Before the Independent Commissioner
Appointed by the Selwyn District Council

Under	the Resource Management Act 1991
In the matter of	a hearing on Plan Change 79 to the Operative Selwyn District Plan
	Birchs Village Limited
	Proponent

Statement of Evidence of Andrew Christopher Jordan

17 April 2023

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Qualifications and Experience

1 My full name is Andrew Christopher Jordan.

2 I hold a Bachelor of Science (Geology) degree and am a member of Engineering New Zealand and the New Zealand Geotechnical Society.

3 I am currently employed as a senior engineering geologist in the Christchurch Tetra Tech Coffey office and have held this (or similar) position/s since 2013.

4 My previous work experience includes working as an engineering geologist at MWH in their Christchurch office.

5 This evidence is provided in support of Birchs Village Limited (**BVL**) private plan change request to rezone approximately 37 ha of land from Inner Plains Living Medium Density Prebbleton and Business 1 in an area south of Hamptons Road, west of Birchs Road and east of Springs Road, Prebbleton (**Site**). My role has been to provide advice in relation to the site's suitability for residential development from a geotechnical and engineering geological perspective.

6 I prepared an assessment dated 9 March 2021 (Rev 1 issued 7 July 2022) which commented on the geotechnical hazards present at the site and commented on the risk of these hazards to future residential development at the Site which accompanied the private plan change request to the Operative Selwyn District Plan (**PC79** - Plan Change Request 79). I understand that medium density residential housing is proposed for the Site. I have worked on a large number of residential projects across Canterbury and New Zealand, including several medium to large subdivisions, I am also currently involved in geotechnical building consent reviews for Christchurch City Council.

7 As part of the Tetra Tech Coffey geotechnical assessment I completed a Site visit at the time of the ground investigation and was the primary author of the Tetra Tech Coffey report.

Code of Conduct for Expert Witnesses

8 While this is not a hearing before the Environment Court, I confirm I have read the Code of Conduct for expert witnesses contained in the Environment Court of New Zealand Practice Note 2023 and I have complied with it when preparing my evidence. Other than when I state I am relying on the advice of another person, this evidence is within my area of expertise. I have not omitted to consider material facts known to me that might alter or detract from the opinions that I express.

Scope of Evidence

9 I have prepared evidence in relation to:

(a) The geotechnical site conditions and the geotechnical hazards at the Site; and

(b) The Site's future risk of geotechnical hazards.

Introduction

10 Tetra Tech Coffey completed an assessment dated 9 March 2021 to support the PC79 by Birchs Village Limited (attached as Appendix 9 to the Application). This assessment included a desktop study, geotechnical investigation, geotechnical analysis and produced a report which quantified the Sites geotechnical hazards and confirmed the Site was considered suitable for future residential development.

11 Subsequently additional testing was completed at the Site which included the installation of 3 piezometers and 7 additional cone penetration tests. These tests were included in an updated report which was issued on 7 July 2022 (attached as **Appendix A**).

Background

12 The desktop study identified that the geology at the Site included "Grey to brown alluvium, comprising silty subangular gravel and sand forming alluvial fans" of the Springston Formation.

13 Three cone penetration tests (**CPT**), one machine borehole and eight hand augured boreholes were identified on the Site from a review of Tetra Tech Coffey's internal records and through a review of the New Zealand Geotechnical Database.

14 The CPTs extended to between 3.7 and 12.3mbgl; while the machine borehole extended to 20mbgl and the hand augured boreholes extended to between 0.8 and 3.0mbgl.

15 A review of the ground shaking which the site experienced during the Canterbury Earthquakes indicted the Site had likely experienced shaking similar to a design serviceability limit state event and evidence of liquefaction induced ground damage was not observed.

16 Environment Canterbury mapping[1] places the Site on the boundary of an area where liquefaction assessment is required and an area where damaging liquefaction is unlikely to occur.

[1] Environment Canterbury report number R12/83: Brackley, H. L. (compiler). 2012. Review of liquefaction hazard information in eastern Canterbury, including Christchurch City and parts of Selwyn, Waimakariri and Hurunui Districts, GNS Consultancy Report 2012/218. 99p.

Investigation

17 Tetra Tech Coffey completed eight initial CPT tests and two additional hand augured boreholes in 2021 and supervised the installation of 3 piezometers and 7 additional CPT tests in 2022. These tests were undertaken to supplement the available geotechnical testing at the site.

18 From the available test information, the ground profile was summarised as 0.3 to 0.4m of topsoil overlying interbedded sand and silt layers to between 1.8 and 4.8mbgl (over the majority of the Site) but to 9.0mbgl near the middle of the eastern side of the Site. Beneath this sand and silt layer medium dense to very dense sand and gravel deposits were identified.

19 Groundwater was assessed using the recently installed piezometers as being between 3.5 and 5.25mbgl.

20 Notwithstanding the above, for consistency with our initial report the liquefaction analysis was carried out using a ground water depth of 2.0mbgl. This is considered to be conservative based on the recent piezometer recordings.

Analysis / Assessment

21 The site is assessed as being Site Subsoil Class – Class D (Deep or soft soil site).

22 Natural hazards which include erosion, falling debris, slippage and inundation were assessed to be either low or able to be managed through specific design by other consultants (i.e. civil design).

23 The main hazard was identified as subsidence. Under static conditions it was assessed subsidence could be managed by adopting normal construction practices.

24 Under earthquake conditions a liquefaction assessment was undertaken which indicated the future site performance was generally in line with a technical category 1 (**TC1**) or TC2 site. In Canterbury it is generally required that future subdivisions meet a TC1 or TC2 classification which was confirmed by our analysis.

25 Further characterisation of TC1 and TC2 portions of the site could be achieved through additional CPT testing at the site once the subdivision plan is confirmed and through ongoing monitoring of the installed piezometers. This is recommended at subdivision stage of the development.

Peer Review

26 Selwyn District Council commissioned a peer review of the 9 March 2021 Coffey report. This peer review was undertaken by Geotech Consulting Limited on 24 June 2021 and concluded:

(a) "Natural hazards (RMA section 106) are assessed and found to be not present or able to be easily mitigated"; and

(b) "The report shows that the site has some liquefaction potential, but generally fall within MBIE Foundation Technical Categories TC1 and TC2. However, observations following the September 2010 earthquake suggest that a small part of the site may be more susceptible than the analysis suggests. We accept the Coffey conclusion that the site is suitable for residential development subject to further investigation and design at subdivision consent stage, but emphasise that further testing and assessment is needed at subdivision stage, along Birchs Road side in particular."

Conclusion

27 From a geotechnical perspective the Site is considered to meet the TC1 or TC2 requirement which has been adopted by consenting authorities in Canterbury.

28 The natural hazards outlined in Section 106 of the RMA are considered to be either low risk or able to be managed by normal design and construction practices.

29 The Tetra Tech Coffey assessment was reviewed by an independent peer reviewer (engaged by Selwyn District Council) who generally supported the above assessment.

30 Based on the above information and my experience in completing similar projects in Canterbury I support the rezoning of the site for future residential development from a geotechnical perspective.

Andrew Christopher Jordan

Dated this 17th day of April 2023

Appendix 1 – Updated Geotechnical Report dated 7 July 2022

Birch's Village Plan Change

Geotechnical Assessment Report

Birch's Village Limited

Reference: 773-CHCGE283773

7 July 2022

BIRCH'S VILLAGE PLAN CHANGE

Birch’s Village Limited

Report reference number: 773-CHCGE283773

7 July 2022

PREPARED FOR

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QUALITY INFORMATION

Revision history

Revision	Description	Date	Author	Reviewer	Approver
Rev 0	GAR	09/03/2021	AJ	RB	AJ
Rev 1	Added testing	7/07/2022	AJ/BC	LB	AJ

Distribution

Report Status	No. of copies	Format	Distributed to	Date
Rev 0	1	PDF	Sally Eldford (Baseline Group)	09/03/2021
Rev 1	1	PDF	Sally Eldford (Baseline Group) Ryan Geddes	27/06//2022

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1. INTRODUCTION

Birch's Village Limited has engaged Tetra Tech Coffey (NZ) Limited (formerly Coffey) to carry out a geotechnical investigation and assessment of suitability for a proposed Plan Change and future subdivision at 57 Hamptons Road and 142 to 214B Birchs Road, Prebbleton, located approximately 12.5 km southwest of Cathedral Square, Christchurch. The purpose of this report is to support a Plan Change application for the construction of new residential Lots at the site.

Our assessment has considered the items required by Section 106 of the Resource Management Act (RMA). In our opinion the site is considered geotechnically suitable for subdivision subject to further investigation and design at the subdivision consent stage.

This report revision has been compiled to include 7 additional CPT tests and the installation of 3 piezometers. These tests/installations were completed following the issue of the original March 2021 Coffey Report[1].

2. SCOPE

An investigation methodology for the 42.3 Ha site was developed and carried out by Tetra Tech Coffey, as outlined below:

- Review of previous geotechnical investigations including previous work on the site and surrounding area.
  - This identified 3 existing CPTs on the site and 1 borehole.
- The completion of 15 cone penetration tests (CPTs) [includes 7 additional CPTs]. The CPT tests are a primary investigation tool used to develop the preliminary ground model at the site.
- 3 hand augered boreholes were also undertaken to check topsoil depth and confirm the depth to ground water.
- Site walkover to assess geotechnical hazards.
- 3 piezometers were installed and spread across the site in order to determine the depth to groundwater. *These were done after the original March 2021 Coffey Report*.
- Assessment of the geotechnical hazards at the site as per Section 106 of the RMA.
- Geotechnical analyses and reporting.

Tetra Tech Coffey have considered the following in the preparation of this report:

- Existing geotechnical investigation data available in the area from the New Zealand Geotechnical Database (NZGD).
- The new geotechnical investigations data.
- Project correspondence with the wider Plan Change by Birch's Village Limited.

Reference has also been made to the MBIE Guidance Part D: Subdivisions, to confirm that the requirements outlined in these documents have been incorporated in this report.

[1] Coffey Report: Birch's Village Plan Change, Geotechnical Assessment Report, Ref 773-CHCGE283773 dated 9 March 2021

3. PROPOSED DEVELOPMENT

The proposed Plan Change area is comprised of a series of nine land parcels, totalling to approximately 42.3 Ha and is located to the south of Prebbleton township. The site is made up by a number of lifestyle properties which comprise large areas of greenfield land with localised residential houses (Figure 1 below).

Figure 1: Proposed area for plan change (GoogleEarth,2022).

4. PUBLICLY AVAILABLE GEOTECHNICAL DATA

As part of our desktop study review, we identified four site specific deep investigation data points and eight site specific shallow data points. These investigations have been summarised in Table 1 below and have been used as part of our assessment of the site. The factual information from each of these tests (including site location plan) is presented in Appendix B of this report.

Table 1: NZGD investigation summary.

Reference	Date of test	Depth of test (metres below ground level)	Depth to groundwater (as measured)	Termination criteria
BH - 35576	17/10/2013	~20.0	~2.0	Target depth
CPT - 115979	13/11/2017	~3.7	Not measured	Effective refusal
CPT - 88221	14/10/2016	~12.3	Not measured	Effective refusal
CPT - 88224	14/10/2016	~9.3	Not measured	Effective refusal
KGA – HA01	13/11/2017	~0.8	Not measured	Effective refusal
KGA – HA02	13/11/2017	~1.0	Not measured	Effective refusal
KGA – HA03	13/11/2017	~3.0	Not measured	Target depth
KGA – HA04	13/11/2017	~1.0	Not measured	Effective refusal
KGA – HA05	13/11/2017	~3.0	Not measured	Target depth
KGA – HA06	13/11/2017	~3.0	Not measured	Target depth
KGA – HA07	13/11/2017	~3.0	Not measured	Target depth
KGA – HA08	13/11/2017	~3.0	Not measured	Target depth

5. TETRA TECH COFFEY SITE INVESTIGATION

Tetra Tech Coffey completed additional testing across the site in order to geotechnically characterise the site. This testing was targeted to generating a generalised ground model across the site for the purpose of resource consent application. We completed the investigation based on land access and note that we did not access two properties on the SE part of the site (see Site Plan in Appendix A). We note that some additional infill investigation may be required in this area prior to final subdivision consent being granted.

The testing was completed on 12 February 2021 and is summarised in Table 2 below. Additional investigations were carried out in April 2022 and comprised 7 CPTs and the installation of 3 piezometers across the site. The investigation locations and logs from each of these investigations are presented in Appendix A and Appendix B respectively to this report.

Table 2: Tetra Tech Coffey's investigation summary.

Reference	Depth of test (metres below ground level)	Depth to groundwater [m] (as measured)	Termination criteria
HA1	~2.0	Not encountered	Target depth
HA2	~1.5	Not encountered	Effective refusal
CPT-01	~2.4	Not measured	Effective refusal
CPT-02	~6.7	Not measured	Effective refusal
CPT-03	~4.8	Not measured	Effective refusal
CPT-04	~1.5	Not measured	Effective refusal
CPT-05	~4.0	Not measured	Effective refusal
CPT-06	~2.3	Not measured	Effective refusal
CPT-07	~2.1	Not measured	Effective refusal
CPT-08	~1.8	Not measured	Effective refusal
CPT-09	~1.8	Not encountered	Effective refusal
CPT-10	~1.5	Not measured	Effective refusal
CPT-11	~3.4	Not encountered	Effective refusal
CPT-12	~1.2	Not encountered	Effective refusal
CPT-13	~1.5	Not encountered	Effective refusal
CPT-14	~0.6	Not encountered	Effective refusal
CPT-15	~3.8	Not encountered	Effective refusal
P01	~6.0	3.5 (13/04/22)	Target depth
P02	~6.0	3.75 (13/04/22)	Target depth
P03	~6.0	5.25 (13/04/22)	Target depth

6. SITE PERFORMANCE

6.1. GROUND MOTION

Using the MBIE[1] and Bradley & Hughes (2012)[2] procedures, we have found that the site was "sufficiently tested" to the Serviceability Limit State (SLS) level of earthquake demand during the 4 September 2010, 22 February 2011 and 13 June 2011 Christchurch earthquake sequence (CES). We note that in Prebbleton the 4 September M7.1 Darfield Earthquake caused stronger and longer duration ground shaking than the 22 February Christchurch Earthquake. An assessment has been made regarding predicted earthquake-induced deformation that may occur in a design earthquake based on geological setting, site terrain, and the level of "test" previously experienced. It is considered that:

- An SLS earthquake event is likely to cause less damage to that experienced in the 4 September 2010 earthquake and to be similar to the February 2011 earthquake.
- Under Ultimate Limit State (ULS) conditions, the nature of land and building damage is likely to be similar to that already experienced in the 4 September 2010 earthquake of the CES.

[2] Bradley & Hughes (2012) *Conditional Peak Ground Accelerations in the Canterbury Earthquakes for Conventional Liquefaction Assessment*. Report for DBH (MBIE), April 2012.

7. GROUND MODEL

7.1. GEOLOGY

The geological map[3] of the area indicates that the site is underlain by "*grey to brown alluvium, comprising silty sub-angular gravel and sand forming alluvial fans (Q1a*)" (also known as alluvium) of the Springston Formation.

7.2. GROUNDWATER

The shallow ground investigation completed by KGA at the site assumed a ground water level of approximately 0.9mbgl based on an inference from the CPT test undertaken at the site. The KGA HA tests were logged as dry to moist to the test termination at 3.0mbgl in some instances. This indicates that standing ground water is not present at the 0.9mbgl that is assumed by KGA in their shallow hand auger (HA) tests.

BH 35576 recorded a standing ground water depth at approximately 2.0mbgl and Tetra Tech Coffey's two shallow HA boreholes undertaken on 12 February 2021 did not encounter groundwater within the upper 1.5 to 2.0m of the soil profile. Based on this evidence, it is likely that the water level recorded in BH 35576 is likely to be a perched water level from drilling.

In April 2022, three piezometers were installed across the site to a depth of 6.0mbgl. After 24 hours post-installation of the piezometers, groundwater across the site of measured to be between 3.5 to 5.25mbgl and may vary seasonally.

Based on the above we consider it appropriate to assume a conservative ground water depth of 3.5mbgl, although we anticipate that over the majority of the site the ground water may be present at greater than 3.5mbgl.

7.3. INVESTIGATION FINDINGS

15 CPTs, eight HA, and one deep borehole test have been used to develop the ground model for the Birch's Village subdivision. A summary of the ground model is provided below:

Table 3: Ground profile

Description		Strength/ consistency	Thickness (m)	Depth to top of layer (mbgl)
Springston Formation	Sandy silt and organic silt (topsoil).		0.3 to 0.4	0.0
	Interbedded alluvium: Silt, sand, sandy silt and silty sand.	Typically: Firm to stiff / loose to dense.	Majority of site: 1.5 to 4.5 Mid -eastern side: up to 9.0	0.3 to 0.4
	Interbedded alluvium: typically sand and gravel deposits with some layers of silt, sandy silt and silty sand.	Medium dense to very dense, non-liquefiable.	>20m	1.5 to 9.0

[3] 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

The above ground profile is simplified as an illustration; however, the actual ground profile includes a highly interbedded layering of silty alluvium and sandy alluvium overlying a dense to very dense gravel layer. These sand and silt layers are typically inorganic and have moderate strength properties. We note that the area surrounding BH 35567 appears to have a deeper silt / sand profile (up to 9.0mbgl) when compared to the remainder of the site where shallow refusal of the CPT tests typically occurred at depths shallower than 4.5mbgl.

7.4. SITE SUB-SOIL CLASS

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.

8. GEOTECHNICAL HAZARD ASSESSMENT

8.1. EROSION

The site has relatively flat topography and is bounded by grassed paddock land. Provided appropriate stormwater systems are installed as part of the development, there will be few viable sources of erosion at this site.

8.2. FALLING DEBRIS

As there are no slopes or exposed hills or rock faces surrounding the site, there are no sources of falling debris at the site, or for the surrounding area.

8.3. SUBSIDENCE

8.3.1. Liquefaction induced settlement

ECan Technical Report: Review of liquefaction hazard in eastern Canterbury, including Christchurch City and parts of Selwyn, Waimakariri and Hurunui Districts describes the sites as falling near the boundary of the mapped *"Damaging liquefaction unlikely"* and *"Liquefaction assessment needed"*. Given the site's zoning we consider it unlikely that liquefaction would be a significant hazard at the site; however, we have carried out analyses as detailed below.

SLS and ULS design earthquake scenarios are assessed using the parameters provided by the MBIE Guidance for an Importance Level 2 (IL2) structure and a Class D subsoil site.

The liquefaction triggering analysis was carried out for the CPTs shown on the site plan (Appendix A) using the Boulanger and Idriss (2014) method[4] and proprietary liquefaction assessment software[5], in accordance with the updates to the MBIE Guidance[1] (Issue 7 October 2014).

8.3.2. Free-field settlements

The type of settlement that is most commonly estimated when liquefaction analysis is conducted (refer to Section 6.3) is referred to as the *free-field settlement*. Free-field settlement is the component of land settlement that does not take account of foundation influences (e.g. loads and stiffness), or the effects of ground loss, lateral spread, strength degradation, sand ejecta and ground cracks.

[4] Boulanger, R.W., Idriss, I.M., CPT and SPT liquefaction triggering procedures, Report No. UCD/CGM-14/01, April 2014, Centre for Geotechnical Modelling, Department of Civil and Environmental Engineering at the University of California, Davis, California
[5] Geologismiki Geotechnical Software, CLiq v.3.0.3.2 – CPT Liquefaction Assessment Software

According to the MBIE Guidance, an "Index Value" for categorising future expected land performance can be assigned by analysing the upper 10m of the soil profile. The rationale for this is that liquefaction in the upper 10m of the profile is known to be most manifested at the ground surface. Where CPTs refused before 10m, we have assessed the predicted values to be representative of the site due to the density and consistency of the refusal layer across the site and in BH 35576.

The estimated free-field settlement values and the correlated residential foundation Technical Category, as defined by Table 3.1 of the MBIE Guidance, are given in Table 4.

Table 4: Estimated "free-field" post-liquefaction ground surface settlements and Technical Category's (TC).

CPT Location	Termination Depth (mbgl)	Free-field settlements to refusal depth (mm)		MBIE Technical Category
		SLS	ULS	TC
CPT - 01	~2.4	<5	<5	TC1
CPT - 02	~6.7	<5	<15	TC1
CPT - 03	~4.8	<10	<50	TC2
CPT - 04	~1.5	<5	<5	TC1
CPT - 05	~4.0	<5	<30	TC2
CPT - 06	~2.3	<5	<5	TC1
CPT - 07	~2.1	<5	<5	TC1
CPT - 08	~1.8	<5	<5	TC1
CPT – 09	~1.8	<5	<5	TC1
CPT – 10	~1.5	<5	<5	TC1
CPT – 11	~3.4	<5	<5	TC1
CPT – 12	~1.2	<5	<5	TC1
CPT – 13	~1.5	<5	<5	TC1
CPT – 14	~0.6	<5	<5	TC1
CPT – 15	~3.8	<5	<5	TC1
CPT-115979	~3.7	<5	<30	TC2
CPT-88221	~12.3	<45	<80	TC2
CPT-88224	~9.3	<35	<95	TC2

The CPT analyses show that the site is predominantly TC1-like with small areas that contain TC2-like ground. This is generally in accordance with the ECan technical report referenced in Section 8.3.1 of this report. It appears that liquefaction was not observed in the site area following the most severe 2010 Darfield Earthquake, which indicates that liquefaction at the site is unlikely in strong earthquake shaking.

Dependent on the desired TC classifications for the development it may be beneficial to the development to conduct additional CPT testing to maximise the amount of land deemed suitable for TC1 foundations. This additional investigation could be completed if needed at subdivision consent stage.

8.3.3. Static settlement

The ground investigation data at the site suggested that the site soils are generally inorganic in nature. Based on this information we consider that the risk of static settlements across the site could be managed through normal residential construction practices such as proof compacting the base of foundation excavations.

8.4. SLIPPAGE

We have not observed any sources of land instability on the site and due to the flat site topography, we consider the risk of slope failure to be very low. The appropriate design of batter slopes near waterways will mitigate this risk further.

8.5. INUNDATION

In relation to stormwater inundation, we recommend that drainage design and management be addressed by specialist consultants as it is beyond the scope of this report. We expect that with appropriate stormwater and flood control systems, the risk of inundation will be low.

9. CONCLUSIONS

The overall site is well covered with CPT probes and other geotechnical investigations. Based on the on-site testing carried out to date, the majority of the site is TC1-like with some minor pockets of TC2-like performance. This categorisation is generally in line with the ECan mapping of the site which places it on the boundary of an area where liquefaction assessment is required and an area where damaging liquefaction is unlikely.

We consider that the site is suitable for residential development subject to further investigation and design at the subdivision consent stage.

Additional geotechnical investigation may be required to refine the technical categories for the proposed Lots once a subdivision plan has been further developed. We also recommend that a groundwater monitoring programme is implemented to allow for more accurate liquefaction analyses.

10. LIMITATIONS

This report has been prepared solely for the use of our client, Birch's Village Limited and Selwyn District Council (SDC) 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.

As subsurface information has been obtained from discrete investigation locations, which by their nature only provide information about a relatively small volume of subsoils, 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 assumed to exist, then the matter should be referred to us immediately.

Please also refer to the enclosed *Important Information about Your Tetra Tech Coffey Report*.

11. CLOSURE

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

For and on behalf of Coffey

Prepared by

Andrew Jordan
Senior Engineering Geologist

Reviewed by

Lee Buhagiar
BE(Hons) CPEng CMEngNZ IntPE(NZ)
Associate Geotechnical Engineer

IMPORTANT INFORMATION ABOUT YOUR TETRA TECH COFFEY REPORT

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.

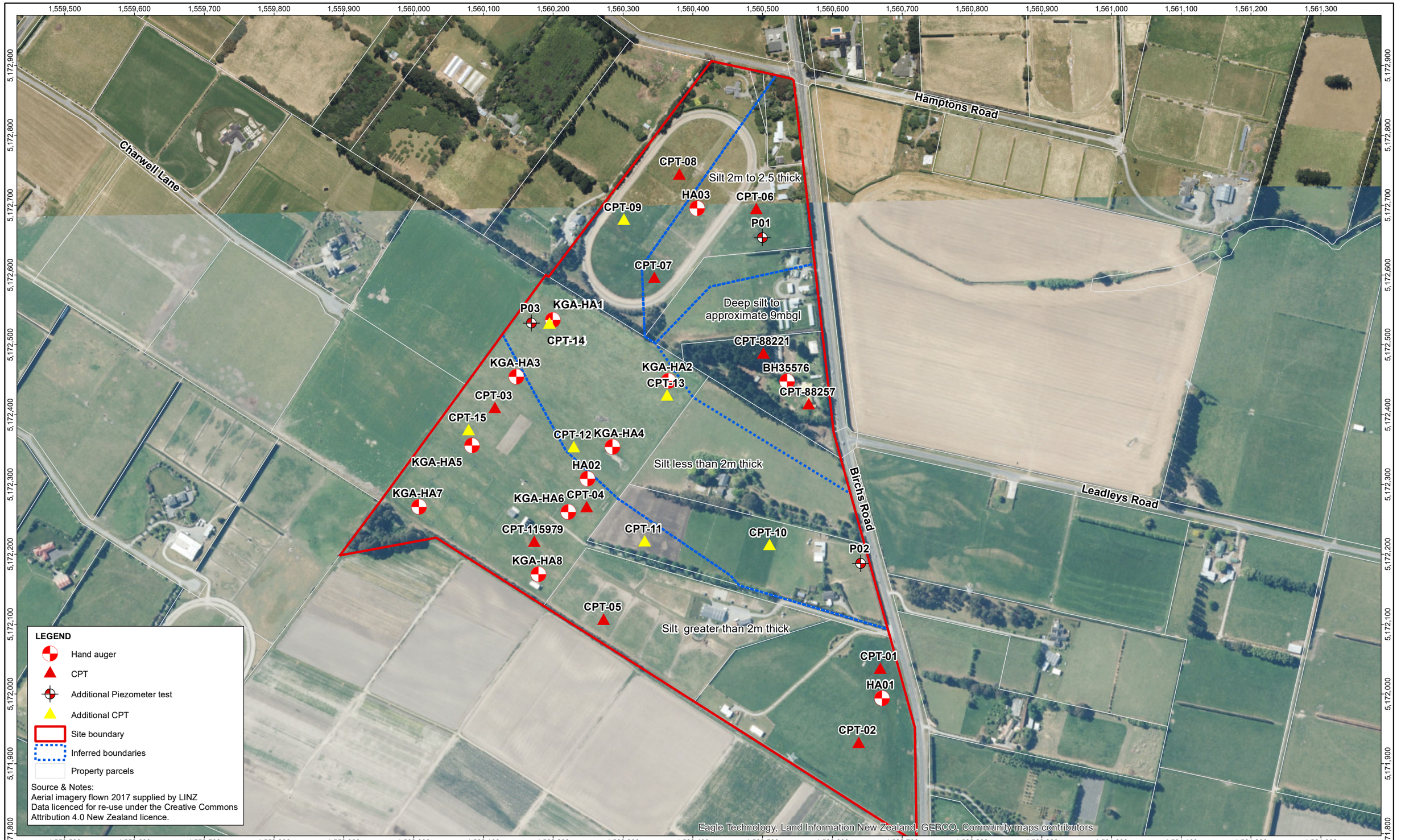
Rely on Tetra Tech Coffey for additional assistance

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: INVESTIGATION PLAN



revision	no.	description	drawn	approved	date
	A	ORIGINAL ISSUE	RZ	AJ	17.05.22

0 50 100 150 200
SCALE 1:5,000 (A3) METRES

Projection: NZGD 2000 New Zealand Transverse Mercator

drawn	RZ
approved	AJ
date	17.05.2022
scale	AS SHOWN
original size	A3

TETRA TECH COFFEY

client: BIRCH'S VILLAGE LIMITED

project: BIRCH'S VILLAGE, PREBBLETON

title: SITE PLAN

project no: 773-CHCGE283773 | figure no: 01 | rev: A

MXD ref: 283773_02_GIS001_1

APPENDIX B: INVESTIGATION DATA

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A TETRA TECH COMPANY

Engineering Log - Hand Auger

Borehole ID.	**HA1**
sheet:	1 of 1
project no.	**773-CHCGE283773**
client:	**Birch's Village Limited**
date started:	**12 Feb 2021**
principal:	**-**
date completed:	**12 Feb 2021**
project:	**Geotechnical Assessment Report for Plan Change**
logged by:	**B. Chau**
location:	**Birchs Road, Prebbleton**
checked by:	**A. Jordan**

position: Not Specified | surface elevation: Not Specified | angle from horizontal: 90°

drill model: Hand Auger | drilling fluid: - | hole diameter : 50 mm

drilling information | **material substance**

method & support	penetration 1 2 3	water	samples & field tests	RL (m)	depth (m)	graphic log	classification symbol	material description (SOIL TYPE: plasticity or particle characteristic, colour, secondary and minor components)	moisture condition	consistency / relative density	hand penetrometer (kPa) 100 200 300 400	structure and additional observations
HA, N		Not Encountered			0.0		ML	**Sandy SILT**: non plastic - low plasticity, pale brown, with trace of rootlets.	D			**TOPSOIL**
					0.5		ML	**SILT**: low plasticity, yellow-brown with orange and grey staining, with some fine grained sand.				**SPRINGSTON FORMATION**
					1.0				M			
					1.5			1.7 to 1.8 m: grey SILT with some fine grained sand				
					2.0		SM	**SILTY SAND**: fine grained, low plasticity, yellow-brown.				
								Hand Auger HA1 terminated at 2.0 m Target depth				
					2.5							
					3.0							
					3.5							

CDF_0_9_06_LIBRARY.GLB rev:AR Log COF BOREHOLE: NON CORED CHCGE283773 BIRCH'S VILLAGE LOGS RAW.GPJ <<DrawingFile>> 25/02/2021 08:34

method
- AD auger drilling*
- AS auger screwing*
- HA hand auger
- W washbore
- HA hand auger

* bit shown by suffix e.g. AD/T
- B blank bit
- T TC bit
- V V bit

support
- M mud
- C casing
- N nil

penetration
1 2 3 — no resistance ranging to refusal

water
- 10-Oct-12 water level on date shown
- water inflow
- water outflow

samples & field tests
- 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/remouded (kPa)
- R refusal
- HB hammer bouncing

classification symbol & soil description based on Unified Classification System

moisture
- D dry
- M moist
- W wet
- Wp plastic limit
- Wl liquid limit

consistency / relative density

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

coffey
A TETRA TECH COMPANY

Engineering Log - Hand Auger

Borehole ID.	**HA2**
sheet:	1 of 1
project no.	**773-CHCGE283773**
client:	**Birch's Village Limited**
date started:	**12 Feb 2021**
principal:	**-**
date completed:	**12 Feb 2021**
project:	**Geotechnical Assessment Report for Plan Change**
logged by:	**B. Chau**
location:	**Birchs Road, Prebbleton**
checked by:	**A. Jordan**

position: Not Specified | surface elevation: Not Specified | angle from horizontal: 90°

drill model: Hand Auger | drilling fluid: - | hole diameter : 50 mm

drilling information | **material substance**

method & support	penetration 1 2 3	water	samples & field tests	RL (m)	depth (m)	graphic log	classification symbol	material description (SOIL TYPE: plasticity or particle characteristic, colour, secondary and minor components)	moisture condition	consistency / relative density	hand penetrometer (kPa) 100 200 300 400	structure and additional observations
HA, N		Not Encountered			0.0		ML	**Sandy SILT**: low plasticity, brown, with trace of rootlets.	D			**TOPSOIL**
					0.5		SP	**SAND**: fine grained, yellow-brown with some orange mottling, and some silt.	M			**SPRINGSTON FORMATION**
					1.0							
					1.5			1.45 m: trace to some medium to coarse grained, subrounded gravel. Hand Auger HA2 terminated at 1.45 m Refusal				
					2.0							
					2.5							
					3.0							
					3.5							

CDF_0_9_06_LIBRARY.GLB rev:AR Log COF BOREHOLE: NON CORED CHCGE283773 BIRCH'S VILLAGE LOGS RAW.GPJ <<DrawingFile>> 25/02/2021 08:34

method
- AD auger drilling*
- AS auger screwing*
- HA hand auger
- W washbore
- HA hand auger

* bit shown by suffix e.g. AD/T
- B blank bit
- T TC bit
- V V bit

support
- M mud
- C casing
- N nil

penetration
1 2 3 — no resistance ranging to refusal

water
- 10-Oct-12 water level on date shown
- water inflow
- water outflow

samples & field tests
- 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/remouded (kPa)
- R refusal
- HB hammer bouncing

classification symbol & soil description based on Unified Classification System

moisture
- D dry
- M moist
- W wet
- Wp plastic limit
- Wl liquid limit

consistency / relative density

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

coffey

Engineering Log - Borehole

Borehole ID.	**BH1**
sheet:	1 of 3
project no.	**GENZCHRI15217AJR**
client:	**IAG Insurance**
principal:	**-**
project:	**IAG Insurance Claims**
location:	**176 Birchs Road, Prebbleton**
date started:	**17 Oct 2013**
date completed:	**17 Oct 2013**
logged by:	**S. Fellers**
checked by:	**D. Harris**

position: Not Specified | surface elevation : Not Specified | angle from horizontal: 90°

drill model: Comacchio MC 900 | mounting: Track | hole diameter : 100 mm

drilling information | **material substance**

method & support	penetration 1 2 3	water	samples & field tests	RL (m)	depth (m)	graphic log	classification symbol	material description (SOIL TYPE: plasticity or particle characteristic, colour, secondary and minor components)	moisture condition	consistency / relative density	shear vane ⊕ remoulded ⊙ peak (kPa) 50 100 150 200	structure and additional observations
S/HQ3 C					0.0		ML	**TOPSOIL: SILT**: non plastic liquid limit, dark brown, with minor rootlets and trace of sand.	M			**TOPSOIL**
							ML	**SILT**: low liquid limit, pale brown, with minor fine grained sand.		F		**SPRINGSTON FORMATION**
			SPT 1, 1, 1, 1, 1, 2 N=5		1.0		SM	**SILTY SAND**: fine to medium, pale brown.		L		
			SPT 1, 1, 1, 2, 2, 1 N=6						W			
		17/10/13 10:00			2.0		ML	**Sandy SILT**: low liquid limit, pale brown with grey mottling.	S	St		
			SPT 2, 3, 3, 3, 3, 4 N=13		3.0			at 3.4m: becoming grey.				
					4.0		ML	**SILT**: low liquid limit, grey, with minor organics (sticks and wood fragments), trace of fine grained sand.				
			SPT 0, 0, 1, 1, 2, 4 N=8				SP	**SAND**: fine to medium, dark grey.		L / MD		
					5.0			at 5.1m: with minor organics (wood fragments).				
								at 5.3m: organics absent.				
			SPT 1, 2, 3, 3, 3, 4 N=13		6.0							
								at 6.4m: with minor organics (wood fragments), grading into fine to coarse grained SAND.				
							ML	**SILT**: low liquid limit, grey, with some sand.		St		
					7.0		SP	**SAND**: fine to medium, grey, with minor silt. at 7.0m: with minor organics (wood) up to 10mm.		L / MD		
			SPT 1, 1, 1, 2, 3, 3 N=9				ML	**SILT**: low liquid limit, grey.		St		

CDF_0_9_04AJ (LATEST LIBRARY).GLB Log COF BOREHOLE: NON CORED AJR - BH GINT.GPJ <<DrawingFile>> 29/10/2013 16:46

method
AD auger drilling*
AS auger screwing*
RR roller/tricone
W washbore
CT cable tool
HA hand auger
S sonic*
B blank bit
V V bit
T TC bit
* bit shown by suffix
e.g. AD/T

support
M mud
C casing
N nil

penetration
1 2 3 — no resistance ranging to refusal

water
10-Oct-12 water level on date shown
water inflow
water outflow

samples & field tests
U## undisturbed sample ##mm diameter
D disturbed sample
B bulk disturbed sample
E environmental sample
HP hand penetrometer (kPa)
N standard penetration test (SPT)
N* SPT - sample recovered
Nc SPT with solid cone
VS vane shear peak/remouded (uncorrected kPa)
R refusal

classification symbol & soil description
based on New Zealand Geotechnical Society

moisture
D dry
M moist
W wet
S saturated

consistency / relative density

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

coffey

Engineering Log - Borehole

Borehole ID.	**BH1**
sheet:	2 of 3
project no.	**GENZCHRI15217AJR**
client:	**IAG Insurance**
principal:	**-**
project:	**IAG Insurance Claims**
location:	**176 Birchs Road, Prebbleton**
date started:	**17 Oct 2013**
date completed:	**17 Oct 2013**
logged by:	**S. Fellers**
checked by:	**D. Harris**

position: Not Specified | surface elevation : Not Specified | angle from horizontal: 90°

drill model: Comacchio MC 900 | mounting: Track | hole diameter : 100 mm

drilling information | **material substance**

method & support	penetration 1 2 3	water	samples & field tests	RL (m)	depth (m)	graphic log	classification symbol	material description (SOIL TYPE: plasticity or particle characteristic, colour, secondary and minor components)	moisture condition	consistency / relative density	shear vane ⊕ remoulded ⊙ peak (kPa) 50 100 150 200	structure and additional observations
S/HQ3 C							ML	**SILT**: low liquid limit, grey. *(continued)*	S	St		**SPRINGSTON FORMATION**
							Pt	**PEAT**: dark brown.		F		
							MH	**SILT**: high liquid limit, grey.		St		
			SPT 10, 12, 4, 11, 12, 14 N=41		9.0		GP	**Sandy GRAVEL**: fine to medium, rounded to sub-rounded, grey, with some silt.		D		
			SPT 4, 9, 11, 10, 12, 11 N=44		10.0		GW	**GRAVEL**: fine to coarse, rounded to sub-rounded, grey brown, with minor sand, trace of cobbles.				
			SPT 8, 14, 14, 18, 6/25mm N=R		11.0 12.0					VD		
			SPT 7, 7, 3, 4, 13, 16 N=36		13.0 14.0			at 14.4m: becoming with some sand.		D		
			SPT 1, 3, 4, 7, 14, 18 N=43		15.0		SP	**SAND**: fine to medium, pale brown. at 14.9m: with minor fine to medium grained, rounded gravel.				
							GW	**GRAVEL**: fine to coarse, rounded to sub-rounded, with minor sand, trace of cobbles.				

