Geotechnical Assessment Report for Plan Change

100 – 110 Te Moana Road, Waikanae

Eric Osbourne

Document Number: 240461-RPT-G-002-A

Date: 2 May 2025

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Document Control:

Project:	100 – 110 Te Moana Road, Waikanae
Document Title:	Geotechnical Assessment Report for Plan Change
Client:	Eric Osbourne
Issued:	Friday, 2 May 2025
Project/File ref:	240461-RPT-G-002-A
Revision:	A

Document QA:

Revision #	Prepared by:	Reviewed and approved by:	Date:
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Revision History:

Revision #	File Reference	Description	Date
A	240461-RPT-G-002-A	First Issue	29-Apr-25

Contents

1. Executive Summary

Table 1: Report Summary			
Project	Site Address		100 – 110 Te Moana Road, Waikanae
	Consent Application		Plan Change
	Consent Authority		Kapiti Coast District Council
Site Assessment	Geotechnical Hazard Assessment	Liquefaction Risk	Refer to Section 8.1
		Lateral Spreading Risk	
		Groundwater Level	Groundwater depth equates to approximate RL of +1.5 m.
		Site Subsoil Classification	Class D – Deep or Soft Soil Site
		AS2870:2011 Expansive Soils Classification	Class A – Non-expansive soils
	HAIL Assessment		Not part of CGW scope
	If fill present, is the fill engineered and to what depth		Fill not encountered on-site.
Foundation Assessment & Recommendations	Development Recommendations		See Section 10
	Further Geotechnical Involvement		• Further site testing to further refine geotechnical risks as part of subdivision consent application.

2. Introduction

CGW Consulting Engineers have been engaged by Eric Osbourne (Client) to undertake a geotechnical investigation and assessment of our findings for a proposed Private Plan Change (PPC) application at 100 – 110 Te Moana Road, Waikanae. We understand the client is proposing to rezone the land from General Rural Zone to General Residential Zone. This report is **not** considered suitable for a subdivision consent application.

The purpose of this investigation is to assess the geotechnical conditions at the site and provide a geotechnical report suitable for a PPC application to Kapiti Coast District Council (KCDC).

We will provide a geotechnical assessment and analysis confirming bearing capacity, ground conditions and a quantitative assessment of the liquefaction risk for the site.

This geotechnical investigation and report will provide further information to assist structural engineers to recommend an appropriate foundation design strategy. Our geotechnical limitations are attached in Appendix A.

This report has been prepared in accordance with the Ministry of Building, Innovation and Employment document "Revised Guidance on Repairing and Rebuilding Houses Affected by the Canterbury Earthquake Sequence", Version 3, dated December 2012, and subsequent updates, hereafter referred to as the MBIE Guidance, and the NZGS/MBIE Geotechnical Engineering Modules.

3. Scope of Works

CGW undertook a preliminary assessment for this site in October 2024. The Client received a Request For Information (RFI) requesting a more detailed investigation as part of the PPC application. Our scope of works have been formulated to satisfy the requirements of the Tonkin + Taylor RFI and are considered suitable for a PPC application.

We envision the following scope of work:

- Two (2) Hand Auger and DCP/Scalas to 3.0 m depth, or prior refusal.
- Five (5) CPT/DPSH tests to 10 m, or prior refusal.
- Geotechnical report, suitable for a PPC application.

4. Tonkin + Taylor Review

Tonkin + Taylor (T+T) was engaged to undertake a geotechnical review by KCDC of the CGW geotechnical report as part of the proposed PPC application. The following items were identified that required addressing for the submission to be granted:

1. *We note that the current investigation, consisting of a single CPT, does not meet the recommended investigation density outlined in MBIE Module 2, which considers factors such as site variability and development scale. Given the site's geomorphology and the potential for liquefaction, we consider that a single CPT is insufficient to assess the ground conditions at the site. Please provide additional deep ground investigation information and groundwater monitoring information, with an investigation density sufficient to adequately cover the proposed development site area in accordance with MBIE Module 2. Please subsequently update the geotechnical assessment, and potential effects of the works.*
2. *Please provide an updated geotechnical ground model based on additional geotechnical investigation in order to adequately cover the entire proposed development site as we expect variability in the ground conditions.*
3. *Please comment on the likely presence of soft soil/weak ground at the site, the associated geotechnical risks if present, and the potential mitigation measures for the proposed development.*
4. *We consider that a single CPT is insufficient to assess the liquefaction risk and associated consequences at the site. Please provide liquefaction analysis from additional test locations covering the entire proposed development site and update the assessment of the liquefaction risks and associated consequences.*
5. *Please comment on the likely presence of high groundwater level at the site, the associated geotechnical risks if present, and the potential mitigation measures for the proposed development.*
6. *Please comment on the geotechnical risk associated with both flood and tsunami, and the mitigation measures for the proposed development.*
7. *Please comment on the likely foundation options, and possible mitigation measures that may be required for the proposed development.*

5. Site Information

5.1 Site Description

The subject site, located at 100 & 110 Te Moana Road, Waikanae is located approximately 0.5 km southeast of Waikanae Beach and 5.6 km north of Paraparaumu. The site is located on the southern side of Te Moana Road and has a total combined area of approximately 5.5 hectares. The site is legally described as Lot 1 DP 71916 (100 Te Moana Road) and Part Lot 2 DP 71916 (110 Te Moana Road). 100 Te Moana Road is generally flat at approximately RL +3.0 m (NZGD2016), while 110 Te Moana Road contains a sand dune in the southern portion of the property, with the elevation ranging from RL +21.0 m at the top of the sand dune to RL +2.0 m.

The nearest significant waterway is the Waikanae River, located approximately 940 m to the south of the site at its closest reach, while the Tasman Sea is located approximately 1.18 km

to the northwest of the site. A stream runs predominantly through the western and southern sides of the 100 Te Moana Road property, while an open water body and surrounding wetland is located within the 110 Te Moana Road property.

A site location plan with the geomorphic features is shown in Figure 1 below.

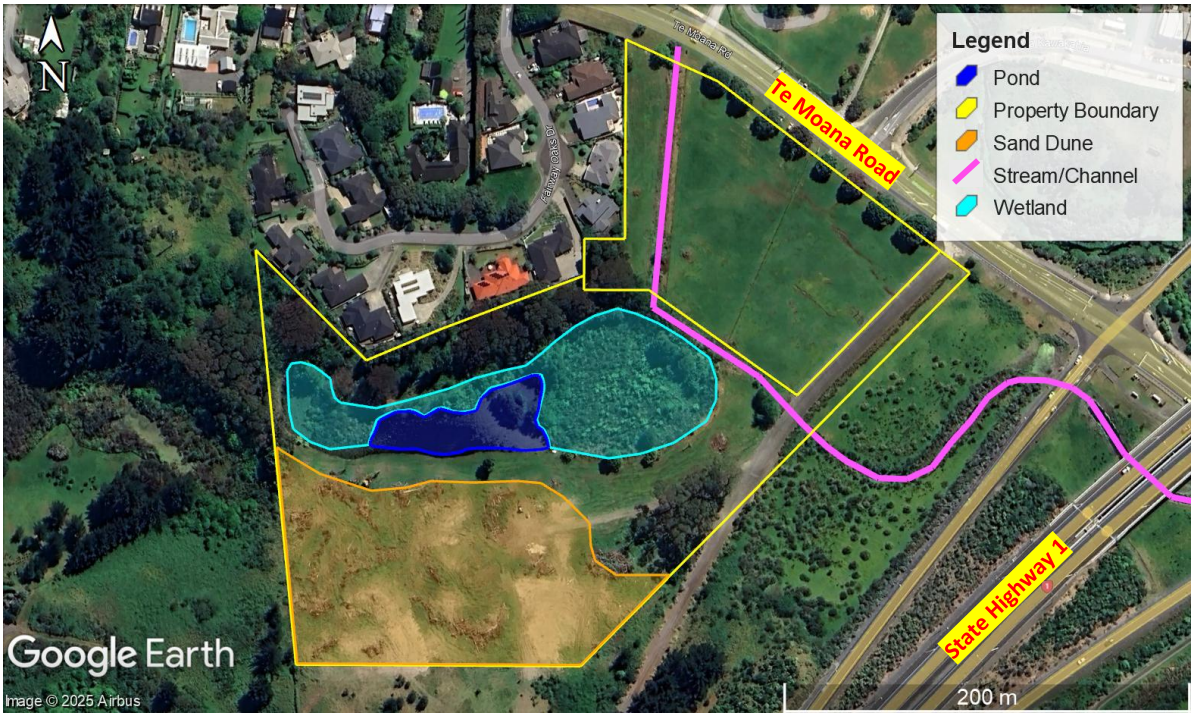

Figure 1: *Site Location Plan with geomorphic features – property boundary of the 2 properties are delineated with the yellow line (Image from Google Earth).*

5.2 Historical Imagery

Historical aerial imagery of the site has been reviewed as part of our assessment and was sourced from Retrolens. This includes historical aerial imagery for the years 1948 to current. The aerial photographs have been reviewed in order to identify changes in land use activities on the site and potential areas of HAIL activity.

The following observations were made from the historical aerial imagery (Retrolens and Google Earth:

1948 – 1966: The site appears to be completely undeveloped and generally covered in grass and trees.
1966: A small, isolated building is visible (on what is now 100 Te Moana Road).
1966 – 1987: A dwelling is developed on the site in the same approximate position as the older building (Figure 2).
1987 – 2007: No further development on the site.

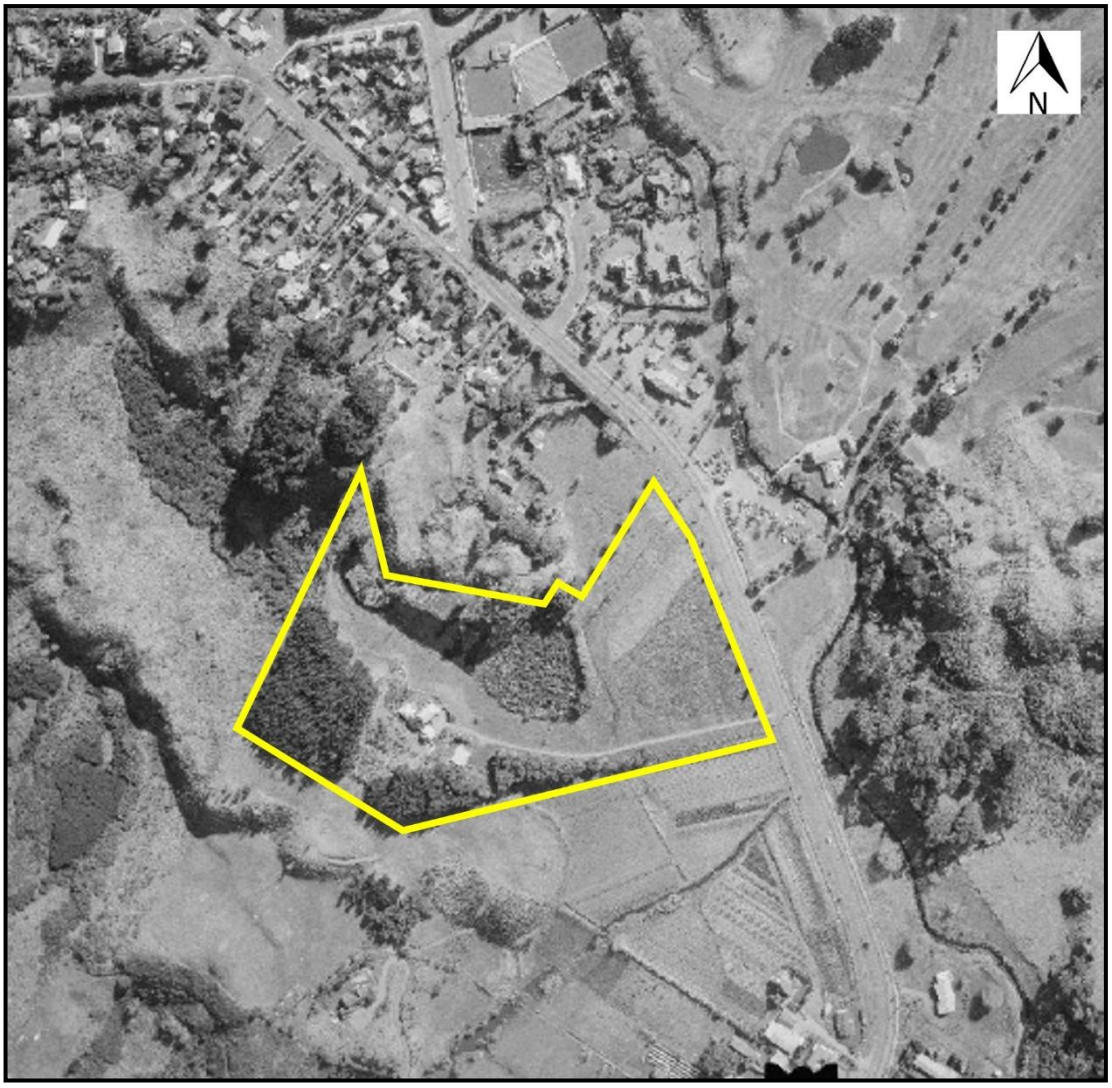

Figure 2: *Aerial image showing the approximate outline of the study site (yellow polygon). Note the dwelling developed within what is now 110 Te Moana Road. Sourced from Retrolens; date of image: 07/06/1994.*

2007 – 2010: Retrolens imagery is only available up to 30/01/2003, thereafter Google Earth historical imagery shows that between January 2007 and March 2010, the buildings are demolished and removed leaving only a concrete base.
2010 – Present: The site remains undeveloped.

5.3 Contaminated Land (HAIL) Assessment

According to the Selected Land Use Register (SLUR) the site has no records of any hazardous activities on the site. We consider, based on the review of the aerial photographs, that the site has primarily been used for pastoral farming. Our site walkover also found no evidence of any historical or current HAIL activities.

We do note that based on anecdotal evidence, that some of the trees have been cleared and as a result wood piles have been formed, burned and then buried. The exact number and extent of these burn piles is not currently known and will require checking during the subdivision consent stage.

6. Geological Model

6.1 Published Geology

The GNS online geological map of the area indicates the site geology straddles the boundary of 2 geological units: Holocene windblown deposits make up the western portion of the site and Holocene river deposits make up the eastern portion of the site. The windblown deposits are described as "inactive dunes", and the river deposits are described as "well sorted floodplain gravels". These deposits are likely underlain by older alluvial and beach deposits which extend to a depth greater than 100 m depth before encountering the Rakaia Terrane. The Rakaia Terrane is the regional bedrock and extends to several kilometres' depth.

According to the GNS Science Active Fault Database, the site lies approximately 4.4 km northwest of the Ohariu Fault, a dextral fault with a recurrence interval of >2,000 to <= 3,500 years.

6.2 NZGD Review

A review of the New Zealand Geotechnical Database (NZGD) identified data within a 250 m radius of the site:

A water well (NZGD ID: Other_83607) drilled approximately 150 m to the northwest of the site intersected sand and gravel to a depth of 11.0 m bgl

A water well (NZGD ID: Other_83498) drilled approximately 160 m to the east of the site intersected intercalated gravel and sand layers to a depth of 123.0 m bgl.

Boreholes (NZGD ID: BH_85132; BH_85133 and BH_86361) drilled approximately 240 m to the east, also intersected intercalated gravel and sand layers to a depth of between 19.77 m and 39.1 m bgl.

6.3 Council Information

A review of the Kapiti Coast District Council (KCDC) and Greater Wellington Regional Council (GWRC) hazard mapping and GIS database indicate the following:

- The site is zoned as 'rural'.
- The site straddles the boundary between a mapped high liquefaction risk area (inactive dune geological unit) and a low liquefaction risk area (floodplain gravel geological unit).
- The site is within an area where there is a "moderate" risk of groundshaking.
- The site is within an area where slope failure risk is mapped as "low".
- Various mapped Flood Hazard Areas are present across the site (Figure 4). Most notably a ponding hazard within 110 Te Moana Road and a residual overflow hazard as well as ponding across 100 Te Moana Road.
- The majority of the site is located within the "Evacuation Zone: Yellow" hazard area.

