

We understand that you require a rough order cost estimate associated with ground contamination related investigation, reporting and remediation to facilitate the proposed residential development of the site. This estimate is related to contamination at the site, over and beyond the proposed residential development costs. It does not allow for costs associated with surface water/stormwater disposal if required). Our rough order cost estimate, exclusive of GST, is set out below and is based on the following assumptions:

- The fill containing wood waste has an area of approximately 2,000 m^2 and is around 1 m thick; therefore total volume is approximately 2,000 m^3.
- The fill containing wood waste is considered to be 'lightly contaminated' and suitable as cover material at the landfill.

Tonkin & Taylor Ltd | Norris Ward McKinnon House, Level 5, 711 Victoria Street, Hamilton 3240, New Zealand
PO Box 9544, Hamilton 3240 | P +64-7-834 7320 F +64-9-307 0265 E ham@tonkintaylor.co.nz

- The clinker/ash material has an estimated volume of 180 m^3 and this material is considered to be 'highly contaminated' by the landfill.
- An estimated 600 m^3 of overburden (topsoil) will require stripping to allow excavation of the underlying fill.
- In preparing this estimate we note that the excavation and disposal of the waste would be done on a measure and value contract.
- The woodwaste and clinker/ash will require secure disposal to a suitably licenced landfill facility, and would not be accepted by local landfills. The landfill is assumed to be Tirohia Landfill, operated by H.G. Leach & Co Ltd.
- Transport and disposal costs are based on a rough order estimate provided by H.G Leach & Co Ltd for truck and trailers carrying 28 tonnes with no backload.
- We have used a bulk density of 0.75 tonnes/m^3 to estimate transport and disposal costs. Collection of bulk samples would allow densities to be assessed more accurately for final budgeting purposes.
- Further refinement of material requiring disposal offsite may be able to be undertaken, resulting in reduced disposal costs. Supply and placement of backfill material is excluded from this estimate.
- A budget provision for the preparation of the consent application to Whakatane District Council and the Bay of Plenty Regional Council has been provided. Note that the application and associated reporting is dependent on level of reporting required by the councils.

Rough order cost estimate

Item	**Unit Rate**	**Quantity**	**Rough Order cost estimate (excluding GST)**
Additional investigation and analysis (budget provision)			$5,000
Resource consent application, and erosion and sediment control plan (budget provision) Consent processing fees (budget provision)			$7,000 $3,000
Excavation of overburden	$7/$m^3$	600 m^3	$4,200
Excavation of woodwaste containing fill	$7/$m^3$	2,000 m^3	$14,000
Excavation of ash/clinker material	$7/$m^3$	180 m^3	$1,260
Transport costs	$4.5/km	350 km 59 trips	$92,925
Landfill disposal - woodwaste containing fill	$46/tonne	1,500 tonnes	$69,000
Landfill disposal - ash/clinker material	$136/tonne	135 tonnes	$18,360
Management and validation sampling (budget provision)			$5,000
Preparation of Remediation Action Plan / Site Management Plan (budget provision)			$5,000
Preparation of Site Validation Report (budget provision)			$5,000
Subtotal			**$229,745**
Contingency 20%			**$45,949**
Total			**$275,694**

Additional considerations

From discussions with the landfill operator, we understand that there could be some cost savings associated with transportation costs if backloading of material is possible.

It may be worth considering other options for addressing the wood waste containing fill material which could potentially involve retention on site. Discussions should be undertaken with the Bay of Plenty Regional Council and Whakatane District Council to confirm the remediation and/or offsite or onsite disposal options.

Additional soil sampling may be required to investigate dioxin contamination sourced from the adjacent Kopeopeo Canal. We suggest that discussions are undertaken with the Bay of Plenty Regional Council and Whakatane District Council in terms of potential dioxin contamination prior to works being undertaken.

Applicability

This letter has been prepared for the benefit of, with respect to the particular brief given to us and it may not be relied upon in other contexts or for any other purpose without our prior review and agreement.

Recommendations and opinions contained in this letter are based on our visual inspection and sampling of material at the site. The nature and continuity of the subsoil away from the sample locations is inferred but it must be appreciated that actual conditions may vary from the assumed model.

Yours sincerely

Glen Nicholson
Project Director

14-Dec-15
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APPENDIX 7
ENVIRONMENT COURT CONSENT ORDER

BEFORE THE ENVIRONMENT COURT **ENV-2006-WLG-000514**

IN THE MATTER	of the Resource Management Act 1991
AND	
IN THE MATTER	of an application under section 316 of the Act for enforcement orders
BETWEEN	**IAN WALLACE LYSAGHT and ADRIAN JUNE LYSAGHT**
	Applicants
AND	**CARTER HOLT HARVEY LIMITED**
	First Respondent
AND	**BRIAN SIMPSON, JOHN HOHAPATA, KAY CHARLES, MAXINE BLUETT, STEVEN MOKAI and WIPARAKI PAKAU**
	Second Respondents
AND	**WHAKATANE DISTRICT COUNCIL**
	Third Respondent

BEFORE THE ENVIRONMENT COURT

Environment Judge Thompson sitting alone under section 279 of the Act

IN CHAMBERS at Wellington

(DRAFT) CONSENT ORDER

Introduction

[1] This Court has read and considered the application for enforcement proceedings, and the memorandum of the parties dated [ ] October 2008.

[2] The Court is making this order under s279(1)(b) of the Act, such order being by consent, rather than representing a decision or determination on the merits pursuant to section 297. The Court understands for present purposes that:

(a) All parties to the proceedings who have given notice of an intention to be heard have executed the memorandum requesting this order;

(b) All parties who have given notice of an intention to be heard are satisfied that all matters proposed for the Court's endorsement fall within the Court's jurisdiction, and conform to relevant requirements and objectives of the Resource Management Act ("RMA"), including in particular Part 2.

Orders

[3] Therefore the Court orders, by consent, and pursuant to section 314(1)(b)(i) and (ii) of the RMA that:

(a) The First Respondent design and construct, so as to be fully operational and effective to its intended purpose, a pump station and associated drainage system generally in the location within Sub-catchment C shown on Drawing SK 507 attached as Appendix 1. Such works shall be of sufficient capacity and otherwise designed to ensure (in combination with a proposed upgrade of the culvert beneath Keepa Road) that the water level at the outfall from the Applicants' property (Point X as shown on Appendix 1) does not exceed:

(i) RL 0.64m (Moturiki Datum) at the commencement of a rainfall event;

(ii) RL 1.0m during the design ten year ARI storm;

(ii) RL 1.7m during the design one hundred year ARI storm.

(b) Nothing in this order shall be implied as imposing any obligation upon the First Respondent with regard to the proposed upgrade of the existing culvert beneath Keepa Road.

(c) The orders in (a) above be complied with by 31 December 2009 provided that this deadline may be exceeded by the First Respondent whereby and to the extent that:

(i) Circumstances arise preventing compliance with the deadline that could not reasonably have been foreseen or

provided against by the First Respondent including but not limited to delays caused by resource consent processing; and

(ii) The First Respondent employs reasonable endeavours to complete the pump station and drainage system referred to in [3](a) above in the circumstance then faced; and

(iii) The First Respondent has at all times employed its reasonable endeavours to comply with the timelines as described and set out in the schedule attached as Appendix 2, and has notified the Applicants of any delays in implementation relative to that timeline, and of the reasons for the same.

(d) Once the pump station referred to in [3](a) above is built, the Third Respondent will take over ownership and diligent operation of the pump station thereafter.

(e) For the avoidance of doubt, this order shall apply notwithstanding the engineering approval granted on 9 December 1986 by the Third Respondent (being the approval recorded in the correspondence referenced at paragraph 4.6 of the Agreed Statement of Facts attached to the memorandum filed by the parties in seeking these orders by consent).

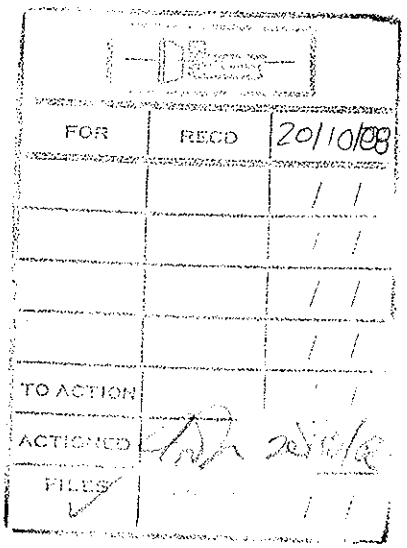
[4] There is no order as to costs.

DATED this day of 2008.

C J Thompson

Environment Judge

1880/0002/000



15 October 2008

Lysaght Developments
P O Box 2095
Kopeopeo
WHAKATANE 3159

Attention: Mr Ian Lysaght

Dear Ian

ENV-2006-WLG-000514 - LYSAGHT V CARTER HOLT HARVEY LIMITED AND WHAKATANE DISTRICT COUNCIL

This letter relates to paragraph 6 of the joint memorandum entered into between the parties (including Lysaght Developments and Whakatane District Council) in settlement of the above Court proceedings.

The settlement achieved between the parties is primarily focused upon Carter Holt Harvey constructing a pumping station and associated drainage system as described and illustrated in the orders agreed to by the parties by consent (as recorded at paragraph 5 of the joint memorandum).

Once the pumping station is constructed, the Council will assume responsibility for its continued operation.

On the basis that the pumping station is constructed and operated in that manner, the Council can confirm its position regarding approval of future development of the land to the west of Keepa Road owned by Lysaght Developments, and as illustrated on plans attached to this letter ("**Lysaght Land**").

Specifically, the Council undertakes that, so far as stormwater management and drainage issues are concerned, it will give approval under the Resource Management Act 1991 to any resource consent required for subdivision or use of the Lysaght Land in a manner compliant with the provisions of the operative and proposed Whakatane District Plans (as in force at the relevant time). For the purpose of this undertaking, the term "compliant", means in accordance with any relevant limitations as to site coverage or impermeable surfaces and as may affect stormwater runoff.

Address all correspondence to: The Chief Executive **Whakatane District Council** Private Bag 1002 Whakatane 3158 New Zealand
Telephone +64 7 306 0500 Facsimile + 64 7 307 0718 Email information@whakatane.govt.nz Website www.whakatane.govt.nz

For the avoidance of doubt, the Council would retain its discretion to grant or refuse any resource consent for use or subdivision of the Lysaght Land having regard to issues other than stormwater management and drainage, and this letter solely relates to that specific issue.

Furthermore, the Council confirms that it accepts a start water level of 0.64 metres (Moturiki Datum) at the point of connection to the public stormwater system for the purpose of clause 4.3.12.3.4 of New Zealand Standard 4404:2004, and whereby, for the purpose of that clause, the point of connection to the public stormwater system is at the western edge of Keepa Road and as indicated on the attached plan.

The Lysaght Land may therefore be developed so as to achieve gravity drainage to that level at that point, and in doing so would meet relevant requirements of the Building Code and Council Engineering Code of Practice.

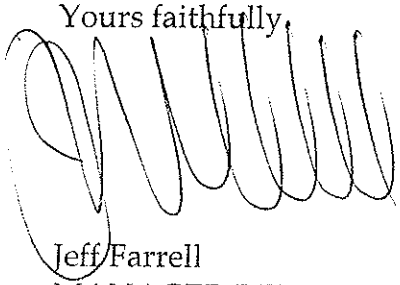
Finally, the Council undertakes that in conjunction with any development of the Lysaght Land it will allow and may require Lysaght to install or upgrade, as necessary to maintain a start water level of 0.64 metres, new or larger culverts under Keepa Road.

This undertaking is given in the Council's capacity as a consent authority under the Resource Management Act 1991, and as the owner of the Keepa Road and Road reserve under the Local Government Act 2002.

The approval and any requirement to install or upgrade the culverts may, in the Council's discretion, be effected through conditions imposed on any relevant resource consent relating to development of the Lysaght Land, and/or by way of development contribution imposed under the Local Government Act 2002 in relation to the same.

The Council acknowledges in giving this undertaking that Lysaght reserves the right for it or any successors to claim a credit as against any financial or development contribution imposed in relation to development of the Lysaght Land, on the basis that the works involved go beyond those necessary to address effects arising from that development but are instead (or in addition) of wider benefit to the District.

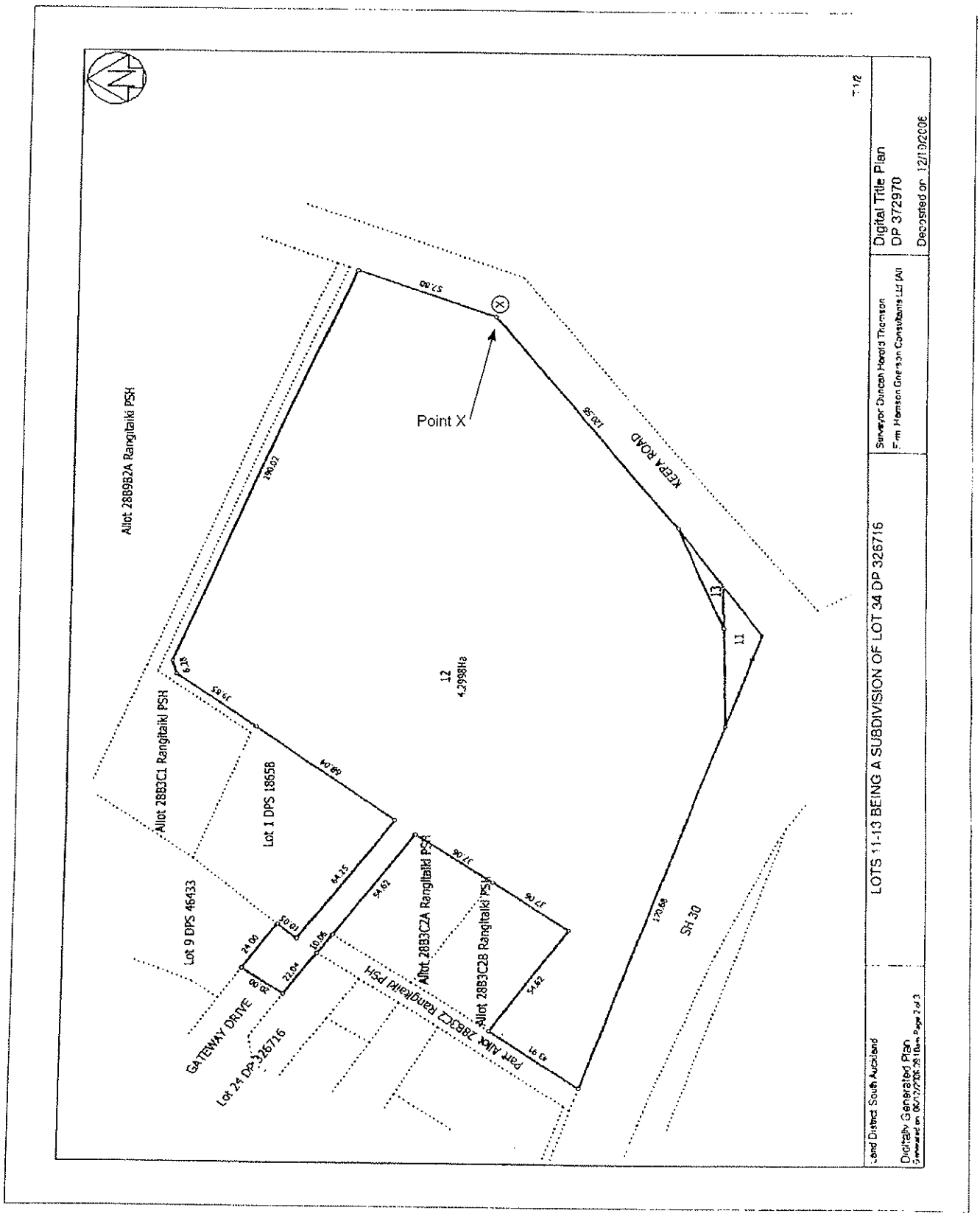
Yours faithfully,



Jeff Farrell
MANAGER DEVELOPMENT & COMPLIANCE

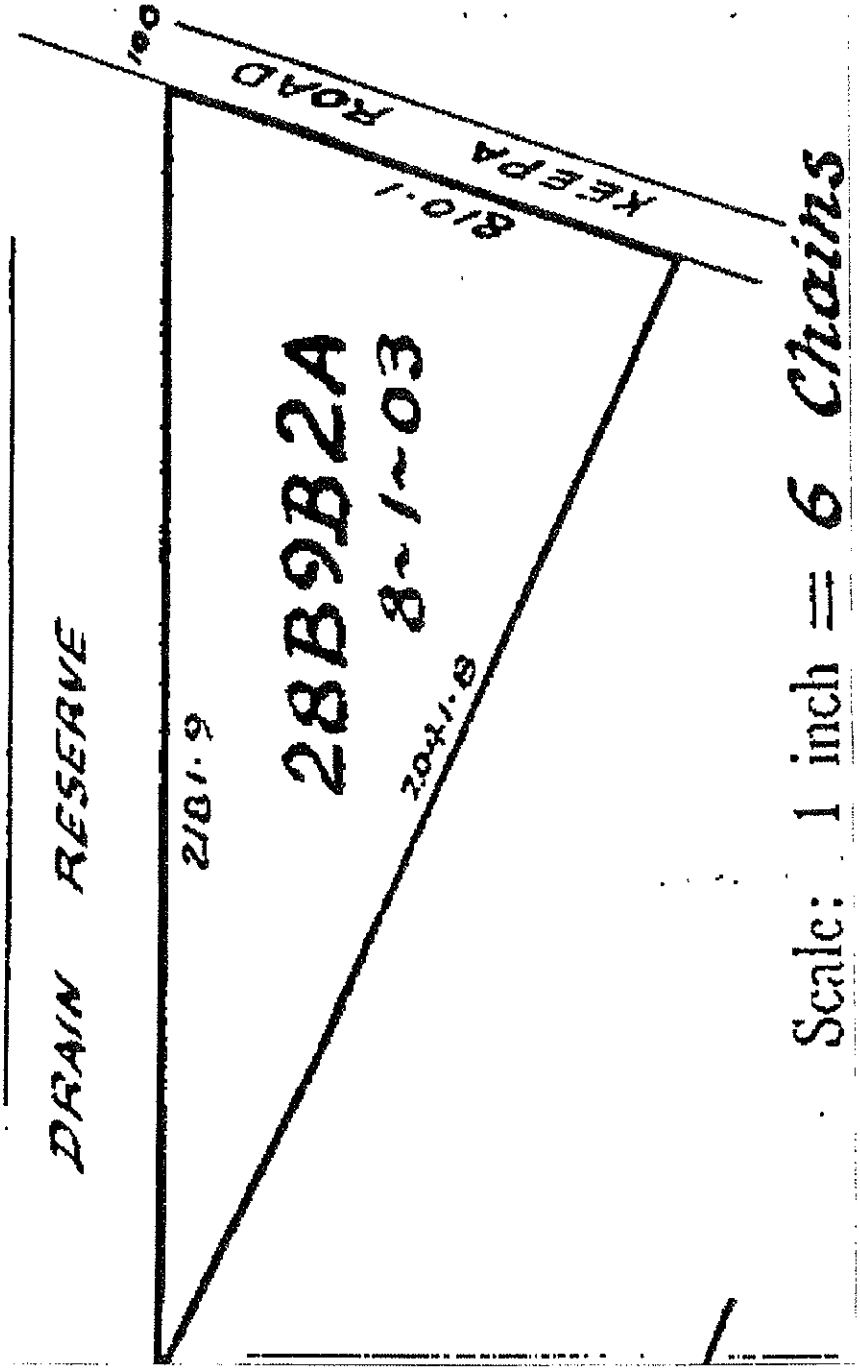
ATTACHMENT: "The Lysaght Land" - 23 Keepa Rd

Identifier **295128**



ATTACHMENT: "The Lysaght Land" – 45 Keepa Rd

Identifier SA12D/1022



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APPENDIX 8
HEGLEY ACOUSTICS ASSESSMENT OF NOISE EFFECTS

HEGLEY ACOUSTIC CONSULTANTS

1/355 Manukau Road
Epsom, Auckland 1023
PO Box 26283
Epsom, Auckland 1344

T: 09 638 8414
E: hegley@acoustics.co.nz

23 & 45 KEEPA ROAD

WHAKATANE

ASSESSMENT OF NOISE EFFECTS

Report No 16329

Prepared for:

Lysaght Developments Ltd
Whakatane
December 2016

Prepared by: .....

Nevil Hegley

CONTENTS

1 INTRODUCTION

It is proposed to rezone the land at 23 & 45 Keepa Road, Whakatane from Light Industrial to Residential and to subdivide this land. The land is located on the north western side of Whakatane on the corner of Keepa Road and State Highway 30 as shown on Figure 1 below.

Figure 1. Location of Proposed Development

The site is adjacent to State Highway 30 and a Light Industrial Zone so it will be necessary to ensure the development will be protected from unreasonable noise from both traffic and any industrial noise from the adjoining sites. In addition, the proposed development will not generate any reverse sensitivity effects. This report addresses the techniques that will be adopted to control any potential adverse noise effects or reverse sensitivity effects.

2 DESIGN REQUIREMENTS

As the Proposed Whakatane District Plan has more stringent noise rules than the Operative District Plan the requirements of the Proposed District Plan have been adopted.

2.1 Traffic Noise

Rule 11.2.8 of the Proposed Whakatane District Plan requires:

11.2.8 Noise sensitive activities near State Highway 2, 30 and 34

11.2.8.1 Within 80m in a Rural Zone and the Residential Zone at Shaw Road, or 40m in any other Residential zone of State Highway 2, 30 and 34 (measured from the nearest painted edge of the carriageway):

a. any new building housing a noise sensitive activity shall meet an internal road-traffic design sound level of 40dB $L_{Aeq(24h)}$ inside all habitable rooms, teaching spaces or general office areas; and

b. any addition, extension or alteration to an existing building housing a noise sensitive activity which exceeds 25% of the existing GFA shall be designed and constructed to achieve a maximum internal road-traffic design sound level of 40dB $L_{Aeq(24h)}$ inside all habitable rooms, teaching spaces or general office areas.

11.2.8.2 An acoustics design report from a suitably qualified and experienced acoustics expert shall be provided to the Council demonstrating compliance with Rules in 11.2.8 – Noise sensitive activities near State Highways 2, 30 and 34 prior to the commencement of construction.

11.2.8.3 As an alternative to complying with Rules 11.2.8.2 and 11.2.8.3 any new building, or alteration/addition to a building which exceeds 25% of the existing GFA, housing a noise sensitive activity shall comply with the following;

a. The windows and any glazing on doors of all habitable rooms, teaching spaces or general office areas shall be constructed with glazing that includes a laminated pane that is at least 6.38mm thick and covers the glazed area.

11.2.8.4 Where windows are required to be closed to achieve the requirements of Rules 11.2.8.2 and 11.2.8.3 a ventilation system shall be installed that;

a. *consist of an air conditioning unit(s) provided that the sound level generated by the unit(s) must not exceed 40dB $L_{Aeq(30s)}$ in habitable rooms (excluding bedrooms), teaching spaces or general office areas, and 35dB $L_{Aeq(30s)}$ in bedrooms; when measured 1m away from any grill or diffuser; or*

b. *comprise a system capable of providing at least 6 air changes per hour in habitable rooms, teaching spaces or general office areas. The occupant must be able to control the ventilation rate in increments up to a high airflow setting that provides at least 6 air changes per hour; and*

c. *the internal air pressure must be no more than 10 Pa above ambient air pressure due to the ventilation systems; and*

d. *the system must provide cooling that is controllable by the occupant and can maintain the temperature at no greater than 25 degrees celsius.*

11.2.8.5 Rule 11.2.8.4 does not apply if;

a. *the nearest façade of the building housing a noise sensitive activity is at least 50m from State Highways 2, 30 and 34 (measured from the nearest painted edge of the carriageway), and there is a solid building, fence, wall or landform that blocks the line of sight from all parts of windows and doors to habitable spaces to any part of the road surface of the State Highway Road; or*

b. *it can be demonstrated by way of prediction or measurement by a suitably qualified and experienced acoustics expert that the road-traffic sound level from State Highway 2, 30 and 34 is less than 55dB $L_{Aeq(24h)}$ at all facades of new building, or extension/alteration to an existing building, housing a noise sensitive activity.*

2.2 District Plan Requirements

The site is located within the Light Industrial Zone of the Proposed Whakatane District Plan as shown on Figure 2.

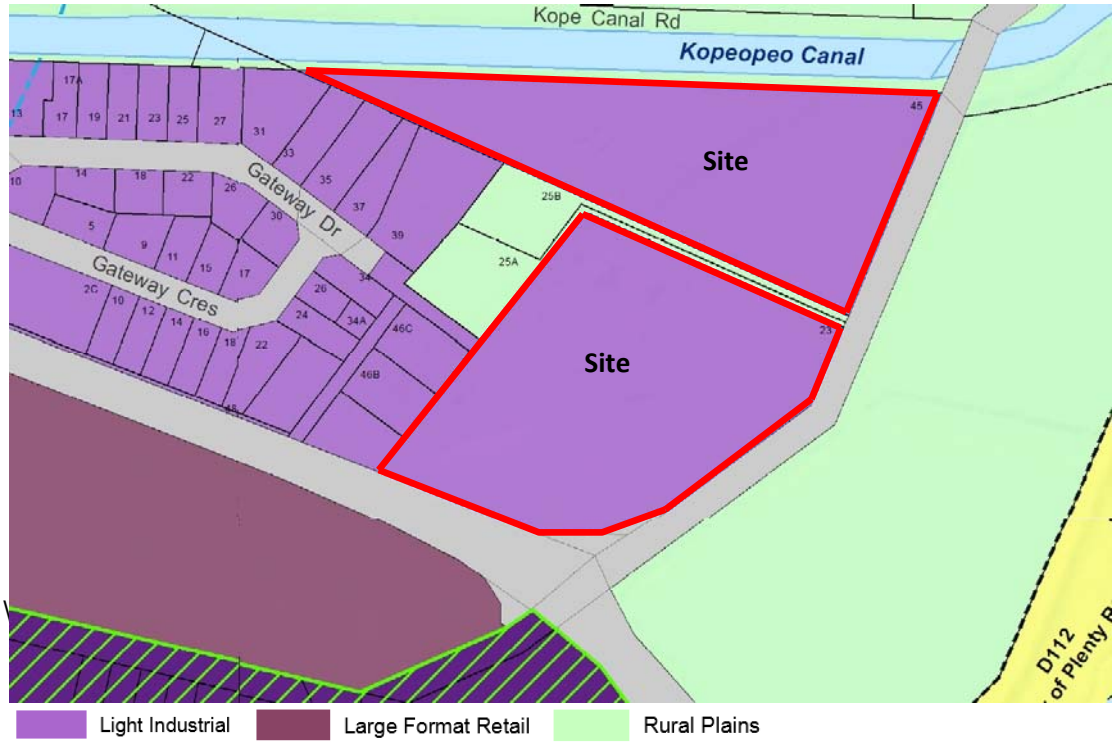

Figure 2. Location of Site

The relevant noise requirements for the site are set out in Rule 11.2.6 of the Proposed District Plan.

11.2.6 Noise Limits

11.2.6.1 Noise from any activity (not listed within Table 11.2) shall not exceed the following limits when measured at any point within the following receiving zones.

Noise Limits, dB		
Receiving Zone	*Daytime 7am to 10pm Monday to Sunday inclusive, including Public Holidays*	*Night-time (At all other times)*
f. Light Industrial	*70 L_{Aeq}*	*60 L_{Aeq}* *75 L_{Amax}*

Table 11:1 Zone Noise Limits

Table 11.2 of Rule 11.2.6.2 sets noise requirements for dwellings located in zones other than Residential and Rural. This rule will not be applicable to the development assuming the site is rezoned to residential. However, the effects of rezoning the site to residential will mean noise from the remaining Light Industrial Zone will be potentially limited by the introduction of the rezoning and hence there would be a reverse sensitivity effect for the remaining Light Industrial Zone. This report addresses how any reverse sensitivity effects will be eliminated for the area that will remain as a Light Industrial Zone.

Activity	*Controls*
Dwellings/ occupancies / habitable spaces in zones other than Residential and Rural (see Note g)	A dwelling or occupancy or habitable space is permitted in zones other than Residential or Rural if the total internal sound level in any habitable room does not exceed a design level of 35dB $L_{Aeq(24\ hours)}$ while at the same time complying with the ventilation requirements of clause G4 of the New Zealand Building Code. The total sound level shall include all intrusive noise and mechanical services. In determining the external sound level, an assumption is made that the noise incident upon the noise sensitive building façade is from at least three separate activities simultaneously generating sound levels up to the noise limit in Table 11.1 of the zone in which the dwelling / occupancy / habitable room is proposed. Compliance with the above must be confirmed in writing by a suitable qualified and experienced acoustic consultant.

Table 11:2 Specific Activity Noise Limits

11.2.7.1 Assessment positions vary according to the assessment method cited. The following notes specify where an assessment position may be found in a cited reference, or where an assessment position is for a zone or activity:

g. Measurements inside buildings NZS 6801:2008

3 TRAFFIC NOISE ASSESSMENT

3.1 Assumptions

To determine the traffic noise exposure from State Highway 30 to the subject site the traffic noise has been assessed based on the following information.

- 24 hour AADT was 15,039 in 2015
- Design year 2027
- Traffic growth rate 3% compound;
- 6% HCV;
- Speed limit 80km/h;
- Road surfaces: Stone matrix asphalt (at roundabout and 60m either side of the approaches to the roundabout) and Grade 2 chip elsewhere.

Based on the above parameters the traffic noise has been predicted using the Brüel & Kjær Predictor v11.10 program. This is a powerful environmental noise calculation software package which allows a scale model of the proposal to be constructed using the development plans and aerial photographs of the surrounding area. The calculations have been based on the requirements of the CRTN calculation algorithms taking into account the recommendations of the Transit New Zealand Research Report No. 28, 1994 calibrated for New Zealand conditions and Road Surface Effects on Traffic Noise: Stage 3 Bituminous Mixes Land Transport New Zealand Research Report 326, 2007.

For this project, a 2m grid has been adopted and the traffic noise has been calculated at each grid point from which the noise contours have been determined. All calculations have been undertaken based on ground absorption of 0.7.

A receiver height of 1.5m has been used for the analysis to reflect the receiver position for a single storey dwelling and a receiver height of 1.5m above the first floor level has been adopted to reflect the receiver location for the two storey dwelling. In both cases the assessment location for traffic noise is at the proposed façade position at the relevant height.

3.2 Predicted Noise Levels

Noise contours have been determined for the pre-development condition, with no acoustic measures included as shown on Figure 3.

Figure 3. Pre-development Traffic Noise Contours - $L_{Aeq(24h)}$

Figure 4 shows the noise contours including a 2m high acoustic barrier along the southern boundary of the site with a western return up to and including Lot 65 and an eastern return up to and including Lot 46. The acoustic barrier will require a minimum

surface density of 10kg/m^2 and may be constructed with a single material, such as timber or an earth bund, or a combination of materials to achieve the final height. If timber is used it should be a minimum of 20mm thick and the joints either butted and battened or lapped to prevent gaps opening as the timber dries out and shrinks.

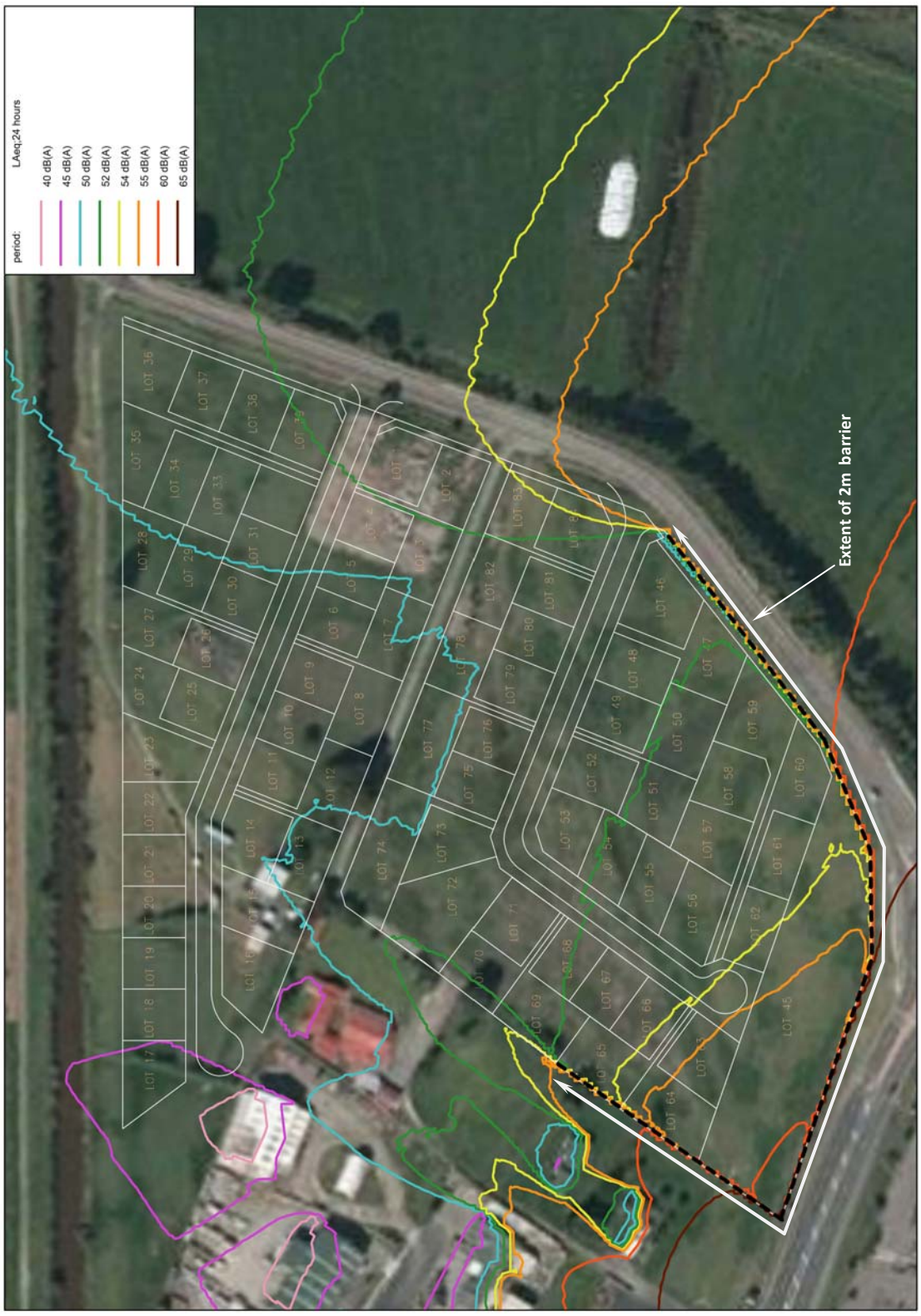

Figure 4. Traffic Noise Contours with 2m Acoustic Barrier - $L_{Aeq(24h)}$

Figure 5 shows the noise contours by increasing the barrier to 3m along the southern boundary and western boundary to Lot 45.

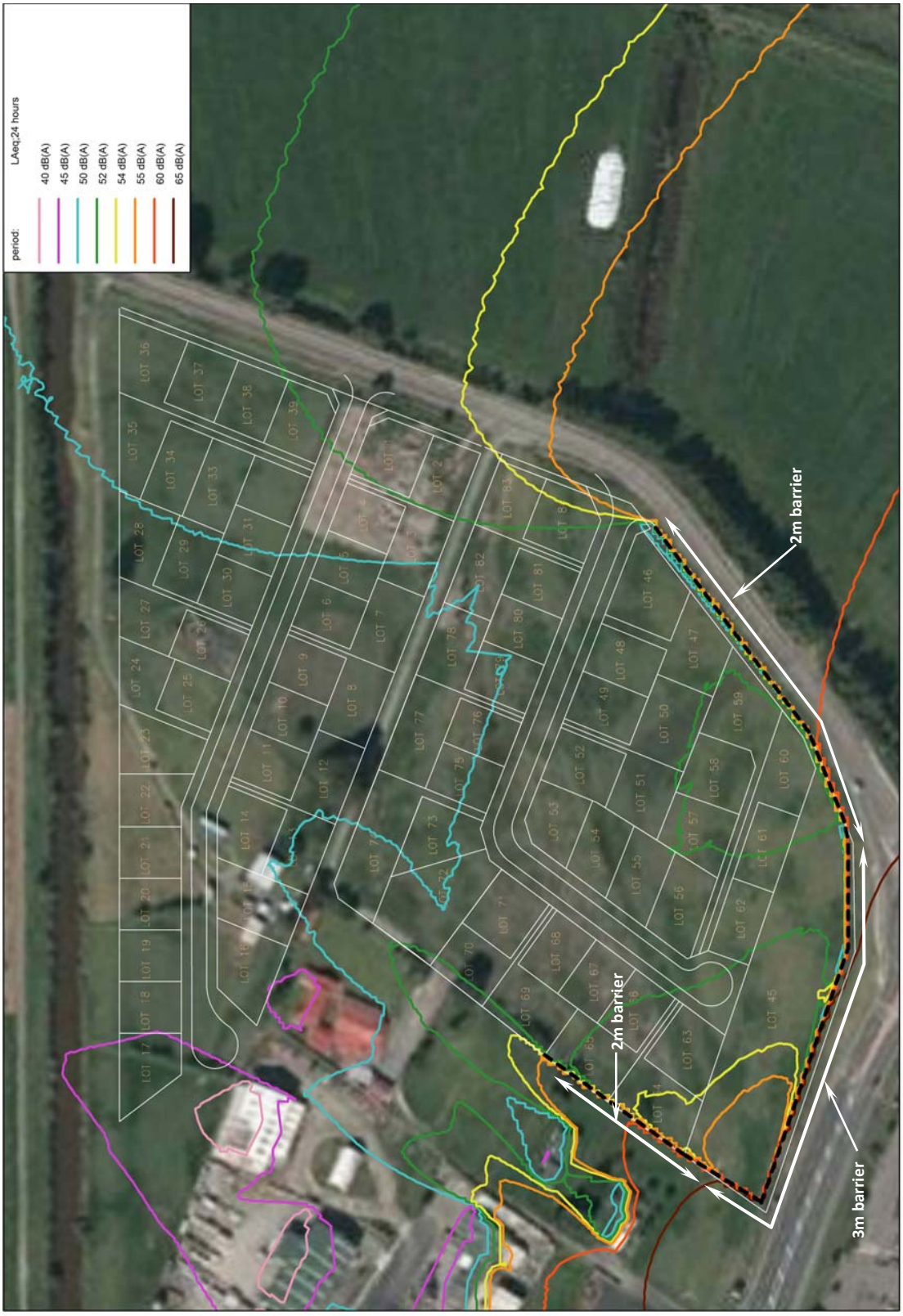

Figure 5. Traffic Noise Contours with 3m and 2m Acoustic Barrier - $L_{Aeq(24h)}$

Figure 6 shows the same design option as Figure 5 except the noise contours have been calculated at 1.5m above the first floor level for any two storey dwelling.

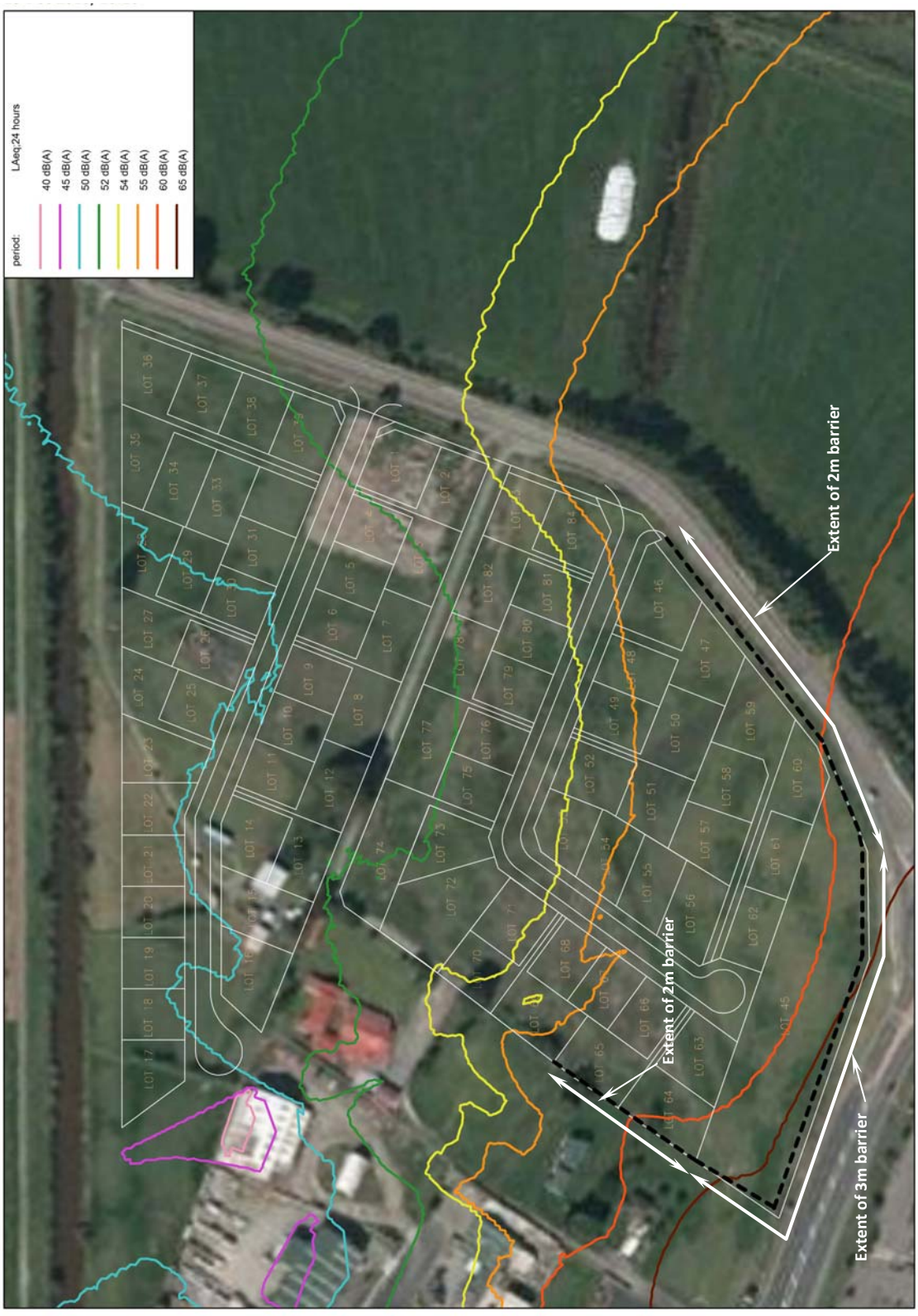

Figure 6. Traffic Noise Contours at 1.5m above 1st Floor Level with a 3m and 2m Acoustic Barrier - $L_{Aeq(24h)}$

From Figure 3, with no noise control treatment implemented the majority of the site will be subject to a noise level above 55dB $L_{Aeq(24hr)}$.

Figure 4 shows that with a 2m acoustic fence added the noise to the site is controlled to 55dB $L_{Aeq(24hr)}$ for all but three lots at ground level.

By increasing the height of the proposed screening for the section most exposed to the traffic noise, as shown on Figure 5, the noise to all Lots is controlled to within 55dB $L_{Aeq(24hr)}$ for all single storey dwellings. In the event the current Lot 45 is developed into residential sections there is the potential for a dwelling in the western corner of Lot 45 to exceed 55dB $L_{Aeq(24hr)}$ by up to 2dB, the exact level being dependent on the location of any dwelling.

In terms of the requirements of Rule 11.2.8.5(b), all dwellings subject to a façade level of less than 55dB $L_{Aeq(24hr)}$ will not require an alternative means of ventilation. Windows may be left open for ventilation purposes and there is therefore no need to implement any specific noise control treatment. In addition, the outdoor level will be within a reasonable level for any residential use.

Should there be any two storey dwellings where the noise exceeds 55dB $L_{Aeq(24hr)}$, as shown on Figure 6, a specific acoustic design of the dwelling façade will be required to ensure an internal level of 40dB $L_{Aeq(24hr)}$ will be achieved as required by Rule 11.2.8.1. This will involve calculating the noise level at each façade and hence the degree of treatment required to achieve the internal limit of 40dB $L_{Aeq(24hr)}$. Where windows need to be closed to achieve the internal design level an alternative form of ventilation may be necessary and that system must satisfy the requirements of Rule 11.2.8.4.

4 NOISE FROM THE LIGHT INDUSTRIAL ZONE

It is proposed to rezone a section of an existing Light Industrial Zone to a Residential Zone as shown on Figure 7.