CDF_0_9_04AJ (LATEST LIBRARY).GLB Log COF BOREHOLE: NON CORED AJR - BH GINT.GPJ <<DrawingFile>> 29/10/2013 16:46

method
AD auger drilling*
AS auger screwing*
RR roller/tricone
W washbore
CT cable tool
HA hand auger
S sonic*
B blank bit
V V bit
T TC bit
* bit shown by suffix
e.g. AD/T

support
M mud
C casing
N nil

penetration
1 2 3 no resistance ranging to refusal

water
10-Oct-12 water level on date shown
water inflow
water outflow

samples & field tests
U## undisturbed sample ##mm diameter
D disturbed sample
B bulk disturbed sample
E environmental sample
HP hand penetrometer (kPa)
N standard penetration test (SPT)
N* SPT - sample recovered
Nc SPT with solid cone
VS vane shear peak/remouded (uncorrected kPa)
R refusal

classification symbol & soil description
based on New Zealand Geotechnical Society

moisture
D dry
M moist
W wet
S saturated

consistency / relative density

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

coffey

Engineering Log - Borehole

Borehole ID.	**BH1**
sheet:	3 of 3
project no.	**GENZCHRI15217AJR**
client:	**IAG Insurance**
date started:	**17 Oct 2013**
principal:	**-**
date completed:	**17 Oct 2013**
project:	**IAG Insurance Claims**
logged by:	**S. Fellers**
location:	**176 Birchs Road, Prebbleton**
checked by:	**D. Harris**

position: Not Specified | surface elevation : Not Specified | angle from horizontal: 90°

drill model: Comacchio MC 900 | mounting: Track | hole diameter : 100 mm

drilling information | **material substance**

method & support	penetration 1 2 3	water	samples & field tests	RL (m)	depth (m)	graphic log	classification symbol	material description (SOIL TYPE: plasticity or particle characteristic, colour, secondary and minor components)	moisture condition	consistency / relative density	shear vane ⊕ remoulded ⊙ peak (kPa) 50 100 150 200	structure and additional observations
S/HQ3 C			SPT 10, 13, 15, 13, 16, 8/35mm N=R		17.0		GW	**GRAVEL**: fine to coarse, rounded to sub-rounded, with minor sand, trace of cobbles. *(continued)*	S	D		**SPRINGSTON FORMATION**
			SPT 6, 8, 9, 6, 5, 8 N=28		18.0			at 17.6m: with minor silt.				
					19.0		GP	**Sandy GRAVEL**: fine to coarse, rounded to sub-angular, sand is fine to coarse grained.				
			SPT 14, 26/65mm N=R							VD		
					20.0			Borehole BH1 terminated at 19.95 m Target depth				
					21.0							
					22.0							
					23.0							

CDF_0_9_04AJ (LATEST LIBRARY).GLB Log COF BOREHOLE: NON CORED AJR - BH GINT.GPJ <<DrawingFile>> 29/10/2013 16:46

method
AD auger drilling*
AS auger screwing*
RR roller/tricone
W washbore
CT cable tool
HA hand auger
S sonic*
B blank bit
V V bit
T TC bit
* bit shown by suffix
e.g. AD/T

support
M mud
C casing
N nil

penetration
1 2 3 no resistance ranging to refusal

water
10-Oct-12 water level on date shown
water inflow
water outflow

samples & field tests
U## undisturbed sample ##mm diameter
D disturbed sample
B bulk disturbed sample
E environmental sample
HP hand penetrometer (kPa)
N standard penetration test (SPT)
N* SPT - sample recovered
Nc SPT with solid cone
VS vane shear peak/remouded (uncorrected kPa)
R refusal

classification symbol & soil description
based on New Zealand Geotechnical Society

