

Before an Independent Hearings Panel  
Appointed by Waimakariri District Council

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*under:* the Resource Management Act 1991

*in the matter of:* Submissions and further submissions on the Proposed  
Waimakariri District Plan and Variation 1

*and:* Hearing Stream 12: Rezoning requests (larger scale)

*and:* **Crichton Developments Limited**  
(Submitter 299)

Statement of evidence of Chris Thompson (Geotech) on behalf of  
Crichton Developments Limited in relation to Gladstone Road  
rezoning request

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Dated: 5 March 2024

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## **STATEMENT OF EVIDENCE OF CHRIS THOMPSON ON BEHALF OF CRICHTON DEVELOPMENTS LIMITED**

### **INTRODUCTION**

- 1 My full name is Christopher Samuel Thompson.
- 2 I hold a Bachelor of Science (Technology) degree and am a member of Engineering New Zealand and the New Zealand Geotechnical Society. I have over 15 years of geotechnical consulting experience. During this time, I have held positions at Foundation Engineering Consultants (Graduate Geologist and Engineering Geologist), Balfour Beatty Ground Engineering (Contracts Engineer) and Coffey / Tetra Tech Coffey (Engineering Geologist to Associate Engineering Geologist).
- 3 I have undertaken a wide range of geotechnical consulting work in New Zealand, Australia and England, including design and construction monitoring for many subdivisions and developments in the Canterbury region and across New Zealand. I have also worked on large infrastructure projects at Lyttelton Port and Kawarau Falls Bridge in Queenstown. In these projects I have carried out geotechnical hazard assessments for settlement (both liquefaction induced and static) and slope stability.

### **CODE OF CONDUCT**

- 2 Although this is not an Environment Court hearing, I note that in preparing my evidence I have reviewed the Code of Conduct for Expert Witnesses contained in Part 9 of the Environment Court Practice Note 2023. I have complied with it in preparing my evidence. I confirm that the issues addressed in this statement of evidence are within my area of expertise, except where relying on the opinion or evidence of other witnesses. I have not omitted to consider material facts known to me that might alter or detract from the opinions expressed.

### **SCOPE OF EVIDENCE**

- 3 I have been asked to comment on the relief sought by Crichton Developments Limited (*Submitter 299*) in relation to the proposed Waimakariri District Plan (*Proposed Plan*). Specifically, the request to rezone land at 145-167 Gladstone Road (*Site*), Woodend to Large Lot Residential Zone (*the Proposal*).
- 4 My evidence will address:
  - 4.1 The geotechnical aspects of the Site and existing environment.

## **SUMMARY OF EVIDENCE**

- 5 Crichton Developments Ltd engaged Tetra Tech Coffey (NZ) Limited to carry out a geotechnical investigation and assessment of suitability for the Proposal, near Woodend, Canterbury. I am the Project Manager for the geotechnical investigation and design for this site.
- 6 The site investigations and preliminary liquefaction assessment indicates that the site is predominantly TC1-like. Other geotechnical hazards (static settlement, erosion, slippage and inundation) are considered low risk with appropriate future engineering design.
- 7 The geotechnical assessment has considered the items required by Section 106 of the Resource Management Act. In our opinion the Site is considered geotechnically suitable for rezoning and future subdivision. Further investigations and design will be carried out at the subdivision consent stage which is (or would be) typical for a residential subdivision.

## **EVIDENCE**

- 8 My evidence for this rezoning request remains the same as the geotechnical report and I will not repeat its contents here. Instead, I refer to this report which is attached as **Appendix 1** to this evidence.

## **CONCLUSION**

- 9 From a geotechnical perspective, the Proposal is considered low risk (TC1-like for foundation design) due to the dense underlying sand and gravel deposits and the ability to design future structures to cope with the seismic and static settlement demands.

Dated: 5 March 2024

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Chris Thompson

# 145 & 167 Gladstone Road Plan Change

## Geotechnical Assessment Report

Crichton Development Group Limited



Reference: 773-CHCGE332958

20 December 2023

# 145 & 167 GLADSTONE ROAD PLAN CHANGE

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Geotechnical Assessment Report

**Report reference number: 773-CHCGE332958**

20 December 2023

## PREPARED FOR

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## 1. INTRODUCTION AND SCOPE

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Inovo Projects Limited, on behalf of Crichton Development Group Limited (client), has engaged Tetra Tech Coffey (NZ) Limited (Tetra Tech Coffey) to provide geotechnical services for the proposed plan change and future subdivision, with consideration of Section 106 of the Resource Management Act (RMA), of 145 & 167 Gladstone Road, Woodend. The client is seeking a land use change from Rural Lifestyle Zone (existing) to Large Lot Residential Zone (LLRZ).

Our scope of work is as follows:

1. Geotechnical desktop study.
2. Shallow ground investigation to consist of four hand auger boreholes (HA) with accompanying dynamic cone penetration (DCP) tests to 2.0 metres below ground level (mbgl) or refusal. This also includes the installation of piezometers at selected locations for groundwater monitoring.
3. Deep ground investigation comprising eight cone penetrometer tests (CPT) to 20.0mbgl or refusal.
4. Geotechnical hazard and liquefaction assessment for equivalent technical category designation.
5. Geotechnical assessment report suitable to support the plan change application.

## 2. SITE DETAILS

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The property located at 145 & 167 Gladstone Road, known as Lot 1-2 DP 29099, spans approximately 20.7 hectares (Ha) and is situated at the southeastern boundary of the Woodend township (Figure 1). It is bordered by Gladstone Road to the north and rural greenfield land to the east and south. The topography of the site is predominantly flat, although there is a terrace in the western section that sits approximately 2.5 – 3.0 meters (m) higher than the eastern portion. Presently, there is a single dwelling with a detached garage and sheds on 145 Gladstone Road, along with a barn shed utilized for stockfeed storage on 167 Gladstone Road. The current purpose of the site is for grazing.





Figure 1: Proposed plan change area (red)

### 3. DESKTOP STUDY

To gain a comprehensive understanding of the site, Tetra Tech Coffey conducted a desktop study. This study involved reviewing various sources of information, including the New Zealand Geotechnical Database (NZGD), the Waimakariri District Council website, the Environment Canterbury well search (ECan), and other publicly accessible sources that are relevant to the subject site. The information gathered from these sources is as follows:

### 3.1 EXISTING GEOTECHNICAL INVESTIGATION DATA

The existing investigation data is summarized in Table 1. Specific test locations can be found in Appendix A, and for a summary of the tests, Appendix B.

**Table 1: NZGD and ECan Well search data summary**

Source	Reference	Termination depth (mbgl)	Reason for termination
NZGD	TP_98789	2.2	Refusal (machine limit)
NZGD	BH_98795	23.9	Target Depth
NZGD	CPT_31513	19.9	Target Depth
ECan	M35/6934	20.5	Target Depth
ECan	M35/18660	23.9	Target Depth
ECan	M35/8677	15.0	Target Depth
ECan	M35/10418	23.5	Target Depth
ECan	M35/18673	2.2	Target Depth
ECan	M35/8679	15.0	Target Depth

### 3.2 CONTAMINATED LAND CONSIDERATIONS

Tetra Tech Coffey has reviewed the ECan Listed Land Use register (LLUR)<sup>1</sup>. It is important to note that the information reviewed does not constitute a full Preliminary Site Investigation (PSI) in accordance with the Resource Management (National Environmental Standard for Assessing and Managing Contaminants in Soil to Protect Human Health) Regulations 2011 (NES). However, the information is considered sufficient to meet the requirements of method 6 (2) of the NES for the identification of a Hazardous Activities and Industries List (HAIL) site.

The LLUR search did not indicate the presence of HAIL on site.

### 3.3 GROUND MOTION

The site is not in an area mapped for ground damage effects as part of the Canterbury Earthquake Sequence response. A report commissioned by ECan<sup>2</sup> mapped the site as being in an area where '*Liquefaction damage is possible*'.

### 3.4 SITE SUBSOIL CLASSIFICATION

In accordance with NZS1170.5, Section 3.1.3, a subsoil classification of "Class D – Deep or soft soil sites" can be assumed for the site.

<sup>1</sup> <https://llur.ecan.govt.nz/home>, retrieved September 2023.

<sup>2</sup> ECan (2012), Review of liquefaction hazard information in Eastern Canterbury, including Christchurch City, and parts of Selwyn, Waimakariri and Hurunui Districts, ref. R12/83.

## 4. GROUND INVESTIGATION

Tetra Tech Coffey completed a geotechnical site investigation on 19 September 2023. This consists of four HA boreholes with DCP testing to a maximum target depth of 2.0mbgl and eight CPTs to a maximum target depth of ~20.2mbgl. Additionally, 6.0m standpipe piezometers were installed within CPT\_02 and CPT\_06.

A summary of our on-site investigation is shown in Table 2 below. The test locations are presented on our site plan in Appendix A and the test results in Appendix B.

**Table 2: Tetra Tech Coffey investigation summary**

Reference	Termination depth (mbgl)	Reason for termination
CPT_01	8.2	Refusal in inferred gravel (Qc~40MPa)
CPT_02	11.5	Refusal in inferred gravel (Qc~57MPa)
CPT_03	1.9	Refusal in inferred gravel (Qc~53MPa)
CPT_04	8.6	Refusal in inferred gravel (Qc~40MPa)
CPT_05	9.7	Refusal in inferred gravel (Qc~30MPa)
CPT_06	11.2	Refusal in inferred gravel (Qc~60MPa)
CPT_07	11.9	Refusal in inferred gravel (Qc~65MPa)
CPT_08	20.2	Target Depth (Qc~46MPa)
HA01	1.4	Refusal on gravel
HA02	2.0	Target Depth
HA03	1.1	Refusal on gravel
HA04	2.0	Target Depth

## 5. GROUND MODEL

### 5.1 GEOLOGICAL SETTING

The geological map<sup>3</sup> of the area indicates that the site is underlain by “*Grey river alluvium beneath plains and low level terraces (Q1a)*”.

### 5.2 SUBSURFACE PROFILE

The site has been divided into two distinct subsurface profiles, separated by an east-facing terrace that gradually increases in height to a maximum of approximately 3.0m. Figure 2 illustrates the subsurface conditions for the western portion of the site, while Figure 3 depicts the eastern portion. To present an indicative ground profile, we have calculated an average on-site and nearby CPT trace using the geometric

<sup>3</sup> Forsyth, P.J.; Barrell, D.J.A.; Jongens, R. (compilers) 2008: Geology of the Christchurch area: scale 1:250,000. Lower Hutt: GNS Science. Institute of Geological & Nuclear Sciences 1:250,000 geological map 16. 67 p. + 1 folded map.

mean, which is represented by the red trace. Based on our interpretation, the following is a summary of the subsurface soil profiles.

### 5.2.1 Western portion of the site

- Figure 2 utilises CPT\_01, 06, 07 and 08.
- There is generally a surficial topsoil layer ranging between 0.4 – 0.6m thick.
- From loose sandy material to ~ 2.0mbgl to medium dense silty sand to very stiff sandy silt to depths of up to ~6.0mbgl.
- Dense to very dense sand/gravelly sand between ~6.0 to at least 20.0mbgl
- The presence of a very stiff silt to clayey silt layer between ~16.0 -19.0mbgl.

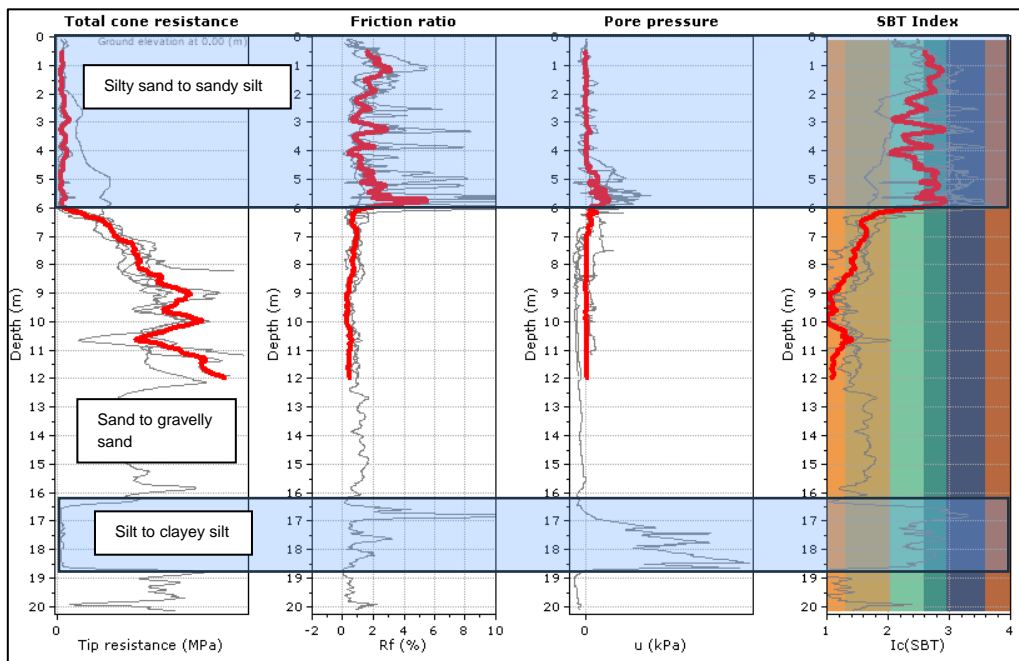


Figure 2: Western portion of the site

### 5.2.2 Eastern portion of the site

- Figure 3 utilises CPT\_02, 03, 04, 08 and 31513.
- There is generally a surficial topsoil layer ranging between 0.3 – 0.5m thick.
- Dense to very dense gravelly silty sand to depths of up to ~4.5mbgl.
- Very stiff silt to clayey silt between ~4.5 – 6.0mbgl.
- Very dense sand/gravelly sand to at least 20.0mbgl with a sandy silt lens between ~16.5 – 18.0mbgl (also present in the western portion of the site).



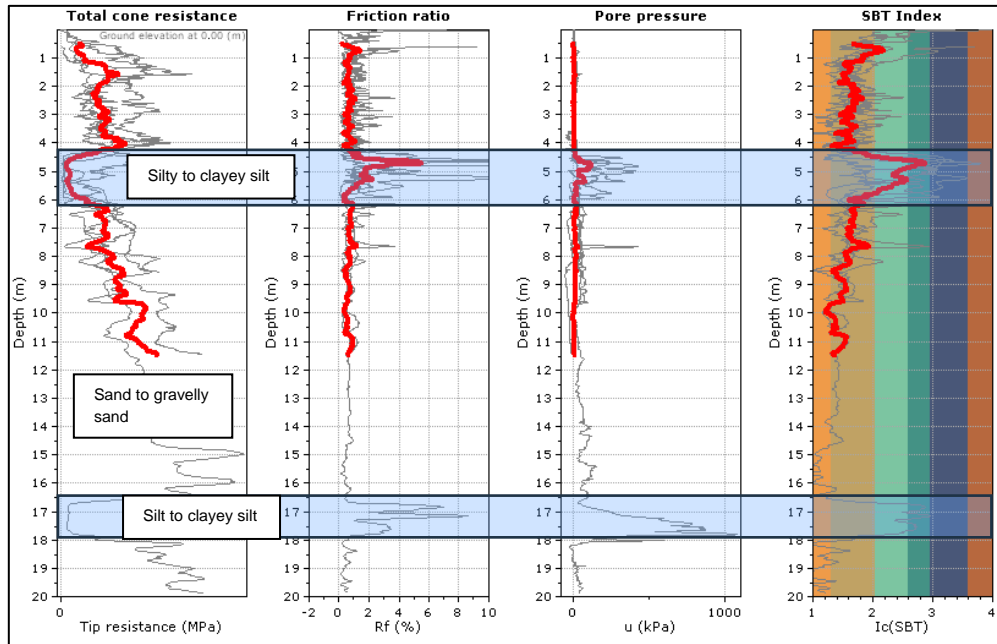


Figure 3: Eastern portion of the site

## 5.3 GROUNDWATER REGIME

Based on our geotechnical investigation and nearby well logs and boreholes, the groundwater regime assessed at the site is as follows:

- Standing groundwater was not encountered in our Tetra Tech Coffey HAs.
- Site-specific CPTs indicate a groundwater level between 2.0mbgl and 5.5mbgl. Deepest groundwater was observed in the southwest of the site and shallowing towards the northwest.
- Standing groundwater was measured within the piezometers at the end of the day in CPT\_02 and CPT\_06 to be 2.5mbgl and 3.6mbgl respectively.
- ECan Well M35/18660 measured groundwater to be at ~5.1mbgl in the month of February 2012.

For analysis purposes, a groundwater level of 2.5mbgl below existing ground surface has been assumed.

## 6. GEOTECHNICAL EVALUATION

### 6.1 LIQUEFACTION TRIGGERING

Tetra Tech Coffey has carried out a liquefaction hazard assessment in accordance with MBIE<sup>Error! Bookmark not defined.</sup> and NZGS Guidelines<sup>4</sup> to assess the liquefaction hazard at the site. Design earthquakes in our assessment were serviceability limit state (SLS);  $M_w=6.0$ ,  $PGA=0.19g$ , SLS:  $M_w=7.5$ ,  $PGA=0.13g$  and ultimate limit state (ULS):  $M_w=7.5$ ,  $PGA=0.35g$ .

Based on our analysis and given that medium dense gravelly sand and very stiff silt to clayey silt, liquefaction susceptibility is considered to be low in future earthquake events. Actual total settlements under SLS or ULS earthquake loading may be greater due to foundation loading. Liquefaction analysis results are presented in Appendix C and summarised in Table 3.

<sup>4</sup> New Zealand Geotechnical Society (NZGS) 2021: Earthquake geotechnical engineering practice Module 3; Identification, assessment and mitigation of liquefaction hazards.

**Table 3: MBIE liquefaction hazard assessment results**

Seismic case	Average free-field settlement (mm), range in brackets	Representative liquefaction severity number (LSN), range in brackets	
<b>SLS (M<sub>w</sub>6.0/0.19g)</b>	~14 (0 to 29)	3 (0 to 6)	<i>Little to no liquefaction expression</i>
<b>SLS (M<sub>w</sub>7.5/0.13g)</b>	~6 (0 to 12)	1 (0 to 2)	<i>Little to no liquefaction expression</i>
<b>ULS (M<sub>w</sub>7.5/0.35g)</b>	~32 (0 to 64)	8 (0 to 16)	<i>Little to no liquefaction expression</i>

## 6.2 LONG-TERM STATIC SETTLEMENT

Static load-induced settlement typically occurs in areas underlain by soft, compressible soils as a result of increase overburden loads. As the site is generally underlain by medium dense to dense sand to sandy gravel, Tetra Tech Coffey considers the potential for static settlement for the site to be low for standard residential construction loads.

## 6.3 LATERAL SPREADING

Given the generally flat topography and lack of continuous liquefiable layers across the site, the risk of lateral spreading within the terrace area is considered to be low.

## 6.4 ASSESSED TECHNICAL CATEGORY

Based on our Tetra Tech Coffey site observations, investigation and analyses, a foundation technical category, as per MBIE, of “TC 1-like” for foundation design is appropriate for the proposed development site.

# 7. ASSESSMENT OF NATURAL HAZARDS AS PER S106 RMA

As per the requirements of Section 106 of the Resource Management Act (RMA) (2017), an assessment of the natural geotechnical hazards that may affect the site has been undertaken. These are summarised in Table 4 below.

Based on our assessment, we consider the site is suitable for a plan change from Rural Lifestyle Zone (existing) to Large Lot Residential Zone (LLRZ).

**Table 4: Natural hazards assessment summary**

Natural Hazard	Assessment
<b>Erosion</b>	No erosion was observed within the exposed east-facing terrace and through the site. The susceptibility to erosion is considered to be low.
<b>Falling debris</b>	Given the sites flat topography and lack of potential sources for falling debris, this is considered to be negligible.
<b>Slippage</b>	The risk of slope failure along the terrace is considered to be low.
<b>Subsidence</b>	Refer to Section 6.
<b>Inundation</b>	Low.

## 8. STATEMENT OF PROFESSIONAL OPINION

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Our assessment has considered the items required by Section 106 of the RMA and in our opinion the site is considered geotechnically suitable for Plan Change and future residential construction. We consider the site is suitable for development subject to further investigation and design at the subdivision consent stage. Additional geotechnical investigation is required to refine the ground model and address any geotechnical risks based on the mapped geology and on-site testing carried out to date, the site is considered TC1-like.

## 9. CLOSURE

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This report has been prepared solely for the use of Crichton Development Group Ltd, their professional advisors and the Waimakariri District Council (WDC) in relation to the specific project described herein. No liability is accepted in respect of its use for any other purpose or by any other person or entity. It is recommended that all other parties seek professional geotechnical advice to satisfy themselves as to its on-going suitability for their intended use.

The subsurface information has been obtained solely from discrete test locations, which by their nature only provide information about a relatively small volume of subsoils, as such, there may be special conditions pertaining to this site which have not been disclosed by the investigation and which have not been taken into account in the report. If variations in the subsoils occur from those described or are assumed to exist, then the matter should be referred back to us immediately.

If you have any queries or you require any further clarification on any aspects of this report, please contact the undersigned.

For and on behalf of Tetra Tech Coffey

Prepared by



**Benjamin Chau**

BSc PMEG

Engineering Geologist

Reviewed and authorised by



**Andreas Giannakogiorgos**

BSc MSc DIC CEngNZ CPEng IntPE (NZ)

Senior Principal Geotechnical Engineer

## IMPORTANT INFORMATION ABOUT YOUR TETRA TECH COFFEY REPORT

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As a client of Tetra Tech Coffey you should know that site subsurface conditions cause more construction problems than any other factor. These notes have been prepared by Tetra Tech Coffey to help you interpret and understand the limitations of your report.

### Your report is based on project specific criteria

Your report has been developed on the basis of your unique project specific requirements as understood by Tetra Tech Coffey and applies only to the site investigated. Project criteria typically include the general nature of the project; its size and configuration; the location of any structures on the site; other site improvements; the presence of underground utilities; and the additional risk imposed by scope-of-service limitations imposed by the client. Your report should not be used if there are any changes to the project without first asking Tetra Tech Coffey to assess how factors that changed subsequent to the date of the report affect the report's recommendations. Tetra Tech Coffey cannot accept responsibility for problems that may occur due to changed factors if they are not consulted.

### Subsurface conditions can change

Subsurface conditions are created by natural processes and the activity of man. For example, water levels can vary with time, fill may be placed on a site and pollutants may migrate with time. Because a report is based on conditions which existed at the time of subsurface exploration, decisions should not be based on a report whose adequacy may have been affected by time. Consult Tetra Tech Coffey to be advised how time may have impacted on the project.

### Interpretation of factual data

Site assessment identifies actual subsurface conditions only at those points where samples are taken and when they are taken. Data derived from literature and external data source review, sampling and subsequent laboratory testing are interpreted by geologists, engineers or scientists to provide an opinion about overall site conditions, their likely impact on the proposed development and recommended actions. Actual conditions may differ from those inferred to exist, because no professional, no matter how qualified, can reveal what is hidden by earth, rock and time. The actual interface between materials may be far more gradual or abrupt than assumed based on the facts obtained. Nothing can be done to change the actual site conditions which exist, but steps can be taken to reduce the impact of unexpected conditions. For this reason, owners should retain the services of Tetra Tech Coffey through the development stage, to identify variances, conduct additional tests if required, and recommend solutions to problems encountered on site.

### Your report will only give preliminary recommendations

Your report is based on the assumption that the site conditions as revealed through selective point sampling are indicative of actual conditions throughout an area. This assumption cannot be substantiated until project implementation has commenced and therefore your report recommendations can only be regarded as preliminary. Only Tetra Tech Coffey, who prepared the report, is fully familiar with the background information needed to assess whether or not the report's recommendations are valid and whether or not changes should be considered as the project develops. If another party undertakes the implementation of the recommendations of this report there is a risk that the report will be misinterpreted and Tetra Tech Coffey cannot be held responsible for such misinterpretation.

### Your report is prepared for specific purposes and persons

To avoid misuse of the information contained in your report it is recommended that you confer with Tetra Tech Coffey before passing your report on to another party who may not be familiar with the background and the purpose of the report. Your report should not be applied to any project other than that originally specified at the time the report was issued.



## Interpretation by other design professionals

Costly problems can occur when other design professionals develop their plans based on misinterpretations of a report. To help avoid misinterpretations, retain Tetra Tech Coffey to work with other project design professionals who are affected by the report. Have Tetra Tech Coffey explain the report implications to design professionals affected by them and then review plans and specifications produced to see how they incorporate the report findings.

## Data should not be separated from the report

The report as a whole presents the findings of the site assessment and the report should not be copied in part or altered in any way. Logs, figures, drawings, etc. are customarily included in our reports and are developed by scientists, engineers or geologists based on their interpretation of field logs (assembled by field personnel) and laboratory evaluation of field samples. These logs etc. should not under any circumstances be redrawn for inclusion in other documents or separated from the report in any way.

## Geoenvironmental concerns are not at issue

Your report is not likely to relate any findings, conclusions, or recommendations about the potential for hazardous materials existing at the site unless specifically required to do so by the client. Specialist equipment, techniques, and personnel are used to perform a geoenvironmental assessment. Contamination can create major health, safety and environmental risks. If you have no information about the potential for your site to be contaminated or create an environmental hazard, you are advised to contact Tetra Tech Coffey for information relating to geoenvironmental issues.

## Rely on Tetra Tech Coffey for additional assistance

Tetra Tech Coffey is familiar with a variety of techniques and approaches that can be used to help reduce risks for all parties to a project, from design to construction. It is common that not all approaches will be necessarily dealt with in your site assessment report due to concepts proposed at that time. As the project progresses through design towards construction, speak with Tetra Tech Coffey to develop alternative approaches to problems that may be of genuine benefit both in time and cost.

## Responsibility

Reporting relies on interpretation of factual information based on judgement and opinion and has a level of uncertainty attached to it, which is far less exact than the design disciplines. This has often resulted in claims being lodged against consultants, which are unfounded. To help prevent this problem, a number of clauses have been developed for use in contracts, reports and other documents. Responsibility clauses do not transfer appropriate liabilities from Tetra Tech Coffey to other parties but are included to identify where Tetra Tech Coffey's responsibilities begin and end. Their use is intended to help all parties involved to recognise their individual responsibilities. Read all documents from Tetra Tech Coffey closely and do not hesitate to ask any questions you may have.