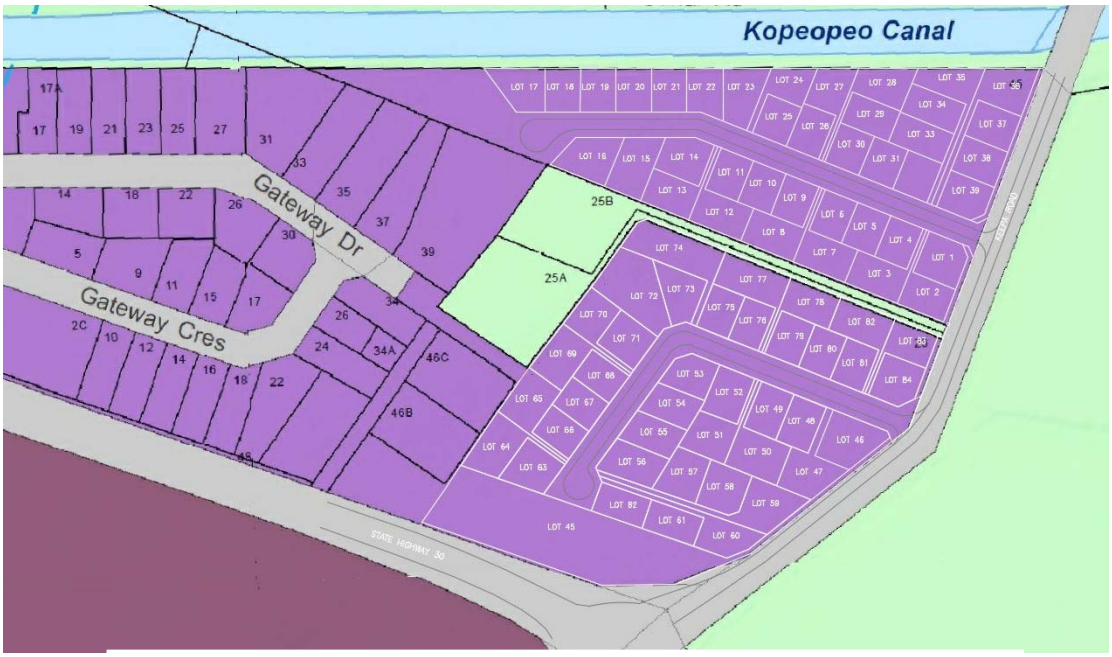

Figure 7. Location of Proposed Residential Lots 1 - 84

To prevent any reverse sensitivity effects, dwellings within the proposed Residential Zone will need to be acoustically designed to ensure satisfactory internal noise levels are achieved based on currently permitted noise limits for the light industrial activities within the remaining Light Industrial Zone. As set out above (Section 2.2) Table 11.1 the permitted boundary level is 70dB L_{Aeq} during the daytime and 60dB L_{Aeq} plus 75dB L_{Amax} at night-time. A daytime noise level of 70dB L_{Aeq} and a night-time noise level of 60dB L_{Aeq} equates to a 24-hour noise level of 68dB $L_{Aeq(24\ hours)}$.

As shown on Figure 2, there are two Rural Plains Zoned lots (Lots 25A and 25B) located in the centre of the Light Industrial Zone. The noise limits for the Light Industrial Zone to the Rural Plains Zone are 50dB L_{Aeq} during the daytime (7:00am – 10:00pm) and 40dB L_{Aeq} plus 70dB L_{Amax} at night-time (10:00pm – 7:00am). These limits are identical to those for the residential zone. Assuming these limits are being achieved by industrial activities any new dwellings bordering this rural zone

(dwellings within Lots 69, 70, 72, 74, 15 and 16) will not be exposed to noise levels above that permitted in a Residential Zone.

The noise that may be experienced at other lots in the proposed development will be dependent on the distance from the remaining industrial sites and the distance those industrial sites are from existing rural lots. The noise that may be generated within the proposed residential subdivision from the adjacent remaining industrial zone will vary from 50/40dB L_{Aeq} for the day night control at Lot 69 to the industrial to industrial limit of 70/60dB L_{Aeq} at Lot 64 as shown on Figure 7.

As set out in Table 11.2 the internal sound level in any habitable room is not to exceed a design level of 35dB $L_{Aeq(24\ hours)}$ while at the same time complying with the ventilation requirements of clause G4 of the New Zealand Building Code. There is a minimum of 15dB noise reduction between the inside and outside of the dwelling when assuming the windows are open sufficiently to provide ventilation. That is, to achieve the internal level the external level cannot exceed 35 + 15 = 50dB $L_{Aeq(24\ hours)}$ for the open window scenario.

Once the final subdivision plans have been determined a detailed assessment will be necessary to establish the exact sites where the noise level has the potential to exceed 50dB $L_{Aeq(24\ hours)}$ from the remaining business zone.

A preliminary assessment of the proposal indicates the Lots where treatment to the dwellings may be required include Lots 17, 18, 45, 56 and 61 – 67. At these sites the façade reduction will vary from an upper limit of 68 – 35 = 33dB $L_{Aeq(24\ hours)}$ to zero.

A general design check adopting typical building facades (brick, weatherboard and either a tiled or iron roof) shows the upper façade design can be achieved using these materials. Double glazing such as 1 x 5mm glass with a 12mm air space and 1 x 6.38mm laminated glass is an example of what may be required for the more exposed windows. However, the exact design will be dependent on the size of the windows.

Where windows need to be closed to achieve the internal level an alternative form of ventilation may be required to habitable rooms within dwellings on those Lots

5 PROPOSED CONDITIONS

Subject to the following conditions the noise rules in the Proposed District Plan will provide the necessary controls to the proposed residential development. The additional condition with any consent to ensure there are no reverse sensitivity effects is:

> *All dwellings shall be designed and constructed to achieve an internal noise level of 35dB $L_{Aeq(24\ hours)}$ while at the same time complying with the ventilation requirements of clause G4 of the New Zealand Building Code. The total sound level shall include all intrusive noise and mechanical services.*
>
> *In determining the external sound level, an assumption is made that the noise level at the interface of the Light Industrial Zone and new Residential Zone boundary from at least three separate activities simultaneously generating sound levels within the Light Industrial Zone is at the maximum level that would be permitted at this boundary had the zoning remained Light Industrial.*

6 CONCLUSIONS

Traffic noise levels from State Highway 30 will be controlled by the construction of an acoustic barrier. With the implementation of an acoustic barrier, noise levels at the façades of all single storey dwellings on the site layout currently proposed may be controlled to less than 55dB $L_{Aeq(24hr)}$ and therefore no specific acoustic treatment will be required.

In the event the final design shows there are single storey dwellings where the façade level exceeds 55dB $L_{Aeq(24hr)}$ and two storey dwellings where the façade noise level exceeds 55dB $L_{Aeq(24hr)}$ from either traffic or the adjacent Light Industrial Zone (or the cumulative noise effects of these two noise sources) the façade will be specifically designed and constructed to achieve the internal noise limit of 40dB $L_{Aeq(24hr)}$.

Due to the location of the existing rural zones, the sections where the potential effects of reverse sensitivity effects from the adjacent Light Industrial Zone are Lots 17, 18, 45, 56 and 61 – 67. Any potential reverse sensitivity effects due to these lots will be controlled by designing the most exposed façades to habitable rooms to achieve an internal level of 40dB $L_{Aeq(24\ hours)}$.

From the above and taking into account the proposed design, the noise effects of the proposed development will be less than minor in terms of the requirements of the Resource Management Act

* * *

APPENDIX 9
NZTA CONSULTATION CORRESPONDENCE

Tim Fergusson

From: TaurangaPlanning <TaurangaPlanning@nzta.govt.nz>
Sent: Thursday, 22 June 2017 4:26 p.m.
To: Tim Fergusson
Subject: RE: 16-005-116 - Lysaght Rezoning, Keepa Road, Whakatane

Hi Tim,

Do you have any further information following on from the Transport Agency's comments below, relating to pedestrian and cycle access?

In terms of the acoustic assessment, all looks fine. The Transport Agency's main concerns with regards to new subdivision like this are related to reverse sensitivity, and ensuring both indoor and outdoor amenity are not compromised.

For outdoor amenity, a fence like the one you have proposed within your application, is to be constructed for the length of the site bordering the State Highway network. Our specifications are as follows:

- *Establishment of acoustic mitigation (bund; barrier), to meet an external noise level that does not exceed 57dBA Leq24hr, shall be designed to:*

  (i) Extend for the full width of the part of the section nearest to the state highway corridor;
  (ii) Be constructed from the finished ground level to a height of at least 3 metres above the finished ground level;
  (iii) Be constructed from a solid impervious material having a surface mass of a minimum of 10 kg/m²;
  (iv) Have no gaps between the noise wall and the finished ground level and no gaps between any components of the wall;
  (v) Have overlapping details at all junctions between individual components of the wall.
  (i) A geotechnical assessment by a suitably qualified geotechnical engineer in consultation with the NZ Transport Agency and submitted to Council to confirm that the acoustic mitigation has no adverse geotechnical effect on the state highway network; and
  (vi) A stormwater assessment to demonstrate that emergency overland flow paths will not be obstructed by the acoustic bund or barrier.
  (vii) The acoustic mitigation shall be vested in Council at the time of subdivision or prior to building consent for a dwelling being issued, whichever occurs first.

Don't hesitate to get in touch should you wish to discuss anything further.

Kind regards,

Alex van Rooyen / Consultant Planning Advisor
Planning & Investment Bay of Plenty

DDI +64 7 927 6006
E alex.vanrooyen@nzta.govt.nz / w nzta.govt.nz

Tauranga Office / Level 3, Harrington House
32 Harington Street, PO Box 13-055, Tauranga 3141, New Zealand

Please note my working days are Monday, Wednesday and Thursday.

From: TaurangaPlanning
Sent: Wednesday, 14 June 2017 3:15 p.m.
To: T.Fergusson@harrisongrierson.com
Subject: RE: 16-005-116 - Lysaght Rezoning, Keepa Road, Whakatane

Good afternoon Tim,

Thank you for the email regarding the private plan change proposal for Keepa Road, Whakatane.

I have spoken with our network engineers here at the Transport Agency, and our main comments are in relation to pedestrian and cycling links/connectivity and safety given that there is likely to be an increase in pedestrian and cyclists demand from the proposed residential zoning of the site. NZ Transport Agency's initial comments from Matt Stulen required an assessment/consideration of active modes of transport, including walking and cycling, yet these have not seemed to be addressed within the application documents provided?

Given this, we require further information around the following:

- Crossing State Highway 30 to access the HUB is considered to be high risk – provide information/ an assessment of how pedestrians will access the HUB? Also potential to consider access to pedestrian facility through Lot 45?
- Whakatane Bridge has been identified through public complaints as hazardous for both pedestrians and cyclists, as the footpath is too narrow – how are cyclists and pedestrians from the proposed residential zone to access the CBD? Potential for consideration of a footpath under the bridge to gain access to the CBD?

I will get back to you shortly with our comments on the Acoustic Assessment that was provided with the application documents.

Kind regards,

Alex van Rooyen / Consultant Planning Advisor
Planning & Investment Bay of Plenty

DDI +64 7 927 6006
E alex.vanrooyen@nzta.govt.nz / w **nzta.govt.nz**

Tauranga Office / Level 3, Harrington House
32 Harington Street, PO Box 13-055, Tauranga 3141, New Zealand

Please note my working days are Monday, Wednesday and Thursday.

From: Tim Fergusson [mailto:T.Fergusson@harrisongrierson.com]
Sent: Tuesday, 30 May 2017 5:02 p.m.
To: TaurangaPlanning
Subject: 16-005-116 - Lysaght Rezoning, Keepa Road, Whakatane

Hi,
On behalf of our client, Lysaght Developments, we are working on a plan change proposal to rezone an area of land on the outskirts of Whakatane from Light Industrial to Residential through a change to the Whakatane District Plan.
Consultation with NZTA was undertaken during the development of the proposal with a meeting between NZTA, WDC and ourselves held in Whakatane on 23 November 2016. The following email was provided by Matt Stulen after the meeting and summarises NZTA's position on the proposal at that time.

Hi Tim,

Thanks for taking the time to meet with both us and Council yesterday.

As referred to in the meeting below are the links to the relevant documentation we referenced, which will help in the design of the proposed subdivision:

- Pedestrian planning and design guide:

https://www.nzta.govt.nz/resources/pedestrian-planning-guide/

- Reverse sensitivity: https://www.nzta.govt.nz/assets/resources/effects-on-noise-sensitive-land/effects-on-noise-sensitive-land-use.pdf

To reinforce the Transport Agency's concerns raised yesterday, they are summarised as:

- Reverse sensitivity effects on the proposed dwellings;
- Traffic effects on the transport network – Industrial vs. Residential traffic flows and composition. The effects of the proposed landuse on the Landing Road roundabout, Keepa Road/State Highway 30 roundabout and the Whakatane River bridge; and
- Consideration of the safety and connectivity of active transport modes (walking and cycling) to the Hub and the Whakatane CBD.

Any further queries, feel free to give me a call.

Kind regards,

Matt Stulen / Planning Advisor
Planning & Investment Bay of Plenty
DDI +64 7 927 6006 M 027 836 4517
E matthew.stulen@nzta.govt.nz / w nzta.govt.nz

Tauranga Office / Level 3, Harrington House
32 Harington Street, PO Box 13-055, Tauranga 3141, New Zealand

Since the time of this meeting we have prepared the plan change request documentation. A copy of the report is attached along with a supporting acoustic report. We would appreciate any further comments NZTA may have regarding the proposal prior to Council making a decision on accepting and publicly notifying the proposal. We are particularly interested in NZTA's view on the acceptability of the mitigation measures recommended in the Hegley acoustic report.

Please feel free to contact me if you have any questions or would like to discuss further.

Cheers

Tim.

TIM FERGUSSON
Whakatane Manager
Principal

First Floor, ASB House
202 The Strand, Whakatane 3120
PO Box 336, Whakatane 3158

M +64 21 748 525 P +64 7 308 5478 DDI +64 7 219 3017

HARRISON GRIERSON. COM

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APPENDIX 10
ENGINEERING DESIGN CONSULTANTS – GEOTECHNICAL ASSESSMENT

23 & 45 Keepa Road, Coastlands

Geotechnical Report

Prepared for Lysaght Developments

Project 47465 - Geo2 - 02/10/2017

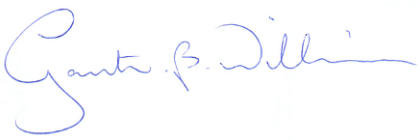
Engineering Design Consultants Ltd
W: www.edc.co.nz
E: team@edc.co.nz
Christchurch: 1st Floor, 39 Carlyle St, Sydenham Ph (03) 355 5559 PO Box 7534, Sydenham, 8240
Auckland: 1st Floor, Unit 1, 100 Bush Rd, Albany Ph (09) 451 9044 PO Box 118, Albany Village, 0755

Revision	Date	Engineer	Description
A	19/07/2017	CG	Preliminary Draft
B	02/10/2017	CG	Draft
C	05/10/2017	CG	Final

REPORT PREPARED BY:

Christopher Green
BSc (Geol)
Engineering Geologist

REPORT CHECKED BY:



Gareth B Williams
MSc(Eng) CPEng MIPENZ IntPE(NZ) MInstD MEIANZ
Snr Geotechnical Engineer, Director

Limitations of Report

Except where required by law, the findings presented as part of this report are for the sole use of our client, as noted above. The findings are not intended for use by other parties, and may not contain sufficient information for the purposes of other parties or other uses. No third party (excluding the local authority) may use or rely upon this report unless authorised by EDC in writing.

To the extent permitted by law, EDC expressly disclaims and excludes liability for any loss, damage, cost or expense suffered by any third party relating to or resulting from the use of, or reliance upon any information contained in this report. It is the responsibility of third parties to independently make enquiries or seek advice in relation to their particular requirements.

Our professional services are performed using a degree of care and skill normally exercised, under similar circumstances, by reputable consultants practicing in this field at this time. No other warranty, expressed or implied, is made as to the professional advice presented in this report, in regard to its accuracy or completeness.

Our opinions and recommendations are based on our comprehension of the current regulatory standards and must not be considered legal opinions. For legal advice, please consult your solicitor. This opinion is not intended to be advice that is covered by the Financial Advisors Act 2010.

This report includes Appendices.

Appendix A – CPT Logs

Appendix B – Liquefaction & Lateral Spreading Analysis

EXECUTIVE SUMMARY

Engineering Design Consultants Ltd (EDC) was commissioned by Lysaght Developments in June 2017 to conduct a desktop study review of the existing site reports and provide a geotechnical assessment to support an application for rezoning from Light Industrial to Residential at 23 & 45 Keepa Road, Whakatane.

The previous report documentation has been provided in hardcopy and has not been included as an Appendix.

Ground Conditions

The ground profile generally consists of non-engineered fill that extends from the surface to between 1.0 – 2.1mbegl and is of differing origin. The fill has been placed over a long period of time as a series of discrete operations and no engineering certification exists for the placement and compaction of this material. Placement of the fill has been under the supervision of Ian Lysaght. The fill is underlain by a bed of silt overtop of sands which extend to depth.

The desktop study suggests that groundwater is likely to be at least 1.2mbegl across the site, though it was encountered as low as 2.1mbegl in places.

Based on the information available to date, it is considered that future land performance of the proposed Lots is within the limits of CERA land classification Technical Category 2 - 3 (**TC2 – TC3**).

The relevant geotechnical hazards standards for the assessment of this site are:

- MBIE Guidelines
- Regional Council Hazard Assessment standards

Flooding

The Bay of Plenty Regional Council has registered this site as being at risk of flooding and has recorded a flood occurring the early 2000's. In response a flood level of RL 3.0m (Moturiki Datum) has been set for the Keepa Road area.

We understand flooding hazards and management is being assessed separately from this report.

Resource Management Act Assessment

It is considered, under Section 106 (1) of the RMA, that from a geotechnical perspective the site is suitable for the proposed residential development and satisfies the requirements of Section 106 and local council regulations. However some building restrictions will be required to minimise the estimated potential deformation (settlement & lateral spreading) from a significant seismic event.

Contamination Assessment

As part of the discrete periods of filling on this site some contaminated material has been placed.

Contamination testing has been previously undertaken on the site to assess the level and location of contamination for this site.

We understand the contamination testing, assessment and hazard management is being undertaken separately from this report.

CONTENTS

1.0 INTRODUCTION

1.1 Terms of Reference

Engineering Design Consultants Ltd (EDC) was commissioned by Lysaght Developments in June 2017 to conduct a desktop study review of the existing site reports and provide a geotechnical assessment to support an application for a proposed Plan Change from Light Industrial to Residential at 23 & 45 Keepa Road, Whakatane, henceforth referred to as 'the site'.

To provide detailed information on potential liquefaction which could affect the site an additional CPT investigation was undertaken in August 2017.

1.2 Objective and Scope of Investigation

The objective of this report was to review the existing reports, provide appropriate geotechnical advice and assess the site against section 106 of the Resource Management Act (RMA) to determine if it is suitable for future residential development.

In order to achieve the outlined objectives this investigation comprised the following scope:

- Site walkover.
- A geotechnical desktop study.
- Review of previous geotechnical reports.
- Resource Management Act Section 106 (1) Assessment and provision of a Geotechnical Statement of Professional Opinion Definition of the Conceptual Site Model.
- CPT investigation and liquefaction / lateral spreading analysis.
- Production of an interpretive report that documents the above and provides comment on possible geotechnical constraints to future residential development and the suitability of the site for residential development.

The Geotechnical aspect of this investigation was completed in accordance with Section 106 of the Resource Management Act (RMA), MBIE Guidance documents and the Bay of Plenty Regional Council Hazards Assessment standards.

1.3 Proposed Development Works

A draft subdivision plan was provided to EDC by the Client. The following information has been extracted from it:

- It is proposed to subdivide the existing land parcel into 85 new residential lots of approximately 508 – 1395m^2.
- Lot 87 is proposed to form a reserve.
- Public Roads are proposed for Lots 89 & 90 from Keepa Road which is situated along the eastern boundary of the site.

The proposed scheme plan for the residential development is included below.

Figure 1: Proposed Scheme Plan (courtesy East Bay Surveyors)

2.0 SITE IDENTIFICATION

2.1 Legal description and location

The site consists of two separate properties, 23 & 45 Keepa Road, both of which are semi-level sites covered in grass and undeveloped.

23 Keepa Road is an irregular polygon on the northwestern corner of the intersection of Keepa Road and State Highway 30 with an undulating surface ranging from 1.5 – 3.0m above sea level.

45 Keepa Road is a triangular strip of land extending west from Keepa Road along the boundary with Kope Canal and behind commercial buildings accessed from Gateway Drive. The site ranges is of a similar undulating nature as 23 Keepa Road, rising towards the northern boundary.

These two properties will be developed together and form the site.

The legal description and area for each property is included in the table below:

Physical Address	Legal Description	Site Area (m^2)
23 Keepa Road	Lot 2 DP 452650	41010
45 Keepa Road	Allot 28B9B2A Rangitaiki PSH	33557
Total Area		74,567

Table 1: Site Description

The site location and an aerial image is included as Figures 2 & 3.

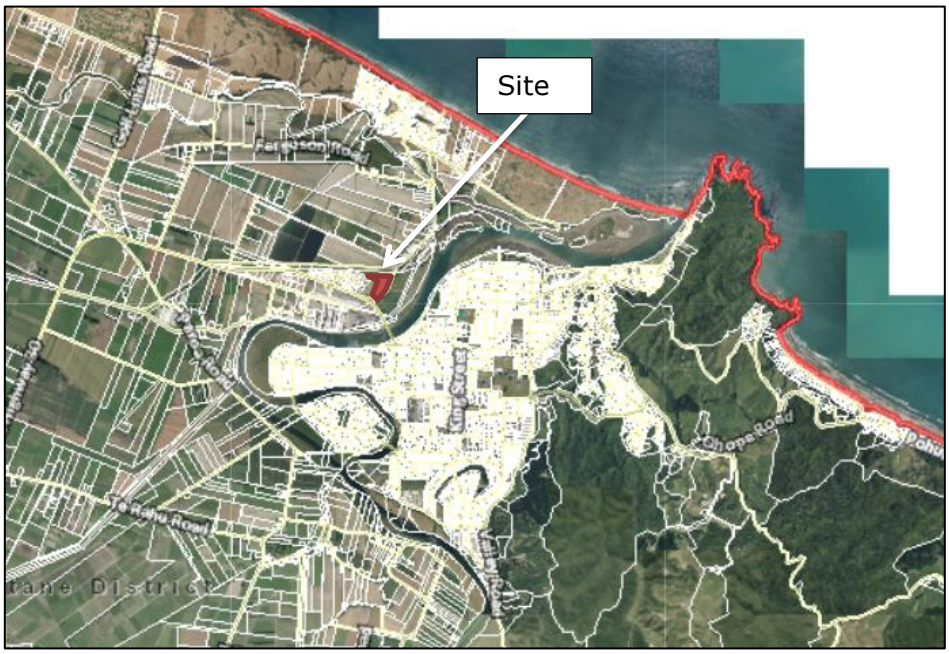


Figure 2: Site Location (courtesy Whakatane District Council)

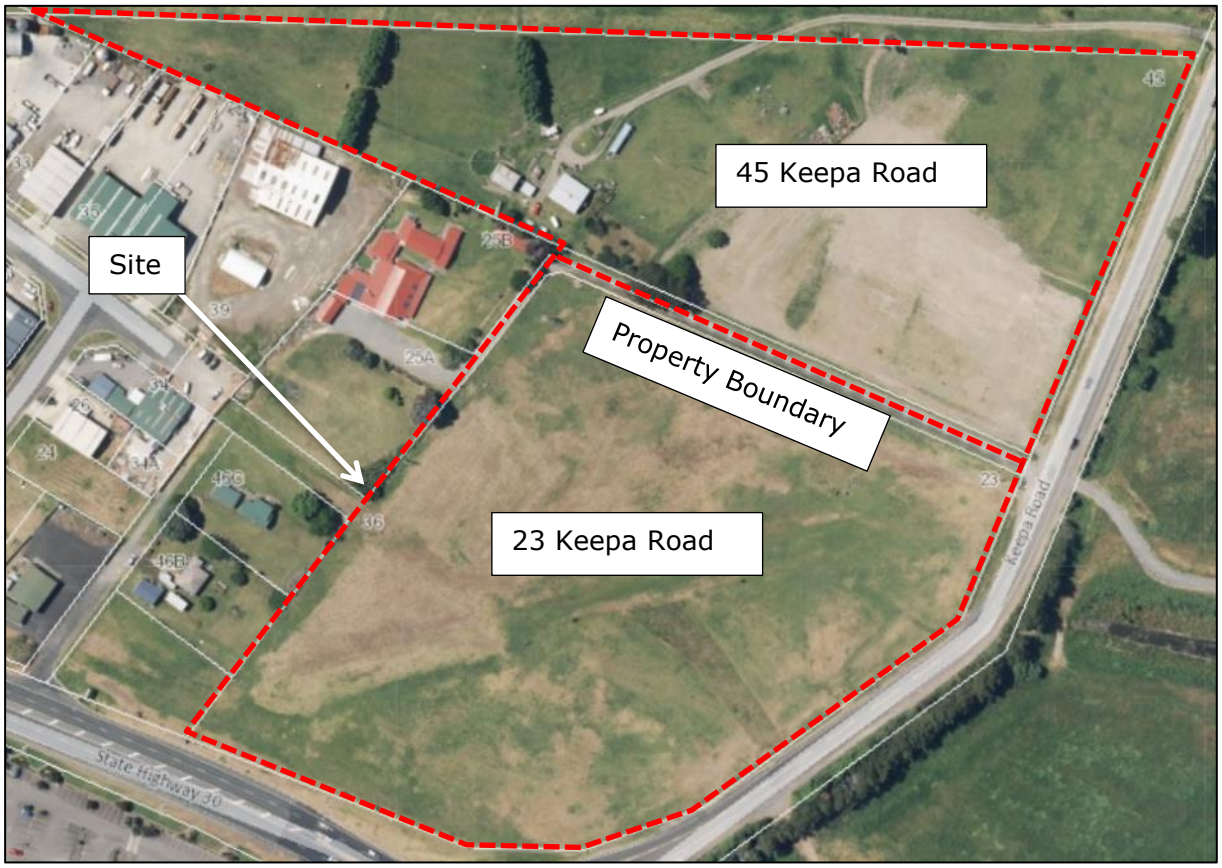


Figure 3: Site Aerial (courtesy Whakatane District Council)

2.2 Site walkover

The following site description is based on our observations from the site walkover conducted on the 05/07/2017.

- The site is accessed from Keepa Road.
- A further site entrance exists part way along the northern boundary of 45 Keepa Road where it connects with the council maintained area south of Kope Canal
- The site is undulating containing sporadic grass and trees on the western edge of site.
- Some minor structures are present along the south western boundary of 45 Keepa Road otherwise the site is bare.

3.0 GEOTECHNICAL DESKTOP STUDY

3.1 Published Geology

Three geological resources were reviewed during production of this report, these were:

- Institute of Geological & Nuclear Sciences (GNS) Ltd map titled "Geological Map: Geology of The Rotorua Area 1:250,000
- New Zealand Geotechnical Database (NZGD)
- Whakatane GIS

The GNS map indicates that the site is underlain by alluvial deposits of the Tauranga Group. These are described as "Alluvial and colluvial gravel and sand dominated by pumice clasts, silt and clay with local peat beds".

The New Zealand Geotechnical Database does not contain any uploaded geotechnical data applicable to this site.

3.2 Previous Reporting

The following geotechnical reports were provided to EDC by Lysaght Developments on the understanding this was the sum of the geotechnical & contamination data accumulated in relation to this site.

A summary of the contents of each report is included below.

3.2.1 Shrimpton & Lipinski Ltd (S&L) Report '*Gateway Industrial Estate Stage Two, State Highway 30 and Keepa Road, Whakatane, Evaluation of Filling Present'*, dated 23 May 2001, Ref: 15392.

The S&L report identifies the following:

- Filling has been occurring on the site on an irregular basis between 1977 – 1999.
- Filling has consisted of discrete placement of Whakatane River dredgings, sands removed from developments in Coastlands and 'scalpings' from regular maintenance of the local highways.
- Placement of the fill by Waiotahi Contractors has been supervised by Ian Lysaght with the reported filling have occurred via the use of bulldozers and vibrating rollers.
- There is no engineering certification of the filling.

A drawing by S&L is included below which indicates the approximate area of testing and location of the different fill materials placed onsite:

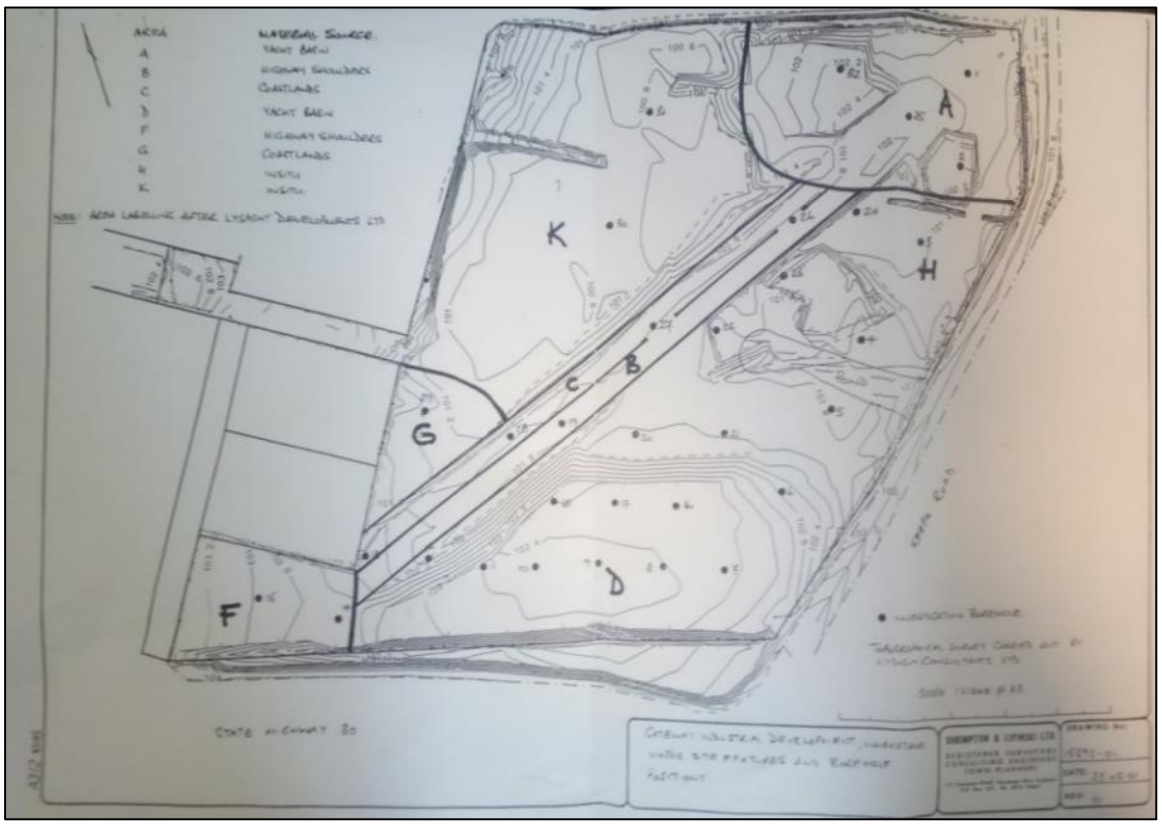


Figure 5: Fill Areas

3.2.2 Environment Bay of Plenty Regional Council (EBoPRC) '*Report Environment B.O.P, Delineation & Risk Assessment, Mill Waste Disposal Sites 24a & 24b – Keepa Road'*, dated November 2003, Ref: 009/EBOP/001/001.

The EBoPRC Report identifies the following:

- Geophysical surveys were undertaken to determine approximate areas of filling.
- Some PCP & dioxin contaminated waste (Wood Mill Waste) is present on the site.
- The contaminated material is covered by ≥0.4m of ash and topsoil (this ash may represent a further contamination issue).
- The "Assumed PCP and dioxin contaminates within former mill wastes at this site in its present state are considered to pose no significant risk to human health as long as the waste remains covered with an adequate depth of overburden and undisturbed. No significant pathways were identified at the site in its present state between the waste encountered and human receptors".

The mill waste was identified in three distinct locations, further observations indicated the mill waste was not present in two of these locations and the third required physical observation and testing to confirm. An excerpt from this report is included below indicating the potential extent of the wood waste:

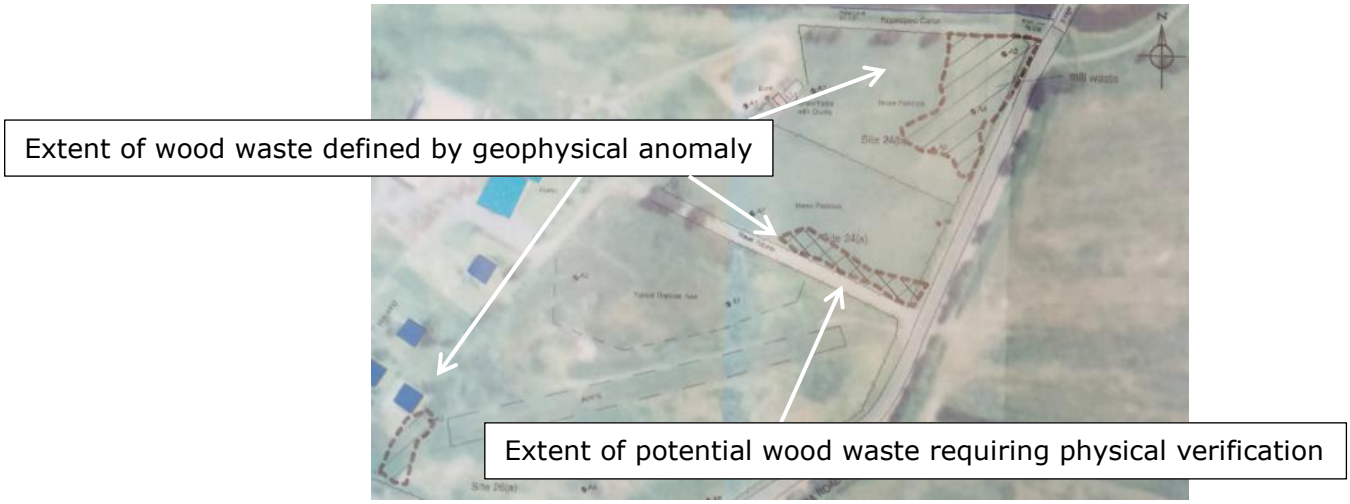


Figure 6: Areas of identified wood waste fill

Attached to this report is a covering letter by Jeff Farrell dated 9 December 2003 which summarises the EBoPRC report. This letter states:

- "The general findings of the report are that no waste (contaminated mill waste) was found on your property but a thin layer of ash was discovered that should be analysed further prior to any future development of the land".

Jeff Farrell of the Whakatane District Council should be consulted to identify the difference between the report (indicating three contaminated areas) and this letter (indicating no contamination).

3.2.3 Tonkin & Taylor Ltd (T&T) Report '*Kohi Commercial Developments – Keepa Road Whakatane'*, dated 15 December 2004, Ref: 60762.

The T&T report identifies the following:

- Testing was undertaken by digging 18 trial pits within the potentially contaminated fill areas identified in the EBoPRC report. Trenching was undertaken following this to identify the extent of the fill. The trenches and trial pits were conducted to 1.8m depth or to the top of the natural soils.
- "The concentrations of metals, PCP and dioxins in the wood waste meet current New Zealand guidelines of commercial operations (as of 2004)"
- "The site is classified as a contaminated site under EBOP Proposed Regional Water and Land Plan and a consent for a discretionary (restricted) activity would be required for any disturbance of the wood waste"

The Figure below illustrates the areas investigated as part of the previous reporting.

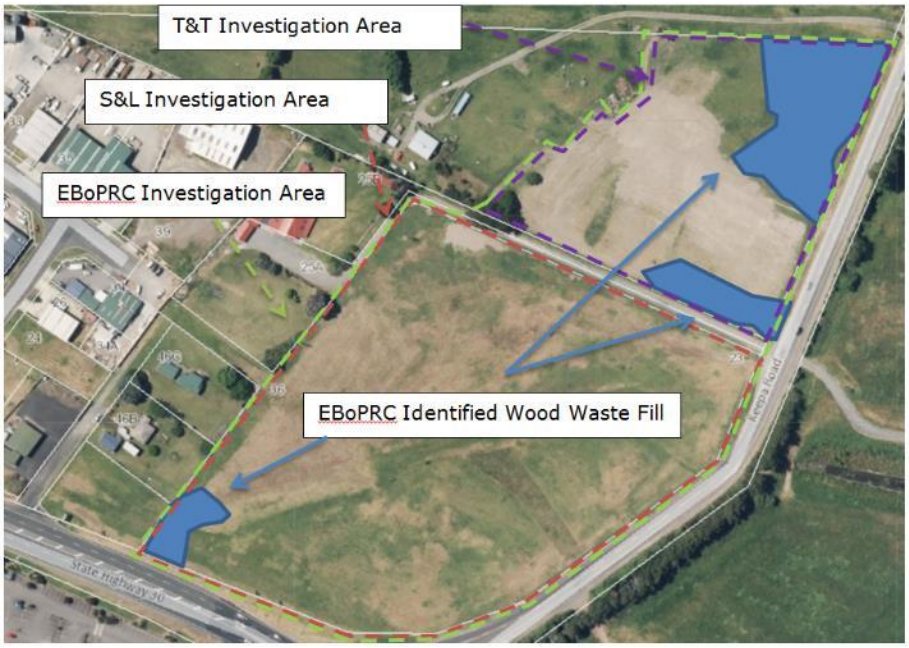


Figure 7: Areas of Investigation

No geotechnical or contamination testing has been undertaken on the western 'tip' of 45 Keepa Road (behind the existing Gateway Drive Developments).

4.0 GEOHAZARDS

The following information has been collected in order to assess the risk to the site from liquefaction and lateral spreading in a future earthquake event:

4.1 Liquefaction

For liquefaction to occur there needs to be three preconditions:

- Young (Holocene or less than 10,000 years old) sediments;
- The soils include fine-grained and non-cohesive (silts and sands);
- The soils are saturated (below the water table).

The soils at the site are of the late Quaternary Age (11,500yo – 24,000yo).

The ground profile generally consists of fill underlain by silts and sands.

The previous geotechnical study on the site indicates that groundwater is likely to be between 1.2 – 2.1mbegl across the site, though no data is available near the Kope Canal where groundwater levels may be higher.

Based on the available information the site is likely to be at some risk of liquefaction induced deformation, to more accurately identify the risks a site specific CPT investigation has been undertaken as described in Section 6.0.

4.2 Previous Liquefaction Studies

4.2.1 New Zealand Geotechnical Society (NZGS) – Issue 92, December 2016

No previous site-specific data which could be used to assess liquefaction on this site was available to EDC for review however, we understand a study by Canterbury & Auckland University supported by Tonkin & Taylor has been conducted which investigated this area.

Part of the findings of this investigation was published in the New Zealand Geotechnical Society (NZGS) – Issue 92, December 2016 titled "Whakatane liquefaction case history from the 1987 Edgecumbe Earthquake: examination of an extensive CPT dataset supplemented by paleo-liquefaction investigations"

This issue included a map which indicates that 'liquefaction and/or lateral spreading may have occurred' at the site. The identification of potential liquefaction through assessment of Liquefaction Severity Numbers (LSN's) does not match the observed performance of this site following the 1987 Edgecumbe Earthquake.

The map is included below.

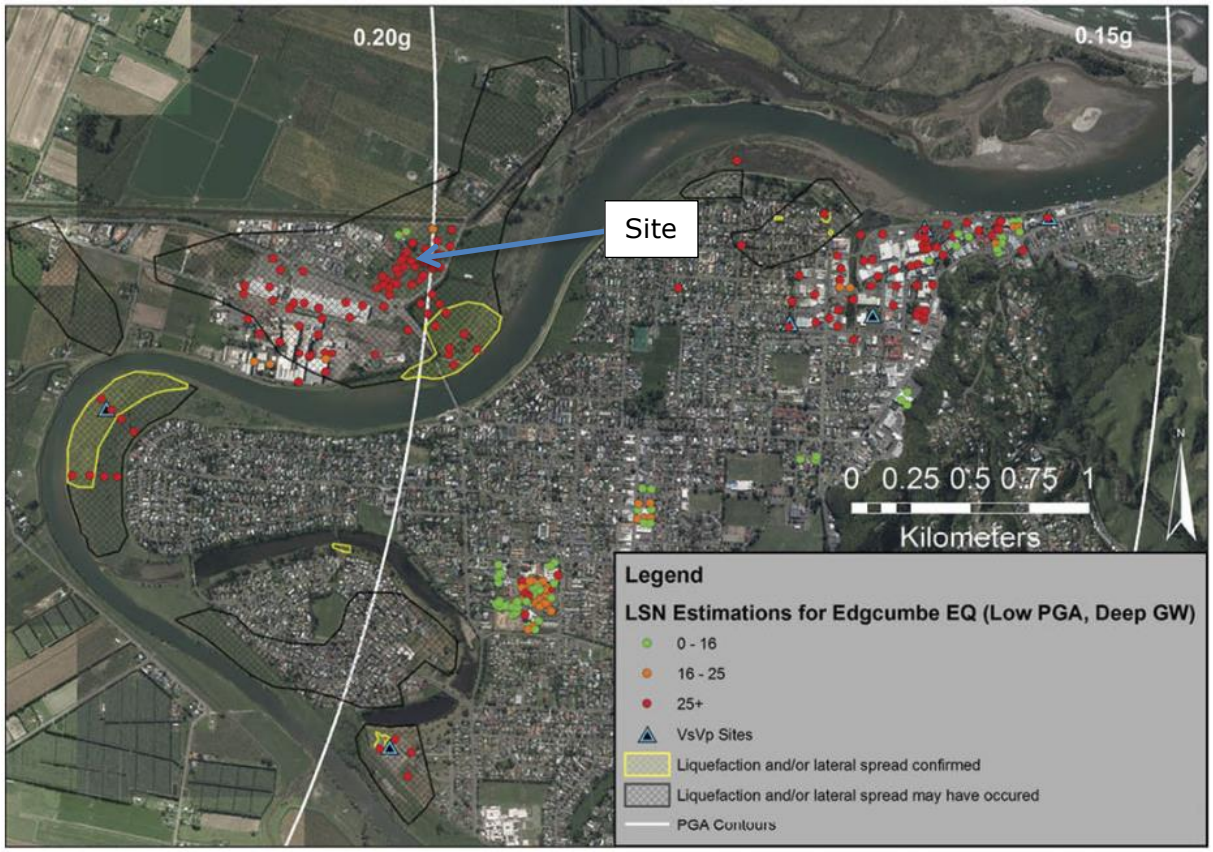


Figure 8: NZGS Estimated Liquefaction presence Map (courtesy NZGS)

Release of the raw data collected as part of the investigation to form this map would provide some assistance in further defining liquefaction risks for this site.

4.2.2 Liquefaction Study for the Whakatane District Council Information

In 2015, GNS Science working with Tonkin & Taylor and Canterbury University released the 'Whakatane Ground Study' report which addressed the Liquefaction risk for the Whakatane CBD.

This report was further supported by a study released in 2016, 'Finding the concealed section of the Whakatane Township with a shear wave land streamer system: A seismic surveying report".

The information within these reports indicates the local area is at risk of liquefaction but that the CBD experienced less liquefaction than would have been expected based on the 'LSN' calculations using the 1987 Edgecumbe Earthquake magnitude data.

The location of the Whakatane Fault is not mapped beyond the extent of the Whakatane Bridge, however, discussions with BoPRC indicate that it is likely to be the same fault as the Keepa Fault that was mapped offshore. If this is the case, then it is likely that the fault trace would pass quite close to the site.

4.3 Technical Category Classification

Based on the information available to date and referenced above, it is considered that future land performance of the proposed subdivision is likely to be within the limits of CERA land classification Technical Category 2 - 3 (**TC2 – TC3**).

To confirm this, an additional CPT investigation has been undertaken and is discussed in section 6.0 below.

4.4 Seismicity

4.4.1 Geological Fault-lines

The nearest known active faults are the Edgecumbe and Whakatane faults.

An excerpt from the GNS Web Map is included below.

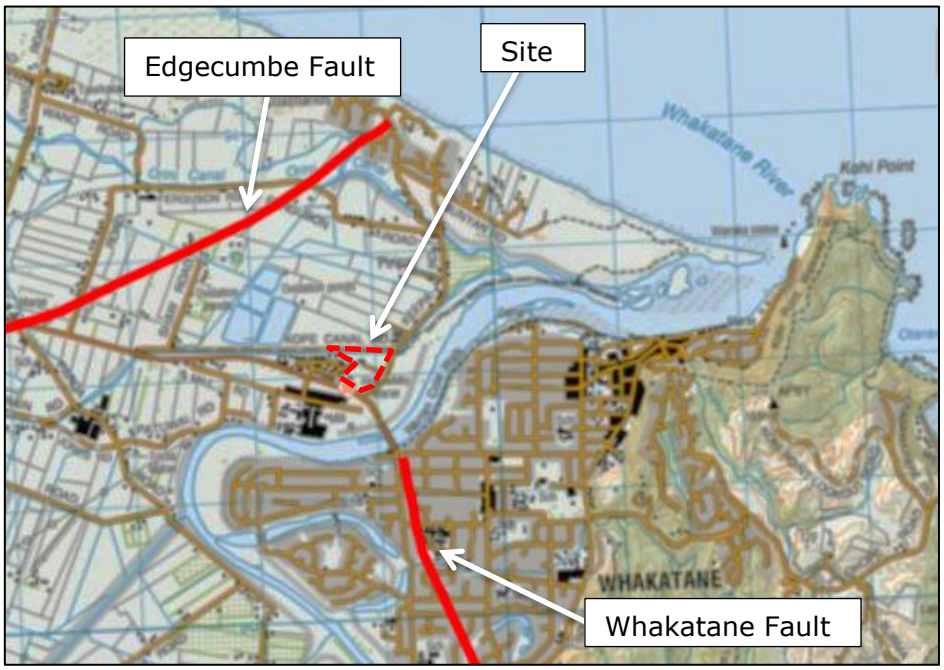


Figure 9: Active Faults

The Edgecumbe Fault is approximately 1.8km west of the site, whilst the nearest indication of the presence of the Whakatane Fault (south of Landing Road Bridge) is approximately 700m south. It is possible that the Whakatane Fault is significantly closer than 700m to the site once it crosses the Whakatane River as discussions with the BoPRC indicate that it is likely to be the same fault as the Keepa Fault that was mapped offshore.