moisture
D dry
M moist
W wet
S saturated

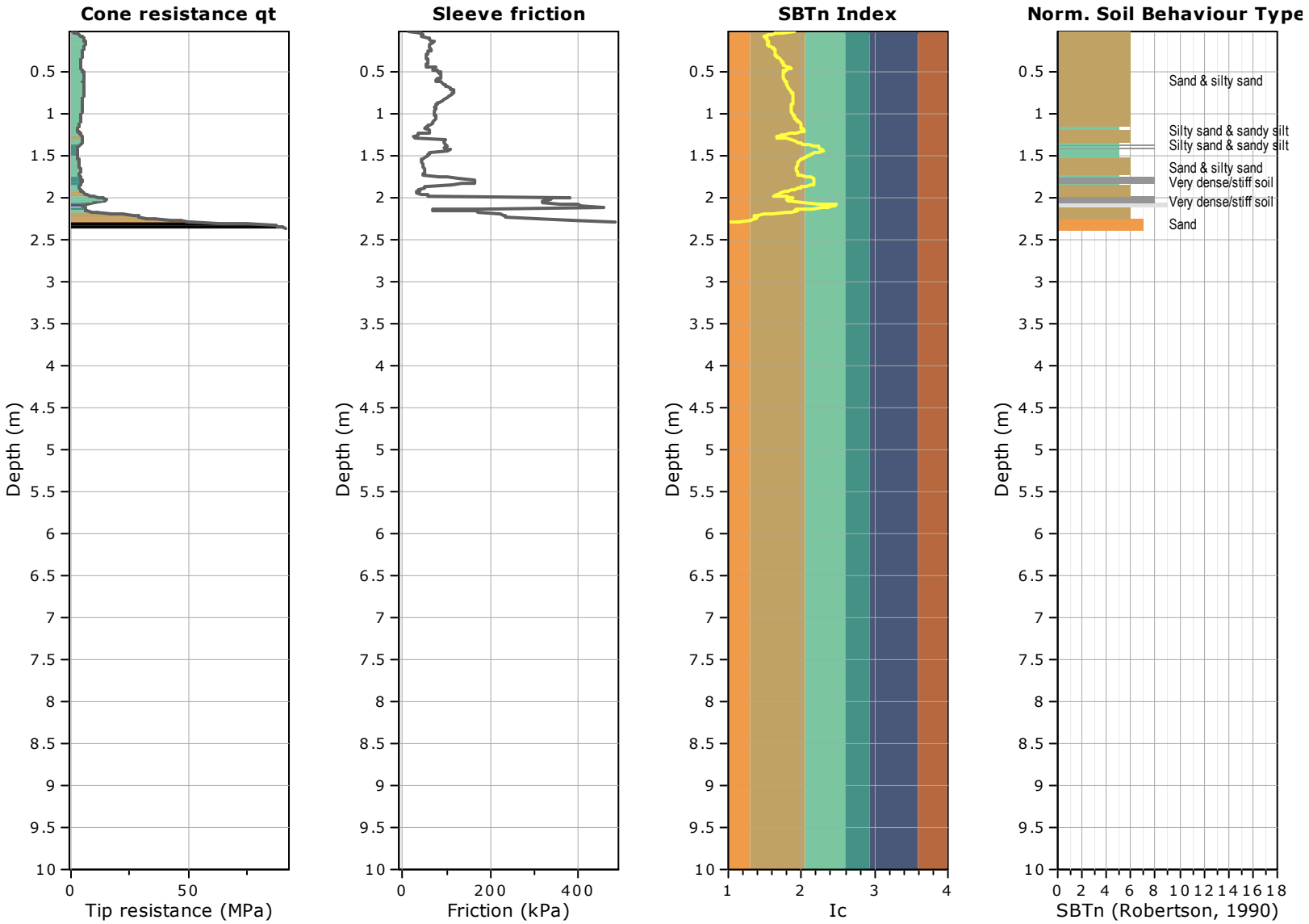
consistency / relative density

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

Coffey
1/254 Montreal Street
Christchurch
www.coffey.com

Project: **Birches Village**
Location: **Prebbleton, Christchurch**

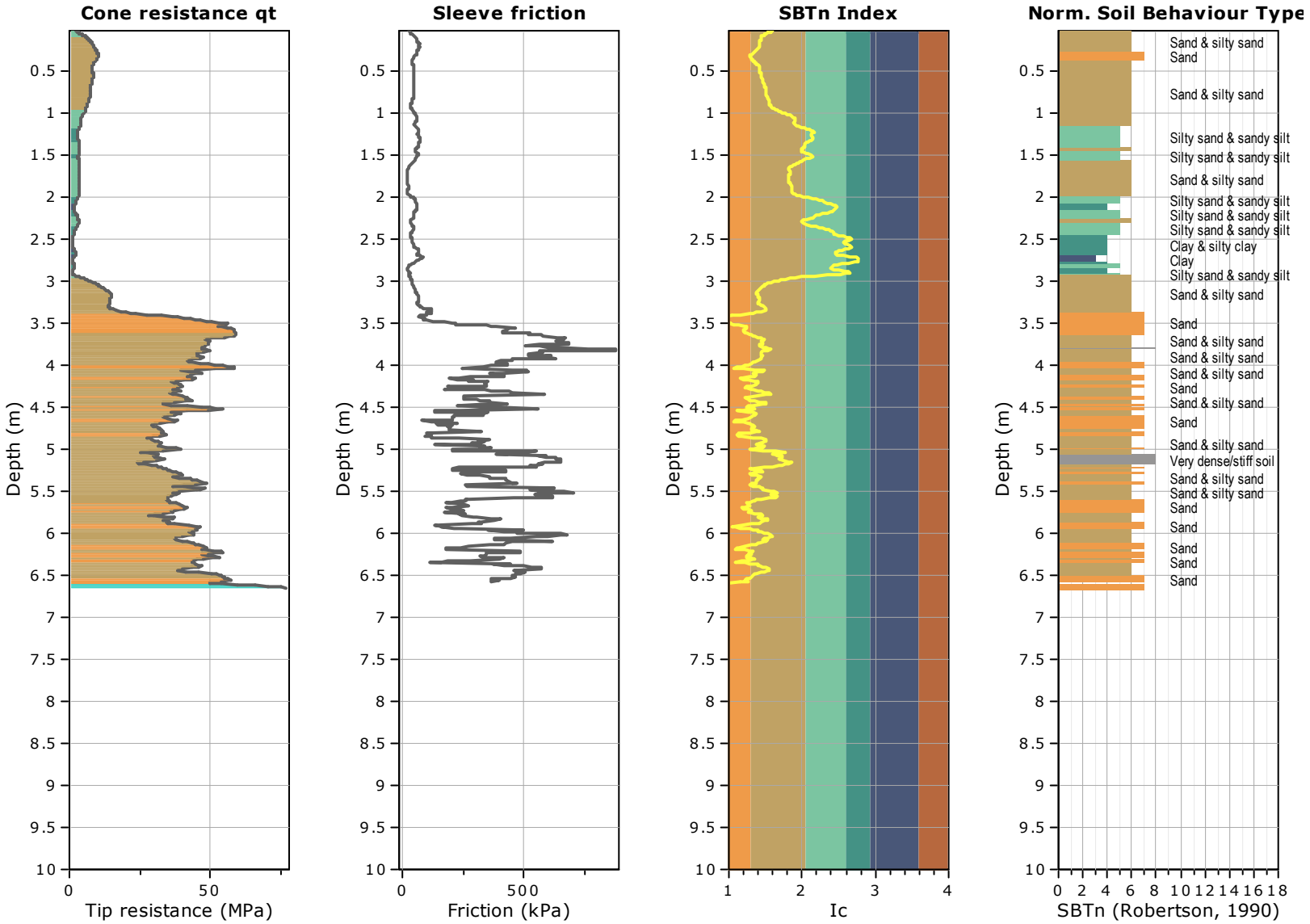
CPT: CPT-01
Total depth: 2.35 m



Coffey
1/254 Montreal Street
Christchurch
www.coffey.com

Project: **Birches Village**
Location: **Prebbleton, Christchurch**

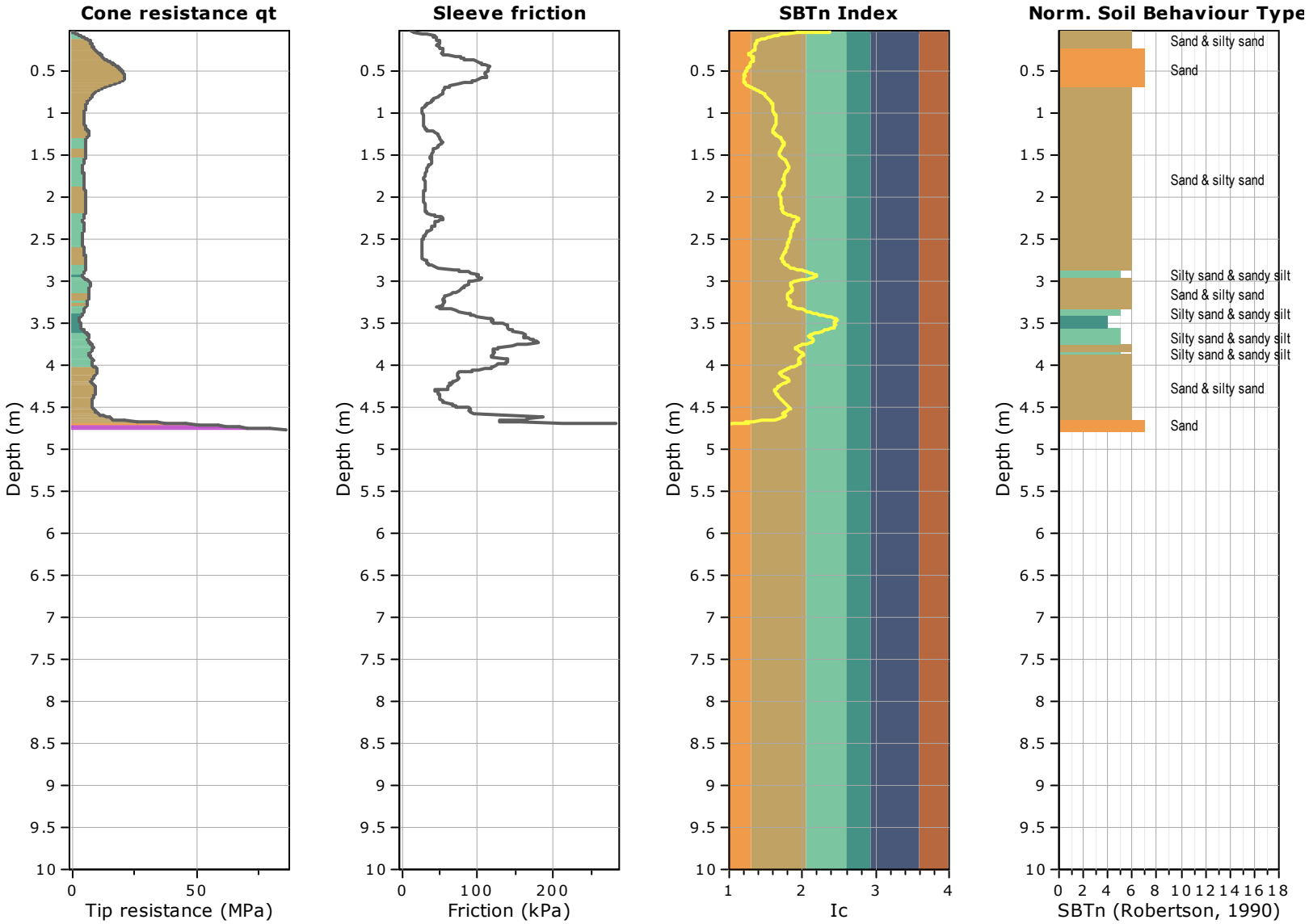
CPT: CPT-02
Total depth: 6.65 m



Coffey
1/254 Montreal Street
Christchurch
www.coffey.com

Project: **Birches Village**
Location: **Prebbleton, Christchurch**

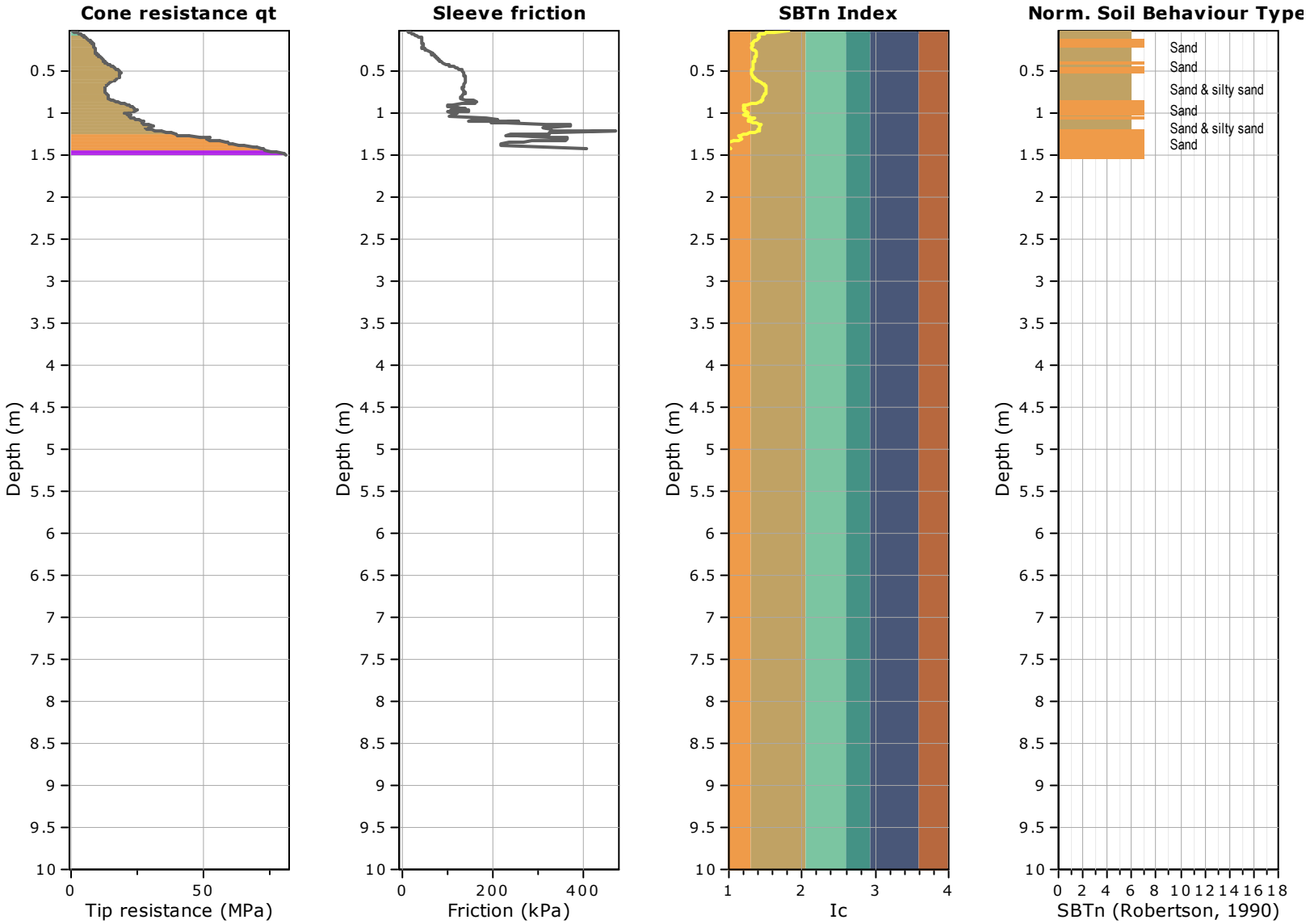
CPT: CPT-03
Total depth: 4.76 m



Coffey
1/254 Montreal Street
Christchurch
www.coffey.com

Project: **Birches Village**
Location: **Prebbleton, Christchurch**

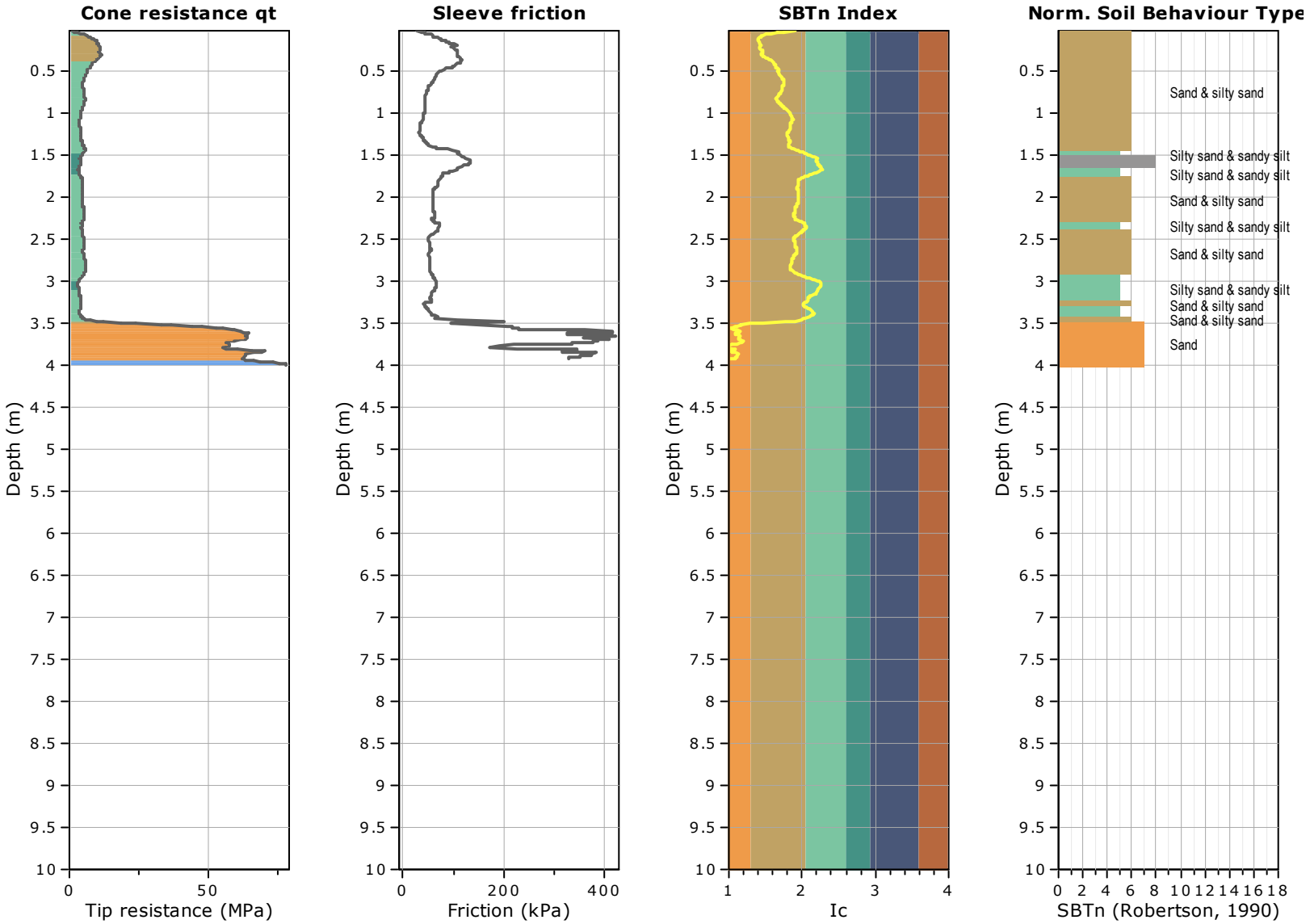
CPT: CPT-04
Total depth: 1.49 m



Coffey
1/254 Montreal Street
Christchurch
www.coffey.com

Project: **Birches Village**
Location: **Prebbleton, Christchurch**

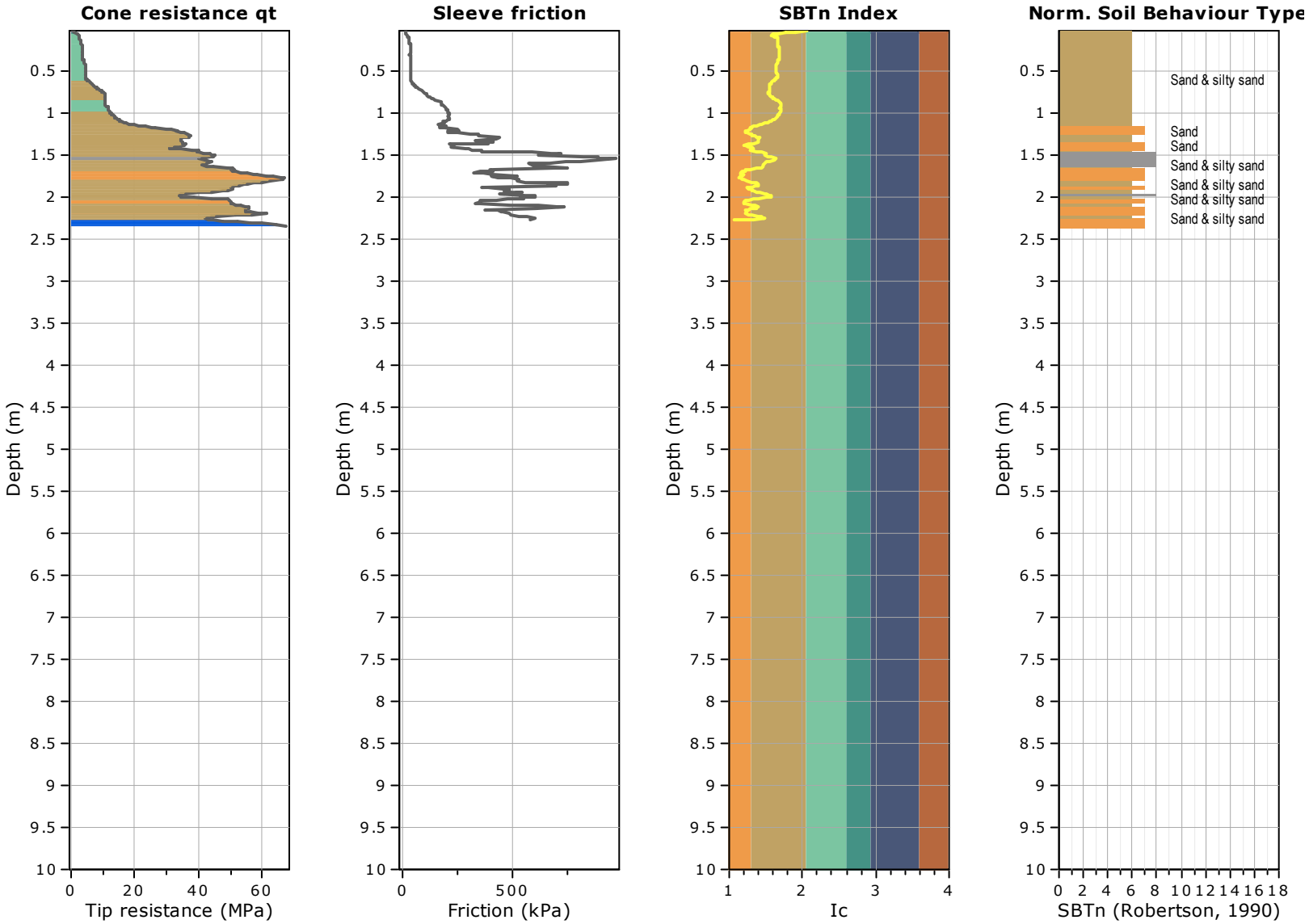
CPT: CPT-05
Total depth: 3.99 m



Coffey
1/254 Montreal Street
Christchurch
www.coffey.com

Project: **Birches Village**
Location: **Prebbleton, Christchurch**

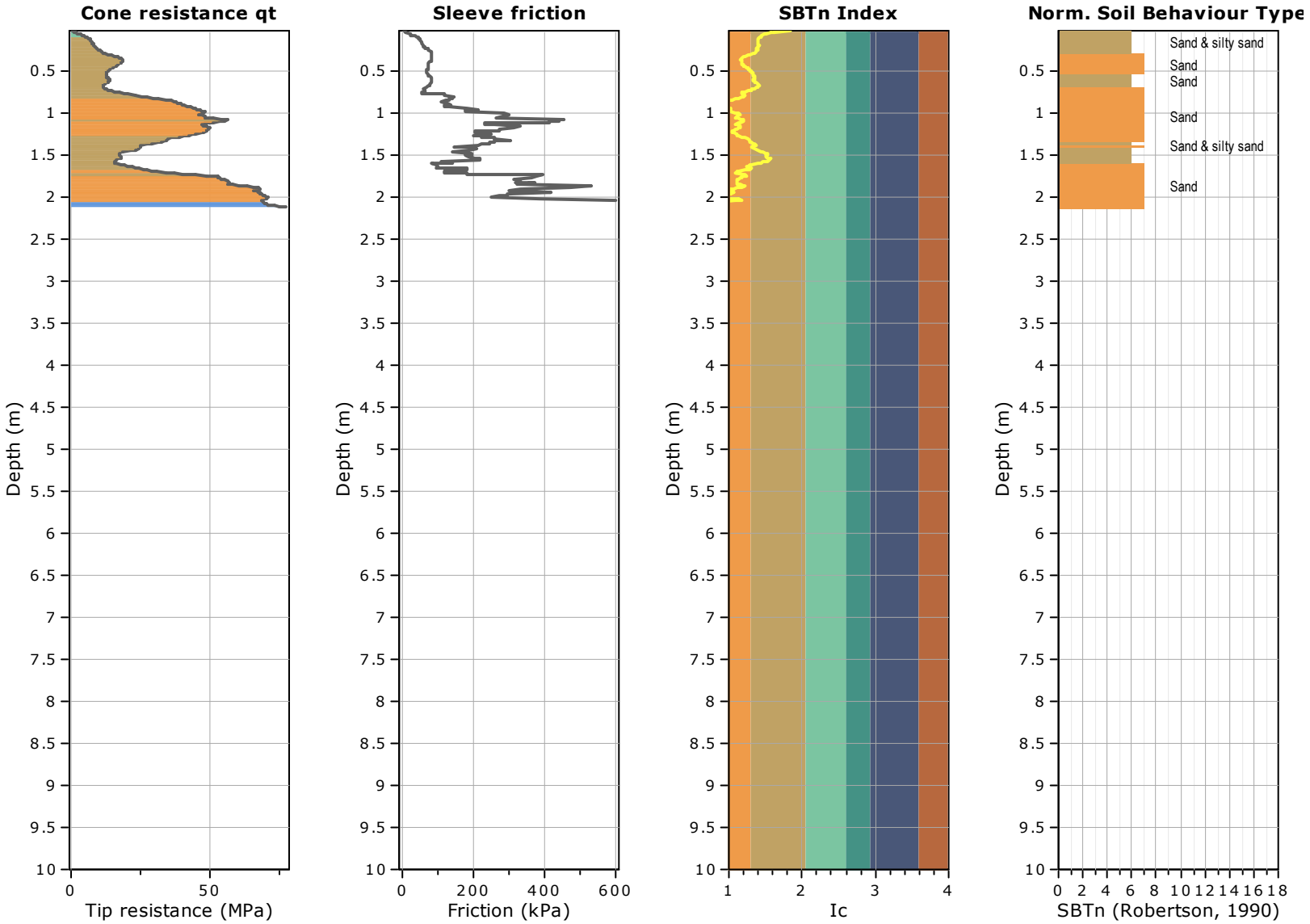
CPT: CPT-06
Total depth: 2.33 m



Coffey
1/254 Montreal Street
Christchurch
www.coffey.com

Project: **Birches Village**
Location: **Prebbleton, Christchurch**

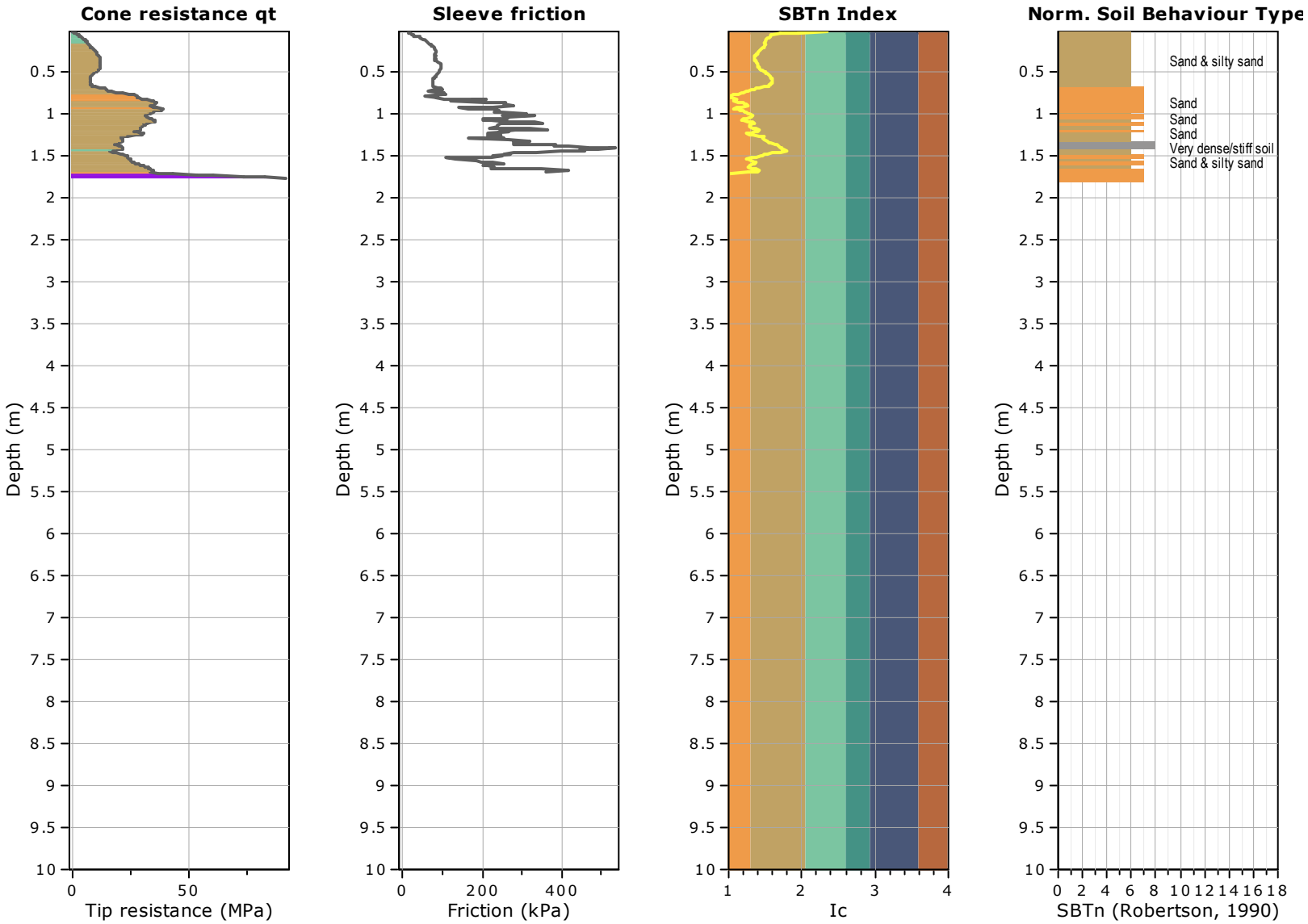
CPT: CPT-07
Total depth: 2.11 m



Coffey
1/254 Montreal Street
Christchurch
www.coffey.com

Project: **Birches Village**
Location: **Prebbleton, Christchurch**

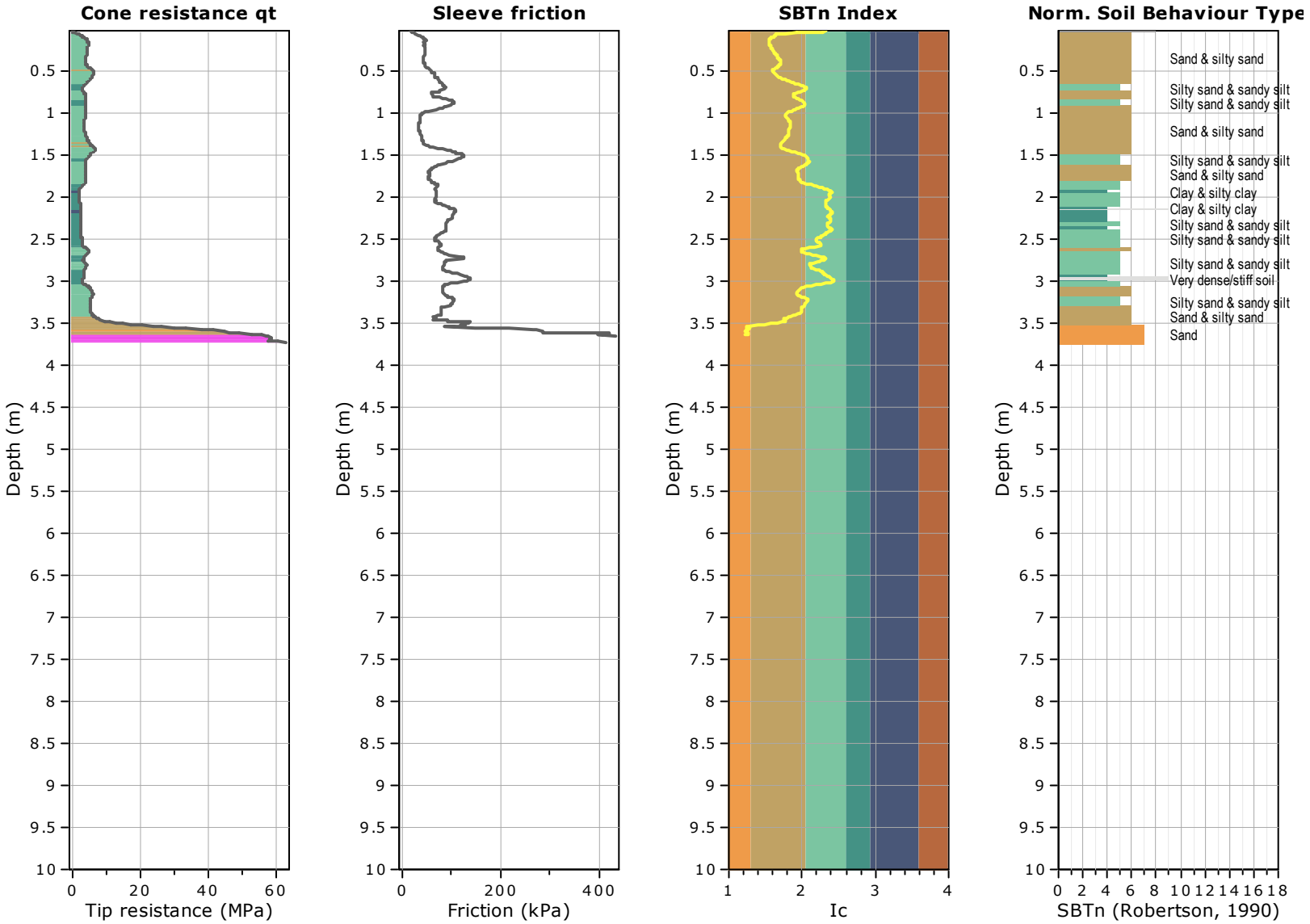
CPT: CPT-08
Total depth: 1.76 m



Coffey
1/254 Montreal Street
Christchurch
www.coffey.com

Project: **Birches Village**
Location: **Prebbleton, Christchurch**

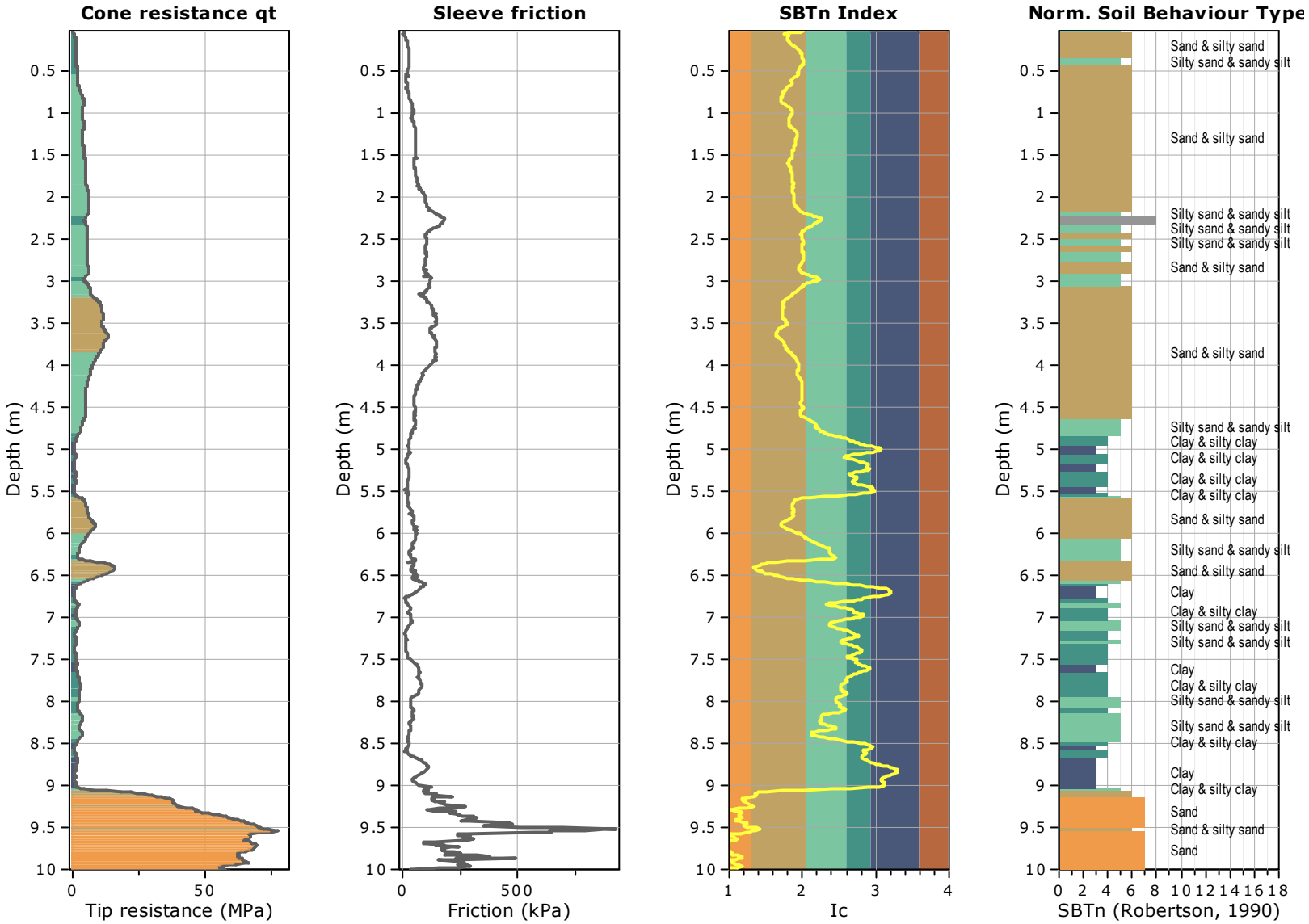
CPT: CPT-115979
Total depth: 3.72 m



Coffey
1/254 Montreal Street
Christchurch
www.coffey.com

Project: **Birches Village**
Location: **Prebbleton, Christchurch**

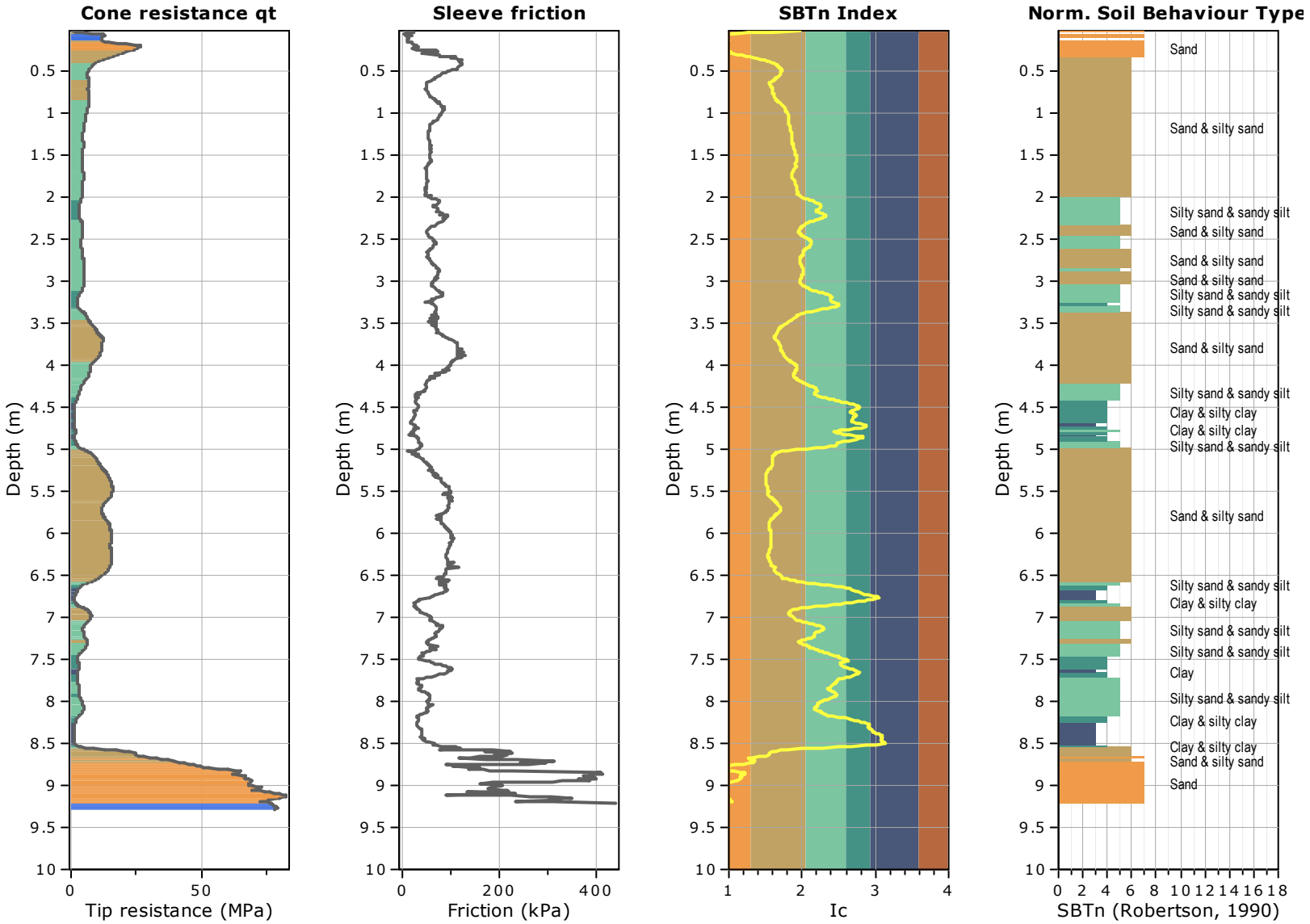
CPT: CPT-88221
Total depth: 12.27 m



Coffey
1/254 Montreal Street
Christchurch
www.coffey.com

Project: **Birches Village**
Location: **Prebbleton, Christchurch**

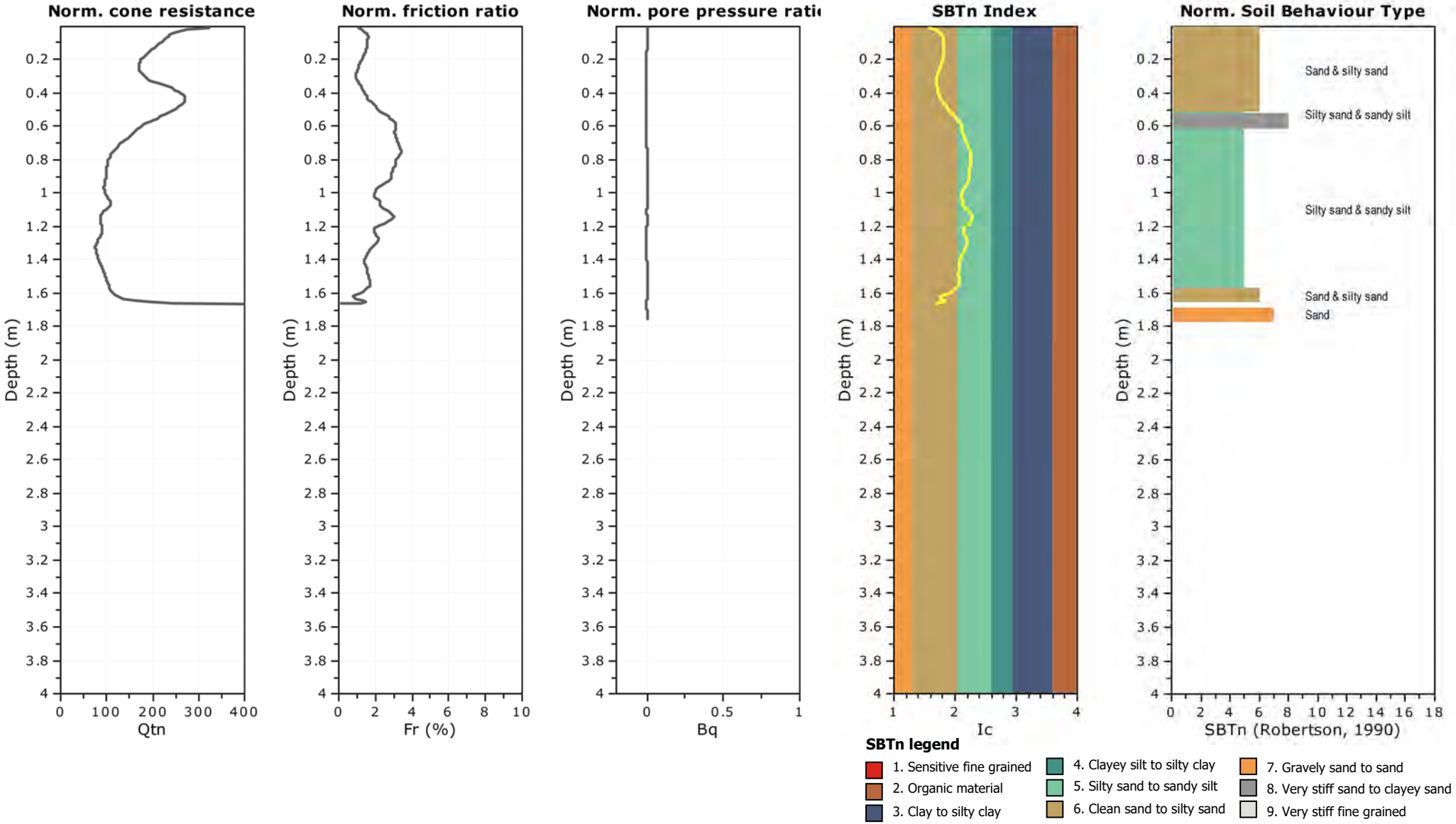
CPT: CPT-88224
Total depth: 9.28 m



Tetra Tech Coffey
254 Montreal Street
Christchurch Central
www.tetratechcoffey.com

Project: **Birchs Village**
Location: **Prebbleton**

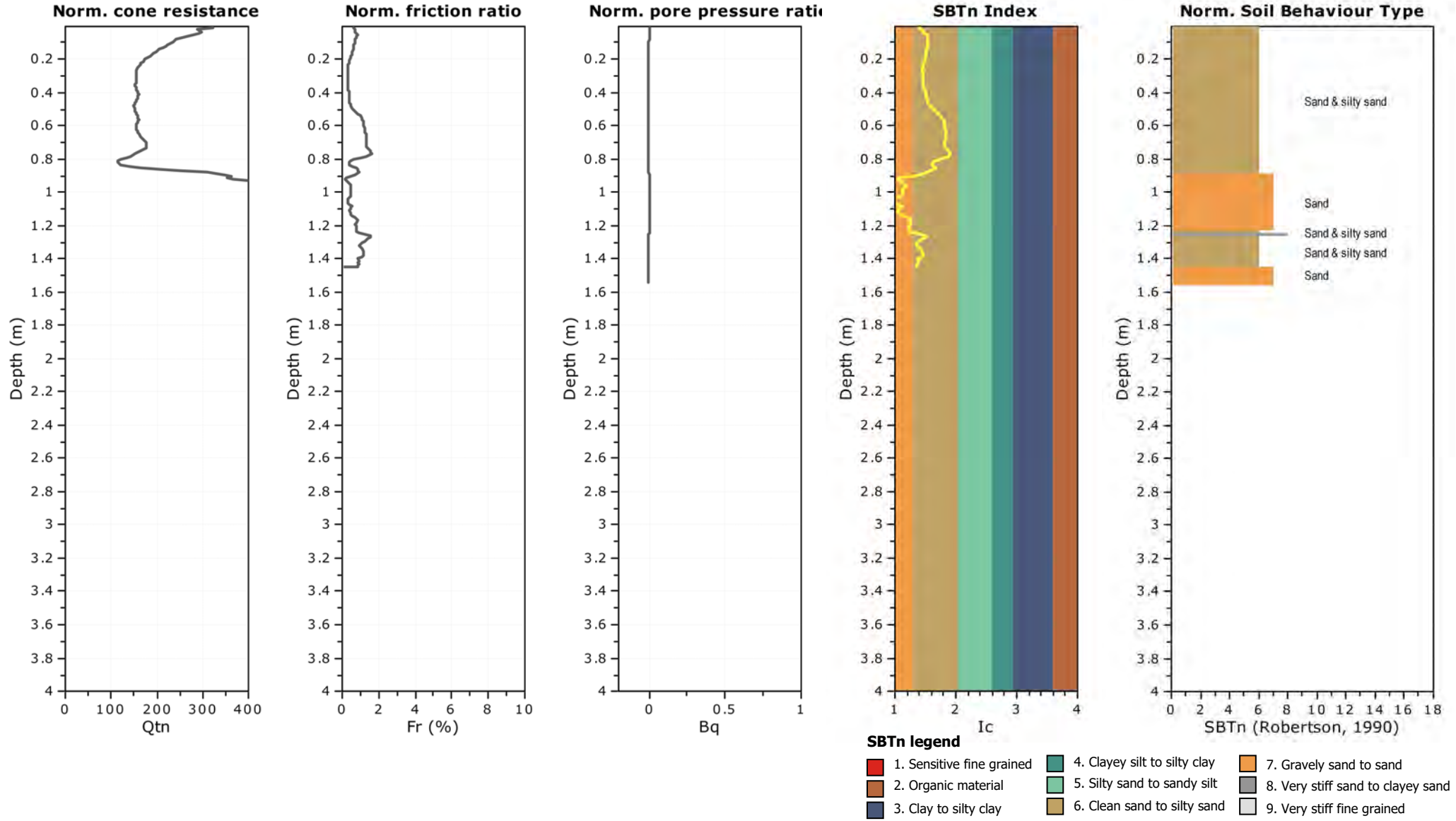
CPT: CPT 09
Total depth: 1.75 m



Tetra Tech Coffey
254 Montreal Street
Christchurch Central
www.tetratechcoffey.com

Project: **Birchs Village**
Location: **Prebbleton**

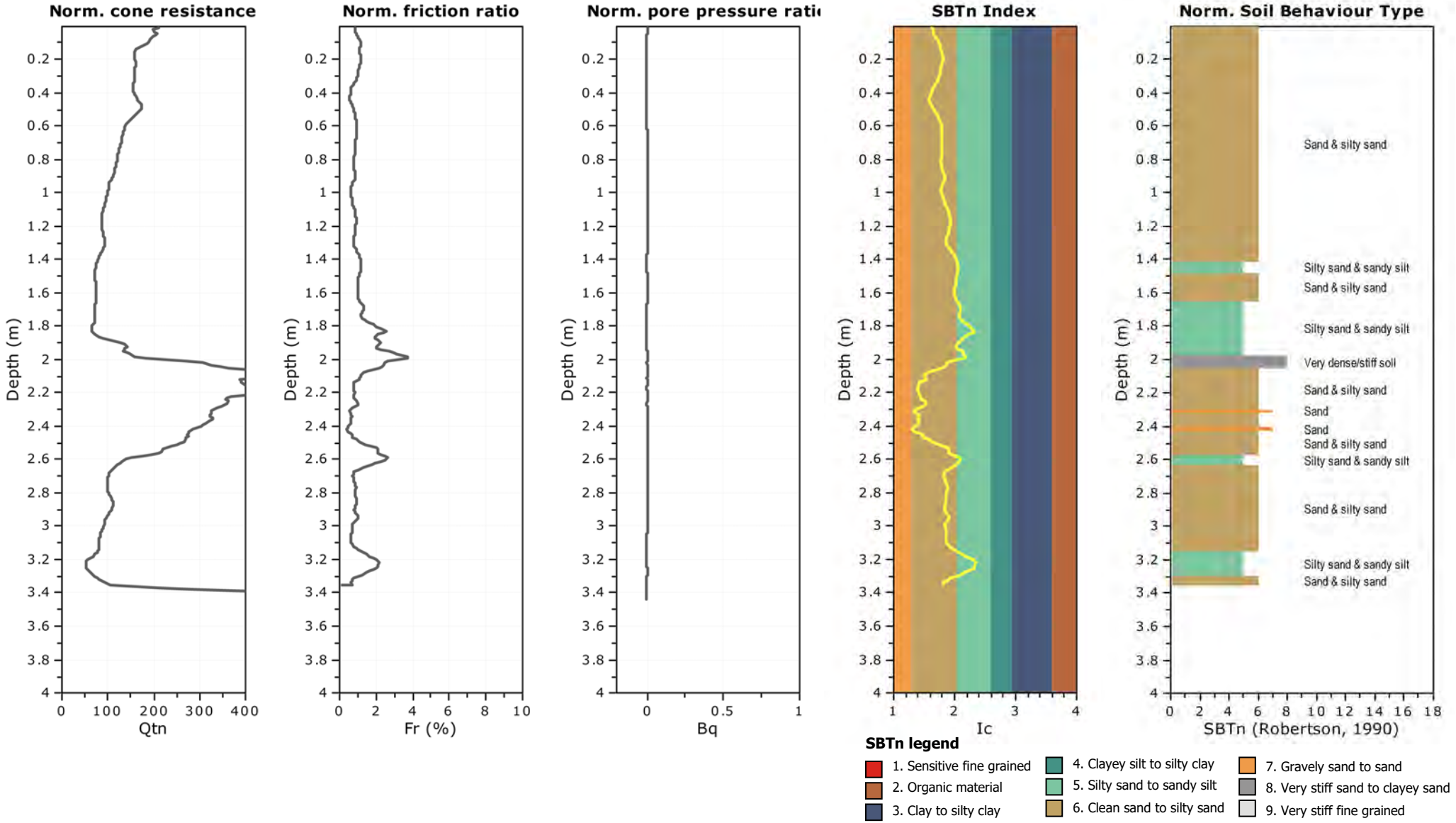
CPT: CPT 10
Total depth: 1.54 m



Tetra Tech Coffey
254 Montreal Street
Christchurch Central
www.tetratechcoffey.com

Project: **Birchs Village**
Location: **Prebbleton**

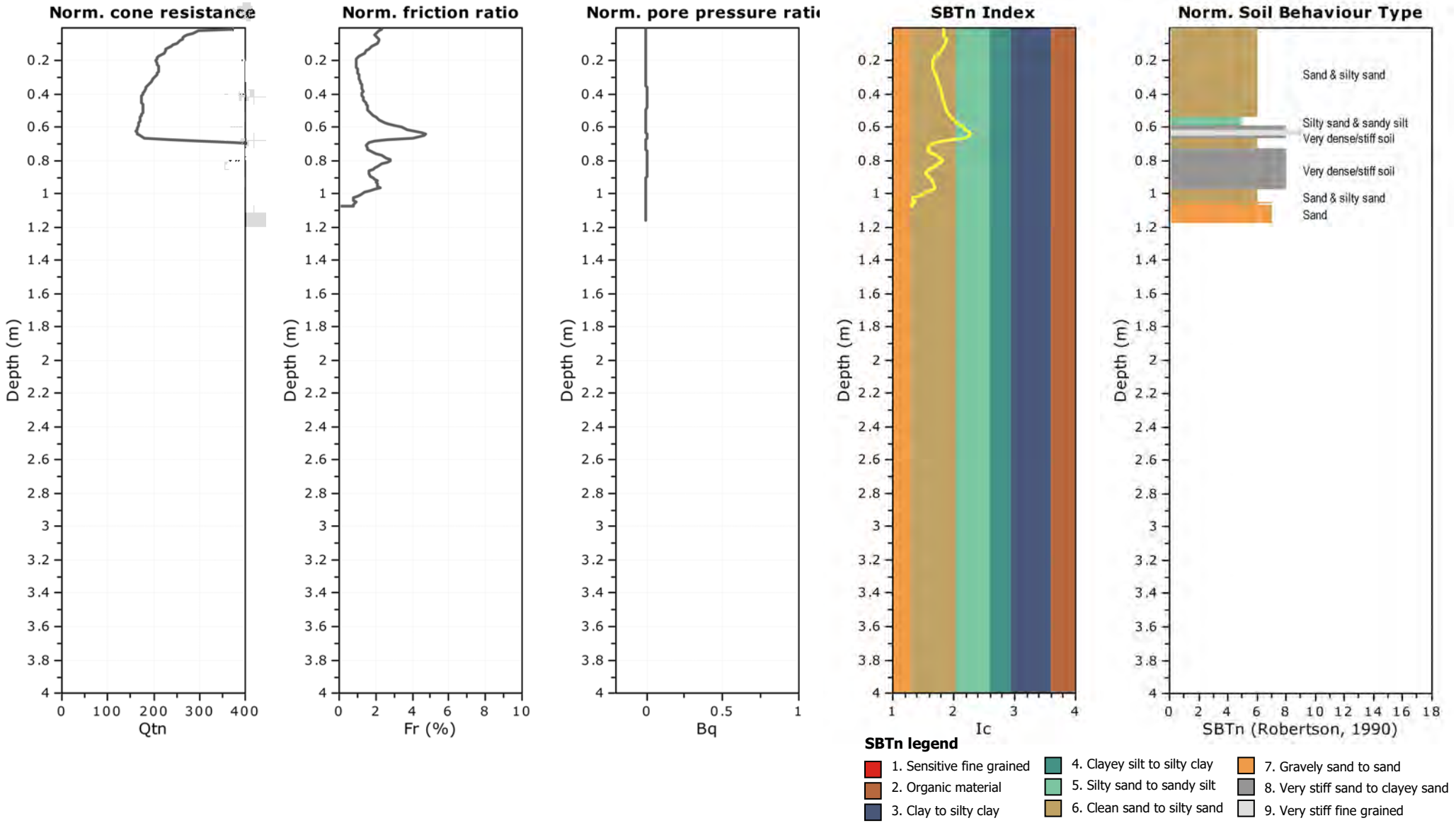
CPT: CPT 11
Total depth: 3.44 m



Tetra Tech Coffey
254 Montreal Street
Christchurch Central
www.tetratechcoffey.com

Project: **Birchs Village**
Location: **Prebbleton**

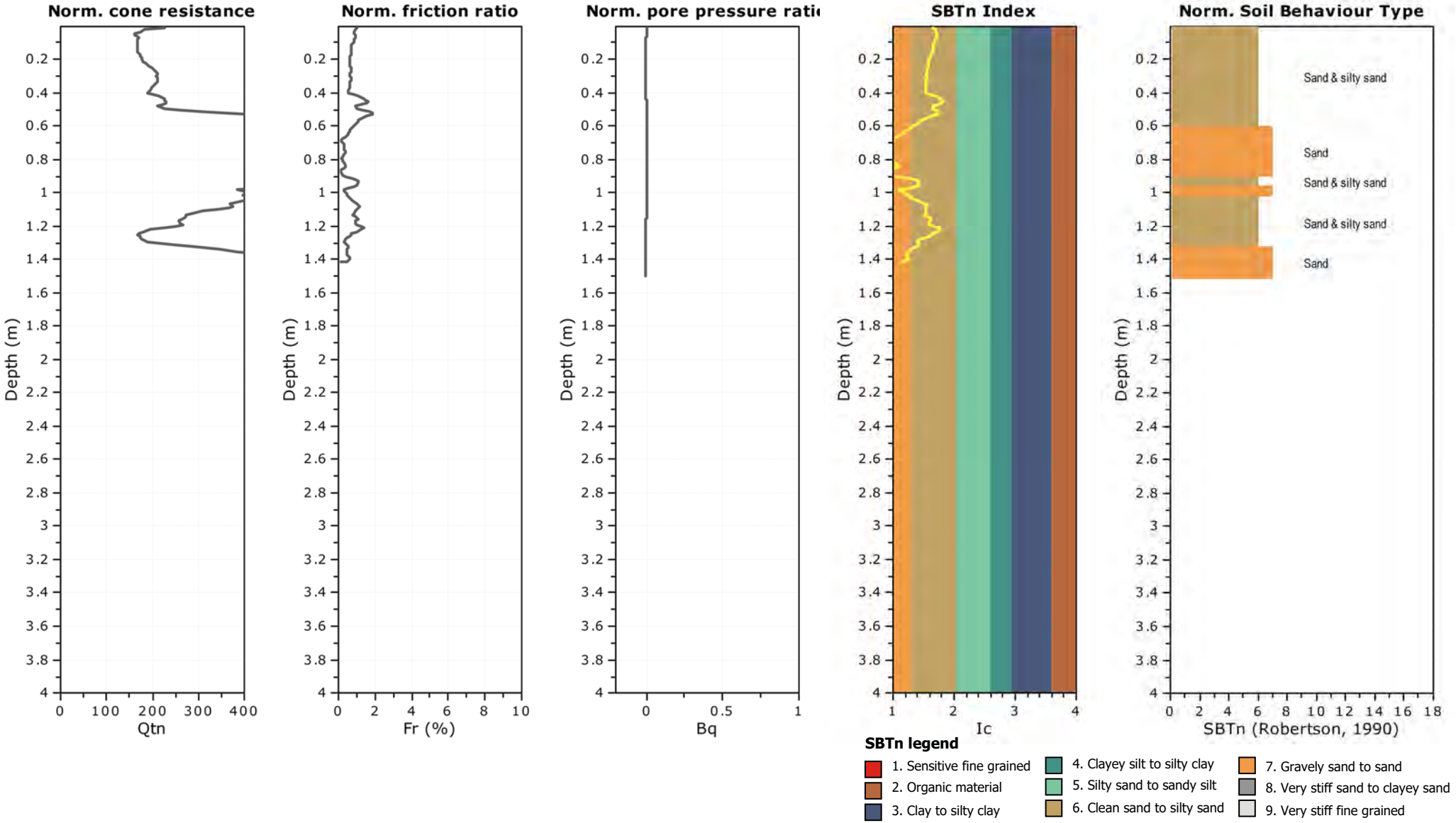
CPT: CPT 12
Total depth: 1.16 m



Tetra Tech Coffey
254 Montreal Street
Christchurch Central
www.tetratechcoffey.com

Project: **Birchs Village**
Location: **Prebbleton**

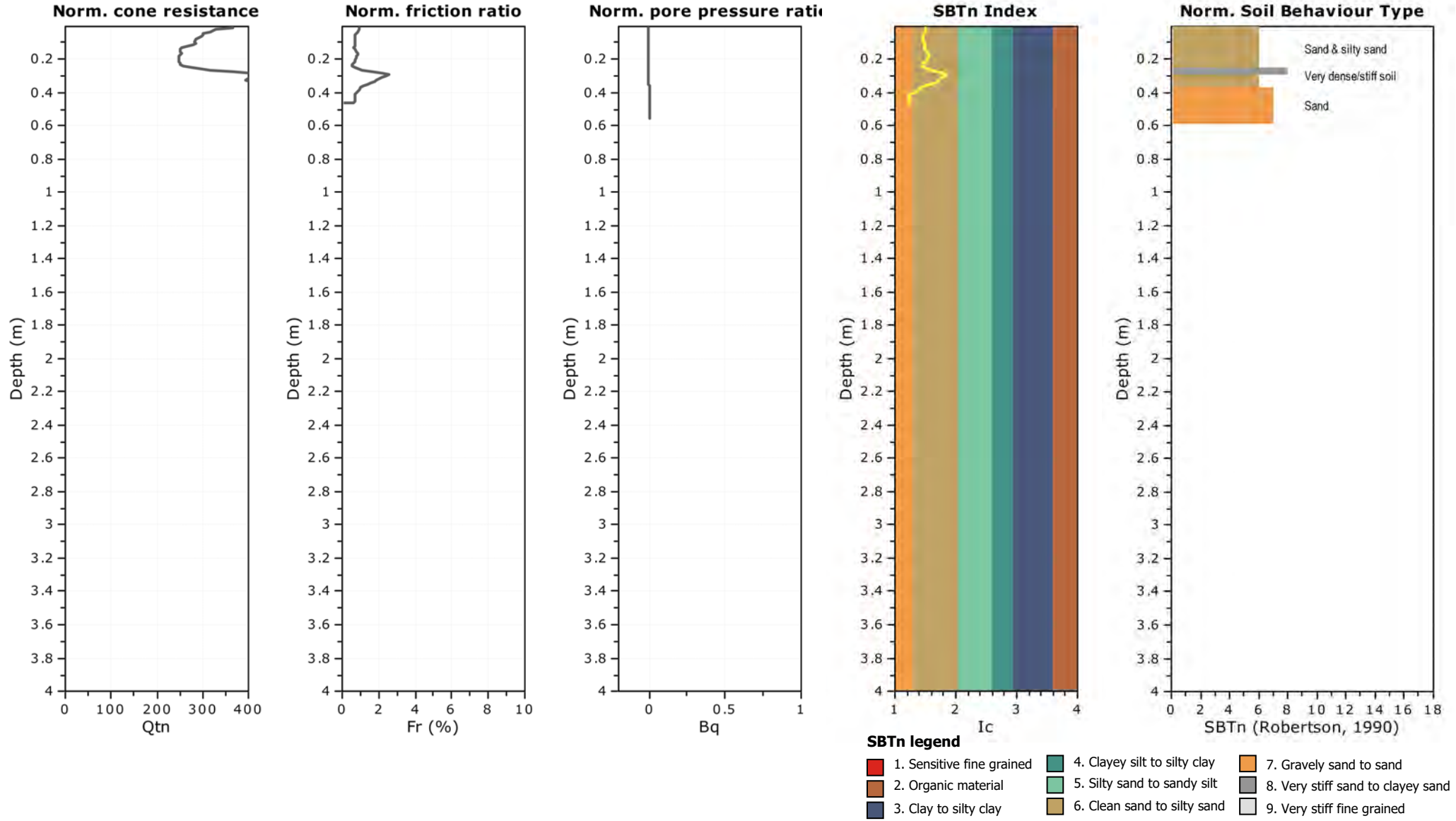
CPT: CPT 13
Total depth: 1.50 m



Tetra Tech Coffey
254 Montreal Street
Christchurch Central
www.tetratechcoffey.com