## APPENDIX A: SITE INVESTIGATION PLAN

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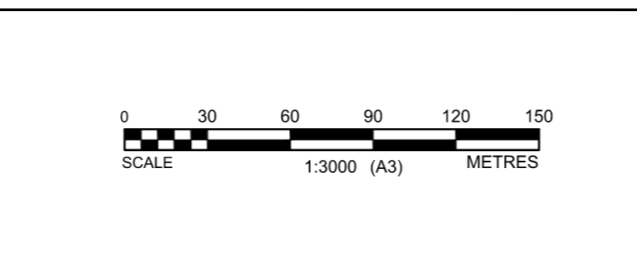




**Legend**

- Tetra Tech Coffey CPT
- NZGD CPT
- Tetra Tech Coffey HA
- NZGD Test pit
- NZGD BH
- ECan Well
- Terrace
- Site boundary

revision	no.	description	drawn	approved	date
	1	Original Issue	BC	CT	16/11/23



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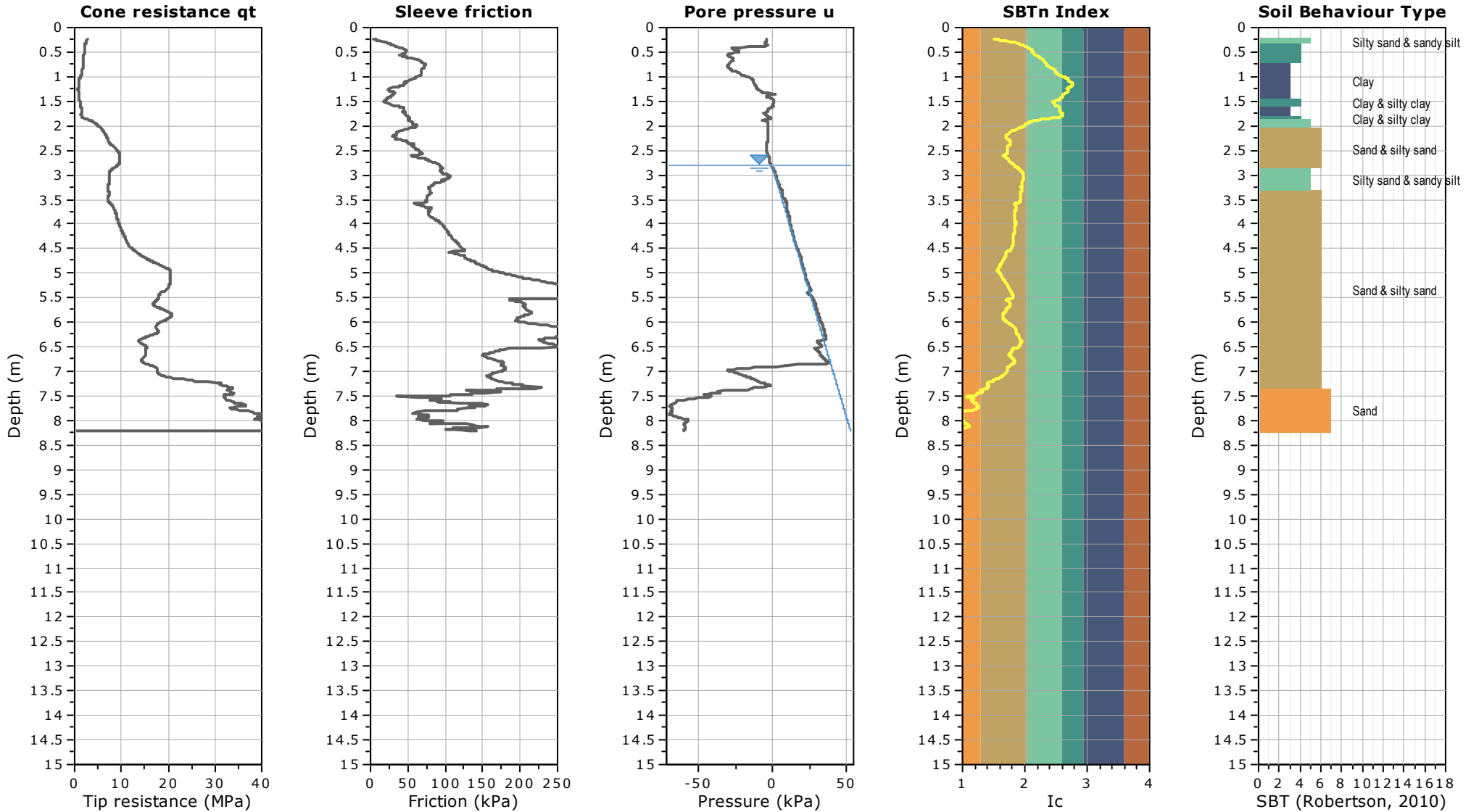
Crichton Development Group Limited		
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title:	Geotechnical Investigation Locations Plan	
project no:	773-CHCGE332958	drawing no: 01
		rev: A

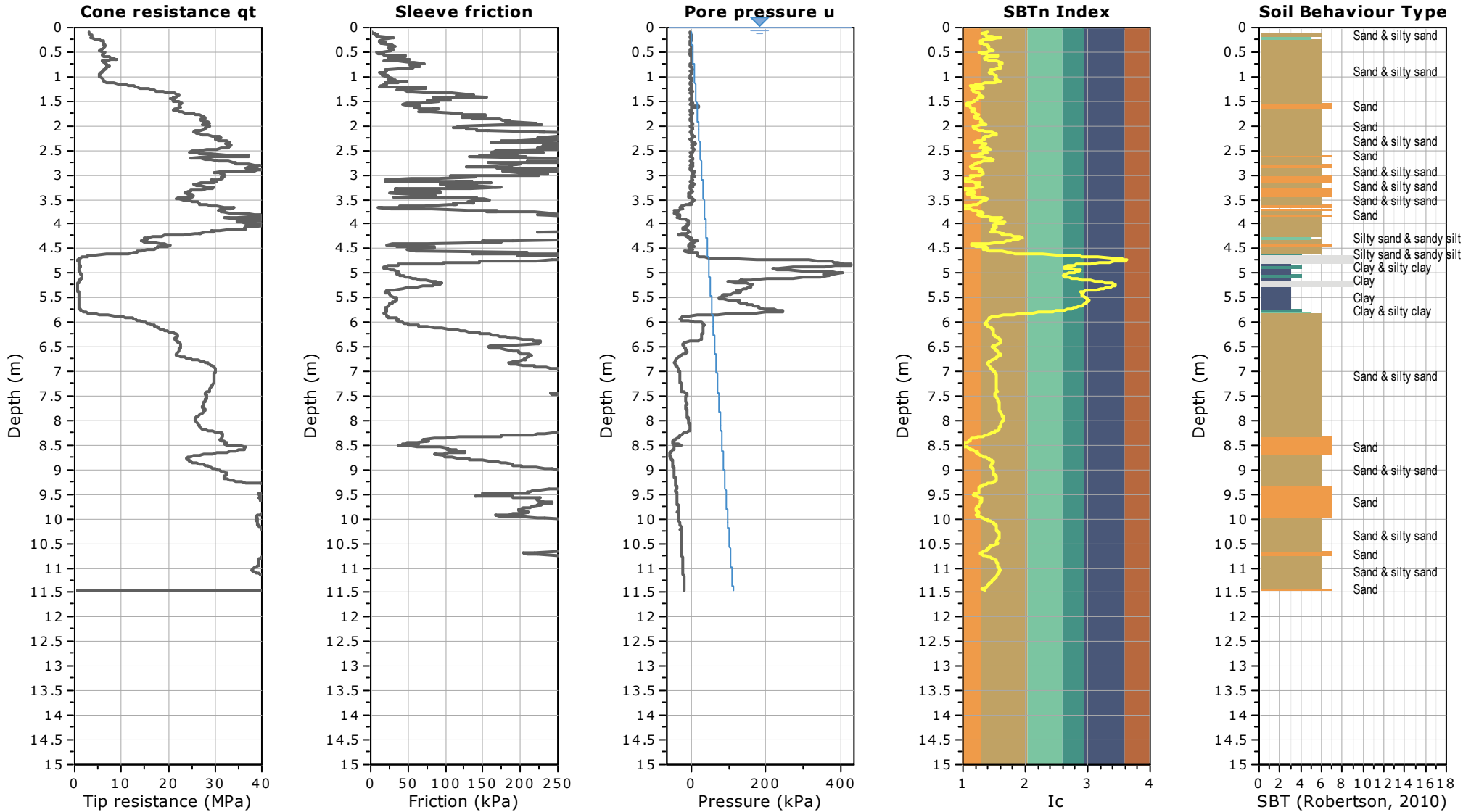
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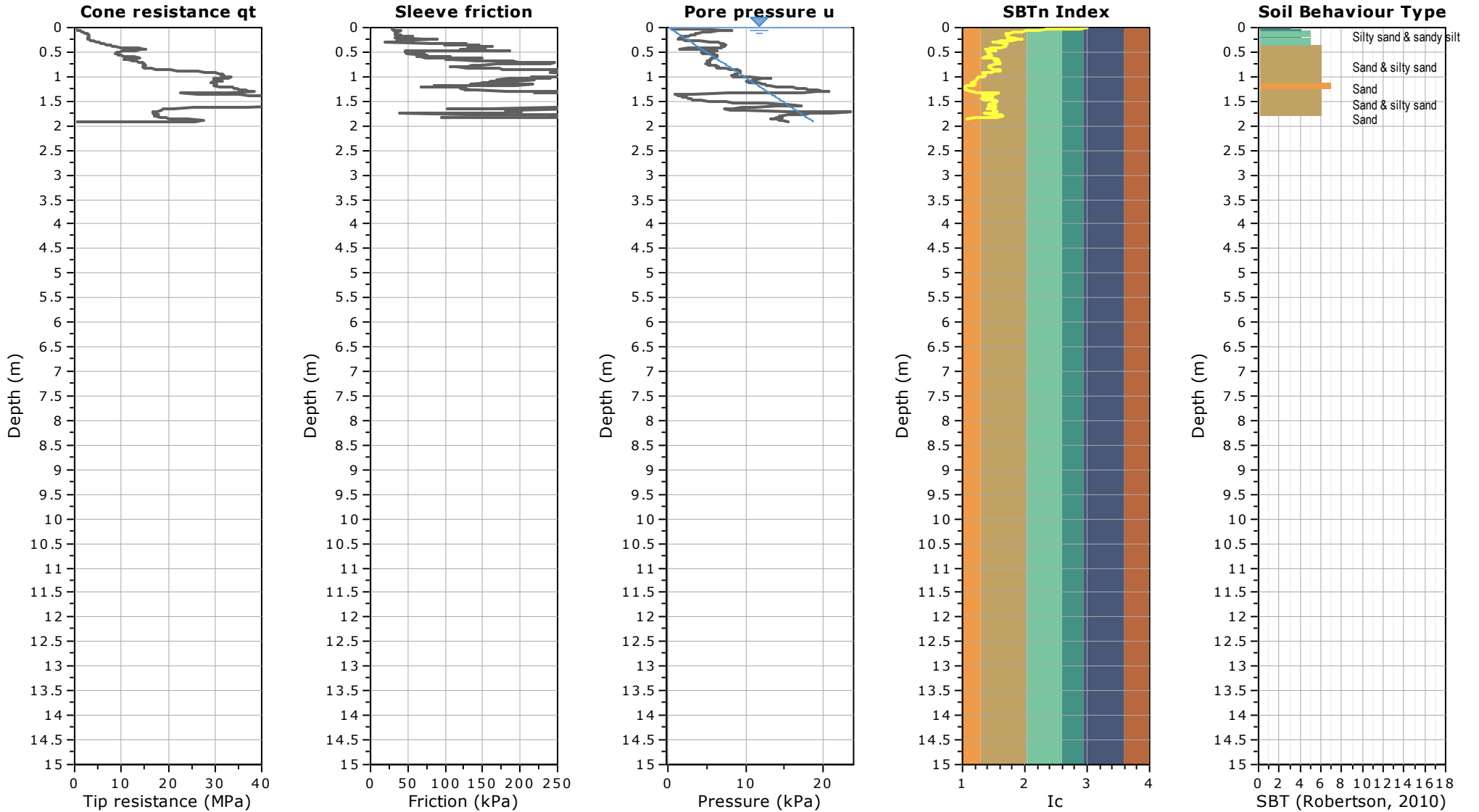


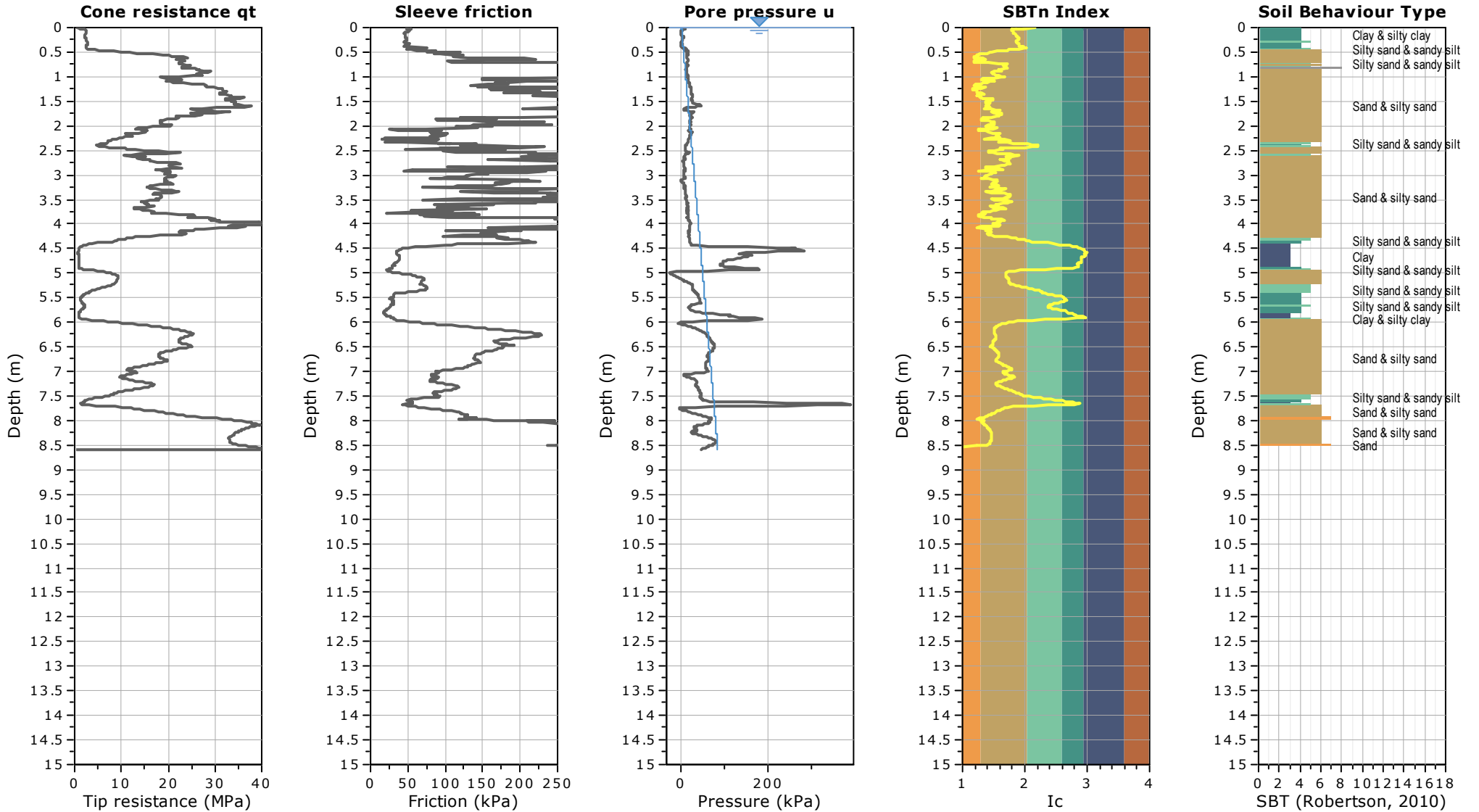
## APPENDIX B: INVESTIGATION DATA

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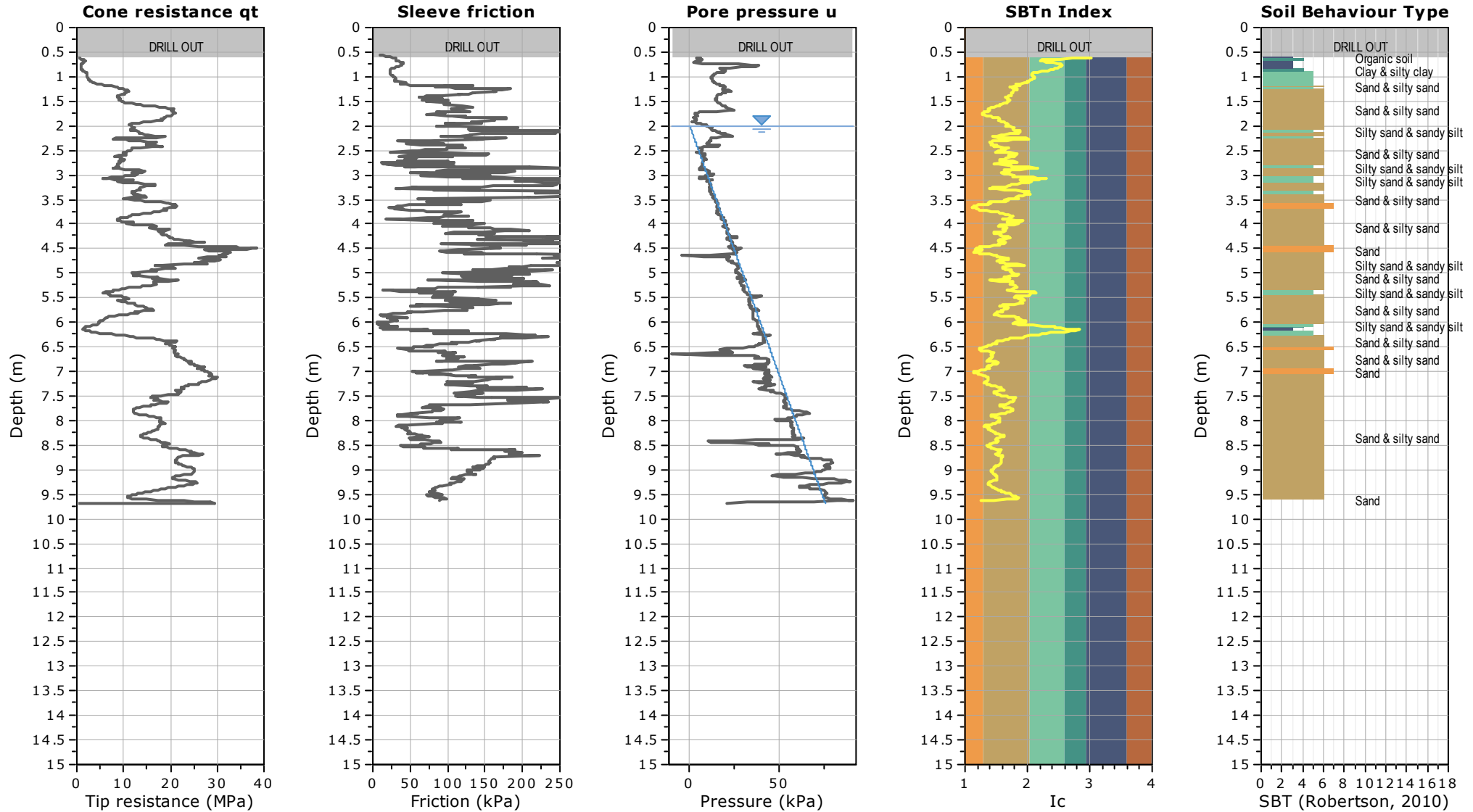


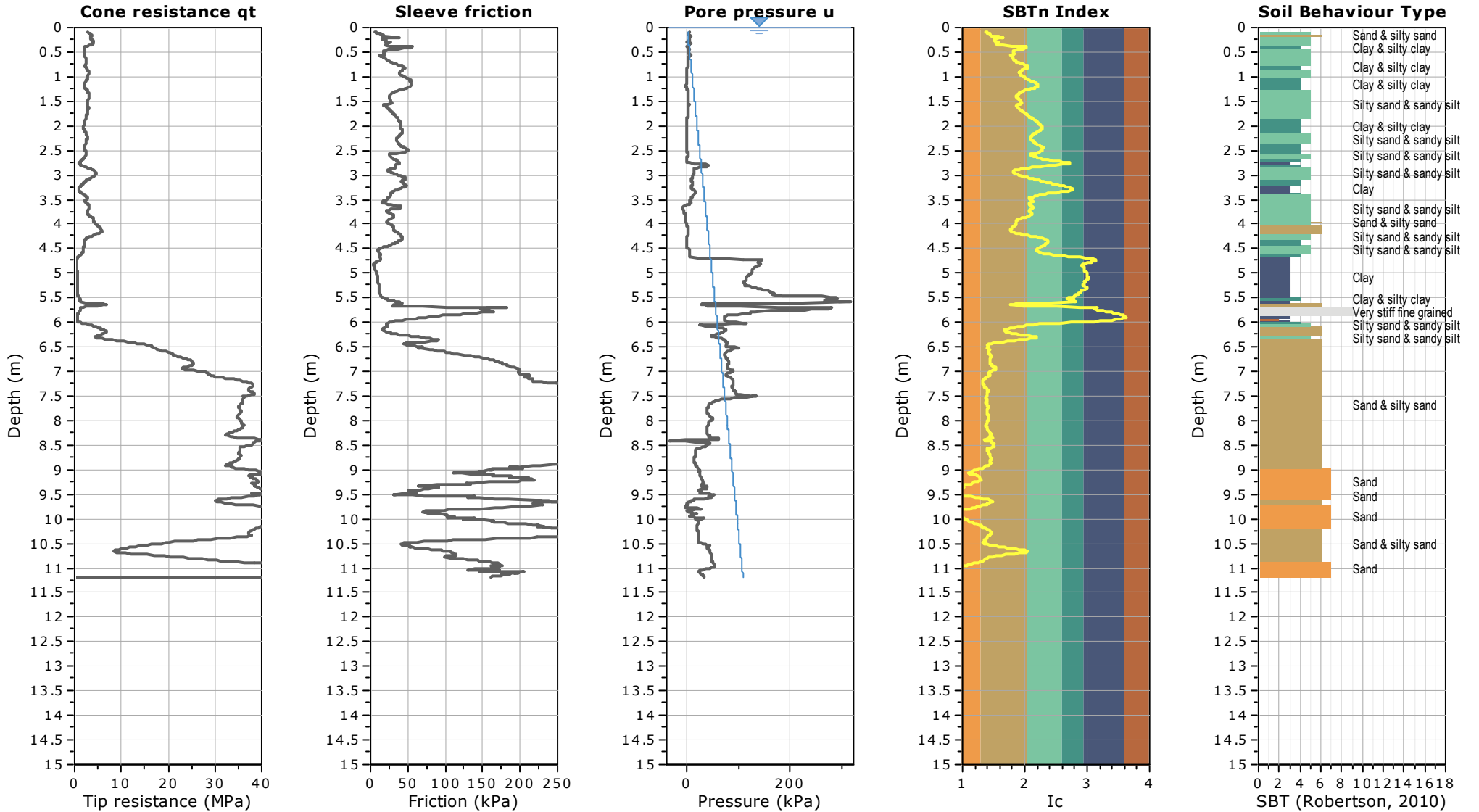


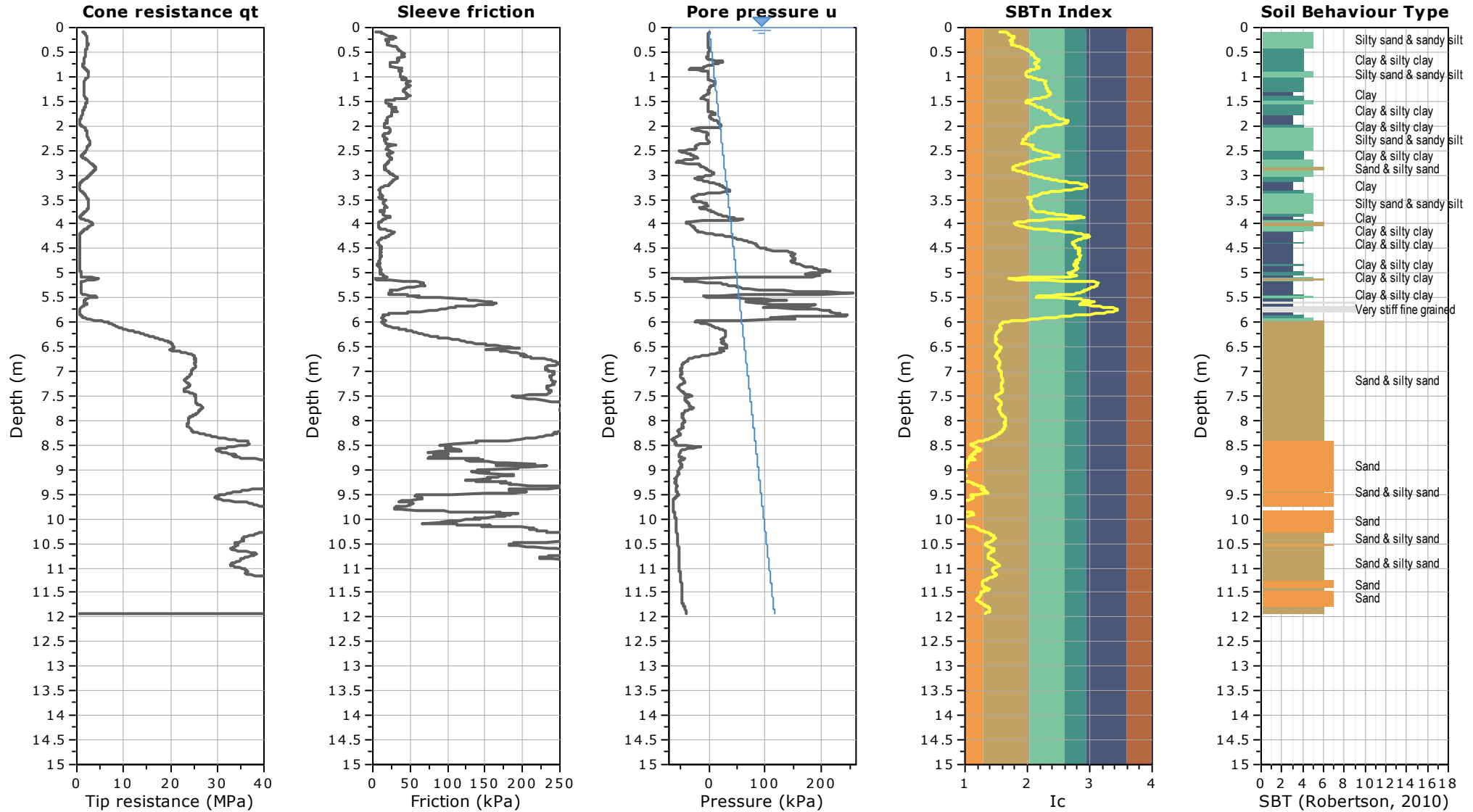


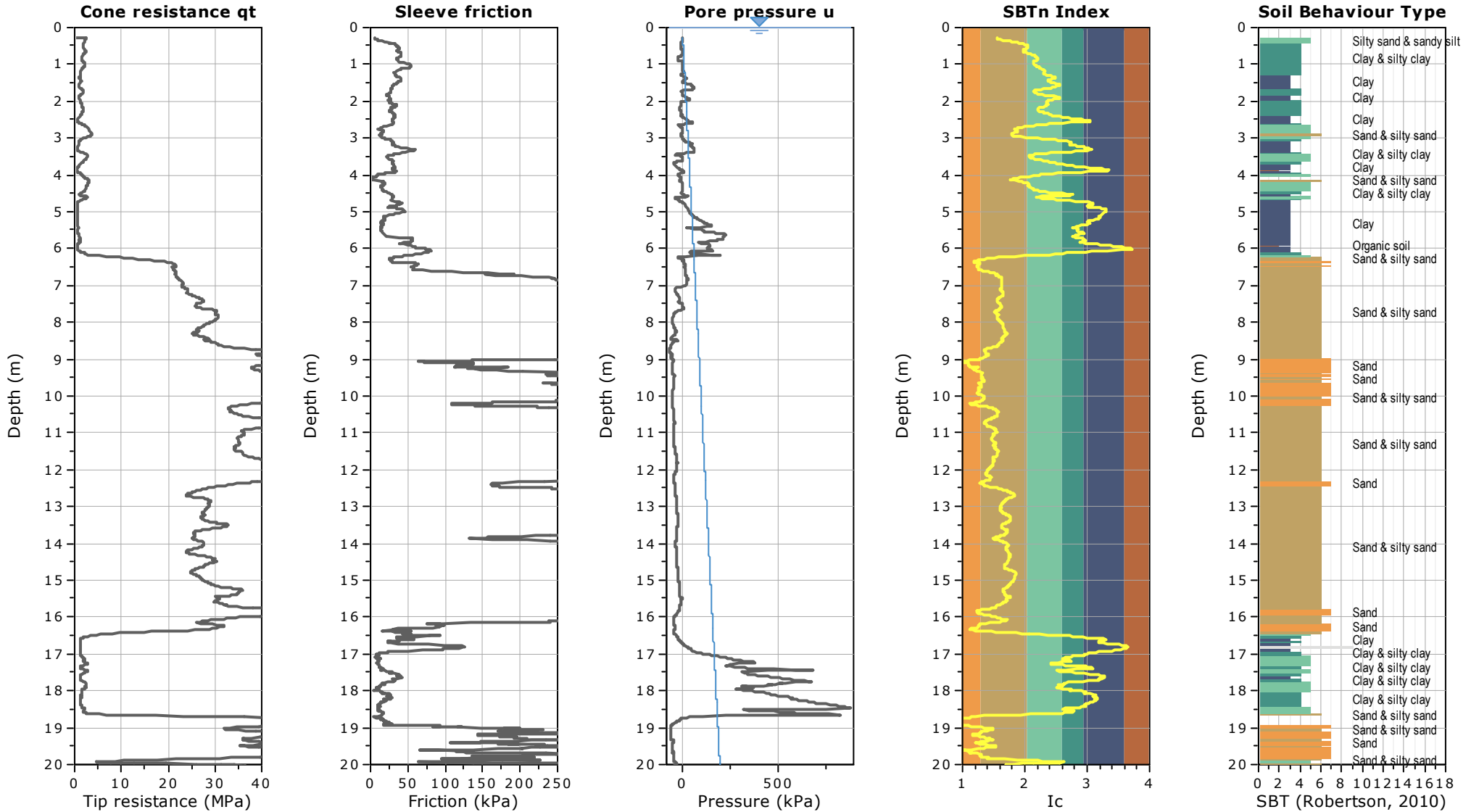













# Engineering Log - Hand Auger


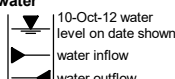
 client: **Crichton Development Group Limited**  
 principal: -  
 project: **145 - 167 Gladstone Road**  
 location: **Woodend, Canterbury**