The GNS Web map provides the following information on these faults:

Fault Name	Fault Sense	Recurrence Interval	Last Event (within the)	Slip Rate	Single Event Displacement
Edgecumbe Fault	Normal	I(<=2000 years)	Unknown	Unknown	Unknown

(#2116)					
Whakatane Fault (#1726)	Dextral	I(<=2000 years)	Millennium	Moderate	Unknown

Table 2: Fault Information

4.4.2 Estimate Peak Ground Accelerations

Figure 8 above indicates the site may have been subject to a PGA of 0.20g during the 1987 Edgecumbe Earthquake.

No information is available on the potential PGA's produced by movement on the Whakatane Fault although we understand they are likely to exceed those of the 1987 Edgecumbe Earthquake.

5.0 FLOODING & WATER BODIES

The Bay of Plenty Regional Council (BoPRC) was contacted with regards to the flood risk at the site.

- The BoPRC indicated a flood event had been recorded on the site in the early 2000's.
- Following this flood event 3 pumps have been installed to assist with drainage of the site (23 & 45 Keepa Road).
- The BoPRC has set the flood level here as RL 3.0m (Moturiki Datum).

The Kope Canal extends along the northern site boundary and the Whakatane river is approximately 400m east of the site on the other side of Keepa Road. The Kope Canal forms part of the Whakatane Plains flood management canal scheme and discharges into the Whakatane River approximately 2km north and west of the site.

We understand the site flood hazard assessment and mitigation is being undertaken separately from this report.

6.0 LIQUEFACTION POTENTIAL - SITE INVESTIGATION

6.1 Rationale

EDC was engaged to provide further geotechnical assessment to assist in the liquefaction assessment of the land and provide an indication of soil types below the depths described in previous geotechnical reports on this site.

6.2 Intrusive Investigation Summary

Cone Penetration Testing (CPT), comprising 7 No. hole (CPT01 – 03 and 05 - 08), was undertaken by Geotech Drilling Ltd on 14 September 2017. CPT 04 could not be completed due to equipment failure on the CPT rig. The CPT's reached the target depth of 20.0m begl.

The approximate locations of the CPT's are indicated on Figure 10. The raw data from the CPT readings was analysed using the program CPet-iT v2.0.1.54. Logs of the CPT results are shown in Appendix A.

6.3 Summary of Ground Conditions

This investigation indicates the following generalised soil section beneath the site:

Depth Range	Ground Description	Density/Consistency
Surface to 2.5m	Silty sand and sandy silt	
2.5m to 20.0m	Sand and silty sand	Medium Dense

Table 3: Ground condition summary

The exception to the above was:

- CPT02 – in which an organic layer was recorded between 1.5m and 2.0m and a clayey layer between 5.0m and 8.0m begl.
- CPT05 – in which a clay and organic layer was recorded between 4.2 m and 4.7m begl.
- CPT07 - in which a clayey soils are present to 2.5m begl.

Groundwater was recorded on the CPT logs to be variable between 0.95m to 2.94m begl.

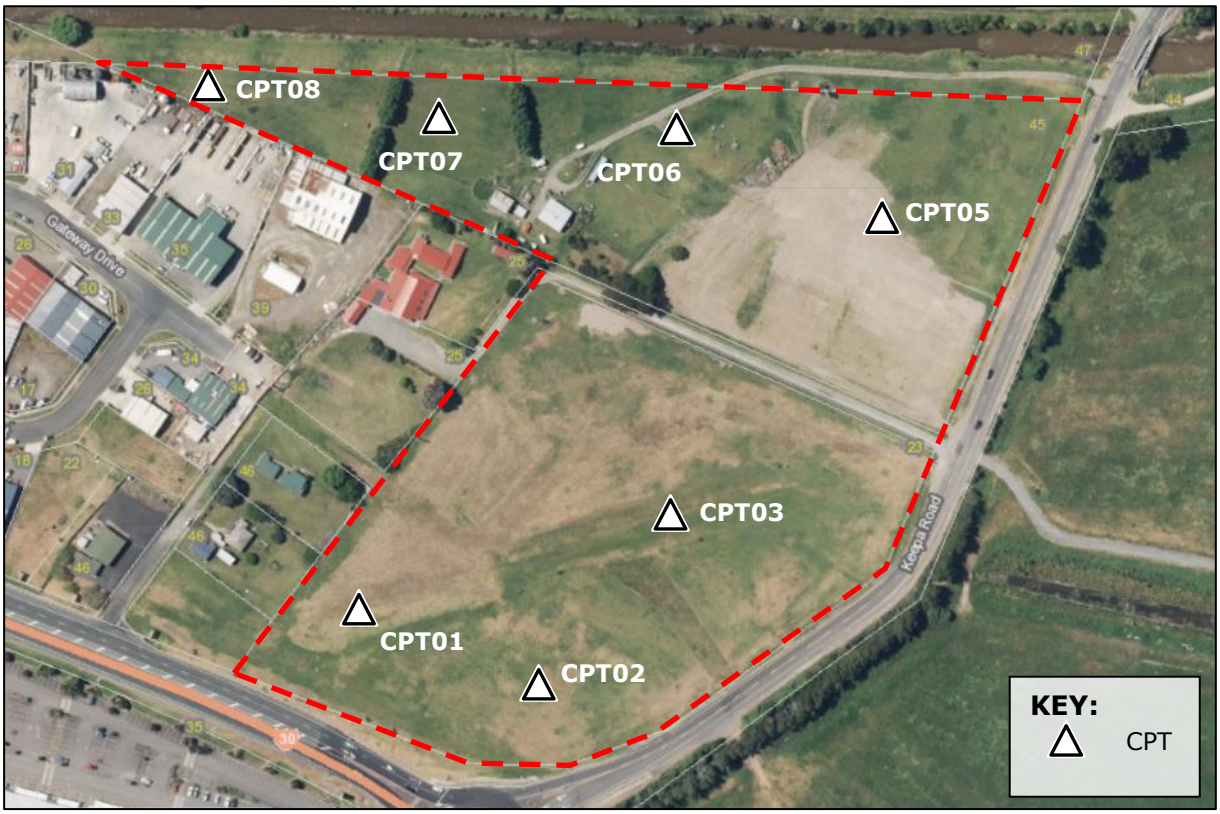


Figure 10: Intrusive Investigation Locations (CPT 04 deleted due to equipment failure)

7.0 LIQUEFACTION ASSESSMENT

7.1 Assessment Methods

Liquefaction analyses to assess estimated ground settlement were undertaken on the data from the CPT's, using the Geologismiki Software "CLiq" v2.0.6.85 and the methods prescribed by the current MBIE guidance (Boulanger and Idriss 2014).

The site is located adjacent to the Kope Canal and as such, in accordance with the MBIE guidance, lateral spreading analysis has been undertaken.

7.2 Analysis Parameters

Groundwater was recorded in the CPT's to be generally between 0.5m and 2.4m begl. The Kaikoura Earthquake Viewer indicates a ground water depth of between 1m and 2m This is in line with the published GNS 85th percentile depth of 1.0m to 2.0m. Therefore, a groundwater level of 0.5m begl used during an earthquake scenario for the liquefaction analyses.

Two seismic scenarios have been analysed for assessing future ground performance. These have been calculated using the NZTA Bridge Manual (2014) method, as per MBIE Guidance. The established parameters, based on a Site Subsoil Class C, used in the liquefaction analyses are shown on Table 5:

Scenario	Earthquake Magnitude	Peak Ground Acceleration
SLS 1	6.1	0.11g
ULS	6.1	0.44g

Table 5: Liquefaction Analysis Scenario Parameters

Notes: Serviceability Limit State (SLS) design assesses the deformations that occur under working conditions, while Ultimate Limit State (ULS) assesses the situation that would lead to the collapse of a structure.

7.3 Estimated Ground Settlement

The graphical results sheets for each of the analyses are included in Appendix B. The following table summarises the results of the estimated total and Index (upper 10m) settlements:

Test Ref.	Estimated Total Settlement			
	SLS Scenario (mm)		ULS Scenario (mm)	
	Total	*Index*	Total	*Index*
CPT 01	30	*30*	265	*150*
CPT 02	51	*51*	270	*139*
CPT 03	23	*23*	265	*174*
CPT 05	5	*5*	143	*35*

CPT 06	0	*0*	96	*79*
CPT 07	0	*0*	50	*15*
CPT 08	2	*2*	80	*40*

Table 1: Summary of Estimated Liquefaction Induced Settlement

The CPT analyses indicated up to 51mm of estimated Index settlement under SLS conditions, and up to 174mm under ULS conditions. It should be noted that these estimated settlements do not account for loss of ground volume via liquefaction ejecta.

The above results suggest a significant difference in land performance between 23 and 45 Keepa Rd, with much greater ULS settlements on 23 Keepa Rd. It should however be noted that the transition between the poorer ground (23 Keepa) and the better ground (45 Keepa) has not been defined and as such this split is an over simplification.

The results indicate that the land should be classified as TC 3 according to MBIE Guidance although most of 45 Keepa Road was within the requirements of TC 2 other than ULS settlement on CPT 5 which exceeded 100mm.

The below graphs indicate the depths of the liquefiable layers:

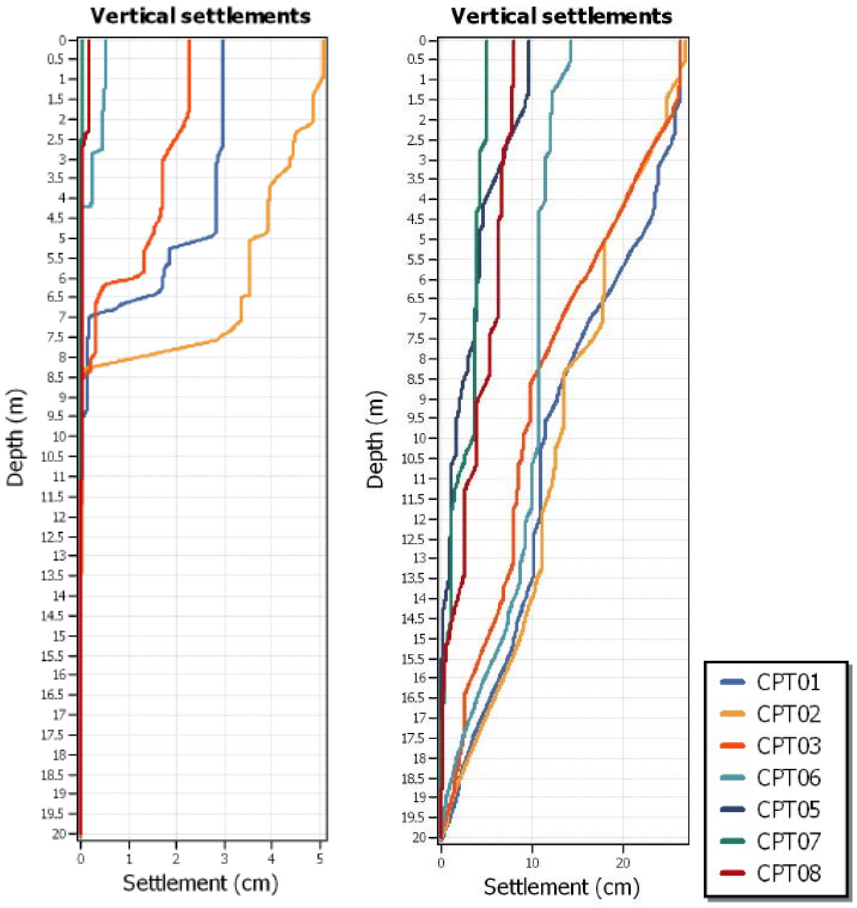


Figure 11: Liquefaction Analysis Overlay Graphs

7.4 Liquefaction Severity

The Liquefaction Severity Number (LSN) is a parameter that predicts the occurrence of damaging liquefaction by recognising that damaging liquefaction is related to the depth at which liquefaction occurs. The LSN's for the CPT analyses are shown below:

CPT ref.	Estimated Ground Damage	
	SLS Scenario	ULS Scenario
CPT 01 - 03	0 – 2	4 – 28
CPT 05 - 08	5 - 11	31 - 50

Table 2: Summary of Estimated Liquefaction Induced Ground Damage

LSN Key
0 – 10 = Little to no expression of liquefaction,
10 – 20 = Minor expression of liquefaction,
20 – 30 = Moderate expression of liquefaction,
30 – 40 = Moderate to severe expression of liquefaction,
40 – 50 = Major expression of liquefaction,
>50 = Severe damage.

The above indicates that in an SLS event, little to no expression of liquefaction could be expected in the north of the site increasing to Minor expression in the south, while in a ULS event, Little to Moderate expression of liquefaction could be anticipated in the north of the site, increasing to Moderate to Major in the south.

7.5 Lateral Spreading Analysis

Lateral spreading analysis was undertaken using an estimated Kope Canal free face height of 3.0m at the distances shown below. CPT's 1 – 3 are considered sufficient distance from the canal to be not included. The following table summarises the results for the estimated horizontal movements:

Test Ref.	Liquefaction Analysis Results – Liquefiable Zones and Total Settlement	
	SLS Scenario (mm)	ULS Scenario (mm)
CPT 05	22	460
CPT 06	0	500
CPT 07	0	65
CPT 08	0	285

The following are the global lateral movement categories for TC3 (at ULS) determined by MBIE:

	Minor to Moderate	Major	Severe
Global Stretch	0 to 300mm global lateral movement	300 to 500mm global lateral movement	>500mm global lateral movement
Stretch across Building Footprint	0 to 200mm lateral stretch across building footprint	200 to 500mm lateral stretch across building footprint	>500mm lateral stretch across building footprint

The amount of lateral spread estimated by the CPT analysis places the site within the 'Minor to Major' global lateral movement category and lateral stretching is also expected to be within the same category.

The estimated lateral spreading is likely to be pessimistic as the earthbund forming the Kope Canal stop bank will have surcharged the soils below. Further detailed geotechnical investigation will be required to determine the extent to which this has occurred.

In consideration of the information above the future land performance of the proposed Lots is within the limits of CERA land classification Technical Category 2 - 3 (**TC2 – TC3**) with a minor to major risk of lateral spreading within 23 Keepa Road.

8.0 RESOURCE MANAGEMENT ACT ASSESSMENT

Section 106 (1) of the Resource Management Act (RMA) states:

'A consent authority may refuse to grant a subdivision consent, or may grant a subdivision consent subject to conditions, if it considers that—

(a) the land in respect of which a consent is sought, or any structure on the land, is or is likely to be subject to material damage by erosion, falling debris, subsidence, slippage, or inundation from any source; or

(b) any subsequent use that is likely to be made of the land is likely to accelerate, worsen, or result in material damage to the land, other land, or structure by erosion, falling debris, subsidence, slippage, or inundation from any source; or

(c) sufficient provision has not been made for legal and physical access to each allotment to be created by the subdivision'

Our assessment considers parts (a) and (b) of the above Section 106 1(c) is not relevant to a geotechnical assessment.

Hazard	**Potential Susceptibility**	
	Current (part a)	**Post Development (part b)**
Erosion	No erosion is evident on the site and due to its flat topography the risk of significant erosion damage is considered very low.	It is not anticipated that the proposed development will accelerate or worsen the erosion rates if appropriate stormwater collection and disposal methods are implemented and sediment and erosion control methods are used during construction.
Falling Debris	N/A = Site and surrounds are relatively flat and therefore no issues are anticipated.	
Slippage	The site is not located on a hillside or located close to any abrupt changes in topography. As such the risk of slippage in static conditions is considered very low. There is a risk of lateral spreading, associated with Kope Canal, along the northern side of the site in a seismic event.	There is no anticipated change to the slippage risk in the event of future residential development of the site.
Subsidence – static conditions	There is no visual evidence of historic subsidence however the uncertified nature of the filling may represent a subsidence issue.	The risk of static settlement will need to be considered in the design of any residential development and suitable measures established to mitigate the risk of unacceptable static settlements.

Hazard	Potential Susceptibility	
	Current (part a)	**Post Development (part b)**
Subsidence – seismic conditions	The desk study indicates that the Whakatane Fault mapping shows the known northern extent of the fault is to the south of the Landing Road Bridge. Due to potential inaccuracy of existing data and the incomplete mapping of the Whakatane Fault beyond the northern extent of the Landing Road Bridge it is inferred that the fault may transect the site. As such there is a, currently unquantifiable, risk of fault rupture on the site. The site should be considered to functions as a TC 2 – TC 3 site (as described in the MBIE document) and is subject to some potential lateral spreading and vertical settlement if subject to a significant shaking event. In view of the above the risk of subsidence is considered to be medium to high.	The proposed development is unlikely to alter the estimated seismic reaction of the soils.
Inundation - Liquefaction	Historical evidence from the 1987 Edgecumbe Earthquake indicates only minor liquefaction was observed on the surface. The analysis results indicate up to 51mm of estimated Index settlement may occur under SLS conditions, and up to 174mm under ULS conditions. The site is considered to function as a TC 2 site under SLS conditions and a TC 3 site under ULS conditions. The analysis results suggest a significant difference in land performance between 23 and 45 Keepa Rd, with much greater ULS settlements on 23 Keepa Rd.	The proposed development is unlikely to alter the estimated seismic reactions of the soils. However any rise in groundlevel via placement of compacted fill is likely to increase the estimated settlement via surcharging of the underlying subgrade but by increasing the density of the soils, will lead to an increase of the 'crust' of non-liquefiable soils above the groundwater table and hence reduce the potential for liquefaction derived settlement
Inundation - Flooding	The Bay of Plenty Regional Council Indicates this site is at risk of flooding and the site will need to be raised to RL 3.0m (Moturiki Datum).	The client reports no earthworks are proposed here rather bunding will be undertaken. The effectiveness of this defence measure is discussed separately from this report.

It is considered, under Section 106 (1) of the RMA, that from a geotechnical perspective the site is suitable for the proposed residential development and satisfies the requirements of Section 106.

However the current proposed design of the subdivision will likely require development restrictions be applied to the title of each individual lot limiting development to certain foundation designs to attempt to mitigate the estimated seismic deformation, as discussed in section 11 below.

Discussion is also needed with the Client and possibly WDC regarding the risks associated with the Whakatane Fault.

9.0 NATURAL HAZARD RISK ASSESSMENT

The site is subject to the following hazards:

- Flooding
- Liquefaction
- Static Settlement
- Fault Rupture

We understand flood risk assessment is being undertaken separately from this report and some solutions have already been formed for the flood level set by the BoPRC.

The analysis indicates the site is likely to be subject to potential liquefaction within the limits of TC 2 in an SLS event and TC 3 in an ULS event. Estimated Lateral spreading within the northern extent of the site is within the limits of TC 3 minor – moderate, however our analysis is likely to be pessimistic.

There is evidence of uncertified filling on the site. The risk of static settlement will need to be considered in the design of any residential development and suitable measures established to mitigate the risk of unacceptable static settlements. It is recommended that this risk is better assessed through on-site investigation works.

Based on the unknown nature of the fault beyond the Whakatane Bridge and possible inaccuracies with current data it is inferred that the fault may transect the site. As such there is a, currently unquantifiable, risk of fault rupture on the site. Discussion is recommended with the Client and possibly WDC, regarding the risks associated with the Whakatane Fault

The key legislation and planning controls around this site include:

- MBIE Guidelines
- Bay of Plenty Regional Council Hazard Assessment standards

10.0 CONTAMINATION HAZARD ASSESSMENT

The previous reports indicate the site contains varying degrees of contamination from the previous filling with ash & clinker and mill waste (potential dioxin & PCP contamination).

The applicability of this site for residential development will require assessment of the known contamination recorded in the earlier reports against the relevant government and local standards/regulations.

The key legislation and planning controls around this site include:

- Resource Management (National Environmental Standard for Assessing and Managing Contaminants in Soil to Protect Human Health) Regulations 2011 (NESCS).
- Bay of Plenty Regional Policy Statement.

We understand the contamination testing, assessment and hazard management is being undertaken separately from this report.

11.0 DEVELOPMENT RESTRICTIONS AND RECOMMENDATIONS

Some development restraints will need to be imposed during development of the individual building platforms under the current design of the subdivision this may include restricting foundation development to a minimum of TC 2 style compacted fill platforms supporting a Waffle Slab style foundation.

Alternatively the potential for liquefaction and lateral spreading induced deformation could be minimised during the earthworks stage of development by placement of geotextiles in the subgrade during filling or the establishment of an engineered in-ground wall along the extent of the Kope Canal.

Any geogrid placed should be orientated such that the dimension of maximum strength is facing the direction of maximum expected stretching (towards the Kope Canal).

The current plan for development of the site will likely require specific geotechnical investigations for each lot during building consent application.

The potential seismic response of the site can be revisited during preparation of the geotechnical completion report.

APPENDIX A

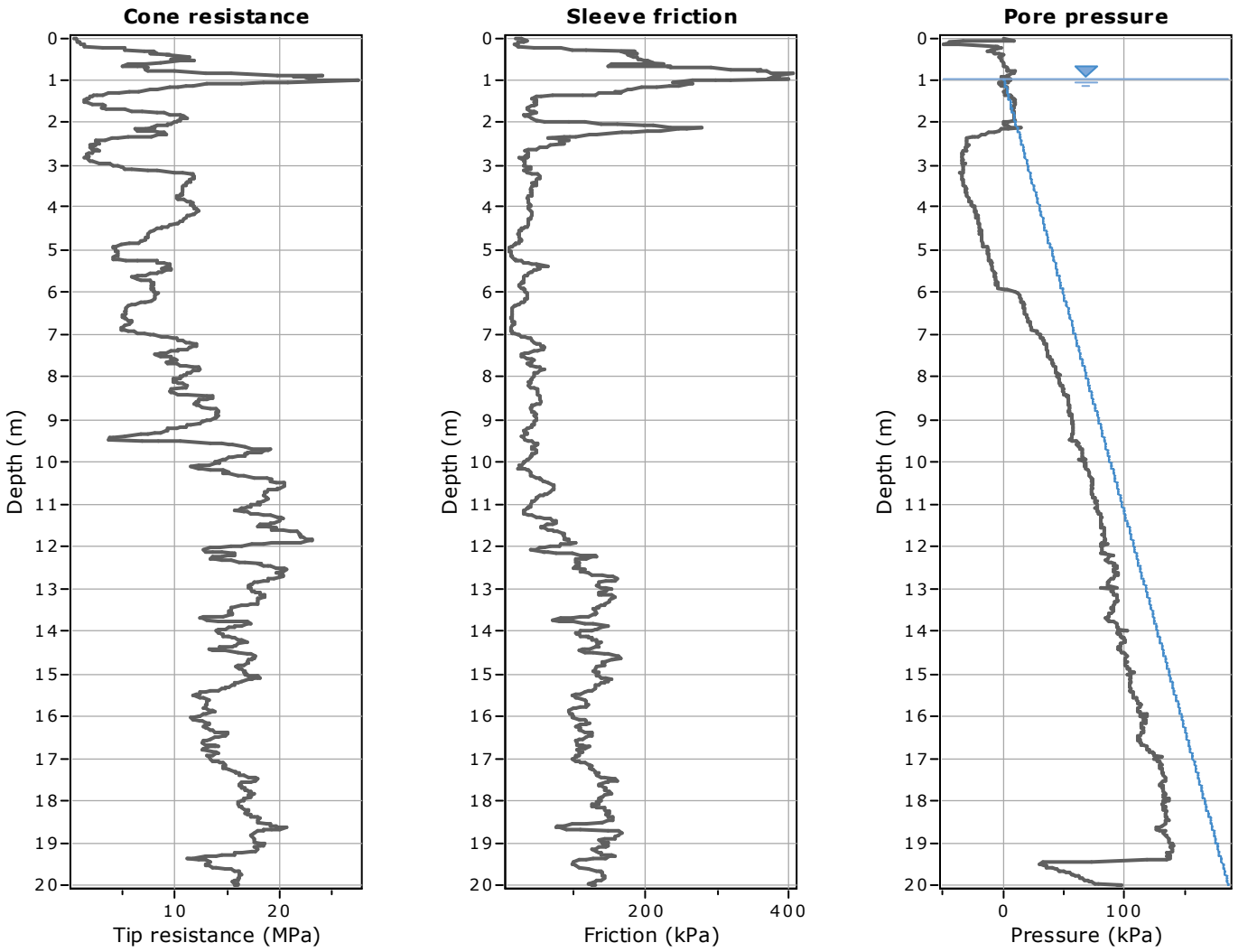
CPT LOGS

ENGINEERING DESIGN CONSULTANTS

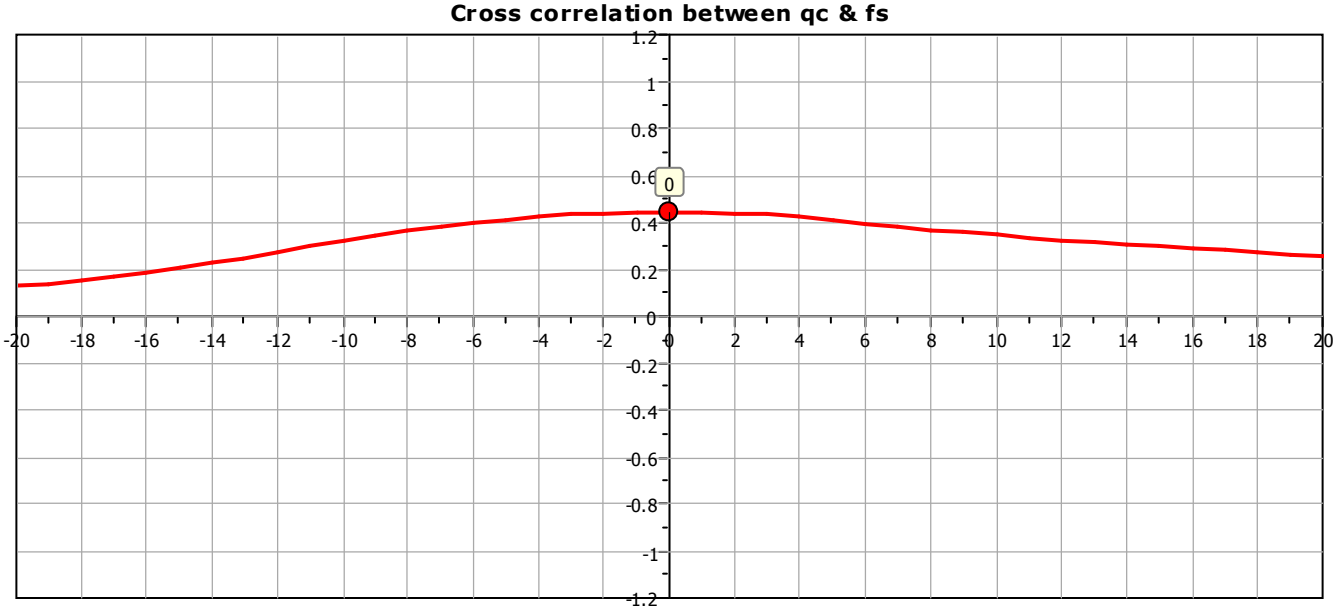
Level 1, 39 Carlyle St,
Sydenham
Christchurch
www.edc.co.nz

CPT: CPT01
Total depth: 20.00 m, Date: 29/09/2017
Surface Elevation: 0.00 m
Coords: X:0.00, Y:0.00
Cone Type: Uknown
Cone Operator: Uknown

Project: 47465 - SLS
Location: 23 & 45 Keepa Rd, Whakatane



The plot below presents the cross correlation coeficient between the raw qc and fs values (as measured on the field). X axes presents the lag distance (one lag is the distance between two sucessive CPT measurements).

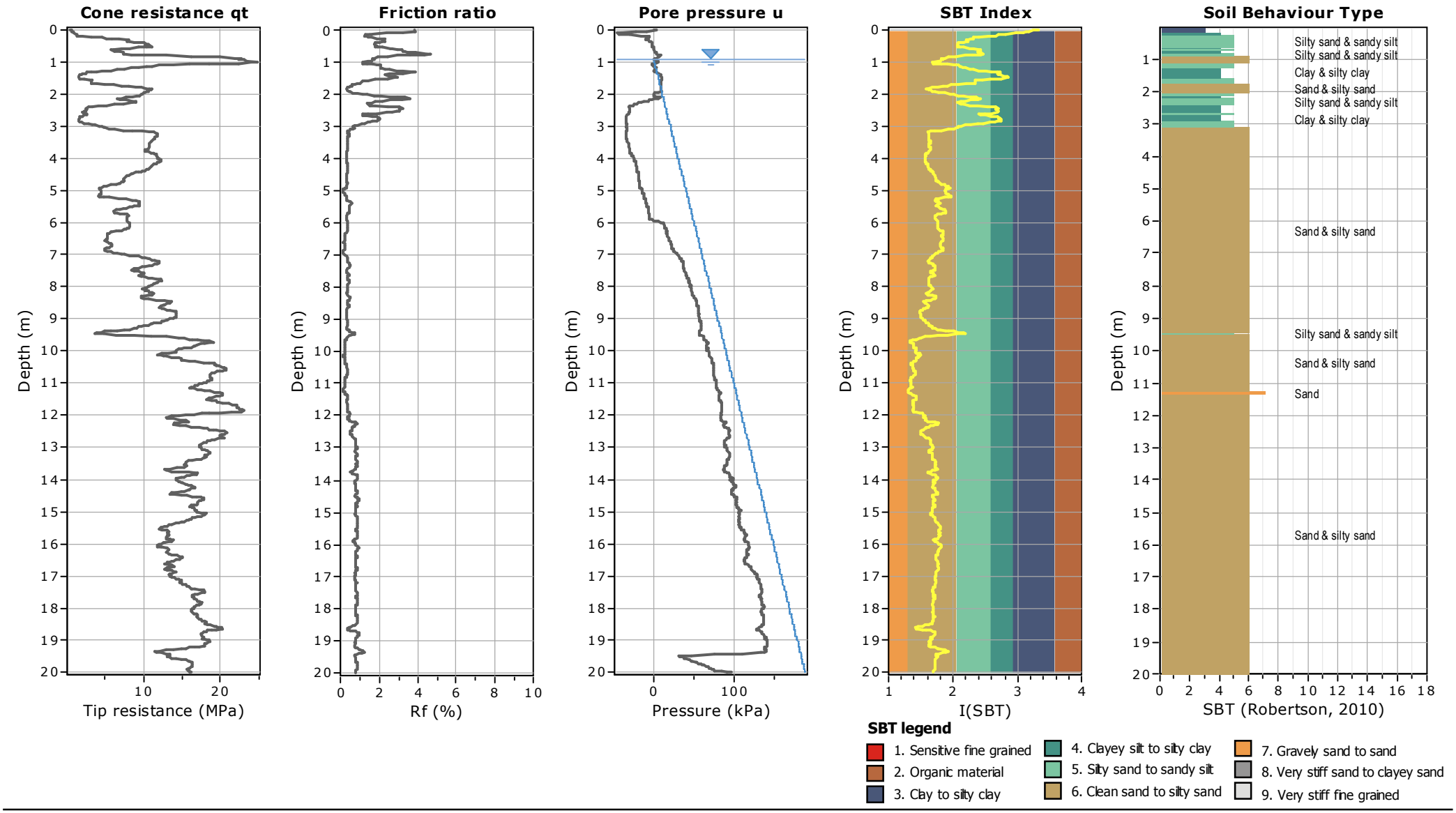


ENGINEERING DESIGN CONSULTANTS

Level 1, 39 Carlyle St,
Sydenham
Christchurch
www.edc.co.nz

Project: **47465 - SLS**
Location: **23 & 45 Keepa Rd, Whakatane**

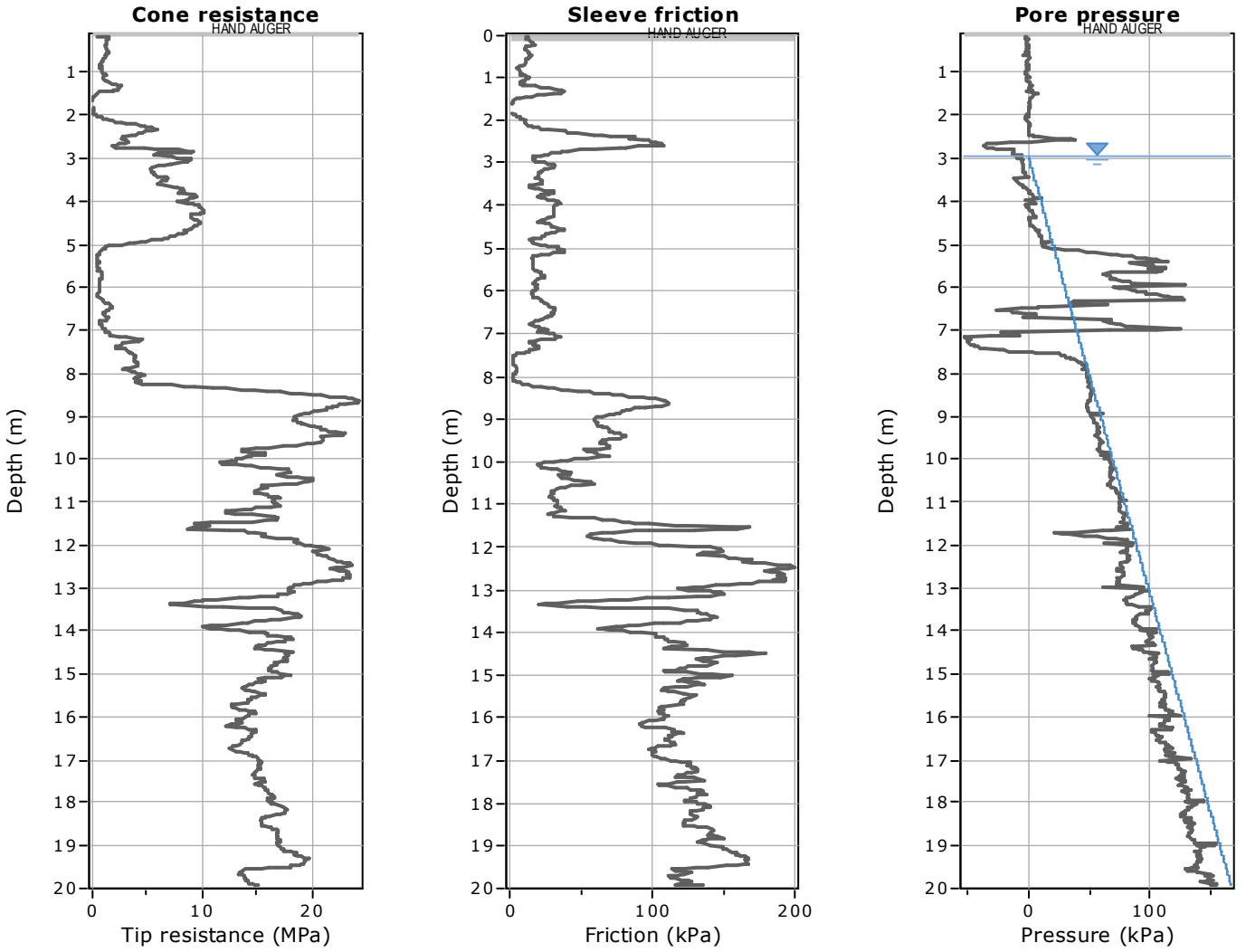
CPT: CPT01
Total depth: 20.00 m, Date: 29/09/2017
Surface Elevation: 0.00 m
Coords: X:0.00, Y:0.00
Cone Type: Uknown
Cone Operator: Uknown



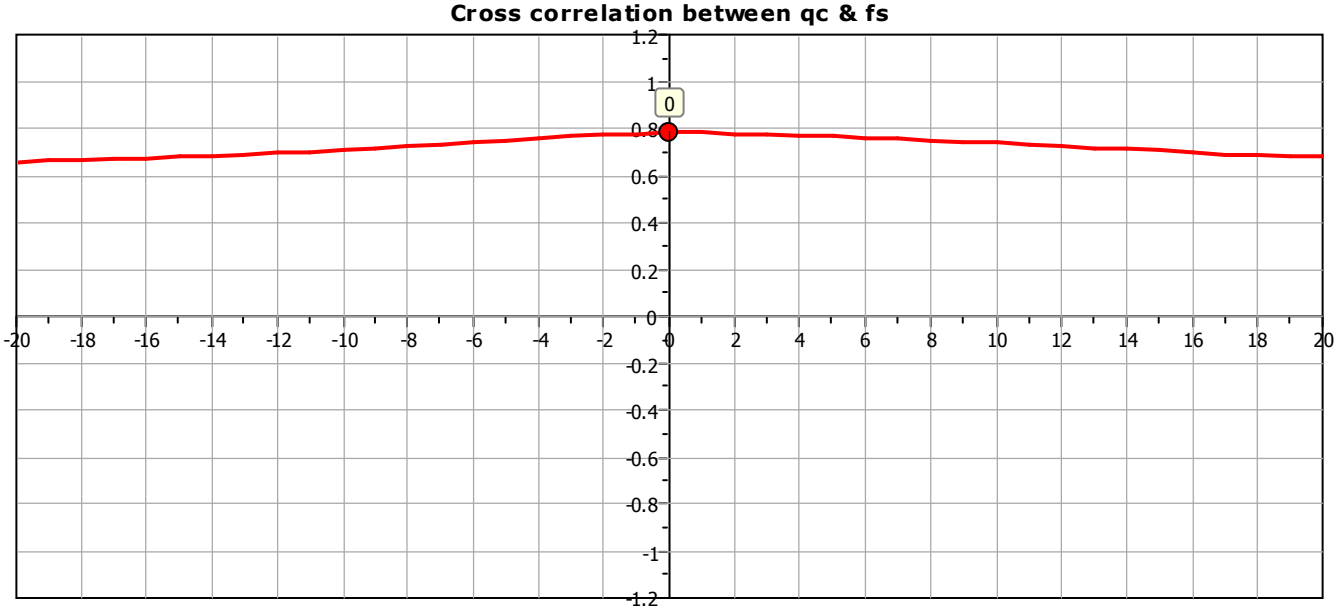
Level 1, 39 Carlyle St,
Sydenham
Christchurch
www.edc.co.nz

CPT: CPT02
Total depth: 19.92 m, Date: 29/09/2017
Surface Elevation: 0.00 m
Coords: X:0.00, Y:0.00
Cone Type: Uknown
Cone Operator: Uknown

Project: **47465 - SLS**
Location: **23 & 45 Keepa Rd, Whakatane**



The plot below presents the cross correlation coeficient between the raw qc and fs values (as measured on the field). X axes presents the lag distance (one lag is the distance between two sucessive CPT measurements).