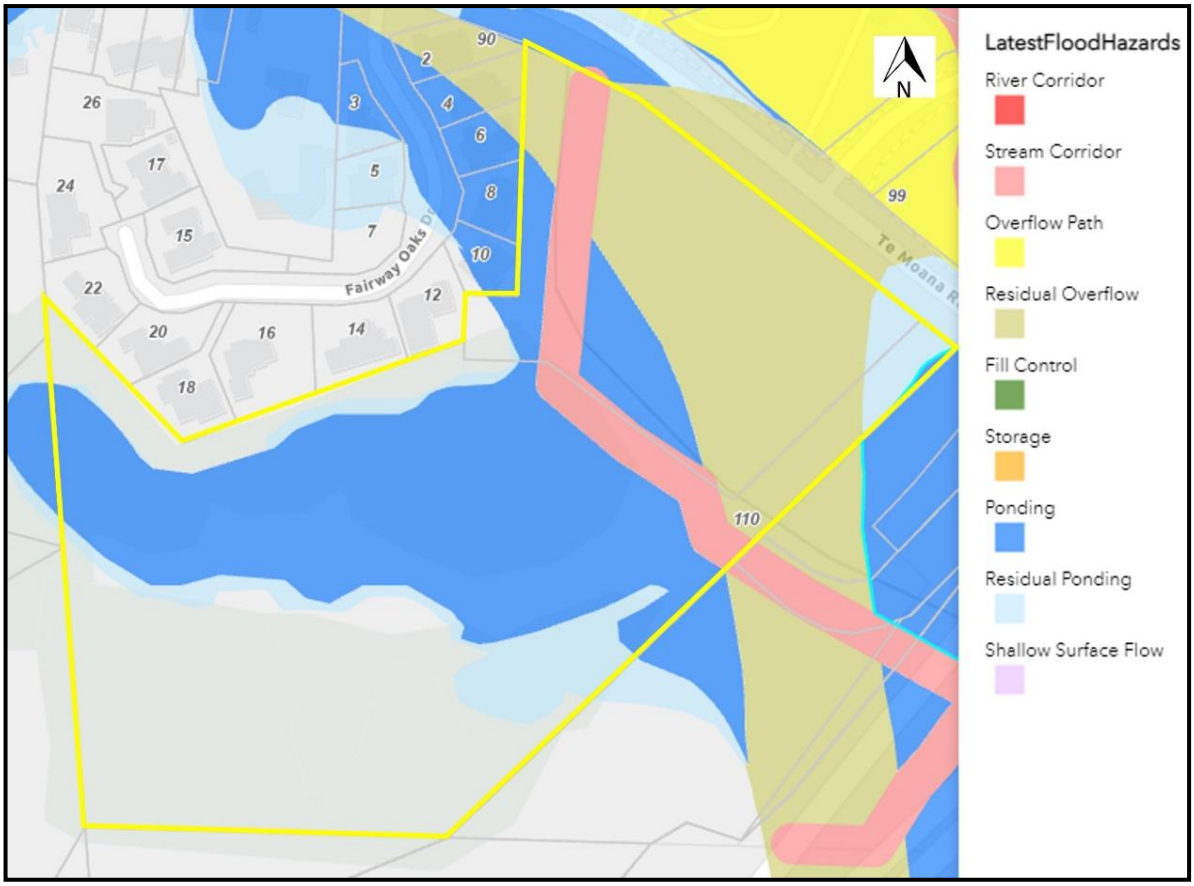

Figure 3: *Flood Hazard Map (KCDC LocalMaps Database).*

7. Geotechnical Investigation

In this section we will present both our site-specific investigation information as well as nearby information.

7.1 Site Walkover

CGW completed an initial site walkover on 9 September 2024.

The site area across 100 Te Moana Road is generally grass-covered and relatively flat to slightly undulating (Figure 4). No obvious signs of instability were observed on the site. There were signs of surface water ponding in the lower areas of the site and the ground was generally moist to wet under foot. Numerous rabbit burrows are prevalent across the site.

Figure 4: *View looking approximately northwest, of the site at the time of the field investigation (100 Te Moana Road). Note Te Moana Road is visible in top right of the photo.*

The site area across 110 Te Moana Road is on sloping, undulating ground that varies from gentle to steep, especially in the southwestern corner (Figure 5). A large area of the site has been cleared, exposing sand. There are established pine trees to the south as well as a cluster of mature gum trees (in the eastern portion of 110 Te Moana Road).

Figure 5: *View looking approximately southwest, of the site at the time of the field investigation (110 Te Moana Road).*

At the time of the site walkover, standing water was noted within the gum tree cluster. The remnants of a concrete foundation are present on the site. There is also a wetland pond along the northern boundary of 110 Te Moana Road (Figure 6).

Figure 6: *View looking approximately northwest, of the wetland pond area. (110 Te Moana Road)*

7.2 Site Specific Investigation

The field investigation was undertaken on 9 September 2024 and 28 April 2025 and consisted of the following:

- Six (6) Cone Penetration Tests (CPT) to a target depth of 10.0 m bgl;
- Two (2) Hand Auger Boreholes (HA) and Dynamic Cone Penetrometer Tests (DCP) to a target depth of 3.0 m bgl.

A visual-tactile field classification of the subsoils encountered during hand auger hole drilling was carried out in accordance with 'Guidelines for the Field Classification and Description of Soil and Rock for Engineering Purposes' (NZGS, 2005) and Dynamic Cone Penetrometer testing was carried out in accordance with NZS 4402.1988, Test 6.5.2, 'Dynamic Cone Penetrometer'.

The CPT was carried out by a specialist CPT rig operated by CPT Elite in accordance with ASTM Standard D5778-12 'Test Method for Performing Electronic Friction Cone and Piezocone Penetration Testing of Soils'. The CPT test data was provided to us in both graphical form and as a full electronic record for use in later data interpretation and analyses.

Investigation details are provided in Table 3. The tests were positioned in areas to provide the most effective coverage of the site considering site access. Test locations were recorded by handheld GPS or approximated from site measurements and reduced levels interpolated from LiDAR and are therefore approximate only.

Table 2: Site Specific Investigation Information			
Test ID	**Elevation RL (m)**	**Termination Depth (bgl)**	**Further Information (Groundwater, piezometer, etc)**
HA/DCP01	~ 15.5	3.0 m / 3.0 m	Groundwater not encountered. HA & DCP: Target Depth Achieved.
HA/DCP02	~ 2.5	2.0 m / 2.3 m	Groundwater encountered at 1.0 m bgl. HA & DCP: Terminated due to refusal in dense soils.
CPT01	~ 12.5	14.94 m	Groundwater not recorded. Target Depth Achieved.
CPT02	~ 5.75	14.9 m	Groundwater not recorded. Target Depth Achieved.
CPT03	~ 3.0	14.08 m	Groundwater not recorded. Target Depth Achieved.
CPT04	~ 2.5	3.36 m / 8.6 m	Groundwater not recorded. CPT: Refusal in dense material. DPSH: Refusal in dense material.
CPT05	~ 3.0	14.89 m	Groundwater not recorded. Target Depth Achieved.
CPT01 (2024)	~ 7.5	14.83 m	Groundwater not recorded. Target Depth Achieved.

The investigations were located to provide coverage of the overall site and are approximate only. All test locations are presented in Appendix B with hand auger borehole and Dynamic Cone Penetrometer tests results depicting detailed soil descriptions and blows per 100mm penetration presented in Appendix C and CPT profiles presented in Appendix D.

7.3 Ground Model

Due to the variable geology on site, the ground model has been split between the low-lying area (Table 3) and the dune area (Table 4).

Table 3: Site Ground Model – Low-lying Area			
Soil Type	**Depth to bottom of layer (RL)**	**Layer Thickness (m)**	**Relative Density / Consistency**
Silty SAND (TOPSOIL/FILL)	+2.1 m	0.4	-
SAND/Clayey SAND (ALLUVIAL DEPOSITS)	+0.5 m*	1.6	Loose to Medium dense
SAND/Silty SAND/Sandy SILT (ALLUVIAL DEPOSITS)	0.0 m	0.5	Loose to Medium dense

Table 3: Site Ground Model – Low-lying Area			
Soil Type	**Depth to bottom of layer (RL)**	**Layer Thickness (m)**	**Relative Density / Consistency**
Sandy GRAVEL/Gravelly SAND (ALLUVIAL DEPOSITS)	-3.0 m to -3.5 m	3.0 – 3.5	Dense to Very dense
SAND/Silty SAND (ALLUVIAL DEPOSITS)	Deeper than -11.9 m	>8.9	Dense to Very dense

* Extent of HA

Table 4: Site Ground Model – Dune Area			
Soil Type	**Depth to bottom of layer (RL)**	**Layer Thickness (m)**	**Relative Density / Consistency**
SAND (DUNE DEPOSITS)	+12.5 m*	3.0	Loose to medium dense
SAND/Silty SAND/Sandy SILT (DUNE DEPOSITS)	Deeper than -9.0 m	>12.0	Medium dense to Very dense

* Extent of HA

7.4 Groundwater

Groundwater was encountered within HA/DCP02 at a depth of 1.0 m bgl (RL +1.5 m). Groundwater was not recorded in the CPT holes or HA/DCP01 following testing. The porewater pressure data indicates a variable groundwater depth though this is related to the different elevations of the test locations and where on the site was undertaken.

Cuttriss and AWA have also undertaken assessments for various reasons on site and indicate a groundwater depth of between 0.6 m and 1.5 m bgl, and likely is influenced by seasonal, wet weather events and soil type.

Groundwater levels may vary in response to environmental factors such as seasonal and wet weather events. It is recommended that standpipe piezometers are installed across the site along with regular water level monitoring to determine the groundwater level across the site. This will aid in future planning and development.

7.5 Site Subsoil Classification

We consider that the site subsoil category in terms of NZS 1170.5 Clause 3.1.3 is Class D (deep or soft soils) based on the following:

- Site specific testing encountering dune and alluvial deposits.
- Geological maps of the area and available geotechnical information from the wider site area.
- Clause 3.1.3 and Table 3.2 of NZS 1170.5:2004.

8. Geotechnical Assessment

8.1 Liquefaction Analysis Methodology

Assessment of liquefaction potential has been undertaken using the site-specific CPT data to determine possible ground subsidence at the site during future design seismic events. Acceleration values for Design Level events and liquefaction analysis methodologies are taken from the MBIE Guidelines Module 1, dated November 2021.

Liquefaction analyses of CPT data was undertaken using CLiq (v.2.2.0.28) software. The Boulanger & Idriss (2014) method was used for liquefaction triggering and fines correction.

Liquefaction analyses have considered the following Serviceability Limit State (SLS) (1:25 year return period) and Ultimate Limit State (ULS) (1:500 year return period) Design Levels:

- SLS M_w 6.5, PGA 0.13g; and
- ULS M_w 6.7, PGA 0.53g.

Due to the variation in elevation of the various tests, a conservative equivalent groundwater level of RL +2.0 m has been used for the analyses of the CPT data. Analysis outputs are presented in Appendix E.

8.2 Liquefaction Induced Settlement

Table 5: CPT Based Liquefaction Analysis Results for Design Events				
Test No *(Termination Depth)*	**Predicted Liquefaction Induced Settlement (mm)**			
	Full Depth (mm)		**Index Depth (mm)**	
	SLS	**ULS**	**SLS**	**ULS**
CPT01 *(14.94 m)*	0	75	0	0
CPT02 *(14.90 m)*	<5	135	<5	95
CPT03 *(14.08 m)*	10	45	10	45
CPT04 (CPT) (3.36m)*	-	-	*<5*	*10*
CPT04 (DPSH) (3.2 - 8.6 m)*	-	-	*<5*	*35*
CPT04 (total)* *(8.6m)*	-	-	<10	45
CPT05 *(14.89 m)*	<5	15	<5	15
CPT01 (2024) *(14.83 m)*	0	105	0	65

The settlements presented in Table 5 above are to the nearest 5 mm. Due to the inherent uncertainty in calculating liquefaction induced settlement, the calculated free field settlements (land settlement) are indicative only. Actual settlements on site may vary from those above and do not take into account foundation influences; volume loss from surface expression, loss in bearing strength and influences from lateral spreading.

* CPT04 terminated before reaching 10 m depth so only the Index values are presented above.

Our liquefaction analysis indicates that generally there are liquefiable layers from RL +2.0 m to RL -3.25 m depth during SLS levels of shaking. These liquefiable layers are not made up of one consistent layer but rather interbedded layers up to 1.0 m thick, but predominantly less than 0.5 m thick.

Liquefaction analysis for ULS levels of shaking indicate that potentially liquefiable layers of soils are generally present during ULS levels of shaking between RL +2.0 m to RL -7.5 m bgl.

From the calculated settlements we consider differential settlements in the order of less than 5 mm following an SLS earthquake event and up to 50 mm following an ULS earthquake event.

8.3 Lateral Spreading Assessment

A stream crosses the site (between 100 and 110 Te Moana Road – see Figure 1) and there is a wetland pond on the northern side of 110 Te Moana Road.

Based on the results of the liquefaction analysis and distance to the nearest free face, CGW considers the site to be susceptible to minor to moderate liquefaction-induced lateral stretch or minor to major global lateral movement, depending on the location within the site. The areas closest to the water body will be more susceptible to lateral spreading and stretch.

8.4 Expected Future Land Performance

The MBIE Guidelines provide broad classification of land for future land performance based on index values of expected settlements. Given in Table 6 below is a summary of expected future land performance criteria for the site based on the current MBIE Technical Category.

Table 6: Expected Future Land Performance Categories

Technical Category	Expected SLS Land Settlement (mm)		Expected ULS Land Settlement (mm)		Expected Global Lateral Movement (mm)		Expected ULS Lateral Stretch (mm)	
TC1	0 – 15	✓	0 – 25		Nil		Nil	
TC2	0 – 50		0 – 100	✓	<300 (Minor)		<50 (Minor)	
TC3	>50		>100		300 – 500 (Major)	✓	0 – 200 (Minor to Moderate)	✓

Our liquefaction assessment and analysis indicate that liquefaction-induced ground subsidence is consistent with minor liquefaction risk. As per the MBIE Guidance, the SLS settlements are assessed as being less than 10 mm and the ULS settlements are assessed at also less than 100 mm. This would classify the site as being consistent with a TC2 Technical Category with regard to liquefaction risk. However, the presence of free faces around the stream and pond/wetland on the low-lying areas, means that major lateral spreading could be a risk to the development. Based on this, we believe the TC3 is suitable for the low-lying areas.

The higher dunes area is not considered susceptible to lateral spreading given the general depth to groundwater. Therefore, we believe the TC2 category for the dunes area is suitable.

8.5 Expansive Soils

In line with the AS2870 methodology of utilising a visual-tactile identification and knowledge of the site soils, we have based our assessment on our investigations and the available geotechnical information for the site. We consider the proposed building to be underlain with Class A, Non-Expansive soils.

8.6 Geotechnical Ultimate Bearing Capacity

With reference to the Dynamic Cone Penetrometer results, in accordance with NZS3604:2011 and the MBIE Guidance, an Ultimate Bearing Capacity of 200 kPa is generally present in natural soils across the site.

9. Assessment Against RMA Section 106

9.1 Criteria

In accordance with the Resource Management Act 1991 (RMA), the site has been assessed in accordance with Section 106 for natural hazards. Section 106 states:

- *There is significant risk from natural hazards; or*
- *Sufficient provision has not been made for legal and physical access to each allotment to be created by the subdivision.*

For the purpose of subsections 1a, an assessment of the risk from natural hazards requires a combined assessment of:

- *The likelihood of natural hazards occurring;*
- *The material damage to land in respect of which consent is sought, other land or structures that would results from natural hazards;*
- *Any likely subsequent use of land in respect of which the consent is sought that would accelerate, worsen or result in material damage of the kind referred to in paragraph b.*

9.2 Assessment

The site has been assessed, based on site mapping, site investigations and research of local information, for the following natural hazards:

- Fault Rupture – the site is not located within an identified active fault hazard zone. Geological mapping indicates there is a mapped active fault approximately 4.4 km from the site.
- Slope Stability – The dune area is generally sloping. There is no evidence of obvious slope instability within the site and surrounding area. We consider the risk of instability is low, subject to further analysis be undertaken during the subdivision stage.
- Inundations (soil, rock debris) – the site is not located at the base of a slope. Debris inundation is unlikely as no mapped debris fans are located within the vicinity of the site, nor are there any rock outcrops or loose debris that may be susceptible to becoming mobile which could impact any site development.

However, we consider the site may be subject to the following hazards, which will need to be mitigated as part of the development design:

- Inundations (flooding) – the site is located within a mapped ponding and overflow risk area. This would need to be taken into consideration for any future development.
- Liquefaction induced settlement – Based on the soil conditions, and available information indicating potential liquefaction induced vertical and lateral spreading hazards along the lower elevated areas of the site. We consider the liquefaction risk will need to be better quantified and the extent mapped during the subdivision assessment stage.

In our opinion, under Section 106 of the RMA, there are no geotechnical reasons preventing the rezoning of this area from rural to residential, provided the developer takes the appropriate measures as recommended in this report.

10. Engineering Considerations

10.1 Low-lying Areas

Based on our initial site walkover assessment and geotechnical investigations, the low-lying areas are categorised by high groundwater and alluvial soils. These areas are at risk of inundation, liquefaction spreading and lateral spreading.

It is likely that large scale earthworks are going to be required to address the inundation risk. If the site is to be built-up, modelling would be required to address the impact on the surrounding area. Building up the area can also address the liquefaction and lateral spreading risk, creating a thicker non-liquefiable crust. Lateral spreading can be addressed by reducing the size of the free-face and by the use of ground improvements techniques.

10.2 Dune Areas

Based on our initial site walkover assessment and geotechnical investigations, the dune area is categorised by loose to medium dense dune sands. The dune area is not necessarily subject to any risks as per Section 106 of the RMA however low bearing capacity is a geotechnical aspect that requires consideration.

10.3 Potential Soft/Weak Soils

Soft and/or weak soils were not encountered during the site investigation. However, we anticipate that these types of soils are likely present in the wetland area and potentially around the margins of the wetland also. These soils could result in static and long-term creep settlements under any potential developments. Mitigation measures include, but not limited to, removal of the weak soils or creation of a buffer zone.