Project: **Birchs Village**
Location: **Prebbleton**

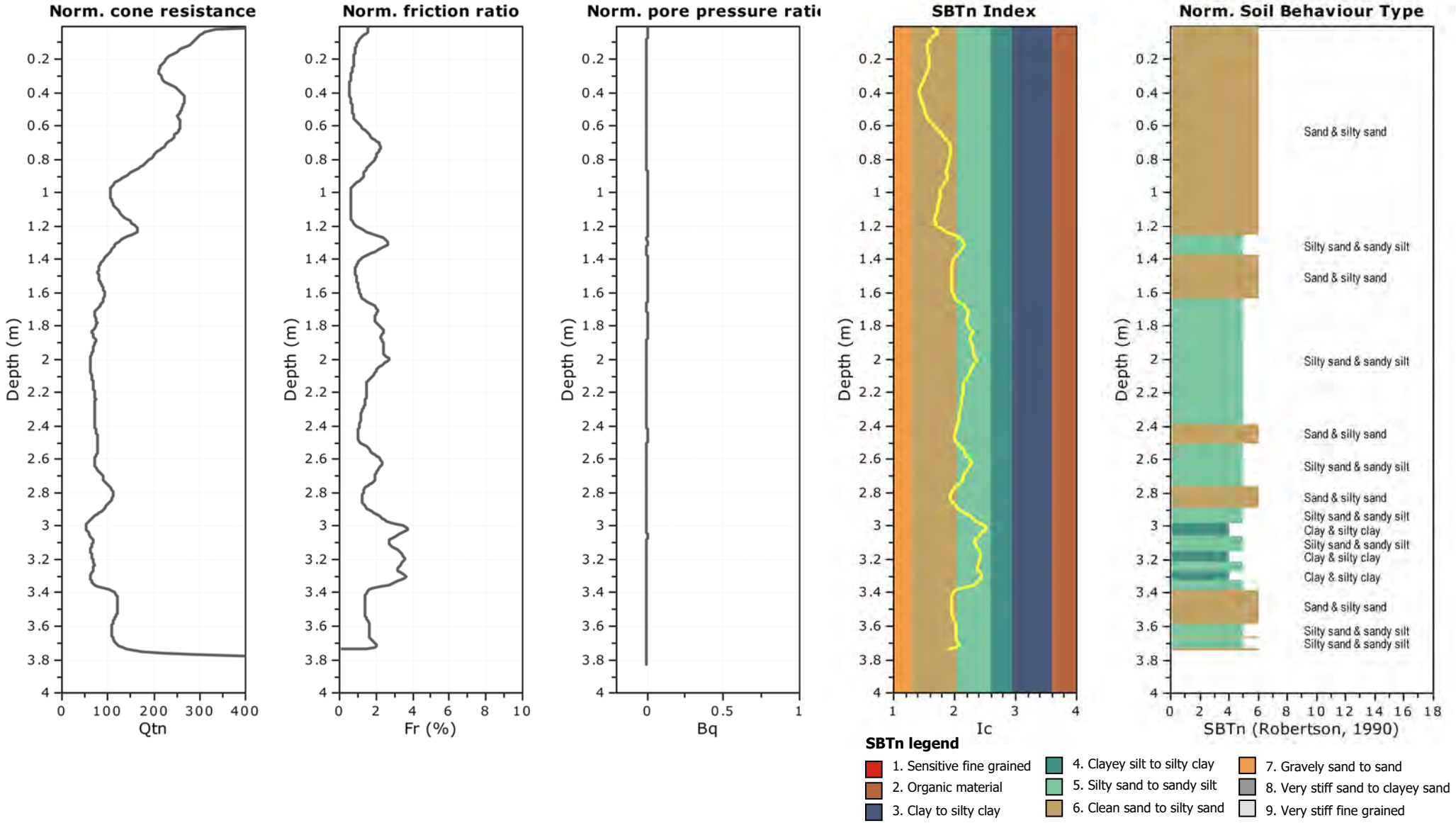
CPT: CPT 14
Total depth: 0.55 m



Tetra Tech Coffey
254 Montreal Street
Christchurch Central
www.tetratechcoffey.com

Project: **Birchs Village**
Location: **Prebbleton**

CPT: CPT 15
Total depth: 3.83 m



HAND AUGER AND SCALA LOG

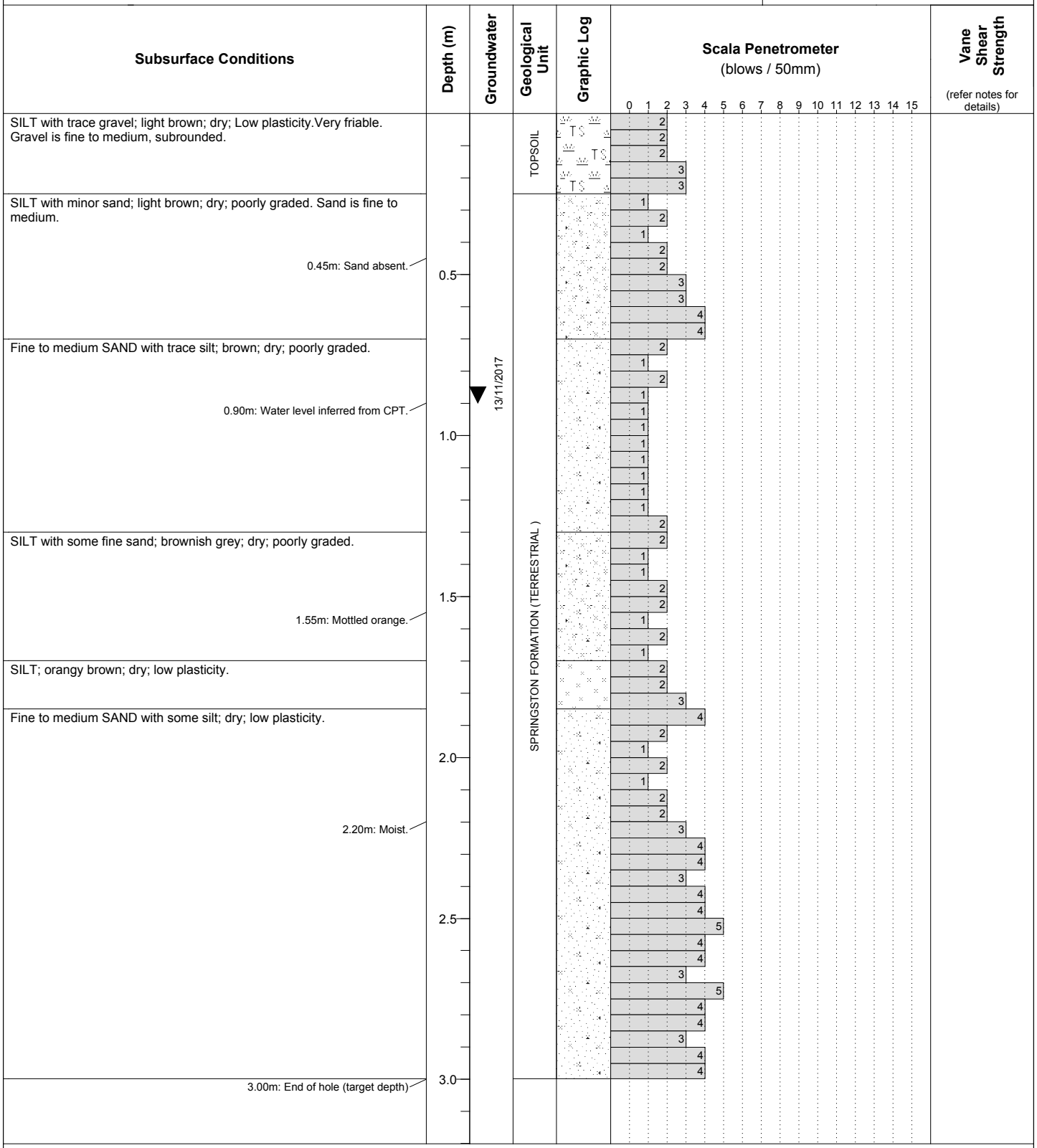
Job No.:	**171064**
Hole No.:	**HA07/SP07**
Date:	13/11/2017
Logged By:	HH
Sheet:	2G

Client: Ryan Geddes

Project: Future Site Development

Location: 212a Birchs Road, Prebbleton

Coordinates: E 1559984.4, N 5172262.4



Notes & Abbreviations

Soils logged in accordance with 'The guidelines for the classification and description of soil and rock for engineering purposes' December 2005, NZGS. Co-ordinates are in NZTM unless otherwise specified.

Water

- ▼ Standing Water Level
- ▽ Water Level At Time Of Drilling
- ◁– Out Flow –▷ In Flow

Shear Vane

Corrected as per NZGS Guidelines
Vane No.:
UTP = Unable To Penetrate
+ = Peak Exceeded
- = No Result

Other Comments

KGA GEOTECHNICAL

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NZGD ID: HA-DCP_110226

HAND AUGER AND SCALA LOG

Job No.:	**171064**
Hole No.:	**HA08/SP08**
Date:	13/11/2017
Logged By:	HH
Sheet:	2H

Client: Ryan Geddes

Project: Future Site Development

Location: 212a Birchs Road, Prebbleton

Coordinates: E 1560177.1, N 5172162.3

Subsurface Conditions	Depth (m)	Groundwater	Geological Unit	Graphic Log	Scala Penetrometer (blows / 50mm)	Vane Shear Strength (refer notes for details)
SILT with trace gravel; light brown; dry; Low plasticity.Very friable. Gravel is fine to medium, subrounded.	0.0		TOPSOIL	TS	2, 3, 3, 3	
SILT: light brown; dry; low plasticity.					4, 3, 3, 3, 3, 2, 1, 1, 1, 2, 1, 1, 1	
0.50m: Minor fine to medium sand.	0.5					
Fine to medium SAND with some silt; light brown; dry; poorly graded.		13/11/2017	SPRINGSTON FORMATION (TERRESTRIAL)		1, 1, 1, 0, 1, 1, 1, 1, 2, 1, 2, 2, 1, 2, 3, 1, 2, 2, 3, 2, 2, 1, 1	
0.90m: Water level inferred from CPT.	1.0					
1.50m: Mottled orange.	1.5					
1.70m: Brownish grey mottled orange.						
Fine to medium SAND; brownish grey mottled orange; dry; poorly graded.	2.0				1, 1, 2, 2, 1, 3, 2, 2, 2, 1, 2, 2, 2, 3, 2	
	2.5					
3.00m: End of hole (Target depth)	3.0					

Notes & Abbreviations

Soils logged in accordance with 'The guidelines for the classification and description of soil and rock for engineering purposes' December 2005, NZGS. Co-ordinates are in NZTM unless otherwise specified.

Water

- ▼ Standing Water Level
- ▽ Water Level At Time Of Drilling
- ◁– Out Flow –▷ In Flow

Shear Vane

Corrected as per NZGS Guidelines
Vane No.:
UTP = Unable To Penetrate
+ = Peak Exceeded
- = No Result

Other Comments

KGA GEOTECHNICAL

Produced with Core-GS

Printed: 21/11/2017 9:35:32 a.m.

NZGD ID: HA-DCP_110226

HAND AUGER AND SCALA LOG

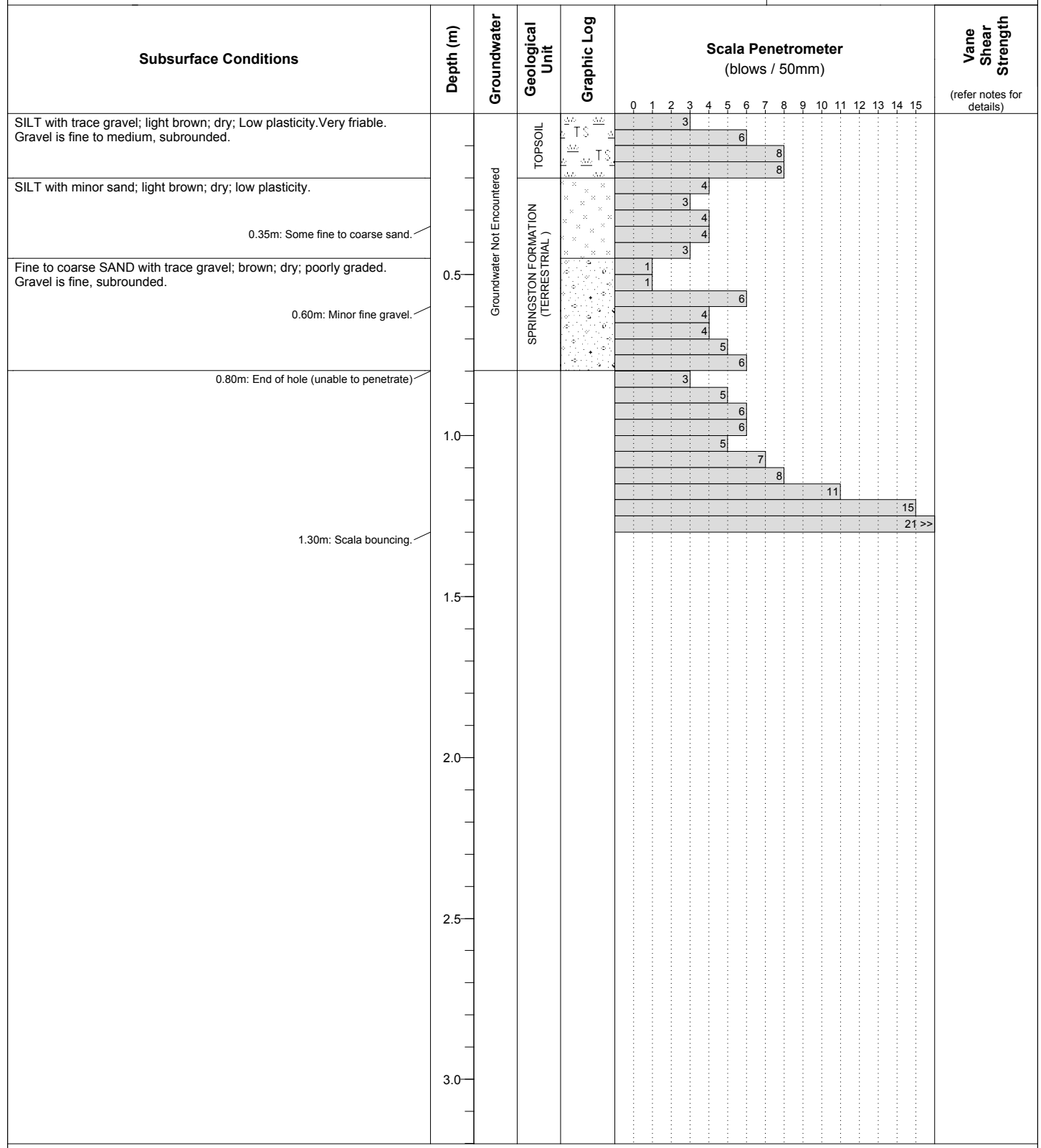
Job No.:	**171064**
Hole No.:	**HA01/SP01**
Date:	13/11/2017
Logged By:	HH
Sheet:	2A

Client: Ryan Geddes

Project: Future Site Development

Location: 212a Birchs Road, Prebbleton

Coordinates: E 1560192.0, N 5172513.1



Notes & Abbreviations

Soils logged in accordance with 'The guidelines for the classification and description of soil and rock for engineering purposes' December 2005, NZGS. Co-ordinates are in NZTM unless otherwise specified.

Water

- ▼ Standing Water Level
- ▽ Water Level At Time Of Drilling
- ◁– Out Flow –▷ In Flow

Shear Vane

Corrected as per NZGS Guidelines
Vane No.:
UTP = Unable To Penetrate
+ = Peak Exceeded
- = No Result

Other Comments

KGA GEOTECHNICAL

Produced with Core-GS

Printed: 21/11/2017 9:36:14 a.m.

NZGD ID: HA-DCP_110226

HAND AUGER AND SCALA LOG

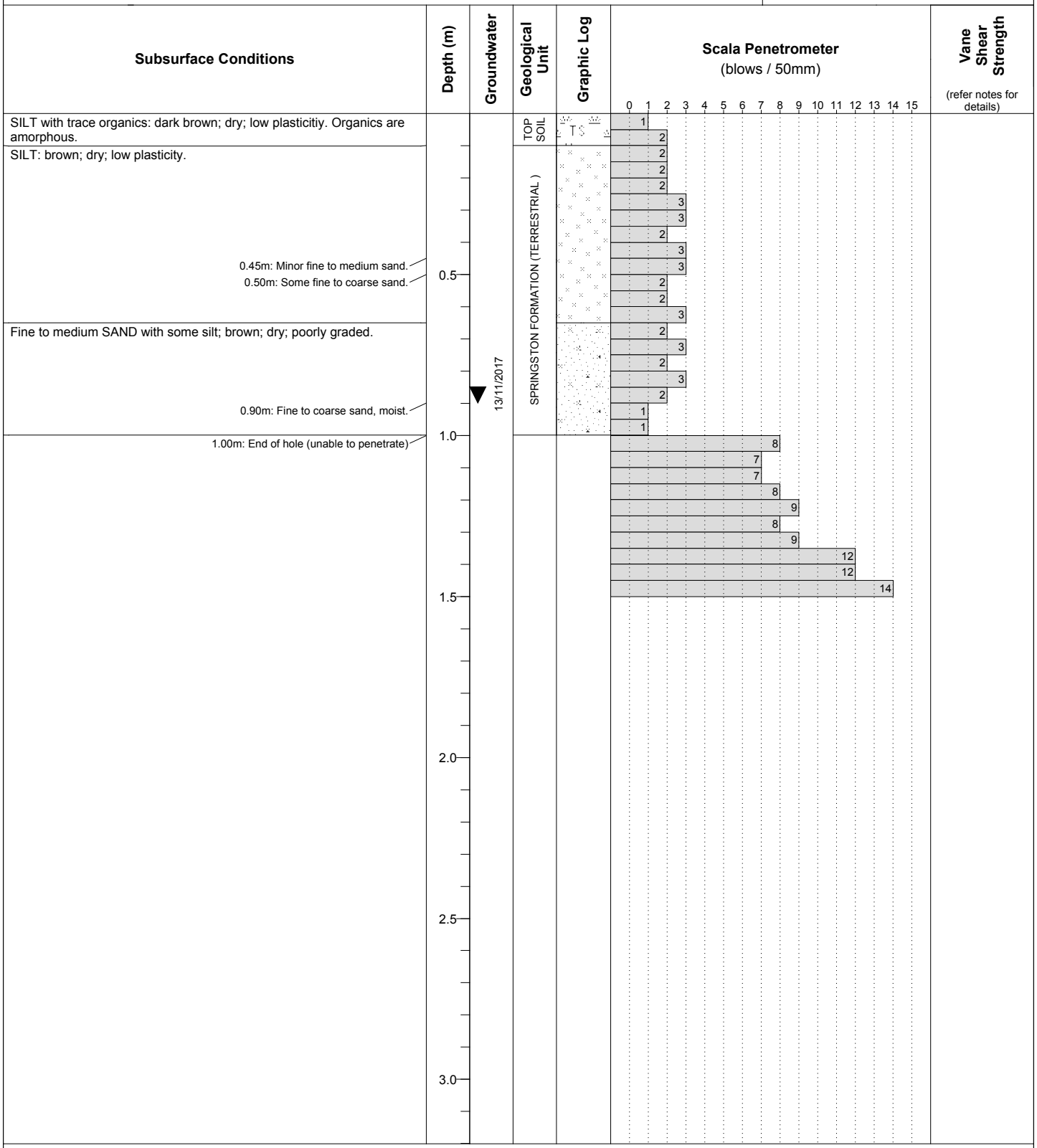
Job No.:	**171064**
Hole No.:	**HA02/SP02**
Date:	13/11/2017
Logged By:	HH
Sheet:	2B

Client: Ryan Geddes

Project: Future Site Development

Location: 212a Birchs Road, Prebbleton

Coordinates: E 1560339.0, N 5172442.8



Notes & Abbreviations

Soils logged in accordance with 'The guidelines for the classification and description of soil and rock for engineering purposes' December 2005, NZGS. Co-ordinates are in NZTM unless otherwise specified.

Water

- ▼ Standing Water Level
- ▽ Water Level At Time Of Drilling
- ◁– Out Flow –▷ In Flow

Shear Vane

Corrected as per NZGS Guidelines
Vane No.:
UTP = Unable To Penetrate
+ = Peak Exceeded
- = No Result

Other Comments

KGA GEOTECHNICAL

Produced with Core-GS

Printed: 21/11/2017 9:36:10 a.m.

NZGD ID: HA-DCP_110226

HAND AUGER AND SCALA LOG

Job No.:	**171064**
Hole No.:	**HA03/SP03**
Date:	13/11/2017
Logged By:	HH
Sheet:	2C

Client: Ryan Geddes

Project: Future Site Development

Location: 212a Birchs Road, Prebbleton

Coordinates: E 1560142.3, N 5172452.6

Subsurface Conditions	Depth (m)	Groundwater	Geological Unit	Graphic Log	Scala Penetrometer (blows / 50mm)	Vane Shear Strength (refer notes for details)
SILT with trace gravel; light brown; dry; Low plasticity.Very friable. Gravel is fine to medium, subrounded.	0.0		TOPSOIL		2	
SILT with some minor sand: brown; dry; low plasticity. Sand is fine to medium.					4	
0.30m: Some fine to coarse sand.					3	
					3	
					3	
					4	
					2	
					1	
Fine to medium SAND with some silt; brown; dry; poorly graded.					1	
					1	
	0.5				2	
					1	
					1	
					1	
					1	
					2	
0.90m: Water level inferred from CPT.		13/11/2017			2	
					2	
	1.0				1	
					2	
					1	
					1	
					2	
Fine to coarse SAND: brown; dry; poorly graded.			SPRINGSTON FORMATION (TERRESTRIAL)		1	
					1	
					2	
	1.5				2	
					1	
					1	
					2	
1.70m: Mottled orange.					2	
					2	
					1	
					2	
					2	
					1	
					1	
	2.0				2	
					2	
					1	
					2	
					2	
					1	
2.30m: Orangy brown.					2	
					1	
					2	
	2.5				2	
					2	
					1	
					2	
					1	
					1	
					2	
					2	
					3	
					2	
3.00m: End of hole (target depth)	3.0				3	

Notes & Abbreviations

Soils logged in accordance with 'The guidelines for the classification and description of soil and rock for engineering purposes' December 2005, NZGS. Co-ordinates are in NZTM unless otherwise specified.

Water

- ▼ Standing Water Level
- ▽ Water Level At Time Of Drilling
- ◁– Out Flow –▷ In Flow

Shear Vane

Corrected as per NZGS Guidelines
Vane No.:
UTP = Unable To Penetrate
+ = Peak Exceeded
- = No Result

Other Comments

KGA GEOTECHNICAL

Produced with Core-GS

Printed: 21/11/2017 9:36:06 a.m.

NZGD ID: HA-DCP_110226

HAND AUGER AND SCALA LOG

Job No.:	**171064**
Hole No.:	**HA04/SP04**
Date:	13/11/2017
Logged By:	HH
Sheet:	2D

Client: Ryan Geddes

Project: Future Site Development

Location: 212a Birchs Road, Prebbleton

Coordinates: E 1560283.5, N 5172363.2

Subsurface Conditions	Depth (m)	Groundwater	Geological Unit	Graphic Log	Scala Penetrometer (blows / 50mm)	Vane Shear Strength (refer notes for details)
SILT with trace gravel; light brown; dry; Low plasticity.Very friable. Gravel is fine to medium, subrounded.	0.0		TOPSOIL		4, 3, 3, 4, 4, 5	
SILT with trace sand: brown; dry; low plasticity. Sand is fine.	0.5		SPRINGSTON FORMATION (TERRESTRIAL)		3, 4, 4, 3, 2, 3, 1, 2, 1, 2, 2	
0.55m: Light brown, minor fine to medium sand.						
0.75m: Some sand.						
Fine to coarse SAND with some silt; brown; dry; poorly graded.		13/11/2017			3, 3, 2, 4	
0.90m: Water level inferred from CPT.	1.0					
1.05m: End of hole (unable to penetrate)					7, 14, 20 >>	
1.20m: Bouncing.	1.5					
	2.0					
	2.5					
	3.0					

Notes & Abbreviations

Soils logged in accordance with 'The guidelines for the classification and description of soil and rock for engineering purposes' December 2005, NZGS. Co-ordinates are in NZTM unless otherwise specified.

Water

- ▼ Standing Water Level
- ▽ Water Level At Time Of Drilling
- ◁– Out Flow –▷ In Flow

Shear Vane

Corrected as per NZGS Guidelines
Vane No.:
UTP = Unable To Penetrate
+ = Peak Exceeded
- = No Result

Other Comments

KGA GEOTECHNICAL

Produced with Core-GS

Printed: 21/11/2017 9:36:01 a.m.

NZGD ID: HA-DCP_110226

HAND AUGER AND SCALA LOG

Job No.:	**171064**
Hole No.:	**HA05/SP05**
Date:	13/11/2017
Logged By:	HH
Sheet:	2E

Client: Ryan Geddes

Project: Future Site Development

Location: 212a Birchs Road, Prebbleton

Coordinates: E 1560055.2, N 5172367.7

Subsurface Conditions	Depth (m)	Groundwater	Geological Unit	Graphic Log	Scala Penetrometer (blows / 50mm)	Vane Shear Strength (refer notes for details)
SILT with trace gravel; light brown; dry; Low plasticity.Very friable. Gravel is fine to medium, subrounded.	0.0		TOPSOIL		2 4 5	
SILT; light brown; ver hard; dry; low plasticity.			SPRINGSTON FORMATION (TERRESTRIAL)		6 5 7 6 6	
Fine to medium SAND with minor silt; dry; poorly graded.	0.5				3 2 2 2 1 2 2 2	
Fine to coarse SAND with trace silt; brownish grey; dry; poorly graded.		13/11/2017			2 2 2 3 3 2 1 2 1 1 2 2 1 2	
0.90m: Water level inferred from CPT.	1.0					
1.10m: Silt absent.						
SILT with trace sand; orangy brown; dry; low plasticity. Sand s fine.	1.5				1 2 1 1	
Fine to medium SAND with minor silt; brownish grey mottled orange; dry; poorly graded.					2 1 2 2 1 1 2 1 2 2 1 2 2 1 2 2 2 1 2 1 2 2 1 2 2 2	
	2.0					
	2.5					
3.00m: End of hole (target depth)	3.0					

Scala Penetrometer (blows / 50mm) scale: 0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15

Notes & Abbreviations

Soils logged in accordance with 'The guidelines for the classification and description of soil and rock for engineering purposes' December 2005, NZGS. Co-ordinates are in NZTM unless otherwise specified.

Water

- ▼ Standing Water Level
- ▽ Water Level At Time Of Drilling
- ◁– Out Flow –▷ In Flow

Shear Vane

Corrected as per NZGS Guidelines
Vane No.:
UTP = Unable To Penetrate
+ = Peak Exceeded
- = No Result

Other Comments

KGA GEOTECHNICAL

Produced with Core-GS

Printed: 21/11/2017 9:35:58 a.m.

NZGD ID: HA-DCP_110226

HAND AUGER AND SCALA LOG

Job No.:	**171064**
Hole No.:	**HA06/SP06**
Date:	13/11/2017
Logged By:	HH
Sheet:	2F

Client: Ryan Geddes

Project: Future Site Development

Location: 212a Birchs Road, Prebbleton

Coordinates: E 1560223.7, N 5172261.6

Subsurface Conditions	Depth (m)	Groundwater	Geological Unit	Graphic Log	Scala Penetrometer (blows / 50mm)	Vane Shear Strength (refer notes for details)
SILT with trace gravel; light brown; dry; Low plasticity.Very friable. Gravel is fine to medium, subrounded.	0.0		TOPSOIL	TS	2 3 3 3 4 3	
SILT with trace sand; light brwn; dry; low plasticity. Sand is fine.	0.5		SPRINGSTON FORMATION (TERRESTRIAL)		3 4 4 3 3 2	
Fine to medium SAND with minor to some silt; brownish grey; dry; poorly graded.					2 2 1 2 1 1	
0.90m: Water level inferred from CPT.	1.0	13/11/2017			0 1 1 1 1 1 1 1	
1.30m:					2 1 2 1 2 2	
SILT; orangy brown; dry; low plasticity.	1.5				2 1 2 2 1	
Fine to medium SAND with some silt; brownish grey; dry; poorly graded.					2 2 1 1 2 1 2 2 1	
SILT: orangy grey; dry; low plasticity.	2.0				2 2 2	
Fine to medium SAND: brownish grey; moist; poorly graded.					1 2 2 2 1 2 1 2 2 3 2 2	
3.00m: Fine to coarse sand, grey.	2.5					
	3.0					

Notes & Abbreviations

Soils logged in accordance with 'The guidelines for the classification and description of soil and rock for engineering purposes' December 2005, NZGS. Co-ordinates are in NZTM unless otherwise specified.

Water

- ▼ Standing Water Level
- ▽ Water Level At Time Of Drilling
- ◁– Out Flow –▷ In Flow

Shear Vane

Corrected as per NZGS Guidelines
Vane No.:
UTP = Unable To Penetrate
+ = Peak Exceeded
- = No Result

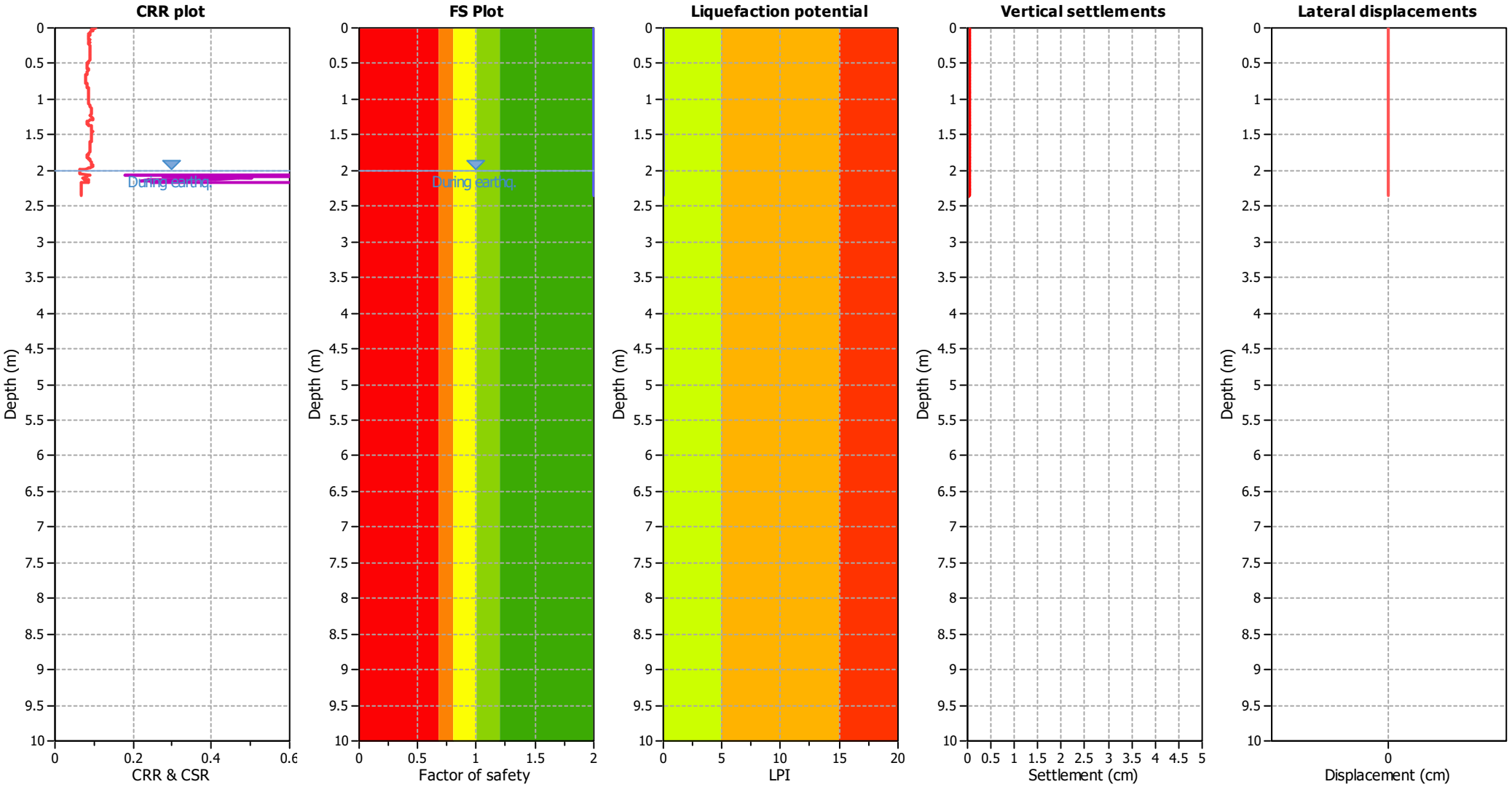
Other Comments

KGA GEOTECHNICAL

Produced with Core-GS

Printed: 21/11/2017 9:35:54 a.m.

Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	2.00 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:	6.00	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.19	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	2.00 m	Fill height:	N/A	Limit depth:	N/A

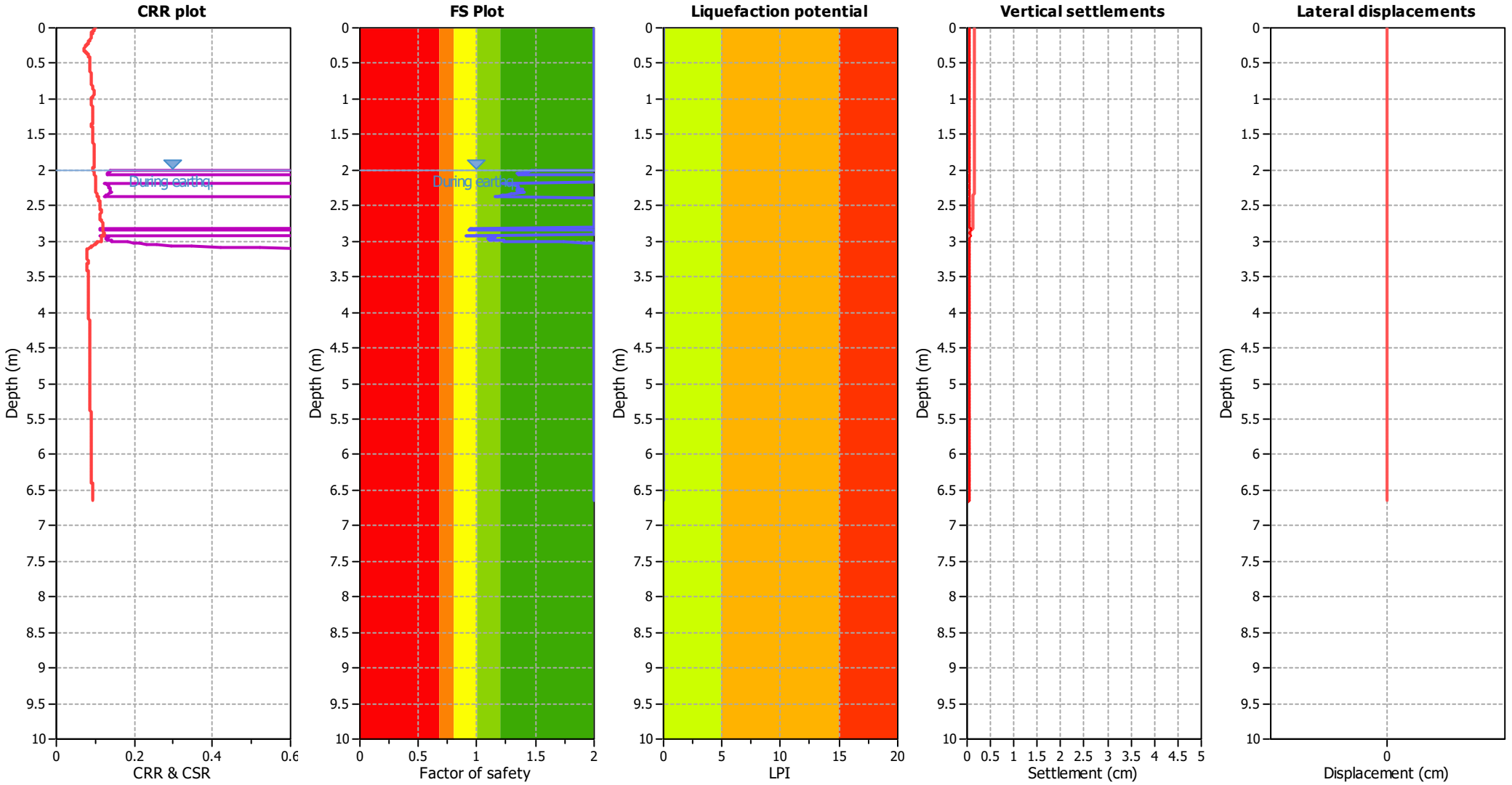
F.S. color scheme

- 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

Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	2.00 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:	6.00	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.19	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	2.00 m	Fill height:	N/A	Limit depth:	N/A

F.S. color scheme

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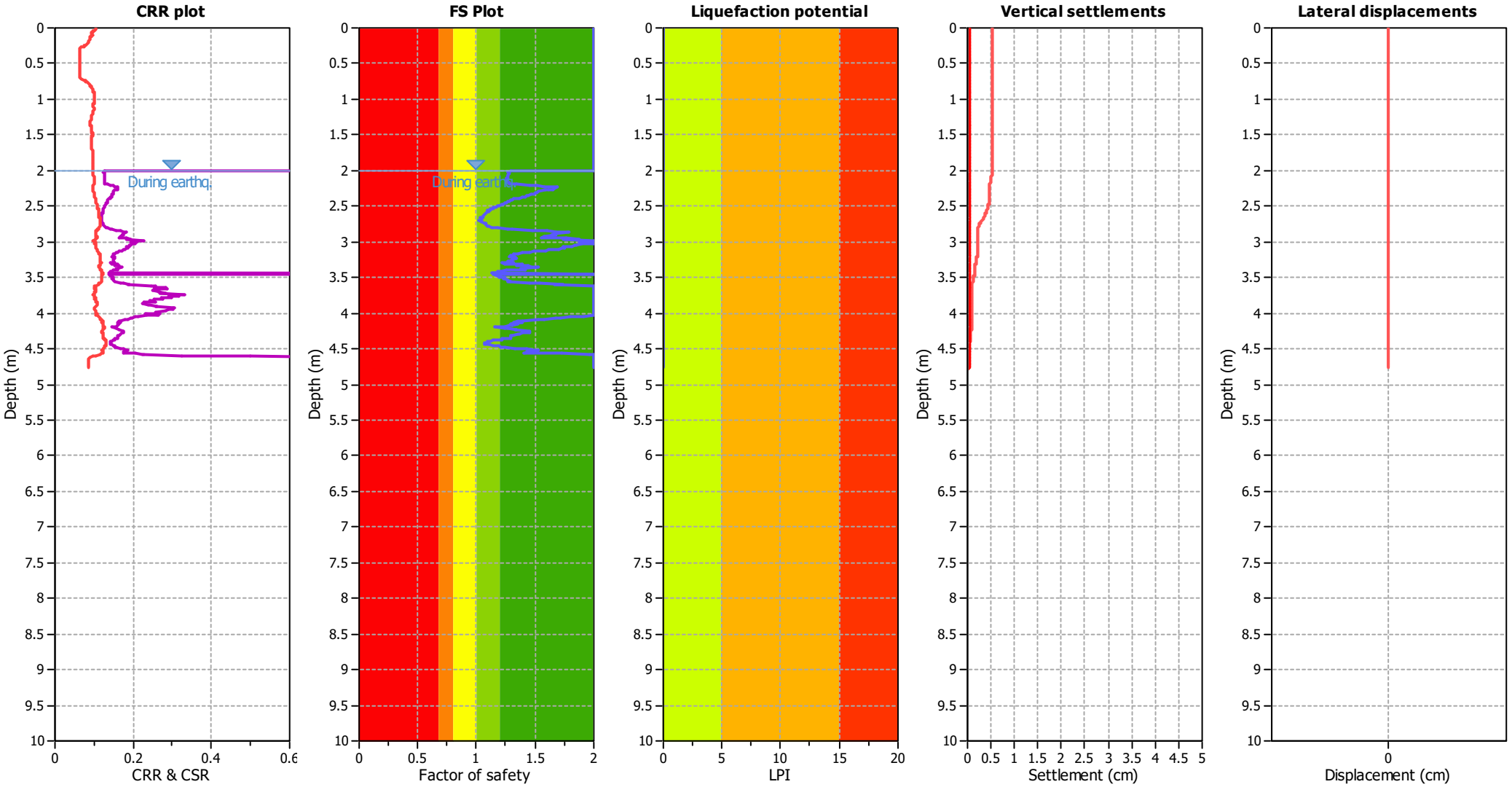
- Unlike to liquefy
- Almost certain it will not liquefy

LPI color scheme

- Very high risk
- High risk
- Low risk

Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	2.00 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:	6.00	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.19	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	2.00 m	Fill height:	N/A	Limit depth:	N/A

F.S. color scheme

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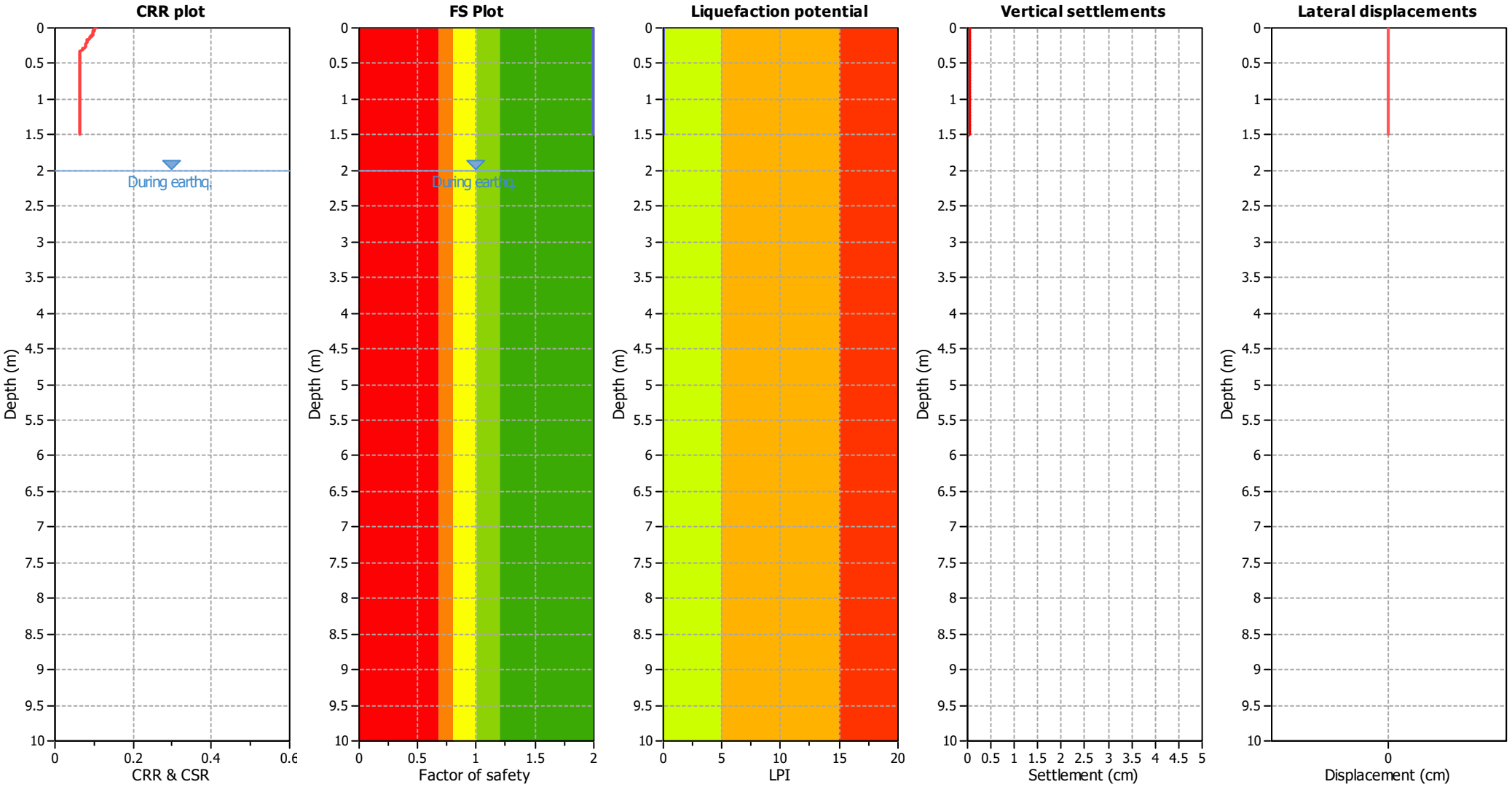
- Liquefaction and no liq. are equally likely
- Unlike to liquefy
- Almost certain it will not liquefy

LPI color scheme

- Very high risk
- High risk
- Low risk

Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	2.00 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:	6.00	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.19	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	2.00 m	Fill height:	N/A	Limit depth:	N/A

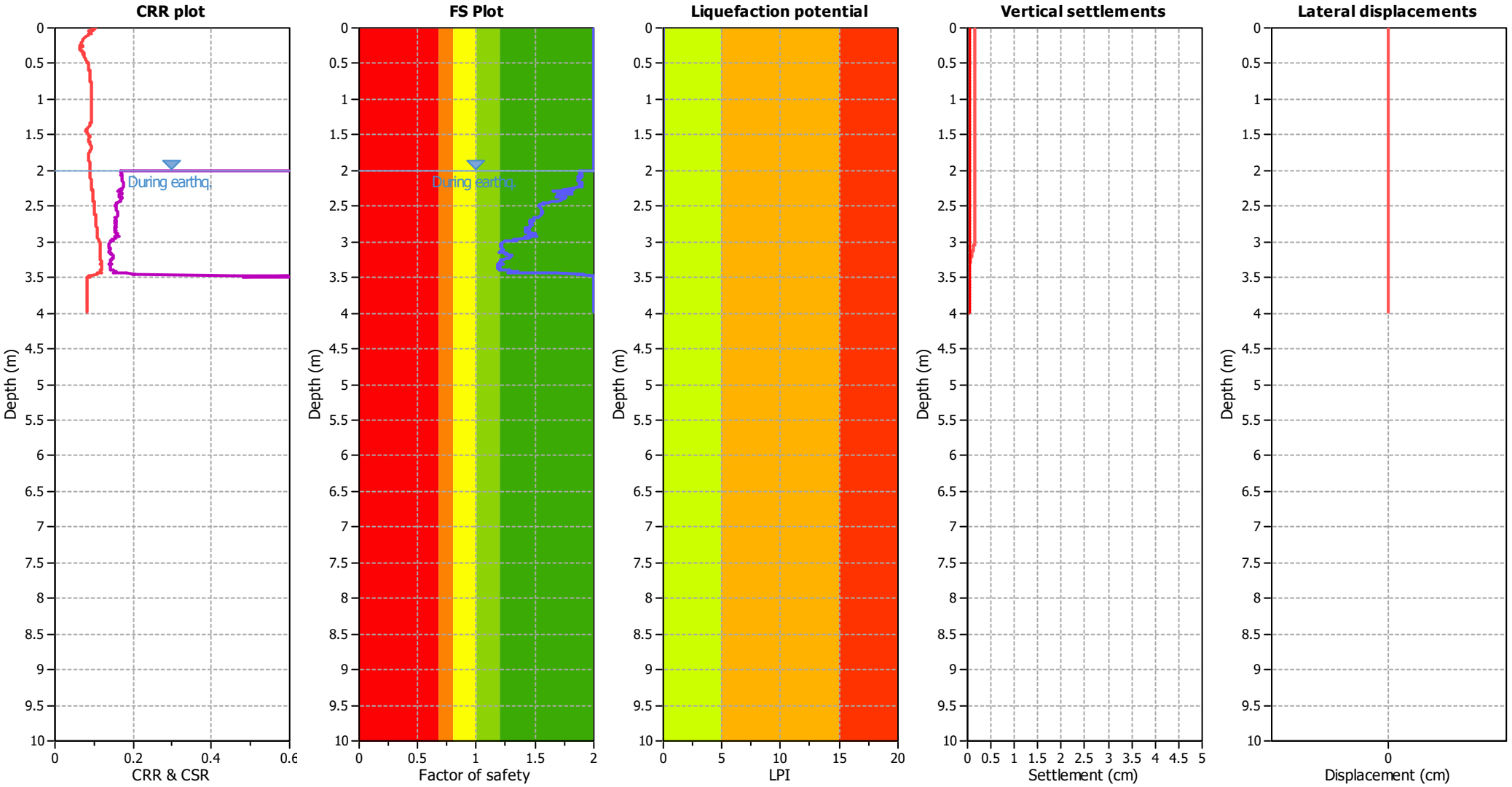
F.S. color scheme

- 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

Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	2.00 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:	6.00	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.19	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	2.00 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
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LPI color scheme

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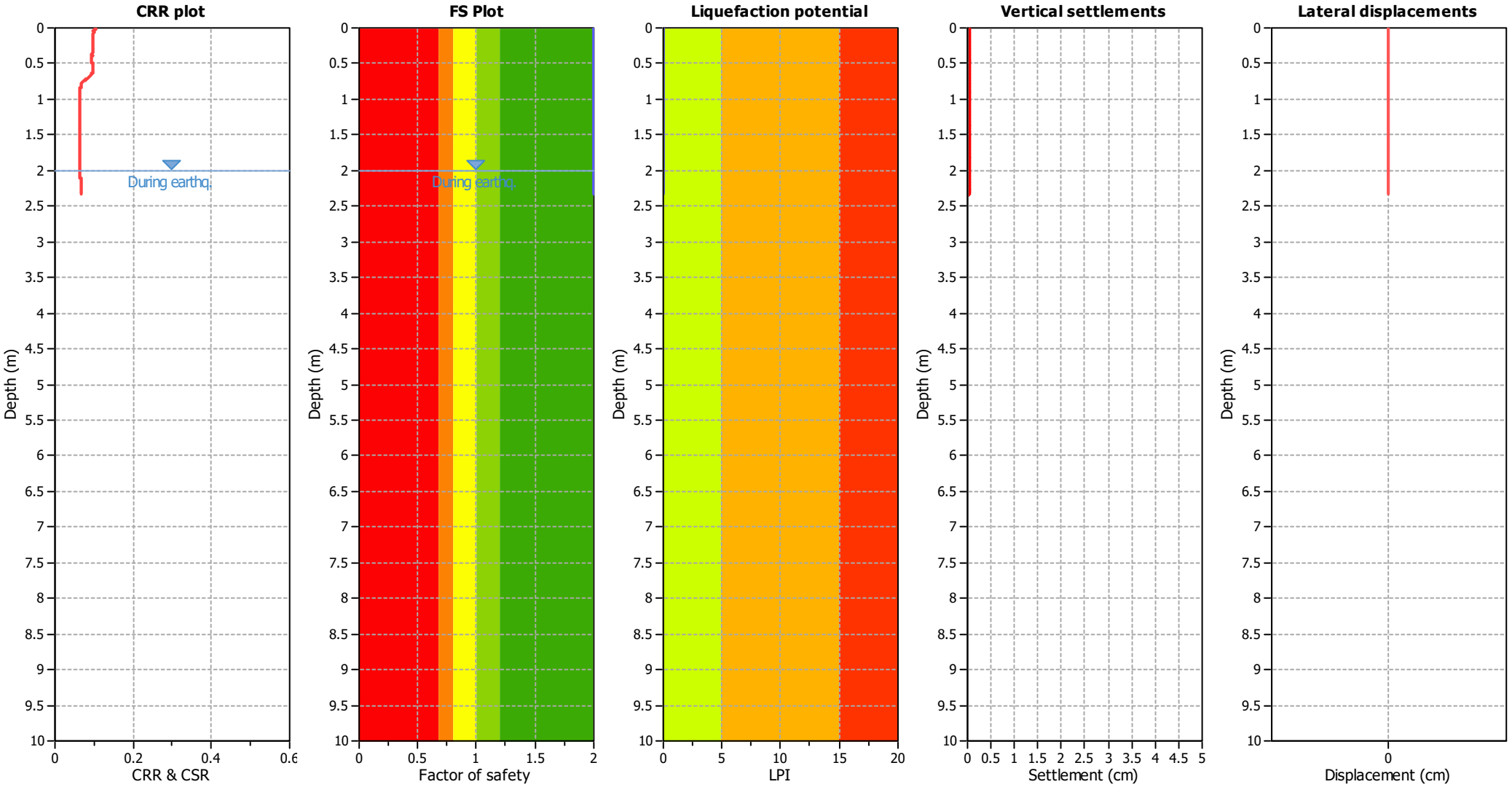
- High risk
- Low risk

Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	2.00 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:	6.00	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.19	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	2.00 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
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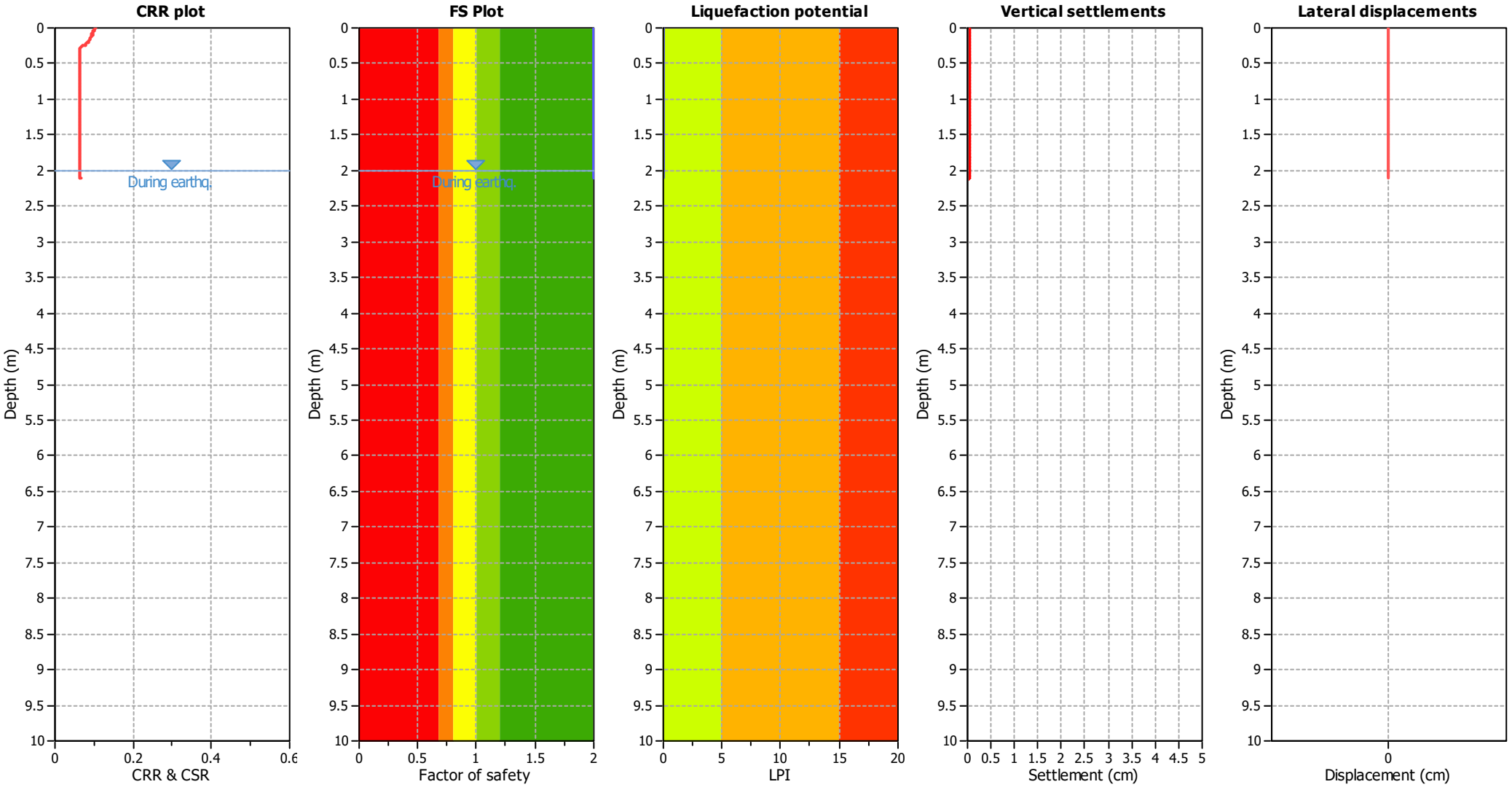

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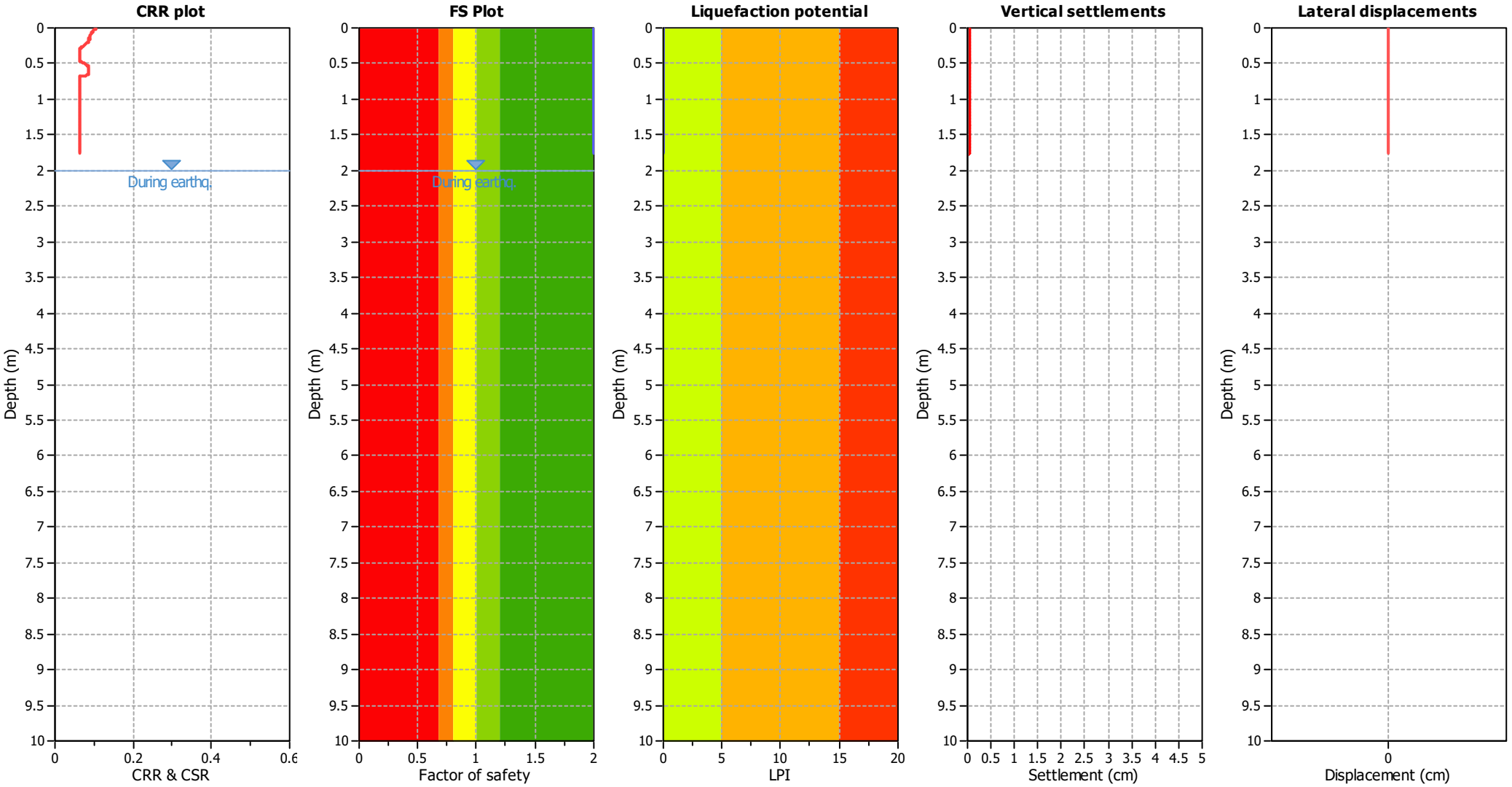

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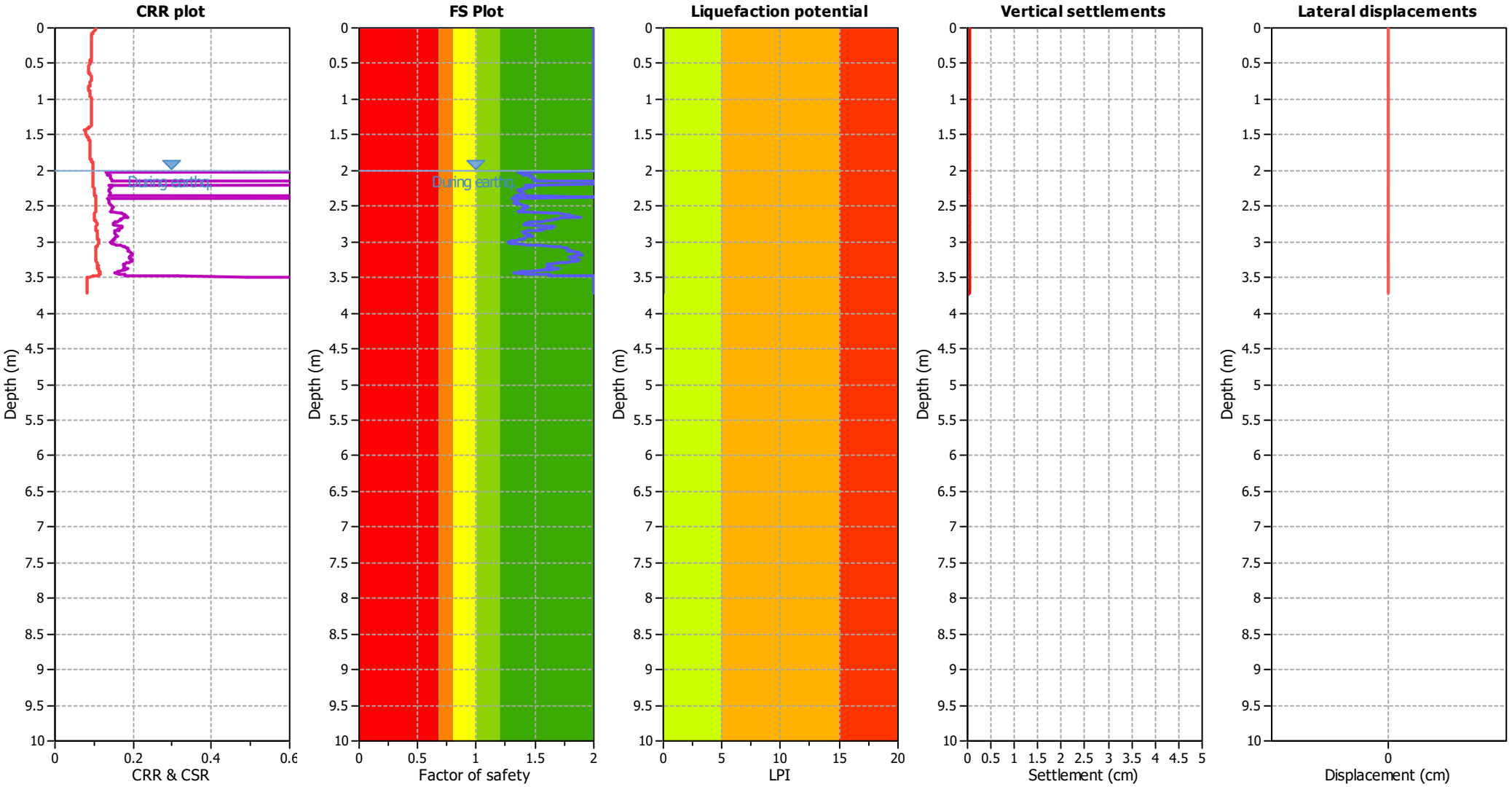

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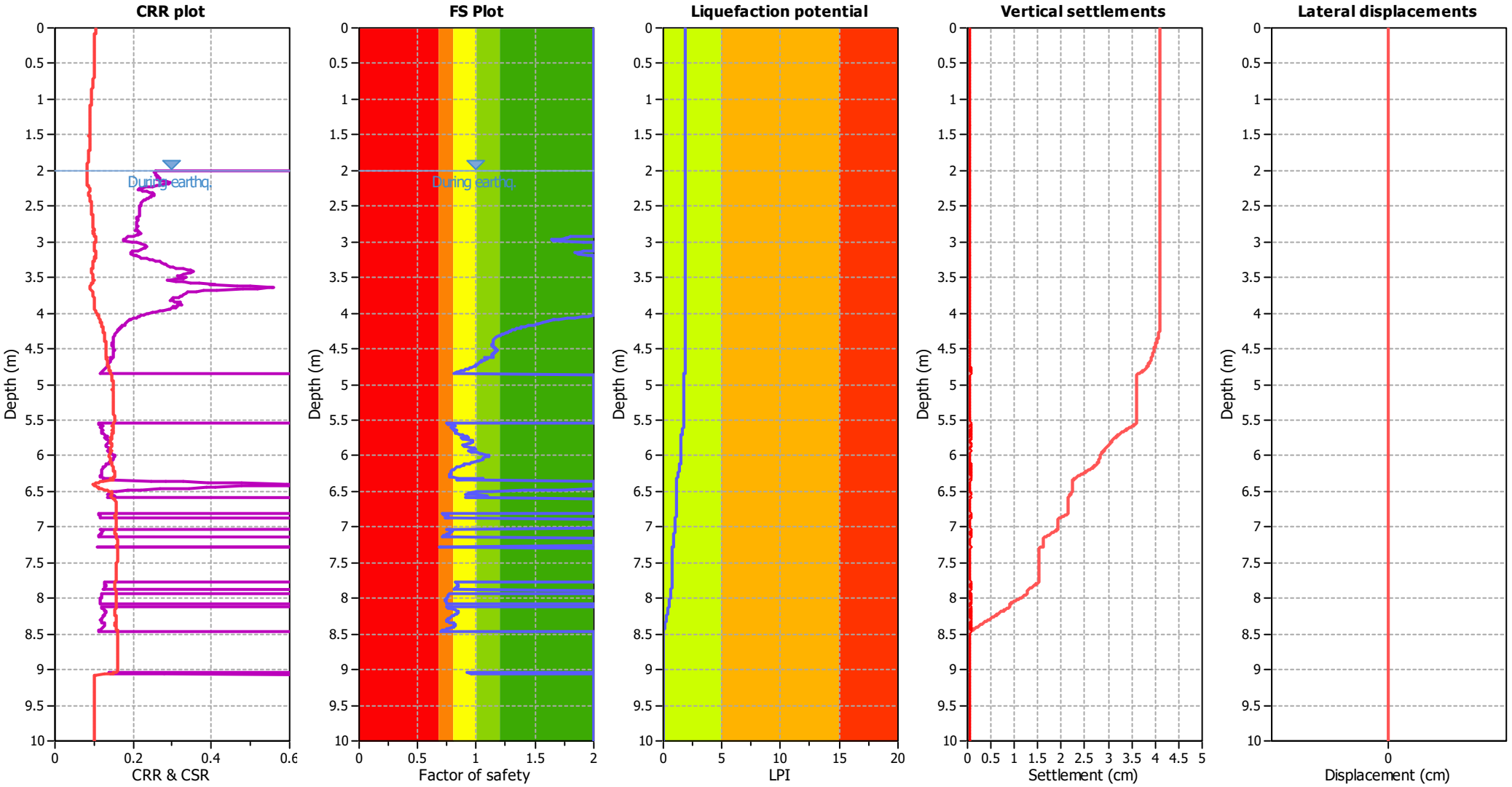

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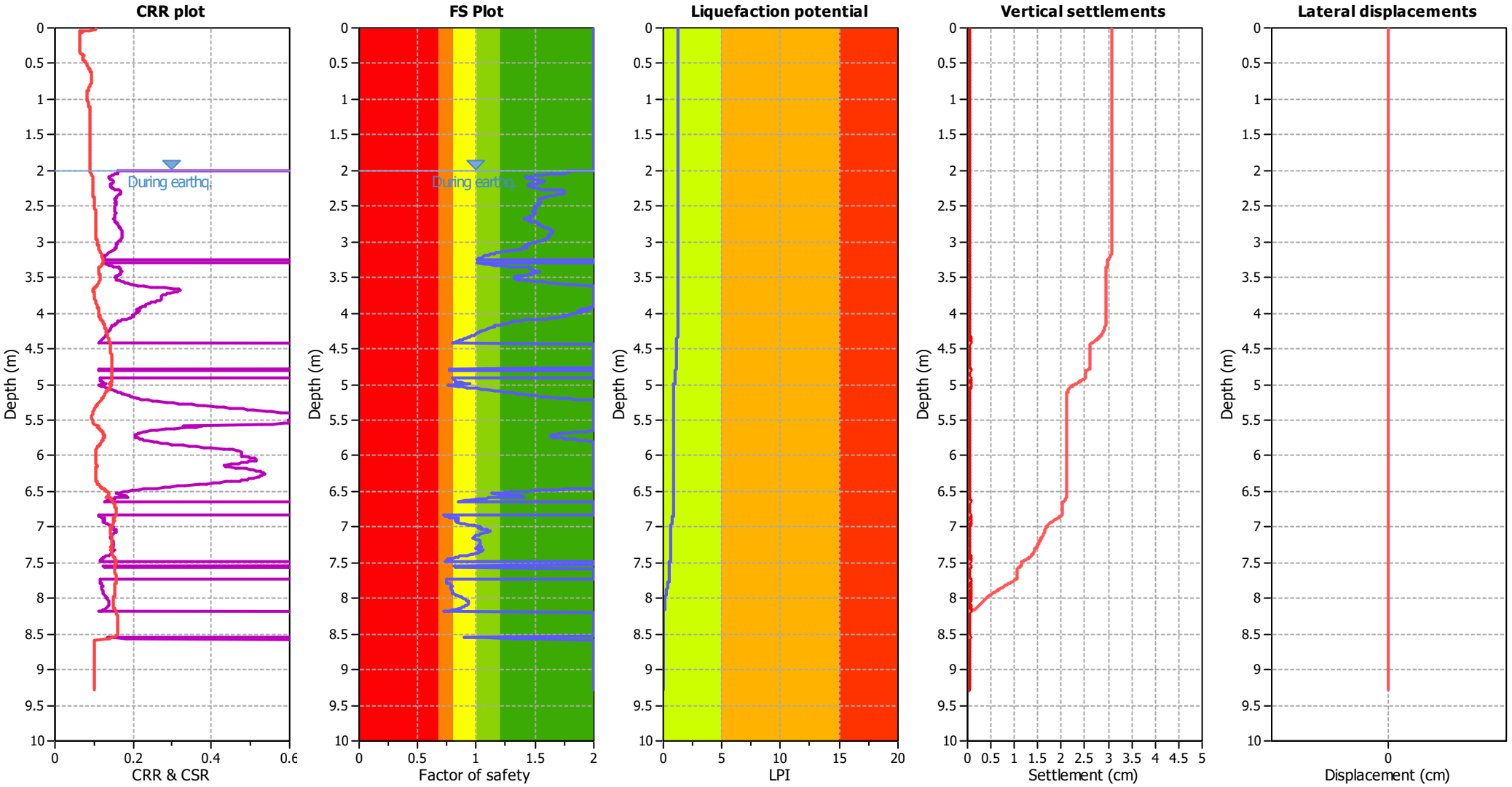