 Borehole ID: **HA01**  
 sheet: 1 of 1  
 project no. **773-CHCGE332958**  
 date started: **19 Sep 2023**  
 date completed: **19 Sep 2023**  
 logged by: **BC**  
 checked by: **AJ**

 position: Not Specified      surface elevation: Not Specified      angle from horizontal: 90°      DCP id.: -  
 drill model: Hand Auger      drilling fluid: -      hole diameter : 50 mm      vane id.: 1508

drilling information				material substance									
method & support	penetration	water	samples & field tests	RL (m)	depth (m)	graphic log	soil group symbol	material description	moisture condition	consistency / relative density	vane shear (kPa)	DCP (blows/100 mm)	soil origin, structure and additional observations
method & support: 1 HA 2 N 3 Not Encountered	penetration: 1 VS 129/55 kPa 2 Not Encountered 3 Not Encountered	water: Not Encountered	samples & field tests: VS 129/55 kPa	RL (m): 0.5 1.0 1.5 2.0 2.5 3.0 3.5	depth (m): 0.5 1.0 1.5 2.0 2.5 3.0 3.5		ML	<b>SILT:</b> non plastic to low plasticity, brown, with minor to some fine grained sand.	D - M		50 100 150 200	2 4 6 8 10	<b>TOPSOIL</b>
							ML	<b>SILT:</b> non plastic to low plasticity, pale brown-grey, with minor fine grained sand.	VSt			<b>ALLUVIUM</b>	
							SM	<b>Silty SAND:</b> fine grained, pale grey to orange-brown with orange staining.	L - MD				
								1.3 m: with trace of fine grained gravel Hand Auger HA01 terminated at 1.35 m Refusal on gravel					DCP 1.55m: Hammer bouncing

CDF\_0\_10\_00.4\_LIBRARY.GLB rev.CDF\_0\_10\_00.4\_2021-09-30 Log COF BOREHOLE: NON CORED + DCP 773-CHCGE332958 167 GLADSTONE.GPJ &lt;&lt;DrawingFile&gt;&gt; 20/12/2023 11:09

<b>method</b> DT diatube AD auger drilling* AS auger screwing* HA hand auger W washbore RR rock roller  * bit shown by suffix e.g. AD/T B blank bit T TC bit V V bit	<b>support</b> M mud      N nil C casing  <b>penetration</b>  <b>water</b> 	<b>samples &amp; field tests</b> B bulk disturbed sample D disturbed sample E environmental sample SS split spoon sample U## undisturbed sample ##mm diameter HP hand penetrometer (kPa) N standard penetration test (SPT) N* SPT - sample recovered Nc SPT with solid cone VS vane shear; peak/remoulded (kPa) R refusal HB hammer bouncing	<b>soil group symbol &amp; material description</b> based on AS 1726:2017  <b>moisture condition</b> D dry M moist W wet S saturated Wp plastic limit Wl liquid limit	<b>consistency / relative density</b> VS very soft S soft F firm St stiff VSt very stiff H hard Fb friable VL very loose L loose MD medium dense D dense VD very dense
--	--	--	--	--





# Engineering Log - Hand Auger

 client: **Crichton Development Group Limited**

principal: -

 project: **145 - 167 Gladstone Road**

 location: **Woodend, Canterbury**

 Borehole ID: **HA04**

sheet: 1 of 1

 project no. **773-CHCGE332958**

 date started: **19 Sep 2023**

 date completed: **19 Sep 2023**

 logged by: **BC**

 checked by: **AJ**

 position: Not Specified      surface elevation: Not Specified      angle from horizontal: 90°      DCP id.: -  
 drill model: Hand Auger      drilling fluid: -      hole diameter : 50 mm      vane id.: 1508

drilling information				material substance									
method & support	penetration	water	samples & field tests	RL (m)	depth (m)	graphic log	soil group symbol	material description	moisture condition	consistency / relative density	vane shear (kPa)	DCP (blows/100 mm)	soil origin, structure and additional observations
HA	N	Not Encountered			0.5		SM	<b>Silty SAND:</b> fine grained, pale brown, with trace of fine grained gravel.	D - M				TOPSOIL
					1.0		SP	<b>SAND:</b> fine grained, pale yellow-brown with orange mottling, and minor to some silt.	L				
					2.0			Hand Auger HA04 terminated at 2.0 m Target depth					

<b>method</b> DT diatube AD auger drilling* AS auger screwing* HA hand auger W washbore RR rock roller  * bit shown by suffix e.g. AD/T B blank bit T TC bit V V bit	<b>support</b> M mud      N nil C casing  <b>penetration</b>  <b>water</b> 	<b>samples &amp; field tests</b> B bulk disturbed sample D disturbed sample E environmental sample SS split spoon sample U## undisturbed sample ##mm diameter HP hand penetrometer (kPa) N standard penetration test (SPT) N* SPT - sample recovered Nc SPT with solid cone VS vane shear; peak/remoulded (kPa) R refusal HB hammer bouncing	<b>soil group symbol &amp; material description</b> based on AS 1726:2017  <b>moisture condition</b> D dry M moist W wet S saturated Wp plastic limit Wl liquid limit	<b>consistency / relative density</b> VS very soft S soft F firm St stiff VSt very stiff H hard Fb friable VL very loose L loose MD medium dense D dense VD very dense
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CDF\_0\_10\_00\_4\_LIBRARY.GLB rev.CDF\_0\_10\_00\_4\_2021-09-30 Log COF BOREHOLE: NON CORED + DCP 773-CHCGE332958 167 GLADSTONE.GPJ &lt;&lt;DrawingFile&gt;&gt; 20/12/2023 11:09





MWH NEW ZEALAND LTD  
 Hazledean Business Park  
 6 Hazledean Road  
 Christchurch 8024  
 Tel: 03 366 7449  
 Fax: 03 366 7780

### BOREHOLE LOG

Job No: Z1873603

Hole No: BH204

Sheet: 1 of 3

Client: NZTA

Started: 31/01/12

Project: NZTA Woodend Bypass

Finished: 02/02/12

Location: Woodend, Christchurch

Logged: JJ

Hole Location Refer to: Factual Report

Checked: SBG

Description:

Easting: 2484041m

Northing: 5764868m

Inclination: Vertical

RL Surface:

Diameter (Int/Ext): /

Datum:

Depth (m)	Elevation (m)	Samples	Shear Vane (kPa)	Standard Penetration Tests		Material Description <small>(Logging carried out in accordance with Guidelines for the Field Classification of Soil and Rock for Engineering Purposes. New Zealand Geotechnical Society, 2005)</small>	Length of Run (m)	Total Core Recovery %	Solid Core Recovery %	Graphic Log	Moisture Condition	Groundwater	Other Observations	Installation
				Blows (Seating // 75mm // 150mm, 225mm/300mm)	N Value/ Refusal Data									
0.0						Silty TOPSOIL, dark greyish brown soft (0.3)								
0.3						Clayey SILT, brown very soft (0.7)	1.10	80			dry			
0.7						MISSING (i.e. not recovered)								
1.0				1/1/0/1/1	3	Fine to medium SAND, yellowish brown (1.3)					moist			
1.3						Silty CLAY, brownish grey mottled orange firm, low plasticity (1.8)	1.52	85			moist			
1.8						Silty fine to medium SAND, brown (2.4)					wet			
2.0						Silty CLAY, brownish grey mottled orange firm, low plasticity (2.7)					wet			
2.4				0/0/0/0/0	0	Silty CLAY, with some fine sand, grey very soft (3.7)	1.52	100			wet	9/2 AD1		
2.7						Silty fine to coarse SAND, dark grey (3.85)					wet			
3.0		Tub sample				Silty CLAY, brownish grey very soft (4.7)	0.56	100			wet	1/2 ATD		
3.7		Pushtube sample		0/0/0/0/0	0	Organic SILT, with some clay, dark brown very soft, low plasticity, Fibrous organics (5.5)	0.96	100			moist	1/2 ATD		
4.0						Fine to medium SAND, with trace of medium to coarse gravel, grey (7.18)	1.52	100			saturated	2/2 ATD	Additional water level at time of logging was 4.8m (11/01/2012) (eng's, m) (2/02/2012)	
4.7		Bulk sample		5/4/6/6/6	22									
5.0														
5.5														
6.0														
6.0														
7.0														
7.18				8/4/4/4/4	16	Fine to coarse GRAVEL, with minor coarse sand, dark grey	1.52	100						
8.0														
8.0														
9.0		Bulk sample		9//10/11/12/14	47	Silty fine to coarse GRAVEL, with minor fine to coarse sand, brownish grey (9)	1.52	100			saturated			
9.0														
9.9														
9.9														

Drilling Method: Rotary-percussion  
 Contractor: McMillans  
 Equipment Type: Geoprobe 8140LS Sonic

Casing:  
 Flush:

Remarks:  
 Borehole Completion:



MWH NEW ZEALAND LTD  
 Hazledean Business Park  
 6 Hazledean Road  
 Christchurch 8024  
 Tel: 03 366 7449  
 Fax: 03 366 7780

### BOREHOLE LOG

Job No: Z1873603

Hole No: BH204

Sheet: 2 of 3

Client: NZTA

Started: 31/01/12

Project: NZTA Woodend Bypass

Finished: 02/02/12

Location: Woodend, Christchurch

Logged: JJ

Hole Location Refer to: Factual Report  
 Description:

Checked: SBG

Easting: 2484041m      Northing: 5764868m      Inclination: Vertical

RL Surface:

Diameter (Int/Ext): /

Datum:

Depth (m)	Elevation (m)	Samples Type	Shear Vane (kPa) Peak Strength/ Residual Strength	Standard Penetration Tests		Material Description  (Logging carried out in accordance with Guidelines for the Field Classification of Soil and Rock for Engineering Purposes. New Zealand Geotechnical Society, 2005)	Length of Run (m)	Total Core Recovery %	Solid Core Recovery %	Graphic Log	Moisture Condition	Groundwater	Other Observations	Installation
				Blows (Seating // 75mm/150mm, 225mm/300mm)	N Value/ Refusal Data									
11.0				13//7/8/9/8	32	Silty fine to medium SAND, with minor fine gravel, light brownish grey Bands of sandy fine gravel at 10.7 - 10.8m and 11.5 - 11.6m[ <i>continued</i> ]	1.52	100						
						(11.6)								
12.0		Bulk sample		10//7/7/9/11	34	Silty fine to coarse SAND, with trace of fine gravel, grey Predominantly fine sand	1.52	100						
13.0														
14.0				50//	50/ 150mm	Band of sandy fine gravel with some silt 13.4 - 13.55m	1.52	100			saturated			
15.0				11//6/10/10/20	46		1.52	50						
16.0						(16.1)								
17.0				13//13/14/15/19	50+	Silty medium to coarse GRAVEL, with trace of fine sand, grey								
						(16.3)								
17.0						Silty CLAY, with minor fine sand, grey hard	1.52	55			wet			
						(17.4)								
18.0				24//13/13/11/13	50	Silty fine to coarse GRAVEL, with some fine to medium sand, with trace of fine to medium cobbles, grey with some brown lenses	1.52	75			saturated			
19.0				28//14/10/11/12	47									

26/03/12 MWH NEW ZEALAND LTD, Project: Z1873603, NZTA Woodend Bypass, Woodend, Christchurch www.mwhglobal.com/nz

Drilling Method: Rotary-percussion  
 Contractor: McMillans  
 Equipment Type: Geoprobe 8140LS Sonic

Casing: \_\_\_\_\_  
 Flush: \_\_\_\_\_

Remarks: Borehole Completion: \_\_\_\_\_



MWH NEW ZEALAND LTD  
 Hazledean Business Park  
 6 Hazledean Road  
 Christchurch 8024  
 Tel: 03 366 7449  
 Fax: 03 366 7780

**BOREHOLE LOG**

Job No: Z1873603

Hole No: BH204

Sheet: 3 of 3

Client: NZTA

Started: 31/01/12

Project: NZTA Woodend Bypass  
 Location: Woodend, Christchurch

Finished: 02/02/12

Hole Location Refer to: Factual Report  
 Description:

Logged: JJ

Checked: SBG

Easting: 2484041m      Northing: 5764868m      Inclination: Vertical

RL Surface:

Diameter (Int/Ext): /

Datum:

Depth (m)	Elevation (m)	Samples		Shear Vane (kPa)	Standard Penetration Tests		Material Description  (Logging carried out in accordance with Guidelines for the Field Classification of Soil and Rock for Engineering Purposes. New Zealand Geotechnical Society, 2005)	Length of Run (m)	Total Core Recovery %	Solid Core Recovery %	Graphic Log	Moisture Condition	Groundwater	Other Observations	Installation
		Type	Peak Strength/Residual Strength		Blows (Seating // 75mm/150mm, 225mm/300mm)	N Value/Refusal Data									
		Bulk sample					Silty fine to coarse GRAVEL, with some fine to medium sand, with trace of fine to medium cobbles, grey with some brown lenses[continued]	1.50	100			saturated			
21.0					26//11/11/12/15	49									
22.0								1.54	80						
23.0					37//28	50+/ 225mm		1.52	80						
							(23.9)								
24.0							Borehole terminated at 23.9m due to Target Depth								
					27//15/15/15/11	50+									
25.0															
26.0															
27.0															
28.0															
29.0															

Drilling Method: **Rotary-percussion**  
 Contractor: **McMillans**  
 Equipment Type: **Geoprobe 8140LS Sonic**

Casing: \_\_\_\_\_  
 Flush: \_\_\_\_\_

Remarks:  
 Borehole Completion:

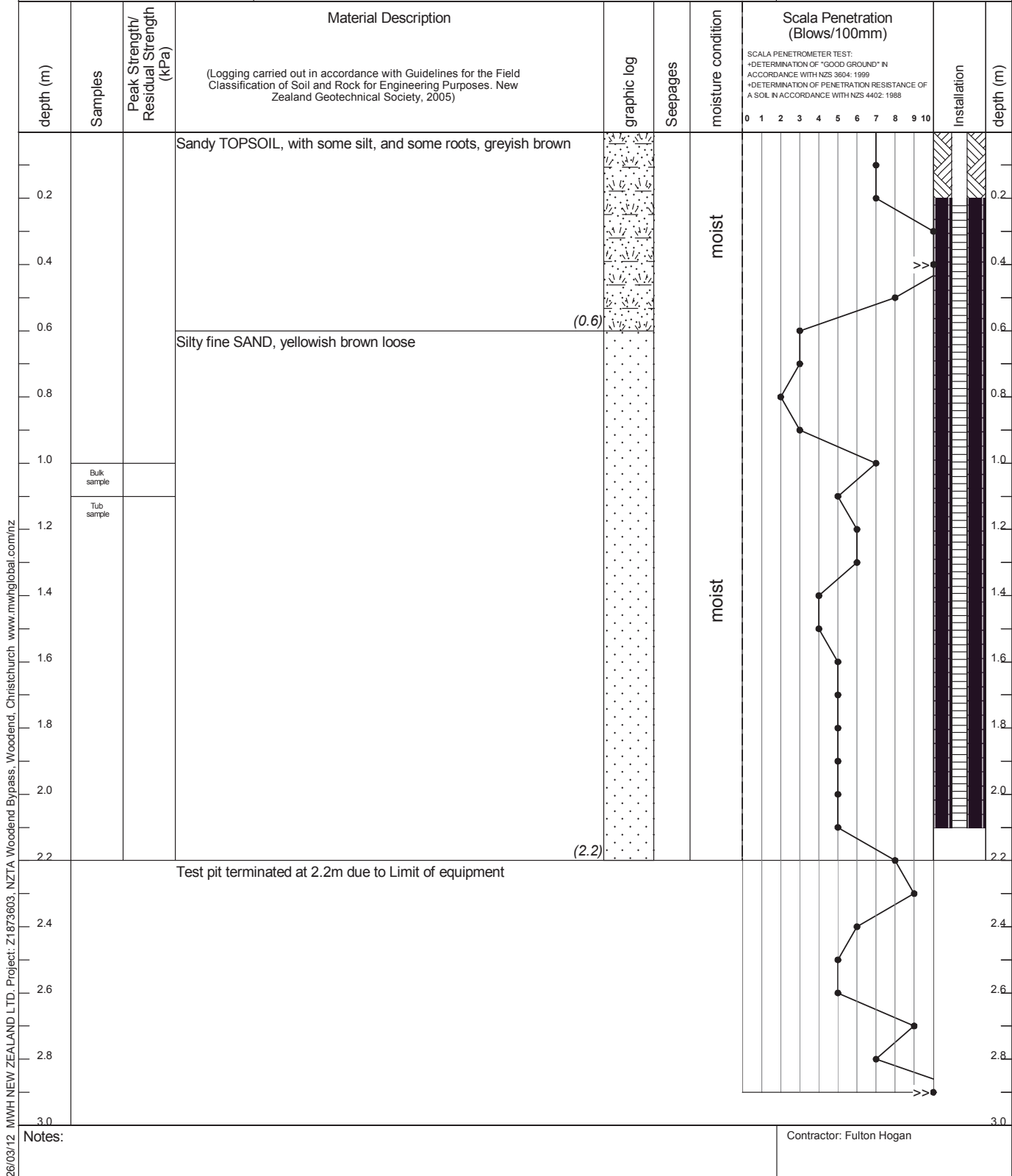
26/03/12 MWH NEW ZEALAND LTD. Project: Z1873603, NZTA Woodend Bypass, Woodend, Christchurch www.mwhglobal.com/nz



# TEST PIT LOG

MWH NEW ZEALAND LTD  
 Hazledean Business Park  
 6 Hazledean Road  
 Christchurch 8024  
 Tel: 03 366 7449  
 Fax: 03 366 7780

Client: NZTA	Job No: Z1873603
Project: NZTA Woodend Bypass	Hole No: TP123
Location: Woodend, Christchurch	Sheet: 1 of 1
Test Pit Location Refer to: Factual Report Description:	Started: 08/12/11
Equipment Type: 5.5ton Wheeled Excavator	Finished: 08/12/11
Easting: 2484181m Northing: 5764432m	Logged: JJ
	Checked: SBG
	RL Surface:
	Datum:



26/03/12 MWH NEW ZEALAND LTD, Project: Z1873603, NZTA Woodend Bypass, Woodend, Christchurch www.mwhglobal.com/nz

Notes: Contractor: Fulton Hogan

# Borelog for well M35/6934

Grid Reference (NZTM): 1573878 mE, 5203129 mN

Location Accuracy: 50 - 300m

Ground Level Altitude: 7.1 m +MSD Accuracy: < 2.5 m

Driller: McMillan Drilling Ltd

Drill Method: Rotary Rig

Borelog Depth: 20.5 m Drill Date: 17-Oct-1994



**Environment  
Canterbury**  
Regional Council  
*Kaunihera Taiao ki Waitaha*

Scale(m)	Water Level	Depth(m)	Full Drillers Description	Formation Code
		0.30m	Light Brown earth- top soil	SP
			Brown sand	SP
		3.80m	Grey sand and some gravel	CH
5				
10				
15				
		16.79m	Grey gravels	RI
		18.50m	Brown stained gravels	RI
20		20.50m		

# Borelog for well M35/8677

Grid Reference (NZTM): 1574305 mE, 5203256 mN  
 Location Accuracy: 2 - 15m  
 Ground Level Altitude: 6.8 m +MSD Accuracy: < 0.1 m  
 Driller: McNeill Drilling Co. Ltd  
 Drill Method: Rotary/Percussion  
 Borelog Depth: 15.0 m Drill Date: 03-Apr-2000



Scale(m)	Water Level	Depth(m)	Full Drillers Description	Formation Code
			Dense Grey/Brown gravel, trace wet sand. Gravel- fine to coarse, subrounded to subangular	SP
		2.00m	Very dense gravel	SP
		3.00m	Very soft clay, some silt, minor subrounded fine to medium gravel, trace organics, wet, highly plastic	SP
		4.00m	Very soft clay, some silt, with moderately thin layer of brown/Black organic clay, moist, highly plastic	SP
5		5.00m	Dense Grey fine to medium sand, wet	CH
		8.00m	Dense Grey fine to medium sand, trace subangular medium gravels, wet	CH
		9.00m	Very dense gravel, no recovery	CH
10		10.00m	Very dense Grey medium to coarse sand, wet	CH
		11.00m	Very dense Grey fine to medium sand with layers of Grey subangular to subrounded, fine gravel, wet	CH
		12.00m	Very dense Grey fine to medium sand, trace subrounded medium gravel, wet	CH
		13.00m	Very dense Grey fine to medium sand, trace coarse sand, wet	CH
		14.00m	Very dense Grey fine sand, trace subrounded fine gravel, wet	CH
		15.00m		



# Borelog for well M35/8679

Grid Reference (NZTM): 1574196 mE, 5202722 mN

Location Accuracy: 2 - 15m

Ground Level Altitude: 5.2 m +MSD Accuracy: < 0.1 m

Driller: Not Known

Drill Method: Rotary/Percussion

Borelog Depth: 15.0 m Drill Date: 04-Apr-2000



Scale(m)	Water Level	Depth(m)	Full Drillers Description	Formation Code
			Very loose Grey mottled or fine sand, minor silt, wet	SP
		1.00m	Very loose Grey fine to med sand, trace silt, trace wood, wet	SP
		2.00m	Very soft Grey mottled or clay, some silt, subrounded fine gravel, wet highly plastic	SP
		3.00m		
		3.30m	Loose Grey fine to med sand, minor silt, wet	SP
		4.00m	Very soft Grey speckled be clay, some silt, wet, highly plastic. Becoming some organics	SP
		5.00m	Very soft Brown organic clay, some silt, wet, highly plastic. Becoming Grey clay, trace organics, trace sand	SP
5			Firm Grey clay, some silt, trace wood, wet, highly plastic	SP
		7.00m	Med dense Grey coarse sand, minor subrounded fine gravel, minor fine sand, wet	CH
		8.00m	Med dense Grey coarse sand, some subrounded fine gravel, trace silt, wet	CH
		9.00m	Very dense Grey fine to coarse sand, trace subangular med gravel, wet	CH
10		10.00m	Dense Grey fine sand, minor silt, wet	CH
		11.00m	Dense Grey fine to med sand, wet	CH
		13.00m	Very dense Grey fine sand, minor silt, wet	CH
		14.00m	Med dense Grey mottled or gravel, trace sand, wet. Gravel- fine to coarse, subrounded to angular	CH
		15.00m		

# Borelog for well M35/10418

Grid Reference (NZTM): 1574418 mE, 5202900 mN

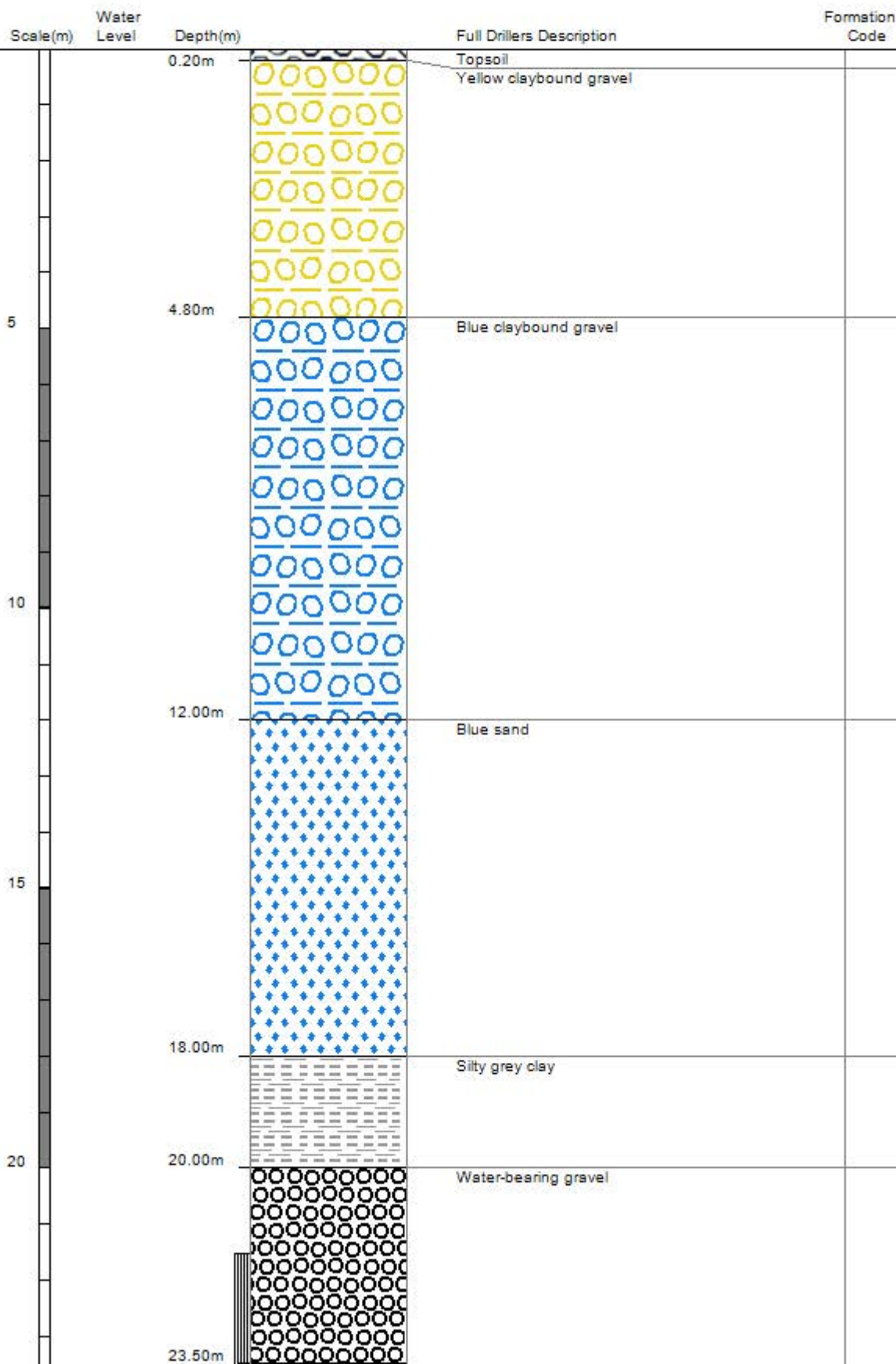
Location Accuracy: 50 - 300m

Ground Level Altitude: 6.3 m +MSD Accuracy: < 2.5 m

Driller: Clemence Drilling Contractors

Drill Method: Rotary/Percussion

Borelog Depth: 23.5 m Drill Date: 21-Dec-2004





# Borelog for well M35/18660

Grid Reference (NZTM): 1574039 mE, 5203247 mN  
 Location Accuracy: 2 - 15m  
 Ground Level Altitude: 7.4 m +MSD Accuracy: < 0.5 m  
 Driller: McMillan Drilling Ltd  
 Drill Method: Sonic  
 Borelog Depth: 23.9 m Drill Date: 02-Feb-2012