ENGINEERING DESIGN CONSULTANTS

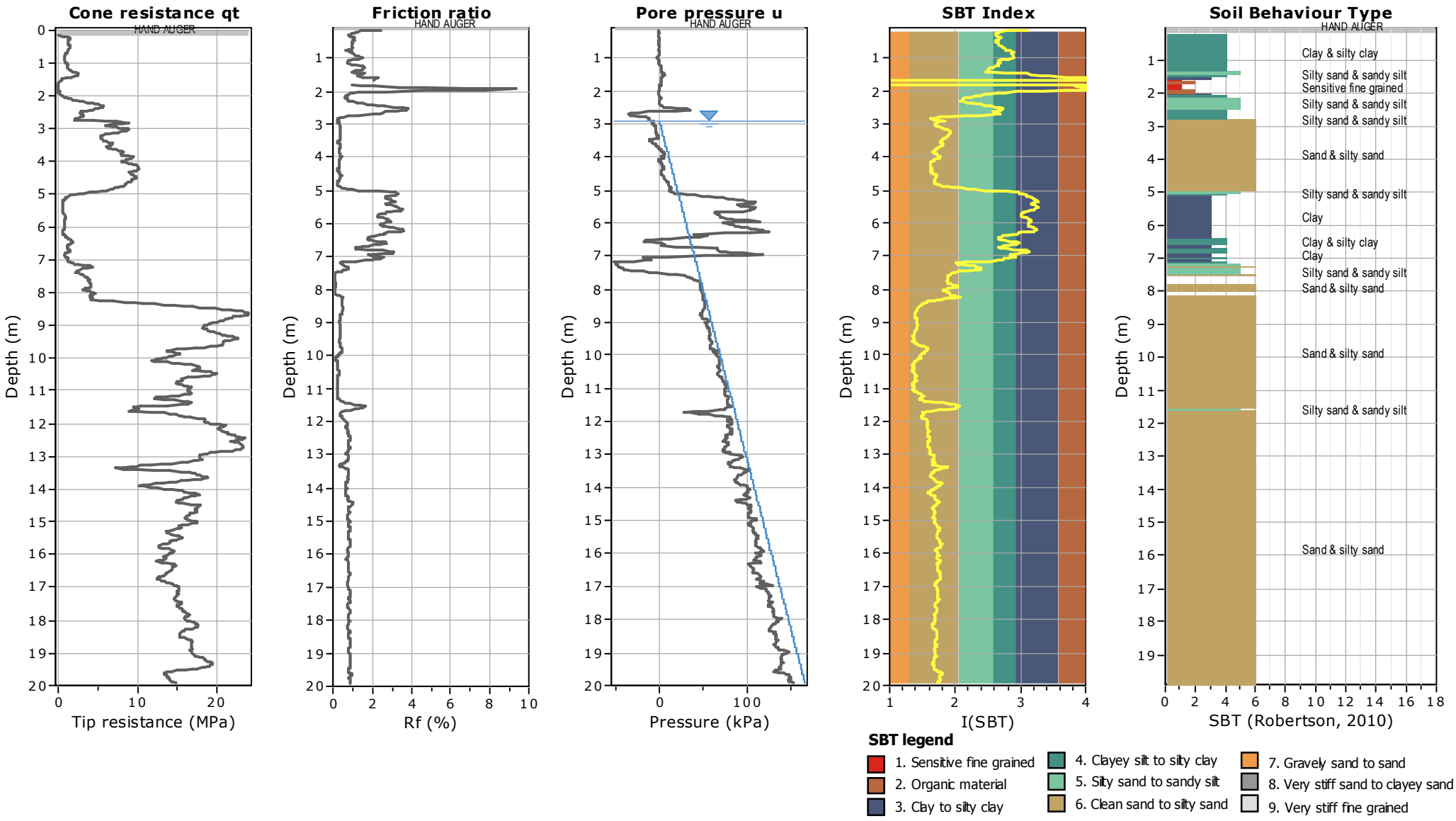
Level 1, 39 Carlyle St,
Sydenham
Christchurch
www.edc.co.nz

Project: **47465 - SLS**

Location: **23 & 45 Keepa Rd, Whakatane**

CPT: CPT02

Total depth: 19.92 m, Date: 29/09/2017
Surface Elevation: 0.00 m
Coords: X:0.00, Y:0.00
Cone Type: Uknown
Cone Operator: Uknown



ENGINEERING DESIGN CONSULTANTS

Level 1, 39 Carlyle St,
Sydenham
Christchurch
www.edc.co.nz

CPT: CPT03
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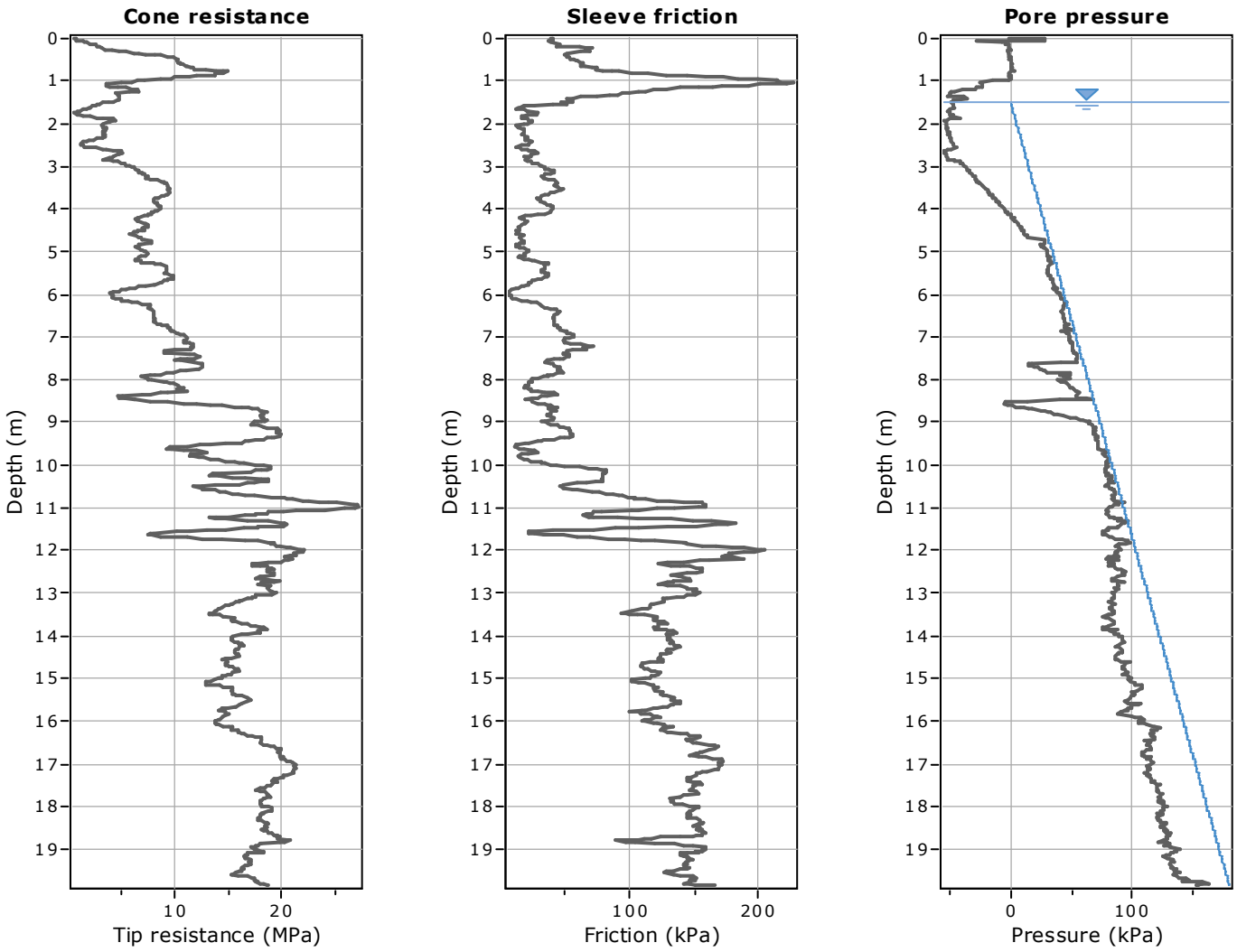
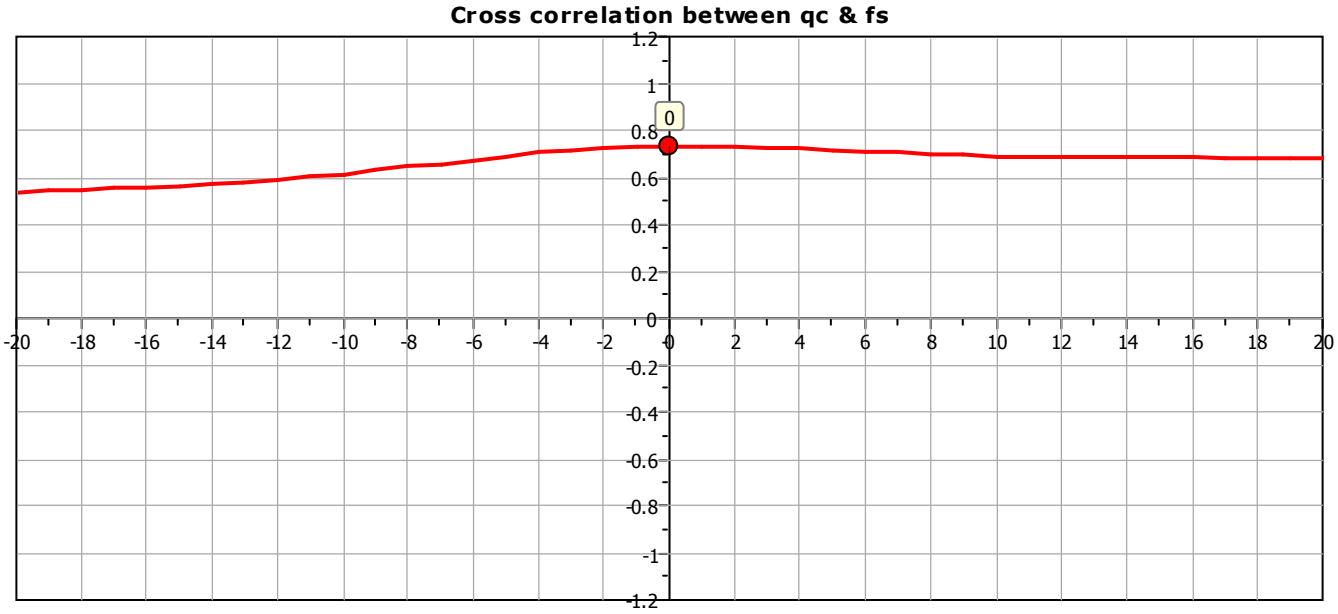
Surface Elevation: 0.00 m
Coords: X:0.00, Y:0.00
Cone Type: Uknown
Cone Operator: Uknown

Project: 47465 - SLS
Location: 23 & 45 Keepa Rd, Whakatane



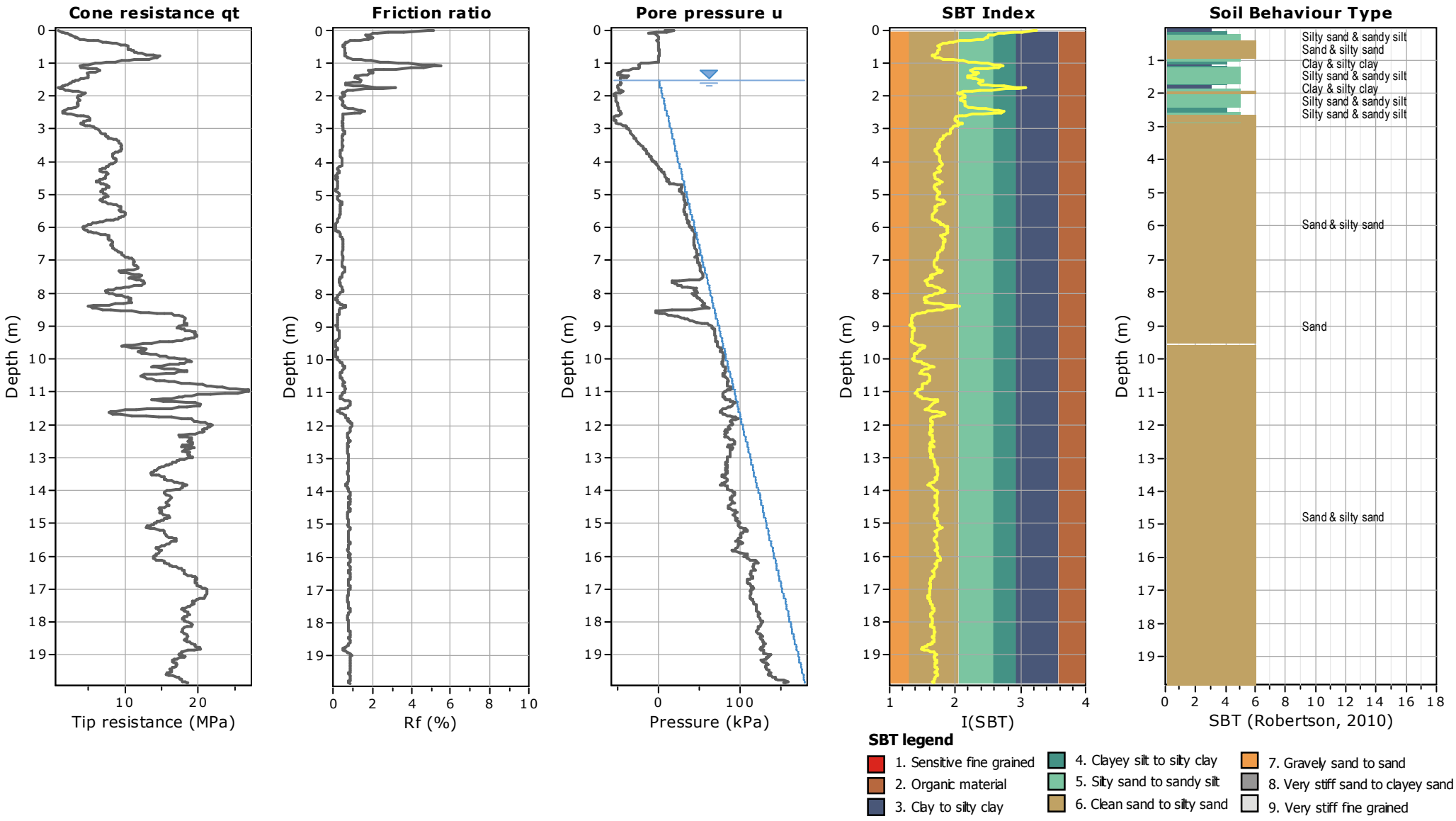
The plot below presents the cross correlation coeficient between the raw qc and fs values (as measured on the field). X axes presents the lag distance (one lag is the distance between two sucessive CPT measurements).



Level 1, 39 Carlyle St,
Sydenham
Christchurch
www.edc.co.nz

CPT: CPT03
Total depth: 19.84 m, Date: 29/09/2017
Surface Elevation: 0.00 m
Coords: X:0.00, Y:0.00
Cone Type: Uknown
Cone Operator: Uknown

Project: 47465 - SLS
Location: 23 & 45 Keepa Rd, Whakatane



Level 1, 39 Carlyle St,
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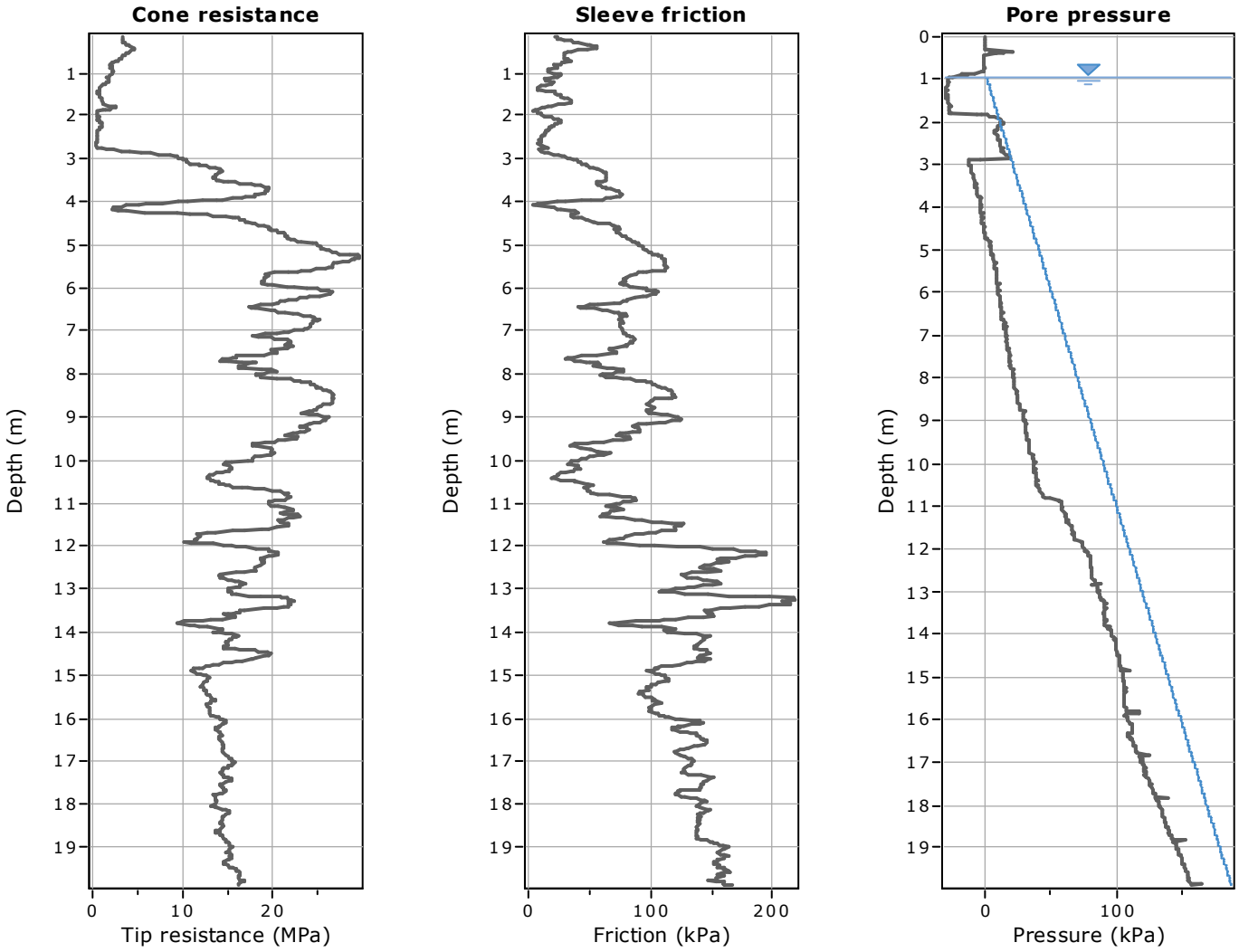
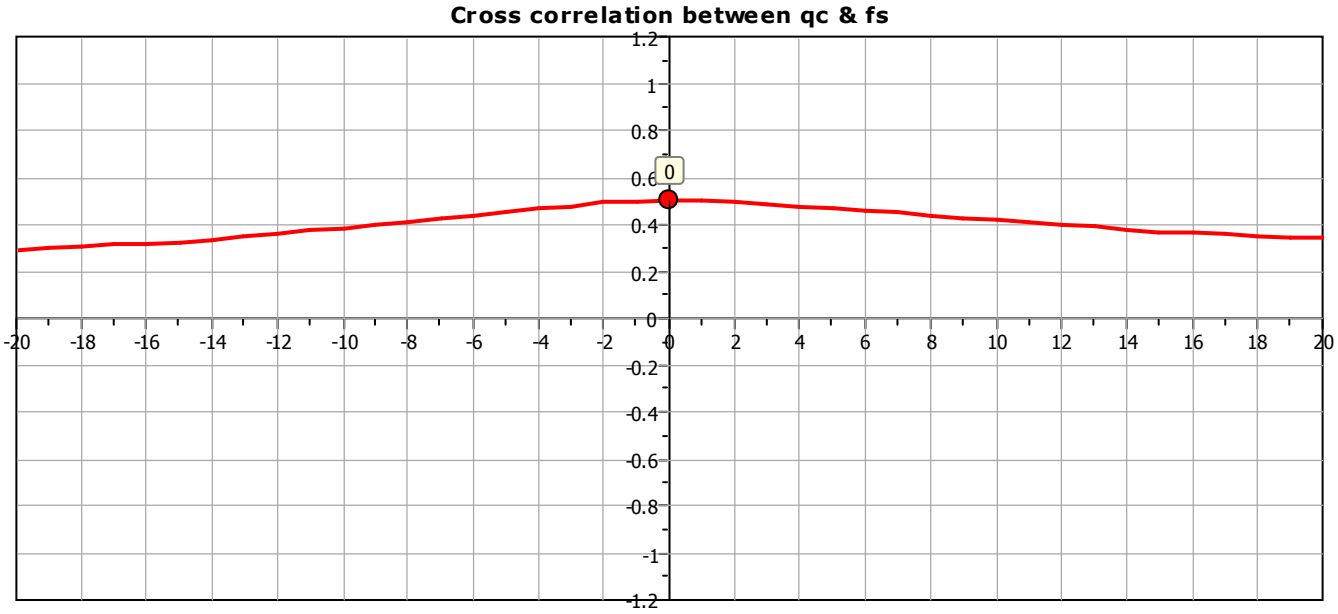
CPT: CPT06
Total depth: 19.88 m, Date: 29/09/2017
Surface Elevation: 0.00 m
Coords: X:0.00, Y:0.00
Cone Type: Uknown
Cone Operator: Uknown

Project: 47465 - SLS
Location: 23 & 45 Keepa Rd, Whakatane



The plot below presents the cross correlation coeficient between the raw qc and fs values (as measured on the field). X axes presents the lag distance (one lag is the distance between two sucessive CPT measurements).



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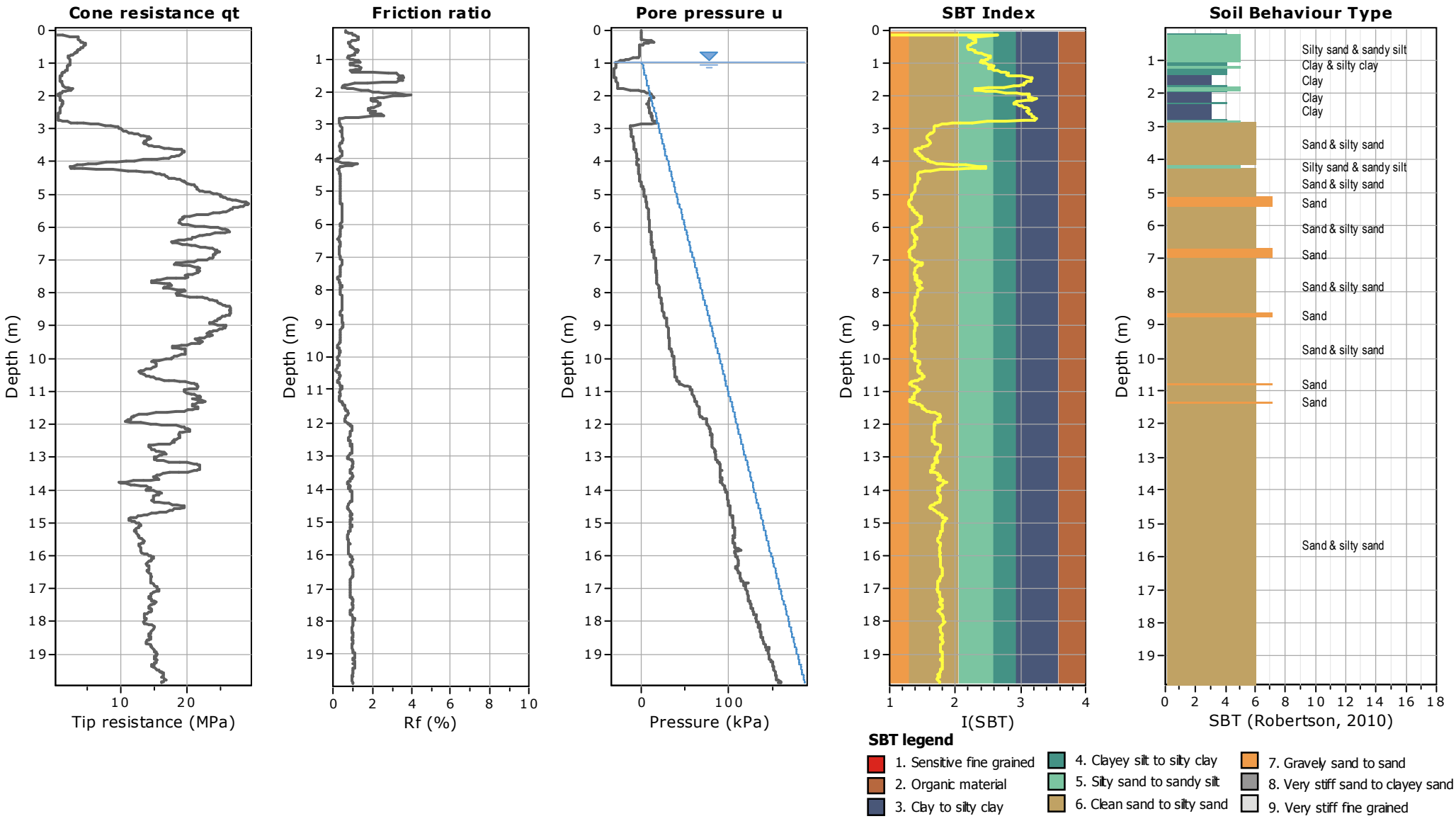
CPT: CPT06
Total depth: 19.88 m, Date: 29/09/2017
Surface Elevation: 0.00 m
Coords: X:0.00, Y:0.00
Cone Type: Uknown
Cone Operator: Uknown

Project: 47465 - SLS
Location: 23 & 45 Keepa Rd, Whakatane



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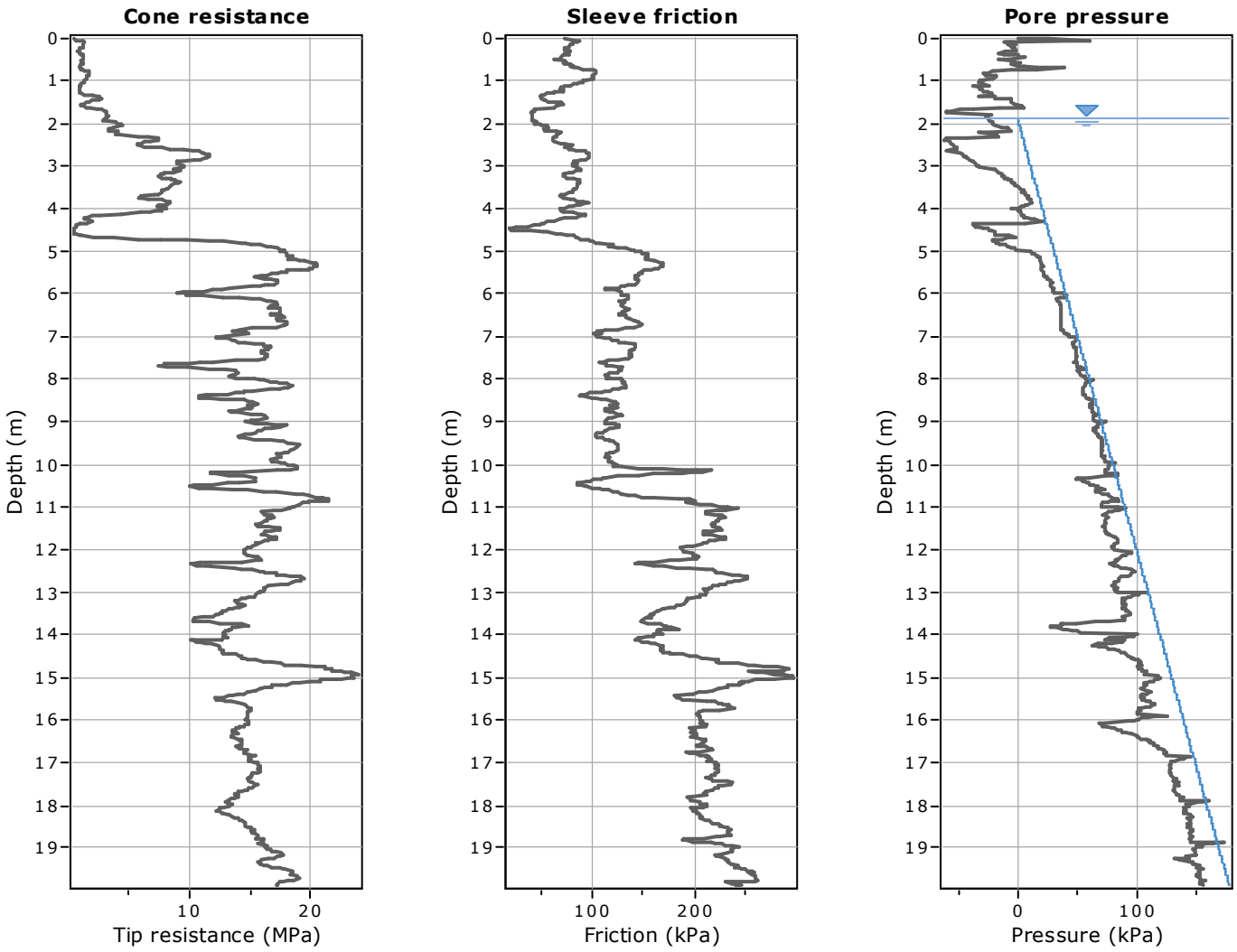
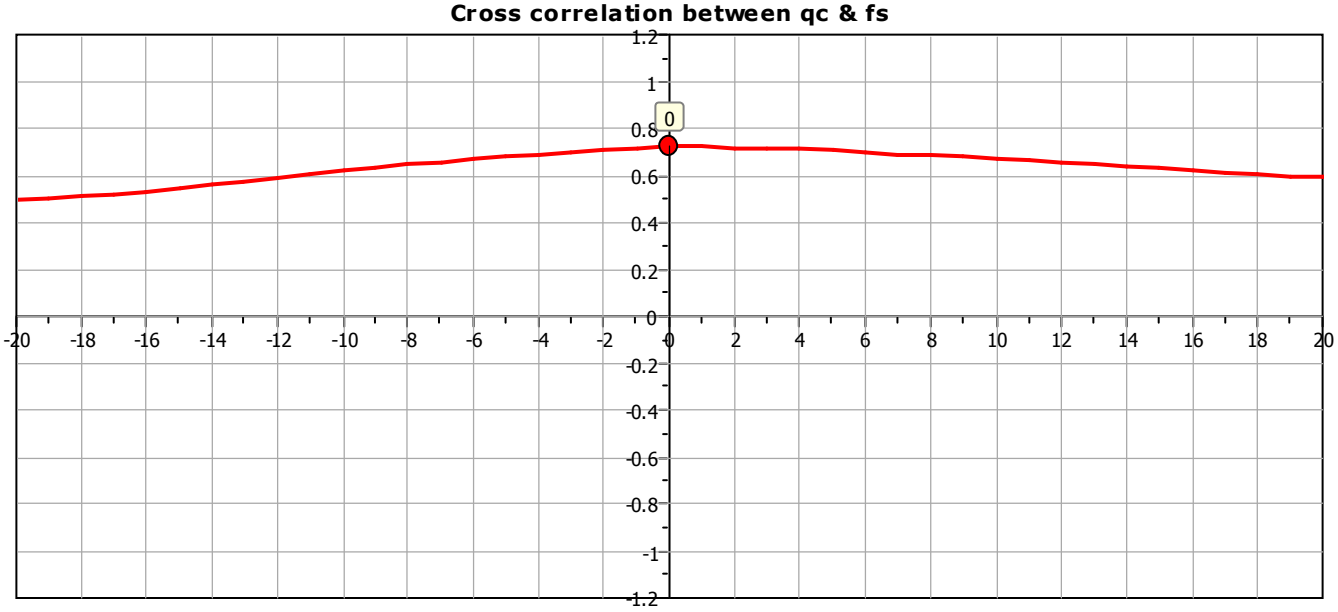
CPT: CPT05
Total depth: 19.88 m, Date: 29/09/2017
Surface Elevation: 0.00 m
Coords: X:0.00, Y:0.00
Cone Type: Uknown
Cone Operator: Uknown

Project: 47465 - SLS
Location: 23 & 45 Keepa Rd, Whakatane



The plot below presents the cross correlation coeficient between the raw qc and fs values (as measured on the field). X axes presents the lag distance (one lag is the distance between two sucessive CPT measurements).



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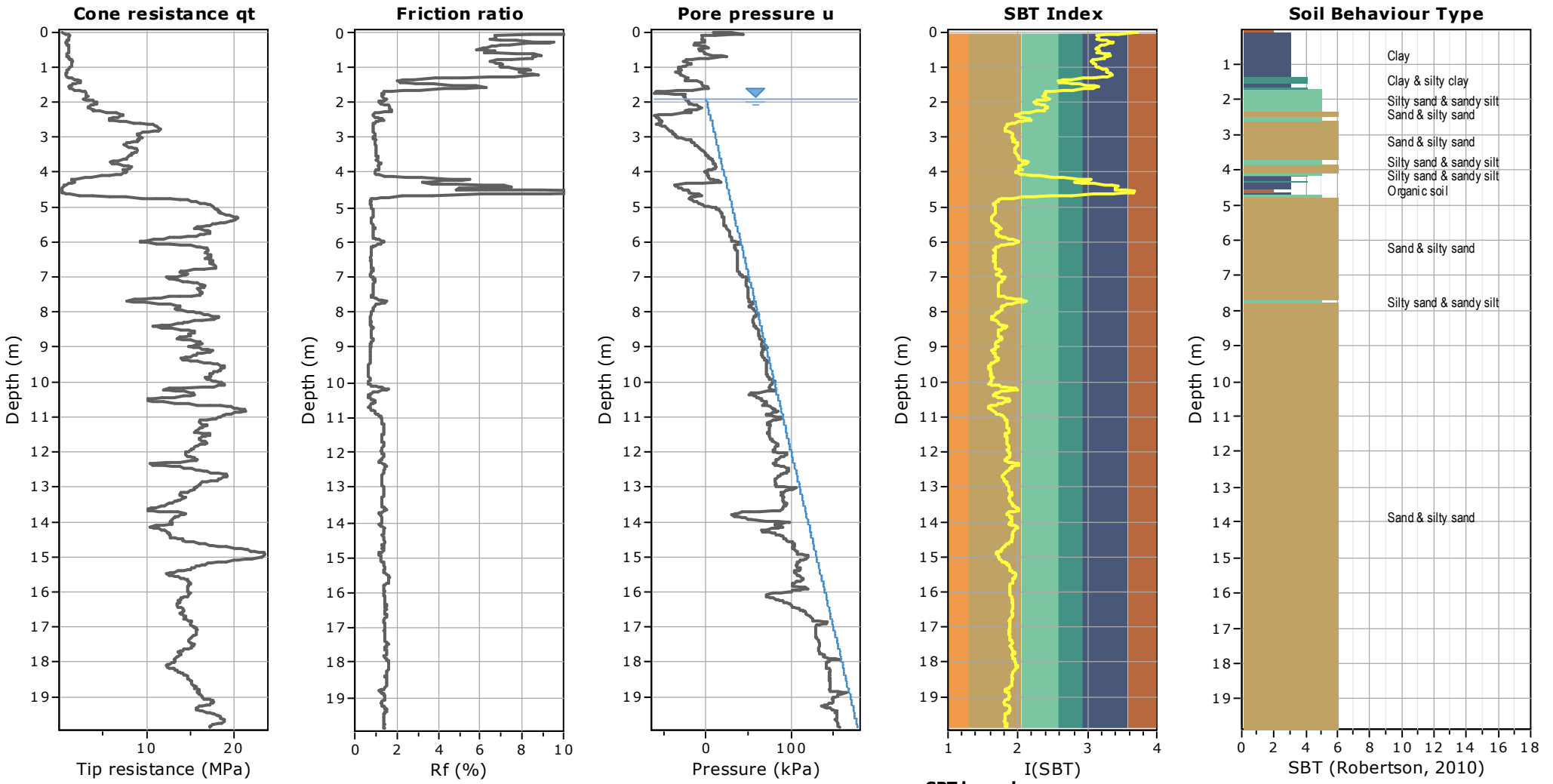
Project: **47465 - SLS**
Location: **23 & 45 Keepa Rd, Whakatane**

CPT: CPT05
Total depth: 19.88 m, Date: 29/09/2017
Surface Elevation: 0.00 m
Coords: X:0.00, Y:0.00
Cone Type: Uknown
Cone Operator: Uknown



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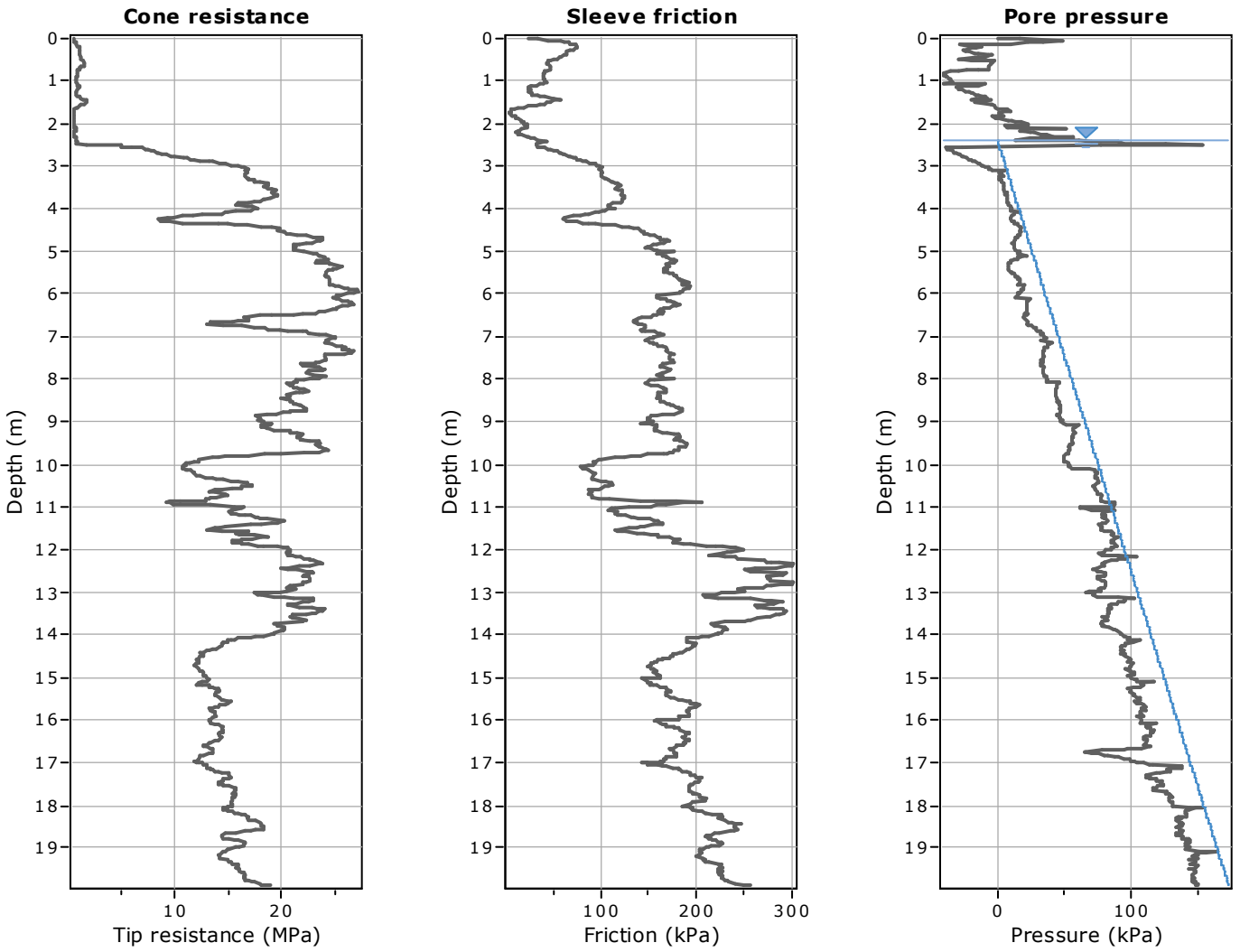
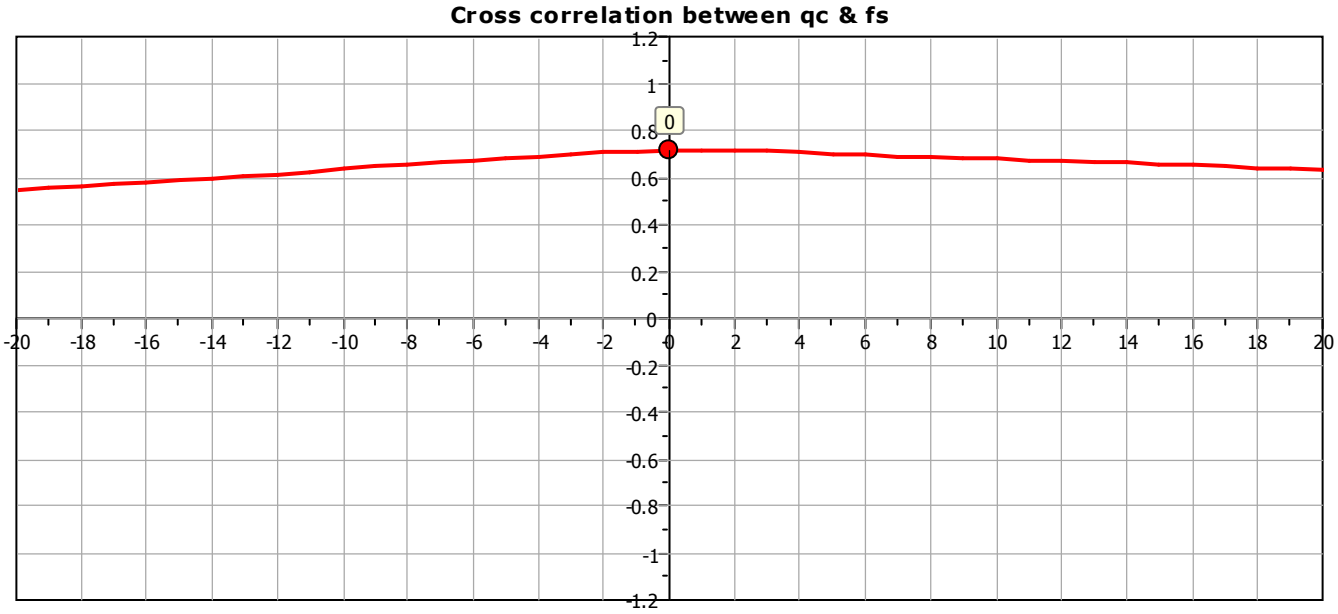
CPT: CPT07
Total depth: 19.88 m, Date: 29/09/2017
Surface Elevation: 0.00 m
Coords: X:0.00, Y:0.00
Cone Type: Uknown
Cone Operator: Uknown

Project: 47465 - SLS
Location: 23 & 45 Keepa Rd, Whakatane



The plot below presents the cross correlation coeficient between the raw qc and fs values (as measured on the field). X axes presents the lag distance (one lag is the distance between two sucessive CPT measurements).



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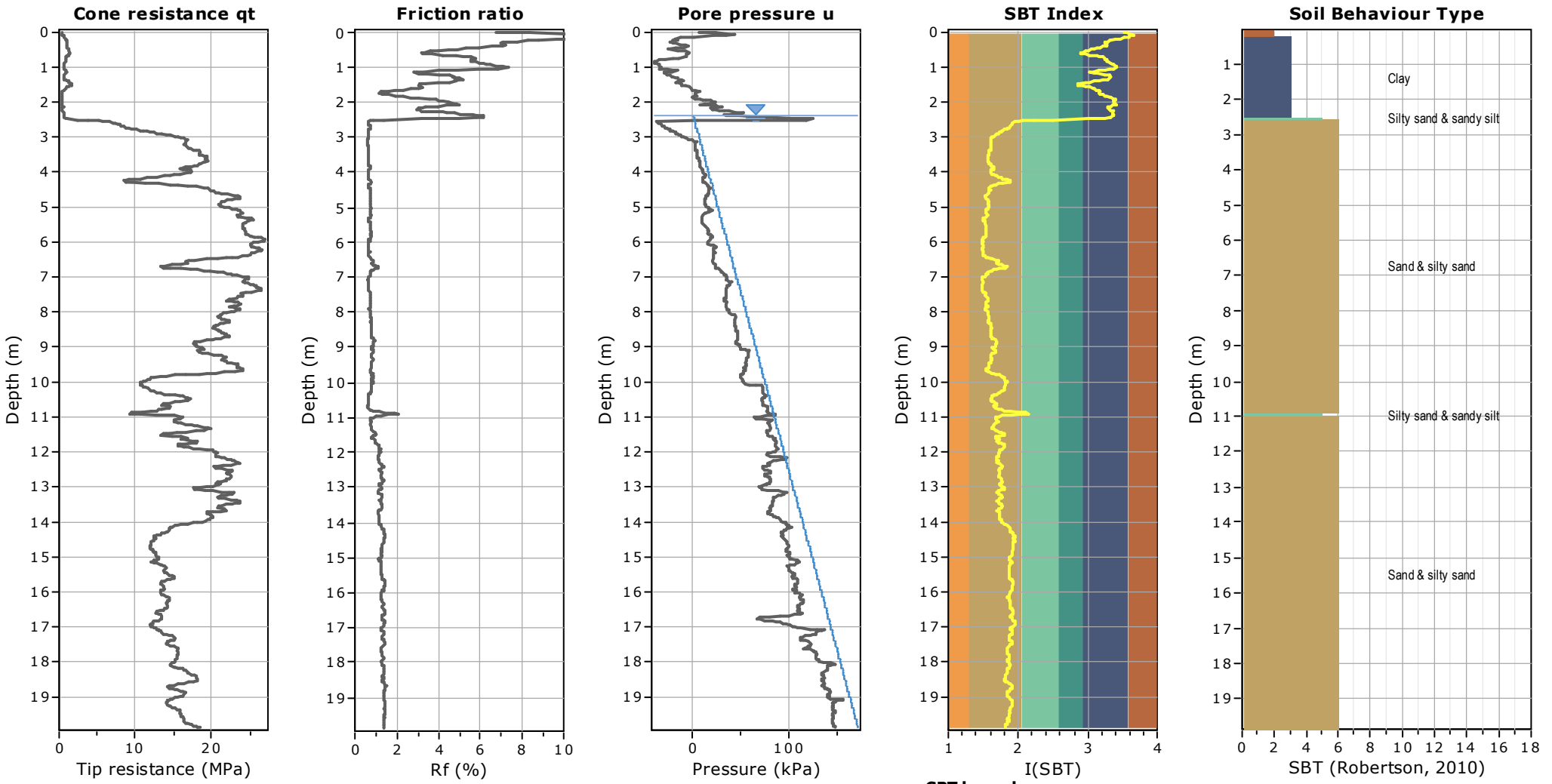
CPT: CPT07
Total depth: 19.88 m, Date: 29/09/2017
Surface Elevation: 0.00 m
Coords: X:0.00, Y:0.00
Cone Type: Uknown
Cone Operator: Uknown

Project: **47465 - SLS**
Location: **23 & 45 Keepa Rd, Whakatane**



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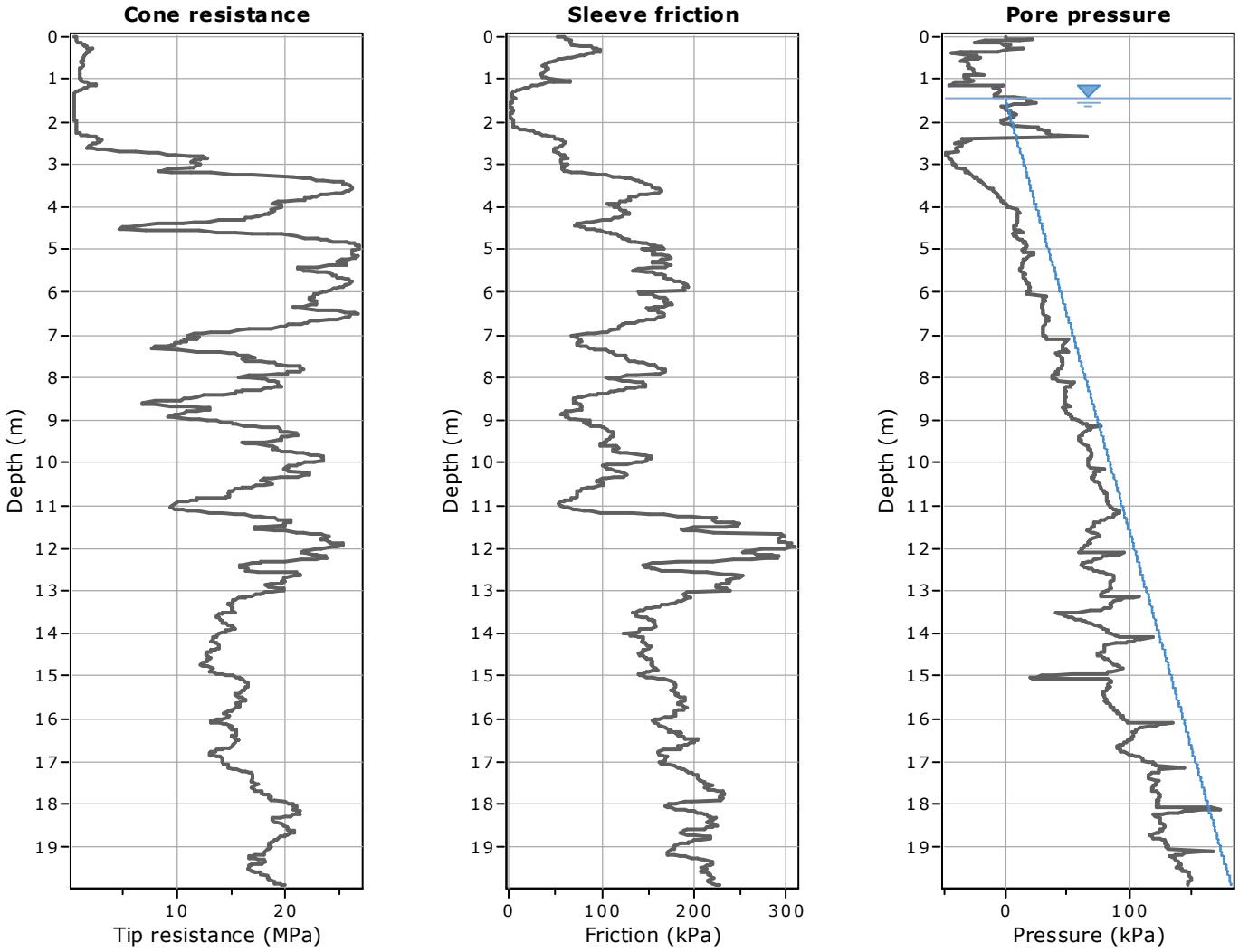
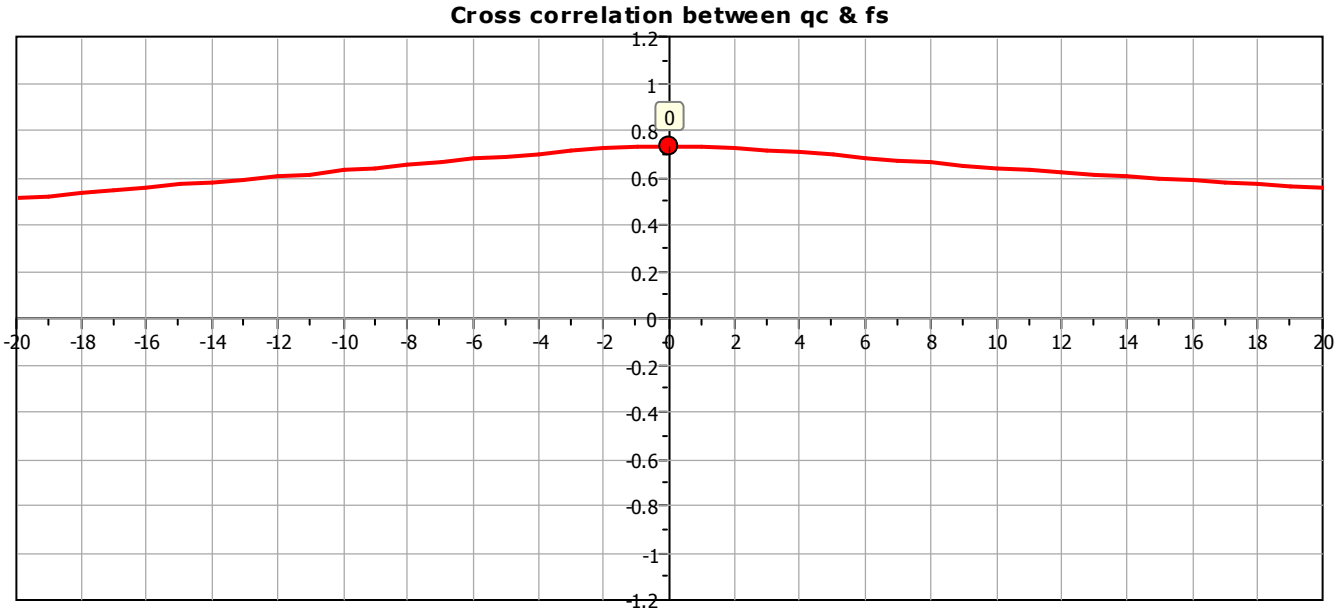
CPT: CPT08
Total depth: 19.90 m, Date: 29/09/2017
Surface Elevation: 0.00 m
Coords: X:0.00, Y:0.00
Cone Type: Uknown
Cone Operator: Uknown

Project: **47465 - SLS**
Location: **23 & 45 Keepa Rd, Whakatane**



The plot below presents the cross correlation coeficient between the raw qc and fs values (as measured on the field). X axes presents the lag distance (one lag is the distance between two sucessive CPT measurements).