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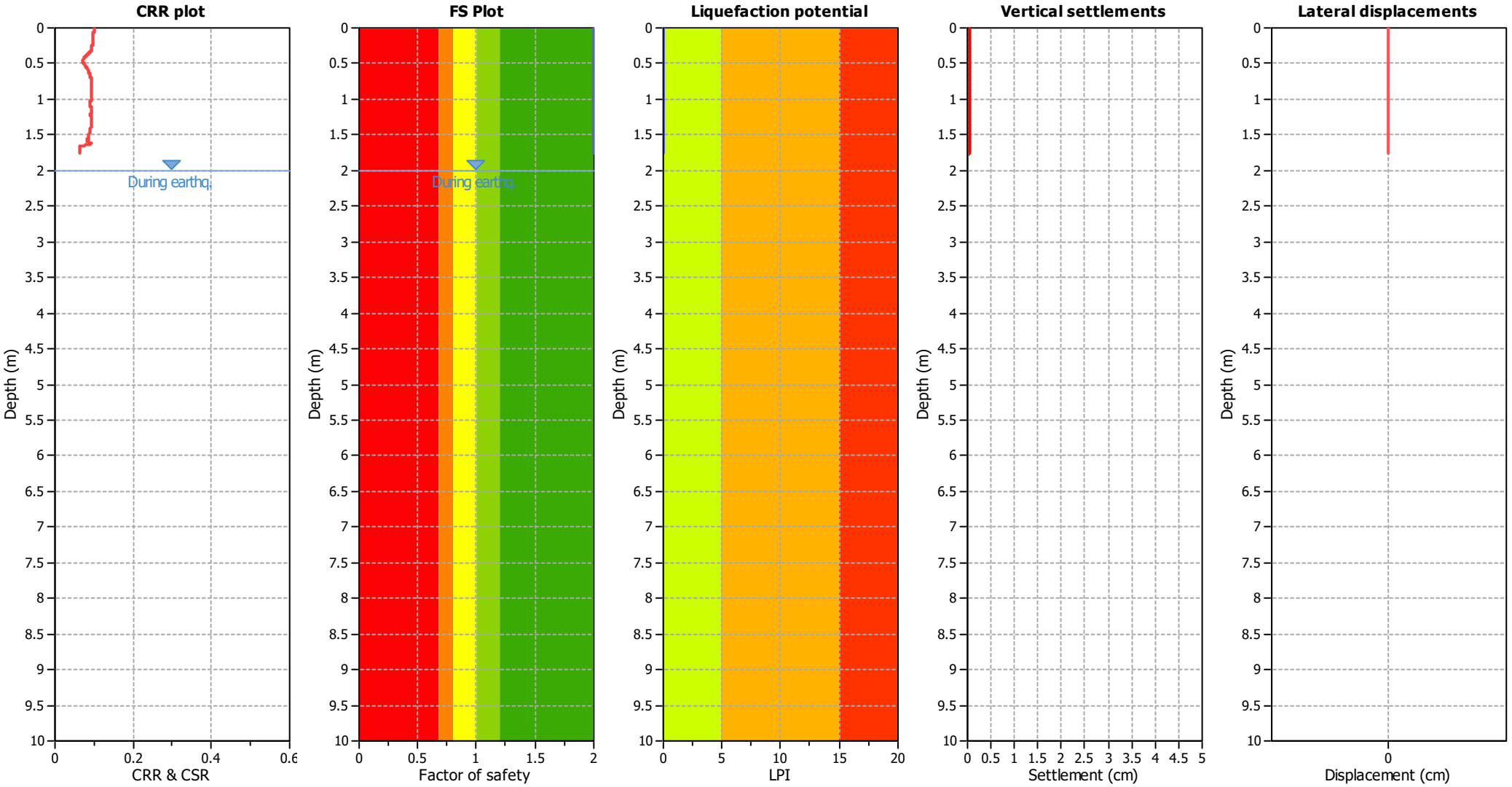

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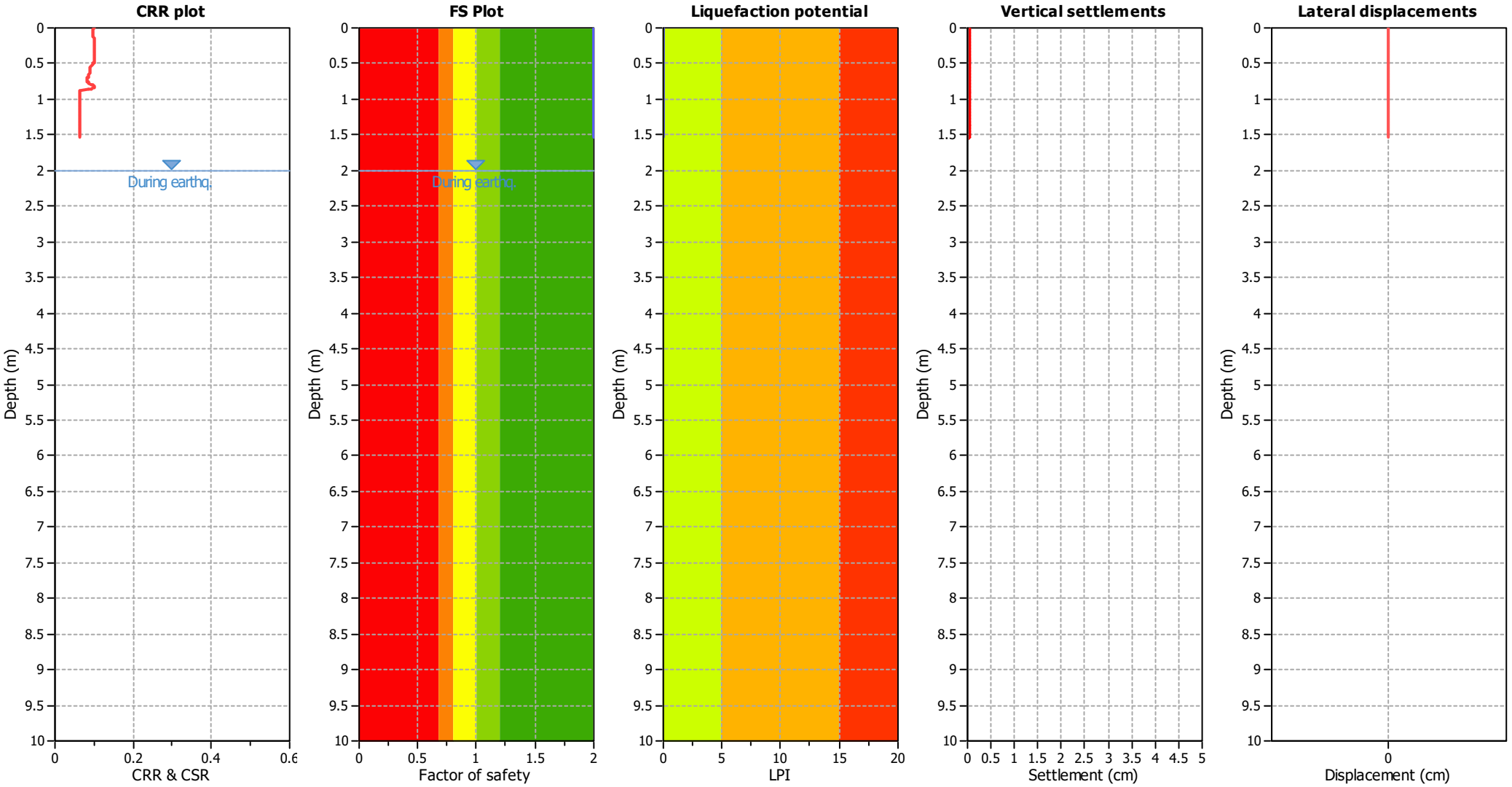

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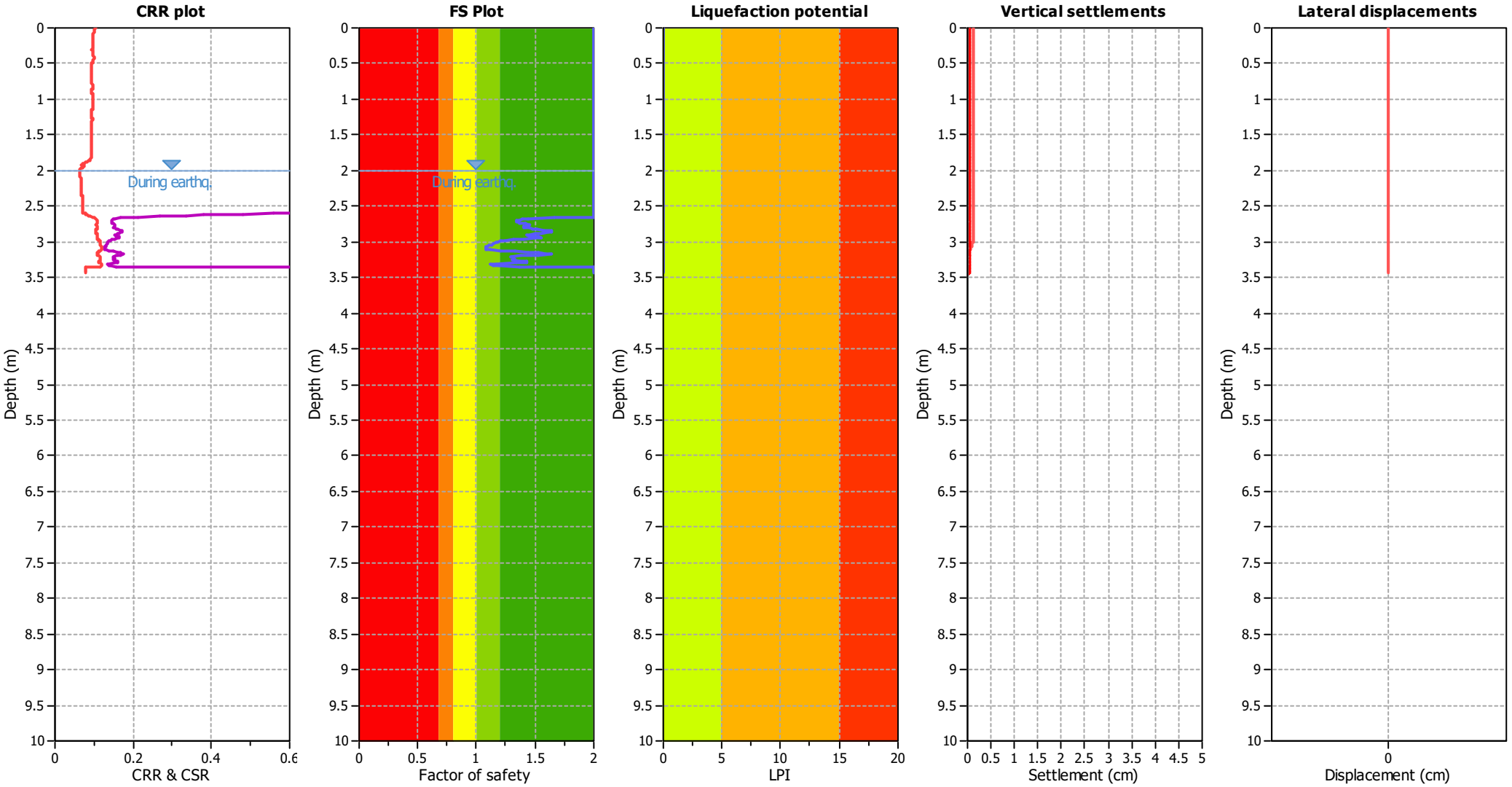

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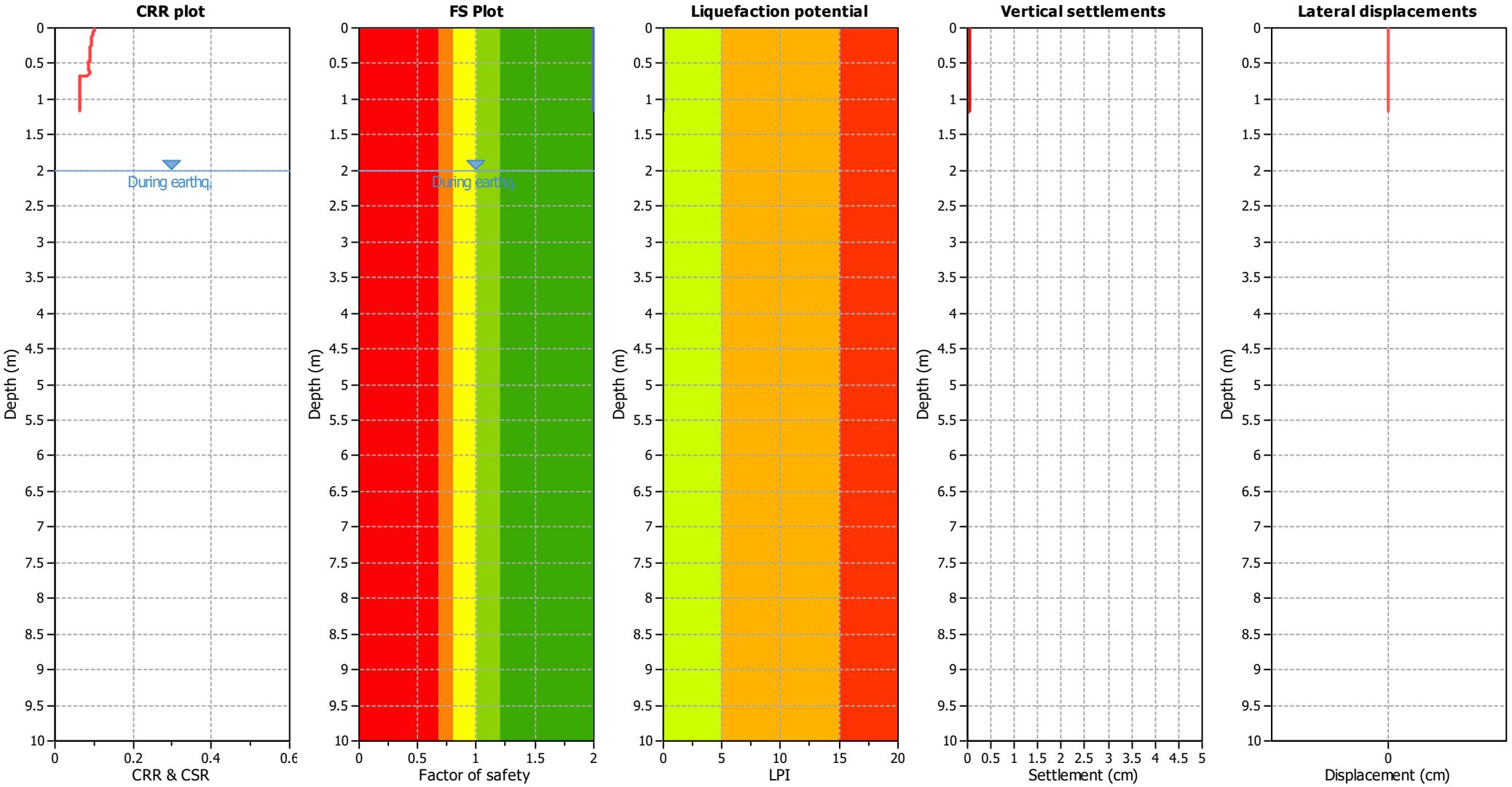

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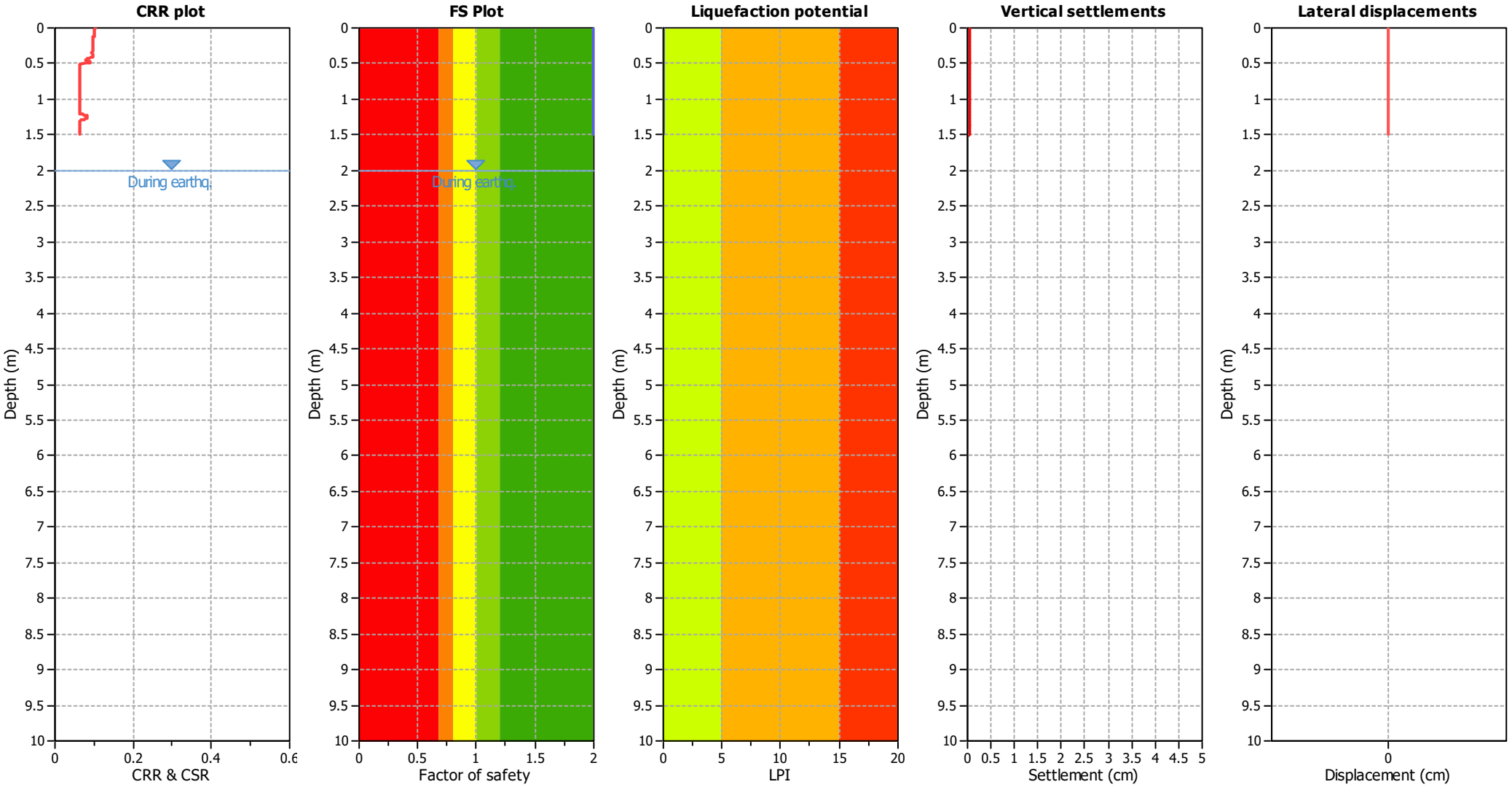

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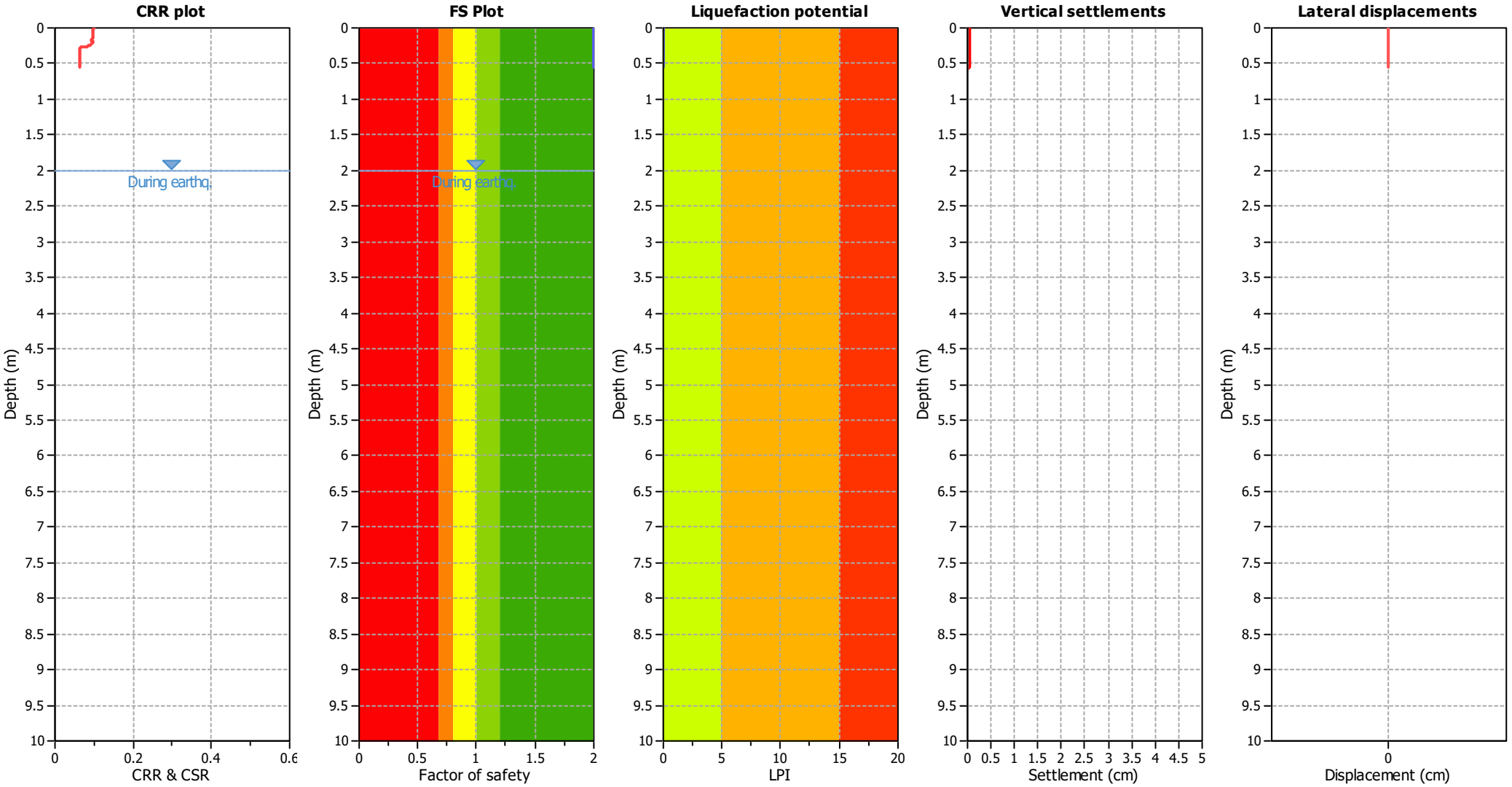

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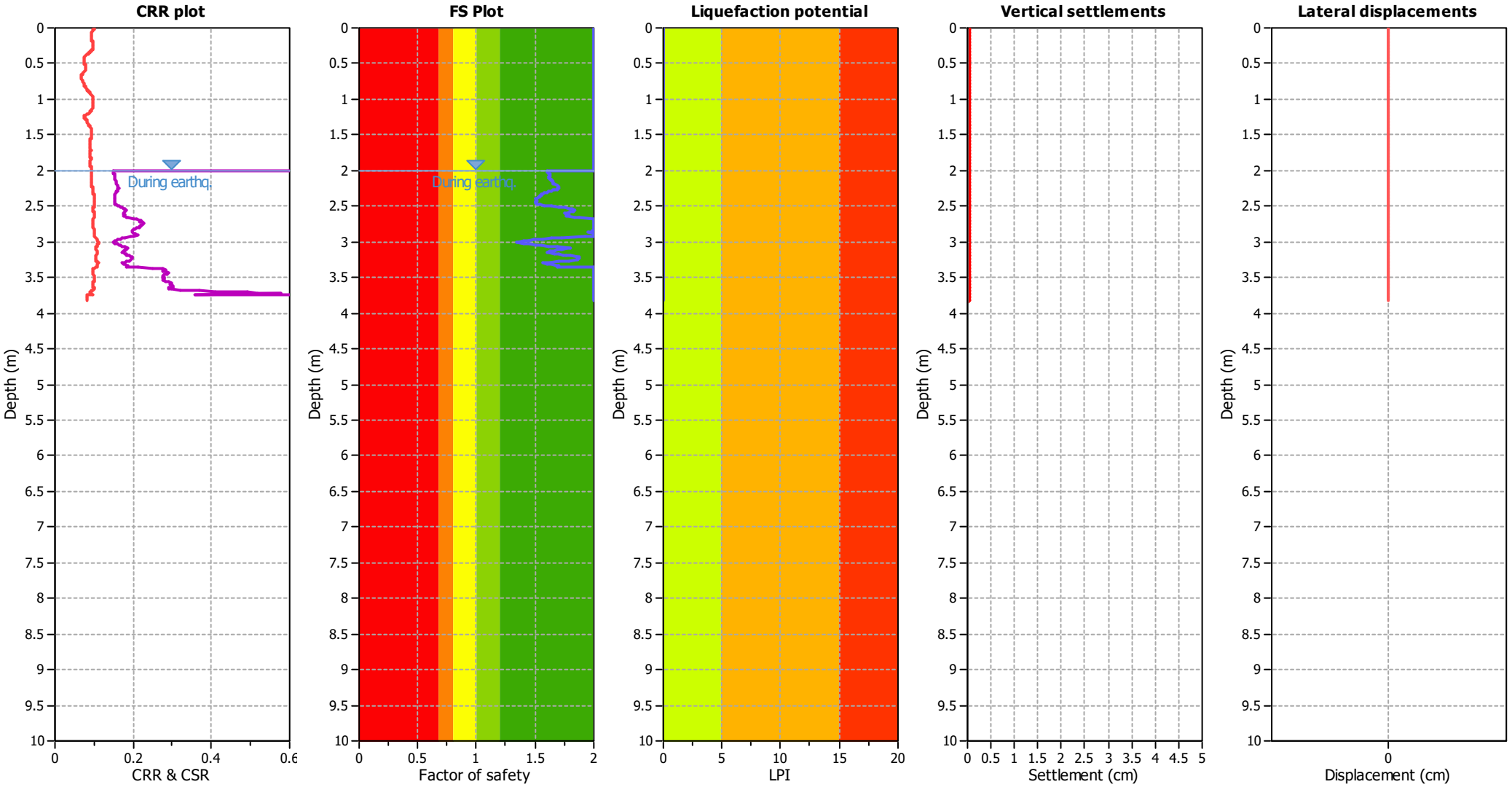

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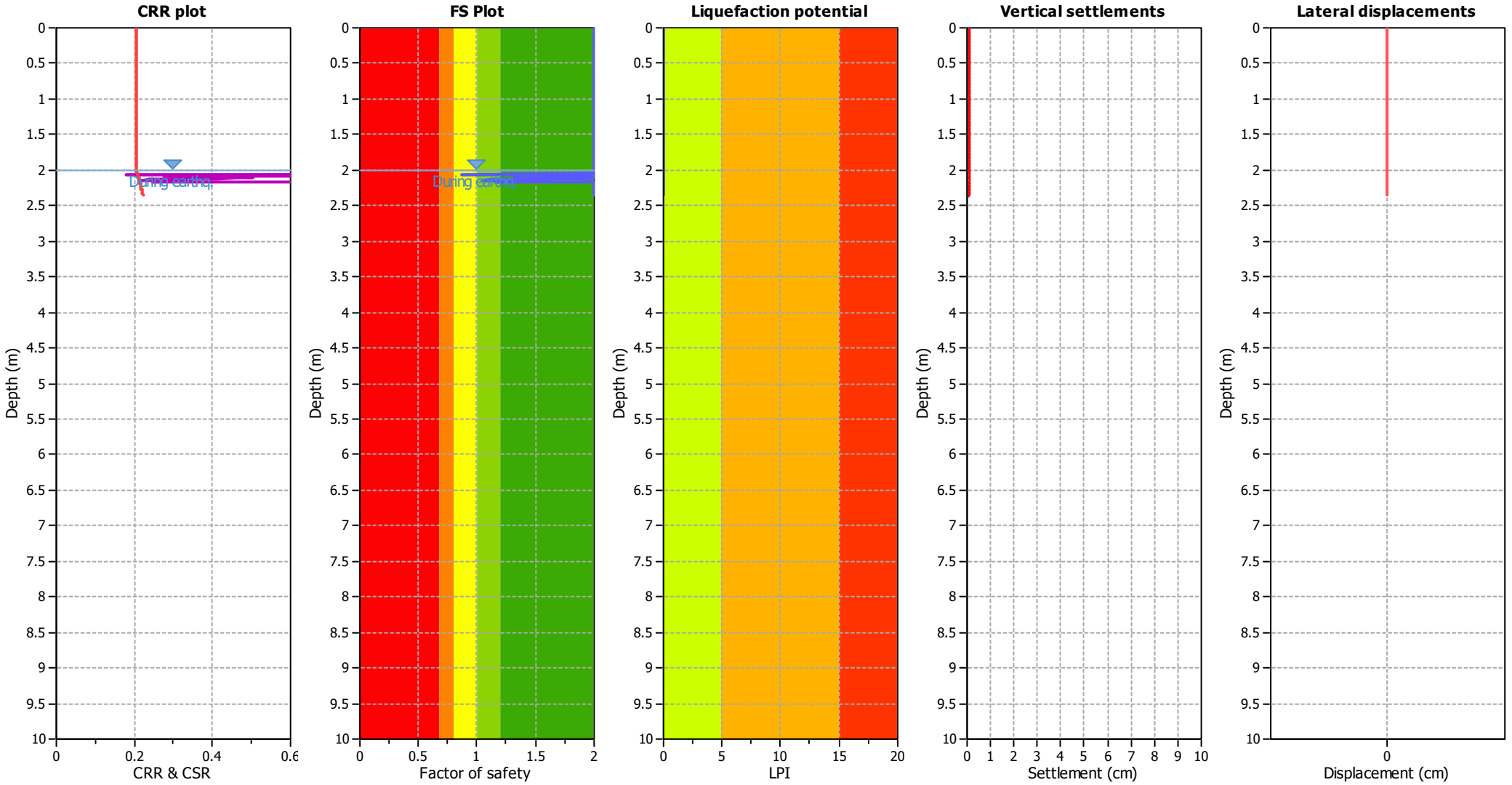

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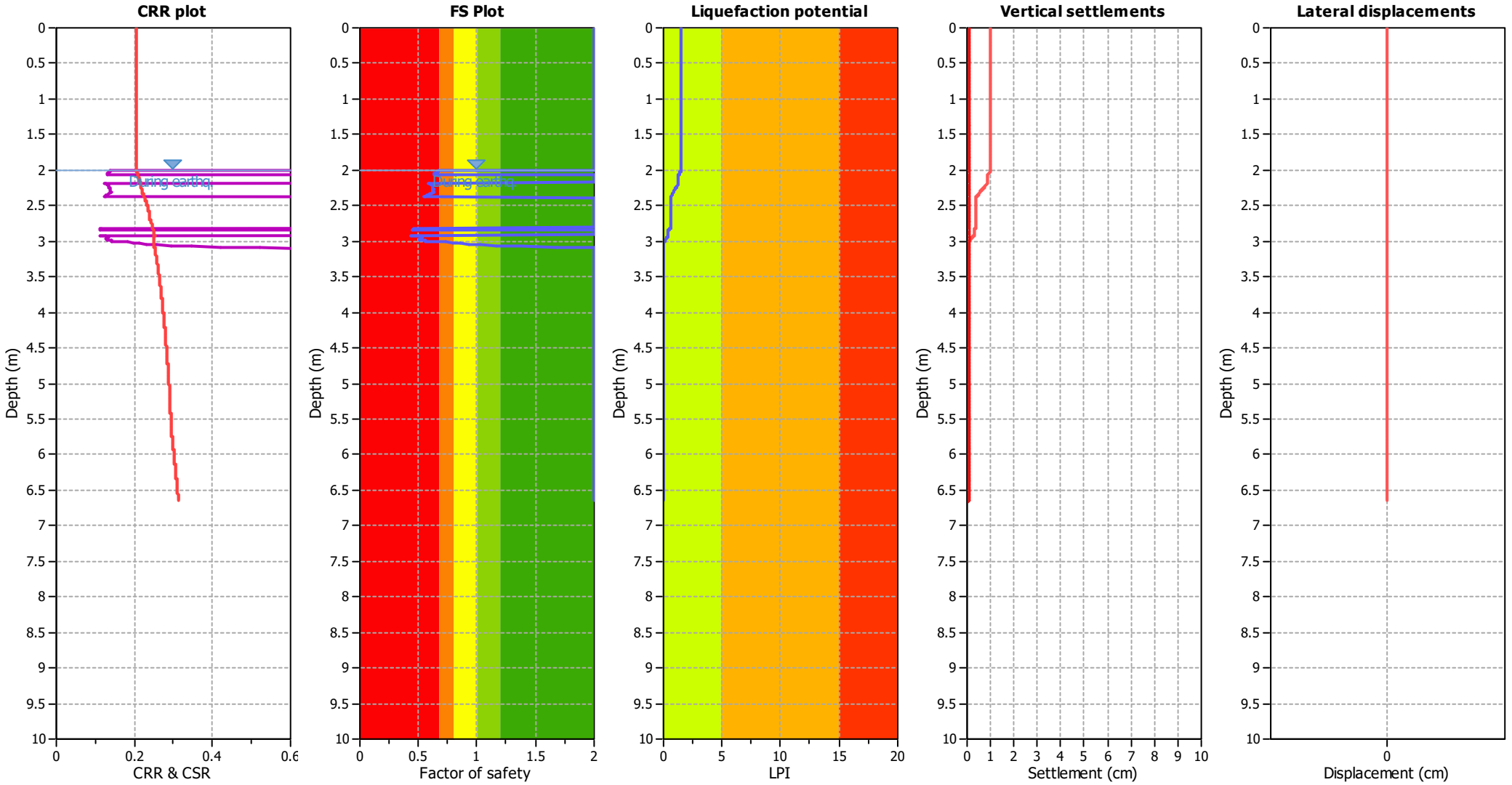