Scale(m)	Water Level	Depth(m)	Full Drillers Description	Formation Code
		0.30m	Silty TOPSOIL, dark greyish brown, DRY	
		0.70m	Clayey SILT, brown, DRY	
		1.10m	No Log	
		1.30m	No Log	
		1.80m	Fine to medium SAND, yellowish brown, MOIST	
		2.40m	Silty CLAY, brownish grey mottled orange firm, low plasticity, MOIST	
		2.70m	Silty fine to medium SAND, brown, WET	
		3.70m	Silty CLAY, brownish grey mottled orange firm, low plasticity, MOIST	
		3.85m	Silty CLAY, with some fine sand, grey, WET	
		4.70m	Silty fine to coarse SAND, dark grey, WET	
		5.10m	Silty CLAY, brownish grey, WET	
5	5.10	5.50m	Organic SILT, with some clay, dark brown low plasticity, fibrous organics, MOIST	
		7.18m	Fine to medium SAND, with trace of medium to coarse gravel, grey, MOIST	
		9.00m	Fine to coarse GRAVEL, with minor coarse sand, dark grey, WET	
		9.90m	Silty fine to coarse GRAVEL, with minor fine to coarse sand, brownish grey, MOIST	
10		9.90m	Silty fine to medium SAND, with minor fine gravel, light brownish grey bands of sandy fine gravel at 10.7-10.8m and 11.5-11.6m, MOIST	
		11.60m	Silty fine SAND, with trace of fine gravel, grey band of sandy fine gravel with some silt at 13.4-13.55m, becomes more saturated with depth	
		16.10m	Silty medium to coarse GRAVEL, with trace of the sand, grey, MOIST	
		16.30m	Silty CLAY, with minor fine sand, grey, WET	
		17.40m	Silty fine to coarse GRAVEL, with some fine to medium sand, with trace of fine to medium cobbles, grey bands of gravells silt at 17.8-18m and 20.66-21.1m, colour becomes brown at 19.5-19.7m, 20.3-20.5m and 23-23.9m	
20		23.90m		

# Borelog for well M35/18673

Grid Reference (NZTM): 1574179 mE, 5202812 mN

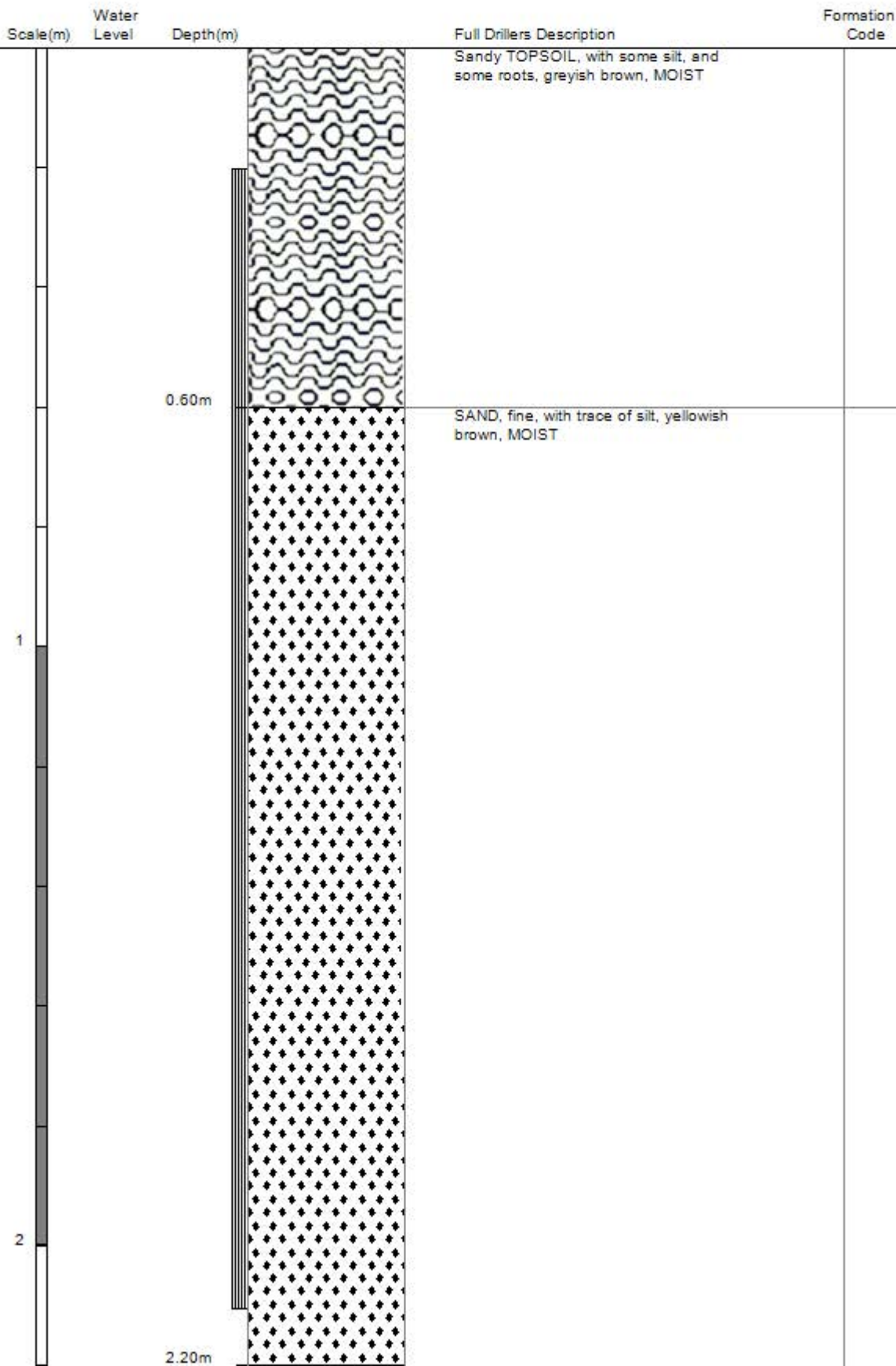
Location Accuracy: 2 - 15m

Ground Level Altitude: m +MSD Accuracy:

Driller: McMillan Drilling Ltd

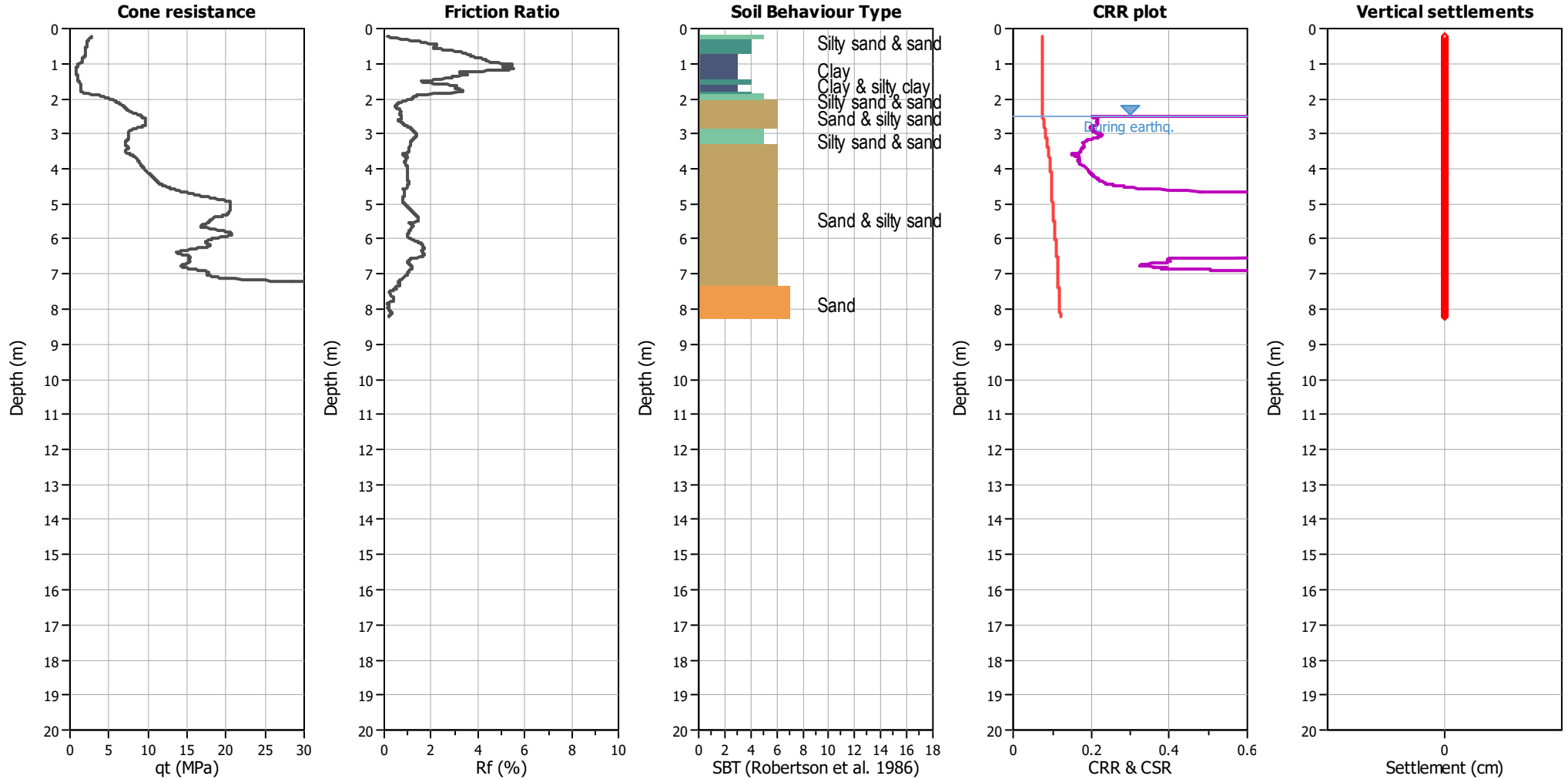
Drill Method: Machine Dug

Borelog Depth: 2.2 m Drill Date: 08-Dec-2011

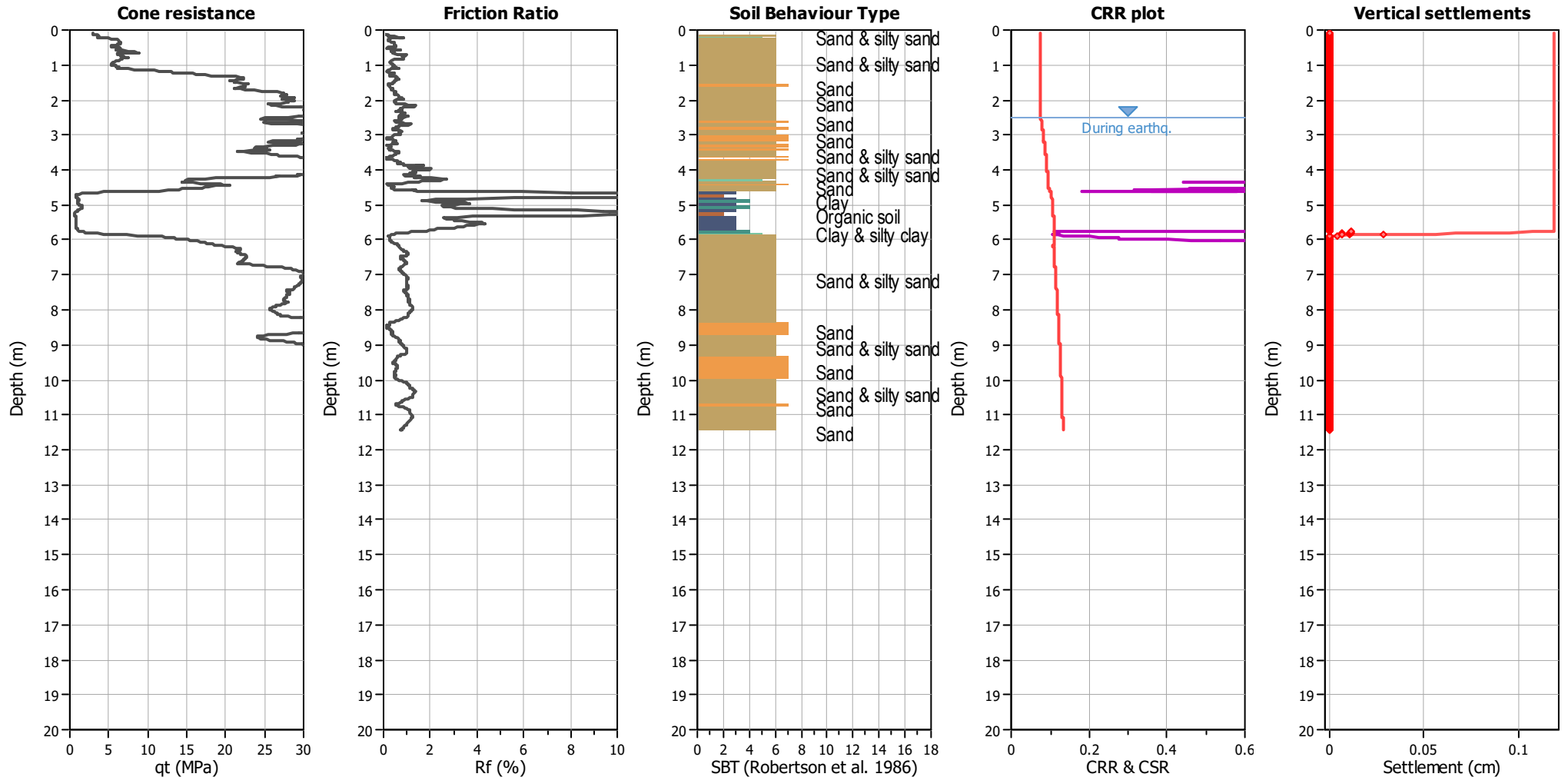


## APPENDIX C: LIQUEFACTION HAZARDS ASSESSMENT

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Analysis method:	B&I (2014)	G.W.T. (in-situ):	2.50 m	Use fill:	No	Clay like behavior	
Fines correction method:	B&I (2014)	G.W.T. (earthq.):	2.50 m	Fill height:	N/A	applied:	.
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth applied:	No
Earthquake magnitude $M_w$ :	7.50	Ic cut-off value:	2.60	Trans. detect. applied:	No	Limit depth:	N/A
Peak ground acceleration:	0.13	Unit weight calculation:	Based on SBT	$K_\sigma$ applied:	Yes	MSF method:	Method based



Analysis method:	B&I (2014)	G.W.T. (in-situ):	2.50 m	Use fill:	No	Clay like behavior	
Fines correction method:	B&I (2014)	G.W.T. (earthq.):	2.50 m	Fill height:	N/A	applied:	.
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth applied:	No
Earthquake magnitude $M_w$ :	7.50	Ic cut-off value:	2.60	Trans. detect. applied:	No	Limit depth:	N/A
Peak ground acceleration:	0.13	Unit weight calculation:	Based on SBT	$K_\sigma$ applied:	Yes	MSF method:	Method based



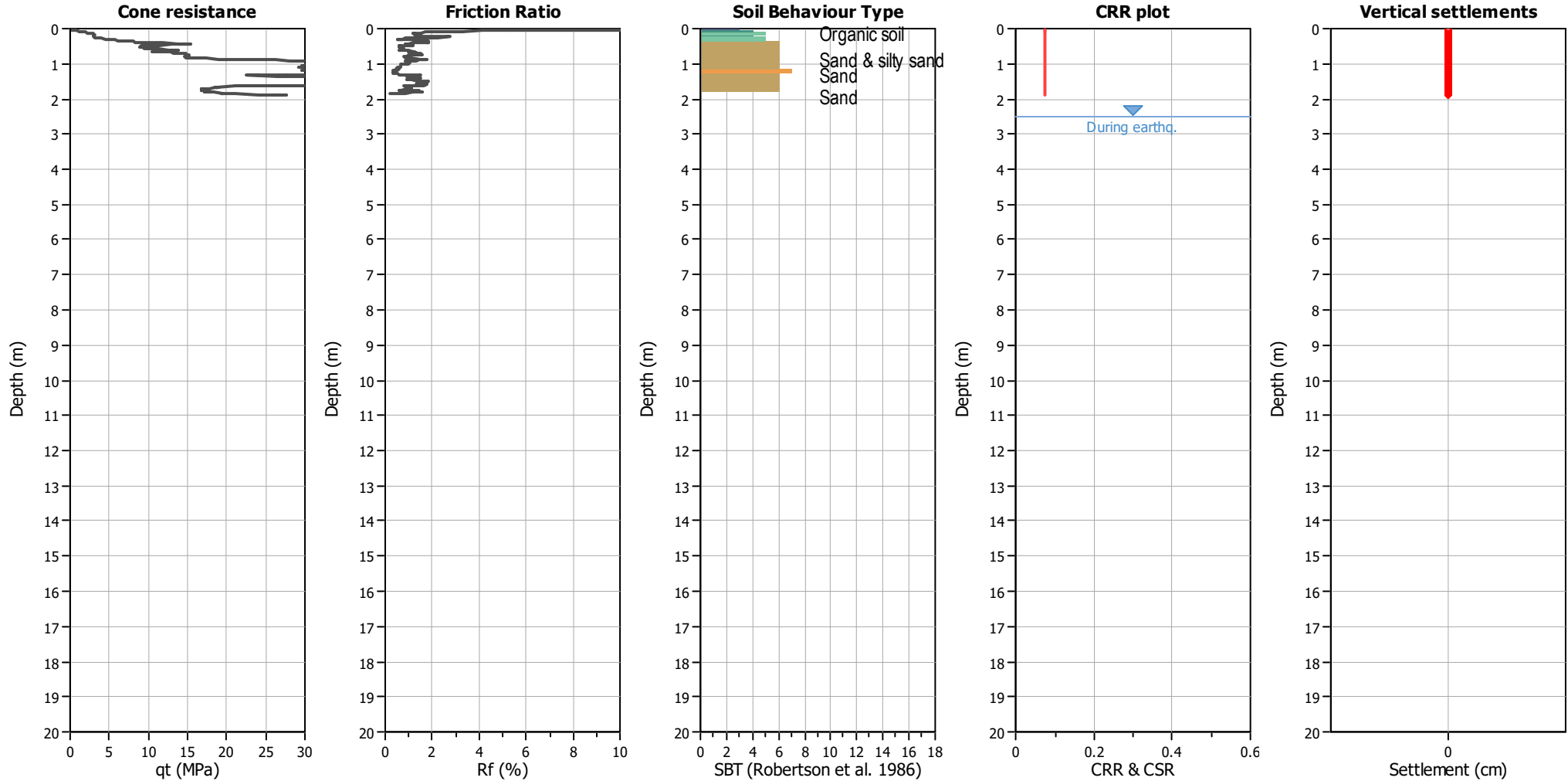


**Project:** SLS M7.5/0.13g

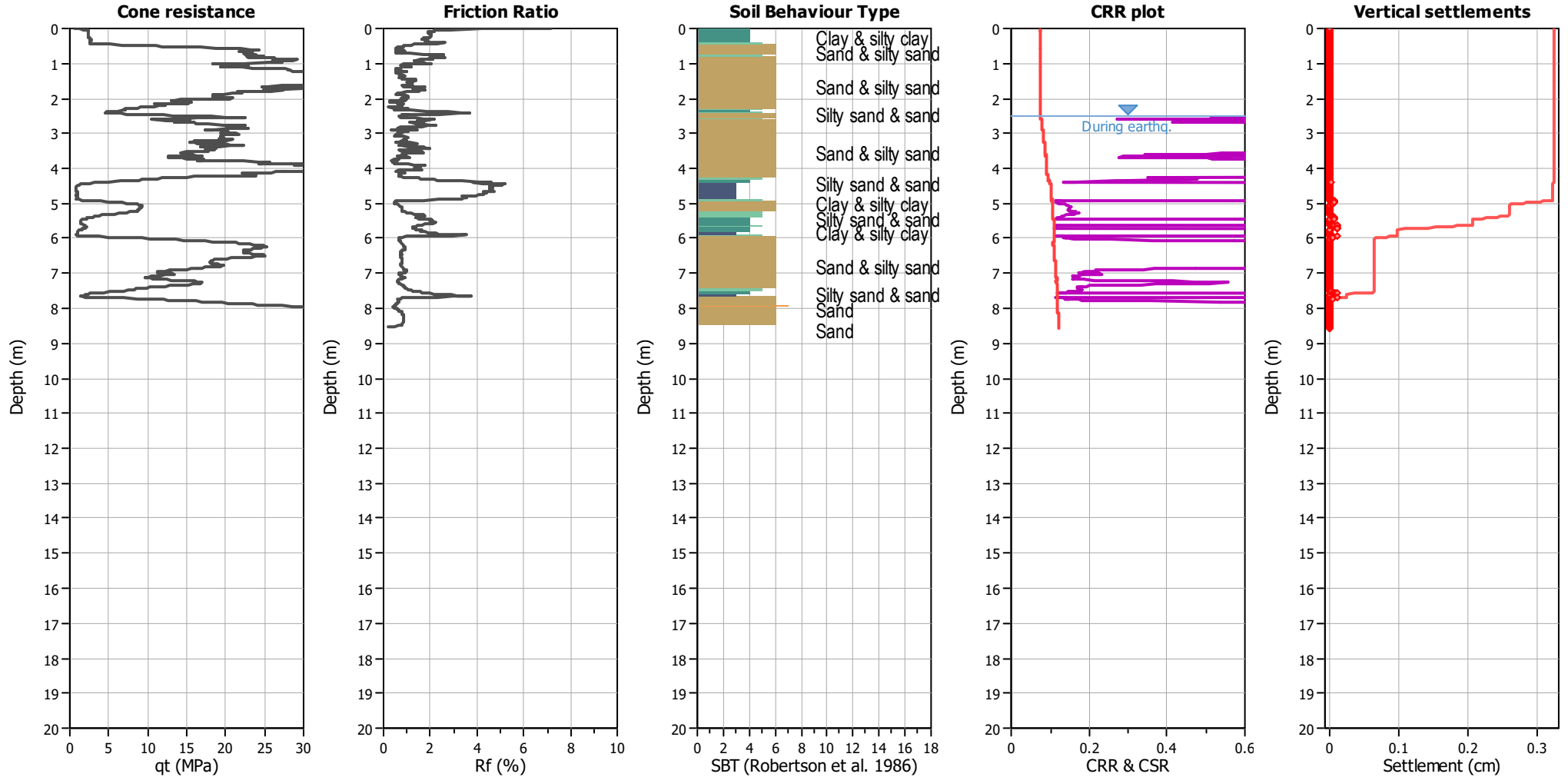
**Location:** 145 & 167 Gladstone Road, Woodend

**CPT: CPT\_03**

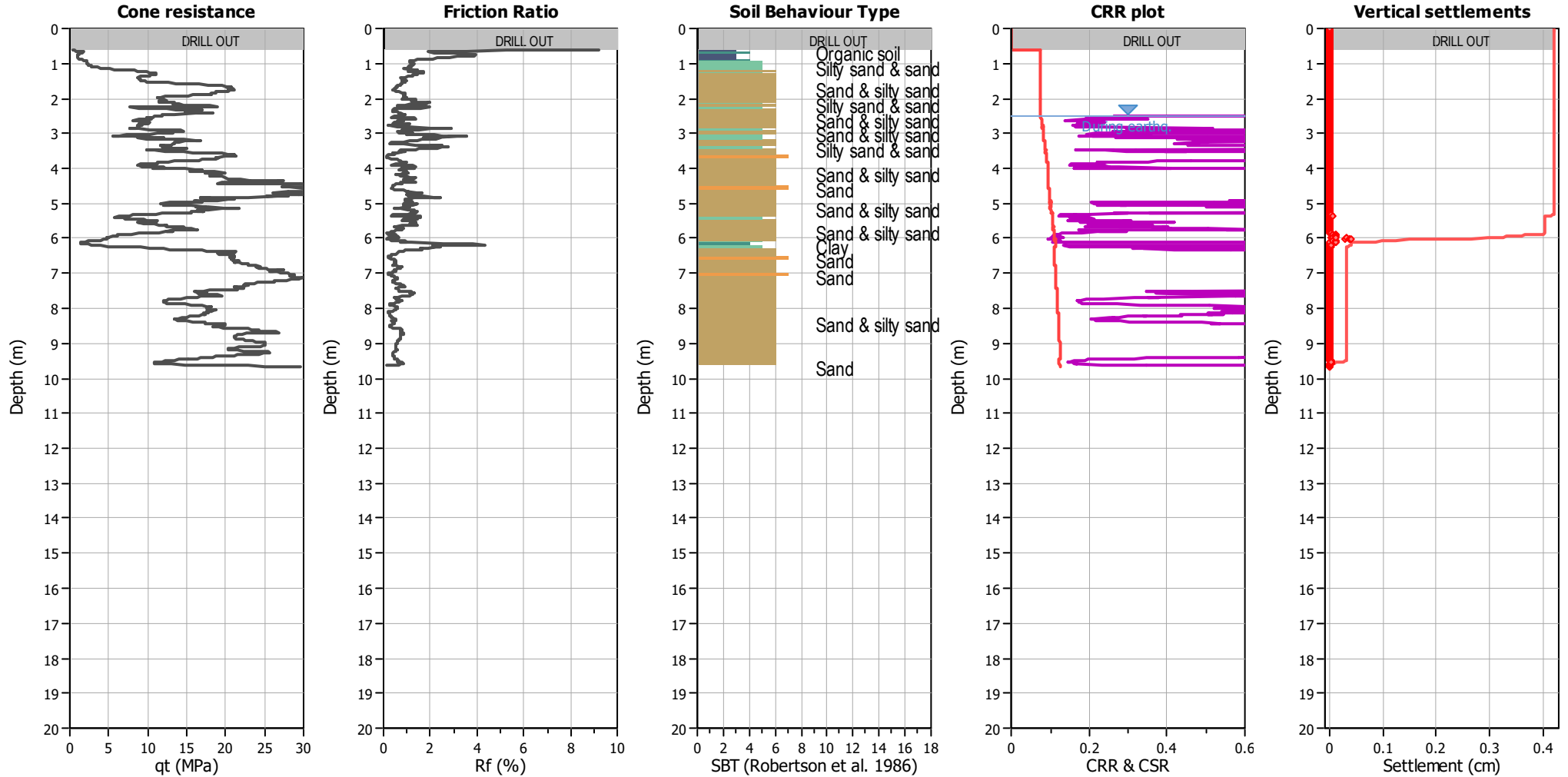
Total depth: 1.91 m



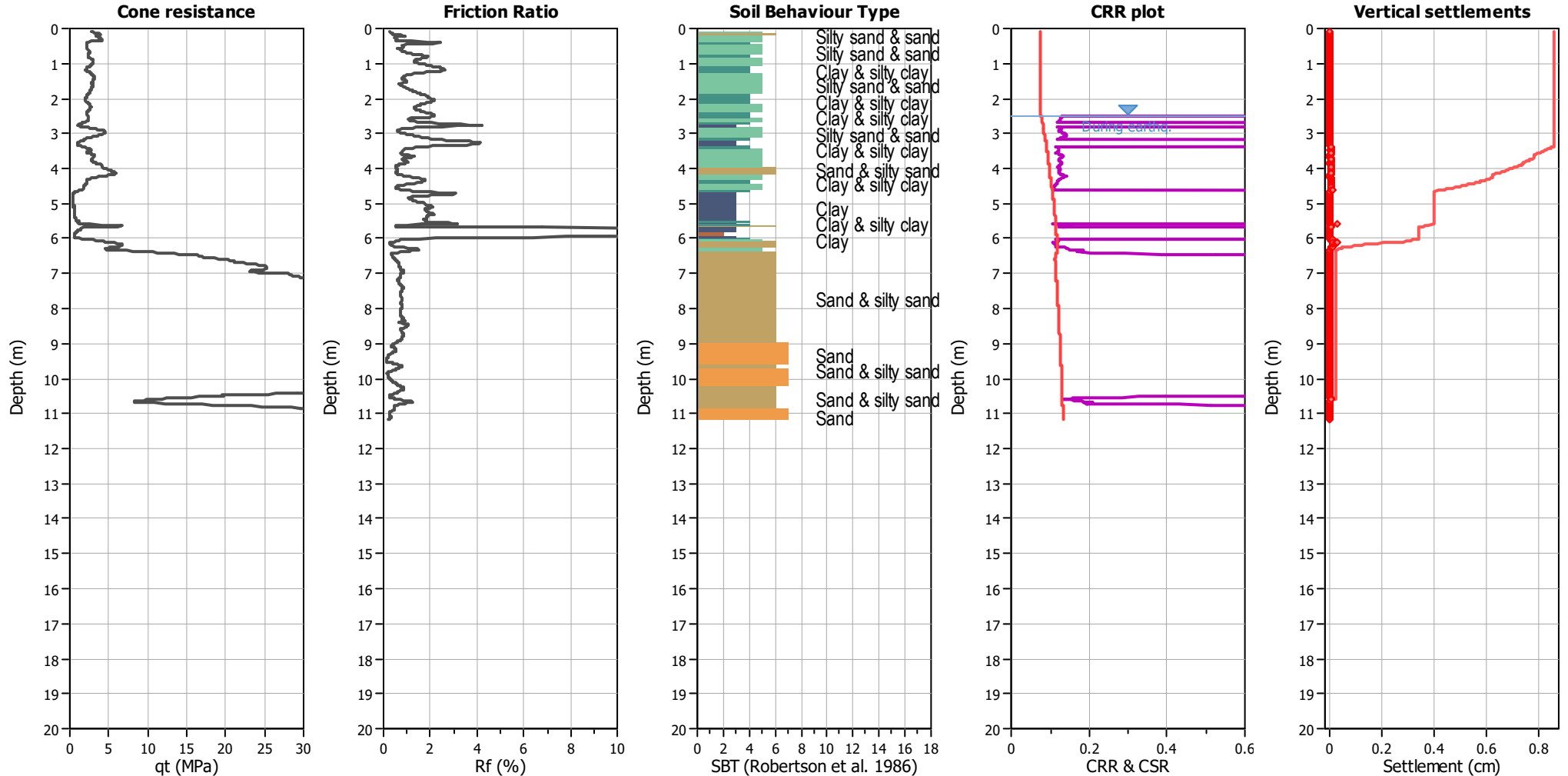
Analysis method:	B&I (2014)	G.W.T. (in-situ):	2.50 m	Use fill:	No	Clay like behavior	
Fines correction method:	B&I (2014)	G.W.T. (earthq.):	2.50 m	Fill height:	N/A	applied:	.
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth applied:	No
Earthquake magnitude $M_w$ :	7.50	Ic cut-off value:	2.60	Trans. detect. applied:	No	Limit depth:	N/A
Peak ground acceleration:	0.13	Unit weight calculation:	Based on SBT	$K_\sigma$ applied:	Yes	MSF method:	Method based