10.4 Further Geotechnical Involvement

This report is compiled in support of a plan change submission to KCDC. It is not intended to represent a comprehensive geotechnical evaluation of the site. Further geotechnical investigations will be required to assess, for example, bearing capacity and extent of liquefaction hazard during Subdivision Consent applications.

Recommendations contained within this report are based on the field results obtained during the site investigations undertaken by CGW. The nature and continuity of the material identified is inferred and it should be appreciated that actual ground conditions may vary from the assumed ground model.

We consider the site is suitable for subdivision subject to further investigation being undertaken suitable for subdivision consenting purposes. Testing would involve further CPT testing to meet the MBIE Geotechnical Engineering Module 2 minimum testing requirements and further shallow investigations. This will allow further refinement of the development areas to more accurately provide solutions for the risks identified.

Following the subdivision investigations, all subdivided sections will need to be individually assessed for suitable bearing and subgrade. We consider the liquefaction risk of the lower elevated areas of the site to be susceptible to potentially moderate to severe liquefaction induced total settlement and lateral spreading hazard. This will need to be better quantified during the subdivision consent investigations and reporting. It is recommended that, as part of the Resource Consent Phase Geotechnical Investigation, standpipe piezometers are installed and monitored to ascertain a more accurate groundwater level across the site. This, coupled with more comprehensive testing could assist in refining the feasibility of developing the lower elevated areas of the site. As per the MBIE guidance document recommendations, ground conditions that exhibit liquefaction induced total settlements and lateral spreading risk consistent with a TC3 categorisation will need to be subjected to extensive ground improvement works to mitigate the liquefaction risk to an acceptable level (TC2 or better). This may include deep ground improvement and in-ground retaining.

11. References

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Appendix A: Limitations

This report has been prepared solely for the benefit of our client, Eric Osbourne as per our brief and an agreed consultancy agreement. The reliance by any other parties on the information or opinions contained in this report shall, without our prior agreement in writing, be at such parties' sole risk.

The conclusions and recommendations contained within this report are based on the investigations as described in detail above. The nature and continuity of subsoil conditions are inferred and it must be appreciated that actual conditions could vary considerably. Defects and unforeseen ground conditions may remain undetected which might adversely affect the stability of the site and the recommendation made herein.

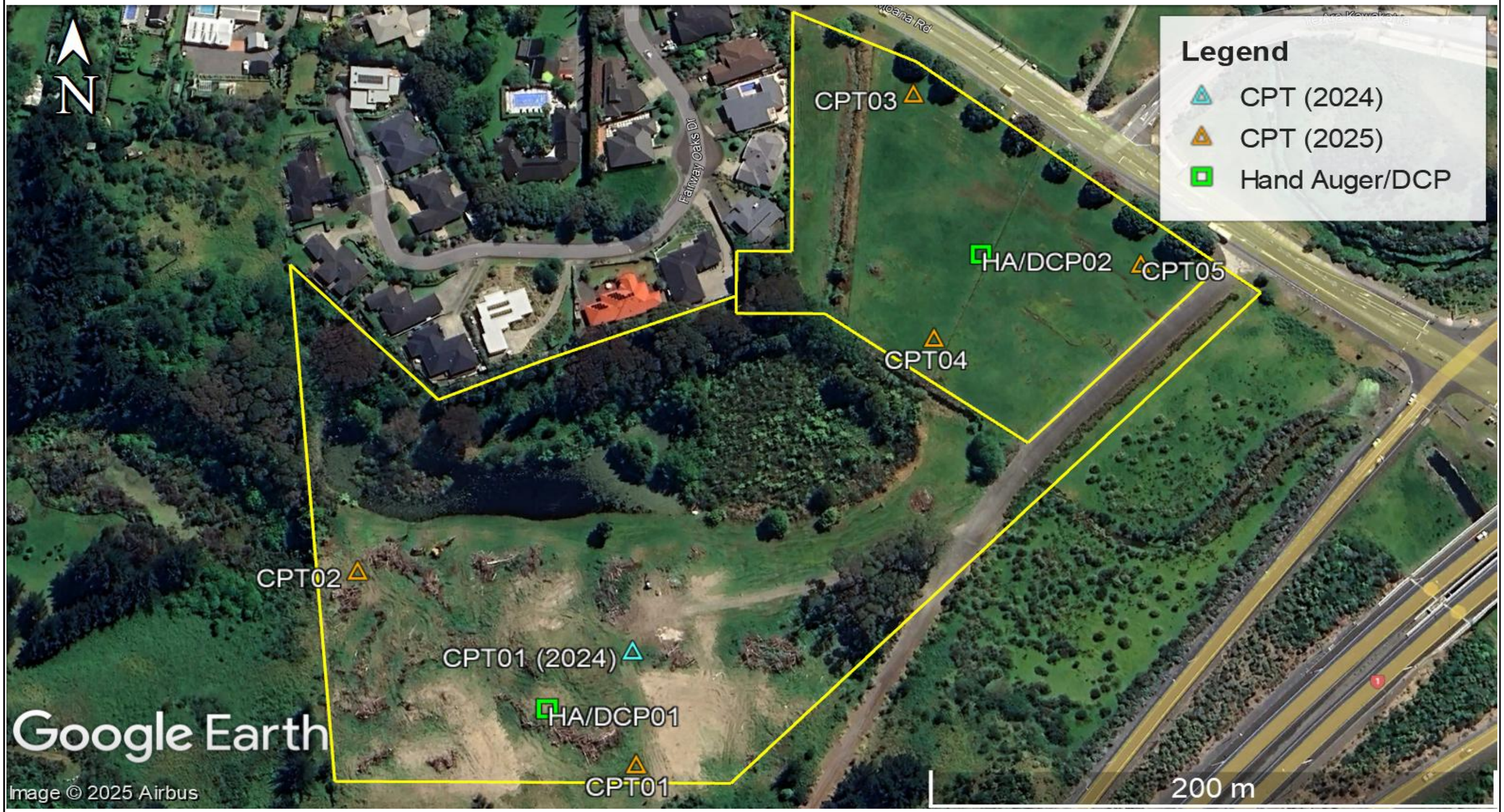
This report has been prepared solely to address the issues raised in our brief, and shall not be relied on for any other purpose.

Where we have provided comments on aesthetic issues these need to be confirmed by an architect or other expert in the field.

In the event the third party investigation data has been provided to us, the client acknowledges that we have placed reliance on this information to produce our report and CGW will accept no liability resulting from any errors or defect in the third party data provided to us.

Appendix B: Site Investigation Plans

A3



GENERAL NOTES:

1) THE INFORMATION CONTAINED ON THIS DOCUMENT IS COPYRIGHT AND MAY NOT BE COPIED, DISSEMINATED OR USED FOR ANY OTHER PURPOSE OTHER THAN THAT FOR WHICH IT HAS BEEN PROVIDED WITHOUT THE WRITTEN PERMISSION OF CAMERON GIBSON AND WELLS

2) VERIFY ALL DIMENSIONS ON SITE

3) DO NOT SCALE FROM DRAWINGS

4) THE ADEQUACY OF THE DESIGN INCORPORATED ON THE PLANS IS SUBJECT TO THE REQUIREMENTS INCLUDED IN THE SPECIFICATION FOR THE WORKS AND THE DESIGN ASSUMPTIONS INCORPORATED IN THE CALCULATIONS AND REPORTS FOR THE PROJECT

CGW CONSULTING ENGINEERS
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www.cgwl.co.nz • office@cgwl.co.nz • Tel: +64 3 548 8259

CLIENT	ERIC OSBOURNE
JOB TITLE	100 - 110 TE MOANA ROAD WAIKANAE BEACH
DRAWING TITLE	TEST LOCATION PLAN
DESIGNED BY:	SARAH CARRAN
DRAFTED BY:	CLEM GIBBENS

REV	DATE	REVISION	CHD	APD
A	30/04/2025	TEST LOCATION PLAN	CG	RS

NOT FOR CONSTRUCTION

SCALE	SIZE
N.T.S.	A3

PROJECT NO	TYPE	SHEET	REV
240461	TLP	G -00 -01	A

Appendix C: Hand Auger & Dynamic Cone Penetrometer Logs

Borehole Record: HA/DCP01

Project: 100 - 110 Te Moana Road, Waikanae	**Position:** Easting: 0.00	**Date Drilled:** 29/04/2025
Location: 100 - 110 Te Moana Road, Waikanae Beach 5036, New Zealand	Northing: 0.00	**Drill Rig** Hand Auger Borehole
Loc Comment:	**Elevation:** 15.5(m)	**Drill Supplier** CGW
Job No: 240461	**Inclination:**	**Logged/Checked:** SC/CG

General comments: No groundwater encountered

Depth (m)	Graphic Log	Soil Description "FIELD DESCRIPTION OF SOIL AND ROCK. Guideline For the Field Classification and Description of Soil and Rock for Engineering Purposes"	Water Level (m)	Depth (m)	Scala Penetrometer (Blows/100 mm)	Well Diagram
0.50 1 1.50 2 2.50		SAND, fine to medium grained, with some silt, brownish grey. Moist, loose to medium dense (DUNE DEPOSITS)		0.50 1 1.50 2 2.50	0 2 4 6 8 10 12 14 16 18 20 22 24 26	... 0-3, Backfill
		HA/DCP01 Target depth achieved at 3m				

Borehole Record: HA/DCP02

Project: 100 - 110 Te Moana Road, Waikanae
Location: 100 - 110 Te Moana Road, Waikanae Beach 5036, New Zealand
Loc Comment:
Job No: 240461

Position: Easting: 0.00
Northing: 0.00
Elevation: 2.5(m)
Inclination:

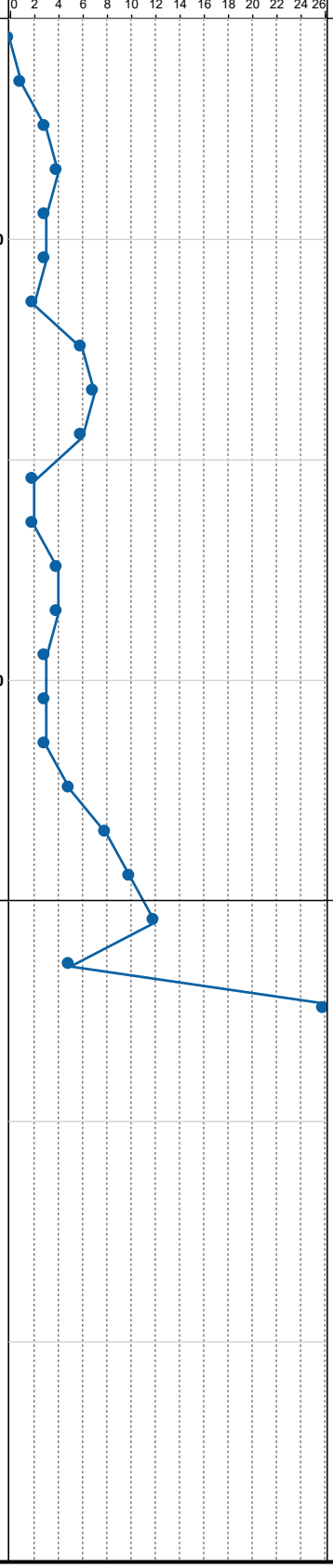
Date Drilled: 29/04/2025
Drill Rig Hand Auger Borehole
Drill Supplier CGW
Logged/Checked: SC/CG

Depth (m)	Soil Description "FIELD DESCRIPTION OF SOIL AND ROCK. Guideline For the Field Classification and Description of Soil and Rock for Engineering Purposes"
	Silty SAND, fine grained, with some rootlets, greyish brown. Moist, loose (TOPSOIL)
0.50	SAND, fine to medium grained, with some silt, greyish brown. Moist, medium dense (ALLUVIAL DEPOSITS)
	0.7 m - Becomes wet.
1	1.0 m - Becomes saturated.
	1.1 m - Becomes dark brown grey.
1.50	Clayey SAND, fine grained, with some silt and trace medium gravel, dark brown grey. Saturated, loose to medium dense. Gravel is subrounded (ALLUVIAL DEPOSITS)
	SAND, coarse grained, with some fine to medium gravel, dark grey. Saturated, dense to very dense. Gravel is subrounded (ALLUVIAL DEPOSITS)

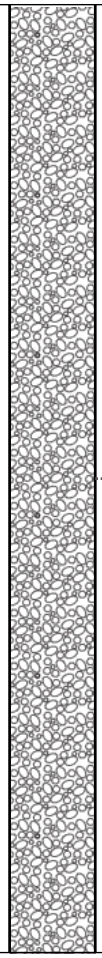
HA/DCP02 refusal due to obstruction at 2m

Water Level (m)

Scala Penetrometer (Blows/100 mm)