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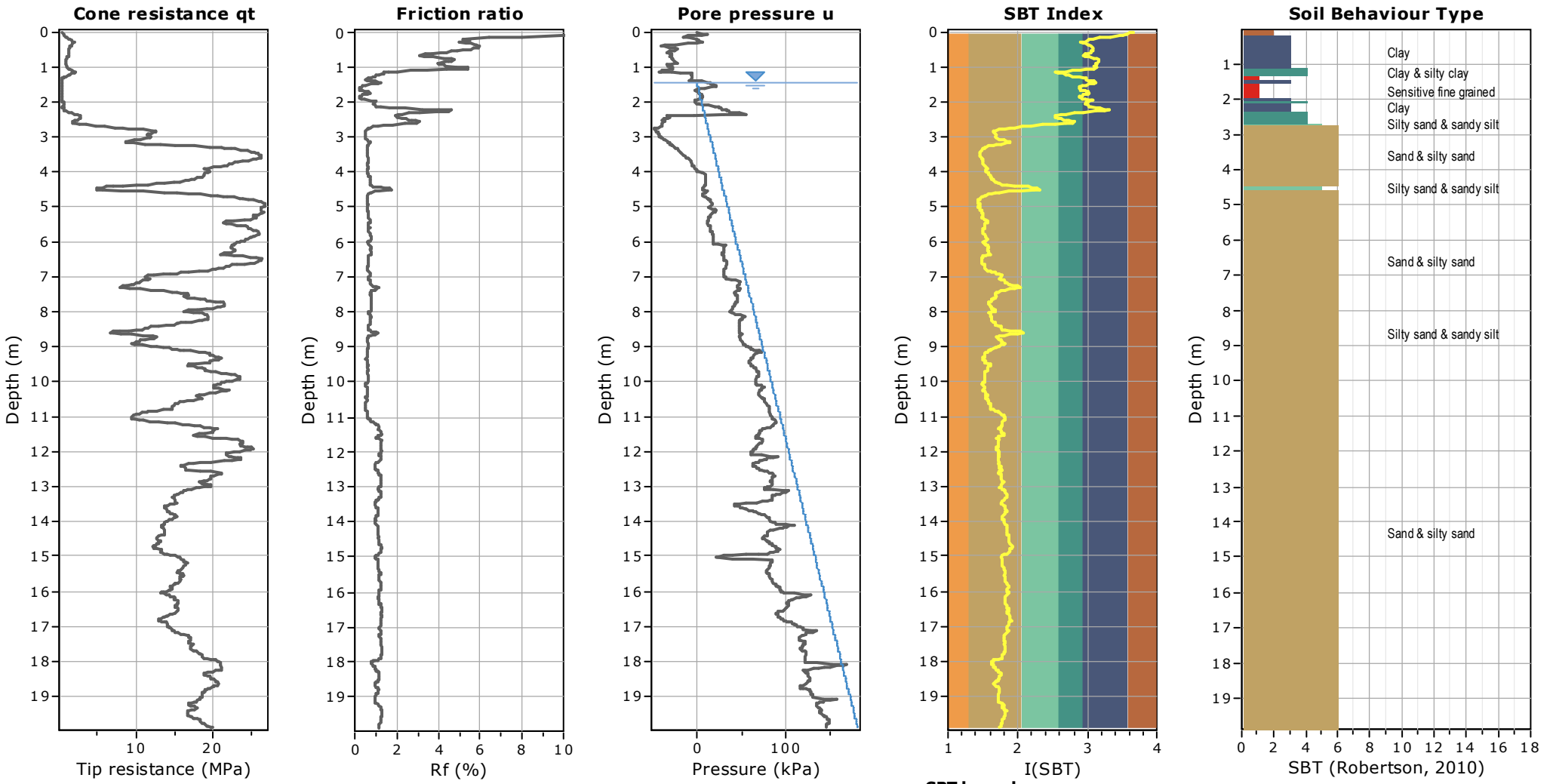
Project: **47465 - SLS**
Location: **23 & 45 Keepa Rd, Whakatane**

CPT: CPT08
Total depth: 19.90 m, Date: 29/09/2017
Surface Elevation: 0.00 m
Coords: X:0.00, Y:0.00
Cone Type: Uknown
Cone Operator: Uknown



APPENDIX B

LIQUEFACTION ANALYSIS

Level 1, 39 Carlyle St,
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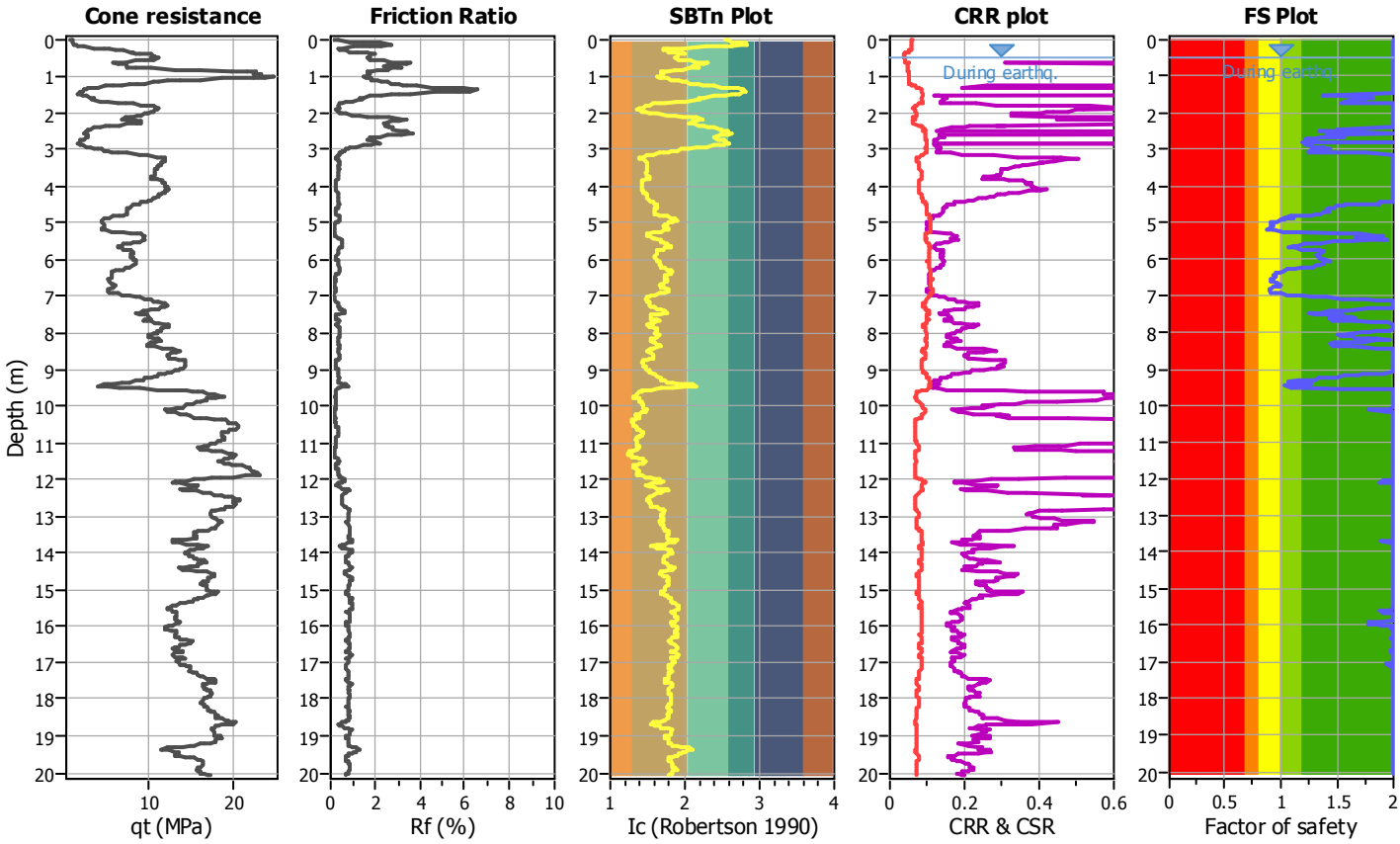
LIQUEFACTION ANALYSIS REPORT

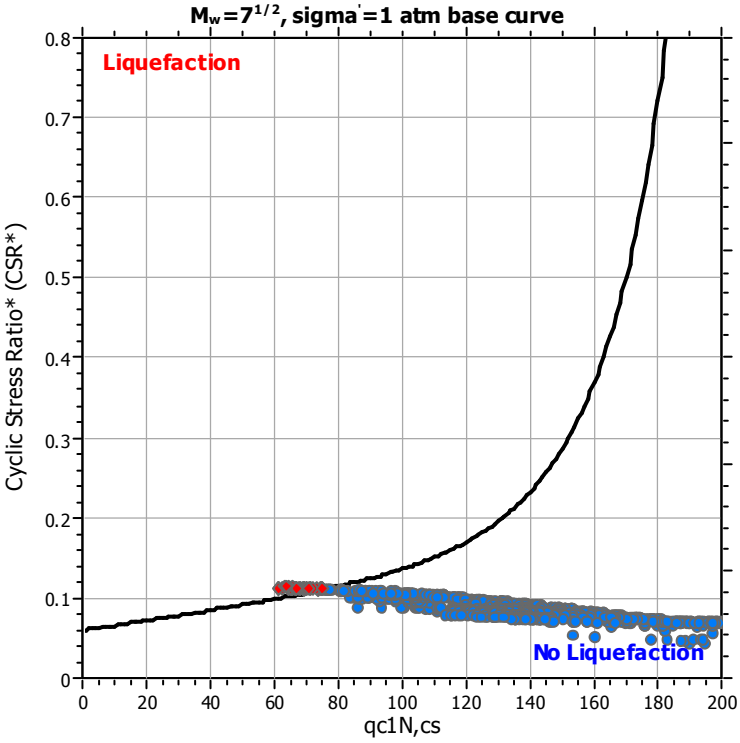
Project title : 47465 - SLS **Location : 23 & 45 Keepa Road, Whakatane**

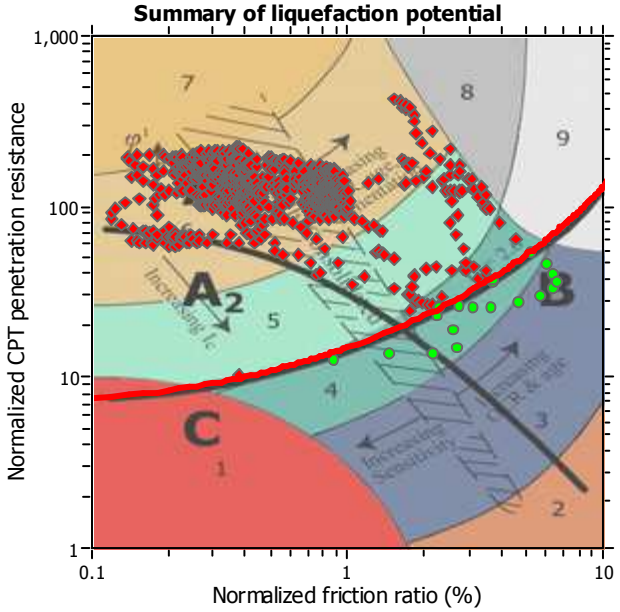
CPT file : CPT01

Input parameters and analysis data

Analysis method:	B&I (2014)	G.W.T. (in-situ):	0.95 m	Use fill:	No	Clay like behavior applied:	Sand & Clay
Fines correction method:	B&I (2014)	G.W.T. (earthq.):	0.50 m	Fill height:	N/A	Limit depth applied:	No
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth:	N/A
Earthquake magnitude M_w:	6.10	Ic cut-off value:	2.60	Trans. detect. applied:	No	MSF method:	Method
Peak ground acceleration:	0.11	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		

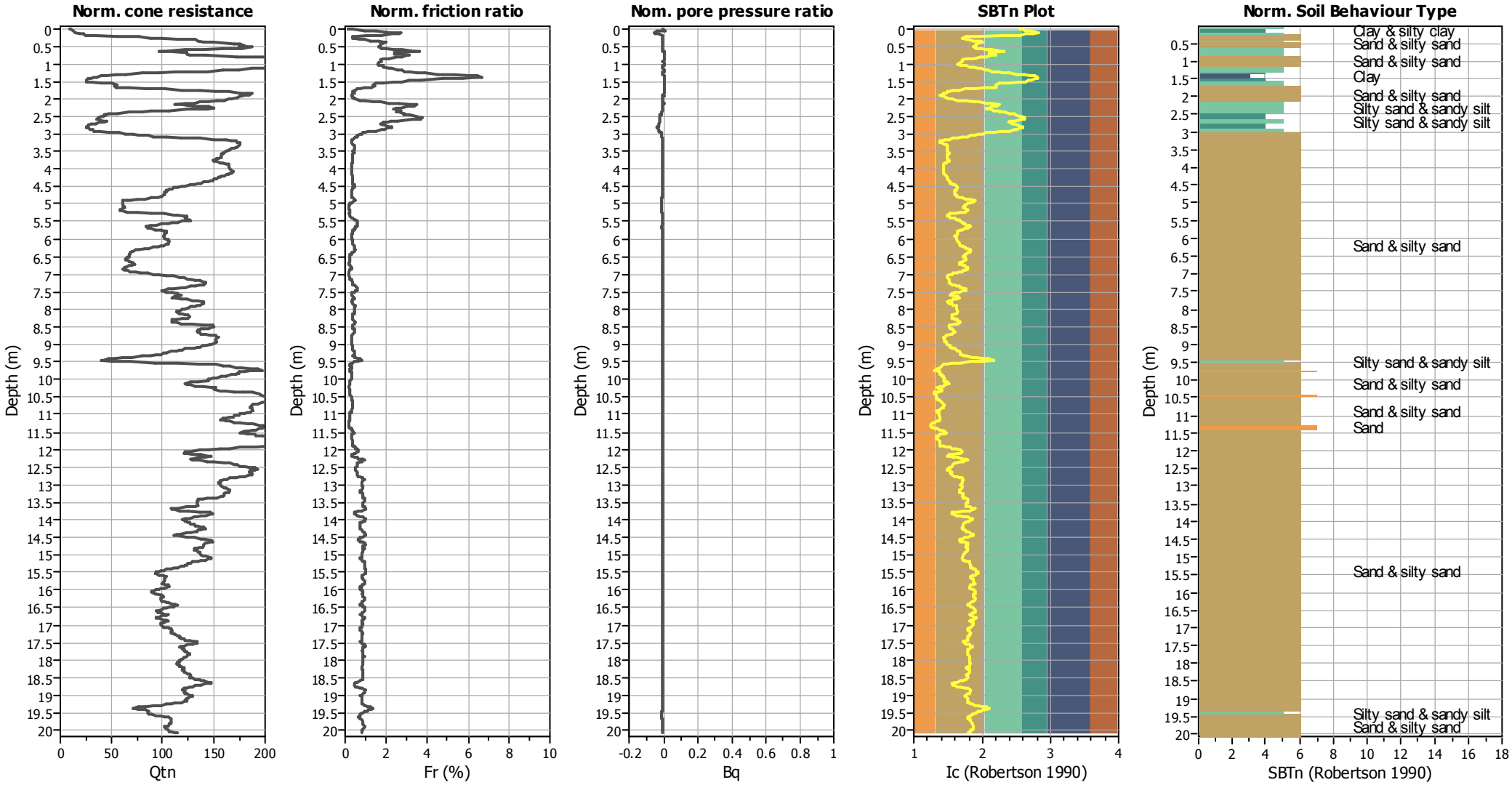






Zone A_1: Cyclic liquefaction likely depending on size and duration of cyclic loading
Zone A_2: Cyclic liquefaction and strength loss likely depending on loading and ground geometry
Zone B: Liquefaction and post-earthquake strength loss unlikely, check cyclic softening
Zone C: Cyclic liquefaction and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

CPT basic interpretation plots (normalized)



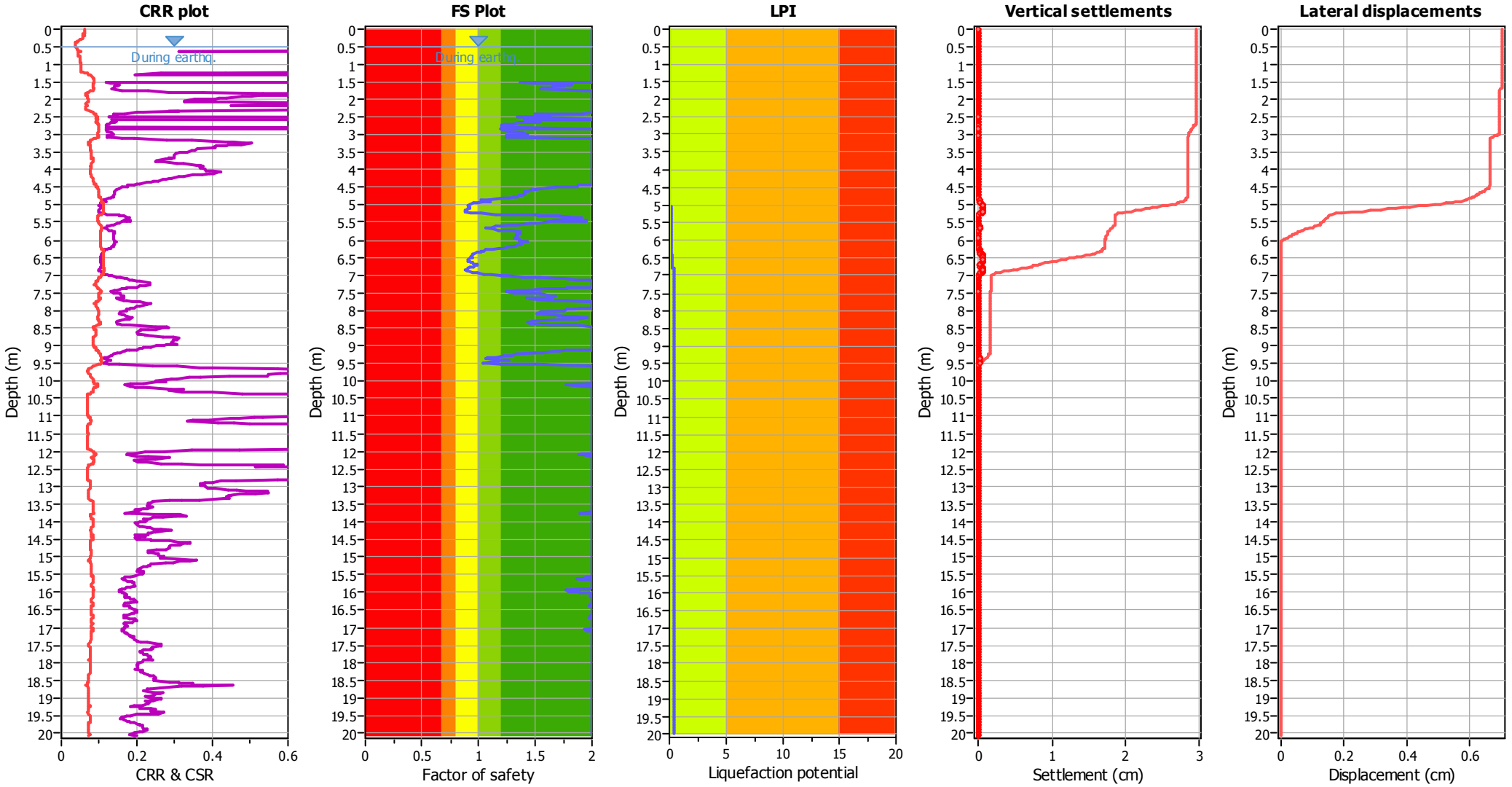
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	0.50 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.10	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.11	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	0.95 m	Fill height:	N/A	Limit depth:	N/A

SBTn legend

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

Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	0.50 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.10	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.11	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	0.95 m	Fill height:	N/A	Limit depth:	N/A

F.S. color scheme

- Almost certain it will liquefy
- Very likely to liquefy
- Liquefaction and no liq. are equally likely
- Unlike to liquefy
- Almost certain it will not liquefy

LPI color scheme

- Very high risk
- High risk
- Low risk

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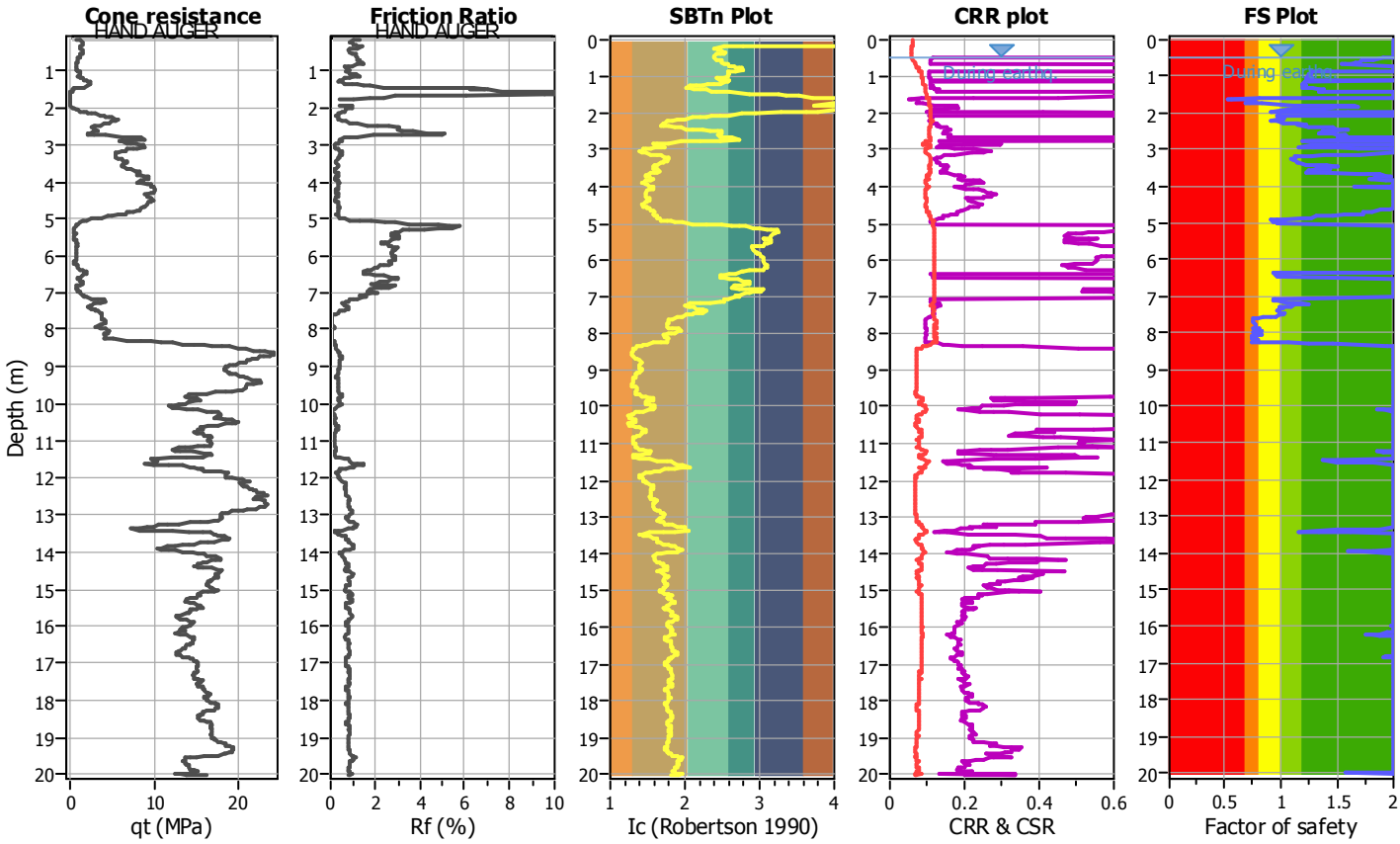
LIQUEFACTION ANALYSIS REPORT

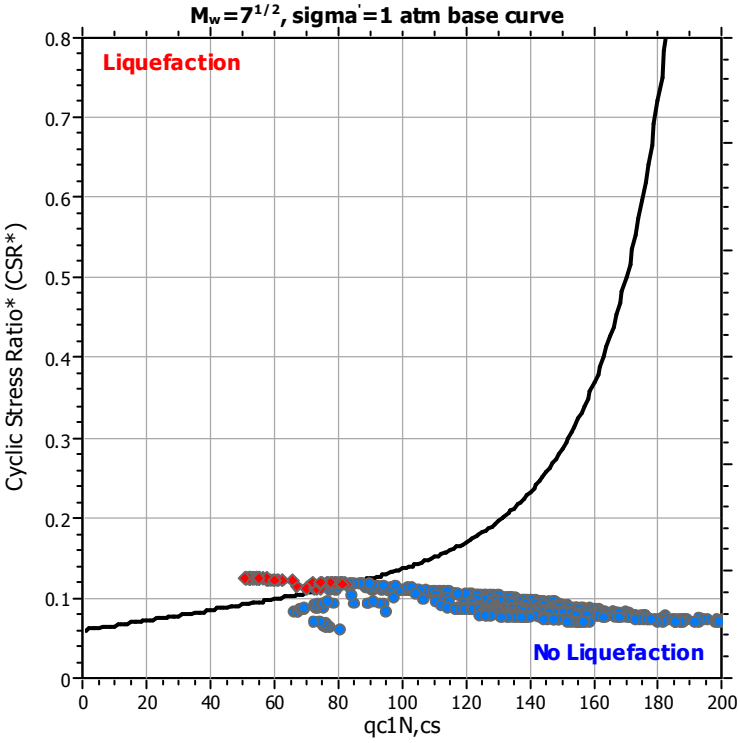
Project title : 47465 - SLS **Location : 23 & 45 Keepa Road, Whakatane**

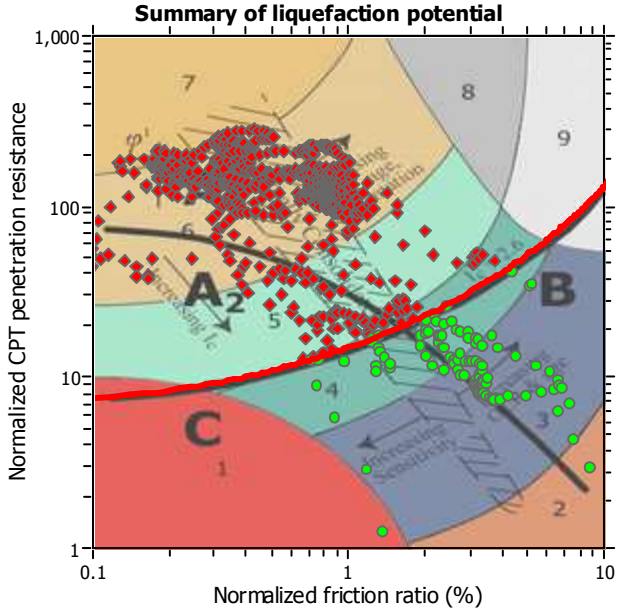
CPT file : CPT02

Input parameters and analysis data

Analysis method:	B&I (2014)	G.W.T. (in-situ):	2.94 m	Use fill:	No	Clay like behavior applied:	Sand & Clay
Fines correction method:	B&I (2014)	G.W.T. (earthq.):	0.50 m	Fill height:	N/A	Limit depth applied:	No
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth:	N/A
Earthquake magnitude M_w:	6.10	Ic cut-off value:	2.60	Trans. detect. applied:	No	MSF method:	Method
Peak ground acceleration:	0.11	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		

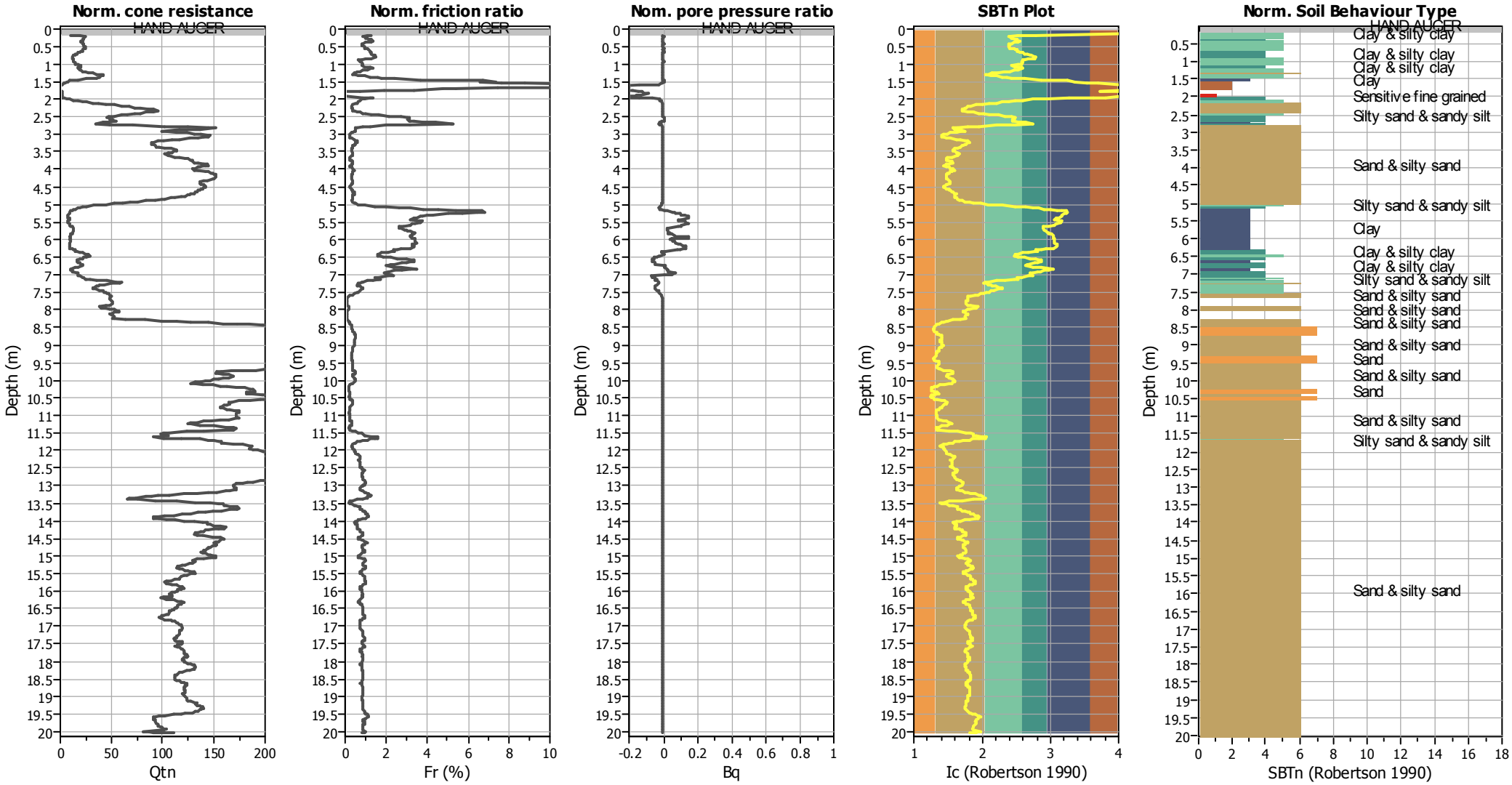






Zone A_1: Cyclic liquefaction likely depending on size and duration of cyclic loading
Zone A_2: Cyclic liquefaction and strength loss likely depending on loading and ground geometry
Zone B: Liquefaction and post-earthquake strength loss unlikely, check cyclic softening
Zone C: Cyclic liquefaction and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

CPT basic interpretation plots (normalized)



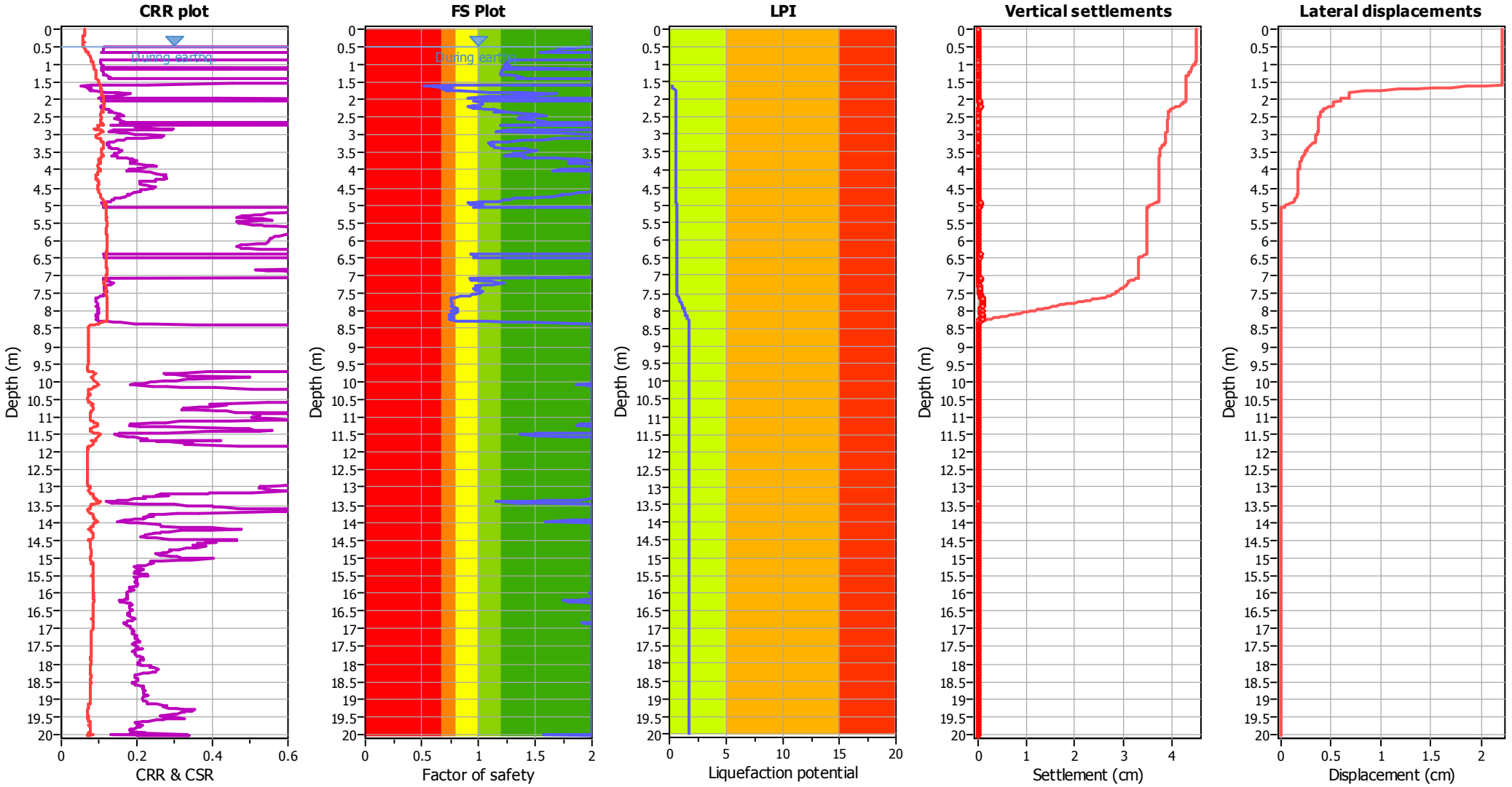
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	0.50 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.10	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.11	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	2.94 m	Fill height:	N/A	Limit depth:	N/A

SBTn legend

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

Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	0.50 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.10	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.11	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	2.94 m	Fill height:	N/A	Limit depth:	N/A

F.S. color scheme

- Almost certain it will liquefy
- Very likely to liquefy
- Liquefaction and no liq. are equally likely
- Unlike to liquefy
- Almost certain it will not liquefy

LPI color scheme

- Very high risk
- High risk
- Low risk

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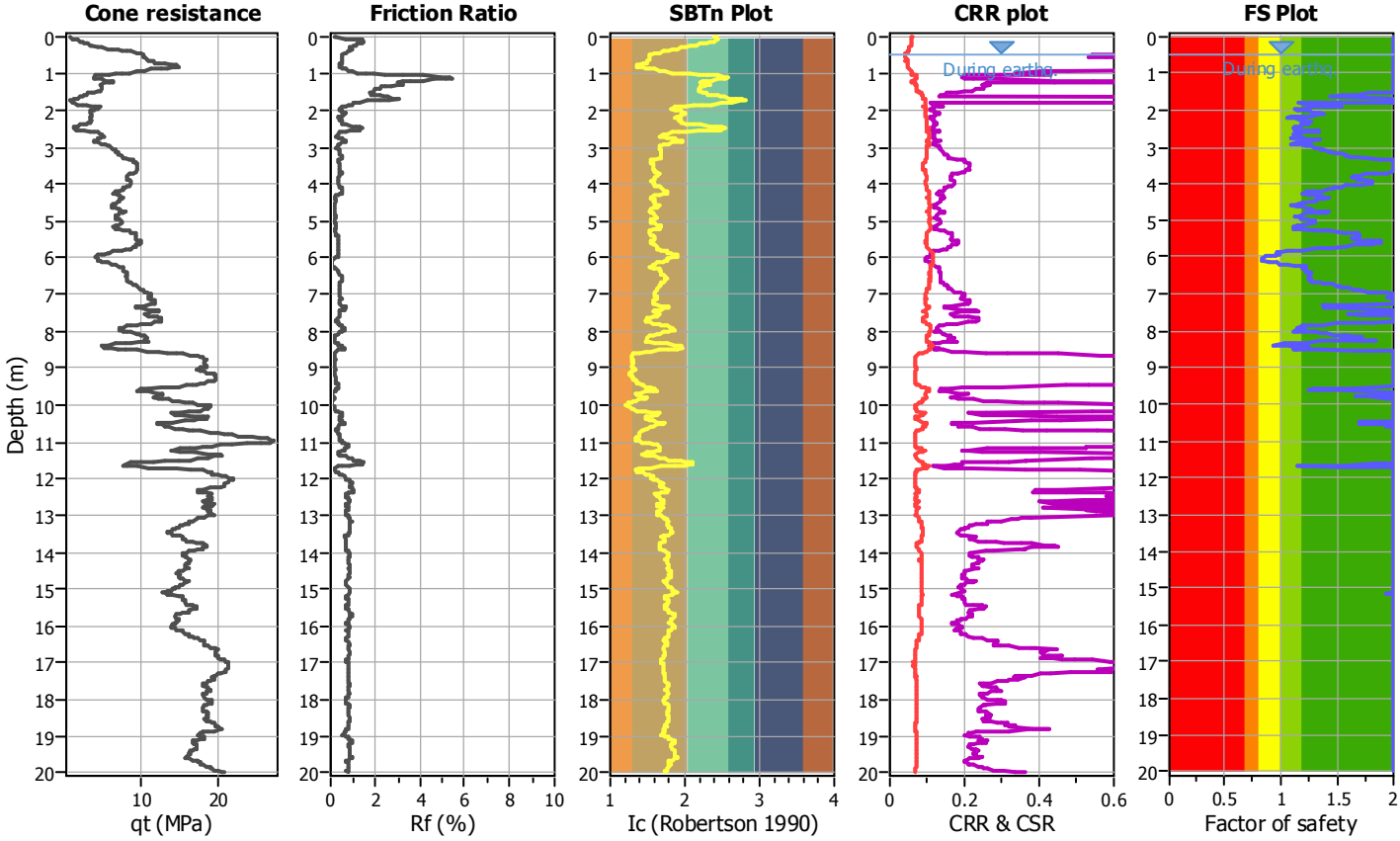
LIQUEFACTION ANALYSIS REPORT

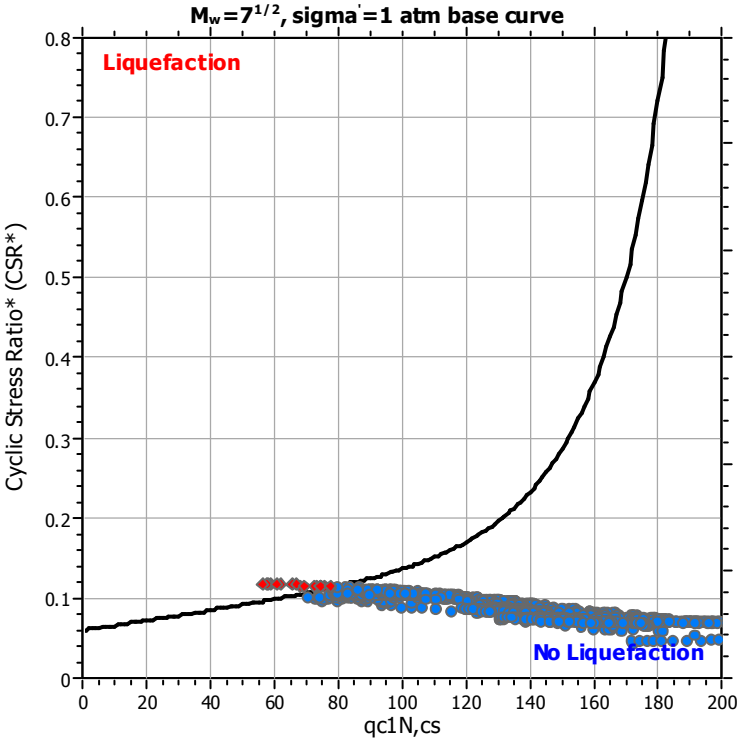
Project title : 47465 - SLS **Location : 23 & 45 Keepa Road, Whakatane**