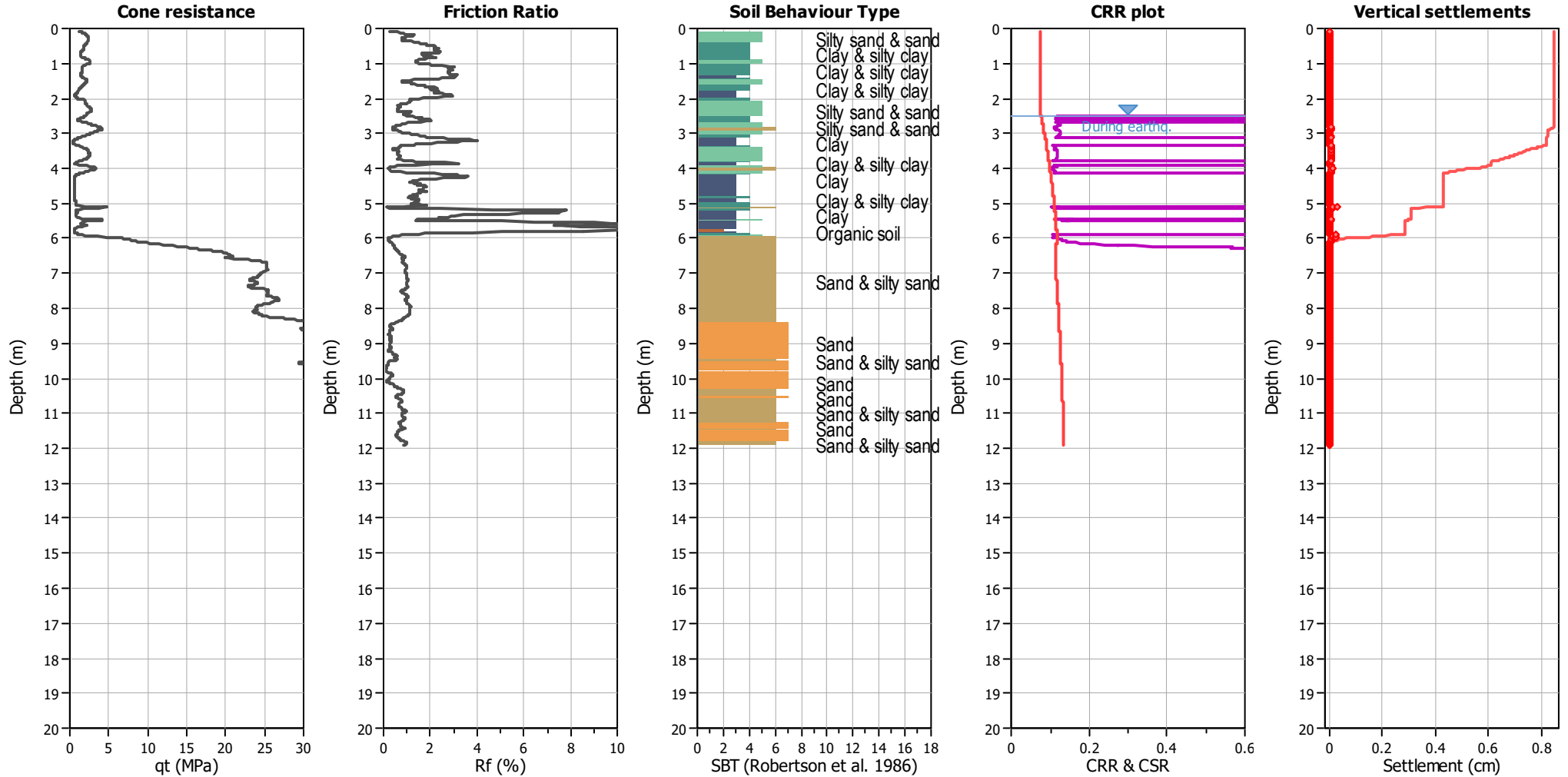
Analysis method:	B&I (2014)	G.W.T. (in-situ):	2.50 m	Use fill:	No	Clay like behavior	
Fines correction method:	B&I (2014)	G.W.T. (earthq.):	2.50 m	Fill height:	N/A	applied:	.
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth applied:	No
Earthquake magnitude $M_w$ :	7.50	Ic cut-off value:	2.60	Trans. detect. applied:	No	Limit depth:	N/A
Peak ground acceleration:	0.13	Unit weight calculation:	Based on SBT	$K_\sigma$ applied:	Yes	MSF method:	Method based



Analysis method:	B&I (2014)	G.W.T. (in-situ):	2.50 m	Use fill:	No	Clay like behavior	
Fines correction method:	B&I (2014)	G.W.T. (earthq.):	2.50 m	Fill height:	N/A	applied:	.
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth applied:	No
Earthquake magnitude $M_w$ :	7.50	Ic cut-off value:	2.60	Trans. detect. applied:	No	Limit depth:	N/A
Peak ground acceleration:	0.13	Unit weight calculation:	Based on SBT	$K_\sigma$ applied:	Yes	MSF method:	Method based

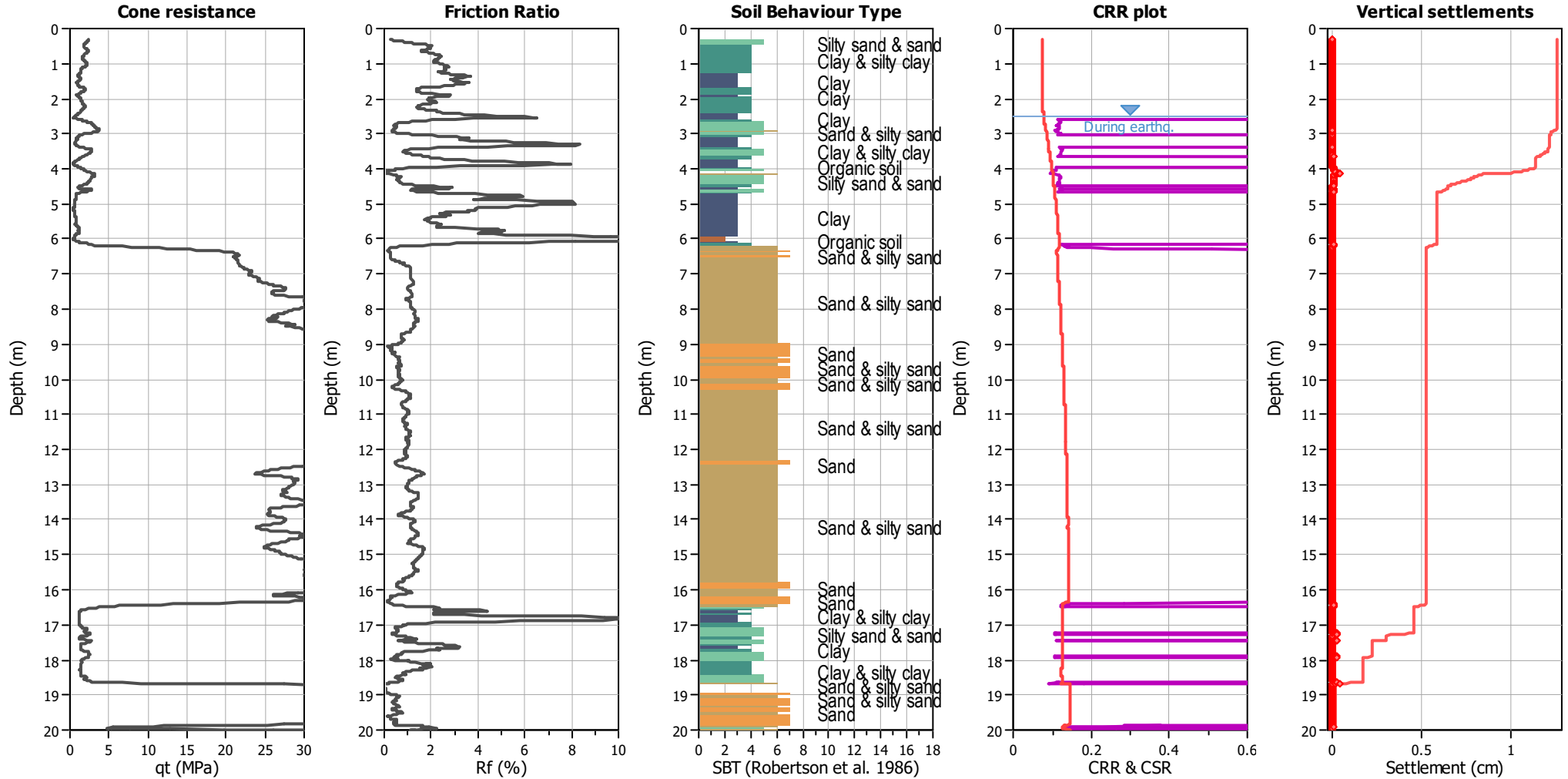


Analysis method:	B&I (2014)	G.W.T. (in-situ):	2.50 m	Use fill:	No	Clay like behavior	
Fines correction method:	B&I (2014)	G.W.T. (earthq.):	2.50 m	Fill height:	N/A	applied:	.
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth applied:	No
Earthquake magnitude $M_w$ :	7.50	Ic cut-off value:	2.60	Trans. detect. applied:	No	Limit depth:	N/A
Peak ground acceleration:	0.13	Unit weight calculation:	Based on SBT	$K_{\sigma}$ applied:	Yes	MSF method:	Method based

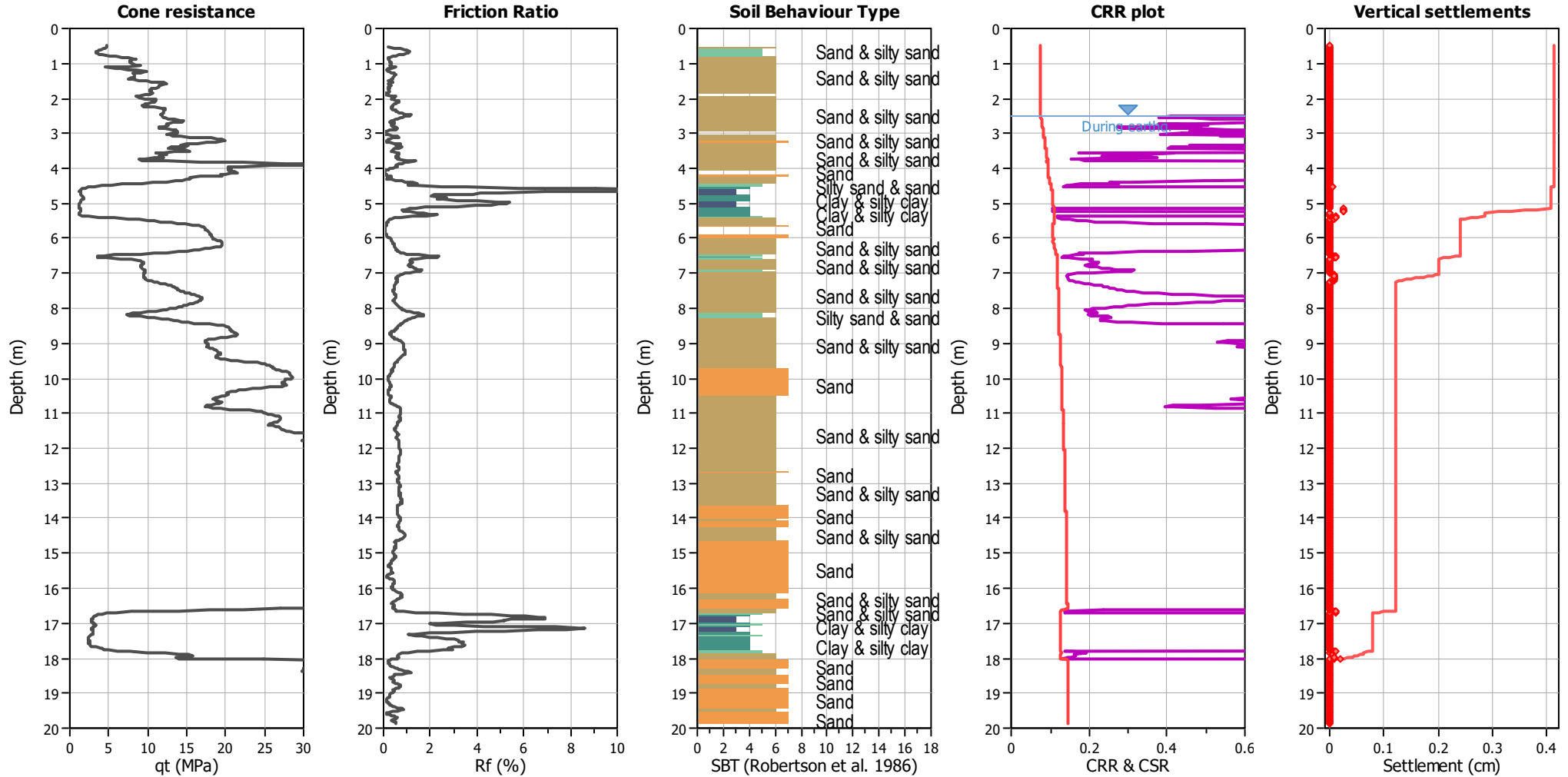


Analysis method:	B&I (2014)	G.W.T. (in-situ):	2.50 m	Use fill:	No	Clay like behavior	
Fines correction method:	B&I (2014)	G.W.T. (earthq.):	2.50 m	Fill height:	N/A	applied:	.
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth applied:	No
Earthquake magnitude $M_w$ :	7.50	Ic cut-off value:	2.60	Trans. detect. applied:	No	Limit depth:	N/A
Peak ground acceleration:	0.13	Unit weight calculation:	Based on SBT	$K_{\sigma}$ applied:	Yes	MSF method:	Method based

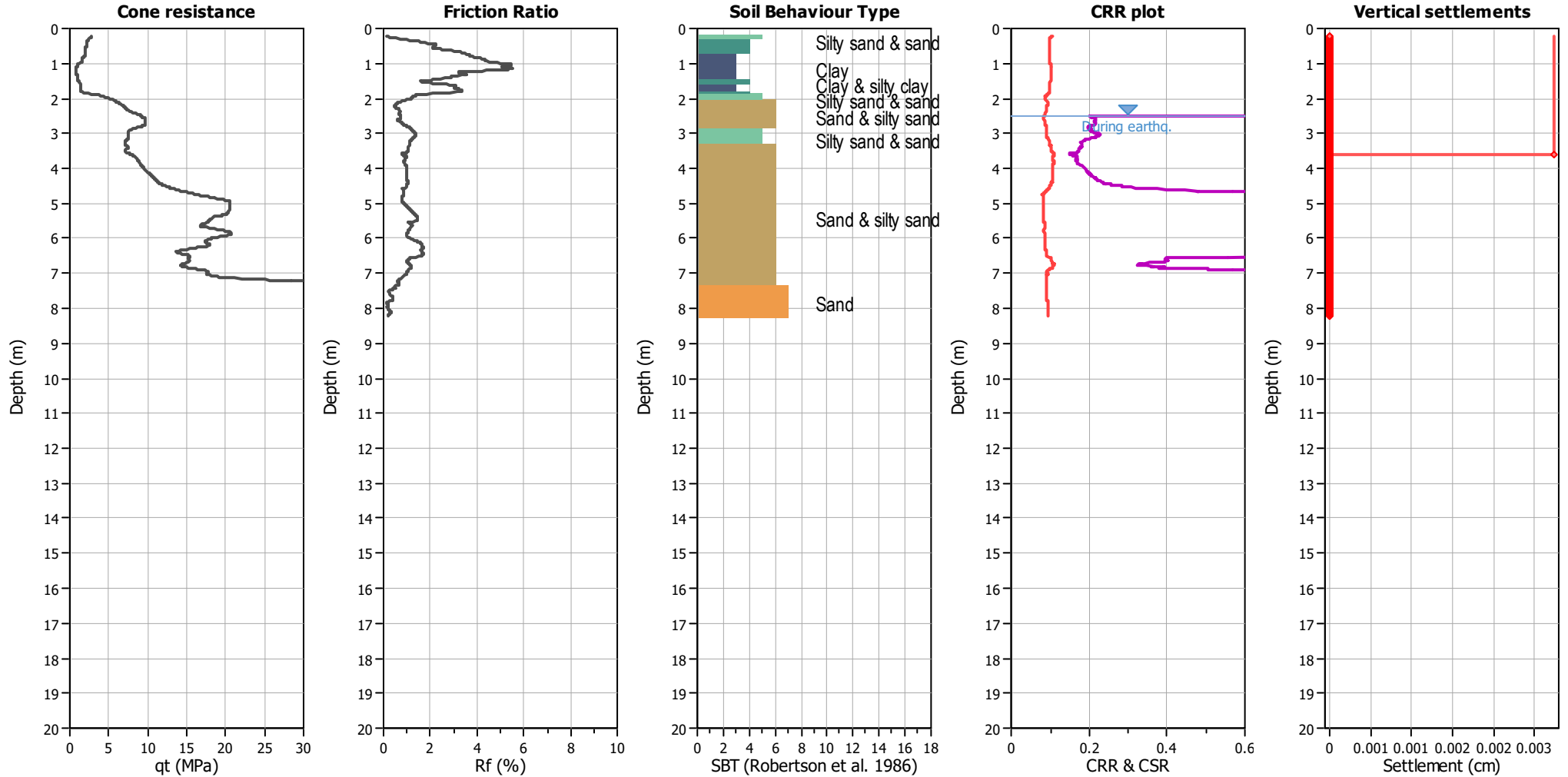




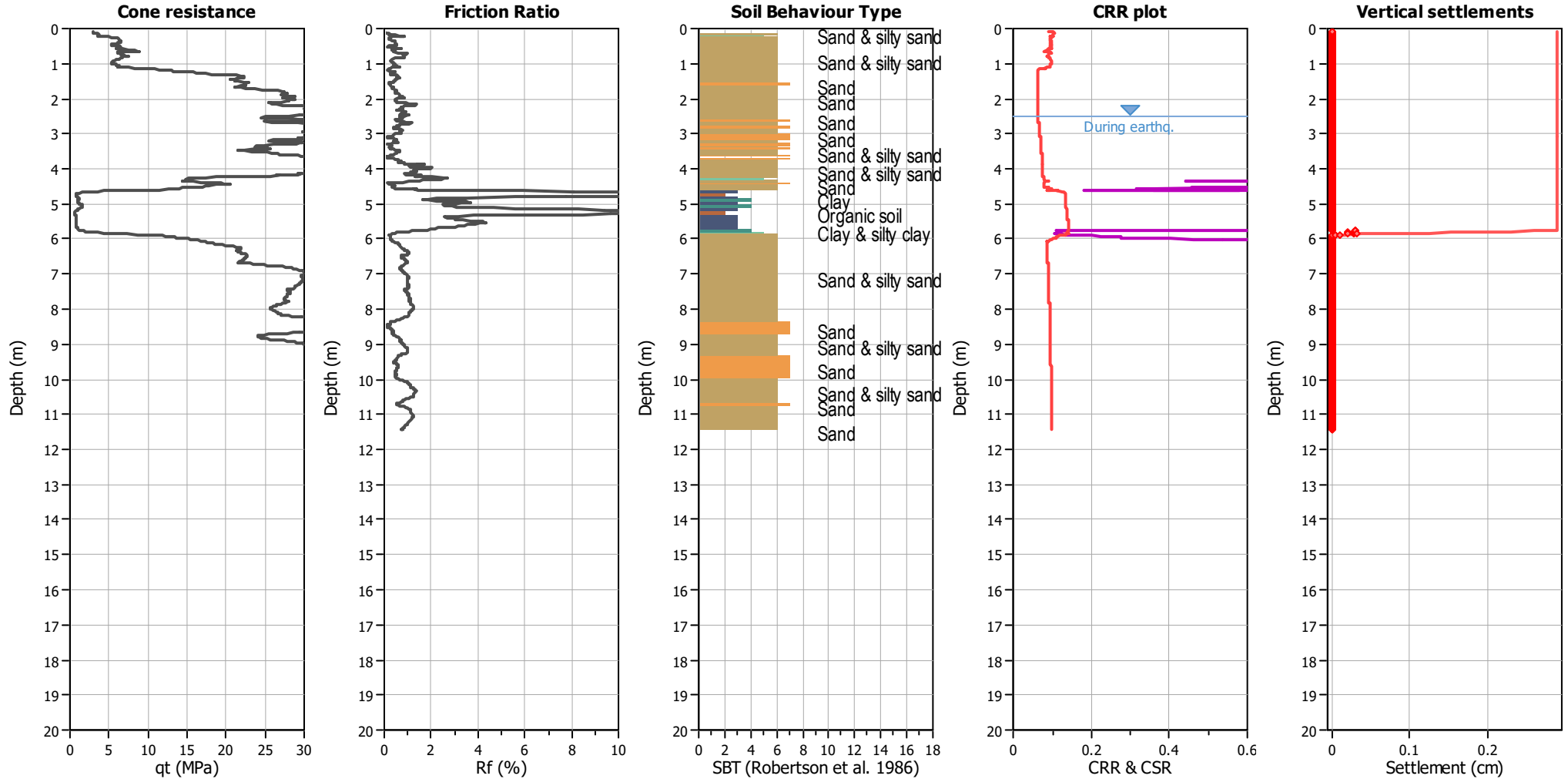
Analysis method:	B&I (2014)	G.W.T. (in-situ):	2.50 m	Use fill:	No	Clay like behavior	
Fines correction method:	B&I (2014)	G.W.T. (earthq.):	2.50 m	Fill height:	N/A	applied:	.
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth applied:	No
Earthquake magnitude $M_w$ :	7.50	Ic cut-off value:	2.60	Trans. detect. applied:	No	Limit depth:	N/A
Peak ground acceleration:	0.13	Unit weight calculation:	Based on SBT	$K_\sigma$ applied:	Yes	MSF method:	Method based



Analysis method:	B&I (2014)	G.W.T. (in-situ):	2.50 m	Use fill:	No	Clay like behavior	
Fines correction method:	B&I (2014)	G.W.T. (earthq.):	2.50 m	Fill height:	N/A	applied:	.
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth applied:	No
Earthquake magnitude $M_w$ :	7.50	Ic cut-off value:	2.60	Trans. detect. applied:	No	Limit depth:	N/A
Peak ground acceleration:	0.13	Unit weight calculation:	Based on SBT	$K_\sigma$ applied:	Yes	MSF method:	Method based



Analysis method:	B&I (2014)	G.W.T. (in-situ):	2.50 m	Use fill:	No	Clay like behavior	
Fines correction method:	B&I (2014)	G.W.T. (earthq.):	2.50 m	Fill height:	N/A	applied:	.
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth applied:	No
Earthquake magnitude $M_w$ :	6.00	Ic cut-off value:	2.60	Trans. detect. applied:	No	Limit depth:	N/A
Peak ground acceleration:	0.19	Unit weight calculation:	Based on SBT	$K_\sigma$ applied:	Yes	MSF method:	Method based



Analysis method:	B&I (2014)	G.W.T. (in-situ):	2.50 m	Use fill:	No	Clay like behavior	
Fines correction method:	B&I (2014)	G.W.T. (earthq.):	2.50 m	Fill height:	N/A	applied:	.
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth applied:	No
Earthquake magnitude $M_w$ :	6.00	Ic cut-off value:	2.60	Trans. detect. applied:	No	Limit depth:	N/A
Peak ground acceleration:	0.19	Unit weight calculation:	Based on SBT	$K_\sigma$ applied:	Yes	MSF method:	Method based