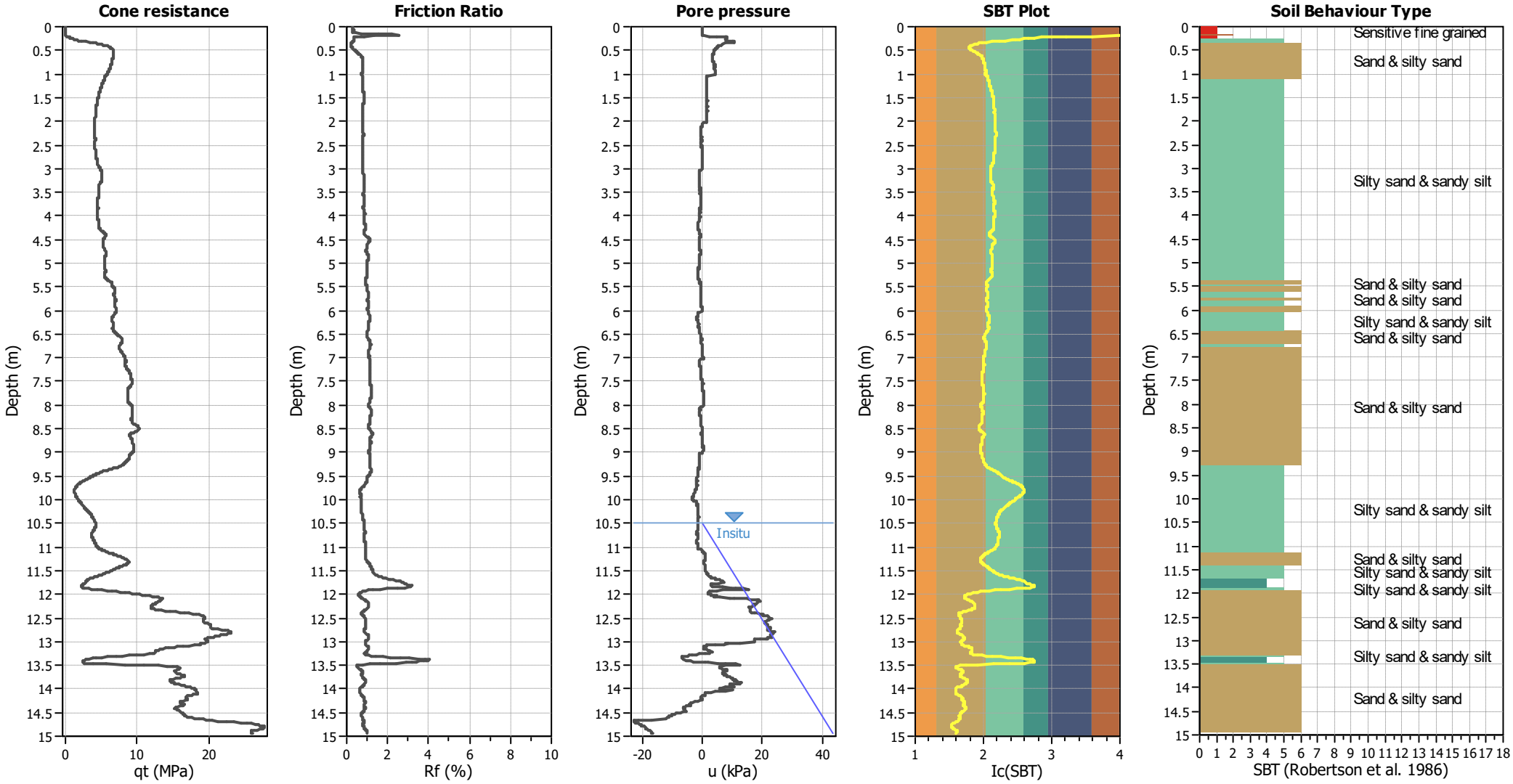


Well Diagram



Appendix D: Cone Penetration Test Results

CPT basic interpretation plots



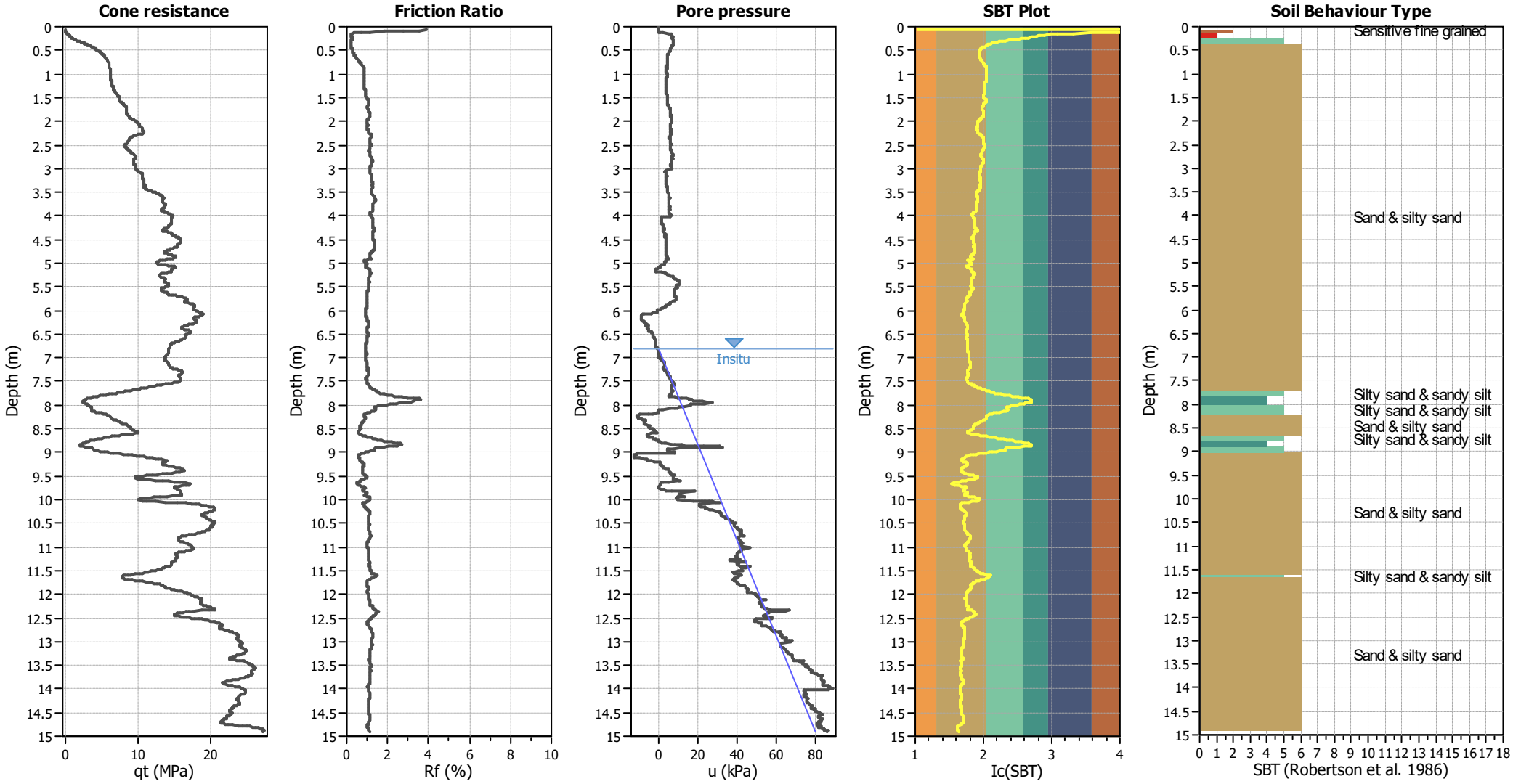
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	10.50 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.50	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.13	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	10.50 m	Fill height:	N/A	Limit depth:	N/A

SBT legend

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

CPT basic interpretation plots



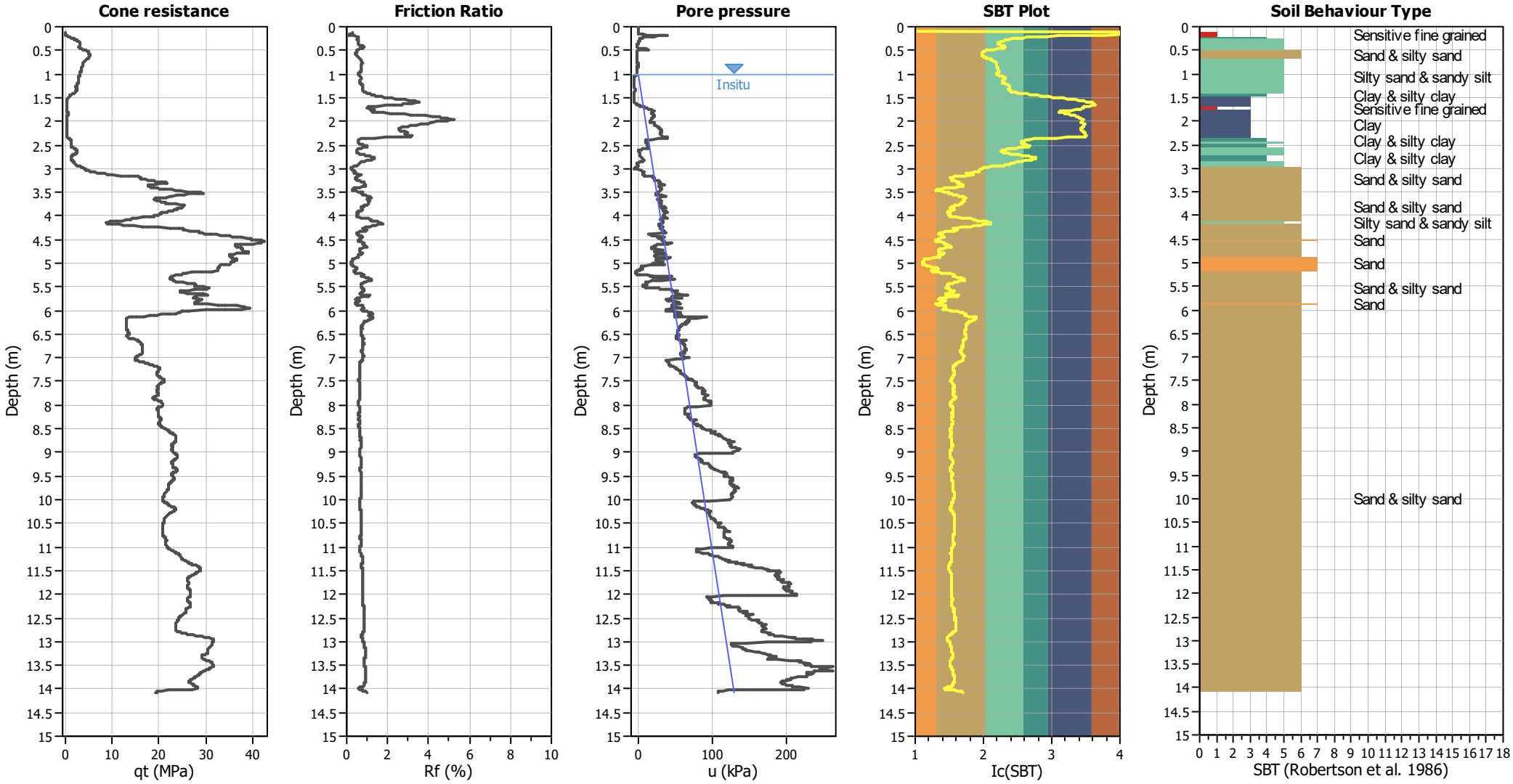
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	3.75 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:	6.50	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.13	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	6.80 m	Fill height:	N/A	Limit depth:	N/A

SBT legend

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

CPT basic interpretation plots



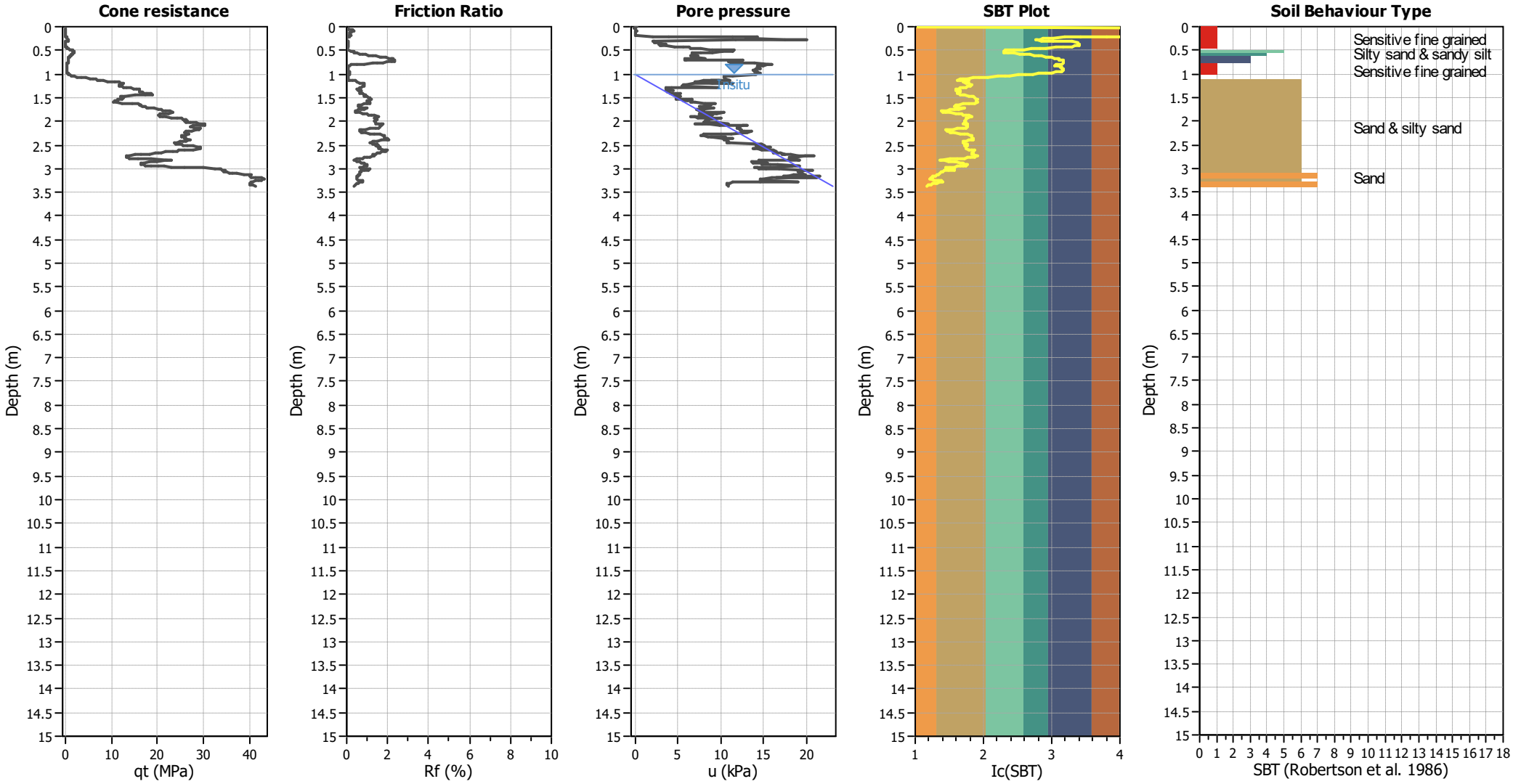
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	1.00 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:	6.50	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.13	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	1.00 m	Fill height:	N/A	Limit depth:	N/A

SBT legend

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

CPT basic interpretation plots



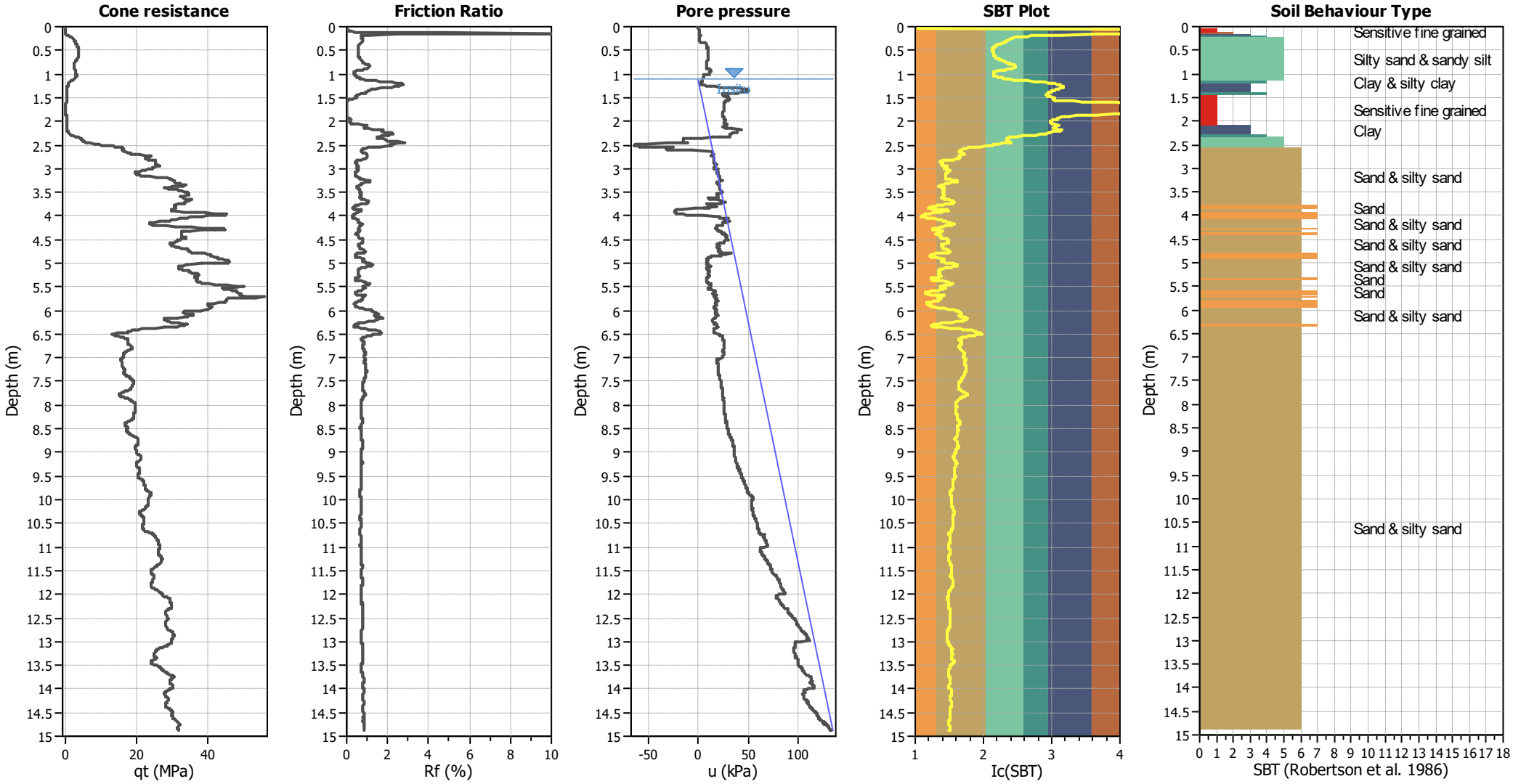
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	0.50 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.50	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.13	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	1.00 m	Fill height:	N/A	Limit depth:	N/A

SBT legend

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

CPT basic interpretation plots



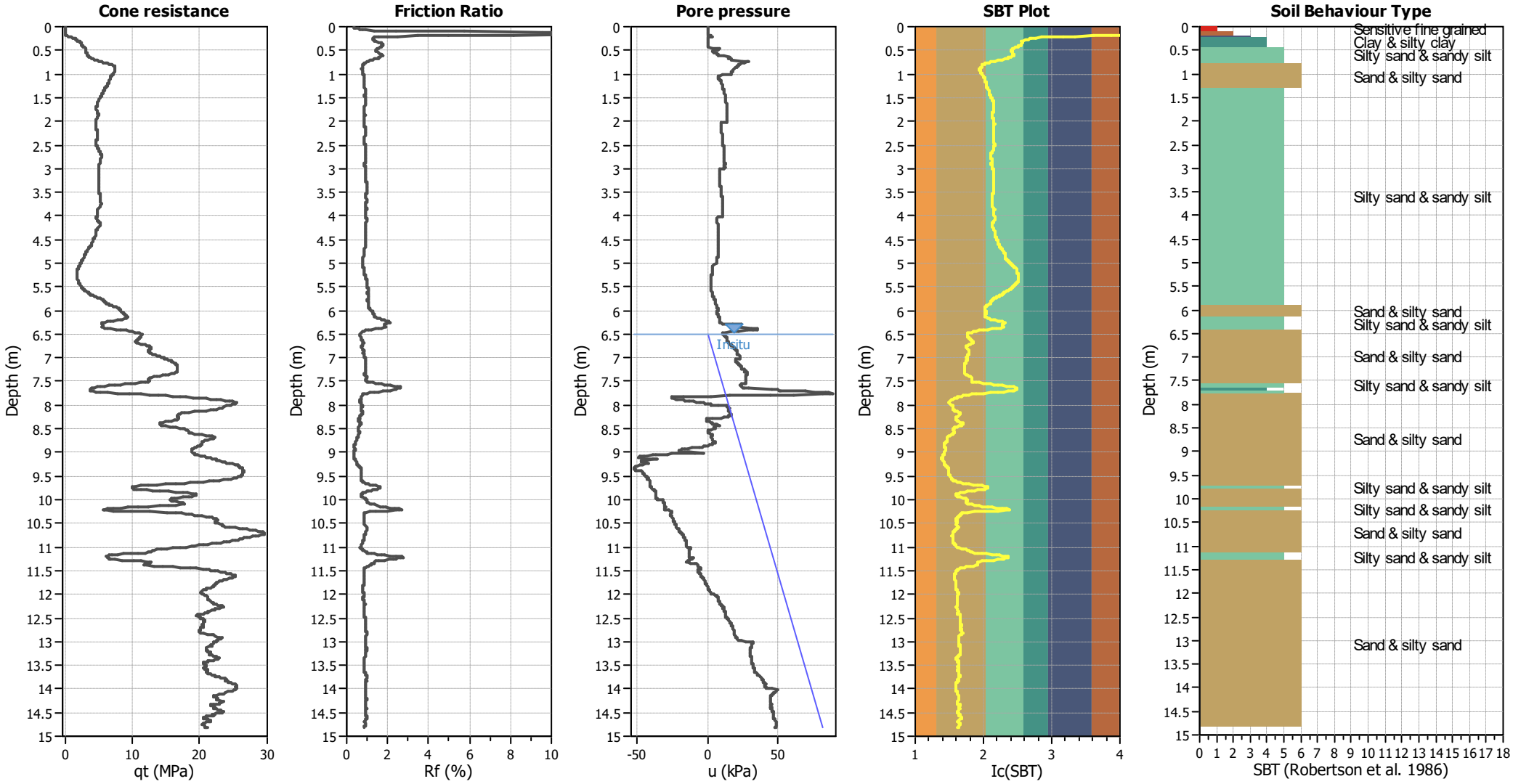
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	1.00 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:	6.50	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.13	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	1.10 m	Fill height:	N/A	Limit depth:	N/A