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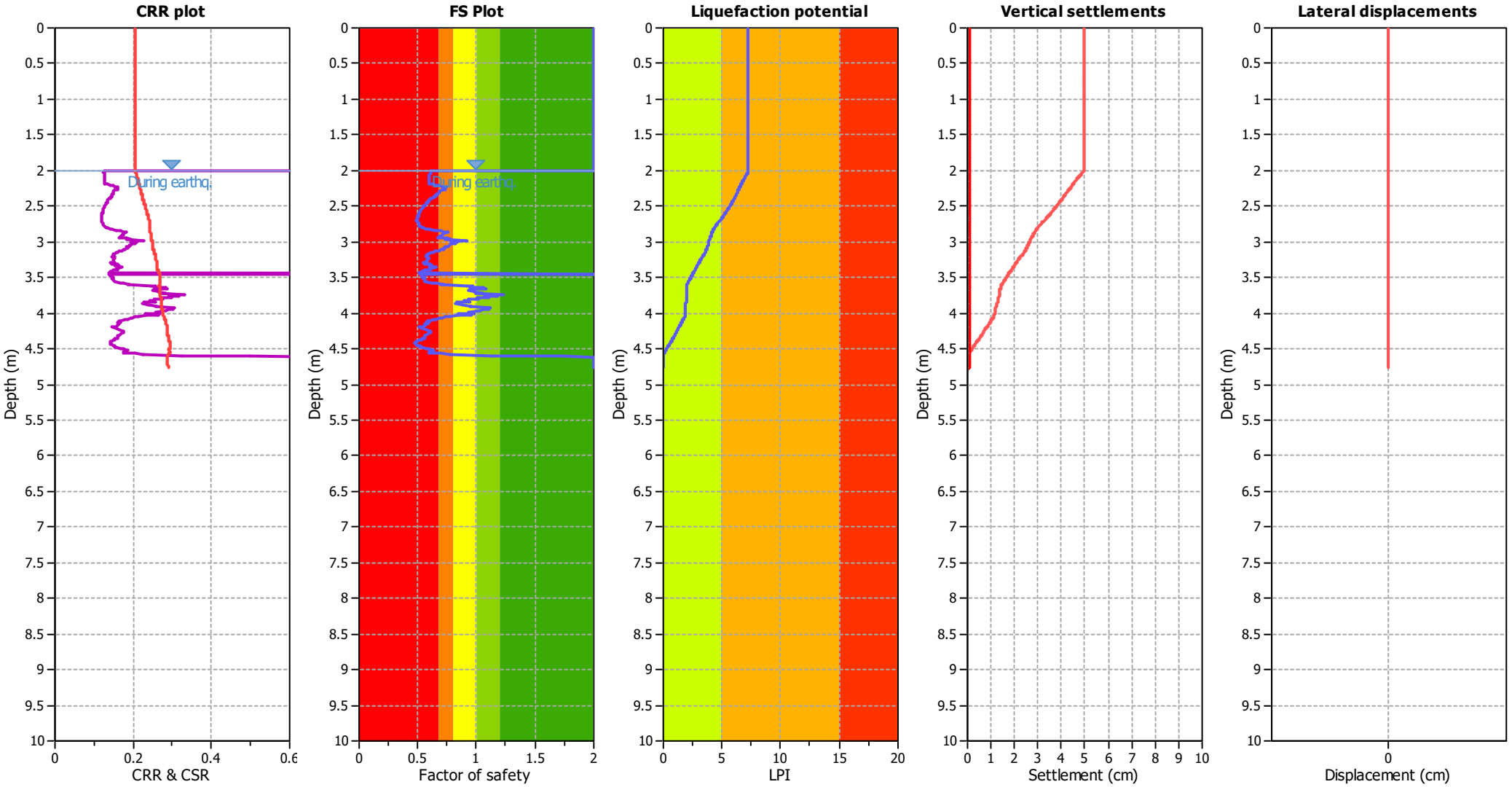

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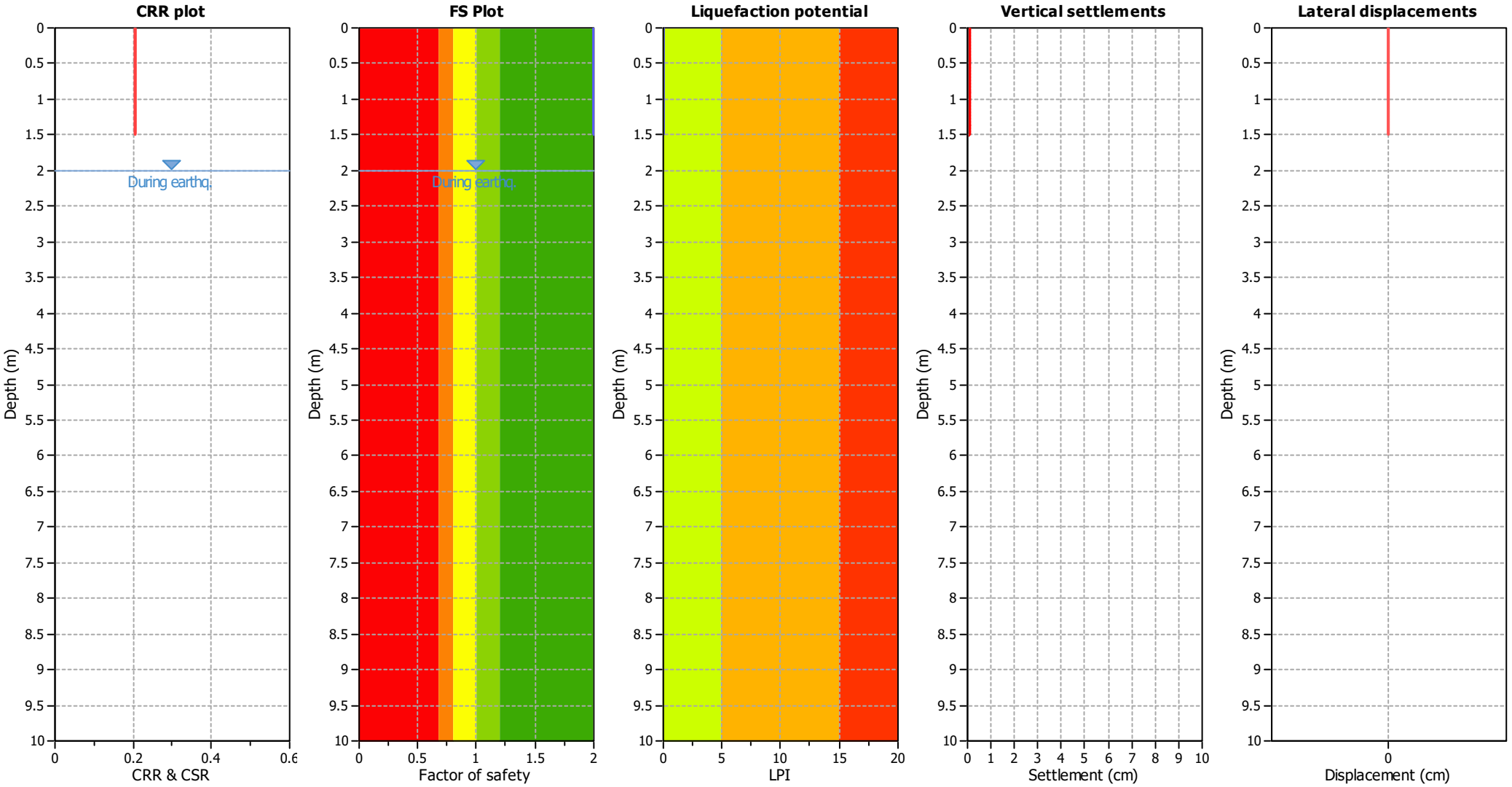

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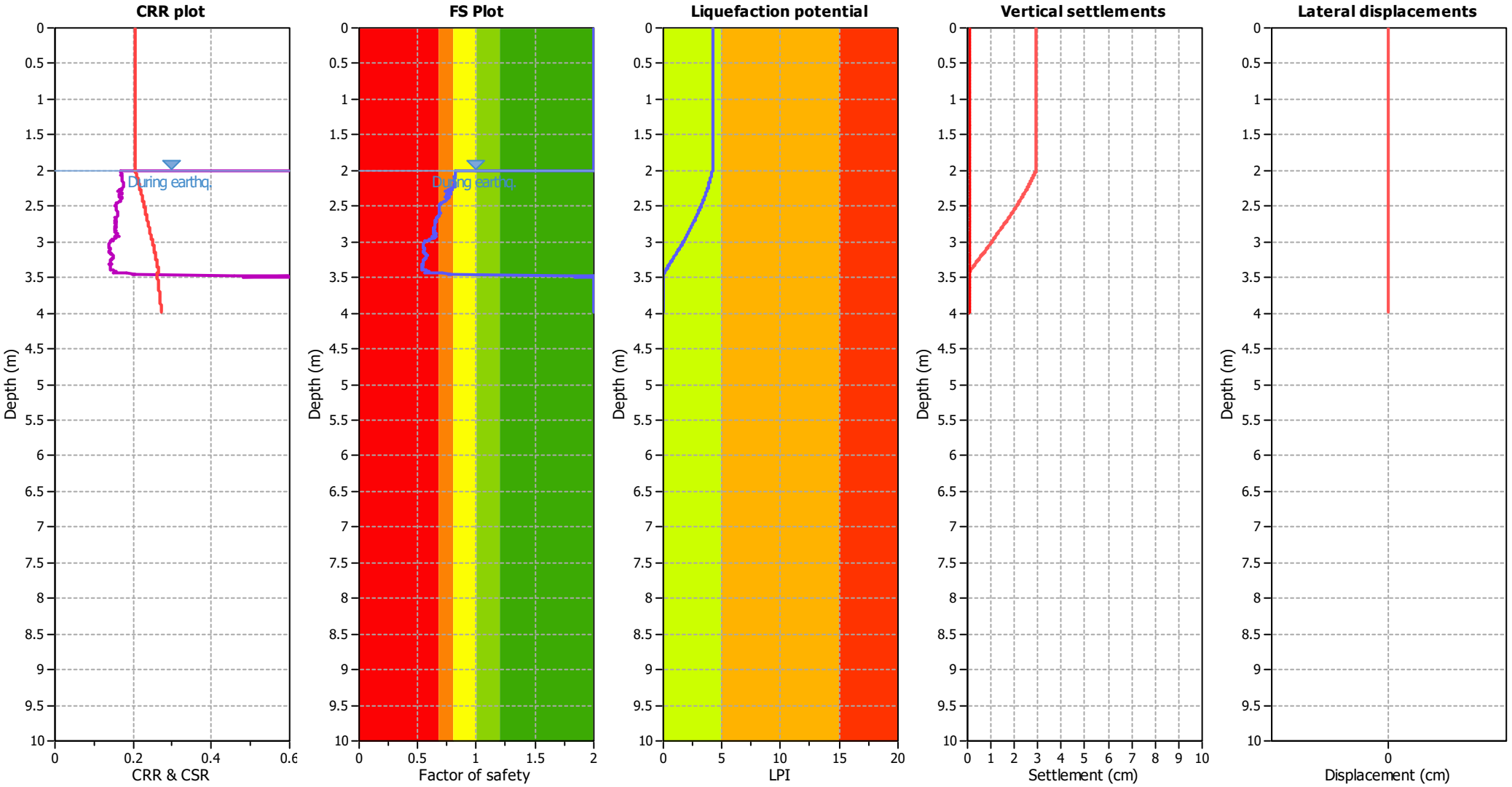

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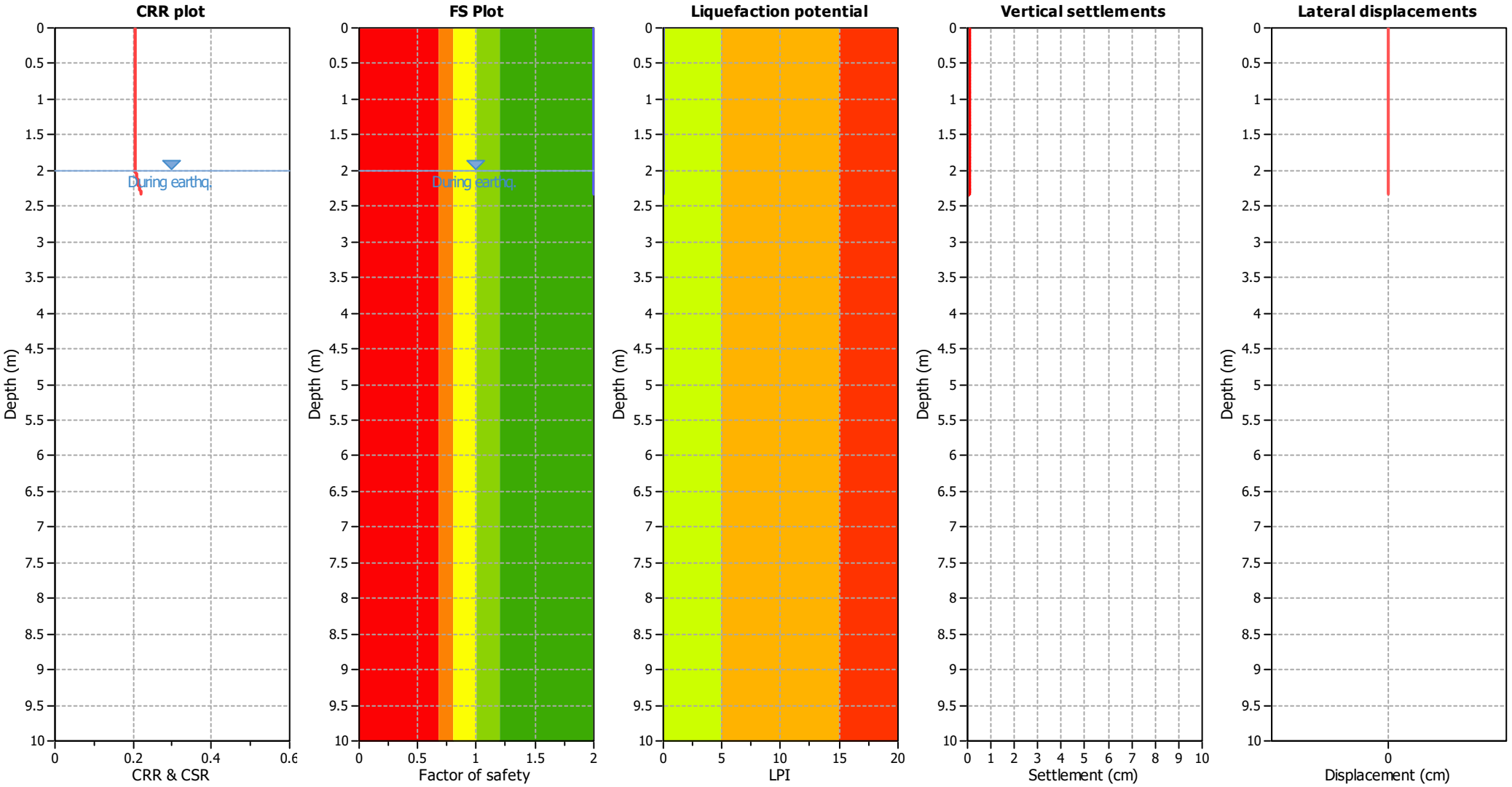

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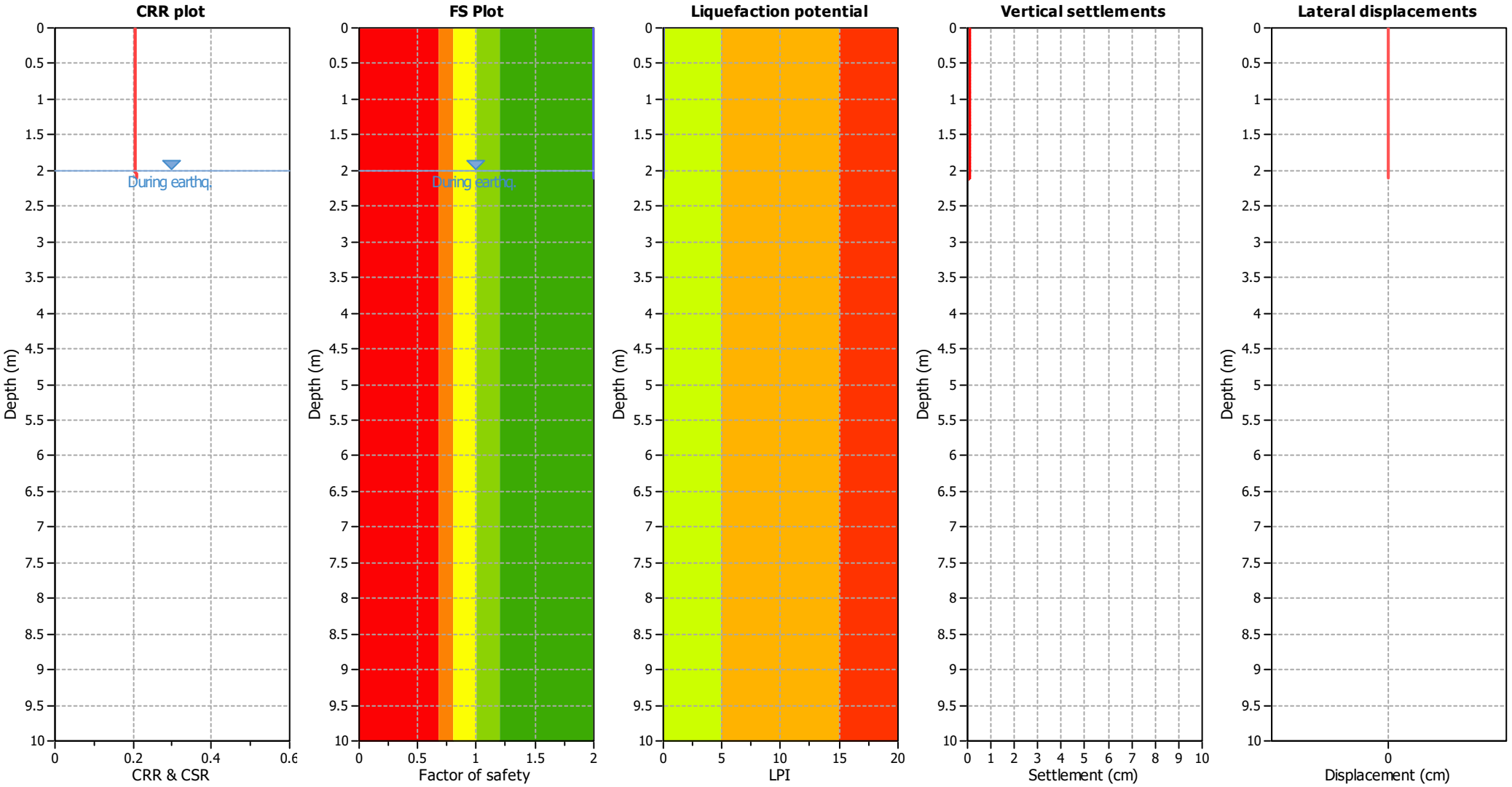

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Depth to water table (insitu):	2.00 m	Fill height:	N/A	Limit depth:	N/A

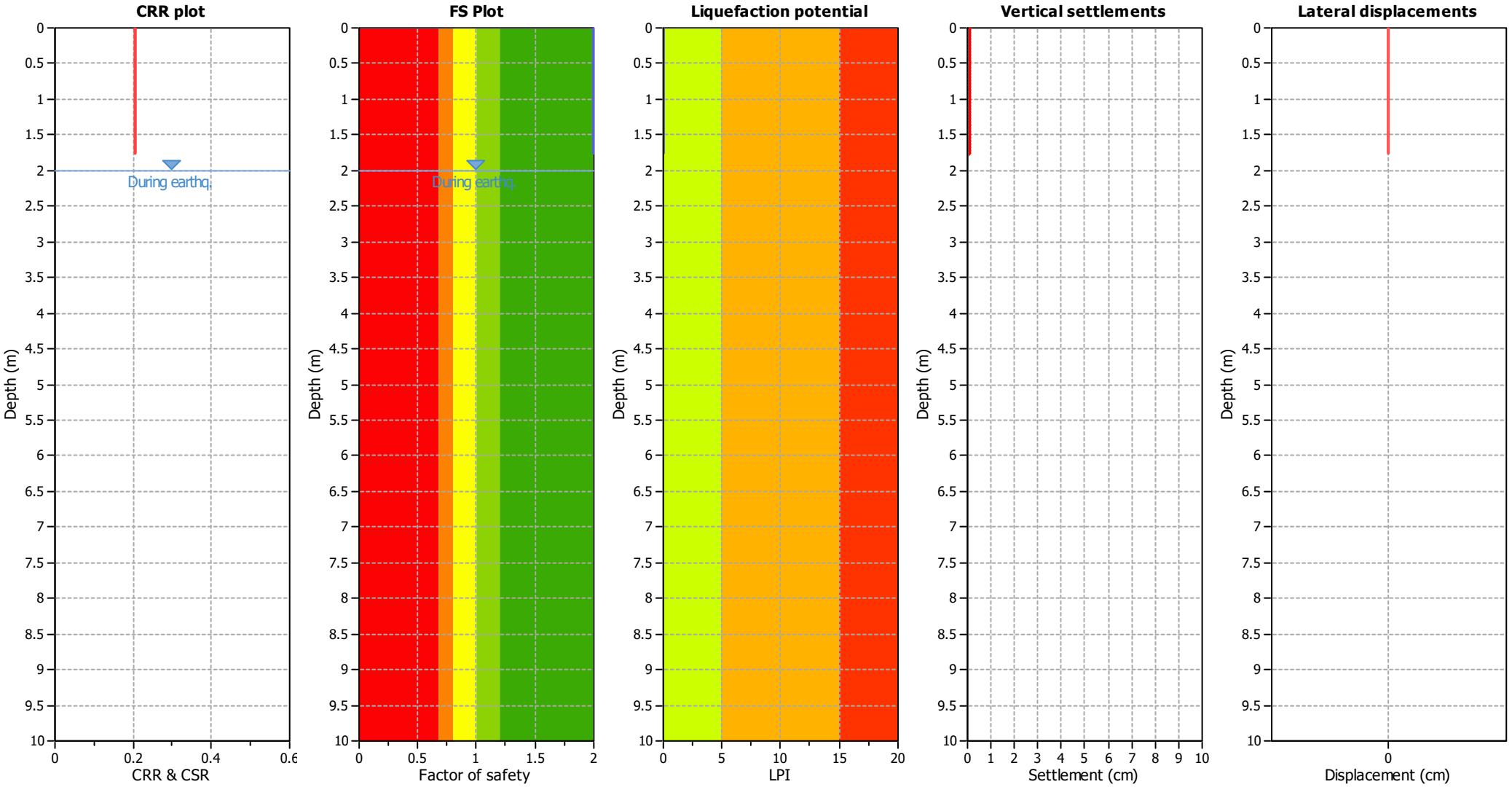
F.S. color scheme

- 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

Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	2.00 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:	7.50	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
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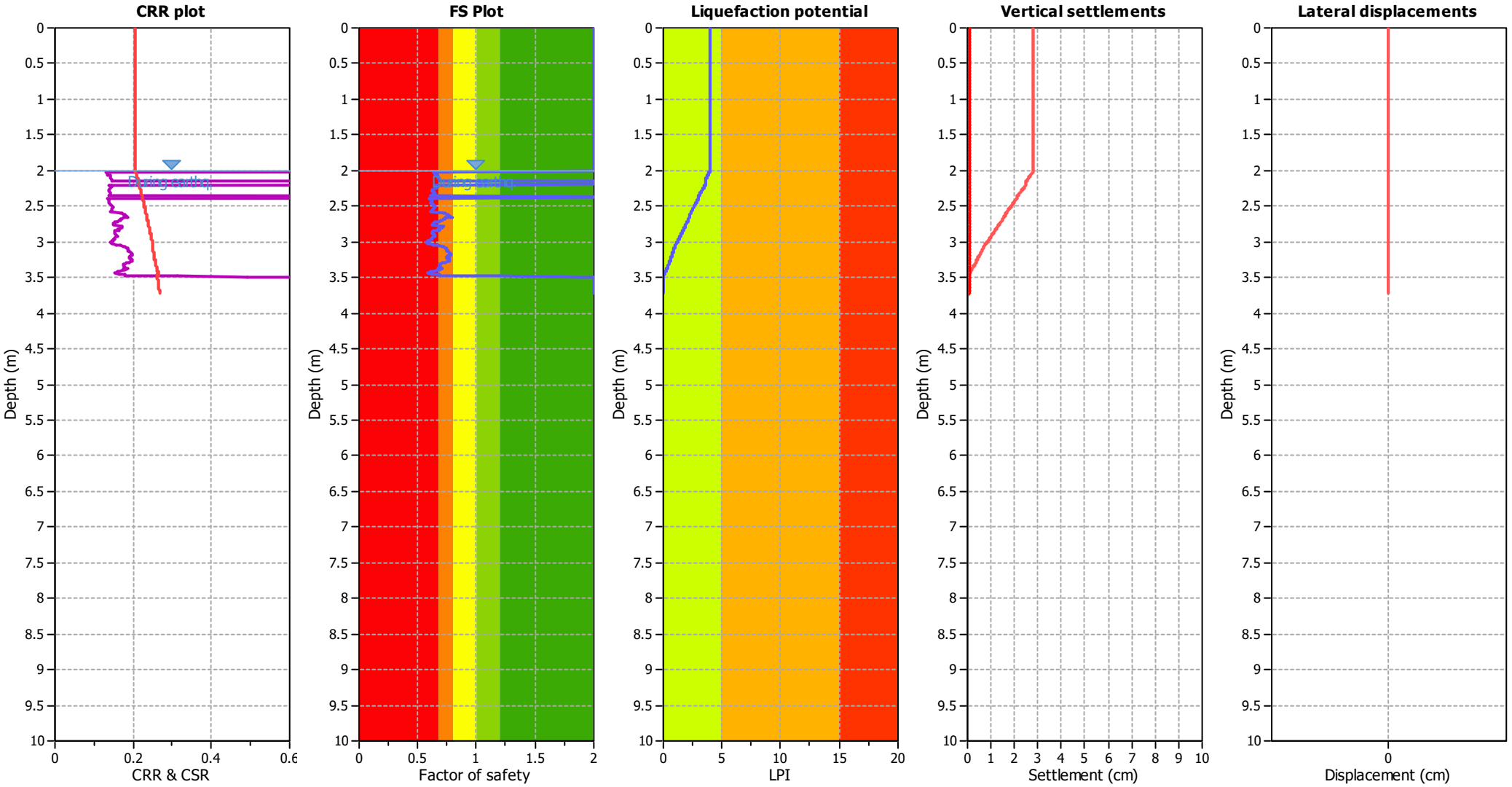

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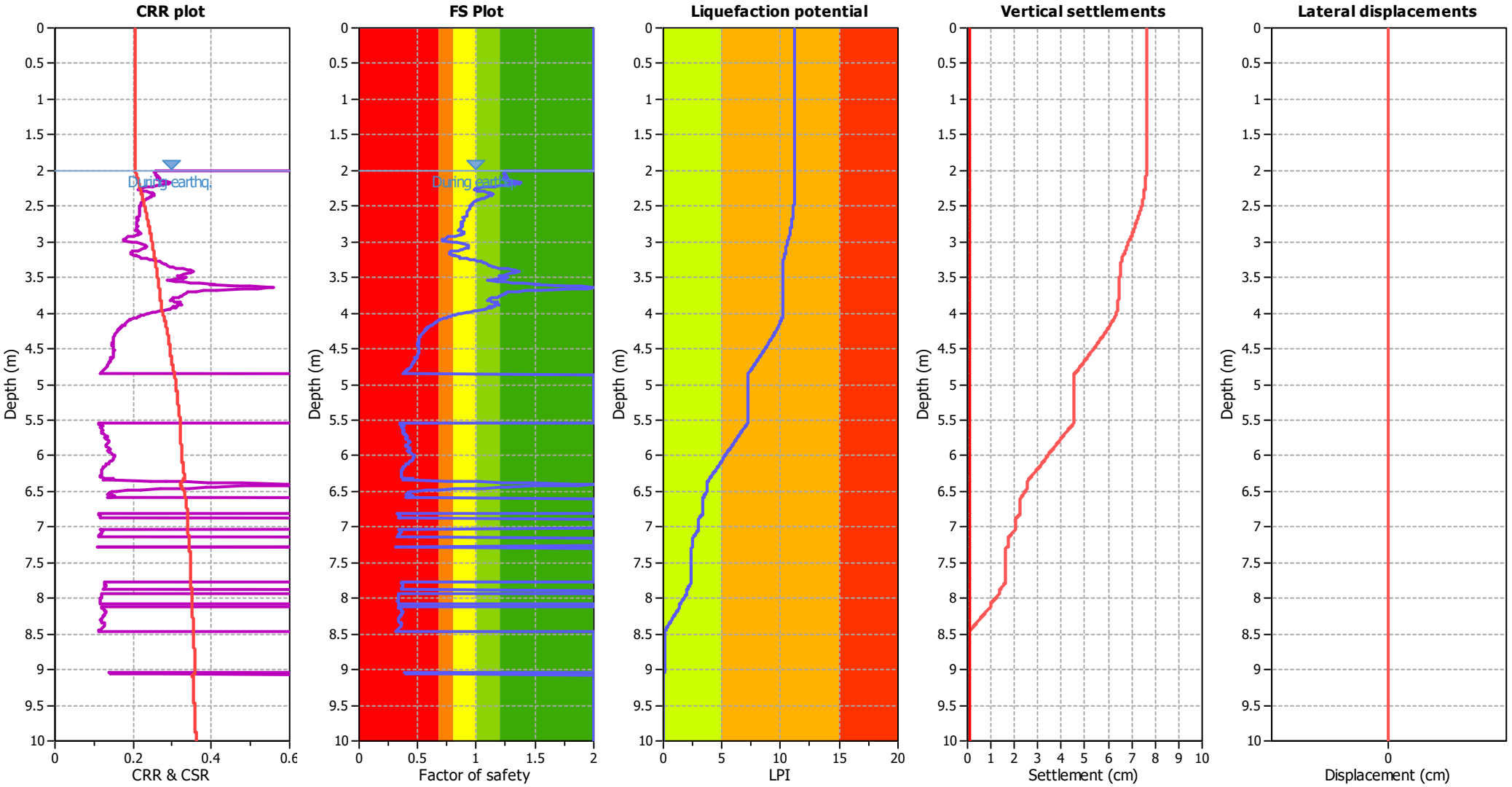

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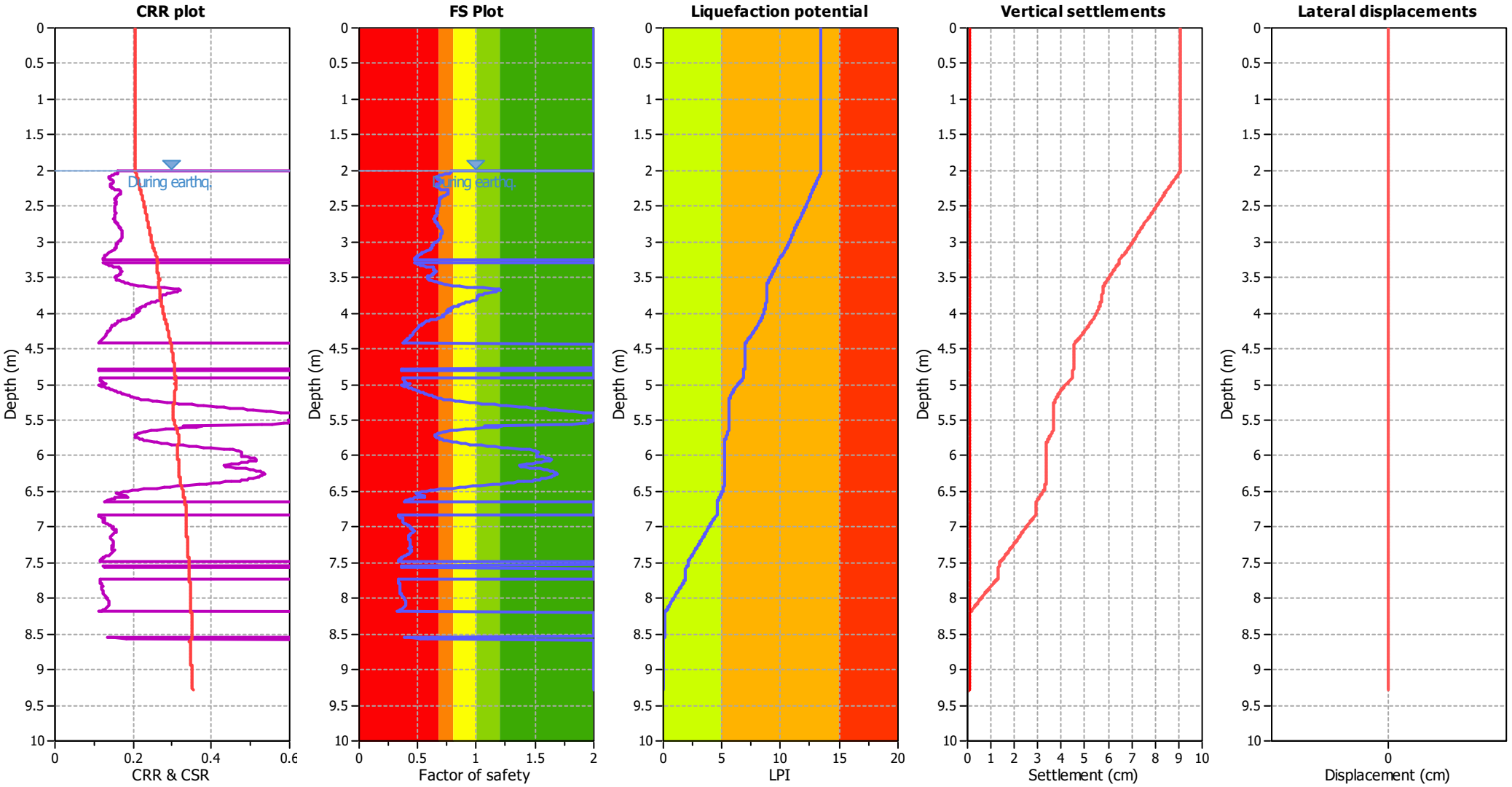

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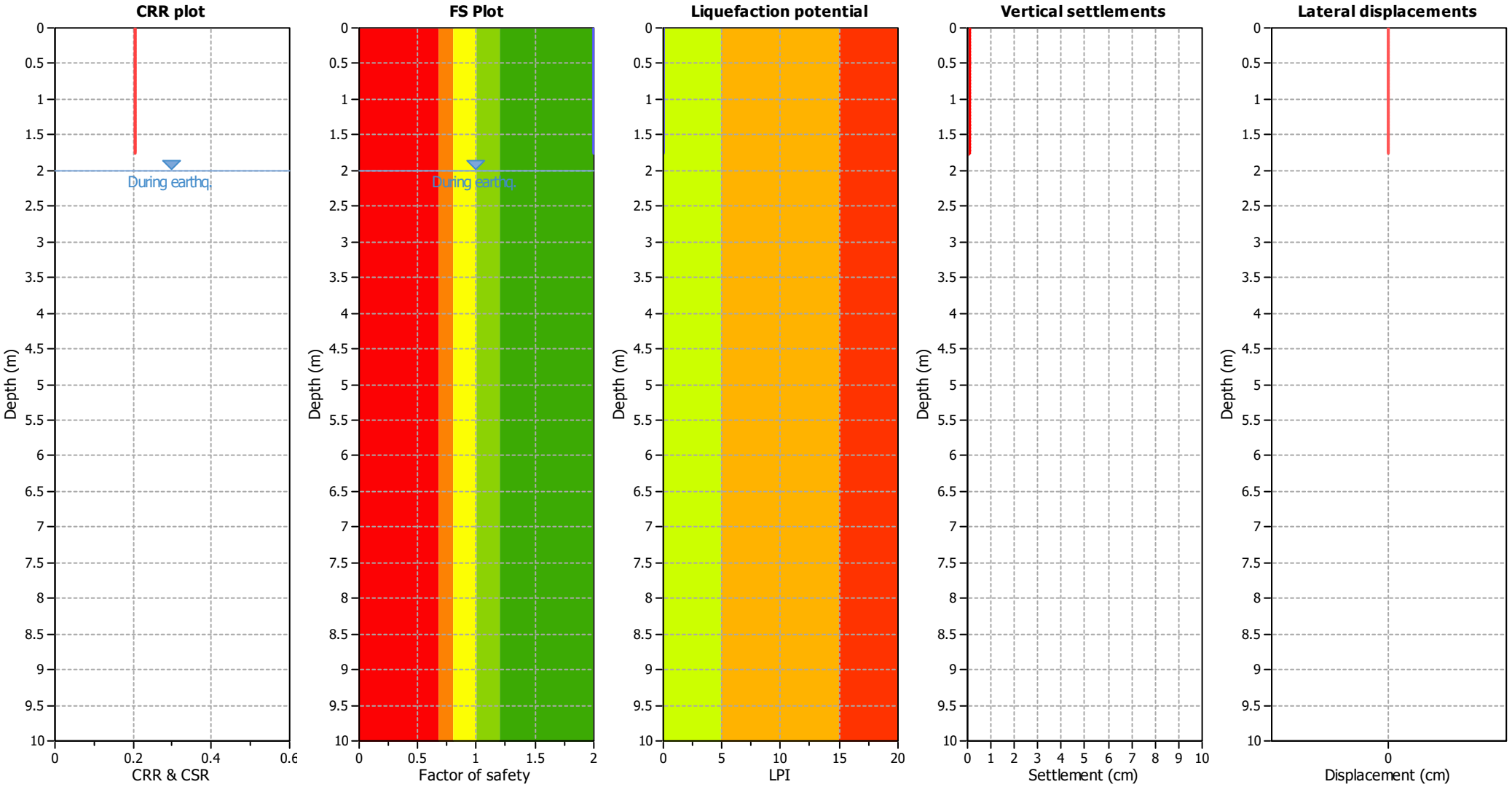