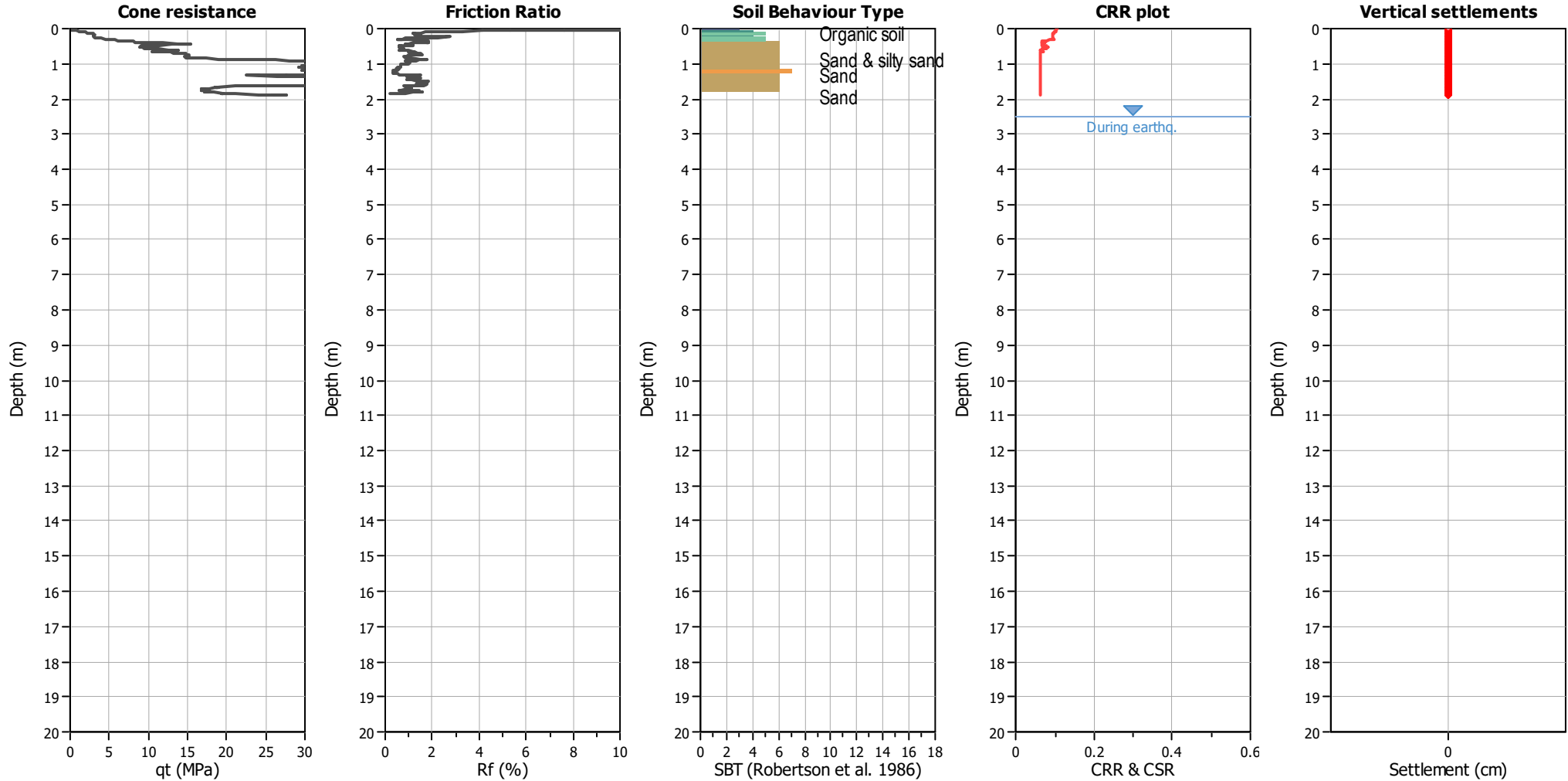


**Project: SLS M6.0/0.19g**

**Location: 145 & 167 Gladstone Road, Woodend**

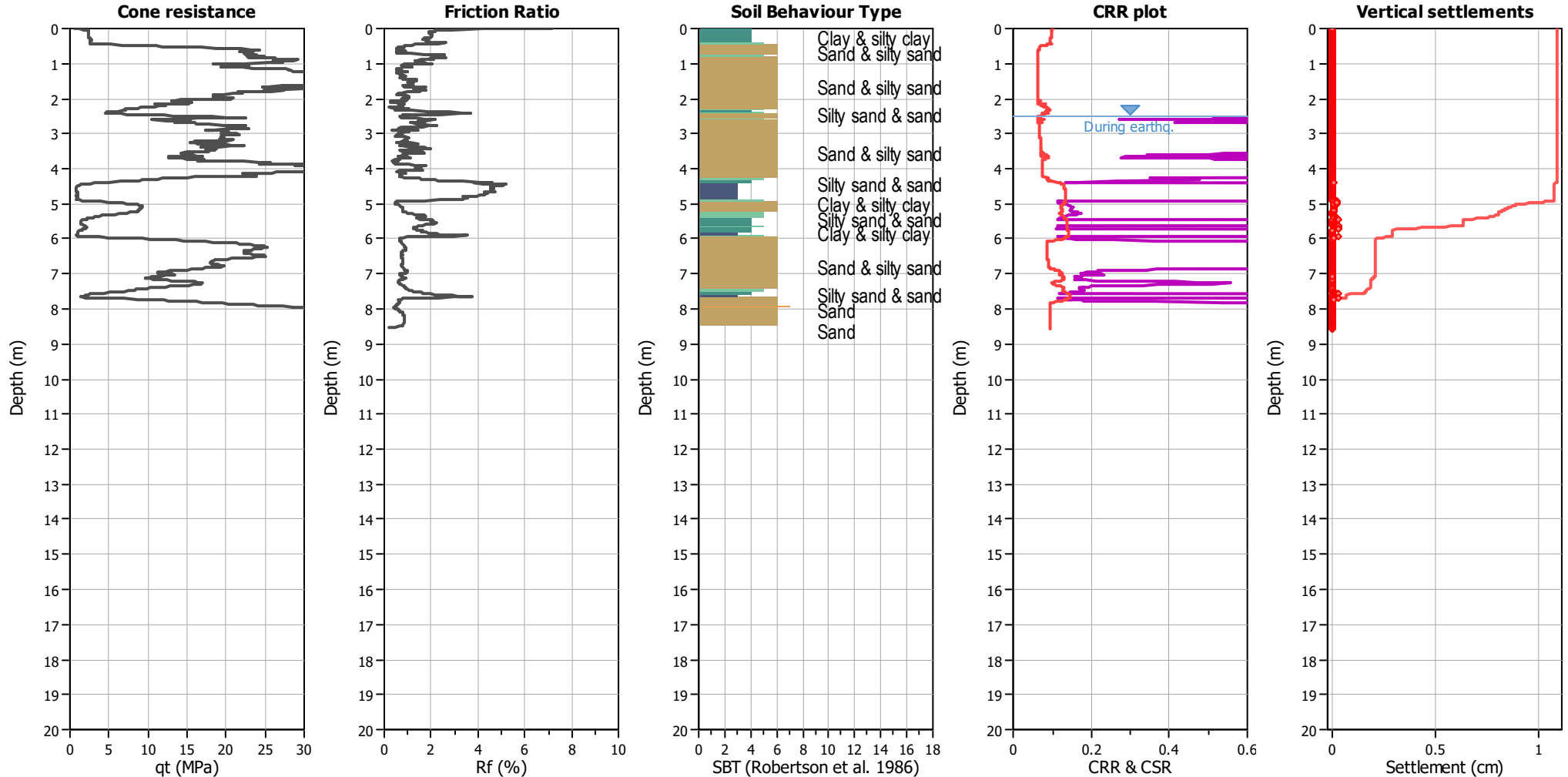
**CPT: CPT\_03**

Total depth: 1.91 m

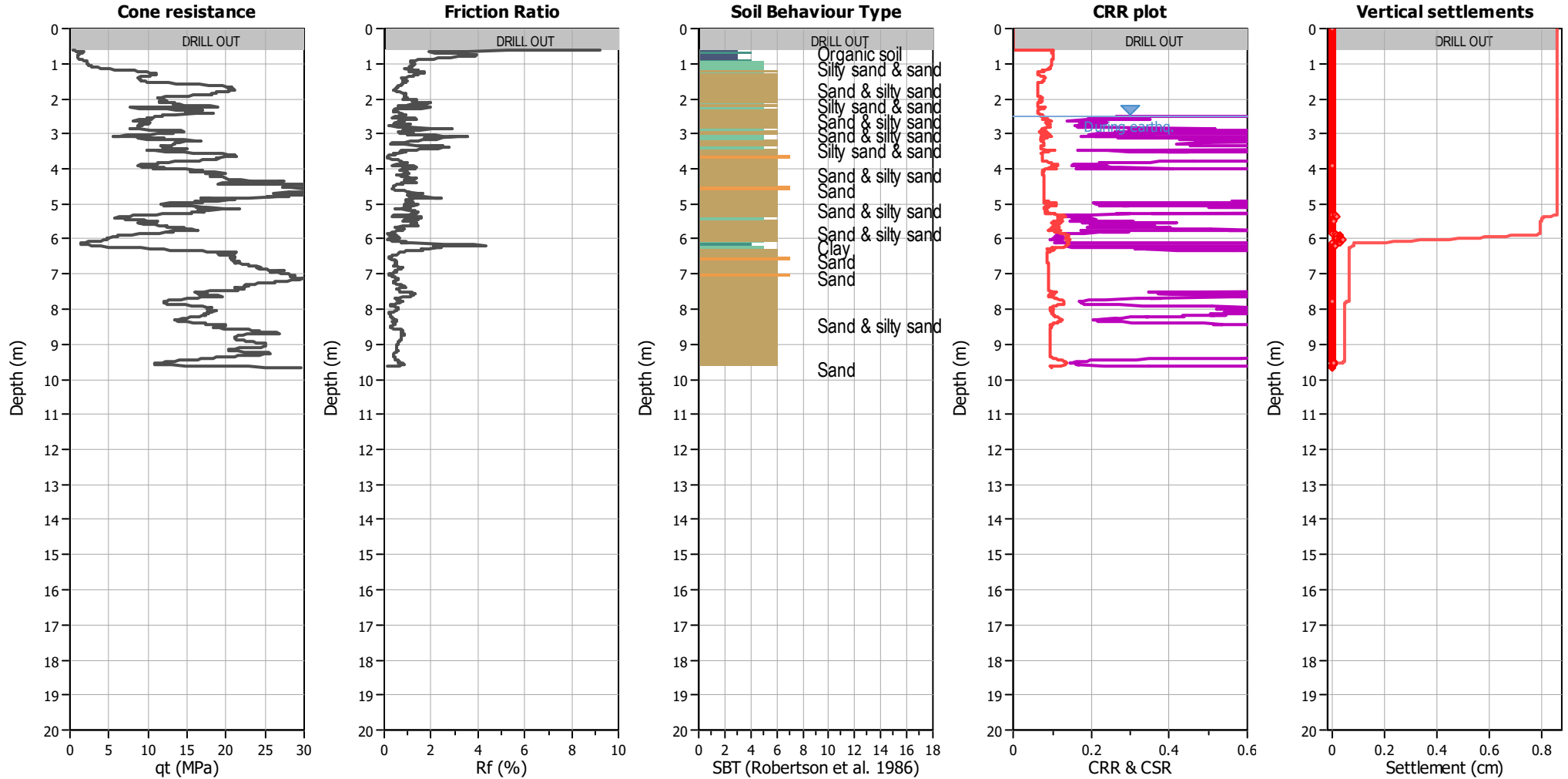


Analysis method:	B&I (2014)	G.W.T. (in-situ):	2.50 m	Use fill:	No	Clay like behavior	
Fines correction method:	B&I (2014)	G.W.T. (earthq.):	2.50 m	Fill height:	N/A	applied:	.
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth applied:	No
Earthquake magnitude $M_w$ :	6.00	Ic cut-off value:	2.60	Trans. detect. applied:	No	Limit depth:	N/A
Peak ground acceleration:	0.19	Unit weight calculation:	Based on SBT	$K_\sigma$ applied:	Yes	MSF method:	Method based

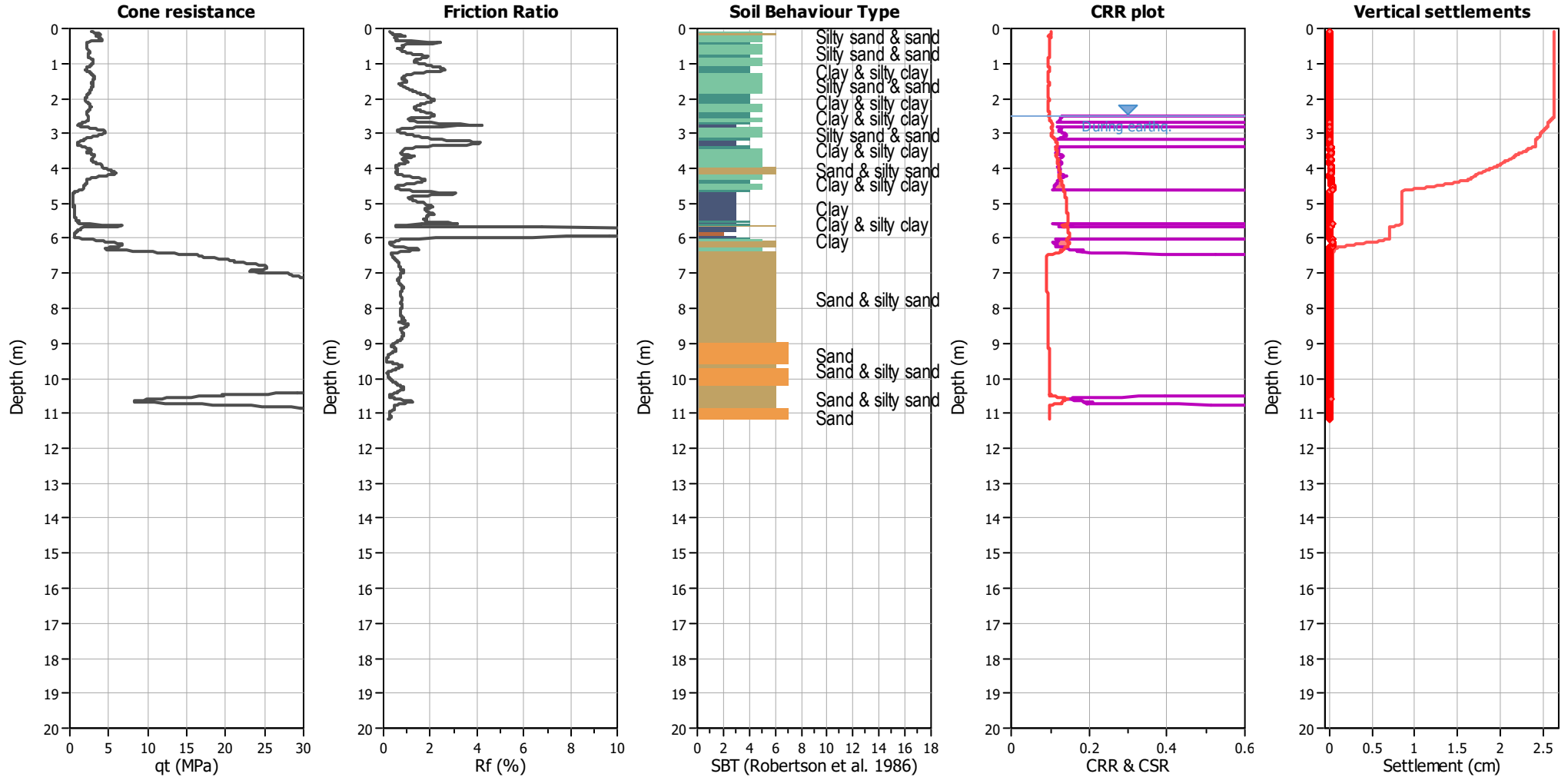




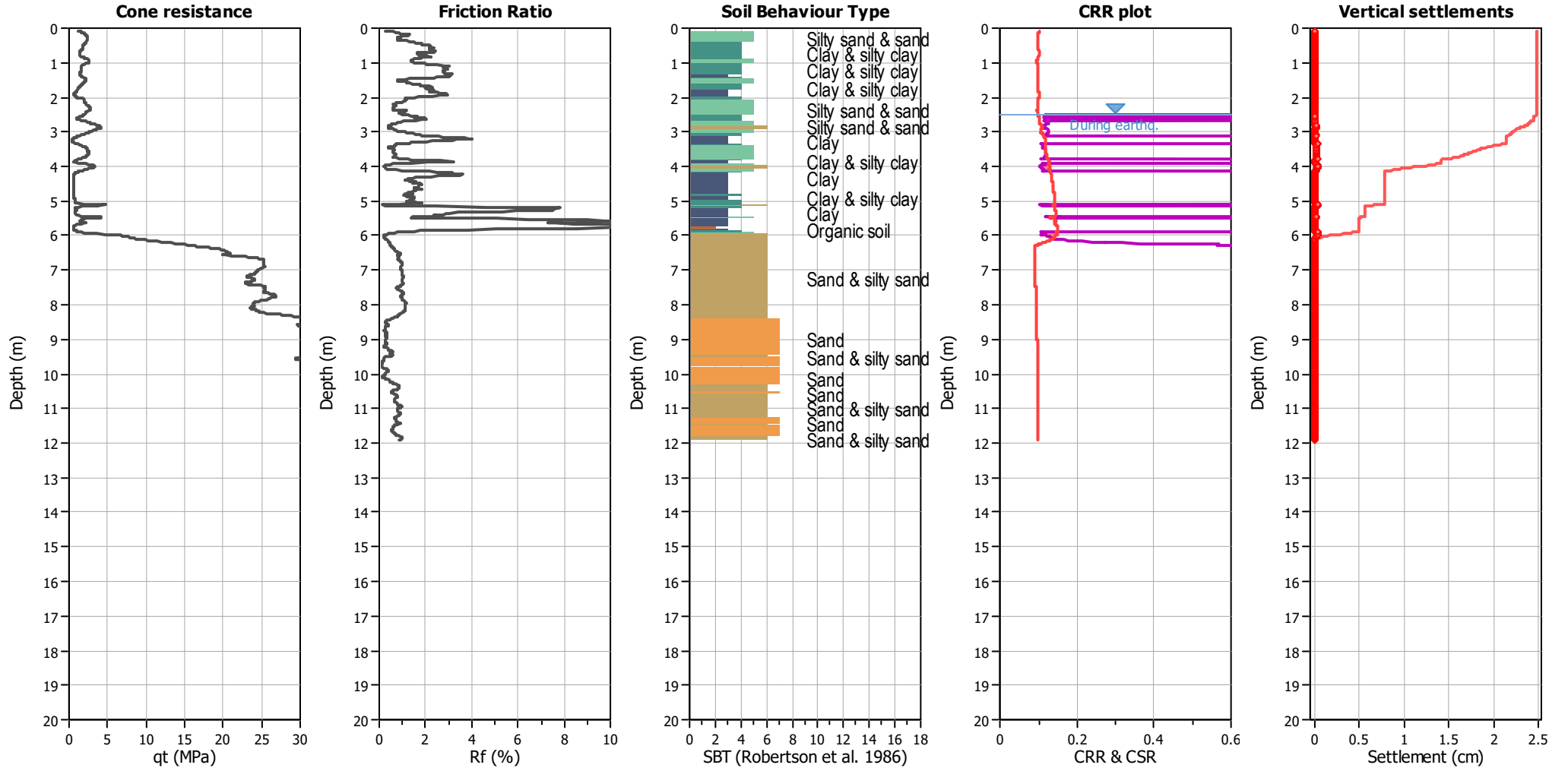
Analysis method:	B&I (2014)	G.W.T. (in-situ):	2.50 m	Use fill:	No	Clay like behavior	
Fines correction method:	B&I (2014)	G.W.T. (earthq.):	2.50 m	Fill height:	N/A	applied:	.
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth applied:	No
Earthquake magnitude $M_w$ :	6.00	Ic cut-off value:	2.60	Trans. detect. applied:	No	Limit depth:	N/A
Peak ground acceleration:	0.19	Unit weight calculation:	Based on SBT	$K_\sigma$ applied:	Yes	MSF method:	Method based



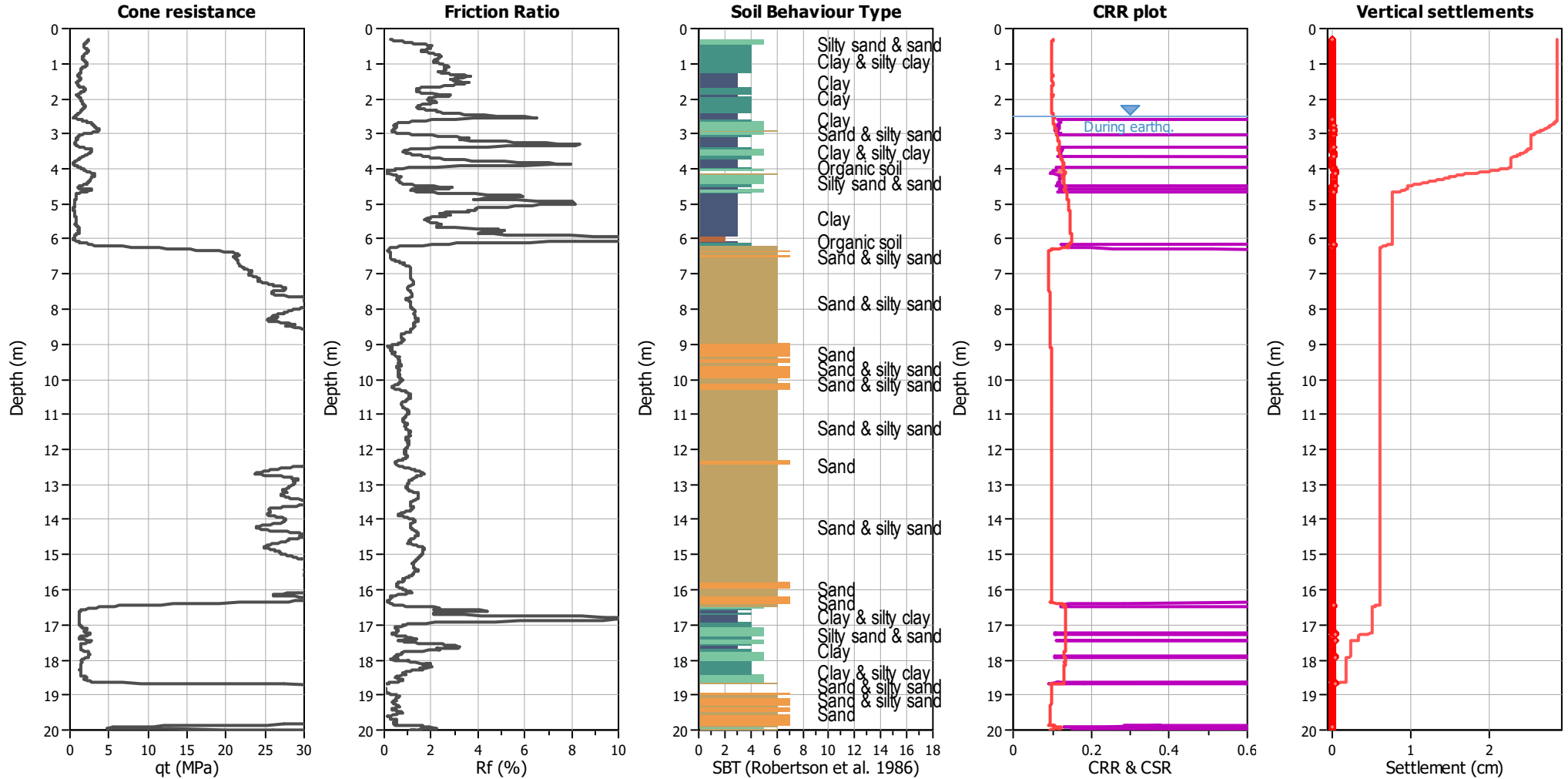
Analysis method:	B&I (2014)	G.W.T. (in-situ):	2.50 m	Use fill:	No	Clay like behavior	
Fines correction method:	B&I (2014)	G.W.T. (earthq.):	2.50 m	Fill height:	N/A	applied:	.
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth applied:	No
Earthquake magnitude $M_w$ :	6.00	Ic cut-off value:	2.60	Trans. detect. applied:	No	Limit depth:	N/A
Peak ground acceleration:	0.19	Unit weight calculation:	Based on SBT	$K_\sigma$ applied:	Yes	MSF method:	Method based



Analysis method:	B&I (2014)	G.W.T. (in-situ):	2.50 m	Use fill:	No	Clay like behavior	
Fines correction method:	B&I (2014)	G.W.T. (earthq.):	2.50 m	Fill height:	N/A	applied:	.
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth applied:	No
Earthquake magnitude $M_w$ :	6.00	Ic cut-off value:	2.60	Trans. detect. applied:	No	Limit depth:	N/A
Peak ground acceleration:	0.19	Unit weight calculation:	Based on SBT	$K_\sigma$ applied:	Yes	MSF method:	Method based



Analysis method:	B&I (2014)	G.W.T. (in-situ):	2.50 m	Use fill:	No	Clay like behavior	
Fines correction method:	B&I (2014)	G.W.T. (earthq.):	2.50 m	Fill height:	N/A	applied:	.
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth applied:	No
Earthquake magnitude $M_w$ :	6.00	Ic cut-off value:	2.60	Trans. detect. applied:	No	Limit depth:	N/A
Peak ground acceleration:	0.19	Unit weight calculation:	Based on SBT	$K_\sigma$ applied:	Yes	MSF method:	Method based

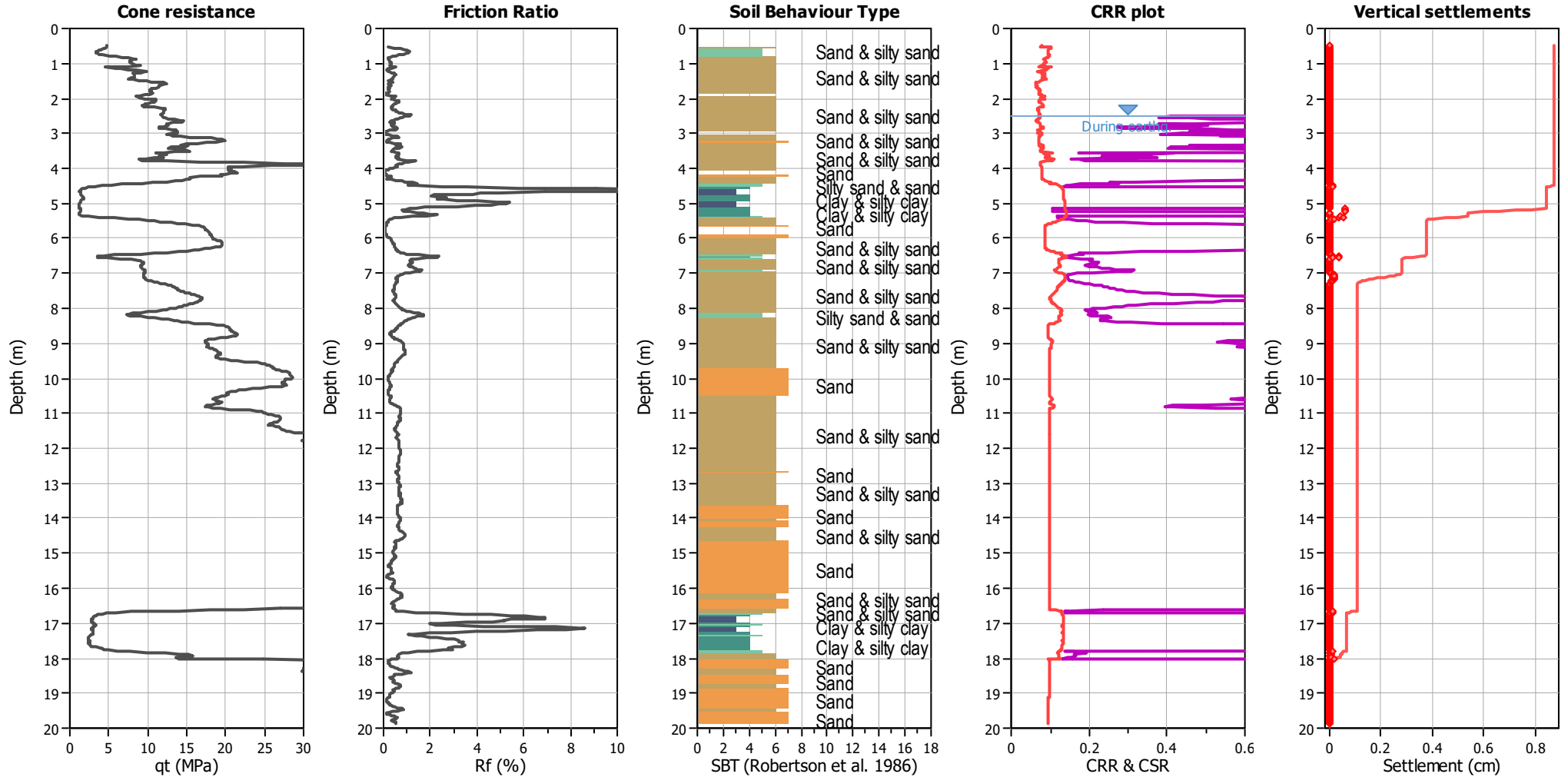


Analysis method:	B&I (2014)	G.W.T. (in-situ):	2.50 m	Use fill:	No	Clay like behavior	
Fines correction method:	B&I (2014)	G.W.T. (earthq.):	2.50 m	Fill height:	N/A	applied:	.
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth applied:	No
Earthquake magnitude $M_w$ :	6.00	Ic cut-off value:	2.60	Trans. detect. applied:	No	Limit depth:	N/A
Peak ground acceleration:	0.19	Unit weight calculation:	Based on SBT	$K_{\sigma}$ applied:	Yes	MSF method:	Method based