SBT legend

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

CPT basic interpretation plots



Input parameters and analysis data

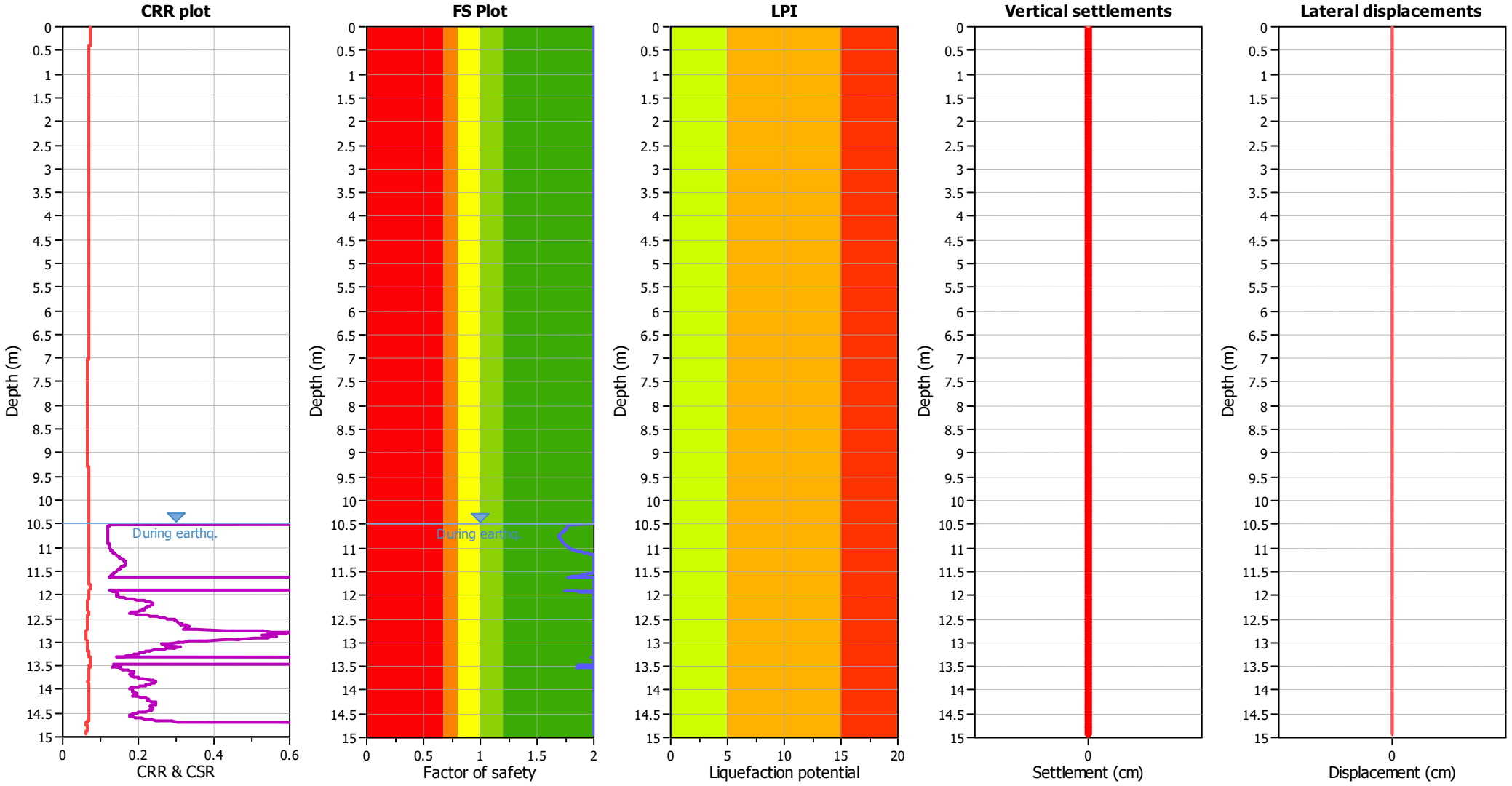
Analysis method:	B&I (2014)	Depth to GWT (erthq.):	5.50 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.50	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.13	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	6.50 m	Fill height:	N/A	Limit depth:	N/A

SBT legend

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

Appendix E: Liquefaction Analysis Outputs

Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	10.50 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.50	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.13	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	10.50 m	Fill height:	N/A	Limit depth:	N/A

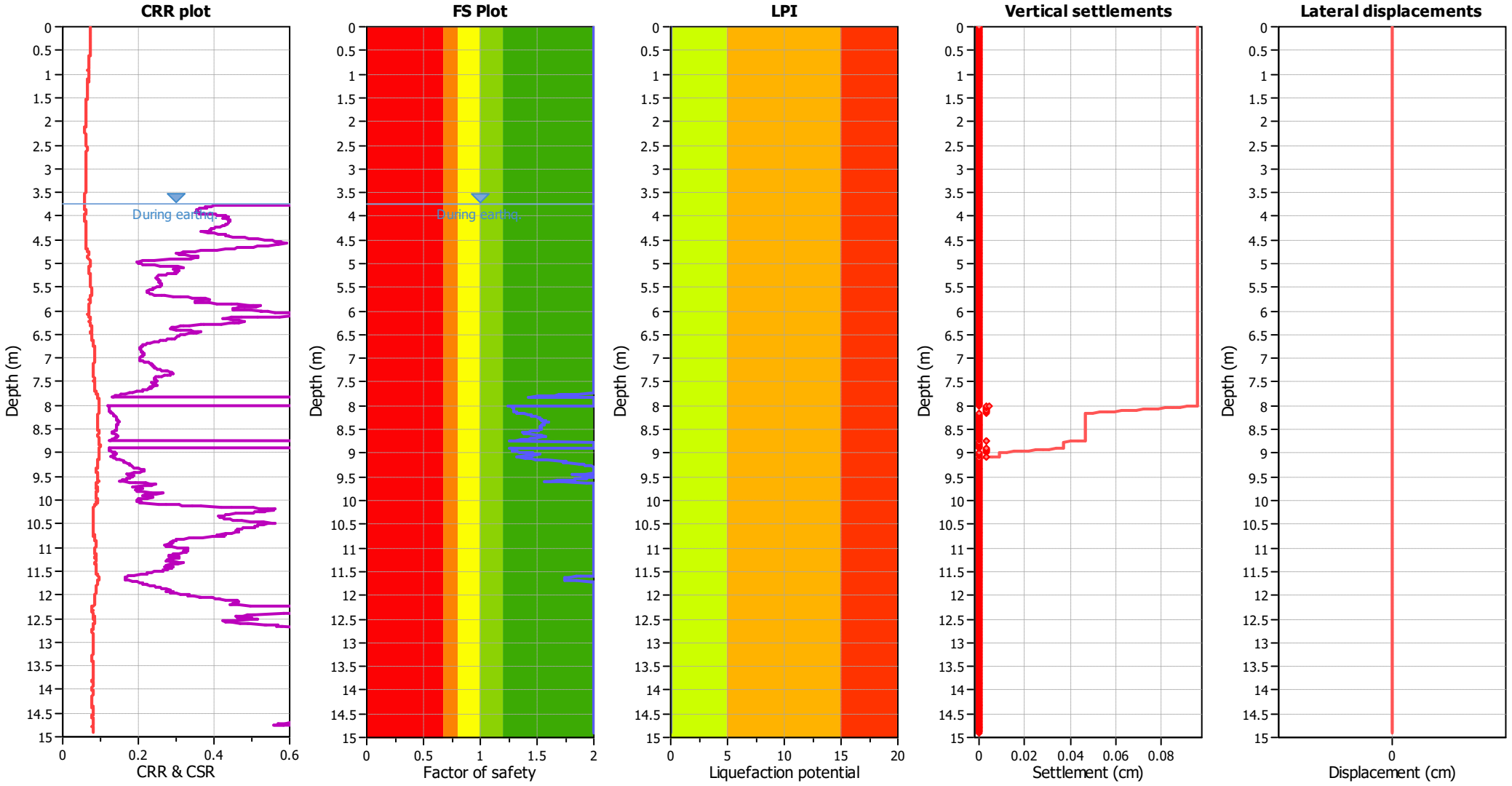
F.S. color scheme

- 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.):	3.75 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:	6.50	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.13	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	6.80 m	Fill height:	N/A	Limit depth:	N/A

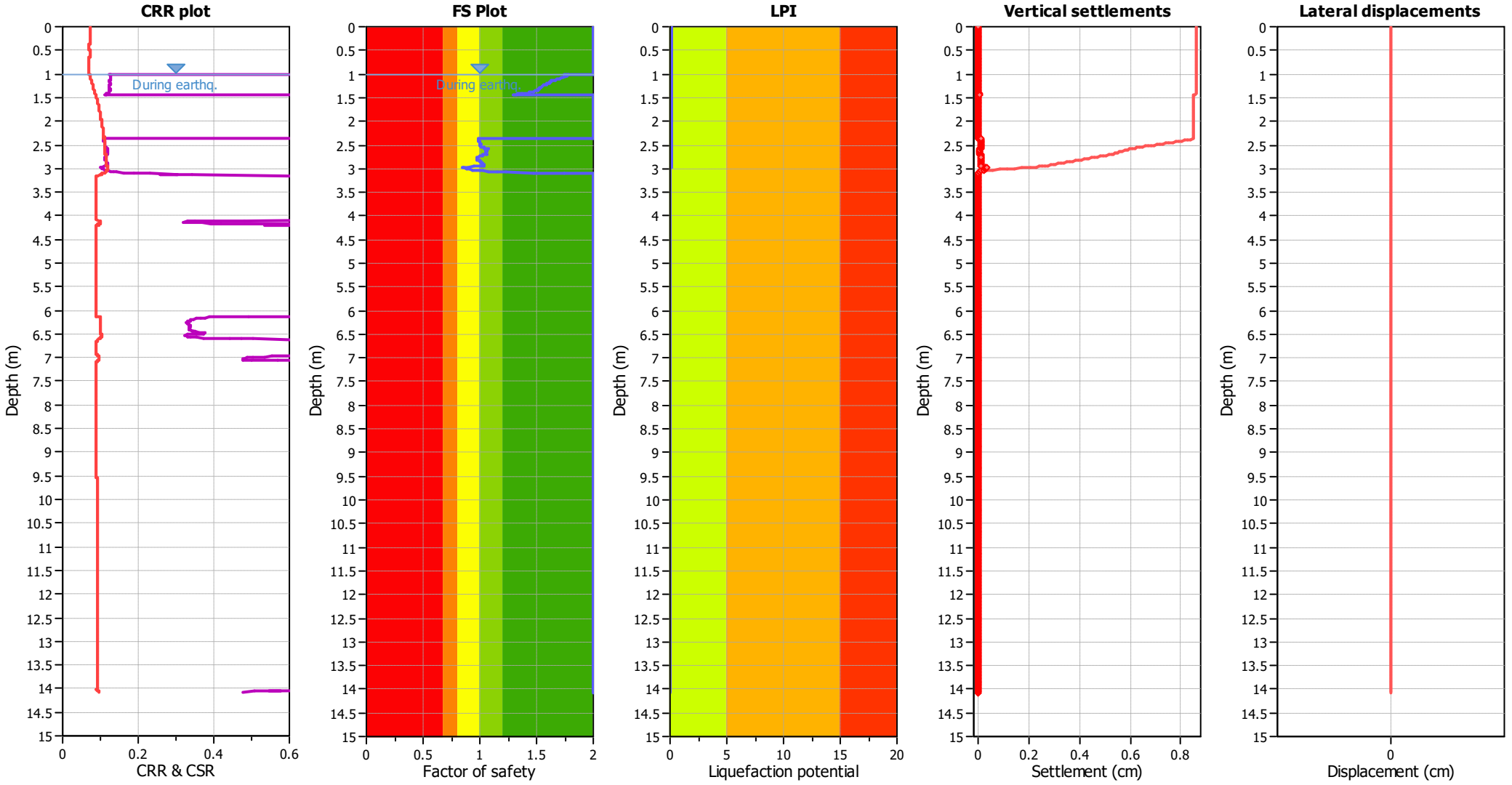
F.S. color scheme

- 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.):	1.00 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:	6.50	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.13	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	1.00 m	Fill height:	N/A	Limit depth:	N/A

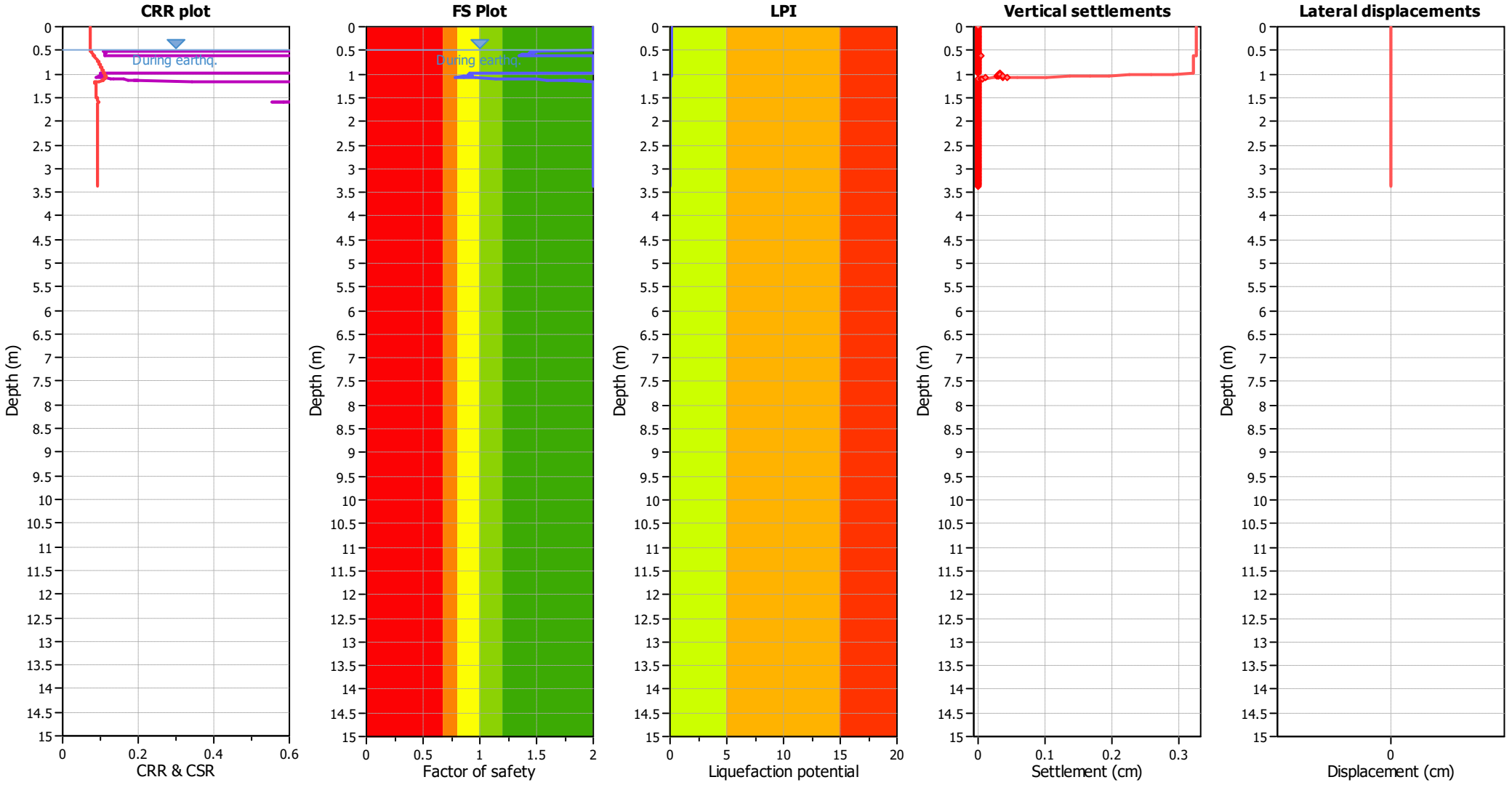
F.S. color scheme

- 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.):	0.50 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.50	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.13	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	1.00 m	Fill height:	N/A	Limit depth:	N/A