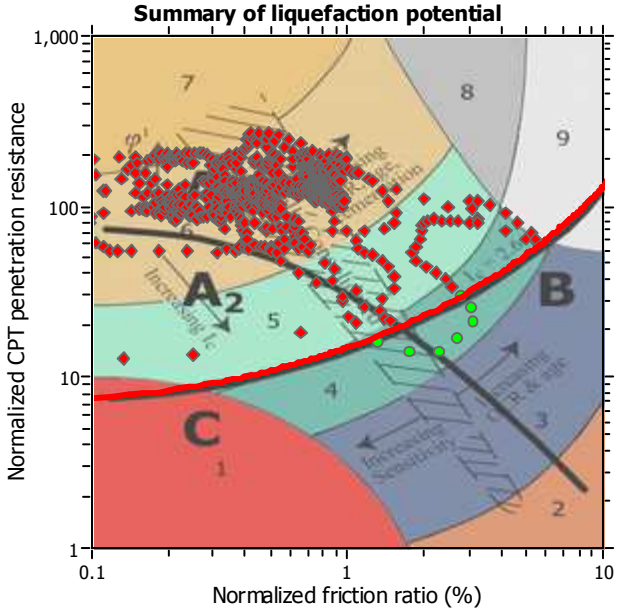
CPT file : CPT03

Input parameters and analysis data

Analysis method:	B&I (2014)	G.W.T. (in-situ):	1.52 m	Use fill:	No	Clay like behavior applied:	Sand & Clay
Fines correction method:	B&I (2014)	G.W.T. (earthq.):	0.50 m	Fill height:	N/A	Limit depth applied:	No
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth:	N/A
Earthquake magnitude M_w:	6.10	Ic cut-off value:	2.60	Trans. detect. applied:	No	MSF method:	Method
Peak ground acceleration:	0.11	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		

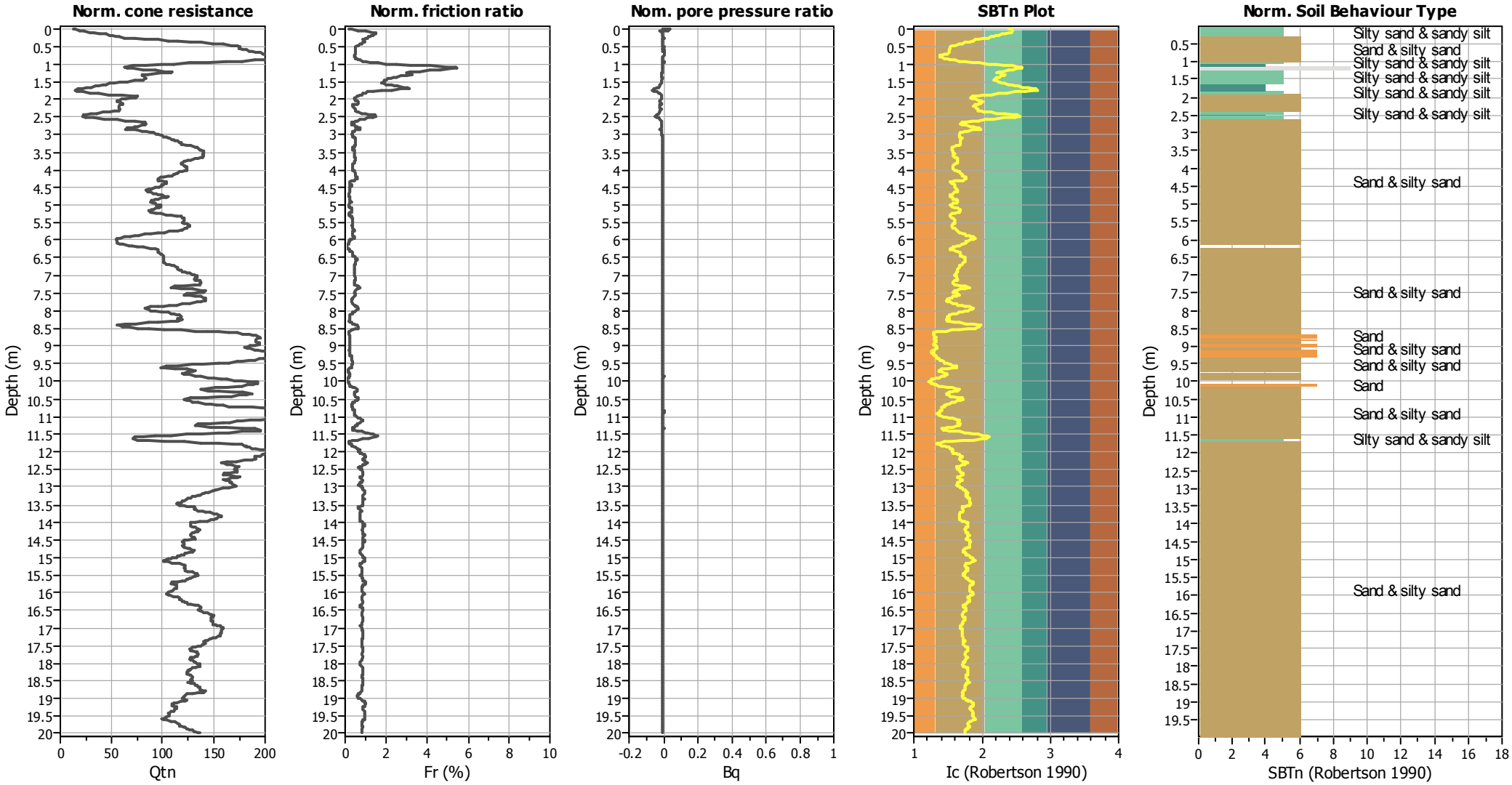






Zone A_1: Cyclic liquefaction likely depending on size and duration of cyclic loading
Zone A_2: Cyclic liquefaction and strength loss likely depending on loading and ground geometry
Zone B: Liquefaction and post-earthquake strength loss unlikely, check cyclic softening
Zone C: Cyclic liquefaction and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

CPT basic interpretation plots (normalized)



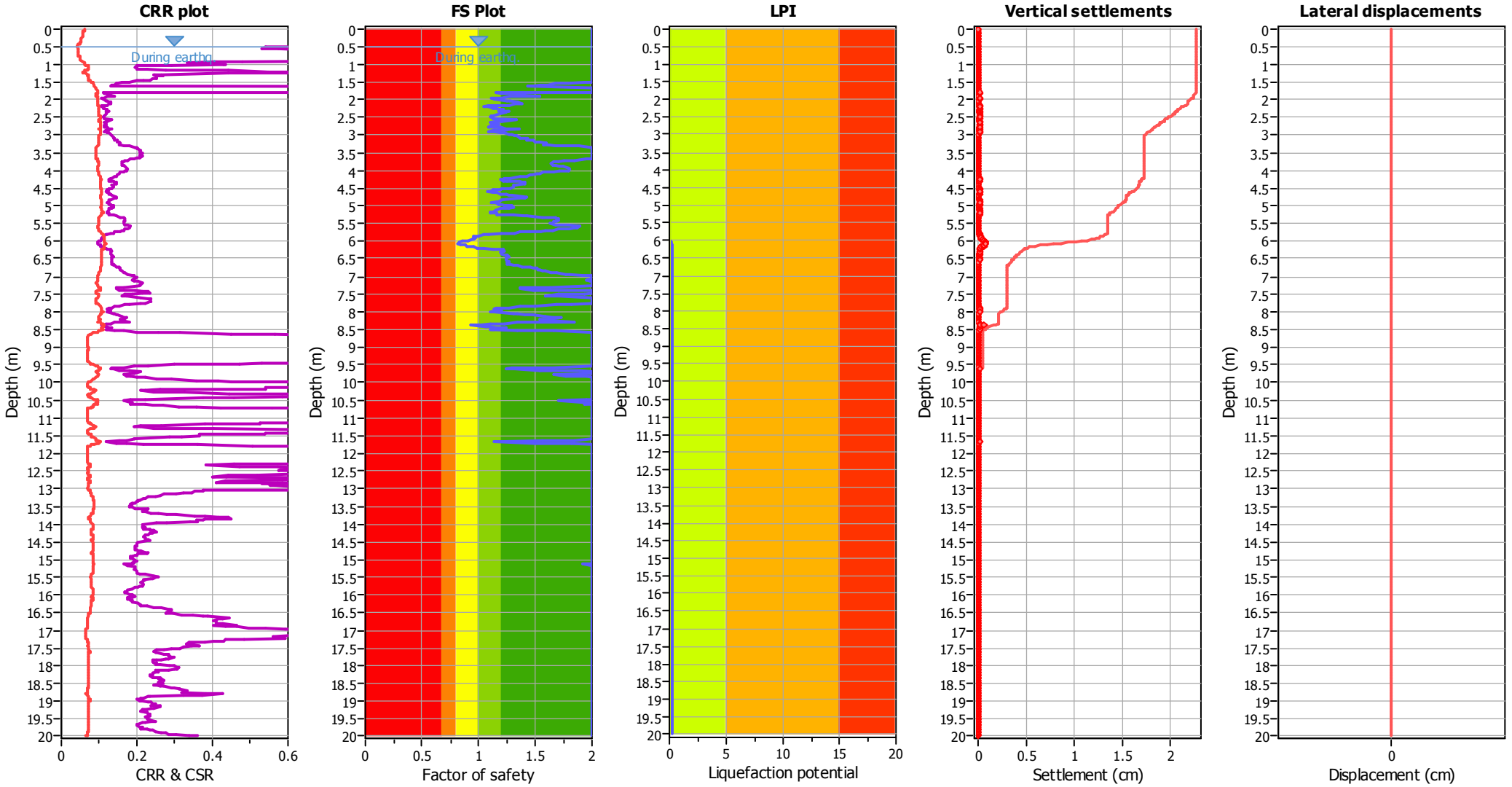
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	0.50 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.10	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.11	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	1.52 m	Fill height:	N/A	Limit depth:	N/A

SBTn legend

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

Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	0.50 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.10	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.11	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	1.52 m	Fill height:	N/A	Limit depth:	N/A

F.S. color scheme

- Almost certain it will liquefy
- Very likely to liquefy
- Liquefaction and no liq. are equally likely
- Unlike to liquefy
- Almost certain it will not liquefy

LPI color scheme

- Very high risk
- High risk
- Low risk

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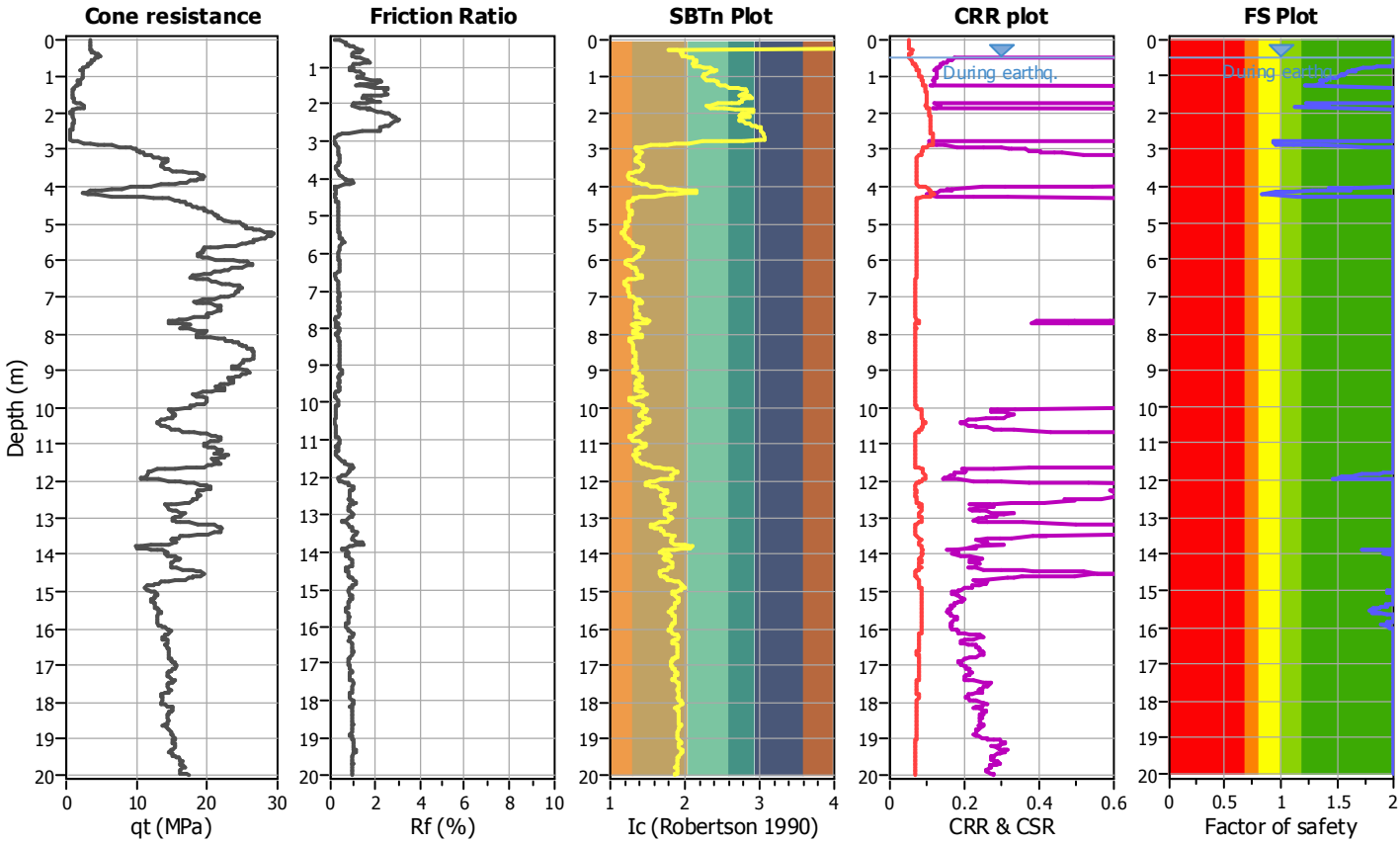
LIQUEFACTION ANALYSIS REPORT

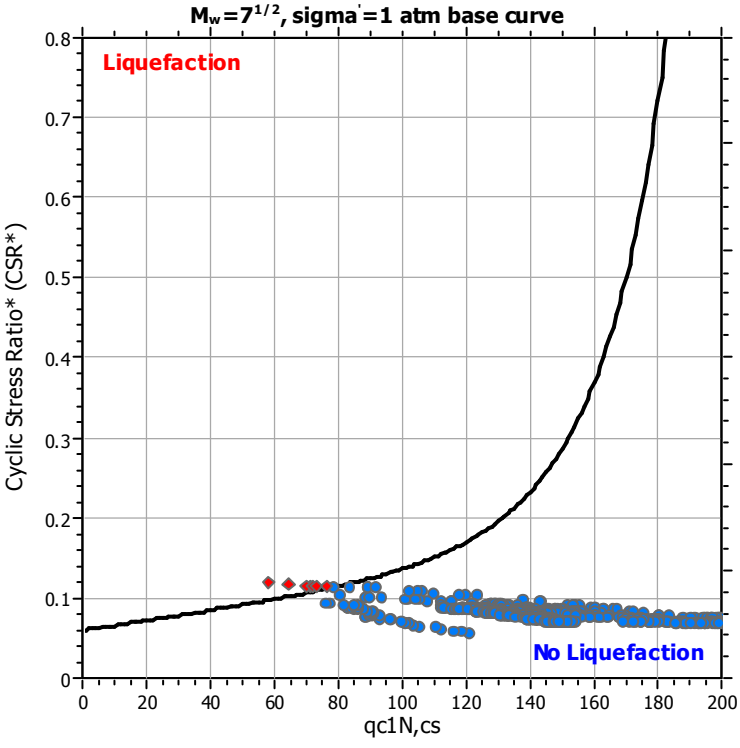
Project title : 47465 - SLS **Location : 23 & 45 Keepa Road, Whakatane**

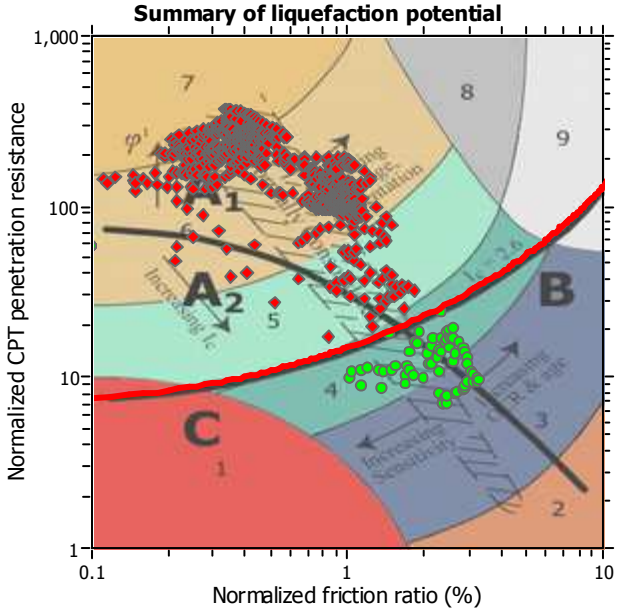
CPT file : CPT06

Input parameters and analysis data

Analysis method:	B&I (2014)	G.W.T. (in-situ):	0.95 m	Use fill:	No	Clay like behavior applied:	Sand & Clay
Fines correction method:	B&I (2014)	G.W.T. (earthq.):	0.50 m	Fill height:	N/A	Limit depth applied:	No
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth:	N/A
Earthquake magnitude M_w:	6.10	Ic cut-off value:	2.60	Trans. detect. applied:	No	MSF method:	Method
Peak ground acceleration:	0.11	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		

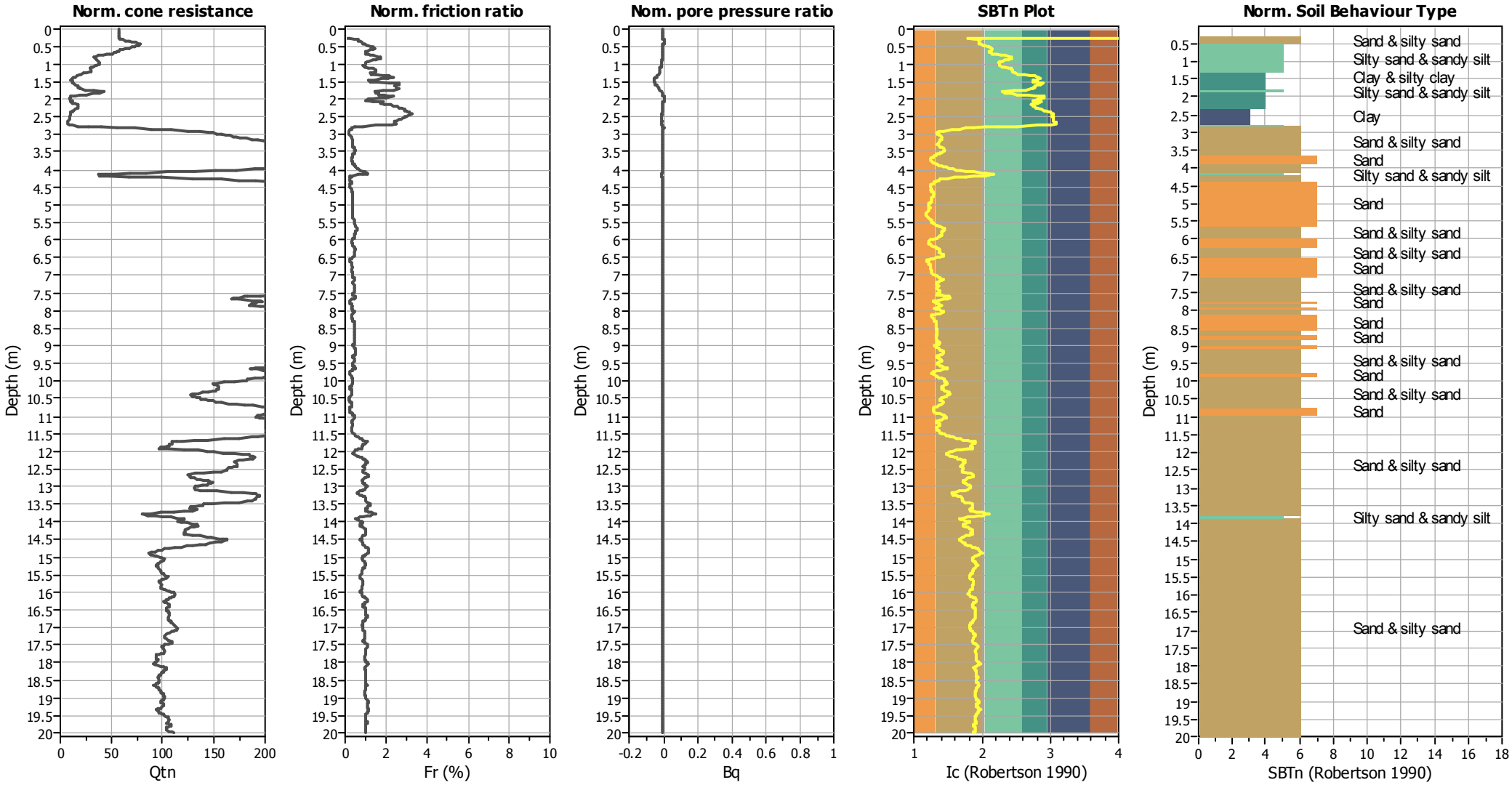






Zone A_1: Cyclic liquefaction likely depending on size and duration of cyclic loading
Zone A_2: Cyclic liquefaction and strength loss likely depending on loading and ground geometry
Zone B: Liquefaction and post-earthquake strength loss unlikely, check cyclic softening
Zone C: Cyclic liquefaction and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

CPT basic interpretation plots (normalized)



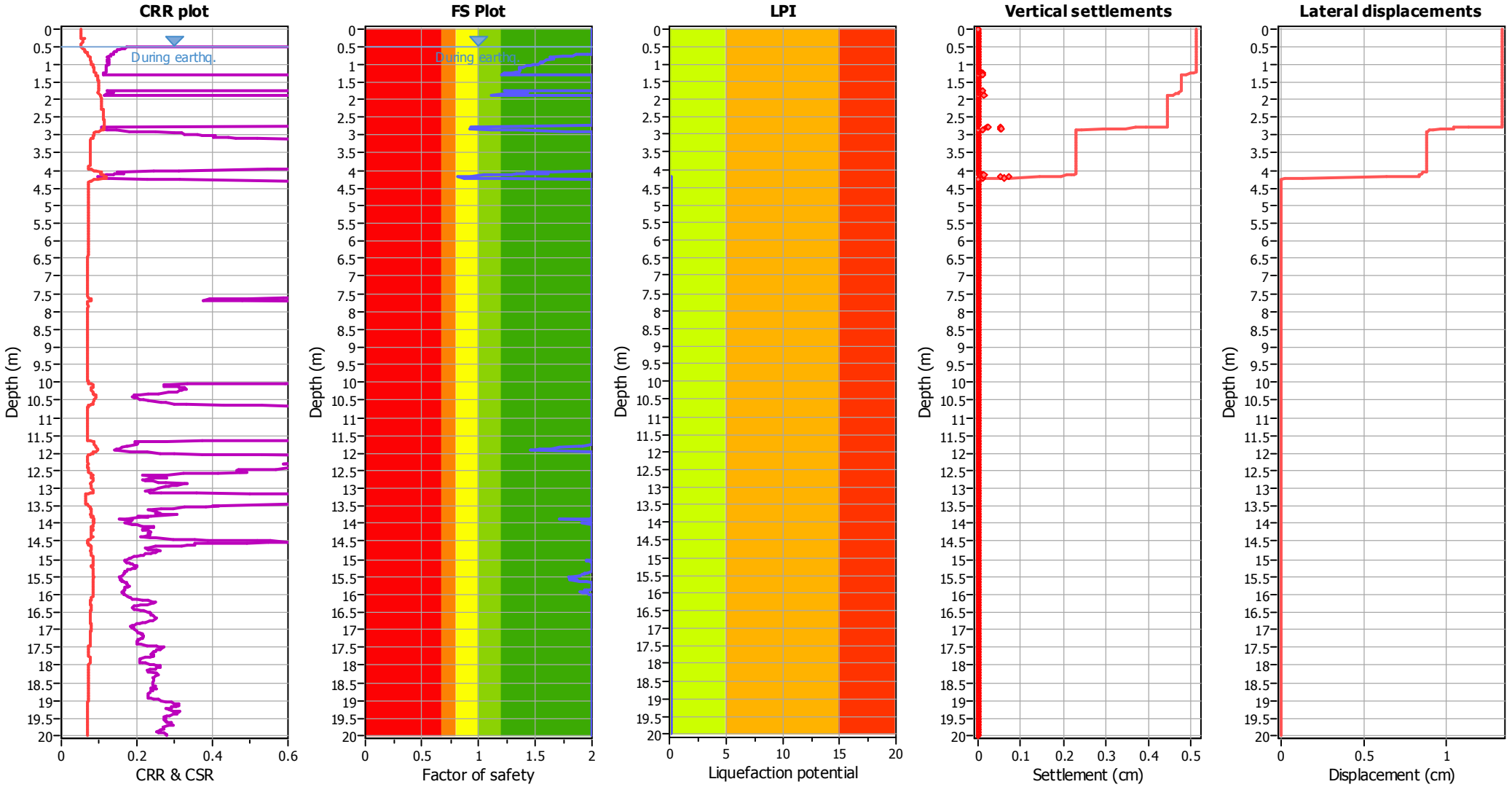
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	0.50 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.10	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.11	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	0.95 m	Fill height:	N/A	Limit depth:	N/A

SBTn legend

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

Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	0.50 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.10	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.11	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	0.95 m	Fill height:	N/A	Limit depth:	N/A

F.S. color scheme

- Almost certain it will liquefy
- Very likely to liquefy
- Liquefaction and no liq. are equally likely
- Unlike to liquefy
- Almost certain it will not liquefy

LPI color scheme

- Very high risk
- High risk
- Low risk

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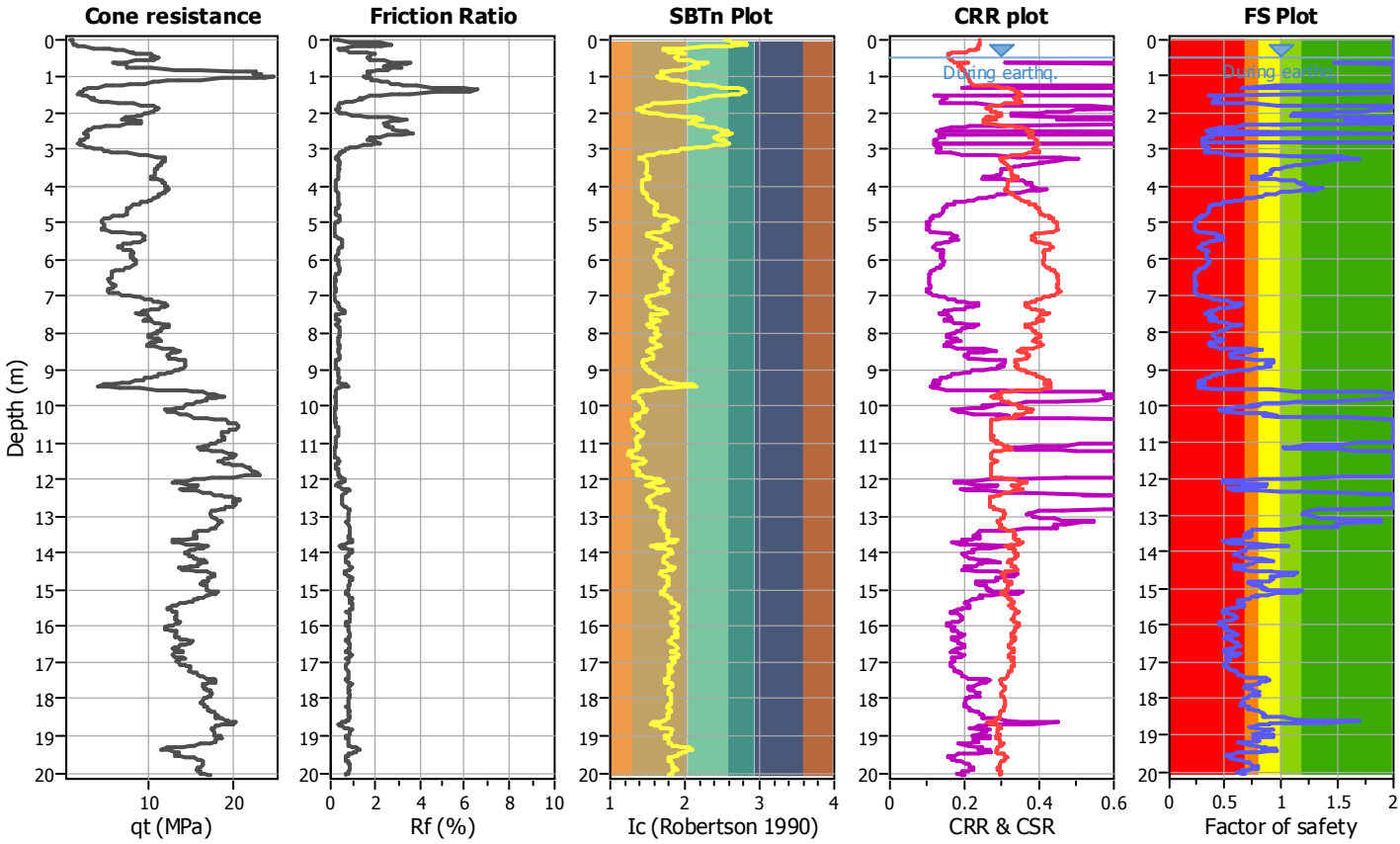
LIQUEFACTION ANALYSIS REPORT

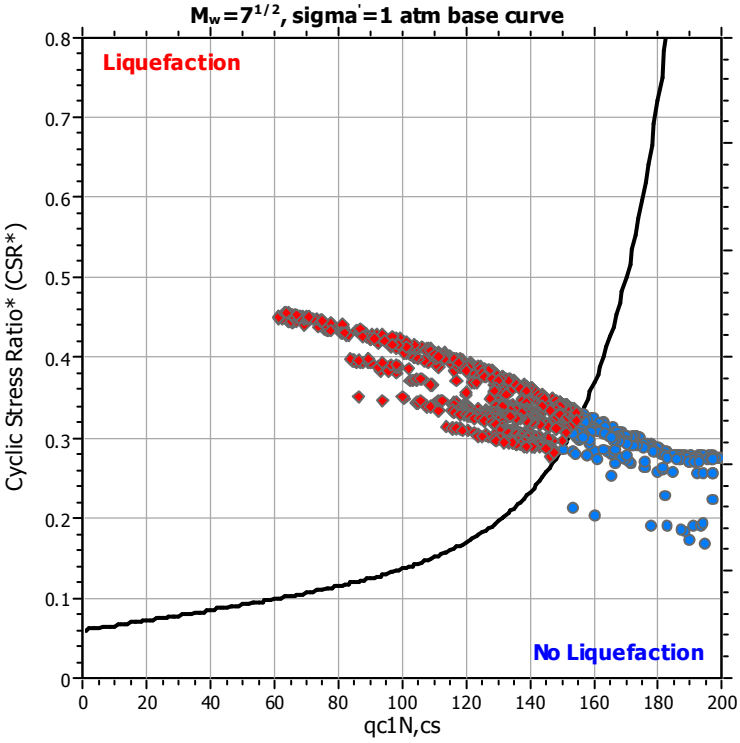
Project title : 47465 - ULS **Location : 23 & 45 Keepa Rd, Whakatane**

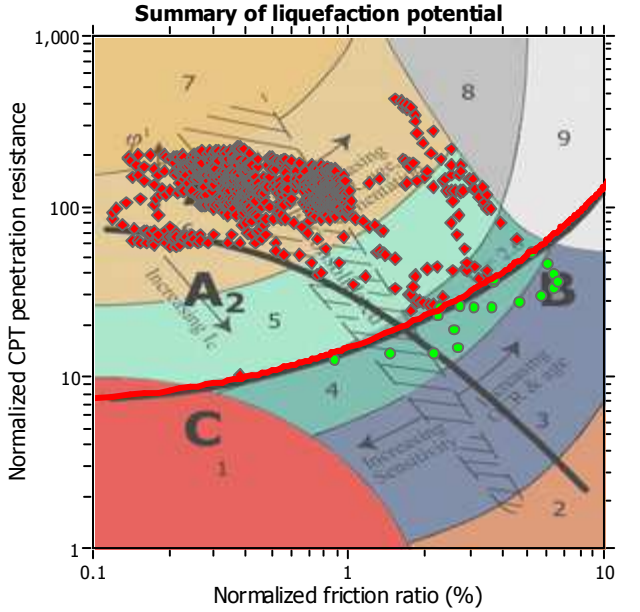
CPT file : CPT01

Input parameters and analysis data

Analysis method:	B&I (2014)	G.W.T. (in-situ):	0.95 m	Use fill:	No	Clay like behavior applied:	Sand & Clay
Fines correction method:	B&I (2014)	G.W.T. (earthq.):	0.50 m	Fill height:	N/A	Limit depth applied:	No
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth:	N/A
Earthquake magnitude M_w:	6.10	Ic cut-off value:	2.60	Trans. detect. applied:	No	MSF method:	Method
Peak ground acceleration:	0.44	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		

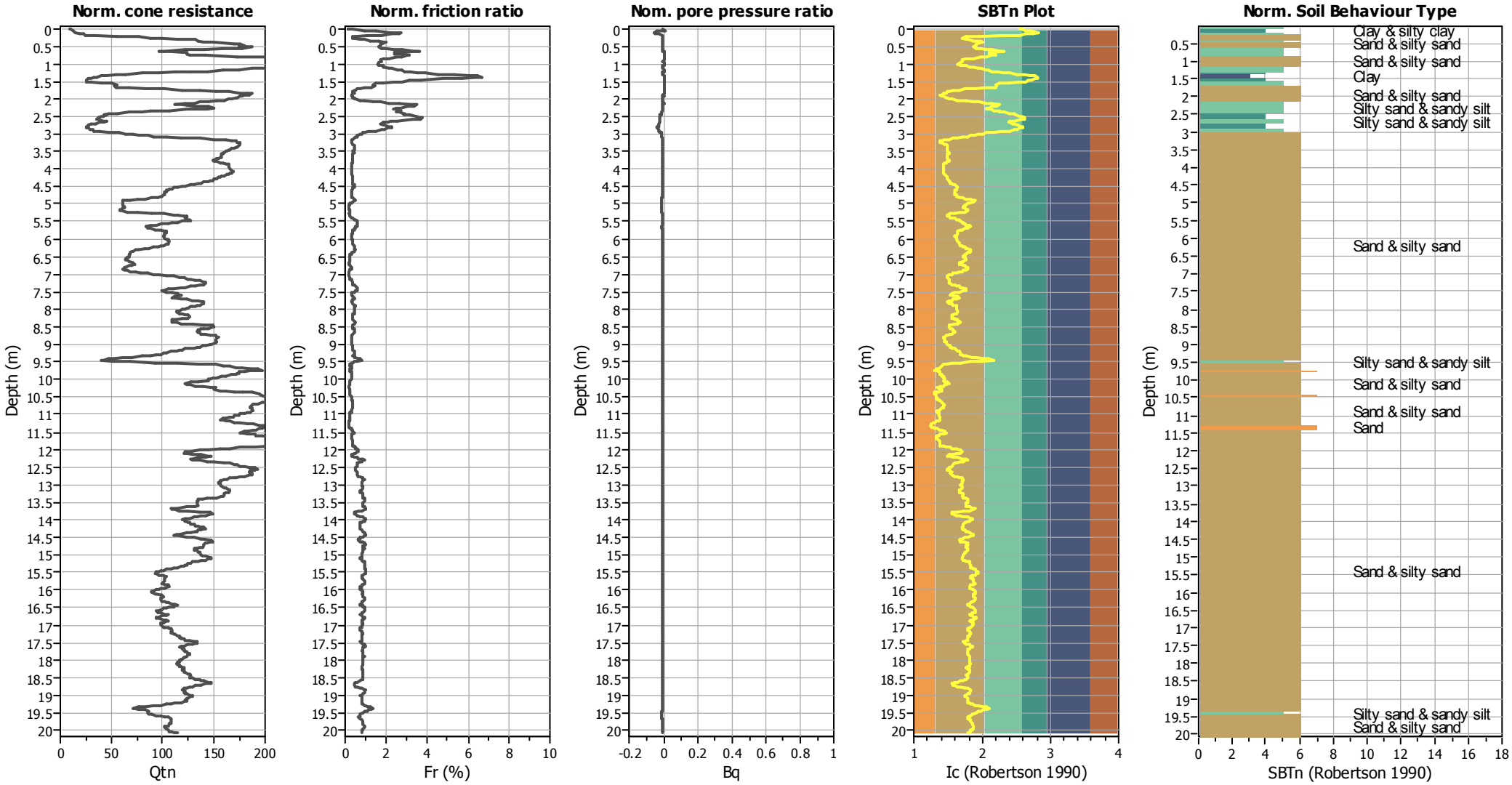






Zone A_1: Cyclic liquefaction likely depending on size and duration of cyclic loading
Zone A_2: Cyclic liquefaction and strength loss likely depending on loading and ground geometry
Zone B: Liquefaction and post-earthquake strength loss unlikely, check cyclic softening
Zone C: Cyclic liquefaction and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

CPT basic interpretation plots (normalized)



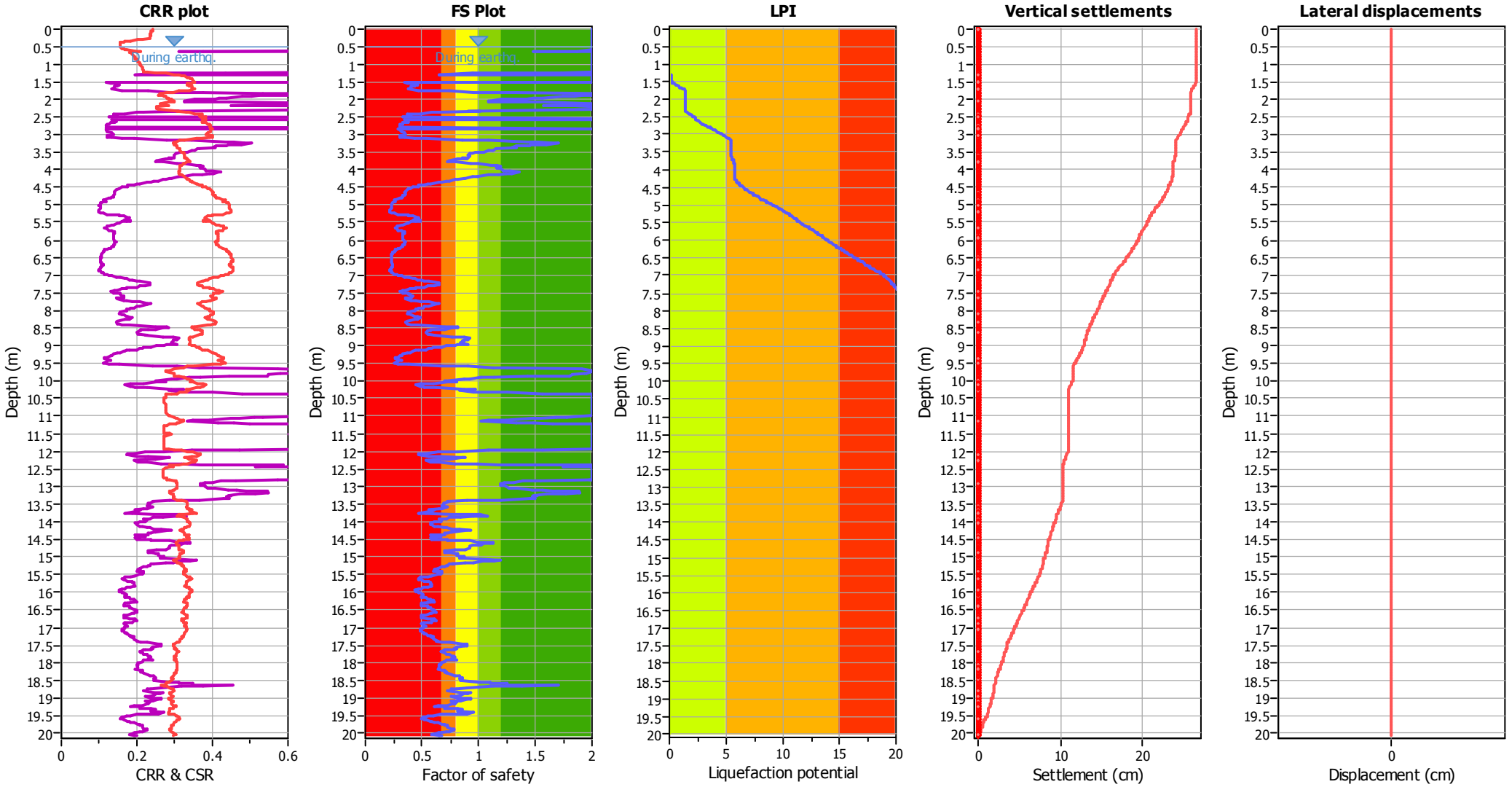
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	0.50 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.10	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.44	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	0.95 m	Fill height:	N/A	Limit depth:	N/A

SBTn legend

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

Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	0.50 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.10	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.44	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	0.95 m	Fill height:	N/A	Limit depth:	N/A

F.S. color scheme

- Almost certain it will liquefy
- Very likely to liquefy
- Liquefaction and no liq. are equally likely
- Unlike to liquefy
- Almost certain it will not liquefy

LPI color scheme

- Very high risk
- High risk
- Low risk

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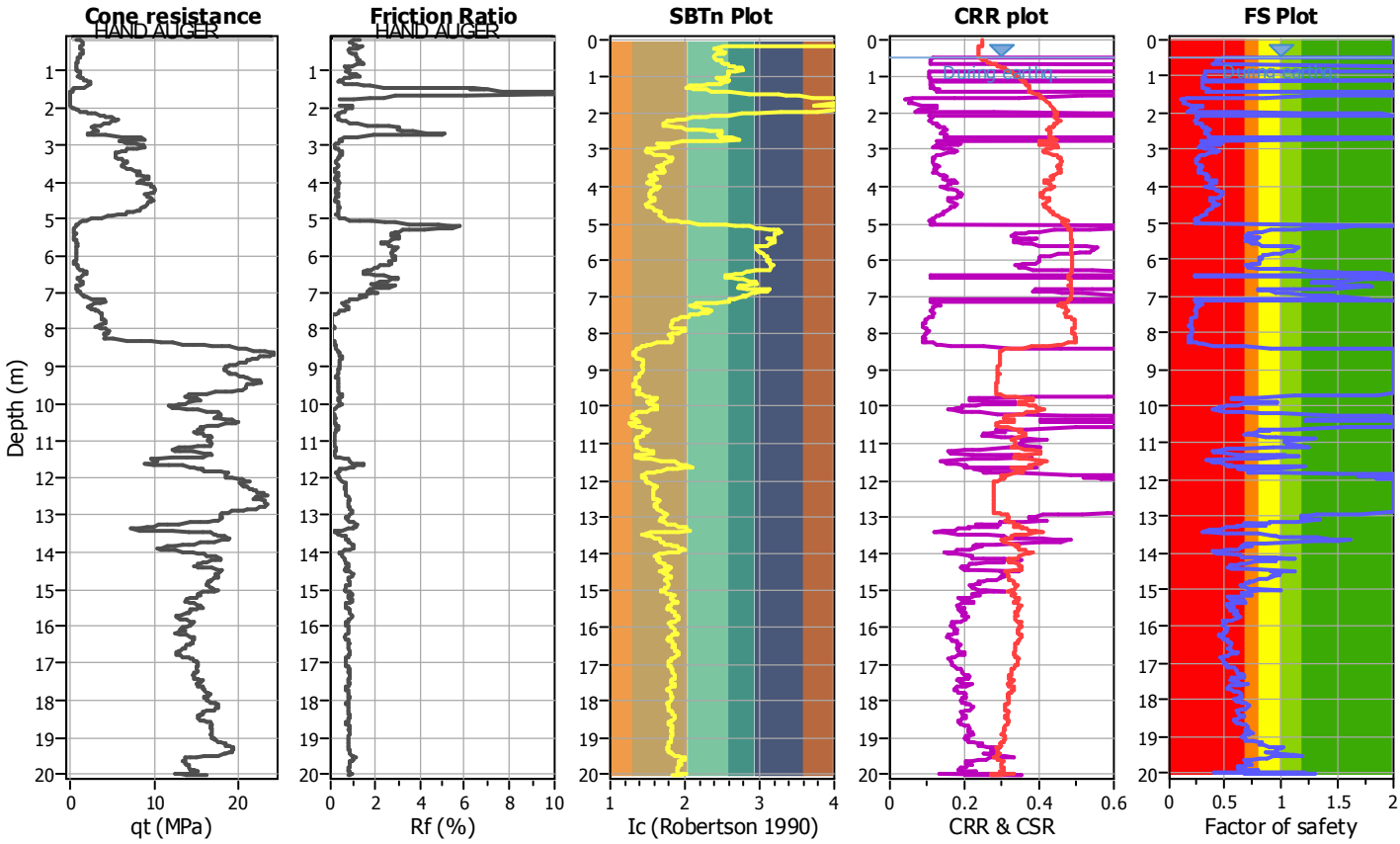
LIQUEFACTION ANALYSIS REPORT