**Project: SLS M6.0/0.19g**
**Location: 145 & 167 Gladstone Road, Woodend**
**CPT: CPT\_31513**

Total depth: 19.88 m



Analysis method:	B&I (2014)	G.W.T. (in-situ):	2.50 m	Use fill:	No	Clay like behavior	
Fines correction method:	B&I (2014)	G.W.T. (earthq.):	2.50 m	Fill height:	N/A	applied:	.
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth applied:	No
Earthquake magnitude $M_w$ :	6.00	Ic cut-off value:	2.60	Trans. detect. applied:	No	Limit depth:	N/A
Peak ground acceleration:	0.19	Unit weight calculation:	Based on SBT	$K_\sigma$ applied:	Yes	MSF method:	Method based

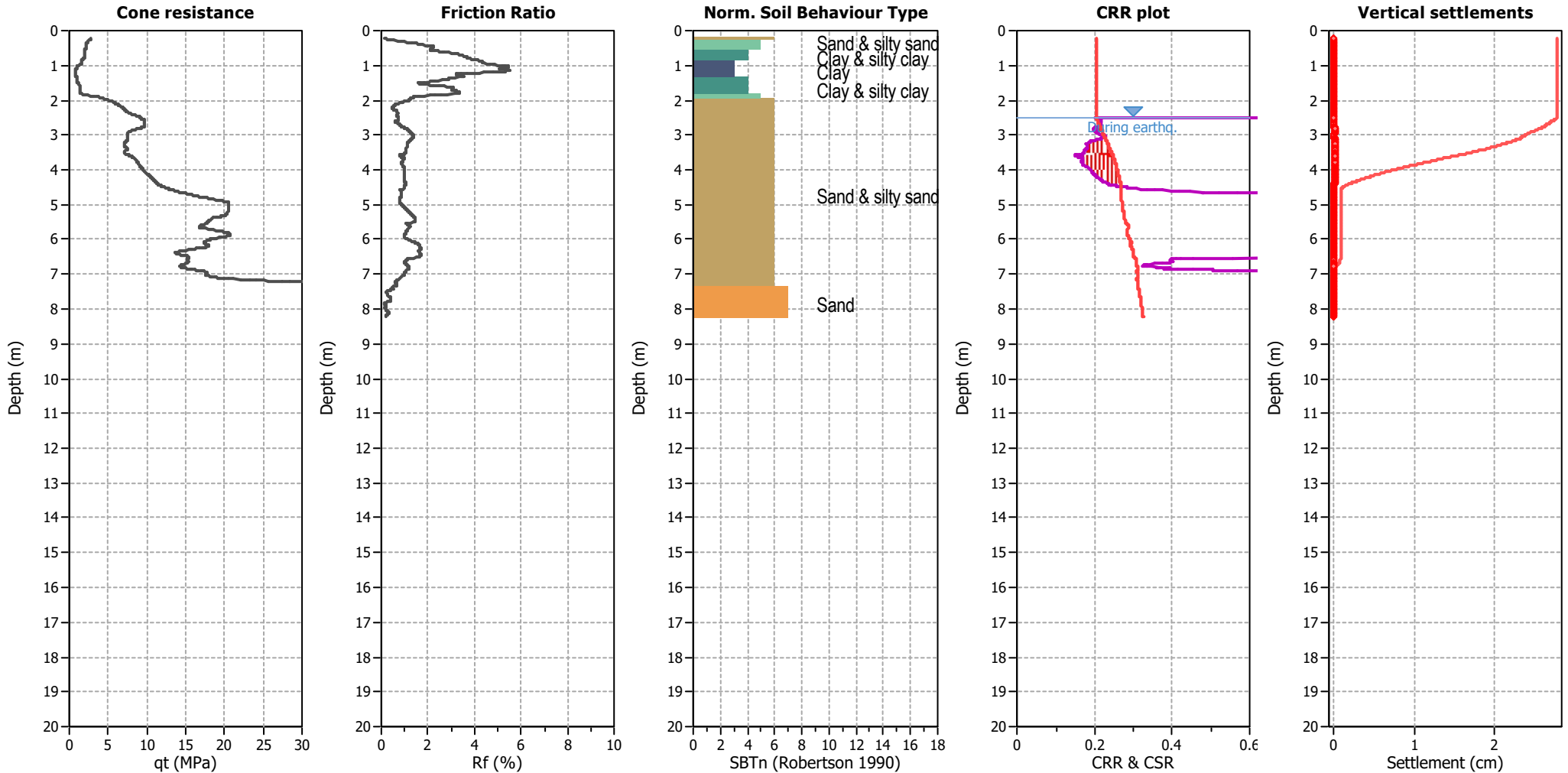


**Project:** ULS M7.5/0.35g

**Location:** 145 & 167 Gladstone Road, Woodend

**CPT: CPT\_01**

Total depth: 8.22 m



Analysis method:	B&I (2014)	G.W.T. (in-situ):	2.50 m	Use fill:	No	Clay like behavior	
Fines correction method:	B&I (2014)	G.W.T. (earthq.):	2.50 m	Fill height:	N/A	applied:	.
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth applied:	No
Earthquake magnitude $M_w$ :	7.50	Ic cut-off value:	2.60	Trans. detect. applied:	No	Limit depth:	N/A
Peak ground acceleration:	0.35	Unit weight calculation:	Based on SBT	$K_0$ applied:	Yes	MSF method:	Method based

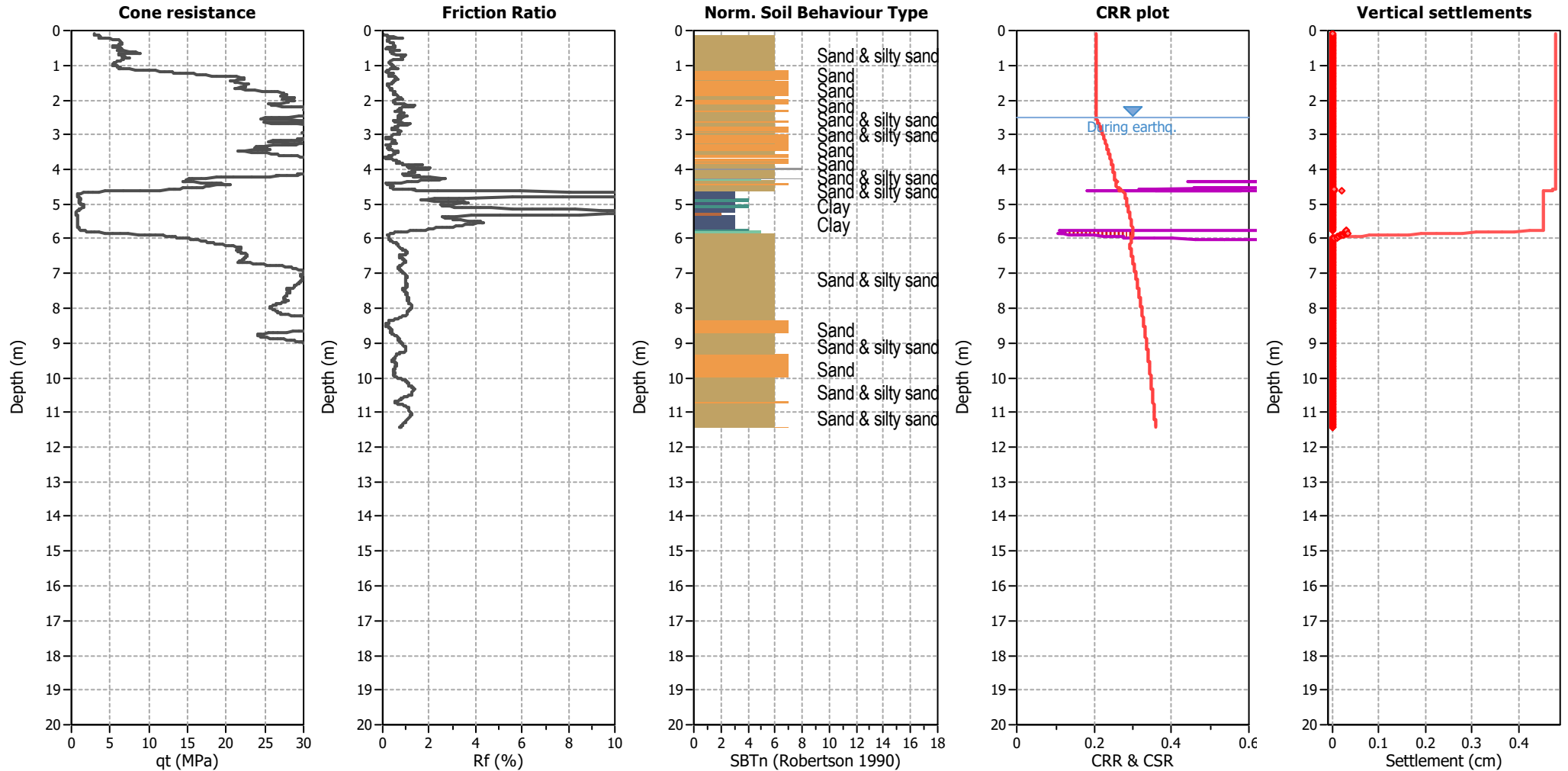


**Project:** ULS M7.5/0.35g

**Location:** 145 & 167 Gladstone Road, Woodend

**CPT: CPT\_02**

Total depth: 11.45 m



Analysis method:	B&I (2014)	G.W.T. (in-situ):	2.50 m	Use fill:	No	Clay like behavior	
Fines correction method:	B&I (2014)	G.W.T. (earthq.):	2.50 m	Fill height:	N/A	applied:	.
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth applied:	No
Earthquake magnitude $M_w$ :	7.50	Ic cut-off value:	2.60	Trans. detect. applied:	No	Limit depth:	N/A
Peak ground acceleration:	0.35	Unit weight calculation:	Based on SBT	$K_q$ applied:	Yes	MSF method:	Method based

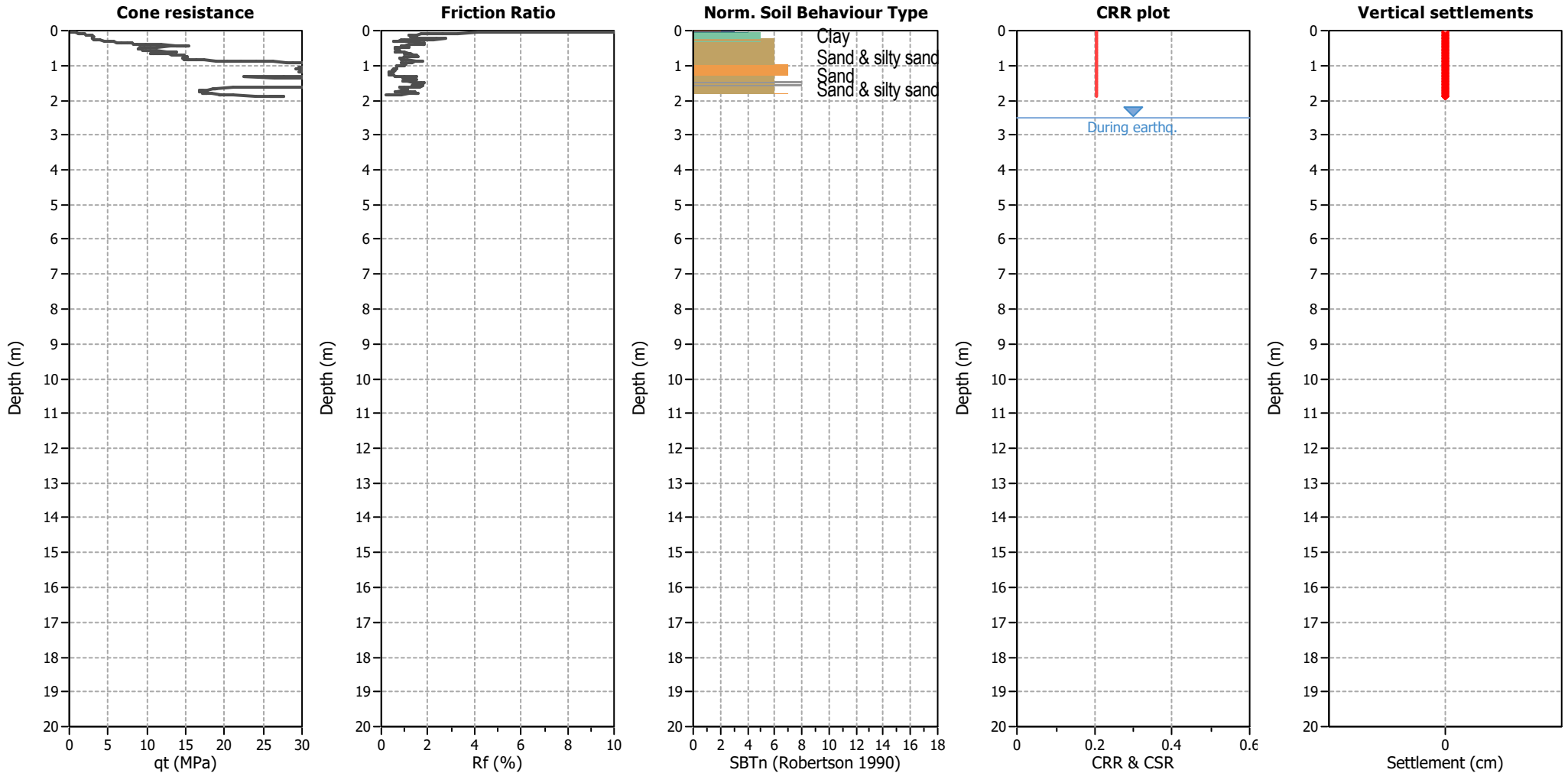


**Project:** ULS M7.5/0.35g

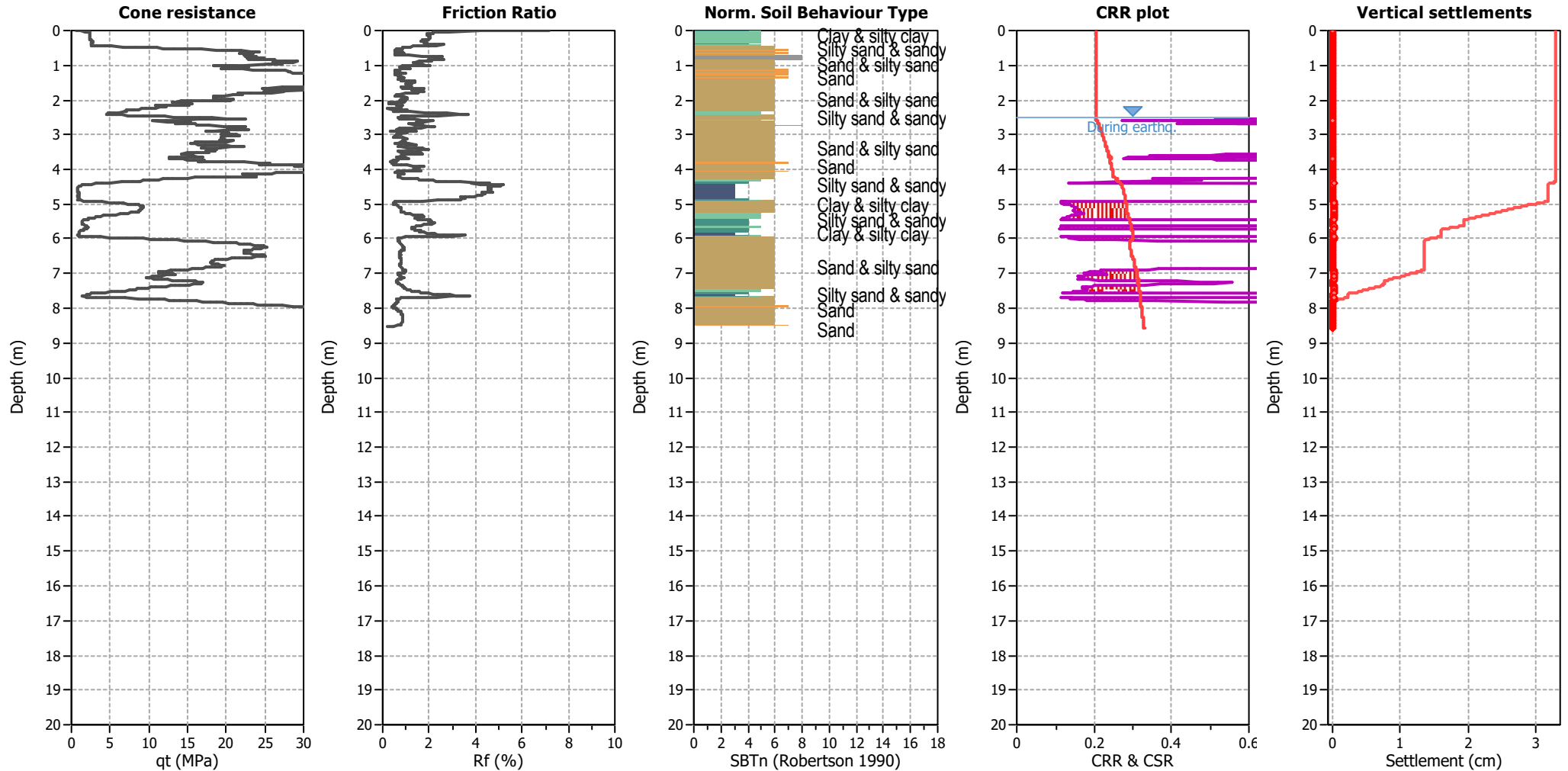
**Location:** 145 & 167 Gladstone Road, Woodend

**CPT: CPT\_03**

Total depth: 1.91 m



Analysis method:	B&I (2014)	G.W.T. (in-situ):	2.50 m	Use fill:	No	Clay like behavior	
Fines correction method:	B&I (2014)	G.W.T. (earthq.):	2.50 m	Fill height:	N/A	applied:	.
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth applied:	No
Earthquake magnitude $M_w$ :	7.50	Ic cut-off value:	2.60	Trans. detect. applied:	No	Limit depth:	N/A
Peak ground acceleration:	0.35	Unit weight calculation:	Based on SBT	$K_0$ applied:	Yes	MSF method:	Method based



Analysis method:	B&I (2014)	G.W.T. (in-situ):	2.50 m	Use fill:	No	Clay like behavior	
Fines correction method:	B&I (2014)	G.W.T. (earthq.):	2.50 m	Fill height:	N/A	applied:	.
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth applied:	No
Earthquake magnitude $M_w$ :	7.50	Ic cut-off value:	2.60	Trans. detect. applied:	No	Limit depth:	N/A
Peak ground acceleration:	0.35	Unit weight calculation:	Based on SBT	$K_0$ applied:	Yes	MSF method:	Method based



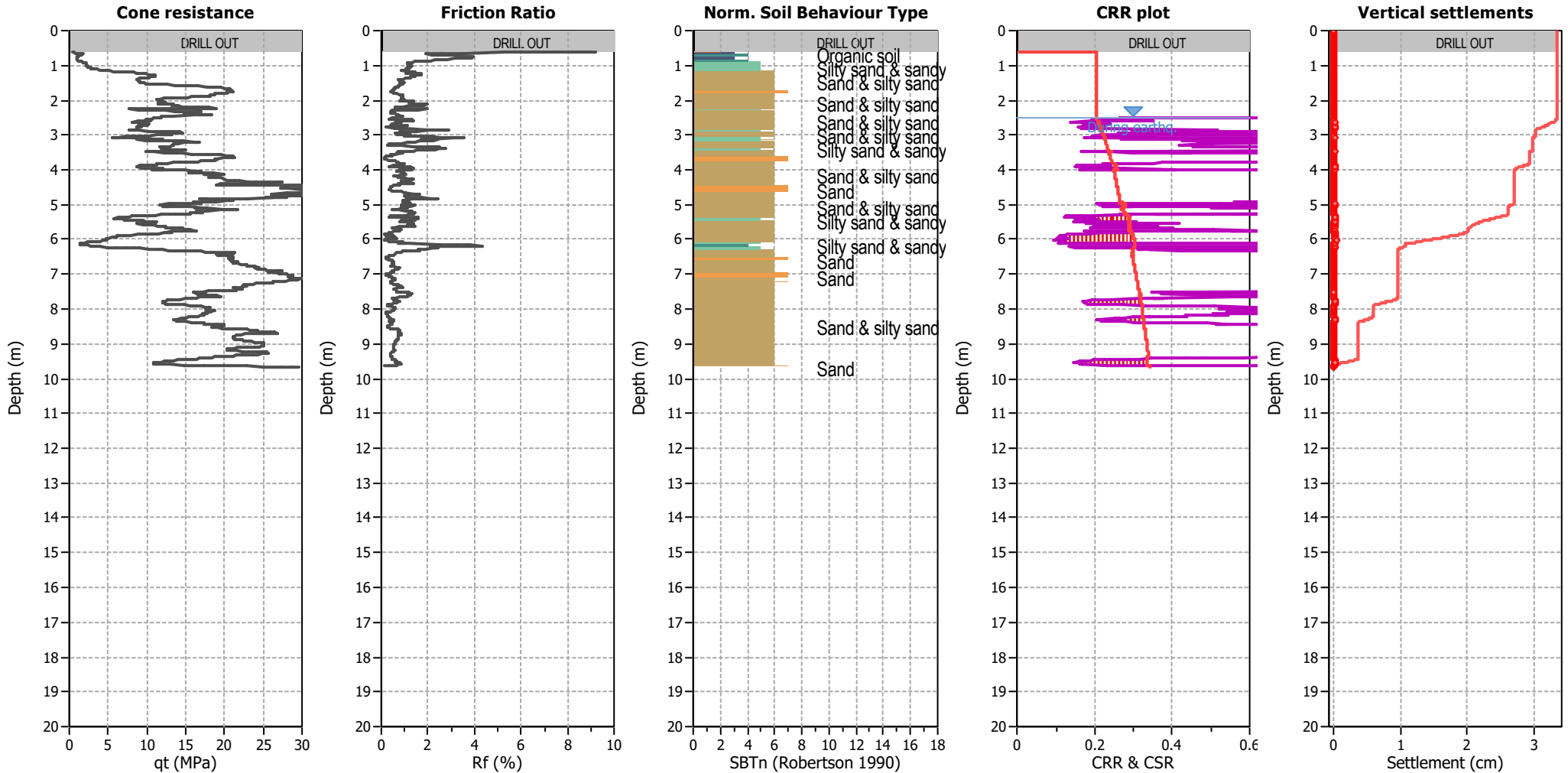


Project: ULS M7.5/0.35g

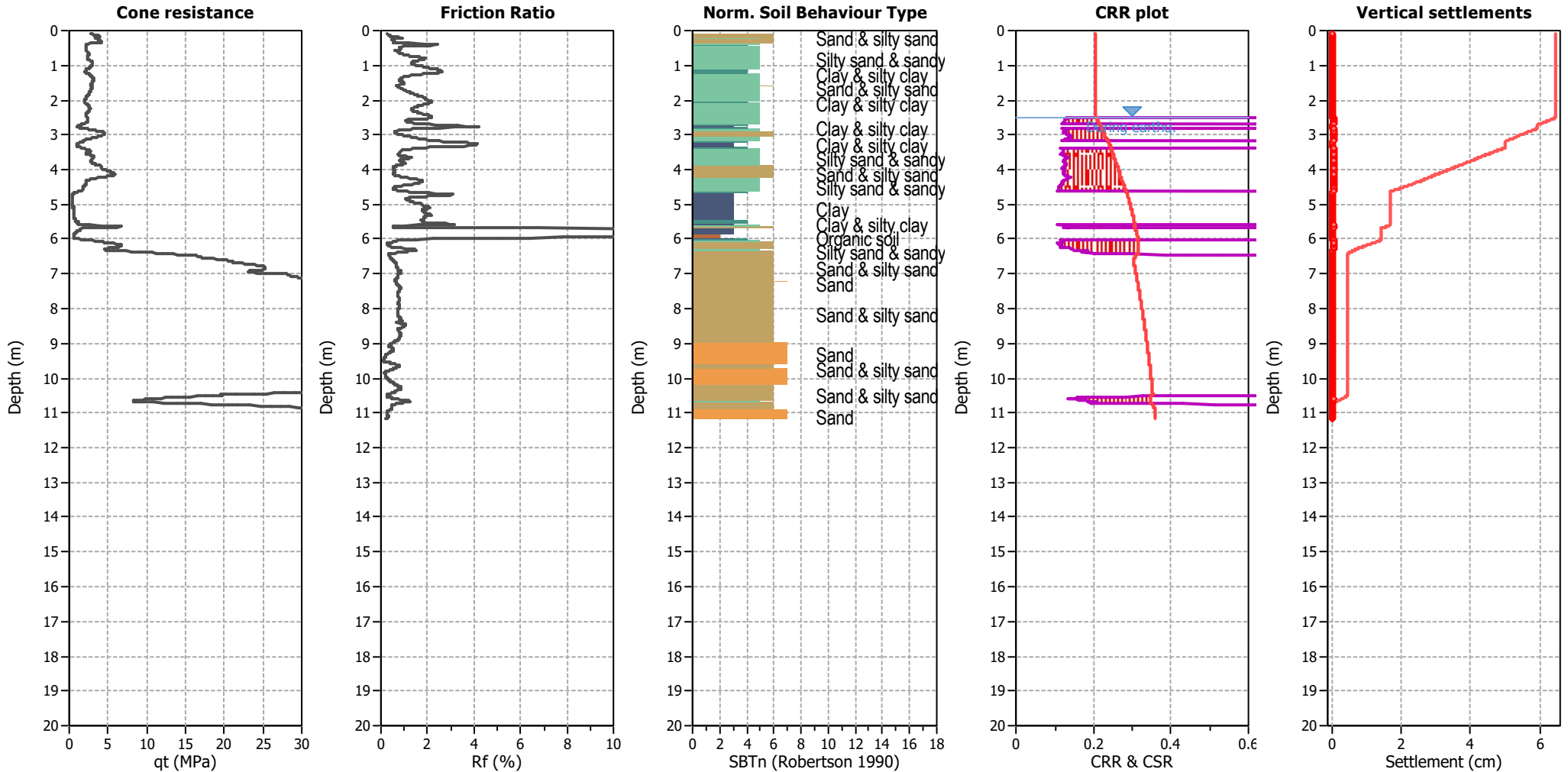
Location: 145 & 167 Gladstone Road, Woodend