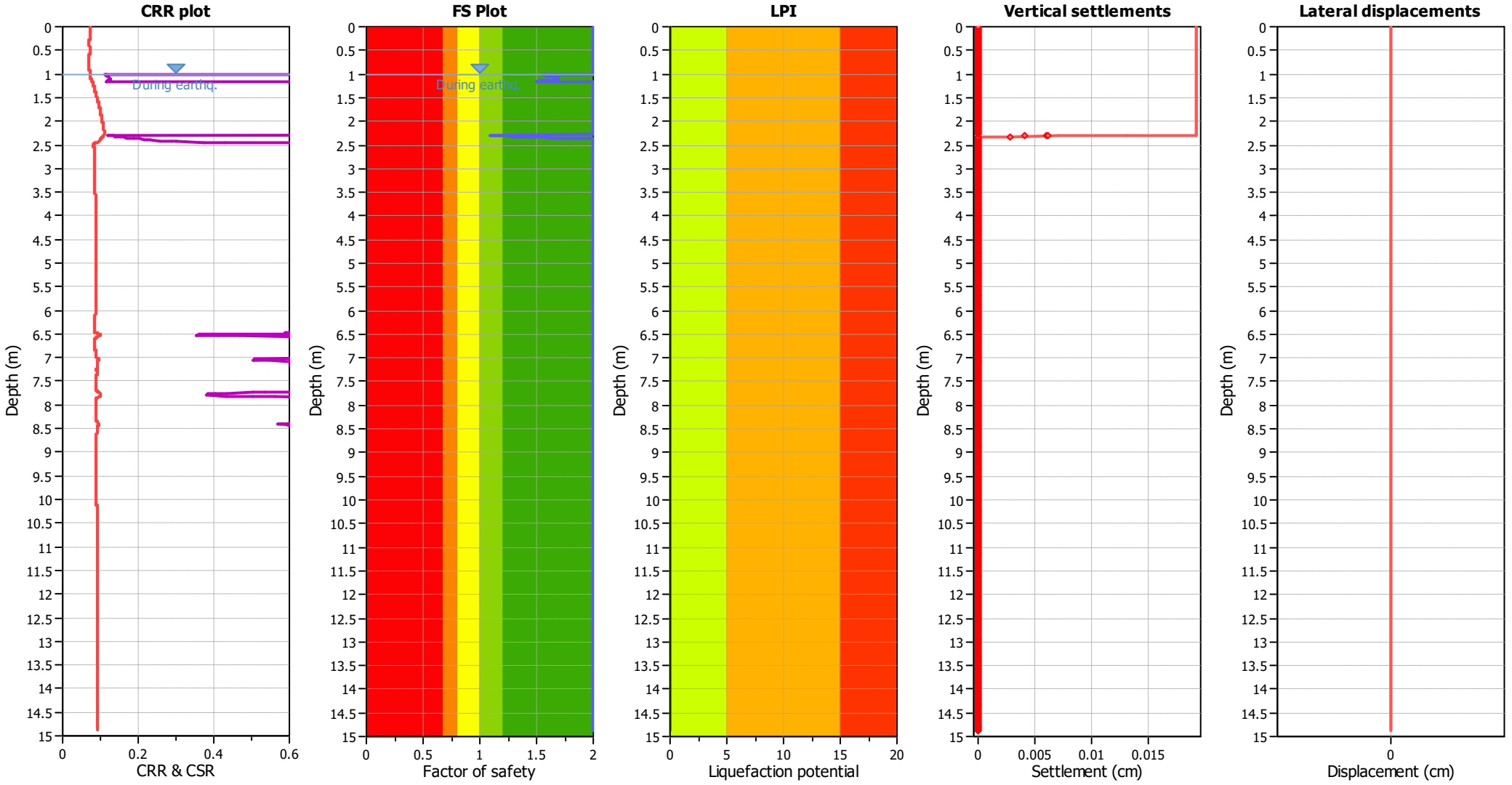
F.S. color scheme

- 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.):	1.00 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:	6.50	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.13	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	1.10 m	Fill height:	N/A	Limit depth:	N/A

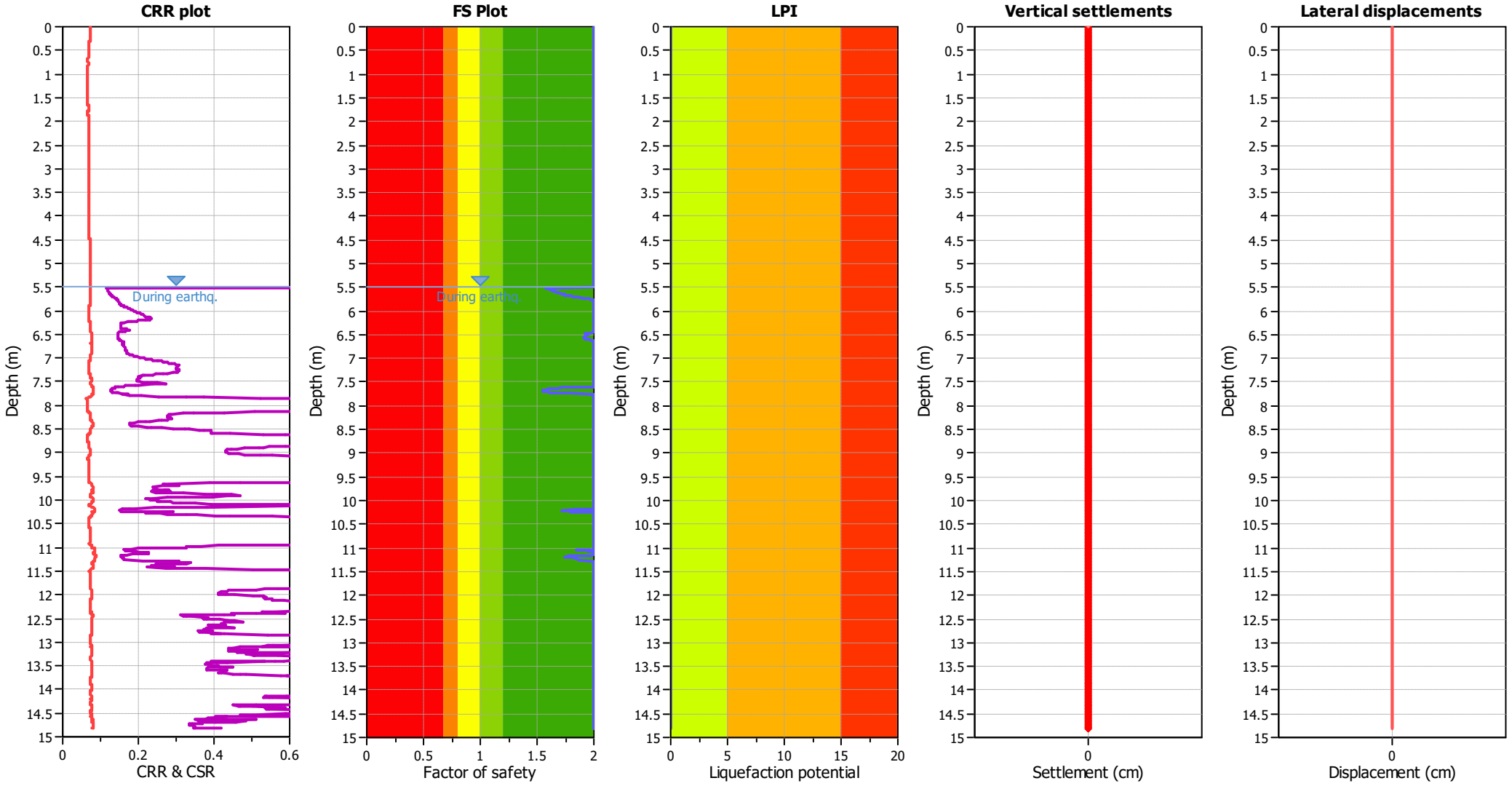
F.S. color scheme

- 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.):	5.50 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.50	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.13	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	6.50 m	Fill height:	N/A	Limit depth:	N/A

F.S. color scheme

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

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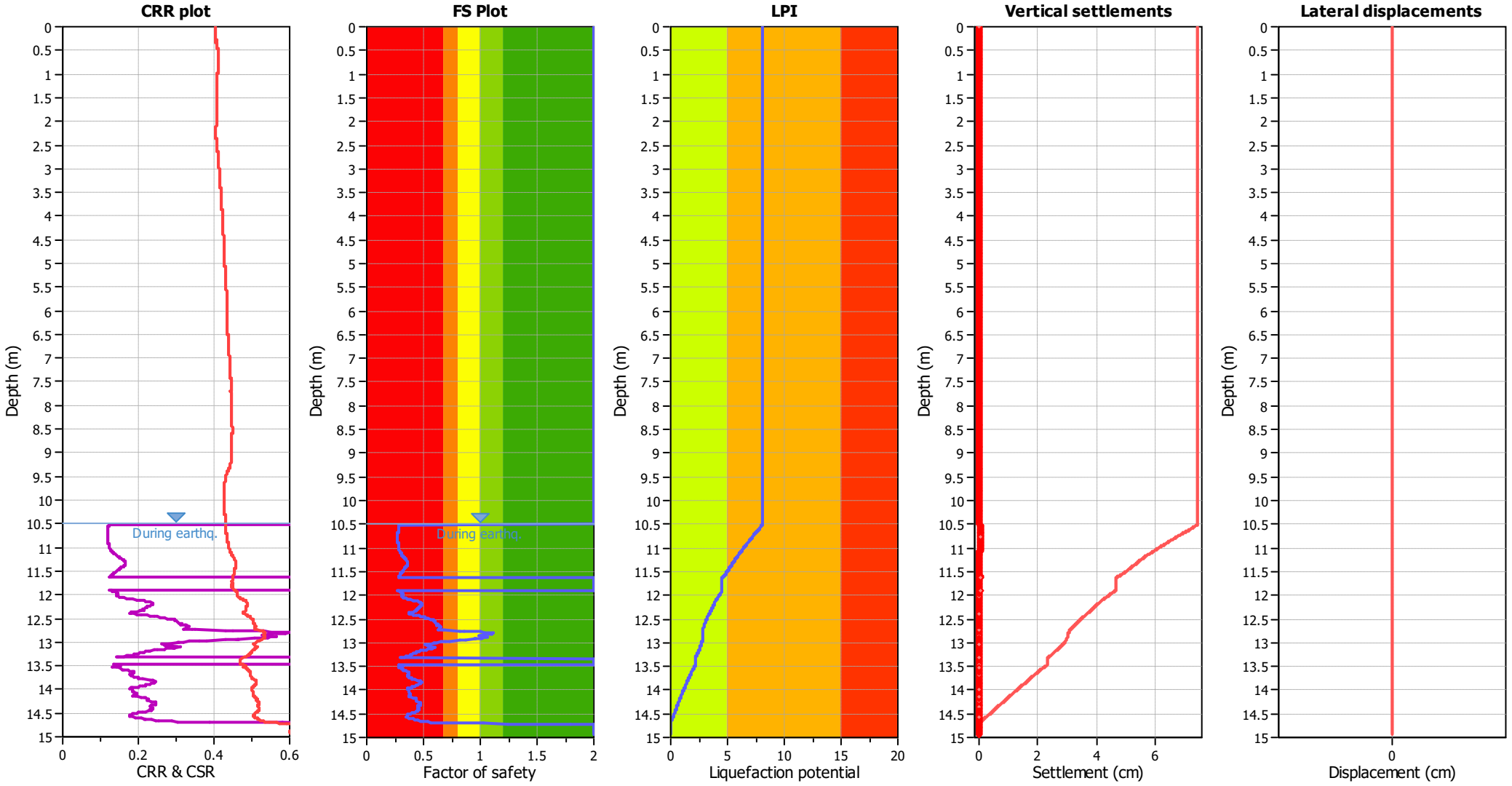
- High risk
- Low risk

Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	10.50 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	7.70	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.68	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	10.50 m	Fill height:	N/A	Limit depth:	N/A

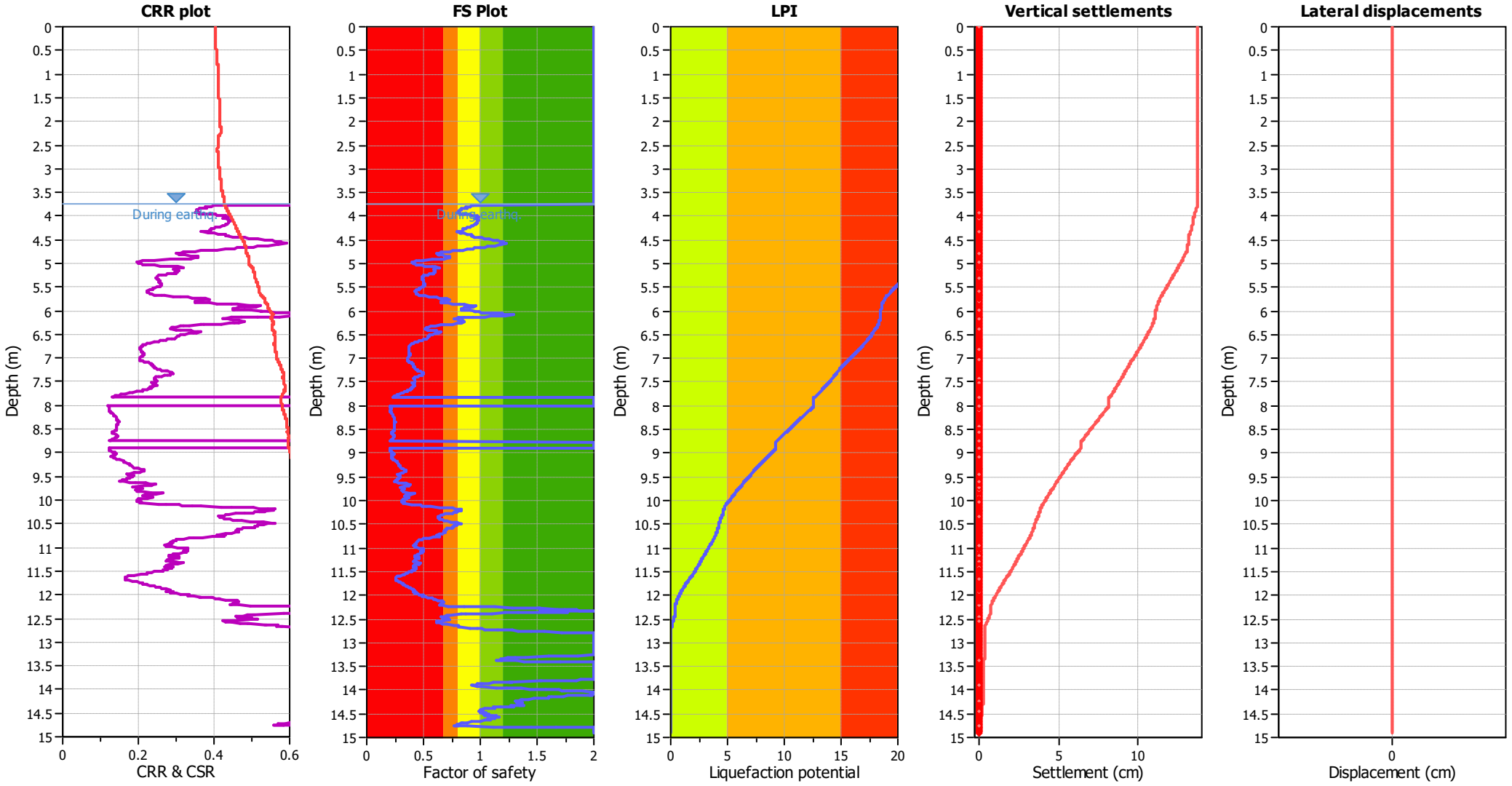
F.S. color scheme

- 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.):	3.75 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:	7.70	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.68	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	6.80 m	Fill height:	N/A	Limit depth:	N/A