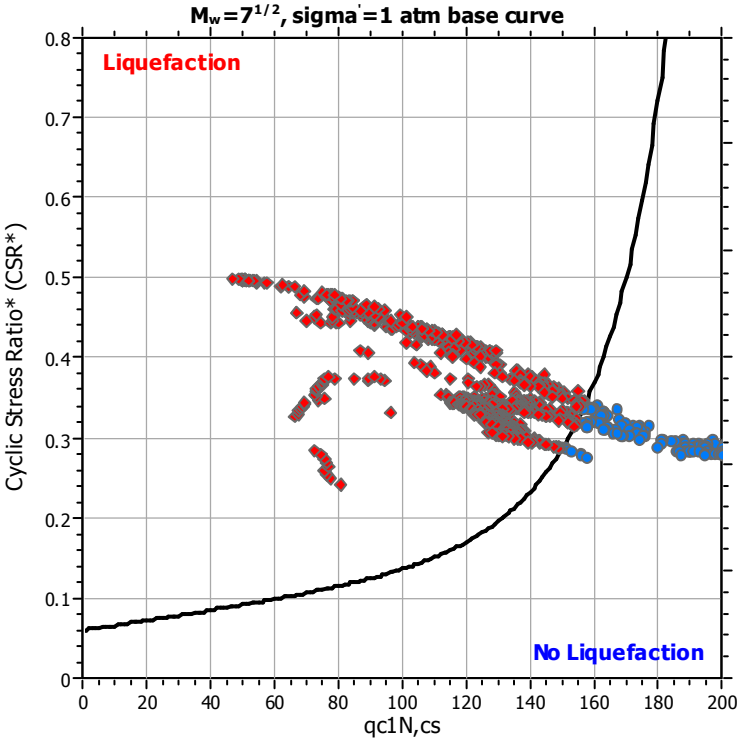
Project title : 47465 - ULS **Location : 23 & 45 Keepa Rd, Whakatane**

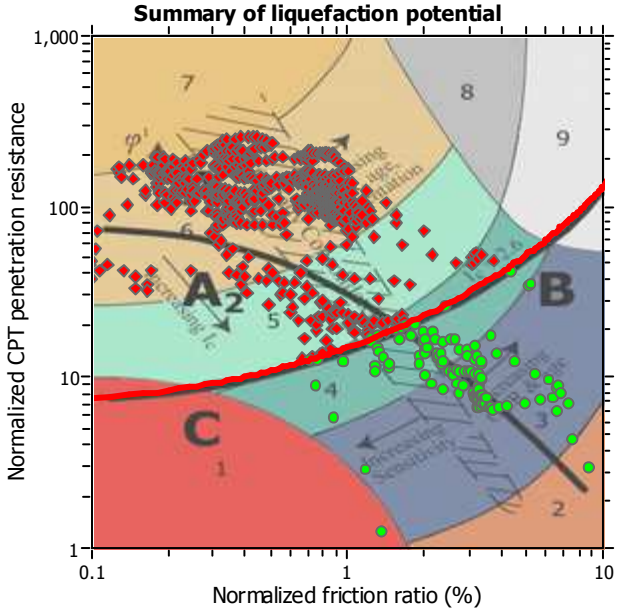
CPT file : CPT02

Input parameters and analysis data

Analysis method:	B&I (2014)	G.W.T. (in-situ):	2.94 m	Use fill:	No	Clay like behavior applied:	Sand & Clay
Fines correction method:	B&I (2014)	G.W.T. (earthq.):	0.50 m	Fill height:	N/A	Limit depth applied:	No
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth:	N/A
Earthquake magnitude M_w:	6.10	Ic cut-off value:	2.60	Trans. detect. applied:	No	MSF method:	Method
Peak ground acceleration:	0.44	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		

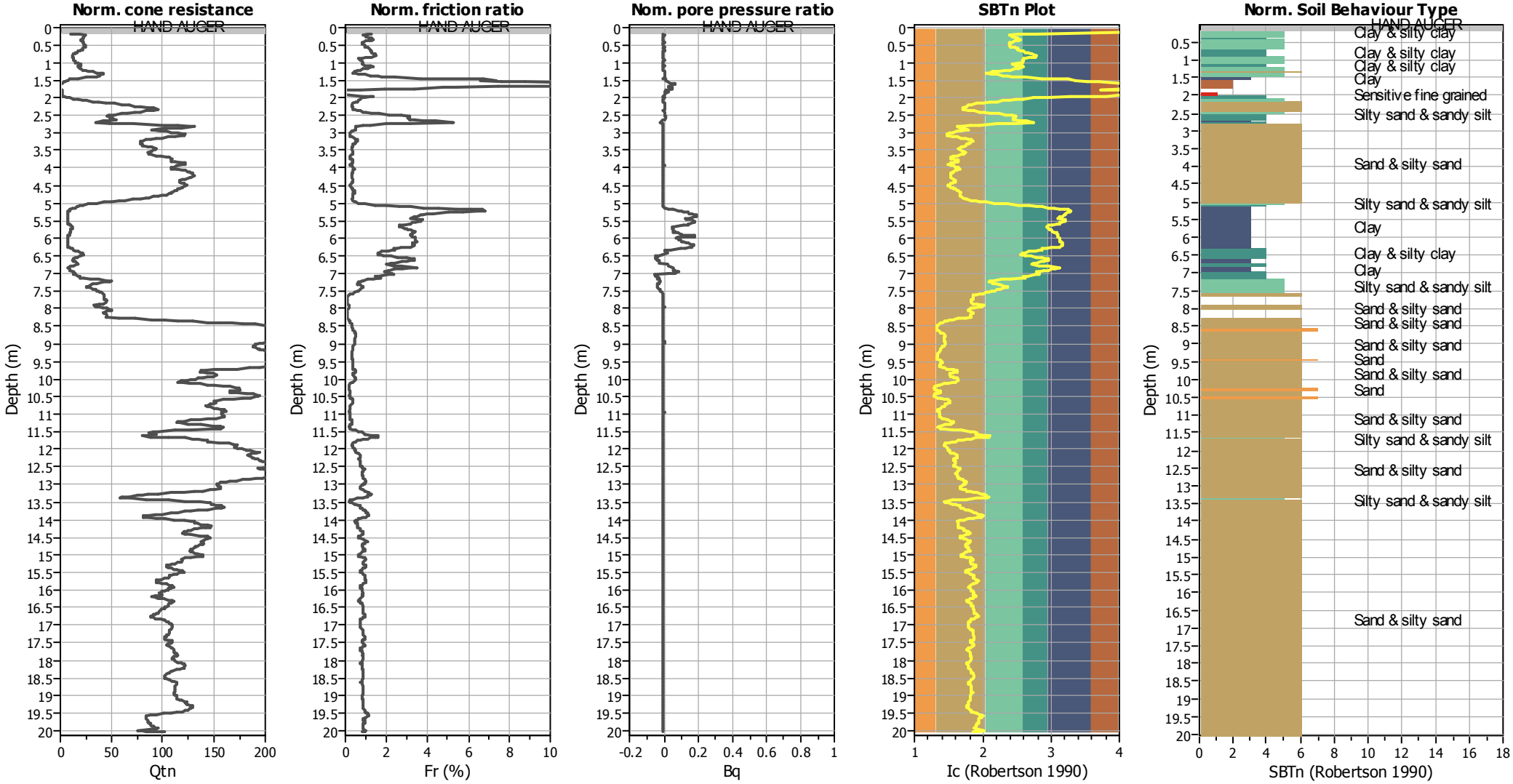






Zone A_1: Cyclic liquefaction likely depending on size and duration of cyclic loading
Zone A_2: Cyclic liquefaction and strength loss likely depending on loading and ground geometry
Zone B: Liquefaction and post-earthquake strength loss unlikely, check cyclic softening
Zone C: Cyclic liquefaction and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

CPT basic interpretation plots (normalized)



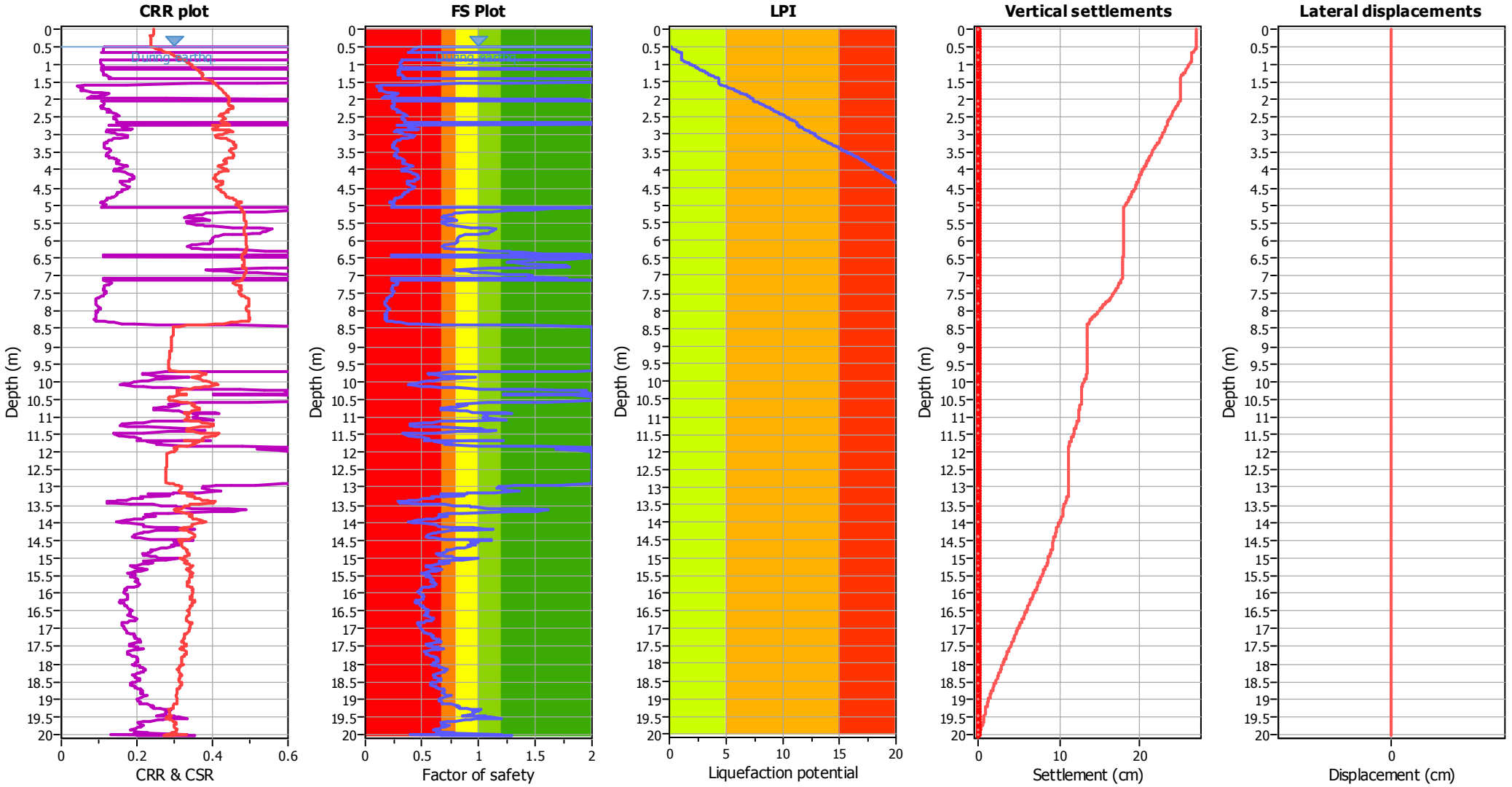
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	0.50 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.10	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.44	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	2.94 m	Fill height:	N/A	Limit depth:	N/A

SBTn legend

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

Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	0.50 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.10	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.44	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	2.94 m	Fill height:	N/A	Limit depth:	N/A

F.S. color scheme

- Almost certain it will liquefy
- Very likely to liquefy
- Liquefaction and no liq. are equally likely
- Unlike to liquefy
- Almost certain it will not liquefy

LPI color scheme

- Very high risk
- High risk
- Low risk

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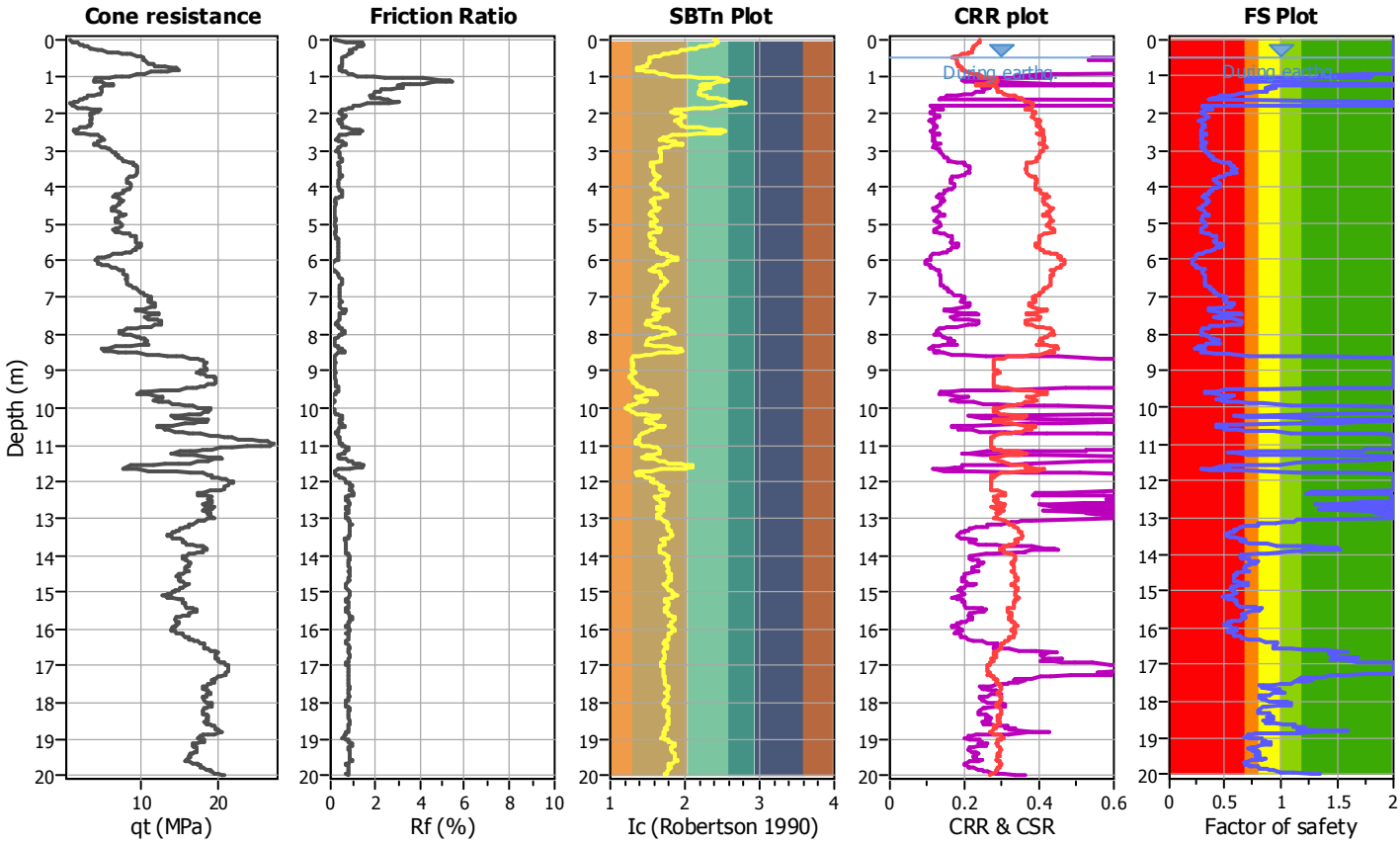
LIQUEFACTION ANALYSIS REPORT

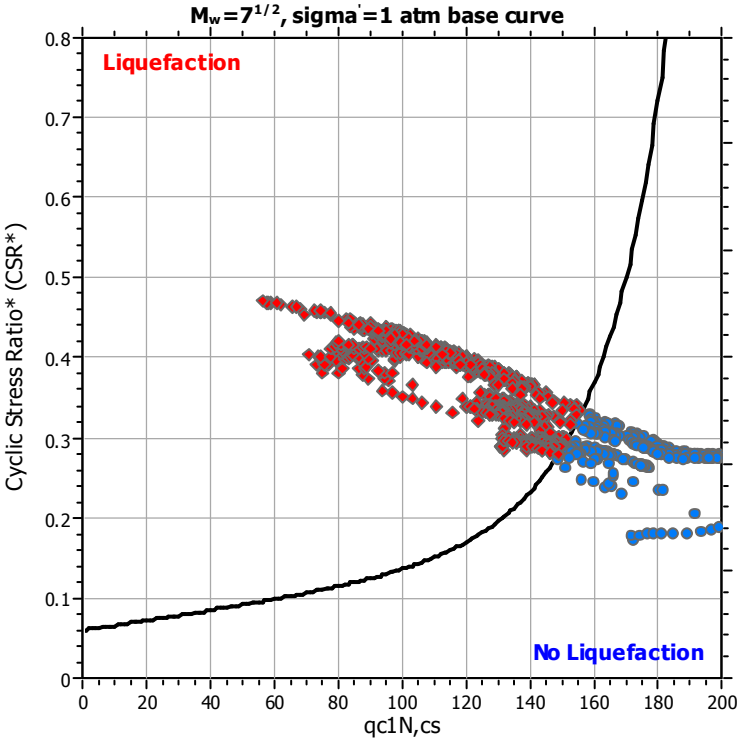
Project title : 47465 - ULS **Location : 23 & 45 Keepa Rd, Whakatane**

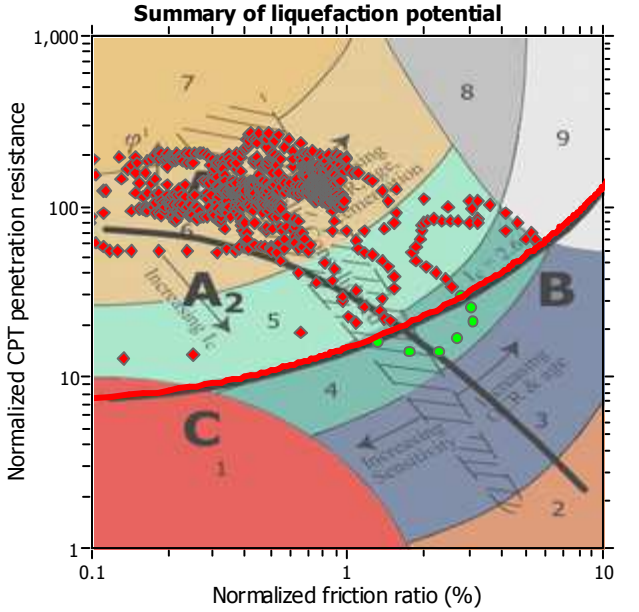
CPT file : CPT03

Input parameters and analysis data

Analysis method:	B&I (2014)	G.W.T. (in-situ):	1.52 m	Use fill:	No	Clay like behavior applied:	Sand & Clay
Fines correction method:	B&I (2014)	G.W.T. (earthq.):	0.50 m	Fill height:	N/A	Limit depth applied:	No
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth:	N/A
Earthquake magnitude M_w:	6.10	Ic cut-off value:	2.60	Trans. detect. applied:	No	MSF method:	Method
Peak ground acceleration:	0.44	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		

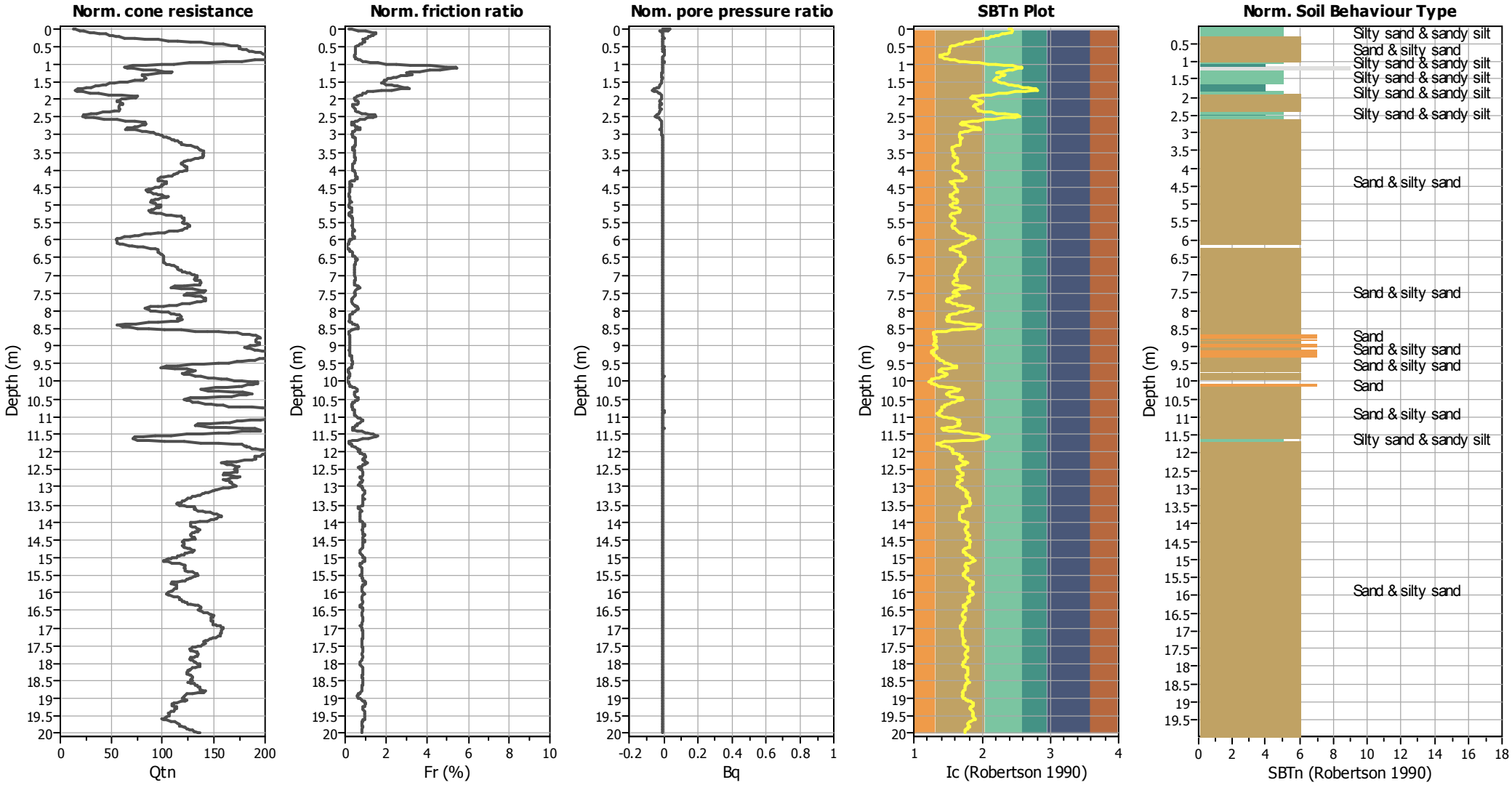






Zone A_1: Cyclic liquefaction likely depending on size and duration of cyclic loading
Zone A_2: Cyclic liquefaction and strength loss likely depending on loading and ground geometry
Zone B: Liquefaction and post-earthquake strength loss unlikely, check cyclic softening
Zone C: Cyclic liquefaction and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

CPT basic interpretation plots (normalized)



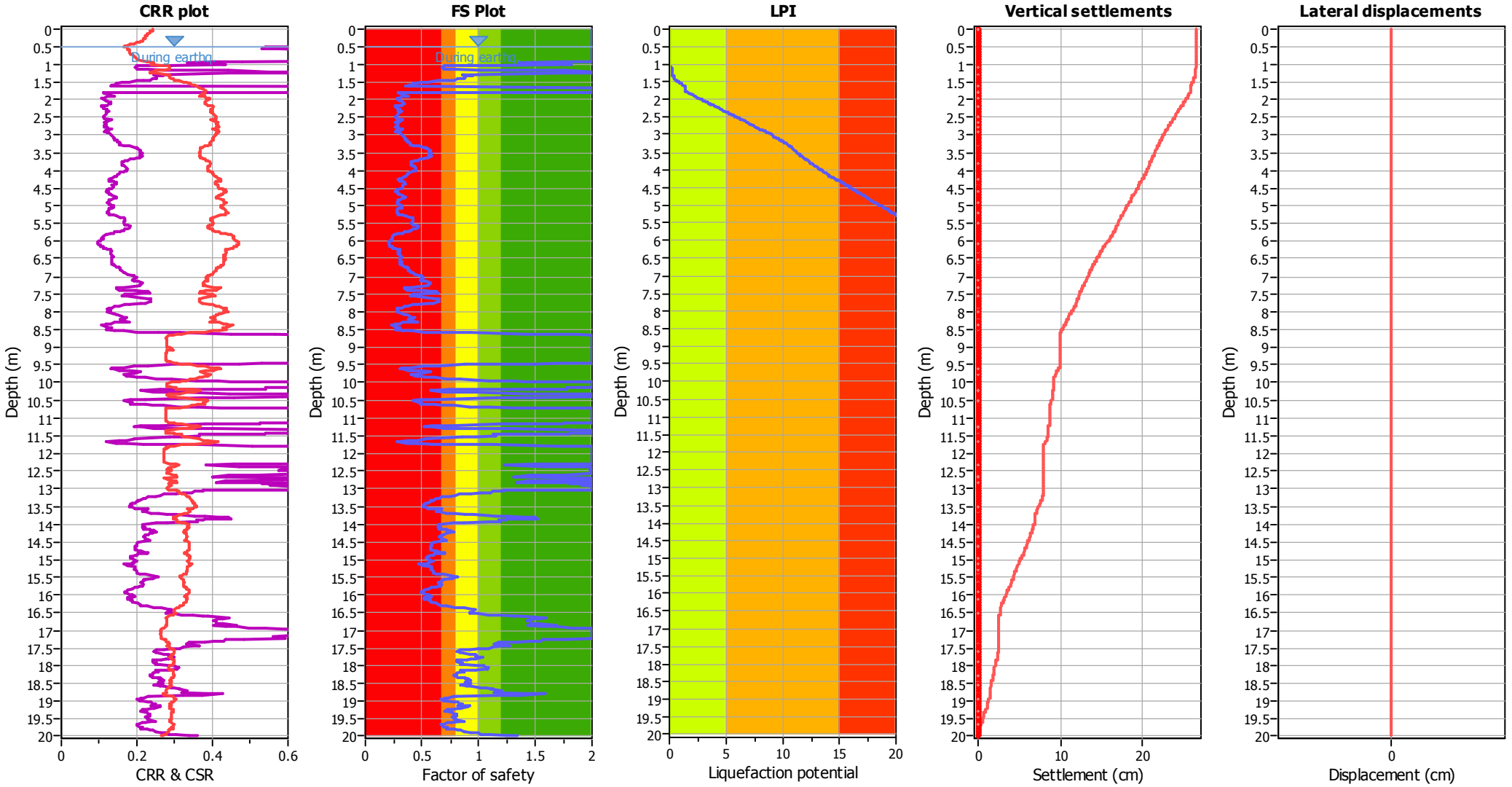
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	0.50 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.10	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.44	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	1.52 m	Fill height:	N/A	Limit depth:	N/A

SBTn legend

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

Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	0.50 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.10	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.44	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	1.52 m	Fill height:	N/A	Limit depth:	N/A

F.S. color scheme

- Almost certain it will liquefy
- Very likely to liquefy
- Liquefaction and no liq. are equally likely
- Unlike to liquefy
- Almost certain it will not liquefy

LPI color scheme

- Very high risk
- High risk
- Low risk

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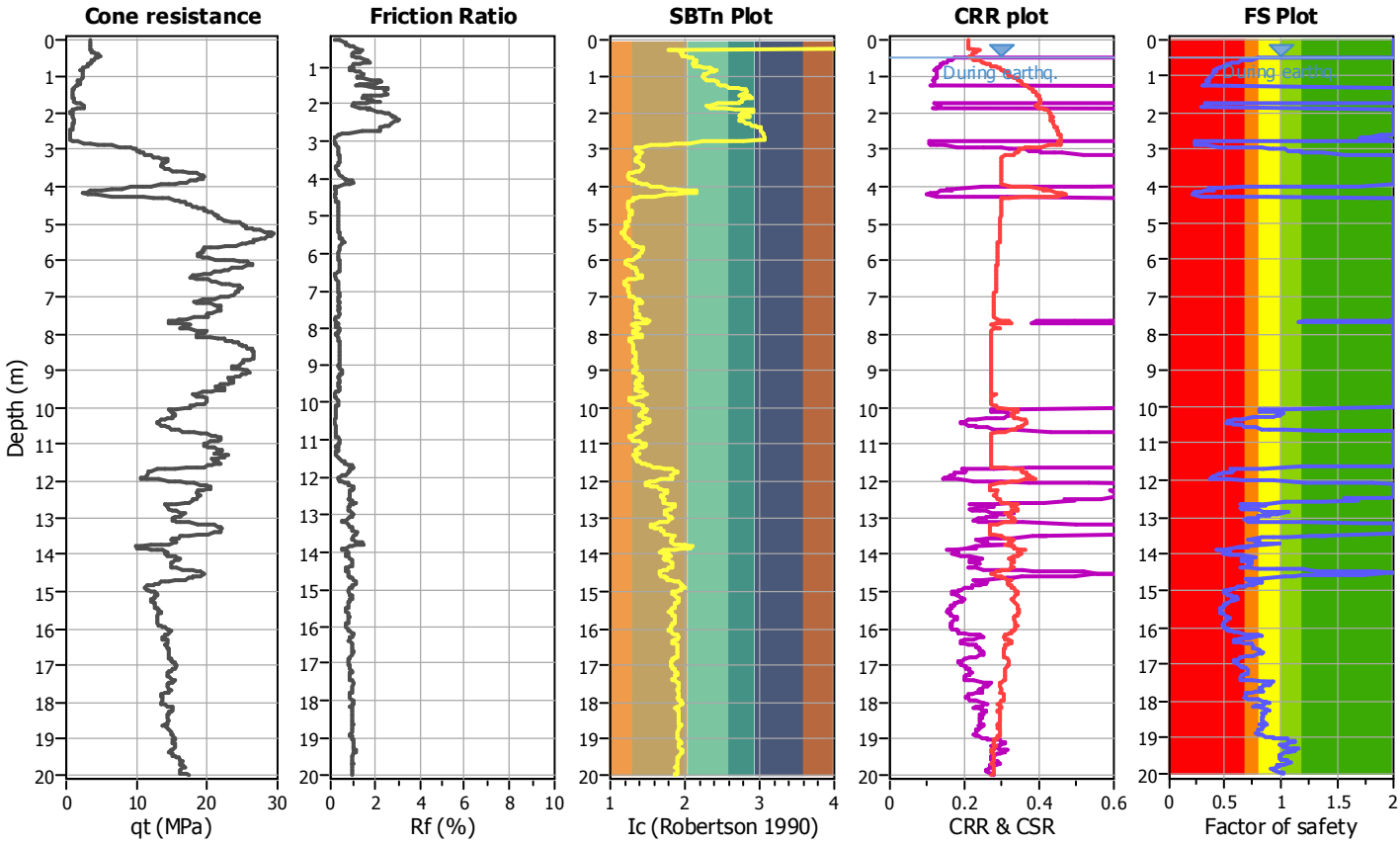
LIQUEFACTION ANALYSIS REPORT

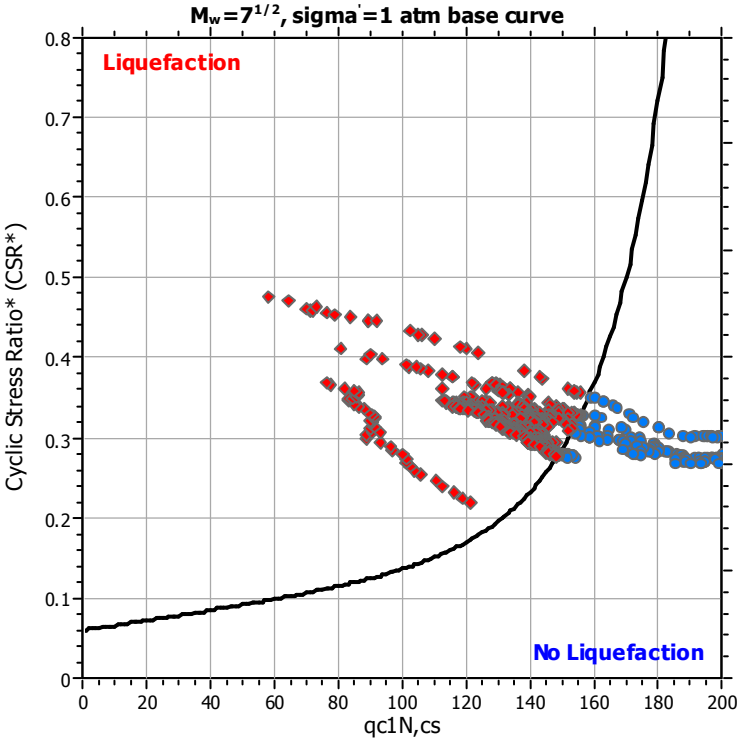
Project title : 47465 - ULS **Location : 23 & 45 Keepa Rd, Whakatane**

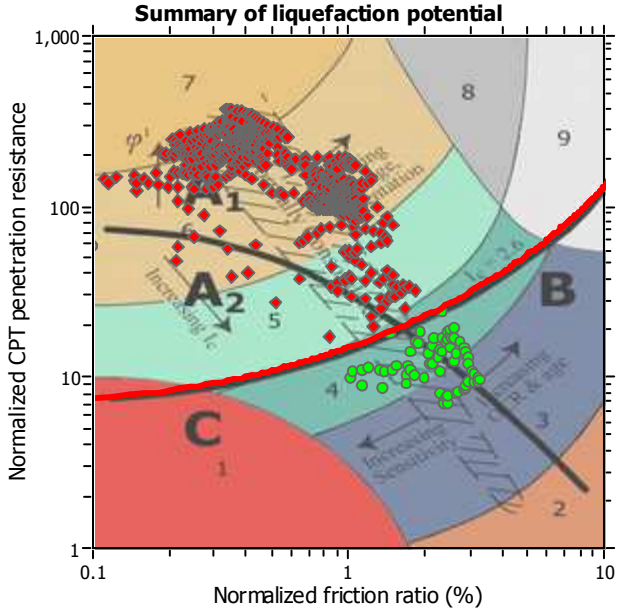
CPT file : CPT06

Input parameters and analysis data

Analysis method:	B&I (2014)	G.W.T. (in-situ):	0.95 m	Use fill:	No	Clay like behavior applied:	Sand & Clay
Fines correction method:	B&I (2014)	G.W.T. (earthq.):	0.50 m	Fill height:	N/A	Limit depth applied:	No
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth:	N/A
Earthquake magnitude M_w:	6.10	Ic cut-off value:	2.60	Trans. detect. applied:	No	MSF method:	Method
Peak ground acceleration:	0.44	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		

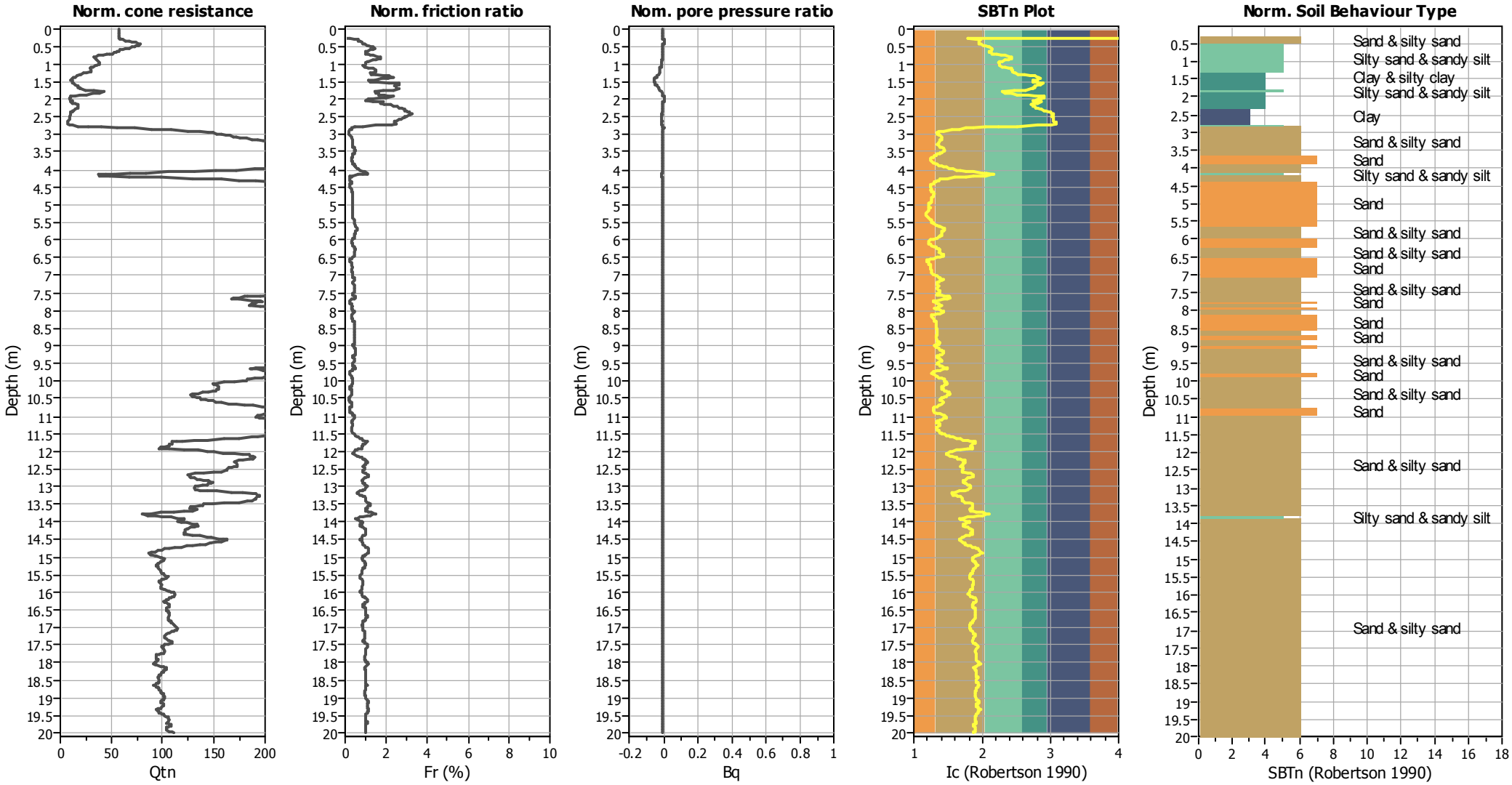






Zone A_1: Cyclic liquefaction likely depending on size and duration of cyclic loading
Zone A_2: Cyclic liquefaction and strength loss likely depending on loading and ground geometry
Zone B: Liquefaction and post-earthquake strength loss unlikely, check cyclic softening
Zone C: Cyclic liquefaction and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

CPT basic interpretation plots (normalized)



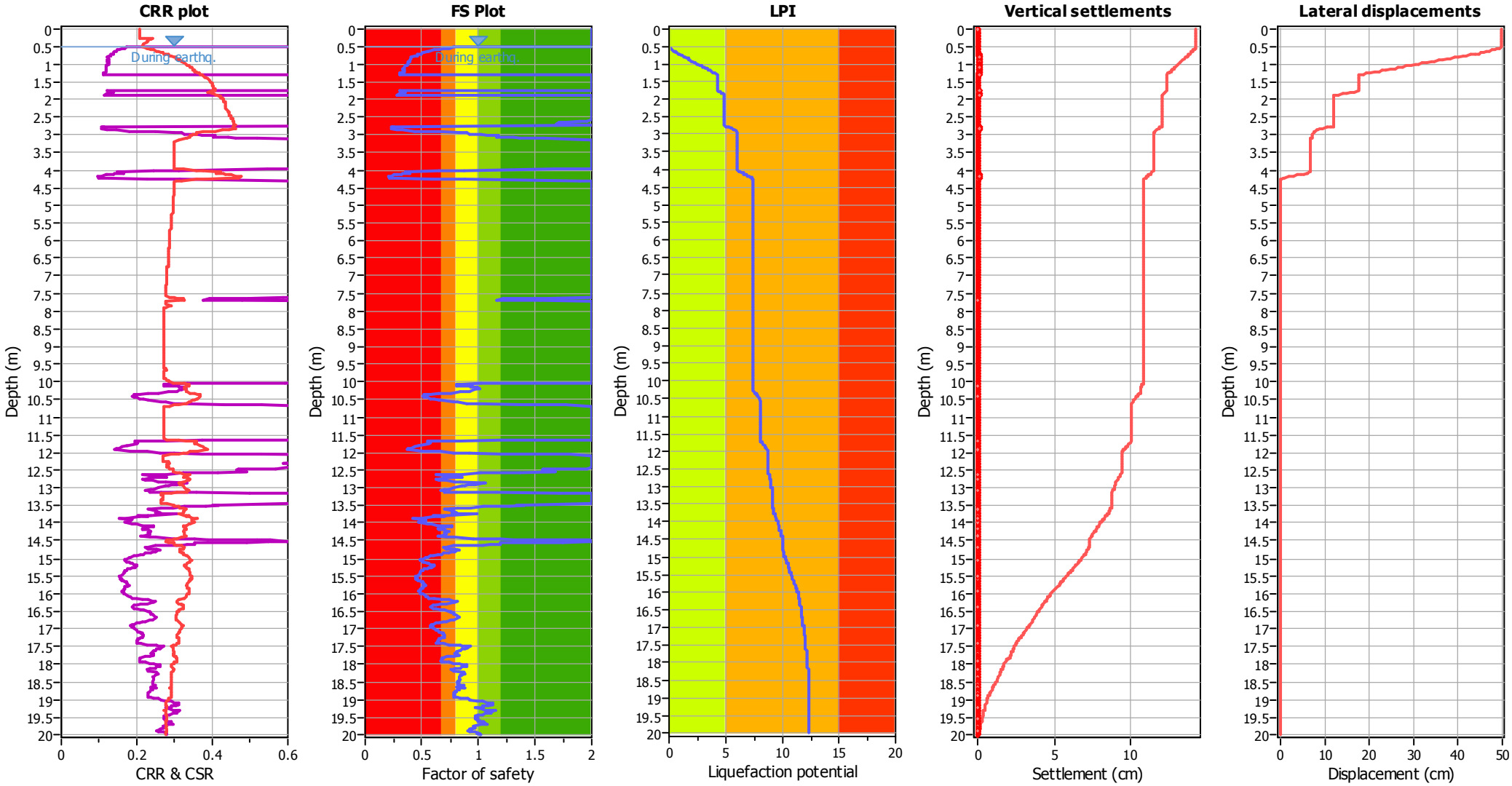
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	0.50 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.10	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.44	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	0.95 m	Fill height:	N/A	Limit depth:	N/A

SBTn legend

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

Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	0.50 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.10	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.44	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	0.95 m	Fill height:	N/A	Limit depth:	N/A

F.S. color scheme

- Almost certain it will liquefy
- Very likely to liquefy
- Liquefaction and no liq. are equally likely
- Unlike to liquefy
- Almost certain it will not liquefy

LPI color scheme

- Very high risk
- High risk
- Low risk

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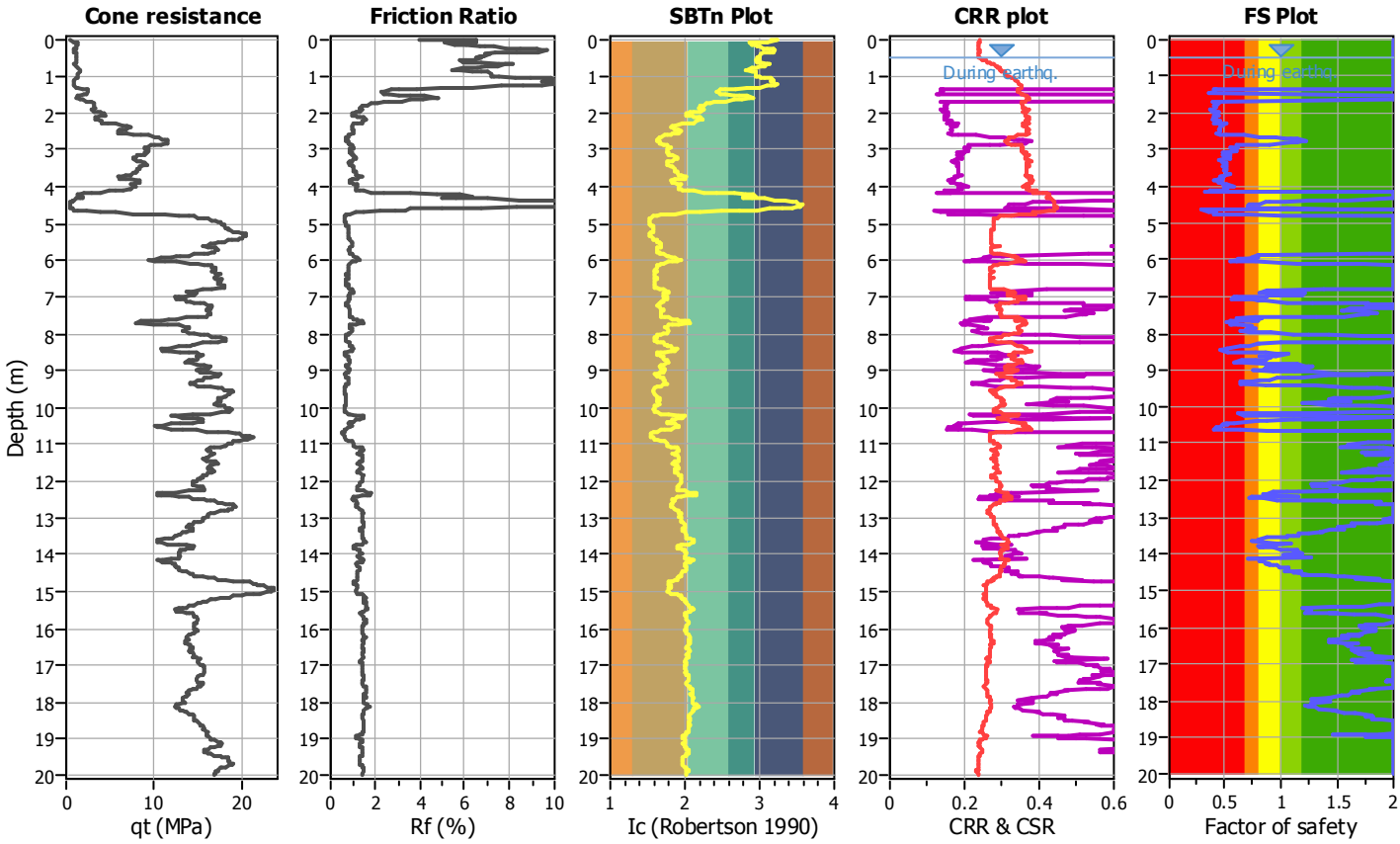
LIQUEFACTION ANALYSIS REPORT