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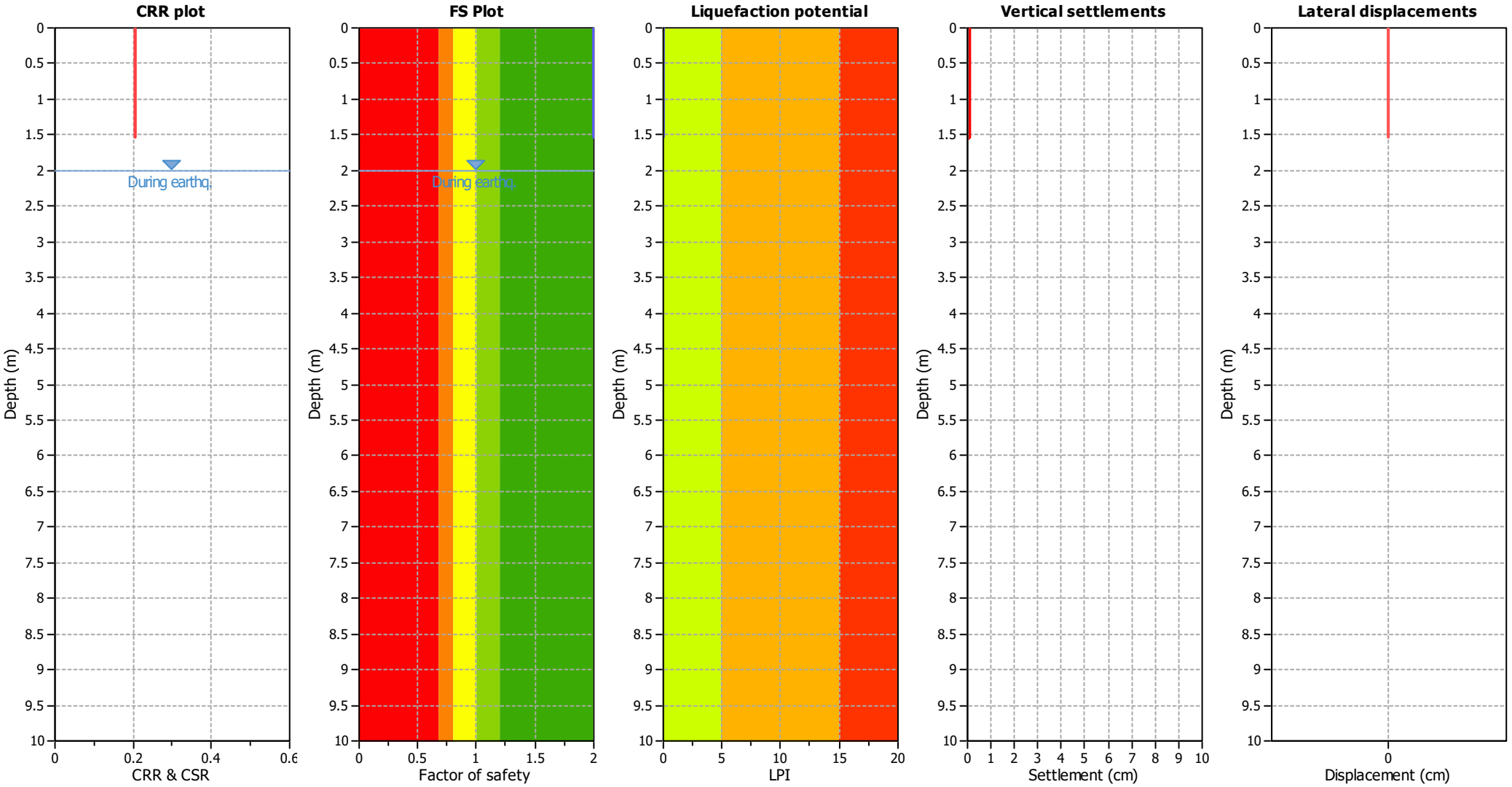

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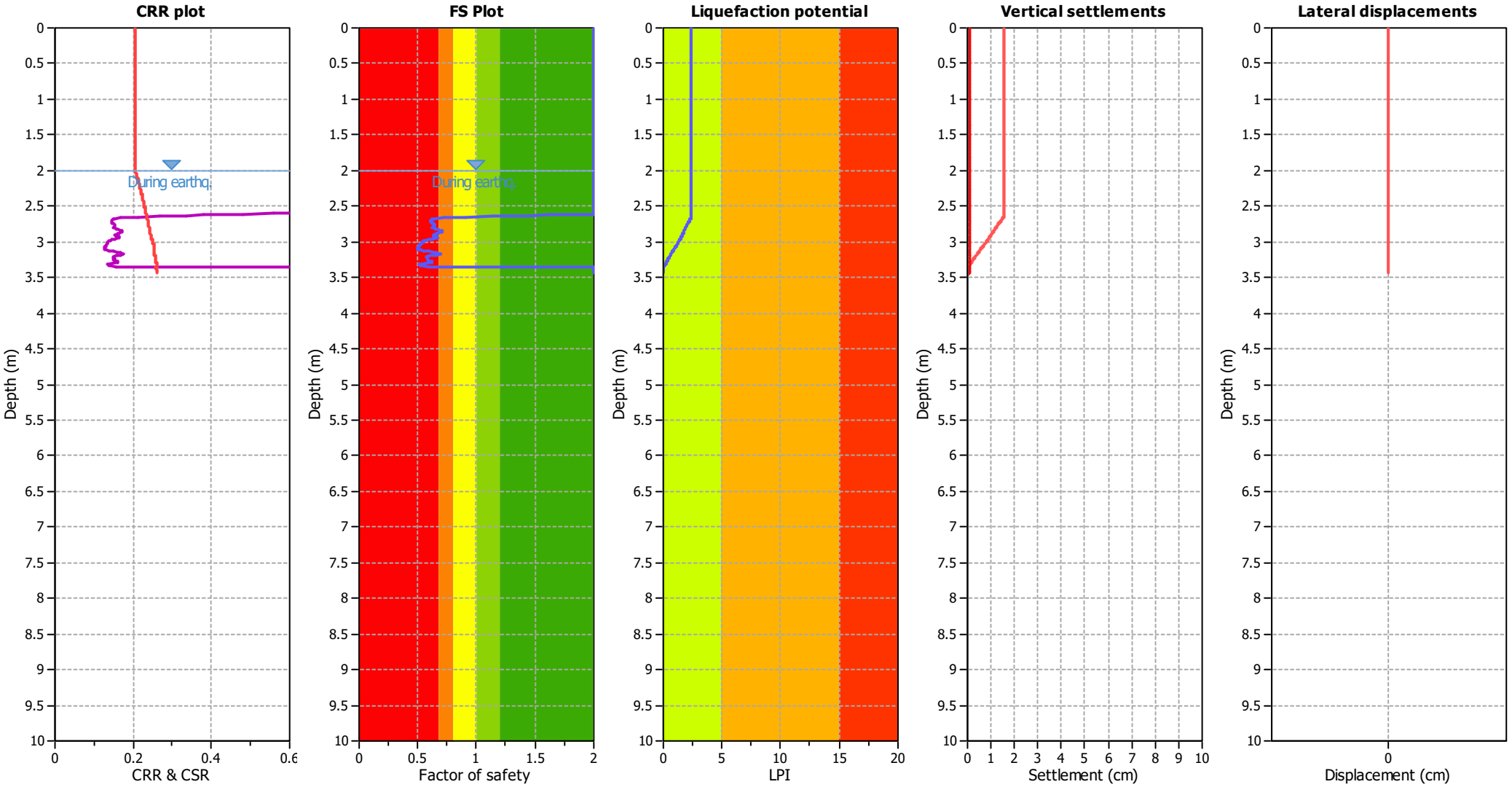

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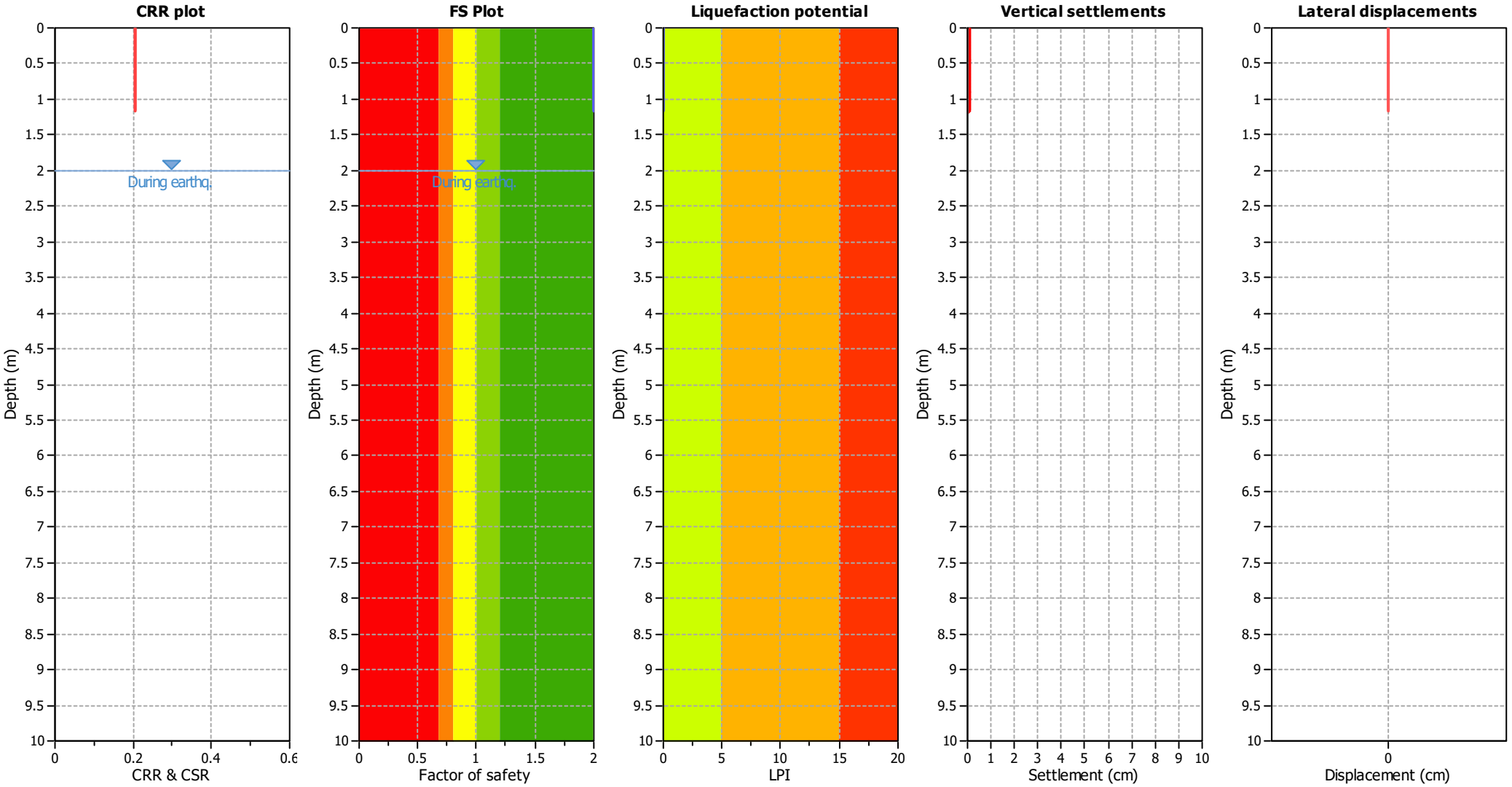

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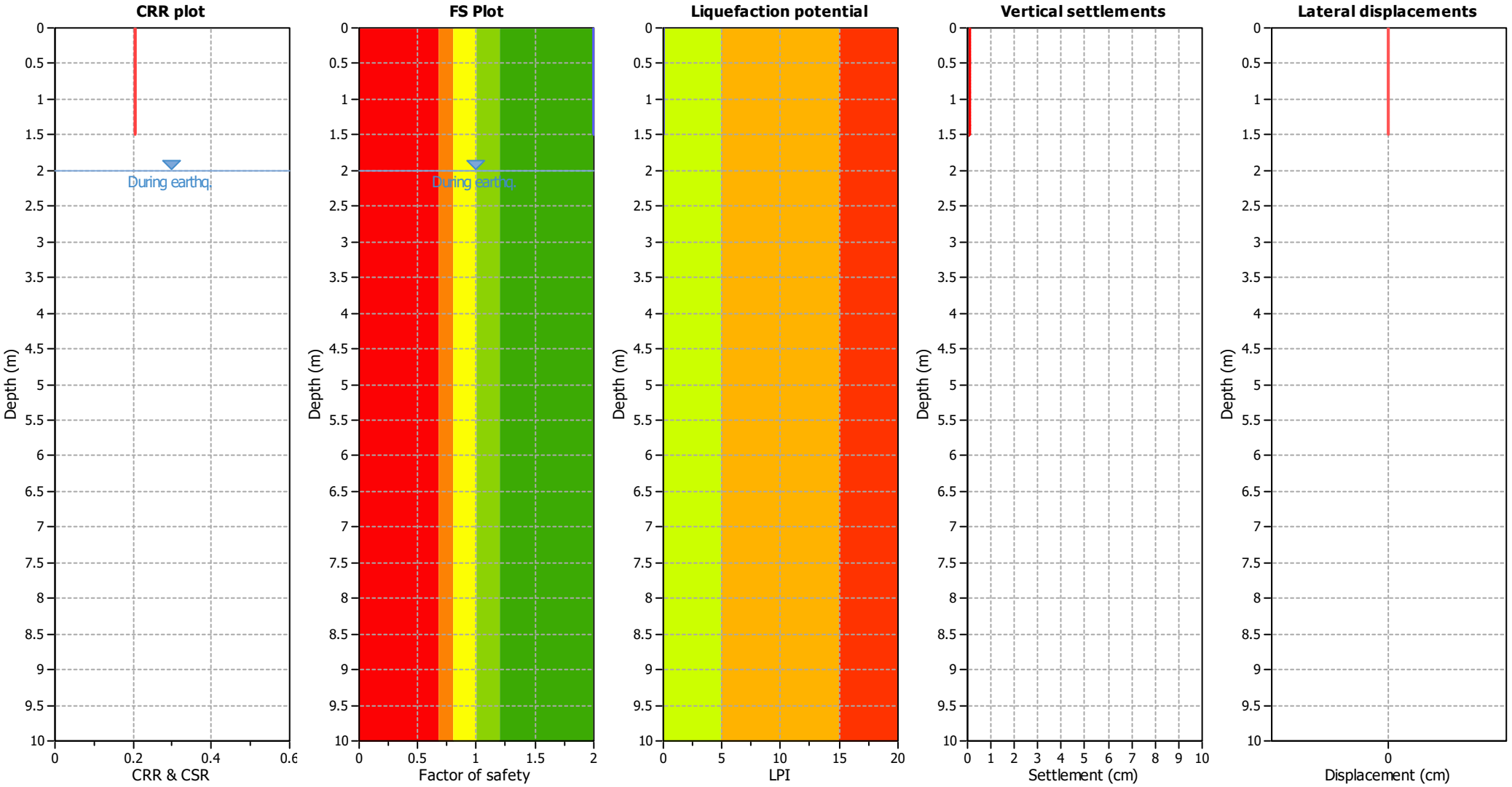

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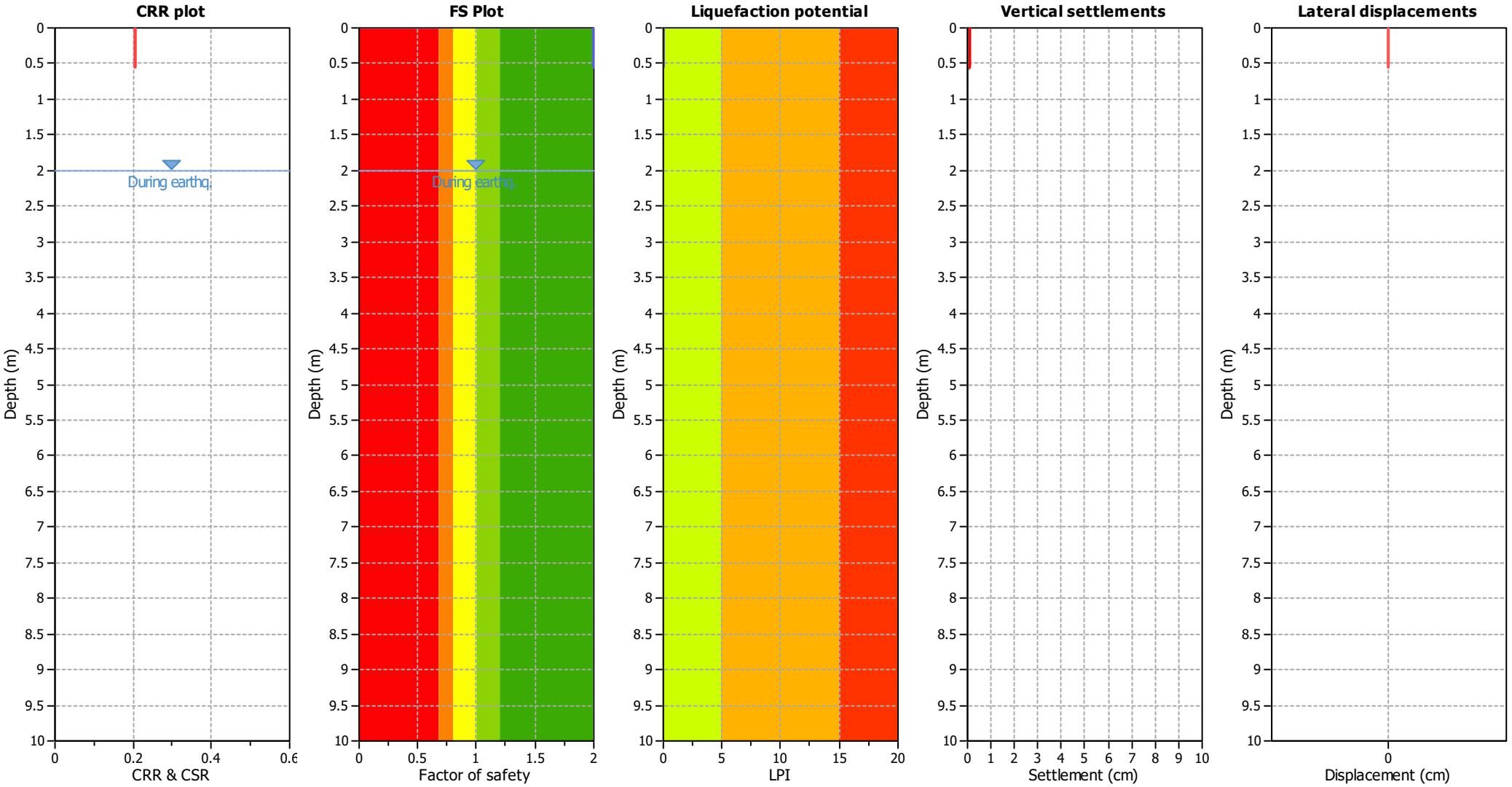

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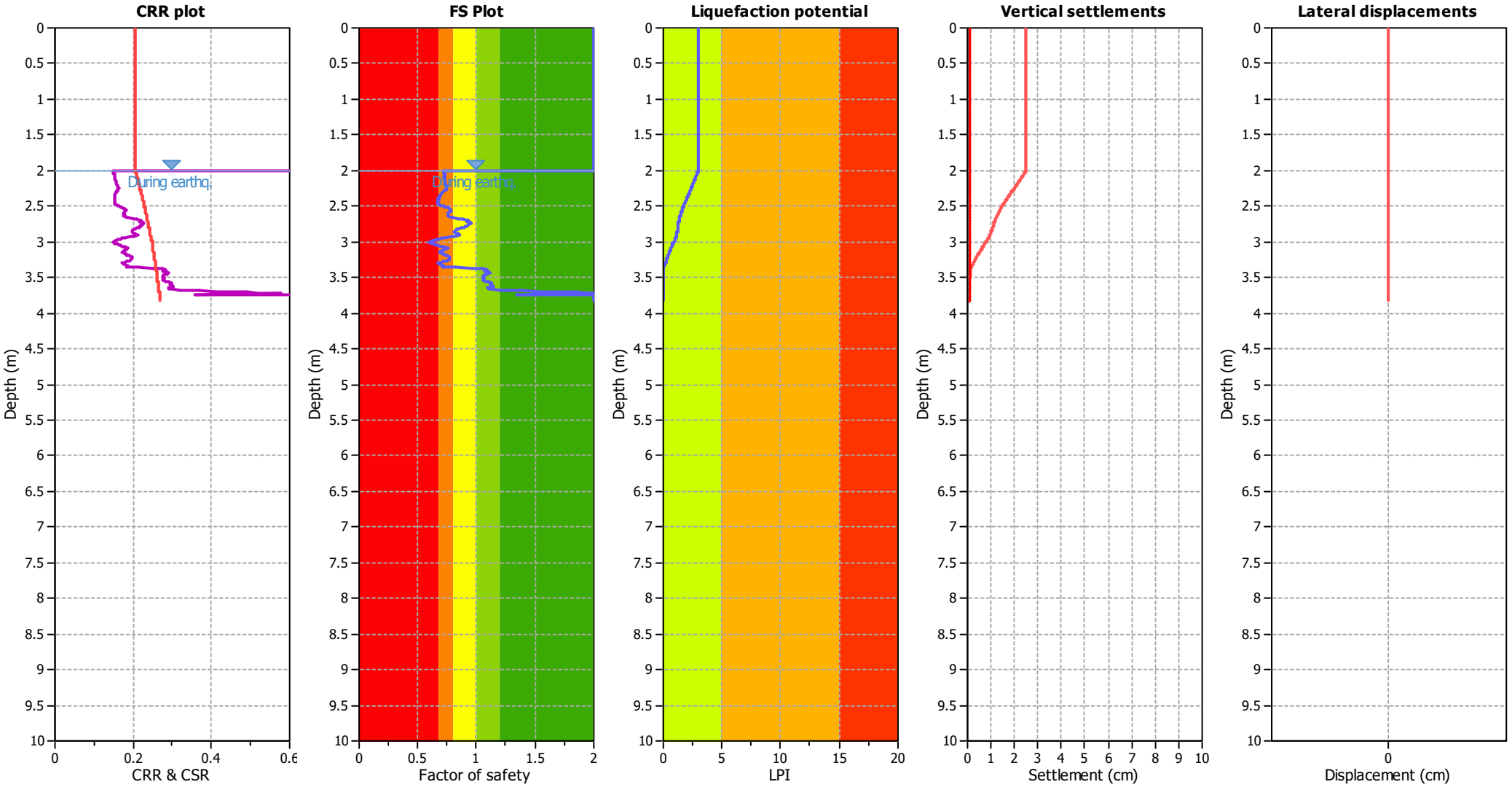

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LPI color scheme

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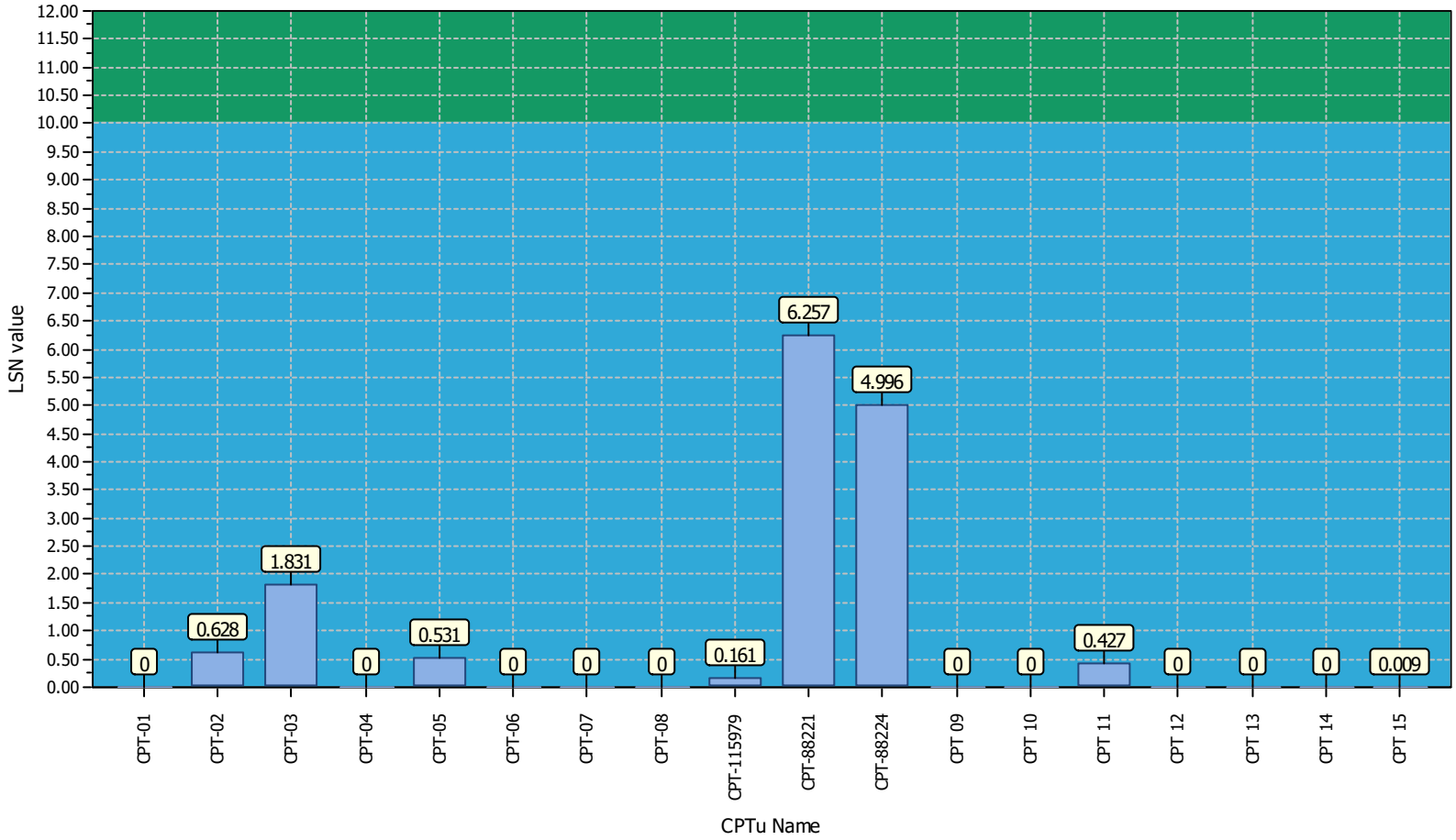
Tetra Tech Coffey
254 Montreal Street
Christchurch Central
www.tetratechcoffey.com

Project title : Birchs Village (SLS case)

Location : Prebbleton

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: 18

100% little liquefaction

0% minor liquefaction

0% moderate liquefaction

0% moderate to major liquefaction

0% major liquefaction

0% severe liquefaction

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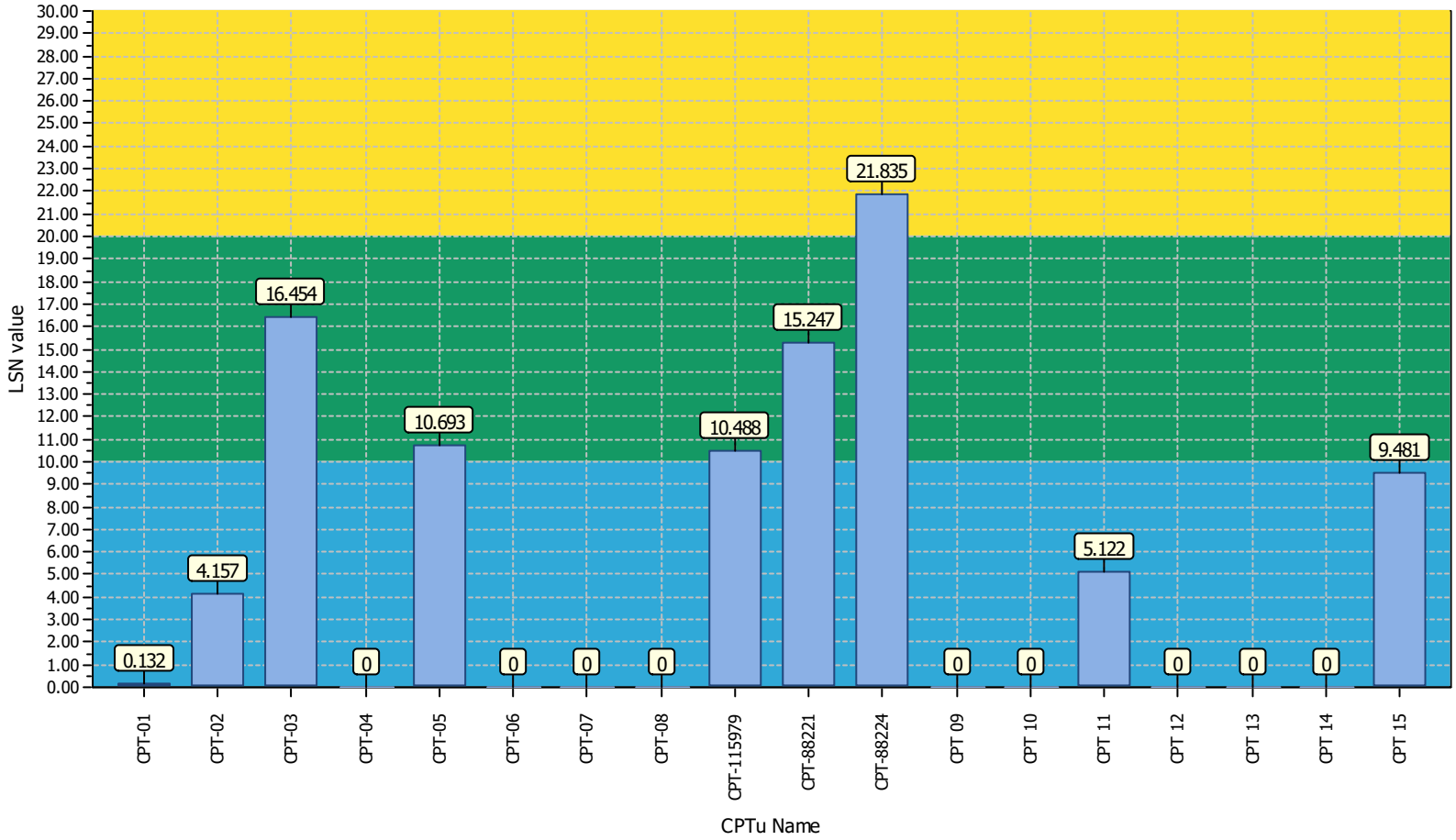

LSN color scheme

- 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: 18

72% little liquefaction

22% minor liquefaction

6% moderate liquefaction

0% moderate to major liquefaction

0% major liquefaction

0% severe liquefaction

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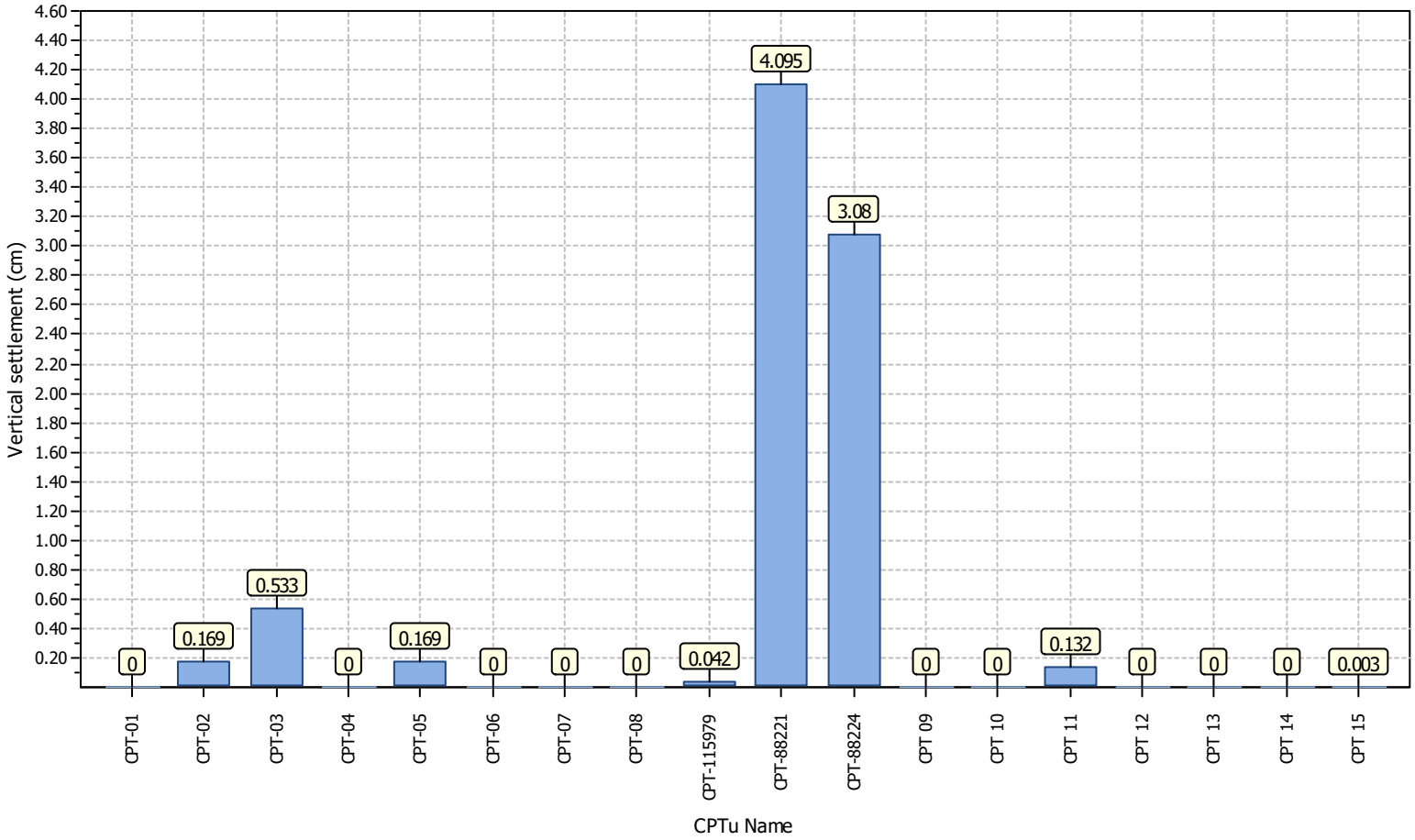
Overall vertical settlements report



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