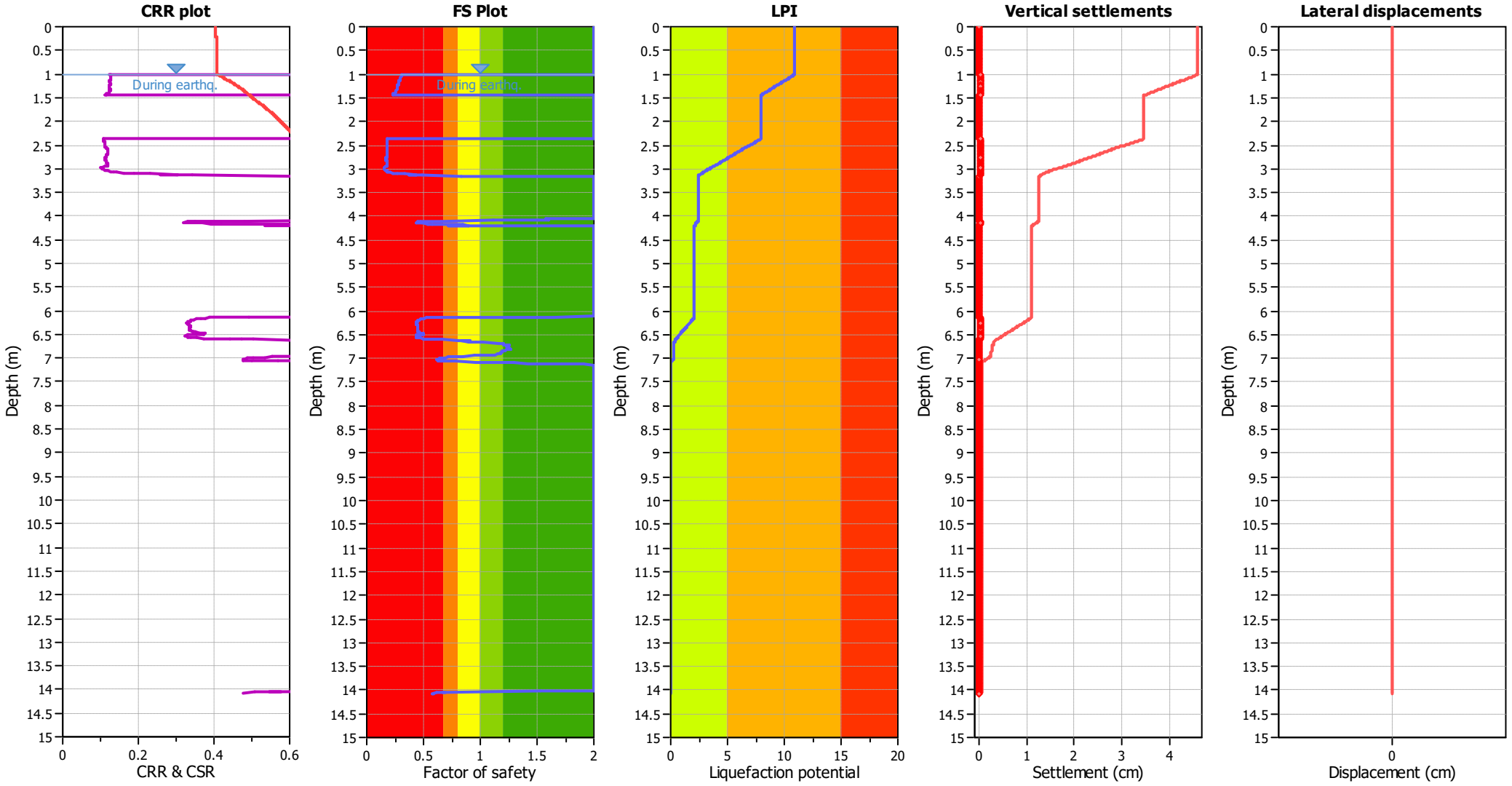
F.S. color scheme

- 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.):	1.00 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:	7.70	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.68	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	1.00 m	Fill height:	N/A	Limit depth:	N/A

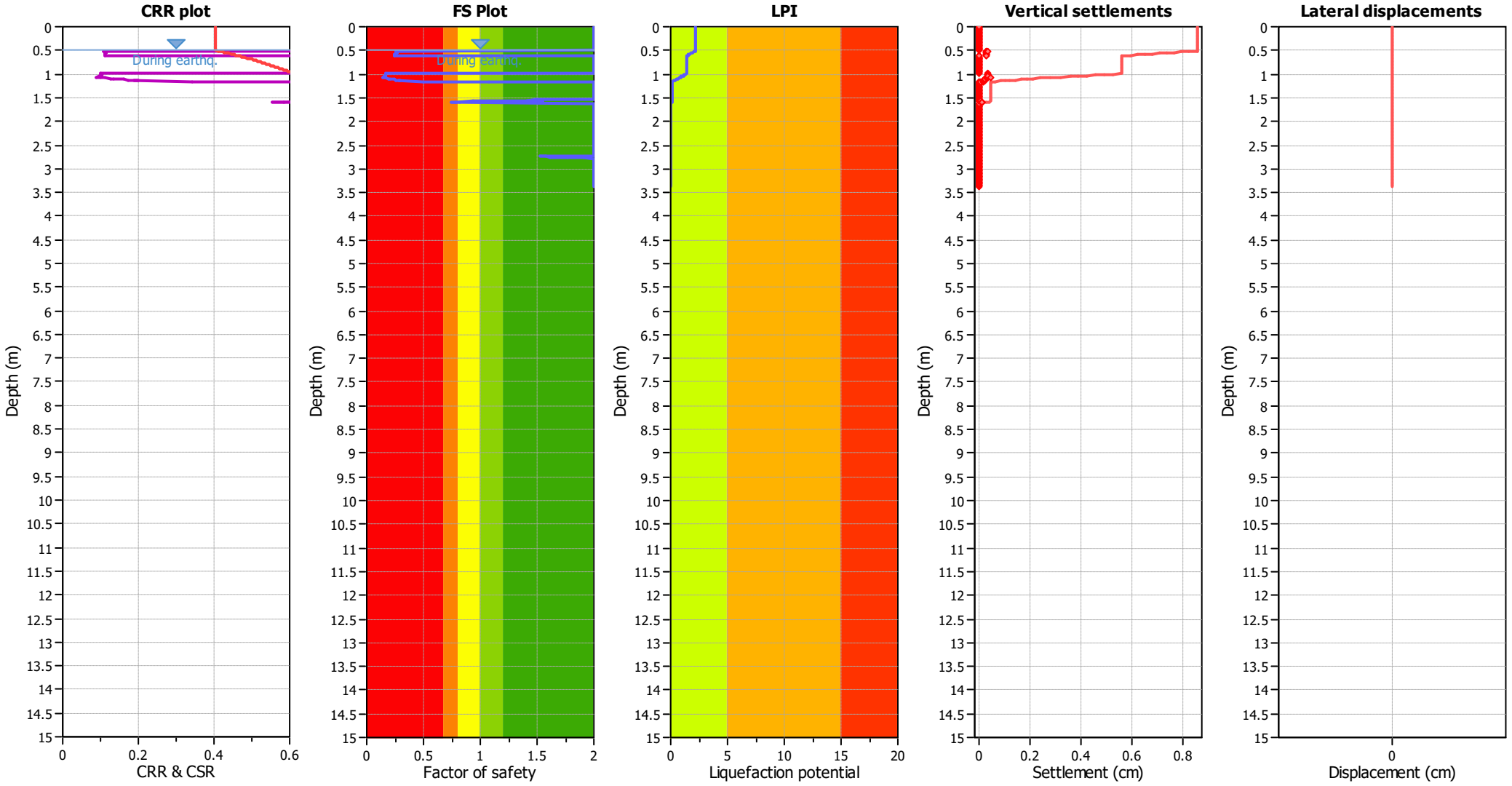
F.S. color scheme

- 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.):	0.50 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	7.70	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.68	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	1.00 m	Fill height:	N/A	Limit depth:	N/A

F.S. color scheme

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LPI color scheme

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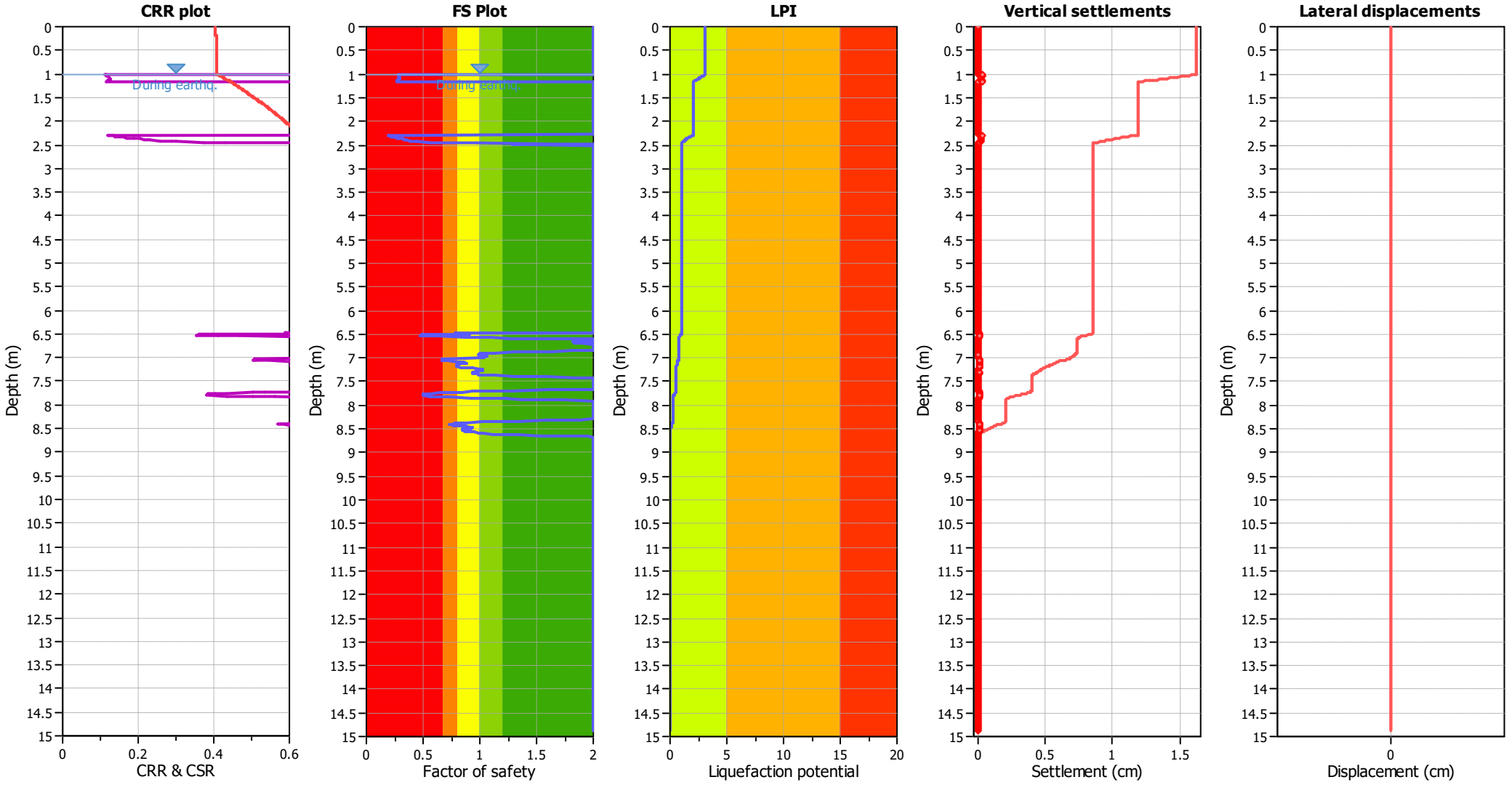
Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	1.00 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:	7.70	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.68	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	1.10 m	Fill height:	N/A	Limit depth:	N/A

F.S. color scheme

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LPI color scheme

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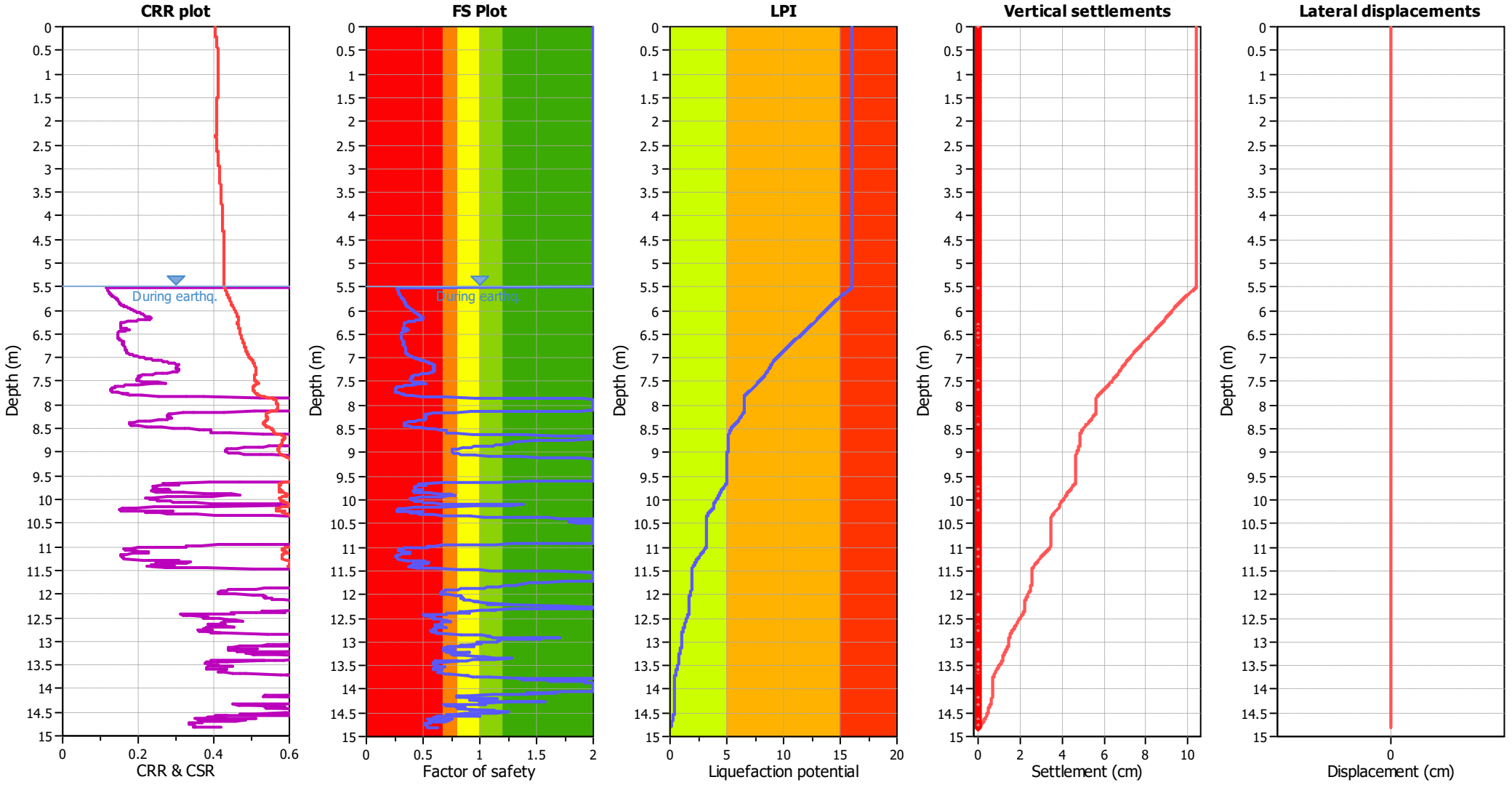
Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	5.50 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	7.70	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.68	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	6.50 m	Fill height:	N/A	Limit depth:	N/A

F.S. color scheme

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LPI color scheme

- Very high risk
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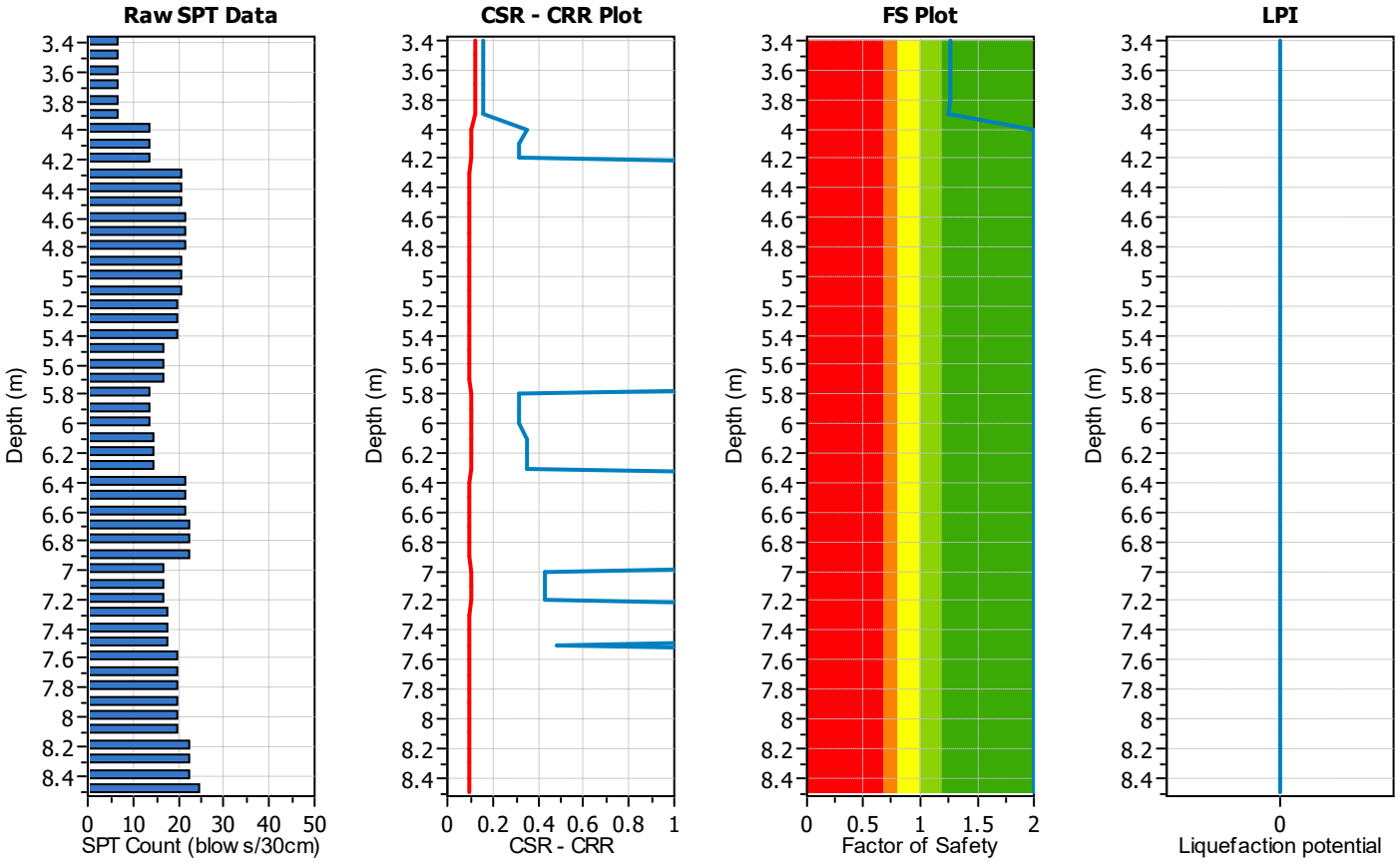
SPT BASED LIQUEFACTION ANALYSIS REPORT