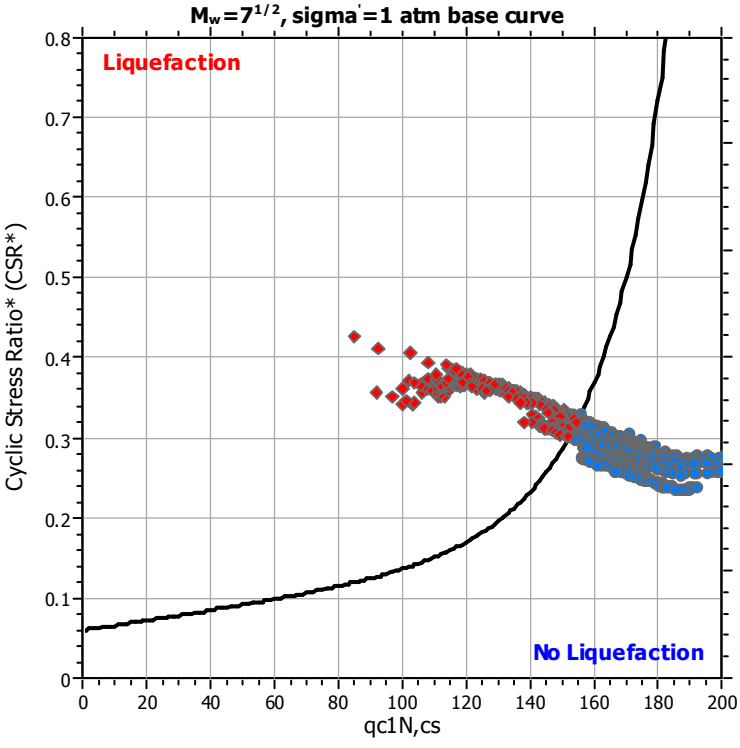
Project title : 47465 - ULS **Location : 23 & 45 Keepa Rd, Whakatane**

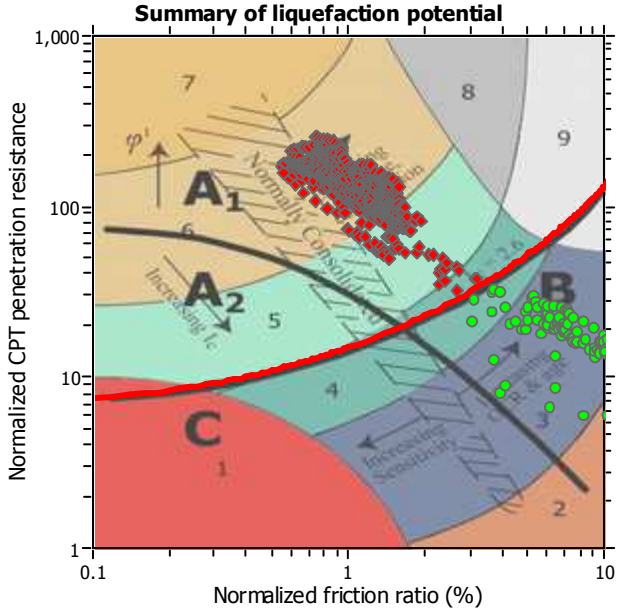
CPT file : CPT05

Input parameters and analysis data

Analysis method:	B&I (2014)	G.W.T. (in-situ):	1.90 m	Use fill:	No	Clay like behavior applied:	Sand & Clay
Fines correction method:	B&I (2014)	G.W.T. (earthq.):	0.50 m	Fill height:	N/A	Limit depth applied:	No
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth:	N/A
Earthquake magnitude M_w:	6.10	Ic cut-off value:	2.60	Trans. detect. applied:	No	MSF method:	Method
Peak ground acceleration:	0.44	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		

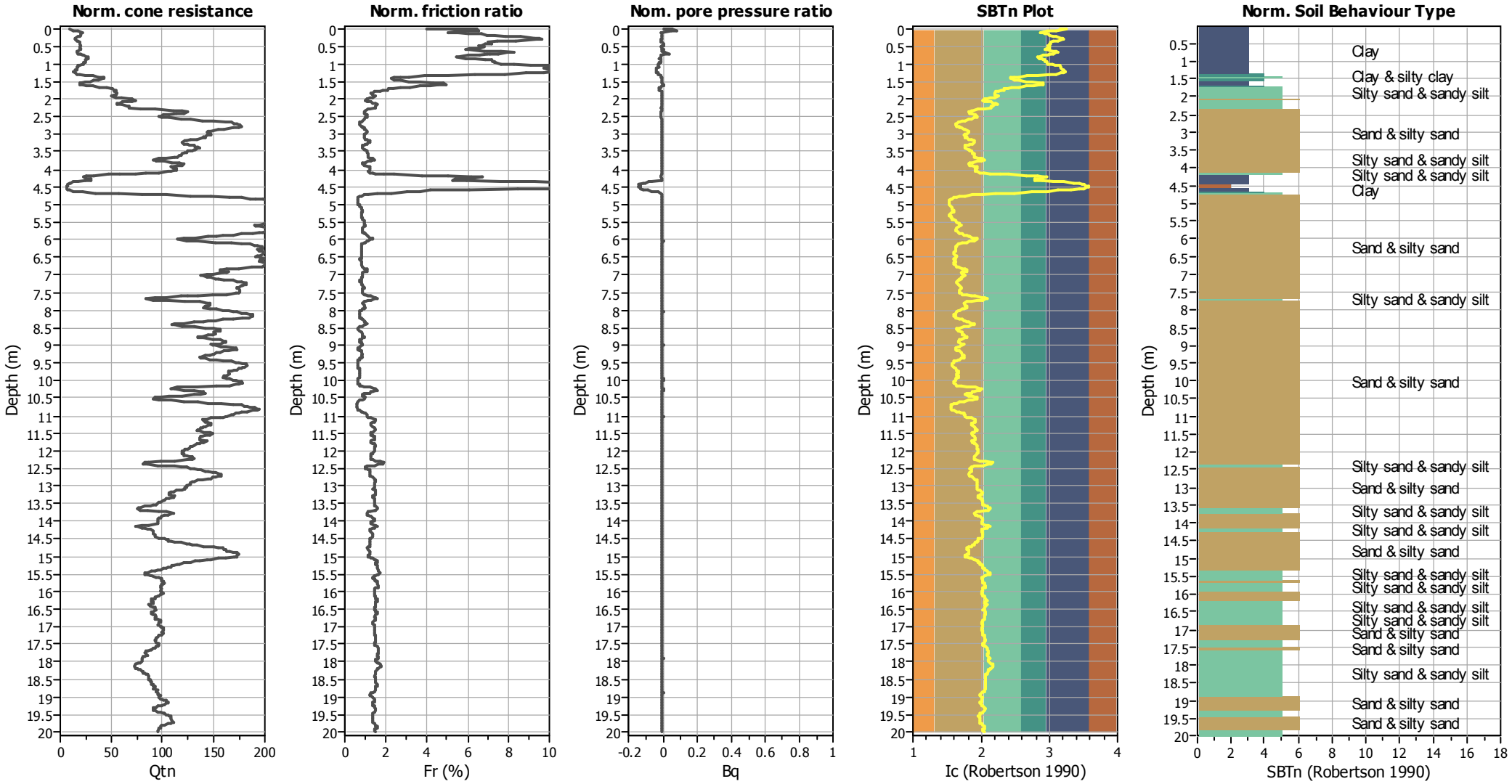






Zone A_1: Cyclic liquefaction likely depending on size and duration of cyclic loading
Zone A_2: Cyclic liquefaction and strength loss likely depending on loading and ground geometry
Zone B: Liquefaction and post-earthquake strength loss unlikely, check cyclic softening
Zone C: Cyclic liquefaction and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

CPT basic interpretation plots (normalized)



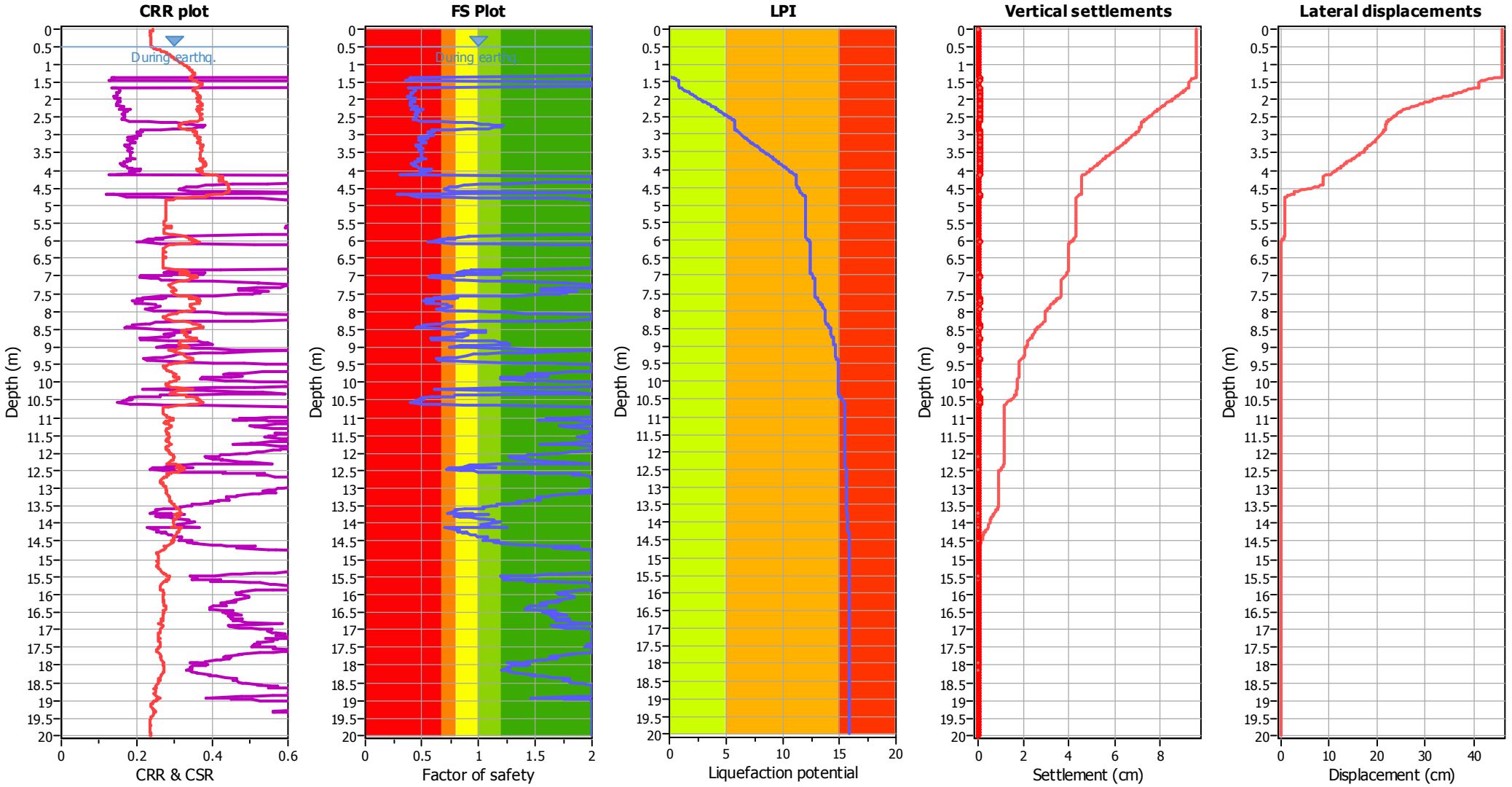
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	0.50 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.10	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.44	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	1.90 m	Fill height:	N/A	Limit depth:	N/A

SBTn legend

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

Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	0.50 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.10	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.44	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	1.90 m	Fill height:	N/A	Limit depth:	N/A

F.S. color scheme

- Almost certain it will liquefy
- Very likely to liquefy
- Liquefaction and no liq. are equally likely
- Unlike to liquefy
- Almost certain it will not liquefy

LPI color scheme

- Very high risk
- High risk
- Low risk

ENGINEERING DESIGN CONSULTANTS
Level 1, 39 Carlyle St,
Sydenham
Christchurch
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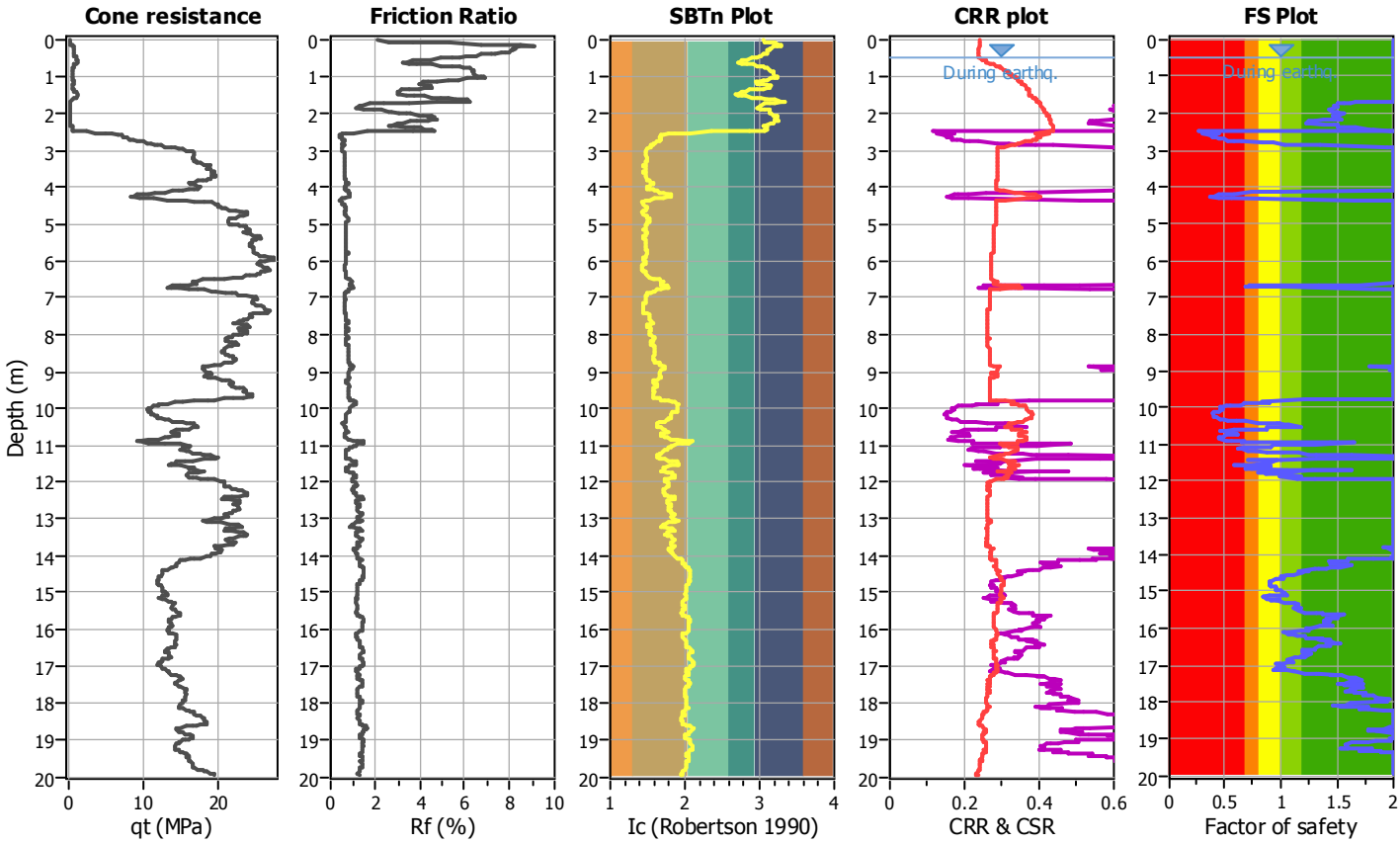
LIQUEFACTION ANALYSIS REPORT

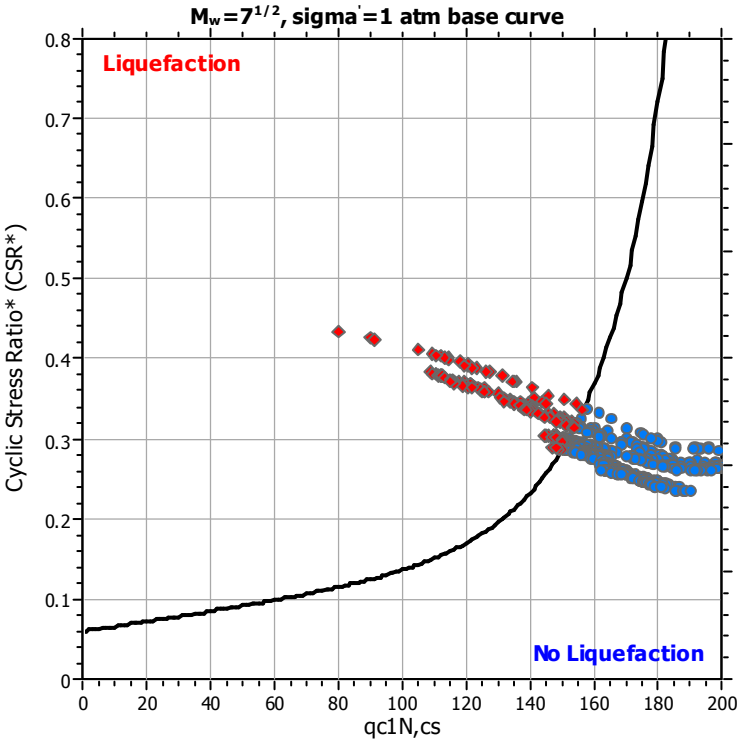
Project title : 47465 - ULS **Location : 23 & 45 Keepa Rd, Whakatane**

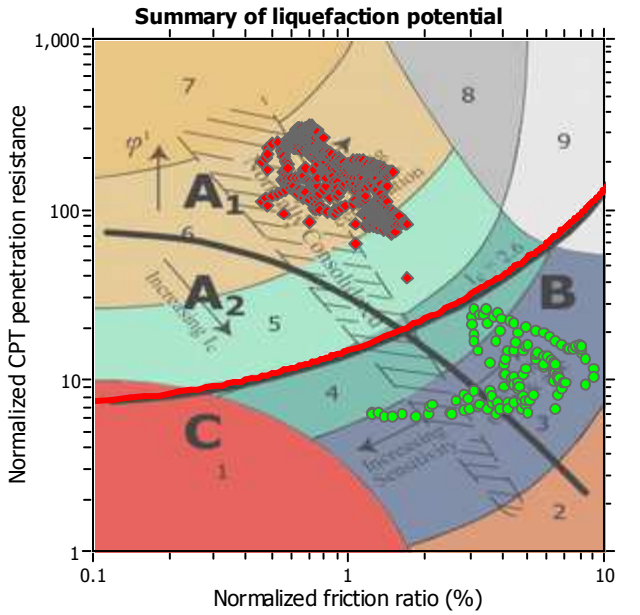
CPT file : CPT07

Input parameters and analysis data

Analysis method:	B&I (2014)	G.W.T. (in-situ):	2.38 m	Use fill:	No	Clay like behavior applied:	Sand & Clay
Fines correction method:	B&I (2014)	G.W.T. (earthq.):	0.50 m	Fill height:	N/A	Limit depth applied:	No
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth:	N/A
Earthquake magnitude M_w:	6.10	Ic cut-off value:	2.60	Trans. detect. applied:	No	MSF method:	Method
Peak ground acceleration:	0.44	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		

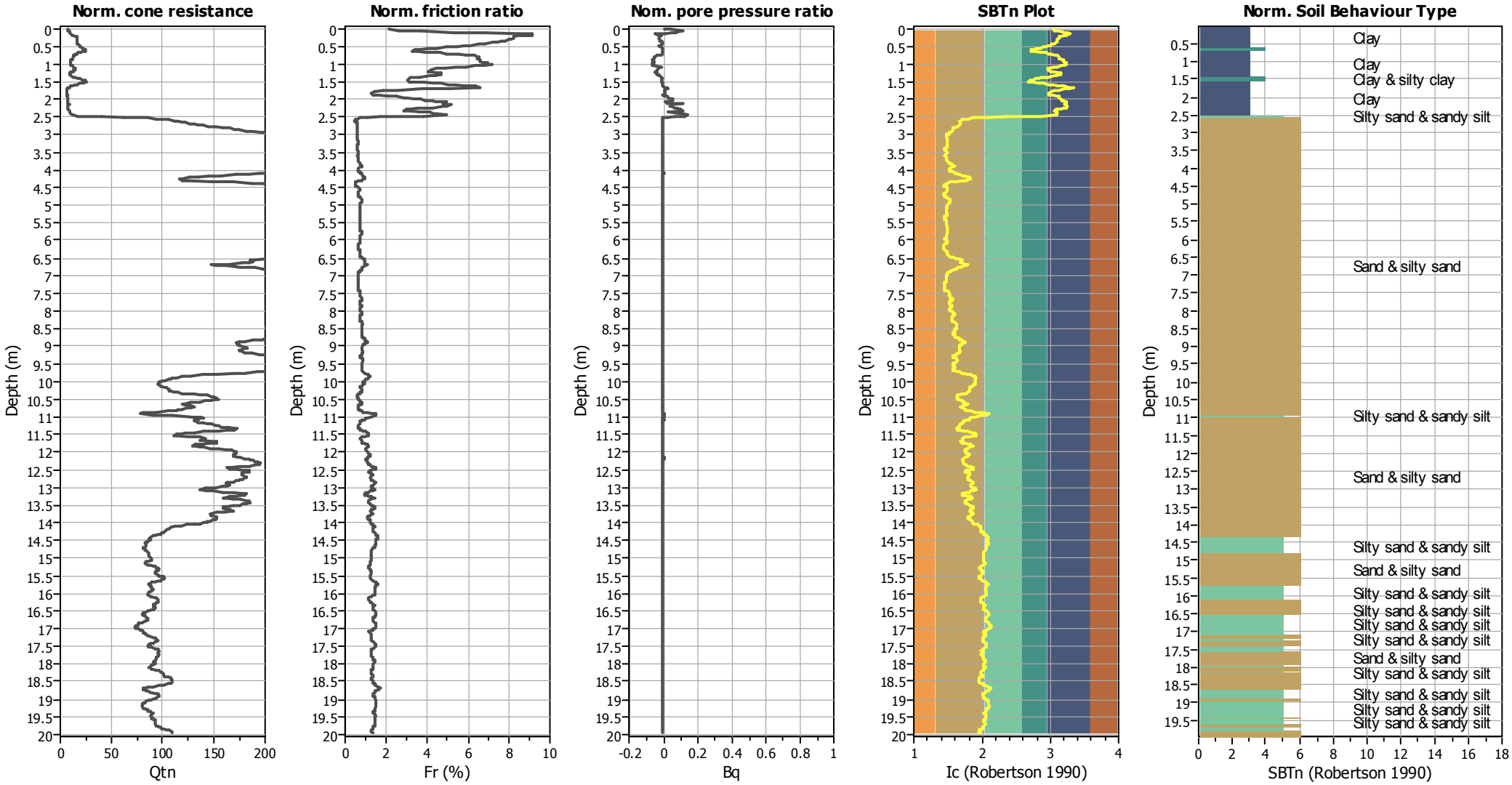






Zone A_1: Cyclic liquefaction likely depending on size and duration of cyclic loading
Zone A_2: Cyclic liquefaction and strength loss likely depending on loading and ground geometry
Zone B: Liquefaction and post-earthquake strength loss unlikely, check cyclic softening
Zone C: Cyclic liquefaction and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

CPT basic interpretation plots (normalized)



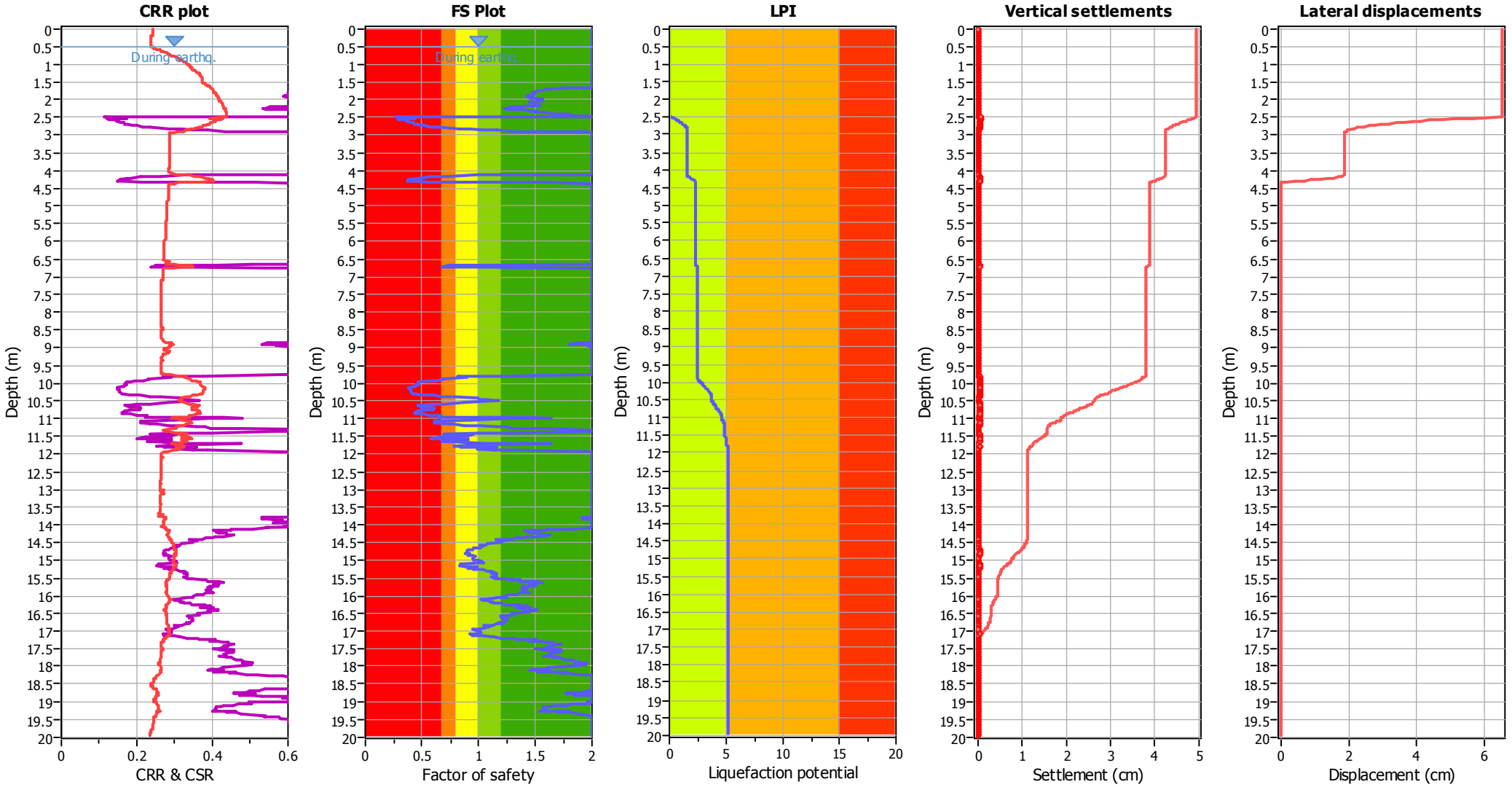
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	0.50 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.10	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.44	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	2.38 m	Fill height:	N/A	Limit depth:	N/A

SBTn legend

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

Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	0.50 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.10	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.44	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	2.38 m	Fill height:	N/A	Limit depth:	N/A

F.S. color scheme

- Almost certain it will liquefy
- Very likely to liquefy
- Liquefaction and no liq. are equally likely
- Unlike to liquefy
- Almost certain it will not liquefy

LPI color scheme

- Very high risk
- High risk
- Low risk

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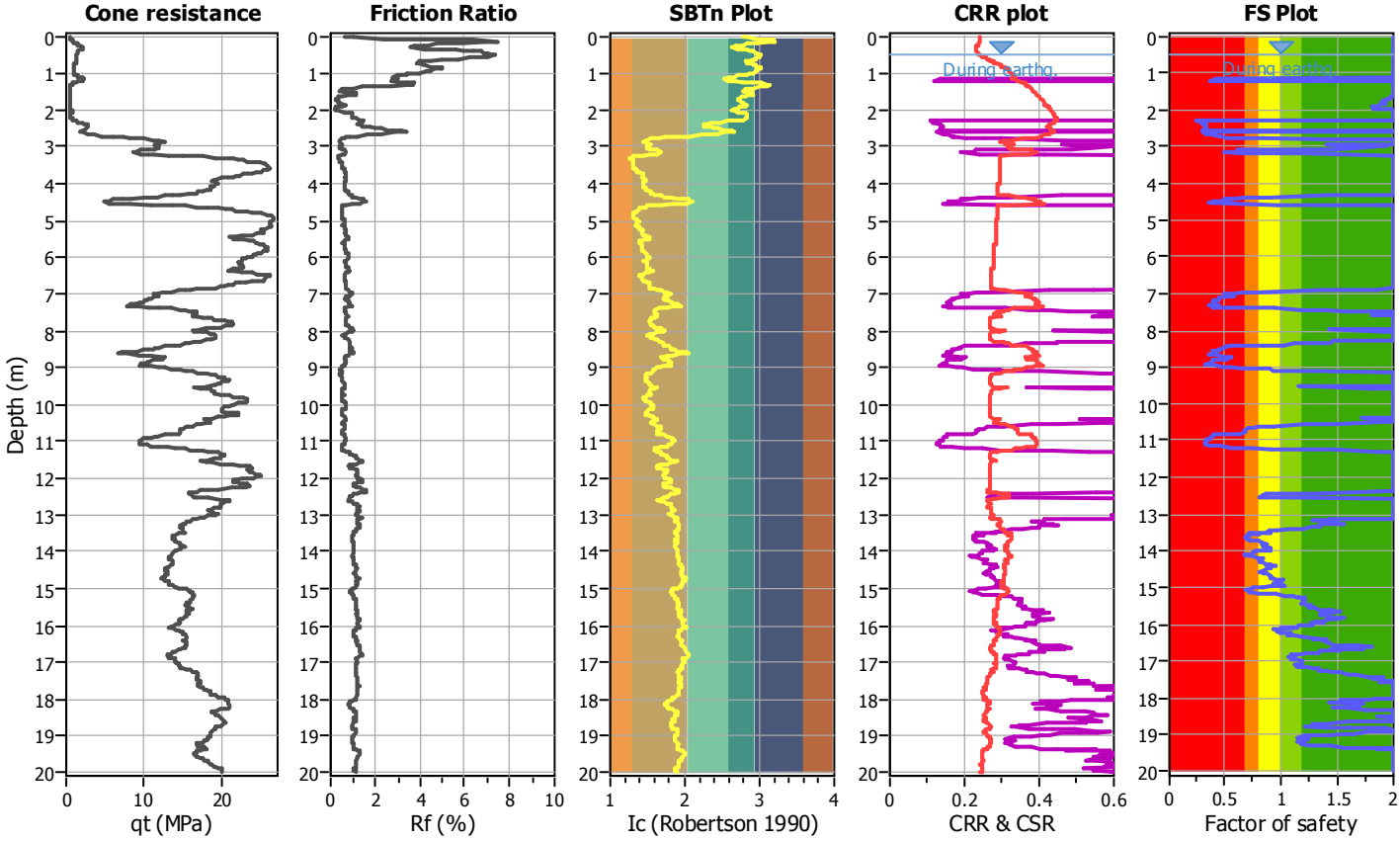
LIQUEFACTION ANALYSIS REPORT

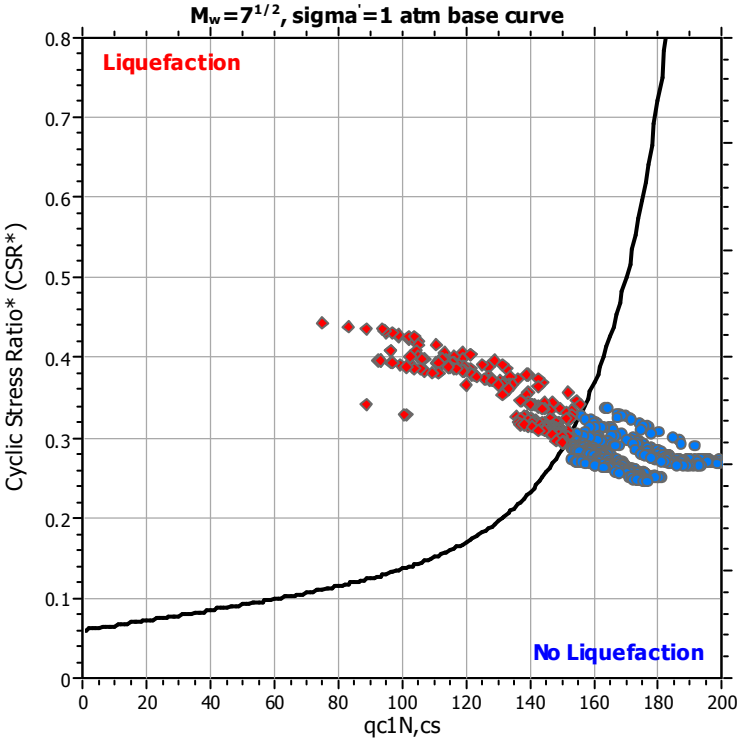
Project title : 47465 - ULS **Location : 23 & 45 Keepa Rd, Whakatane**

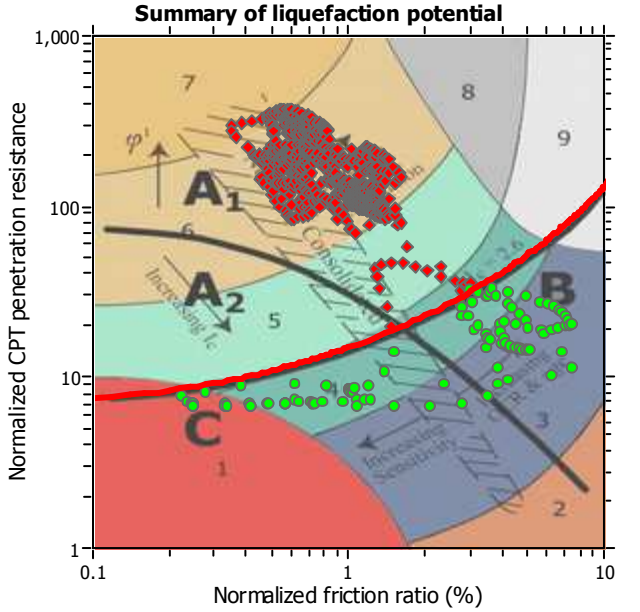
CPT file : CPT08

Input parameters and analysis data

Analysis method:	B&I (2014)	G.W.T. (in-situ):	1.45 m	Use fill:	No	Clay like behavior applied:	Sand & Clay
Fines correction method:	B&I (2014)	G.W.T. (earthq.):	0.50 m	Fill height:	N/A	Limit depth applied:	No
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth:	N/A
Earthquake magnitude M_w:	6.10	Ic cut-off value:	2.60	Trans. detect. applied:	No	MSF method:	Method
Peak ground acceleration:	0.44	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		

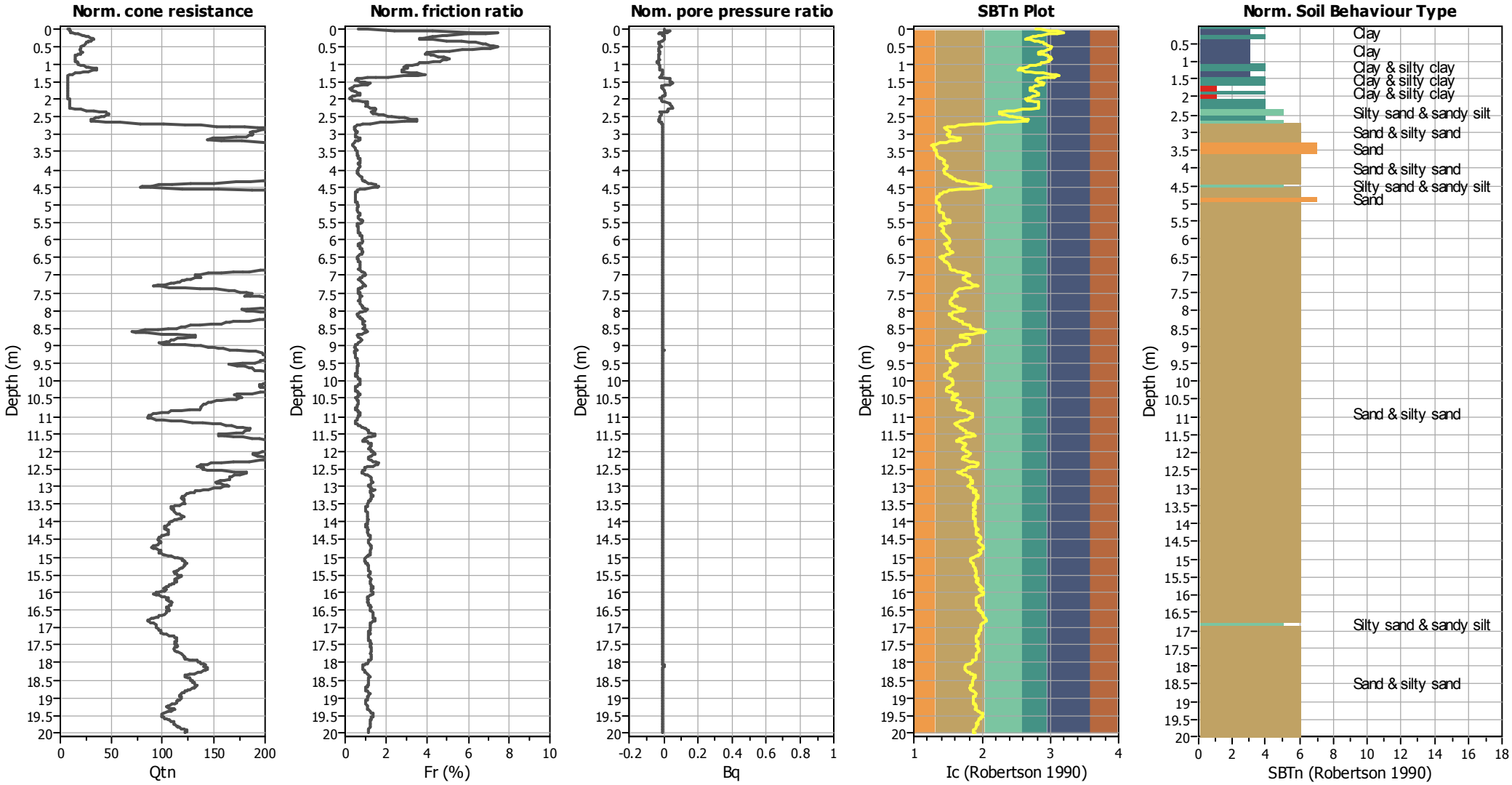






Zone A_1: Cyclic liquefaction likely depending on size and duration of cyclic loading
Zone A_2: Cyclic liquefaction and strength loss likely depending on loading and ground geometry
Zone B: Liquefaction and post-earthquake strength loss unlikely, check cyclic softening
Zone C: Cyclic liquefaction and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

CPT basic interpretation plots (normalized)



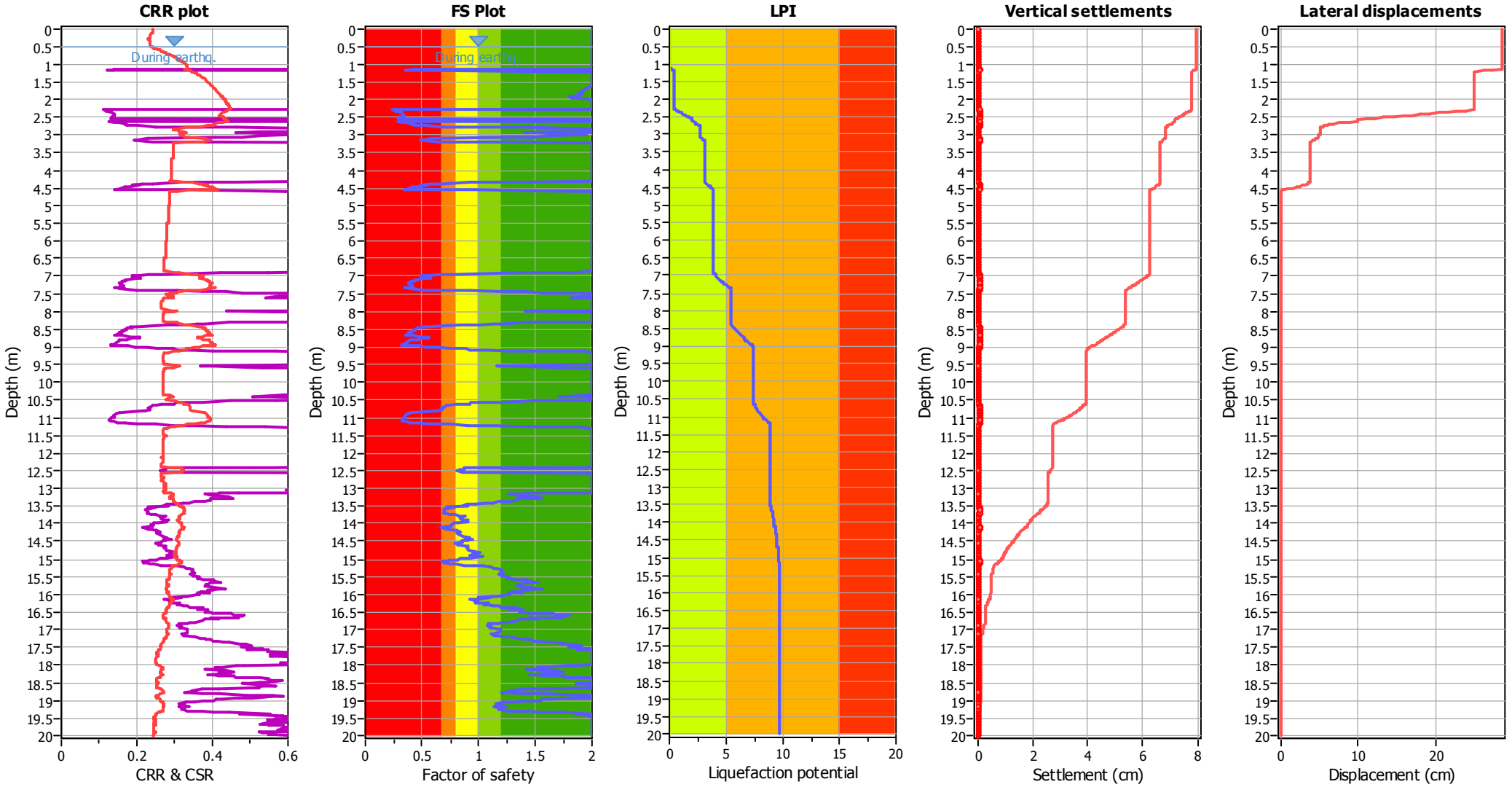
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	0.50 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.10	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.44	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	1.45 m	Fill height:	N/A	Limit depth:	N/A

SBTn legend

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

Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	0.50 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.10	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.44	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	1.45 m	Fill height:	N/A	Limit depth:	N/A

F.S. color scheme

- Almost certain it will liquefy
- Very likely to liquefy
- Liquefaction and no liq. are equally likely
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LPI color scheme

- Very high risk
- High risk
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