CPT: CPT\_05

Total depth: 9.68 m



Analysis method:	B&I (2014)	G.W.T. (in-situ):	2.50 m	Use fill:	No	Clay like behavior	
Fines correction method:	B&I (2014)	G.W.T. (earthq.):	2.50 m	Fill height:	N/A	applied:	.
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth applied:	No
Earthquake magnitude $M_w$ :	7.50	Ic cut-off value:	2.60	Trans. detect. applied:	No	Limit depth:	N/A
Peak ground acceleration:	0.35	Unit weight calculation:	Based on SBT	$K_0$ applied:	Yes	MSF method:	Method based



Analysis method:	B&I (2014)	G.W.T. (in-situ):	2.50 m	Use fill:	No	Clay like behavior	
Fines correction method:	B&I (2014)	G.W.T. (earthq.):	2.50 m	Fill height:	N/A	applied:	.
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth applied:	No
Earthquake magnitude $M_w$ :	7.50	Ic cut-off value:	2.60	Trans. detect. applied:	No	Limit depth:	N/A
Peak ground acceleration:	0.35	Unit weight calculation:	Based on SBT	$K_0$ applied:	Yes	MSF method:	Method based

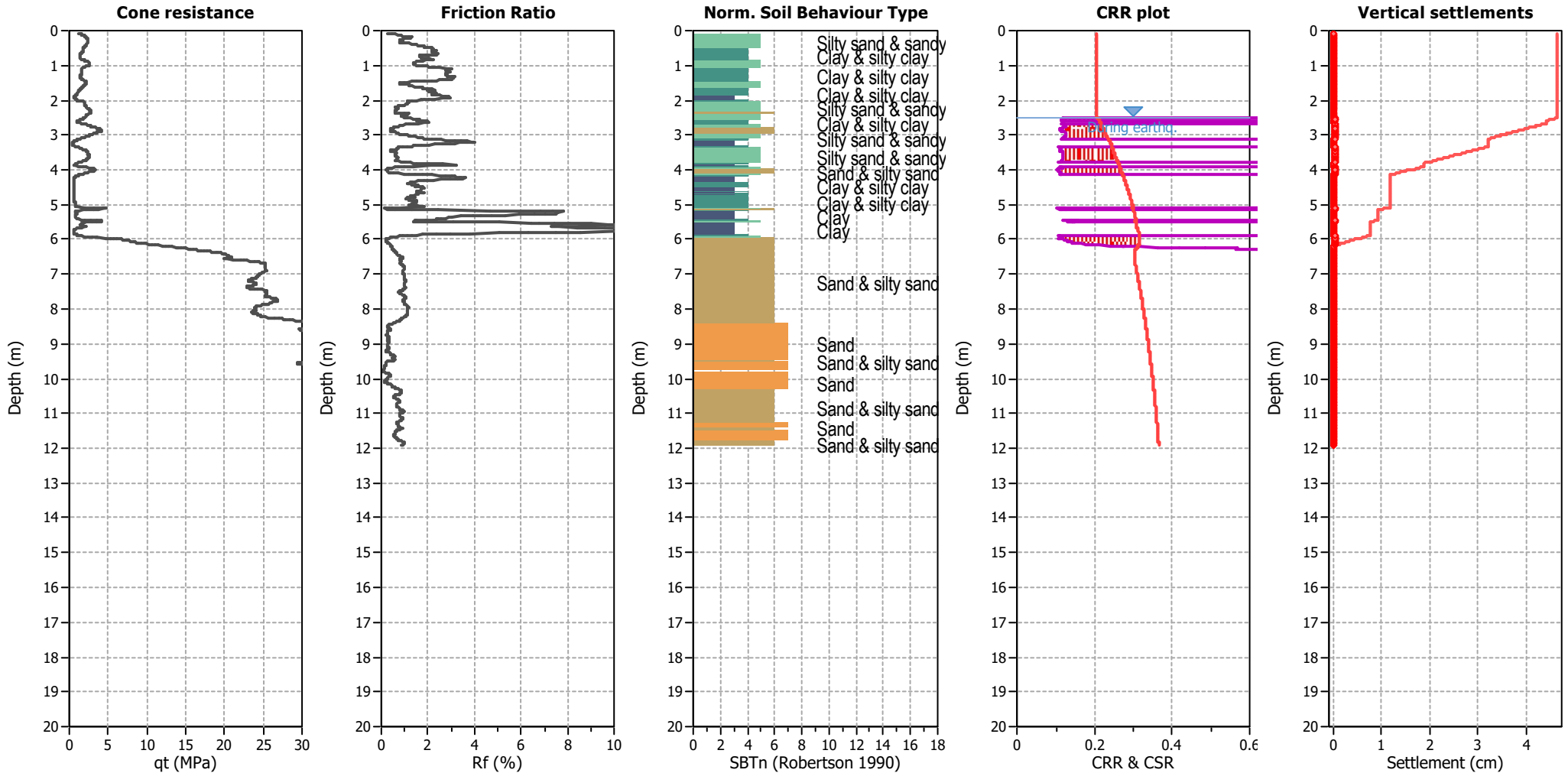


Project: ULS M7.5/0.35g

Location: 145 & 167 Gladstone Road, Woodend

CPT: CPT\_07

Total depth: 11.92 m



Analysis method:	B&I (2014)	G.W.T. (in-situ):	2.50 m	Use fill:	No	Clay like behavior	
Fines correction method:	B&I (2014)	G.W.T. (earthq.):	2.50 m	Fill height:	N/A	applied:	.
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth applied:	No
Earthquake magnitude $M_w$ :	7.50	Ic cut-off value:	2.60	Trans. detect. applied:	No	Limit depth:	N/A
Peak ground acceleration:	0.35	Unit weight calculation:	Based on SBT	$K_0$ applied:	Yes	MSF method:	Method based

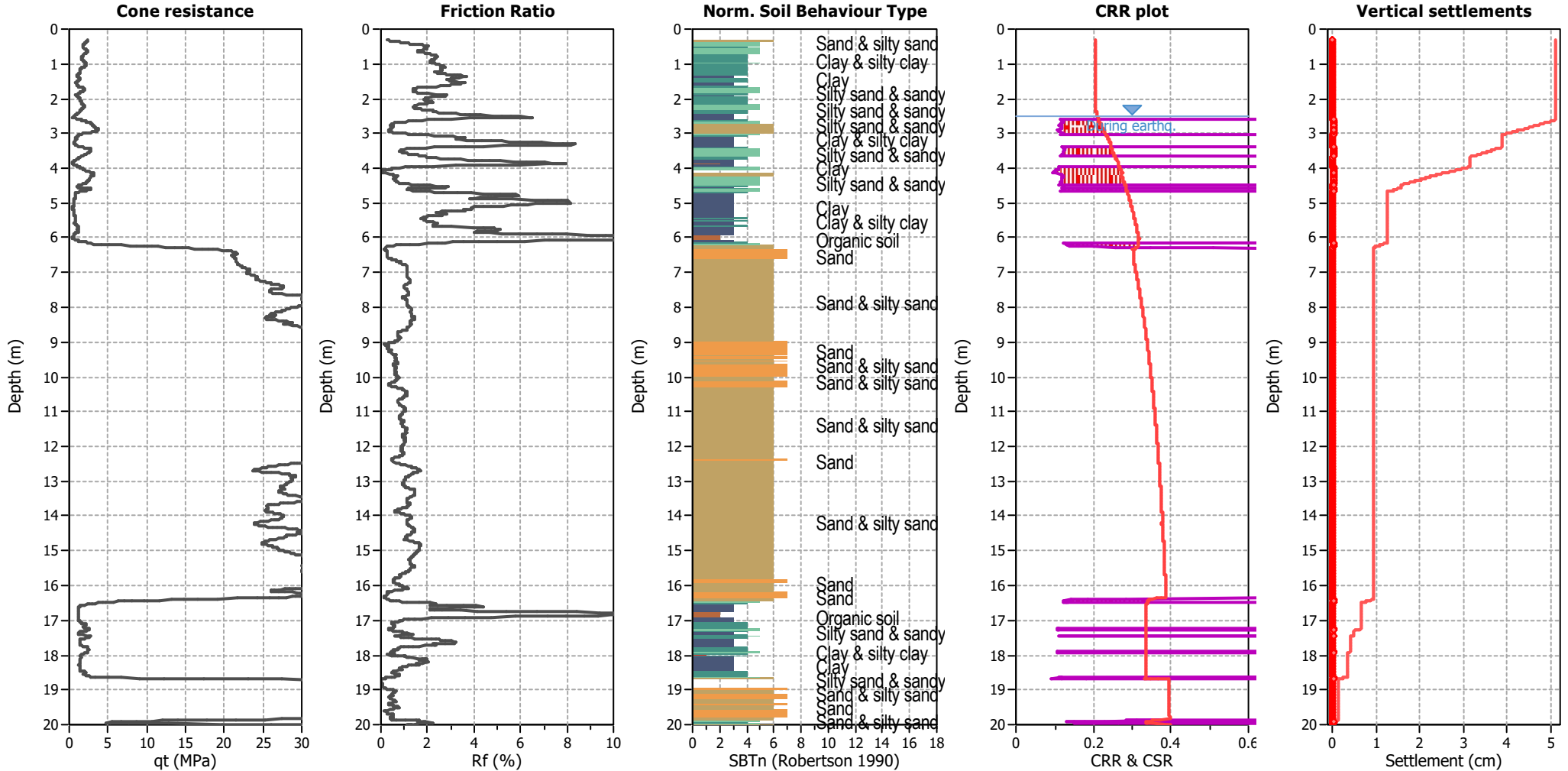


Project: ULS M7.5/0.35g

Location: 145 & 167 Gladstone Road, Woodend

CPT: CPT\_08

Total depth: 20.15 m



Analysis method:	B&I (2014)	G.W.T. (in-situ):	2.50 m	Use fill:	No	Clay like behavior	
Fines correction method:	B&I (2014)	G.W.T. (earthq.):	2.50 m	Fill height:	N/A	applied:	.
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth applied:	No
Earthquake magnitude $M_w$ :	7.50	Ic cut-off value:	2.60	Trans. detect. applied:	No	Limit depth:	N/A
Peak ground acceleration:	0.35	Unit weight calculation:	Based on SBT	$K_0$ applied:	Yes	MSF method:	Method based

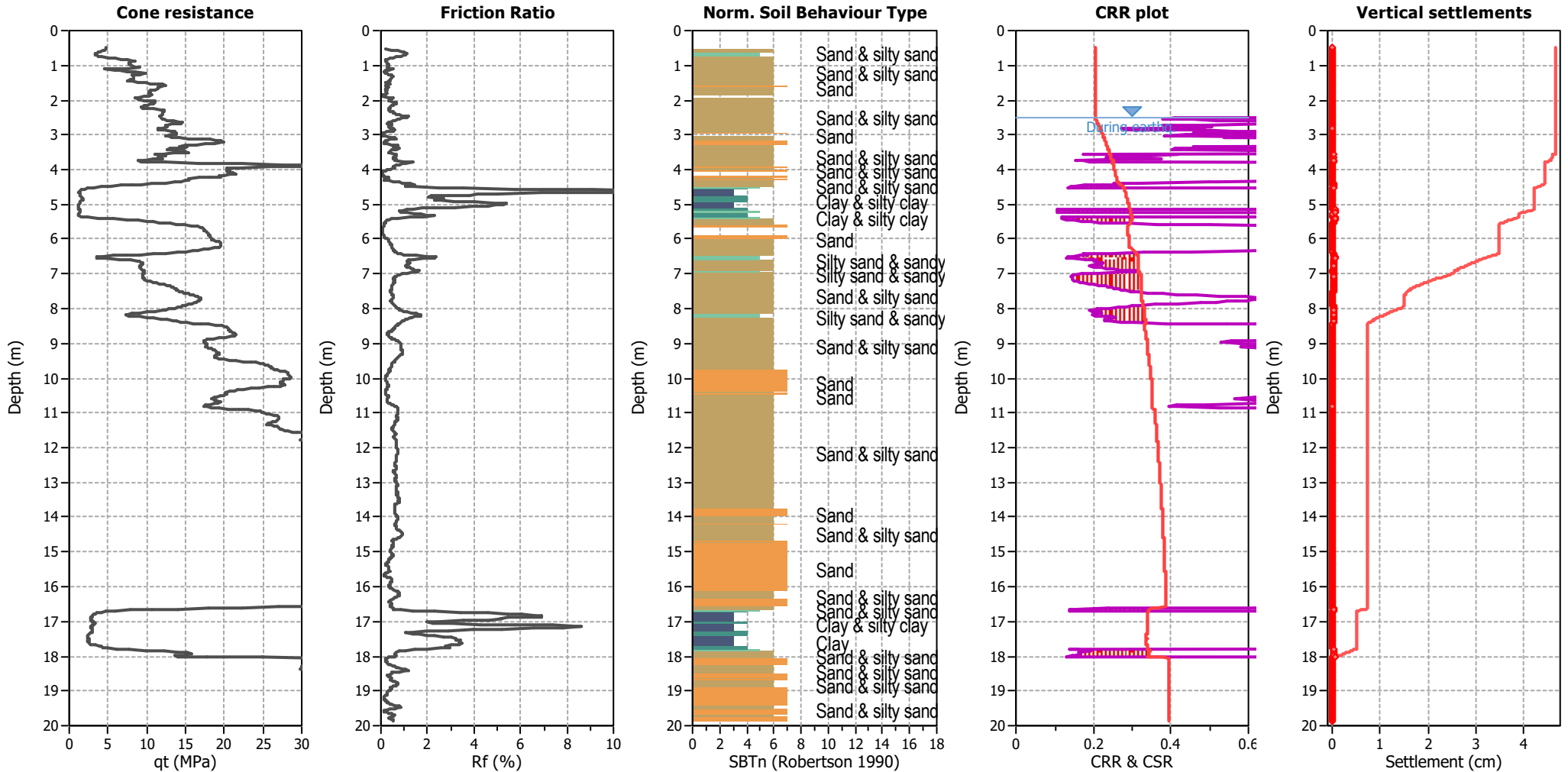


Project: ULS M7.5/0.35g

Location: 145 & 167 Gladstone Road, Woodend

CPT: CPT\_31513

Total depth: 19.88 m



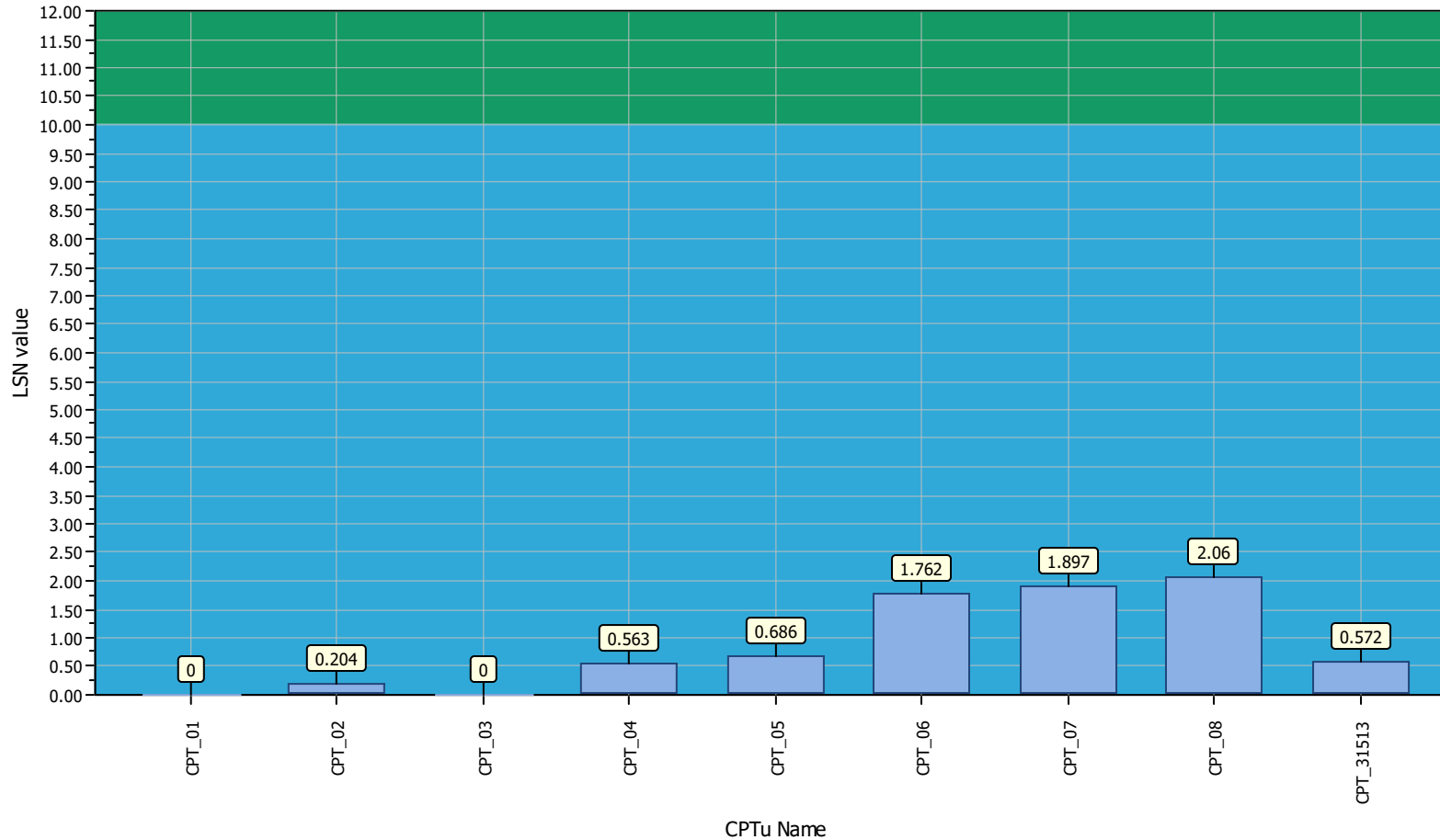
Analysis method:	B&I (2014)	G.W.T. (in-situ):	2.50 m	Use fill:	No	Clay like behavior	
Fines correction method:	B&I (2014)	G.W.T. (earthq.):	2.50 m	Fill height:	N/A	applied:	.
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth applied:	No
Earthquake magnitude $M_w$ :	7.50	Ic cut-off value:	2.60	Trans. detect. applied:	No	Limit depth:	N/A
Peak ground acceleration:	0.35	Unit weight calculation:	Based on SBT	$K_0$ applied:	Yes	MSF method:	Method based



Project title : SLS M7.5/0.13g

Location : 145 & 167 Gladstone Road, Woodend

### Overall Liquefaction Severity Number report



#### LSN color scheme

- Severe damage
- Major expression of liquefaction
- Moderate to severe exp. of liquefaction
- Moderate expression of liquefaction
- Minor expression of liquefaction
- Little to no expression of liquefaction

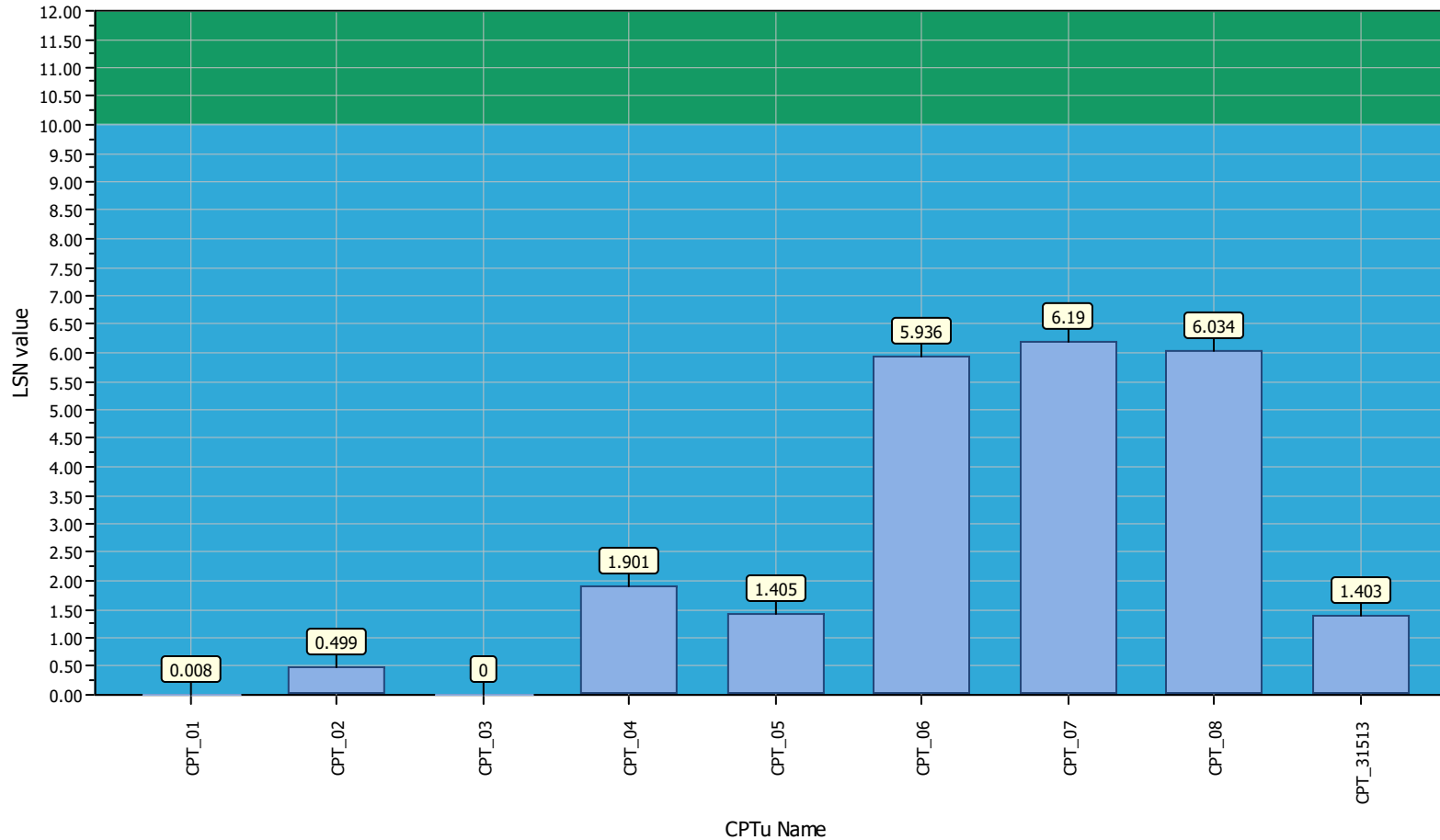
#### Basic statistics

- Total CPT number: 9
- 100% little liquefaction
- 0% minor liquefaction
- 0% moderate liquefaction
- 0% moderate to major liquefaction
- 0% major liquefaction
- 0% severe liquefaction

Project title : SLS M6.0/0.19g

Location : 145 & 167 Gladstone Road, Woodend

### Overall Liquefaction Severity Number report



#### LSN color scheme

- Severe damage
- Major expression of liquefaction
- Moderate to severe exp. of liquefaction
- Moderate expression of liquefaction
- Minor expression of liquefaction
- Little to no expression of liquefaction

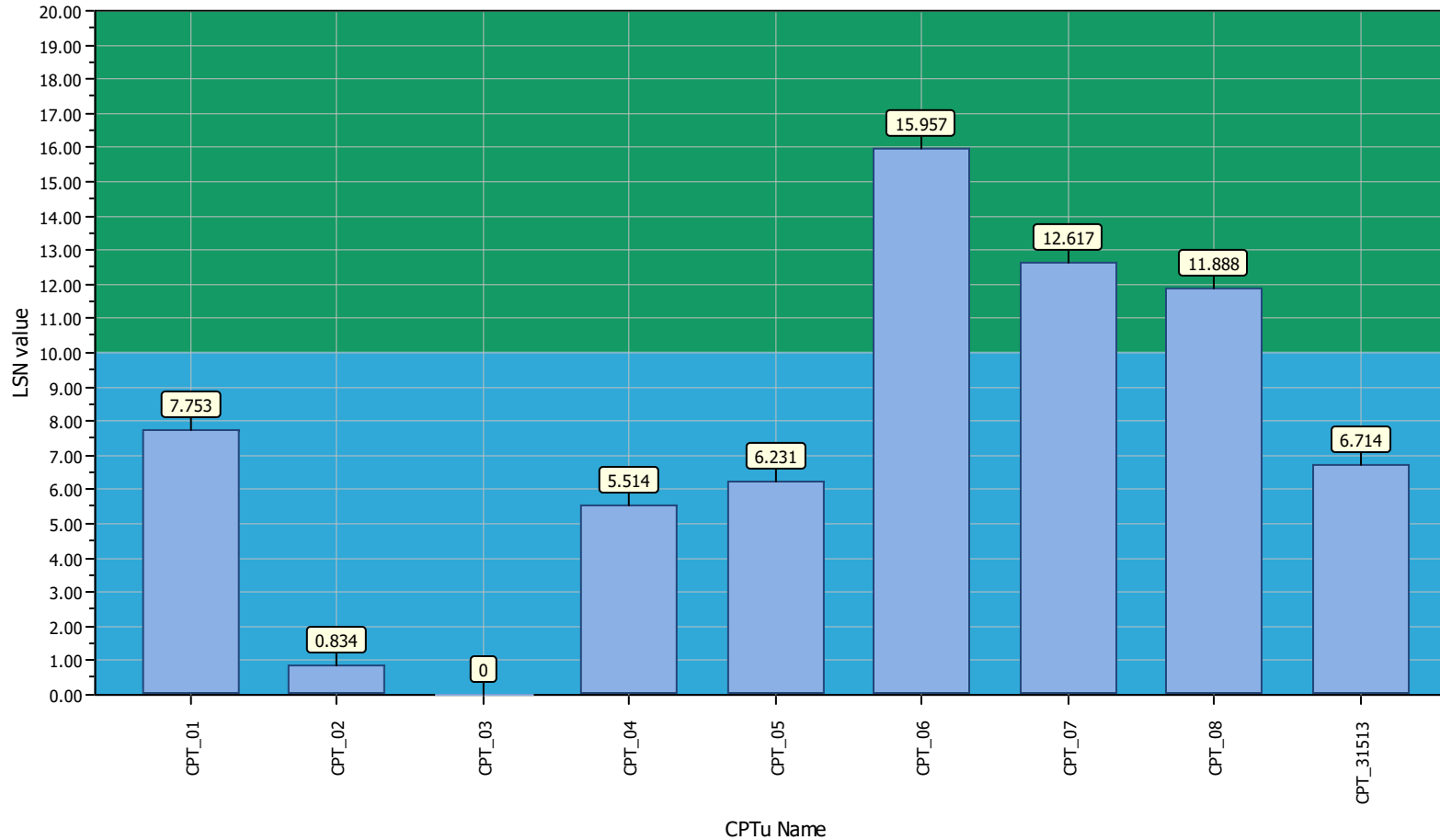
#### Basic statistics

- Total CPT number: 9
- 100% little liquefaction
- 0% minor liquefaction
- 0% moderate liquefaction
- 0% moderate to major liquefaction
- 0% major liquefaction
- 0% severe liquefaction

Project title : ULS M7.5/0.35g

Location : 145 & 167 Gladstone Road, Woodend

### Overall Liquefaction Severity Number report



#### LSN color scheme

- Severe damage
- Major expression of liquefaction
- Moderate to severe exp. of liquefaction
- Moderate expression of liquefaction
- Minor expression of liquefaction
- Little to no expression of liquefaction

#### Basic statistics

- Total CPT number: 9
- 67% little liquefaction
- 33% minor liquefaction
- 0% moderate liquefaction
- 0% moderate to major liquefaction
- 0% major liquefaction
- 0% severe liquefaction