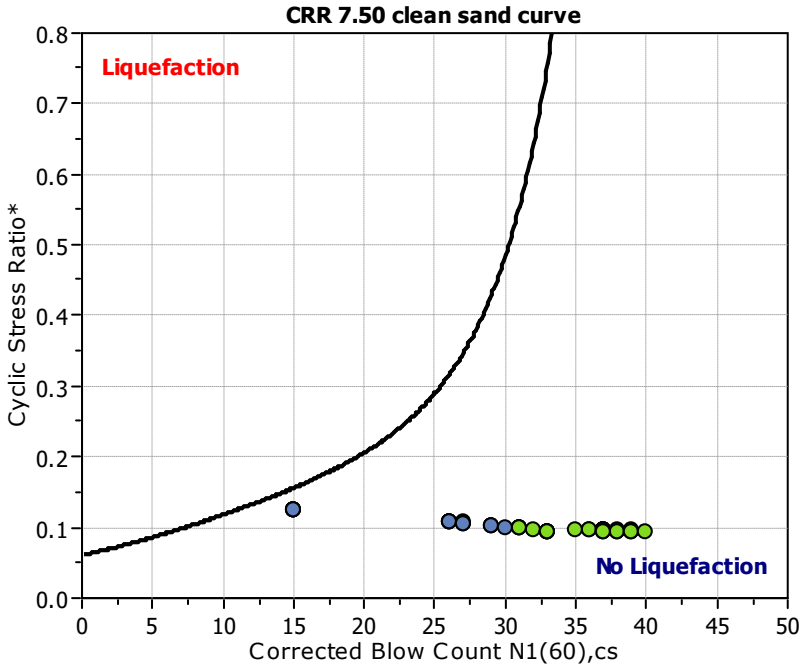
Project title : 240461 - Geotechnical Investigation & Assessment **SPT Name: CPT01 SLS**

Location : 100-110 Te Moana Road, Waikanae Beach

:: Input parameters and analysis properties ::

Analysis method:	Boulanger & Idriss, 2014	G.W.T. (in-situ):	1.00 m
Fines correction method:	Boulanger & Idriss, 2014	G.W.T. (earthq.):	0.50 m
Sampling method:	Sampler wo liners	Earthquake magnitude M_w:	6.50 m
Borehole diameter:	65mm to 115mm	Peak ground acceleration:	0.13 g
Rod length:	1.00 m	Eq. external load:	0.00 kPa
Hammer energy ratio:	1.33		





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LPI color scheme
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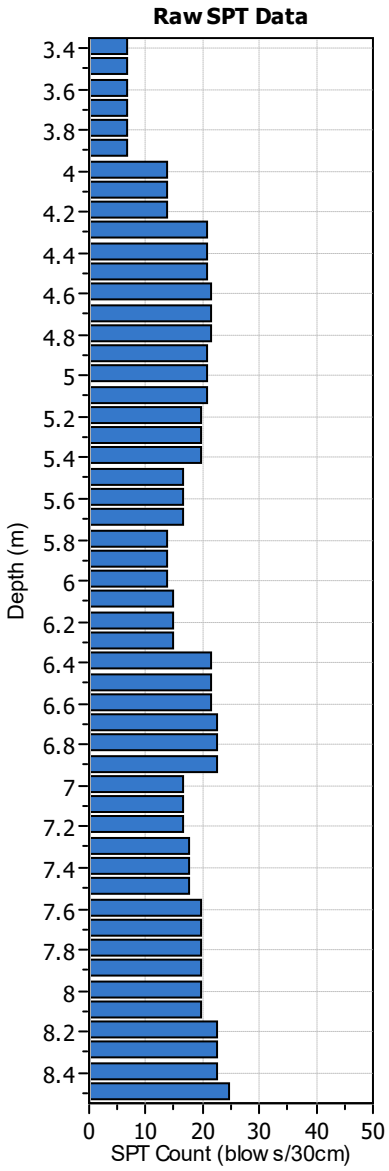
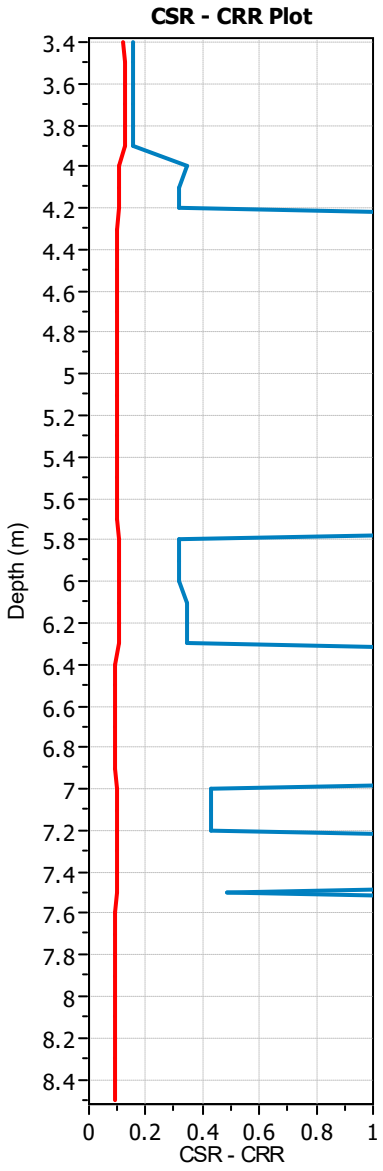
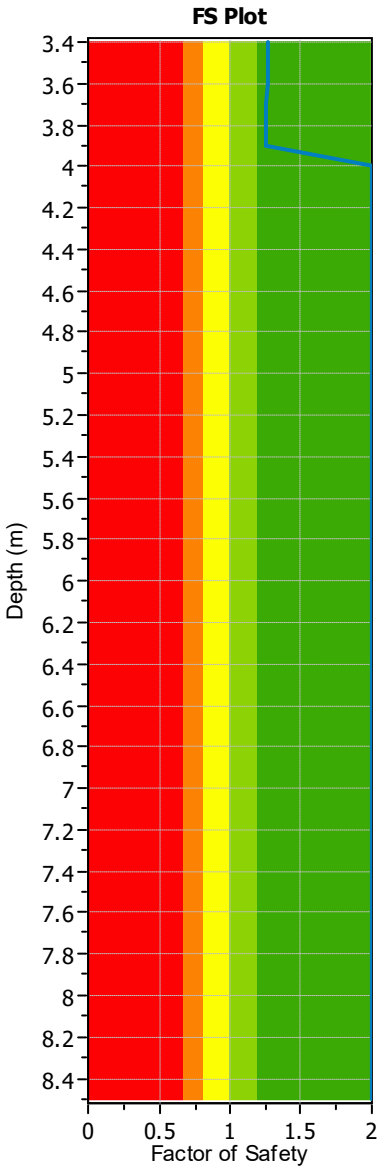
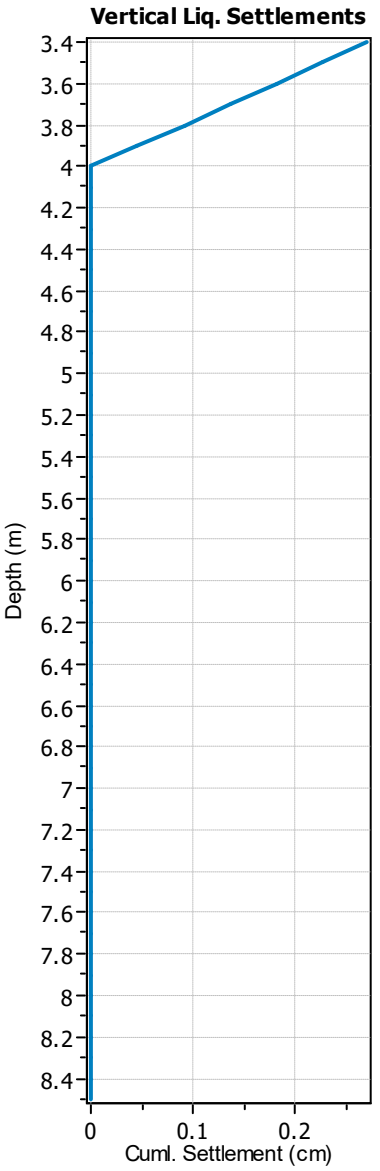
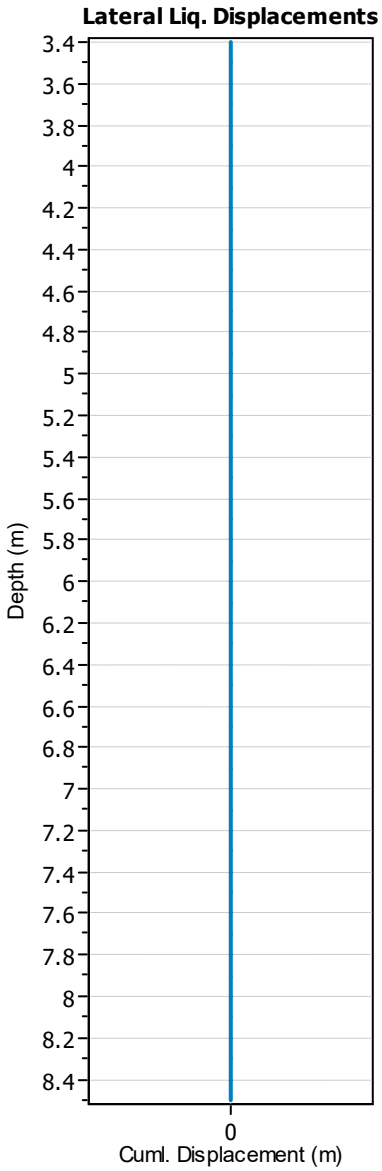
:: Overall Liquefaction Assessment Analysis Plots ::











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SPT BASED LIQUEFACTION ANALYSIS REPORT

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SPT Name: CPT01 ULS

Location : 100-110 Te Moana Road, Waikanae Beach

:: Input parameters and analysis properties ::

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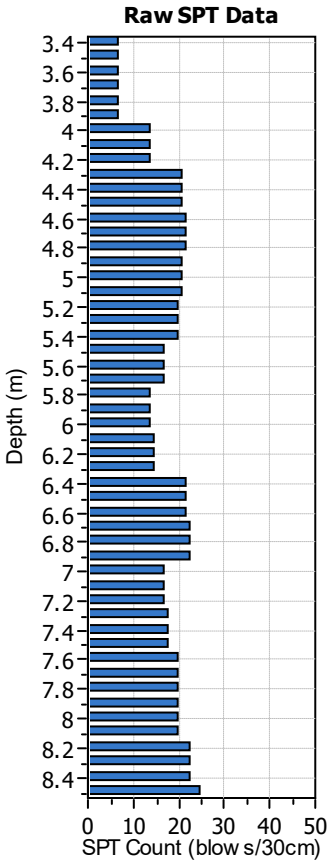

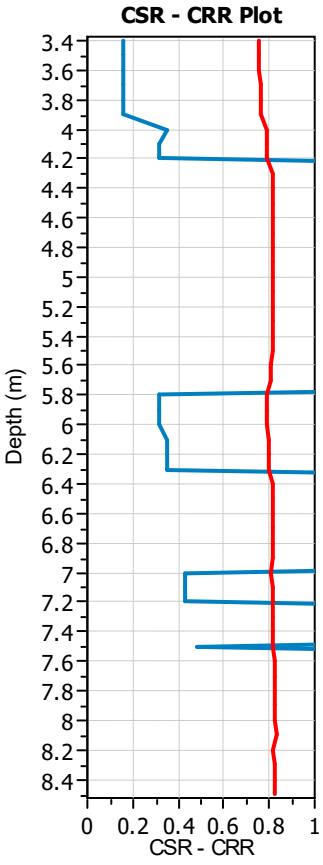

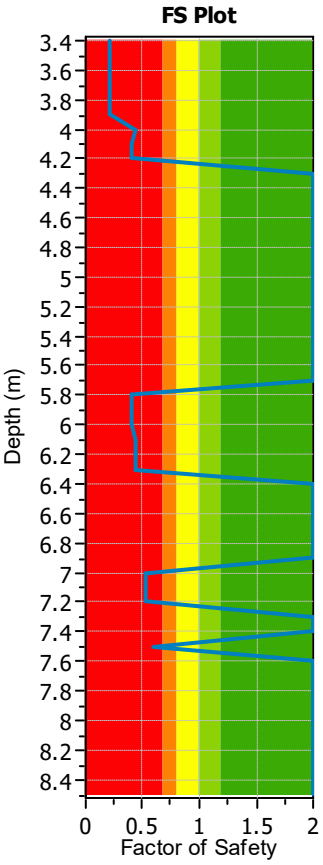

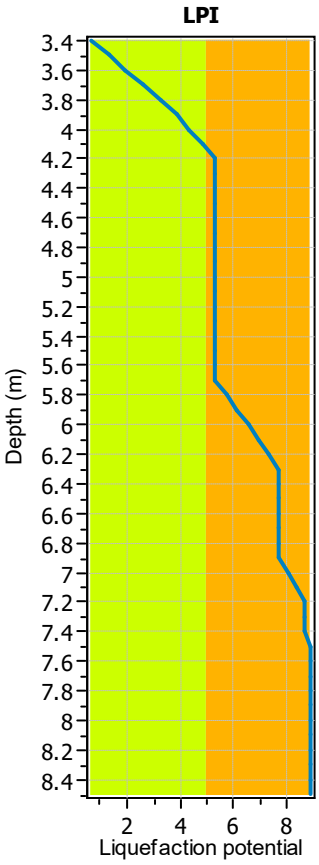

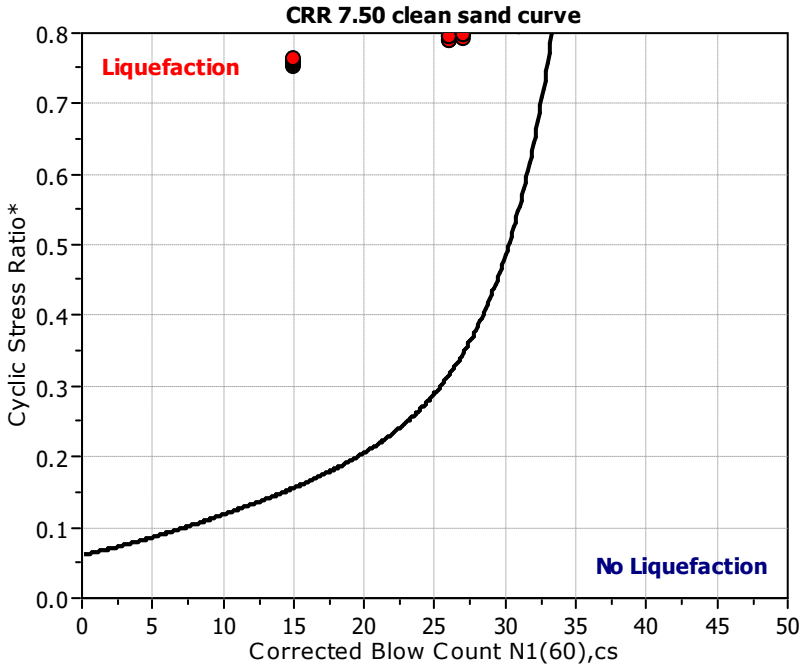

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:: Overall Liquefaction Assessment Analysis Plots ::